

BOOSTING BUILDING RENOVATION. AN OVERVIEW OF GOOD PRACTICES

Renovation requirements, long-term plans and support programmes in the EU and other selected regions

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1. INTRODUCTION	3
2. METHODOLOGY	5
3. SYNOPSIS OF LEGAL PROVISIONS FOR BUILDING RENOVATION IN DIRECTIVES	6
4. TOWARDS LONG-TERM RENOVATION STRATEGIES IN THE EU	8
5. IMPLEMENTATION STATUS OF THE EPBD RENOVATION REQUIREMENTS IN THE EU	11
6. ECONOMIC INSTRUMENTS SUPPORTING THERMAL RENOVATION OF EXISTING BUILDINGS	16
7. BUILDING RENOVATION REQUIREMENTS IN SELECTED EU COUNTRIES	20
7.1 AUSTRIA	24
7.2 BELGIUM	25
7.3 DENMARK	28
7.4 FINLAND	30
7.5 FRANCE	31
7.6 GERMANY	34
7.7 ITALY	36
- RENOVATION REQUIREMENTS IN ITALIAN REGIONS AND CITIES	37
7.8 THE NETHERLANDS	39
7.9 UNITED KINGDOM	41
8. EXAMPLES OF BUILDING RENOVATION REQUIREMENTS AT GLOBAL LEVEL	44
9. CONCLUSIONS AND RECOMMENDATIONS	52
10. REFERENCES	55

1. INTRODUCTION

The building sector is the largest consumer of energy in Europe, accounting for nearly 40% of the total consumption and 36% of the greenhouse gas emissions (EC, 2013). While new buildings can be constructed with high energy performance levels, the existing stock is predominantly of poor energy performance and consequently in need of renovation work. With their potential to deliver high energy and CO₂ savings, energy efficient buildings can play a pivotal role in a sustainable, low carbon future. At the same time, building renovation provides a number of societal benefits, including fuel poverty alleviation, health benefits, increased energy security, increased employment, higher rental and resale values and air quality improvement.

The EU policies and strategies acknowledge the importance of building renovation as a key element in reaching the long-term energy and climate goals, as well as having a positive economic impact. Therefore, the building sector is considered in all **EU's energy, climate and resource** efficiency related strategies by 2050:

- To reach the long-term decarbonisation goals, the *EU Roadmap for moving to a competitive low carbon economy in 2050* (COM, 2011a) identified the need of reducing carbon emissions in residential and services sectors by 88-91% by 2050 compared to 1990 levels.
- In addition, the *Energy Roadmap 2050* (COM, 2011b) concludes that **'higher energy efficiency potential in new and existing buildings is key'** in reaching a sustainable energy future in the EU, contributing significantly to the reduction of energy demand, the security of energy supply and the increase of competitiveness.
- Furthermore, the *Roadmap for a Resource Efficient Europe* (COM, 2011c) identified buildings among the three key sectors responsible for 70-80% of all environmental impacts. Therefore, better construction and use of buildings in the EU would influence 42% of the final energy consumption, about 35% of the carbon emissions, more than 50% of all extracted materials and could save up to 30% of water consumption.

The Energy Performance of Buildings Directive (EPBD, 2002 & EPBD, 2010) introduced in 2002 and reinforced by the 2010 recast, introduces the requirement of implementing energy efficiency measures in case of major renovation of a building¹ and all EU Member States (MS) transposed it into national legislation. This is an important step towards boosting building renovation activities, even if the implementation is not yet vigorous in all EU MS and still has to be significantly improved by adding secondary supporting

¹ According to the EPBD, major renovation is defined as one affecting 25% of the building envelope or where the total cost related to the building envelope or the technical building systems is 25% or more of the value of the building.

legislation. At the same time, the EPBD asked EU Member States (EU MS) to introduce cost-optimal energy performance requirements for renovation activities as well as to eliminate the market barriers and to introduce economic support instruments to stimulate the renovation of the existing building stock.

Moreover, the more recent Energy Efficiency Directive (2012) (which replaces the Energy Services and Co-generation Directives) requires EU MS to establish by April 2014 a long-term strategy to mobilise investment in the renovation of national building stocks. The existence of a long-term renovation framework will provide on the one hand the necessary investment predictability for building owners and investors and will increase on the other hand the macro-economic benefits and, eventually, lead to the transformation into a sustainable building sector.

Therefore, EU MS have to undertake more significant actions in order to address the energy and carbon savings potential of the existing building stock, by improving the regulatory, administrative and investment environment. Mandatory renovation requirements at national or local levels, mechanisms that simplify the investment environment, tailor-made economic support measures to overcome the barrier of high up-front capital and owners' purchasing power, are some of the measures that should receive serious consideration in national long-term renovation roadmaps.

While some of these measures are already in place in many EU MS, they are not always effective or ambitious enough to stimulate renovation activities towards higher rates or drive market transformation. Nevertheless, there are still many good practices among EU MS that should be highlighted and publicly shared to facilitate knowledge sharing in the process of developing long-term renovation strategies.

Therefore, the main aim of this report is to contribute to the exchange of good practices and to support EU MS by providing potential ideas for the elaboration of long-term renovation plans. The report compiles renovation requirements as well as financial instruments, support programmes and market mechanisms for building renovation in a number of countries and regions. While the main focus of the report is on selected EU MS, a few global examples are also presented.

2. METHODOLOGY

The report examines existing and planned renovation requirements in eleven EU MS: Austria, Belgium, Denmark, Finland, France, Germany, Italy, The Netherlands, Sweden and the UK. Additionally, renovation requirements and programmes from the United States, Australia and China are considered. The study not only focuses on the country level, but also explores policies that exist at regional as well as municipal level.

The information presented is based on an extensive review of existing literature, including the following sources:

- **Second National Energy Efficiency Action Plans (NEEAPs) (NEEAPs II, 2011)**, in which MS describe the energy efficiency measures they have introduced in order to reach the 9% indicative energy saving target by 2016, according to the *Energy End-Use Efficiency and Energy Savings Directive* (ESD) (2006/32/EC). From these plans, focus was given to measures related to building renovation.
- **MURE II database (Mesures d'Utilisation Rationnelle de l'Energie) (MURE II, 2013)**. A database of energy efficiency policies and measures that have been carried out in EU MS. The database was developed within the framework of the ODYSSEE MURE project coordinated by ADEME and supported under the Intelligent Energy Europe Programme of the European Commission.
- **BEEP database**, a global database for Buildings Energy Efficiency Policies (**BEEP, 2013**), developed by the International Energy Agency's Sustainable Buildings Centre.
- Relevant **IEE projects**, e.g. **ENTRANZE**, which provides information on EU-27 building policies and programmes.
- **BPIE Data Hub (BPIE DATA, 2013)**, a database developed by BPIE that serves as an open data portal for information and data pertaining to the energy performance of European buildings.
- **BUILD-UP National Projects (BUILD-UP, 2013)**: a series of national reports available on the BUILD-UP Skills website, providing a detailed analysis of the status quo of the building sector in EU countries.
- **National energy agencies reports**, referring to building codes and regulations.
- **Other relevant studies**, providing information about renovation building requirements at national/regional/city level and relevant financial and support programmes.

The literature review was completed by private communication with national experts in target countries and regions.

3. SYNOPSIS OF LEGAL PROVISIONS FOR BUILDING RENOVATION IN EU DIRECTIVES

Across both the residential and non-residential building sectors, there is a large potential for cost-effective investment in energy saving, yet there is great inertia, since only around 1% of the existing floor area is renovated annually. In recognition of this historic low level of activity, EU policy makers have sought to increase energy savings in the existing building stock through a series of Directives spanning two decades.

Early efforts in the 1990s focused on issues such as labelling and information, as well as single products such as boilers. It was not until 2002 that the first comprehensive legislation focusing on buildings as a whole was introduced, namely the Energy Performance of Buildings Directive (EPBD, 2002/91/EC). The EPBD imposed requirements on Member States to introduce certification of buildings, inspections of boilers and air conditioning systems, training of experts and energy performance standards for buildings. The absence of previous requirements in most Member States covering all these areas meant that entirely new legislative vehicles needed to be established. Consequently, the first EPBD took a number of years to be implemented at MS level.

In light of certain weaknesses in the original EPBD, and the growing realisation of the need to mitigate climate change through reductions in energy use, the Directive was recast in 2010 (EPBD recast, 2010/31/EU) with more ambitious provisions.

One of the main provisions relating to building renovation is Article 7 stipulating the implementation of energy saving measures in the case of a major upgrade of a building (defined as one affecting 25% of the building area or where the total cost is 25% or more of the value of the building). However, this situation pertains in only a small fraction of cases, so for the most part there are no requirements on building owners or occupiers to undertake energy saving measures in buildings. Rather, the EPBD relies on information (generated following building certification, or as a result of inspections of the heating and air conditioning plant) to act as a motivator to deliver energy savings.

Recognising that progress towards EU's objective to improve energy efficiency was behind schedule², the EU introduced further legislation in form of the Energy Efficiency Directive (EED 2012/27/EU), published in November 2012. The EED amends and subsequently repeals the Cogeneration Directive (2004/8/EC) and

² One of the so-called "20-20-20" objectives in EU's climate and energy package for 2020: a 20% reduction in EU greenhouse gas emissions from 1990 levels; Raising the share of EU energy consumption produced from renewable resources to 20%; and a 20% improvement in the EU's energy efficiency. http://ec.europa.eu/clima/policies/package/index_en.htm

the Energy Services Directive (2006/32/EC). The EED introduces a considerable number of requirements on Member States, including in the area of energy efficiency in buildings.

Regarding renovation requirements, Article 4 of EED stipulates that Member States should establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private. A first version of the strategy shall be published by April 30, 2014 and submitted to the Commission as part of the National Energy Efficiency Action Plans, and updated every three years thereafter.

Moreover, the EED gives focus to the exemplary role that public buildings should play and accordingly, mandates Member States to ensure that, as from January 1, 2014, 3 % of the total floor area of heated and/or cooled buildings owned and occupied by its central government should be renovated each year to meet at least the minimum energy performance requirements that each Member State had set in application of Article 4 of Directive 2010/31/EU (EPBD).

One additional piece of EU legislation also has a bearing on improving the energy performance of buildings. The Renewable Energy Directive (2009/28/EC) requires Member States to introduce measures to increase the share of energy from renewable sources in the building sector in building regulations and codes. This applies to new buildings as well as to existing buildings that are subject to major renovation.

A summary of renovation related requirements in European Directives is provided in Table 1.

Table 1: Overview of renovation related provisions of European Directives

Provisions of renovation requirements in European Directives	
<p>Energy Performance of Buildings Directive (EPBD, 2002/91/EC)</p>	<p><u>Article 7:</u> When buildings undergo major renovation, the energy performance of the building or the renovated part thereof needs to be upgraded in order to meet minimum energy performance requirements in so far as this is technically, functionally and economically feasible.</p> <p><i>'major renovation'</i> means the renovation of a building where:</p> <ul style="list-style-type: none"> (a) the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25 % of the value of the building, excluding the value of the land upon which the building is situated; or (b) more than 25 % of the surface of the building envelope undergoes renovation;

Energy Efficiency Directive (EED 2012/27/EU)	<u>Article 4:</u> Member States shall establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private.
	<u>Article 5:</u> Obligation for a renovation quota of 3% of all public buildings owned and occupied by central governments.
Renewable Energy Directive (2009/28/EC)	Member States should introduce measures to increase the share of energy from renewable sources in new and renovated buildings

4. TOWARDS LONG-TERM RENOVATION STRATEGIES IN THE EU

Following Article 4 of the EED, Member States must establish a long-term strategy for mobilising investment in the renovation of national building stocks, including residential and commercial buildings, both public and private. Each national long-term strategy has to include: a status report about the building stock, an identification of cost-effective approaches to renovation, policies to stimulate cost-effective "deep" renovations of buildings, including those done in stages, forward-looking guidance for investment decisions by individuals, the construction industry and financial institutions, and an indicative estimate of the expected energy savings and other benefits.

In designing renovation strategies, it is essential that Member States assess the particular barriers affecting the renovation market in their country. Action to address these barriers must then be taken if the strategy is to achieve the desired outcome and increase the propensity for building owners to undertake deep renovation. These measures include, but are not limited to, new policies and regulatory initiatives targeting particular building sectors, as well as removal of existing barriers which may be holding back the renovation market (BPIE, 2013).

It is important to tailor the policy response to the specific barriers affecting different market sectors (such as split incentive dilemma), including specific measures to overcome the actual complexity of a multi-stakeholders framework inducing a significant administrative burden for building owners undertaking renovation. Accordingly, the policy mix will need to encompass a range of measures that, collectively, address all building categories, ownership profiles and tenures.

To reinforce the importance of this issue, Article 19 of the EED requires Member States to evaluate and take appropriate measures to remove regulatory as well as non-regulatory barriers to energy efficiency.

Most renovation activities at the moment achieve only modest energy savings, perhaps 20-30%, but this needs to increase to deep renovation of at least 60% if the full economic and environmental potential is to be realised. The impact of different renovation pathways on the resulting energy and carbon savings was modelled by BPIE in its 2011 publication *Europe's Buildings under the Microscope* (BPIE, 2011). This showed that only in those scenarios where both the rate and the depth of renovation were substantially increased (alongside rapid decarbonisation of the energy supply system) the carbon saving ambition of 88-91% set at for the building sector **in the Commission's 2050 Low Carbon Economy Roadmap** could be achieved. Therefore, an effective renovation plan has to be long-term and to target the deep transformation of the existing building stock and to significantly improve its actual energy performance towards nearly zero energy levels. The renovation plan must have interim milestones to be achieved and to be based on a continuous and effective monitoring process.

A long-term renovation plan has to be elaborated in conjunction with other long-term energy, environmental, economic and societal strategies in order to exploit synergies, to minimise costs and to maximise benefits. For a successful implementation of long-term renovation plan it is vital to engage all relevant stakeholders into its elaboration and periodical revision, including experts, industry and investment communities.

The implementation of the renovation plan has to be based on policies and measures able to scale up renovation rates and depth. Indeed, in order to reach the ultimate objective of transforming the existing building sector into a sustainable one by 2050, renovation rates need to ramp up from the prevailing rate of around 1% of the total floor area renovated annually, to around 3% p.a. from 2020 onwards (BPIE, 2013). Efforts to increase the rate and depth of renovation will stimulate at the same time the market uptake of highly efficient and renewable technologies and construction techniques that can deliver the expected increase of the actual energy performance of buildings. Therefore, it is important to take technological developments into consideration in the long-term renovation plan, as well as educational and training activities for the necessary upgrade of skills and qualification of all white and blue collars involved in delivering low-energy buildings (e.g. architects, construction workers, certifiers and auditors etc.).

Last but not least, a successful and realistic long-term renovation plan has to consider all societal, environmental and macro-economic benefits (e.g. job creation and additional tax income to public budgets, development of supply chain industry, avoidance of new power plants etc.) and to consequently define

the right level of public support to be given to private owners renovating their buildings. Nevertheless, the goal of a long-term renovation plan has to be a complete market transformation by 2050 and a gradual reduction of public support leading to renovation activities on commercial basis. Thus, only by creating a longer-term predictable business framework, private banks and institutional investors will find buildings renovation a low risk investment, and by consequently the necessary flow of private capital upscaling renovation activities will be reached.

Several EU MS have already set out some form of long-term vision for the evolution of the building sector. While more measures are needed to implement these renovation plans and reach the long-term goals, there are some good practices which are briefly introduced in the followings.

Denmark has a long tradition of active energy policy since the oil crises of the 1970s. In 2012, widespread political support was secured for a further package of measures, including building retrofitting, that brings the country closer to the ultimate goal of eliminating fossil fuel use in the energy and transport sectors by 2050 (BPIE, 2013).

In **France**, the **Environment Round Table (Grenelle de l'Environnement)** set a target of reducing energy consumption in the existing building stock by 38% by 2020 (NEEAP_FR, 2011). In order to achieve this reduction, an ambitious target of 400 000 renovations per year over the period 2013-2020 was set. This target is supported by incentive measures to reduce the cost of work in relation to both the residential sector (for private individuals and social landlords) and the service sector. The measures are based on a national programme to support thermal renovation which was significantly strengthened within the framework of the Environment Round Table. Regulatory measures will supplement this mechanism. However, the actual framework has to be significantly improved in order to reach this target.

In **Germany**, the **energy transition strategy ("Energiewende")** adopted by the federal government in 2011 proposed the elaboration of a long-term renovation plan for the existing building stock which will lead to an almost climate-neutral sector by 2050 (NEEAP_DE, 2011). To support this objective, mid- and long-term targets have been set:

- Doubling of the building energy modernisation rate from 1% to 2% per year;
- 20% reduction in the heating energy demand by 2020;
- 80% reduction in the primary energy requirement in the building sector by 2050.

Implementation of the German long-term renovation strategy has to take into account the following:

- The further elaboration of tailor-made economic incentives to motivate owners to include energy saving measures when undertaking building renovation;
- The continuation of financial support schemes administered by the German investment bank KfW, such as low interest loans and grants;
- Continuous evaluation and tightening of energy performance requirements in building regulations.

Sweden has a system of 16 national environmental quality objectives that describe the state of the Swedish environment in 2020 or 2050 respectively (NEEAP_SE, 2011). One of the 16 environmental quality objectives is to achieve **“A good built environment”**. This objective incorporates six interim targets, one of which is to achieve more efficient energy use in buildings. An objective was adopted through the *Riksdag’s decision on a national energy efficiency and energy-smart building programme* whereby **“the total energy use per unit of heated area in residences and business premises [is] to be reduced by 20% by 2020 and 50% by 2050 in comparison with the usage in 1995.”** Objectives are supported by several implementing programmes and financial incentives, including tax deductions.

5. IMPLEMENTATION STATUS OF THE EPBD RENOVATION REQUIREMENTS IN THE EU

While most EU MS had some form of minimum requirements for the thermal performance of building envelopes prior to its introduction, the EPBD was the first major attempt requiring all Member States to introduce a general framework for setting building energy code requirements based on a **“whole building” approach**. Examining the requirements set by each EU MS, it is clear that large variations exist in terms of the approach each country has taken in applying building energy codes. In some countries two approaches exist in parallel, one based on the whole building approach and the other one on the performance of single elements. In others, the whole building approach acts as a supplementary demand or alternative to single element requirements.

As the EPBD asks **for requirements in case of ‘major renovation’**, EU MS can choose to define a ‘major renovation’ either in terms of a percentage of the surface of the building envelope or in terms of the value of the building. If an EU MS decides to define a major renovation in terms of the value of the building, a

value such as the current value based on the cost of reconstruction, excluding the value of the land on which the building is situated, can be used.

Minimum requirements for components had to be introduced for all replacements, though no specific target was set for existing buildings, which represent the biggest potential for energy savings of the sector. Table 2 provides a summary of the energy requirements adopted by several EU MS when a building is subject to major renovation.

Table 2: Overview of building requirements in case of major renovations (Source: SBI, 2009, BPIE, 2011 and BPIE updates in 2013)

Country	Renovation requirements
AT	Specific maximum heating energy demand targets for major renovation of residential and non-residential buildings. Values for renovated buildings are around 25-38% higher than new build requirements. Heat recovery must be added to ventilation systems when renewed. Maximum permitted U values for different elements in case of single measure or major renovations. Prescriptive requirements to limit summer over-heating.
BE	There are specific component requirements (i.e. maximum U-values) as well as additional prescriptive requirements such as for ventilation, summer comfort etc. [Brussels]: Minimum energy performance threshold for rented homes. From 2015, major renovations should achieve a very low energy standard (NEEAP-BCR, 2011) [Flanders]: When extension or renovation, "protected volume" > 800 m ³ : same requirements as for new buildings (U/R-value, K-level, E-level, ventilation and for residential buildings also summer overheating). When renovation, "protected volume" ≤ 800 m ³ : only U/R-values for new and renovated parts of the building + ventilation.
BG	Regulations requiring performance-based standards of existing housing and other buildings after renovation. Requirements for new and renovated buildings are the same.
CH	Renovated buildings are required to use no more than 125% of the space heating demand of an equivalent new building. A single element approach may also be applicable for renovations.
CY	Minimum energy performance requirements (class A or B) for buildings over 1 000 m ² undergoing major renovation.
CZ	Performance-based requirements when a building over 1 000 m ² is renovated. Requirements for new and renovated buildings are the same. Individual parts of the building envelope and systems in the buildings have to fulfil minimum requirements. If it is not possible to achieve the minimum performance criteria, this has to be proven by means of an energy audit. There are also minimum requirements in case of major renovation of individual building elements such as for U-values, internal temperature at the internal leaf of envelope structures (which has to be higher than dew point temperature), thermal bridging limits to avoid condensation, thermal stability of the room in summer and in winter, minimum efficiency of boilers, etc. Furthermore, buildings shall achieve a healthy indoor climate.

DE	<p>Both energy performance and specific component-based requirements. For renovations of single components or systems, there are specific requirements for these components/systems. Alternatively the building owner can choose to prove that the primary energy demand requirements for retrofitted buildings are met (140 % of the demand for a comparable new building).</p> <p>Building surface components and building system components must not be changed in a way that decreases the energy performance of the building. There are additional cost-effective obligations that need to be fulfilled by the building owners within a specific time-frame for: insulation of hot water pipes and top floor ceilings, retrofit of HVAC systems and replacement of electrical heat storage systems.</p>
DK	<p>Component level requirements when existing buildings are refurbished for change of use of the building and for complete or partial renovation of building elements or technical systems, regardless of the building size. Individual parts of the building envelope and systems in the buildings have to fulfil certain minimum requirements in the renovated building. Thus there is no overall performance requirement for the renovated building, but only for the individual components and systems. Minimum U-values and linear losses requirements.</p> <p>The partial renovation measures must be cost-effective (i.e. payback time shorter than 75% of the measure's lifetime). If the implementation of the full requirement is not profitable to the owner, a lower level of renovation or indeed none at all, has to be implemented. In case of replacement of floors, external walls, doors, windows or roof structure, requirements apply regardless of cost-effectiveness. Thermal bridging should be avoided in external construction elements including windows and doors due to the risk of condensation. There are special energy requirements (less strict) when renovating windows with small transparent fields due to preservation of architectural values. In the case of renewal of an installation in existing buildings, the same requirements of an installation in new buildings apply.</p>
EE	<p>Performance-based requirements for all building types when buildings undergo major renovations. Values for renovated buildings are around 25-38% higher than new build requirements.</p>
ES	<p>Existing buildings over 1000 m² must comply with the same minimum performance requirements as new buildings if more than 25% of the envelope is renovated. There are additional energy efficiency requirements for building elements, heating and lighting systems, minimum solar-thermal contribution and in certain cases also for minimum solar photovoltaic contribution.</p>
FI	<p>Shift from requirements concerning the heat loss of individual components to one indicator (the E index) describing the total calculated energy use of the building. New regulations came into effect on 1 June 2013 introducing minimum energy performance requirements for energy efficiency concerning renovations. There are three ways to achieve these requirements: a) improving the heat retaining capacity of building parts that need reparation or renewal, b) improving the energy efficiency of the building by examining the whole building's energy consumption in relation to its surface area, c) reducing the building's E-number, by reducing the total energy consumption of the buildings. Technical systems (like heating and ventilation) have their own requirements and should be checked when insulation is added to the building, when air-tightness is improved, or when systems are renewed.</p>
FR	<p>Performance-based requirements for buildings undergoing renovation apply for residential buildings and values depend on the climate and type of heating (fossil fuel/electricity). Requirements for components also apply during building renovation. New renovation requirements for all buildings are expected to come in 2013.</p>

	<p>For major renovations (>1000 m²): the overall energy performance target for renovated buildings built after 1948 is in the range 80-165 kWh/m²/year since 2010. For renovations <1000 m²: element-based requirements for replacement or renovation of elements (for heating, insulation, hot-water production, cooling and ventilation equipment).</p> <p>For large renovations, a minimum summer comfort level is required in order to avoid the use of cooling systems. Smart systems should be installed every time there is major renovation work on a building.</p>
GR	<p>Individual parts of the building envelope and systems in the buildings have to fulfil certain minimum requirements in the renovated building.</p> <p>Minimum thermal resistances defined for different types of building components and also different efficiency of systems. Thermal bridges are also considered.</p>
HU	<p>Performance-based requirements (in terms of primary energy) apply for residential buildings, offices and educational buildings. Requirements for new and renovated buildings are the same.</p> <p>The specific primary energy consumption in kWh/m² must comply with the requirement, either for the renovated zone or for the whole building - option that can be selected by the designer. The requirement cannot be met if the components are of low quality.</p>
IT	<p>Energy performance requirements are based on single components, with the same requirements as new buildings.</p> <p>There are also minimum energy efficiency requirements for boilers.</p>
LT	<p>Buildings over 1 000 m² undergoing major renovation must achieve the energy performance standard of a Class D building where D corresponds to 110 kWh/m²yr for buildings > 3 000 m² ; 130 kWh/m²yr for buildings from 501 to 3 000 m²; 145 kWh/m²a for buildings up to 500 m².</p> <p>Not less than efficiency class D. Individual parts of the building envelope and systems in the buildings have to fulfil certain minimum requirements depending on renovation.</p>
LV	<p>Requirements on different elements are applicable.</p>
MT	<p>U-value requirements for building renovation.</p>
NL	<p>The Energy Performance Standard (EPN) sets requirements for the energy performance of major renovations of existing buildings (expressed as an energy performance coefficient).</p> <p>For renovations, the same EPN requirements as for new buildings apply. Stricter efficiency requirements for heating, hot water, cooling and ventilation systems in existing homes and large residential buildings (offices, schools, shops, hospitals, etc).are expected to be applied from July 2013. All materials and products used for renovation must have an approved label.</p>
NO	<p>Building regulation requirements as for new buildings only apply when the purpose or use of the building is changed at renovation or in case of major renovations. The requirements are either for the renovated zone or for the whole building (an option of the designer).</p>
PL	<p>For major renovations or system component replacement there are the same requirements as for new buildings.</p>

PT	<p>Special requirements for buildings over 1000 m² and over a specified energy cost threshold. A mandatory energy efficiency plan must be prepared and all energy efficiency improvement measures with a payback of less than 8 years must be implemented (compulsory by law). The threshold is based upon 40% of the worst performing buildings by typology.</p> <p>Minimum requirements for thermal resistances defined for different types of building components and for energy efficiency of buildings systems. These values are based on moisture and mould prevention. Furthermore, buildings shall achieve a healthy indoor climate.</p> <p>Thermal bridging should be avoided in external construction elements including window and doors because of the risk of condensation. There are minimum energy requirements for the building as a whole as well as minimum insulation levels for the building envelope and minimum requirements for shading of windows.</p>
RO	<p>The actual energy performance of a building is compared with a "reference building" which is a virtual building having the same geometry as the actual building but the energy performance of a new one - concerning individual parts of the building envelope and systems (indirectly, after renovations, the building have to fulfil certain minimum requirements for the individual components and systems as well as an overall performance requirement).</p>
SI	<p>Minimum requirements apply to major renovations (i.e. if at least 25 % of the envelope is renovated). The requirements apply to all buildings, irrespective of floor area. There are also minimum requirements for heating systems.</p>
SE	<p>Depending on the size of the renovation, the renovated zone has to fulfil the energy requirements for new buildings. In case of heritage buildings or when renovation may negatively influence other features of the building, then the energy requirements may be lowered. In case of major renovation, the minimum energy efficiency requirements may be extended also to other parts of the building.</p>
SK	<p>When major renovation is foreseen, there are requirements to improve the thermal performance by at least 20%.</p> <p>There are minimum requirements in terms of energy use and energy performance (delivered energy), U-value for building structures as well as, walls, roofs, windows, insulation of heat and hot water systems, thermal comfort and indoor air quality.</p>
UK	<p>Specific energy efficiency requirements for residential buildings when replacing "controlled elements" such as windows, boilers and thermal elements. Moreover, there are energy performance requirements for buildings over 1 000 m² undergoing major renovation in so far as they are "technically, functionally and economically feasible".</p> <p>For the repairing/ renewal of a building element (thermal element), like the wall, floor, roof etc., the performance of the whole element should be improved to achieve specific U-value standards. These improvements should also be technically, functionally and economically feasible (i.e. payback time ≤15 years). More specifically, for roof renovation and repair, requirements apply in case of 50% or more of the roof refurbishment.</p> <p>In Scotland, homes must meet the "Tolerable Standard", which comprises of a variety of criteria, including satisfactory thermal insulation.</p>

As seen in the table above, most EU MS have introduced specific requirements for retrofitting of individual parts of the building envelope or of the technical systems of the building. These requirements are easier to be fulfilled, compared

to requirements for the overall energy performance of the renovated building. Only a few MS have energy performance requirements for the entire renovated building, while even fewer have energy performance requirements solely for the renovated zone. In some MS, building or zone requirements are combined with requirements for individual components (BPIE, 2011).

Moreover, when dealing with total renovations of an existing building or with changed use of the building, some MS have the same requirements for renovated buildings as for new buildings. Other MS have requirements for building components, but no requirements for the total energy performance of the renovated building (Sbi, 2009).

6. ECONOMIC INSTRUMENTS SUPPORTING THERMAL RENOVATION OF EXISTING BUILDINGS

Improving the energy performance of the European building stock is a major challenge and actual European and national strategies set a long-term horizon with a final target in 2050. **With Europe's overall policy aiming** to substantially decarbonise its economy by 80 to 95 % by 2050, the building sector - with 40% **of the region's energy consumption and almost the same level of CO₂ emissions** - must play a key role.

However, the need to significantly foster the market transformation and the necessity to increase the renovation depth and rate of the existing building stock may go beyond the actual financial resources of building owners. Therefore, any renovation strategy will require significant economic support to fill the actual gap between the financial potential of different categories of building owners and the necessary quality of renovation dictated by the long-term climate targets. In 2012, BPIE undertook a review of the financing instruments in Europe (BPIE, 2012) evaluating financial instruments in place and their effectiveness and impact. The review led to the following findings:

- In general, all 27 MS have on-going programmes to support the energy performance of buildings, in the form of conventional or innovative financing measures or through the help of external funding.
- Most financial instruments have targeted existing buildings, mainly in the residential sector.
- Grants and subsidies are used more than other financial instruments. They are followed by preferential loans. Fiscal instruments (e.g. tax credits) are widely used but not to the extent of financial instruments such as grants.

- Many of the new Member States are more highly reliant on external funding (e.g. EU Structural Funds or support through international financial institutions such as the European Investment Bank) than most of the EU-15.
- While there are many programmes in place, the understanding of their overall effectiveness is unclear. Relevant information on different programme evaluations is often hard to collect and even harder to compare as there is no standardised way to monitor and evaluate the individual programmes, and Member States use different key performance indicators. Very few programmes have set ex-ante goals and objectives, and few have an evaluation of their effectiveness. Few of the programmes have identified an on-going monitoring (feedback) process along the programme implementation.
- Few financial instruments target deep renovations or low energy buildings in general.
- Many financial instruments target specific technologies or building aspects although about one-third of the financial instruments support a holistic approach.
- Non-government instruments such as Energy Performance Contracting and Energy Efficiency Obligations (white certificates) have an important role to play because they can mobilise private funding.
- European-wide and international funding streams (EU Structural Funds, European Investment Bank and the like) are increasingly important and can play an even greater role in the future, though there is concern that some Member States are almost entirely dependent on such funding for their **“national” programmes**.
- There is no single solution. Funding a major retrofit strategy will require the use and possible bundling of all of the financial instruments available because of the overall cost of a deep retrofit.
- There is much more to know and learn from existing programmes. New ways are needed to better understand the existing programmes in order to learn how to achieve better implementation and impact.

Therefore, a great variety of economic instruments are available throughout Europe to support the improved energy performance of buildings. The way Member States use them vary from country to country, mostly depending on the political context.

These economic instruments can be divided into two broad categories: **“conventional” and “innovative”**. The conventional financial instruments that have been used since the oil crises of the 1970s include: grants and subsidies, loans, and tax incentives. Levies have been used to a much lesser extent. There have also been funds (such as from international financial institutions) that often provide the financing for loans or grants. There are also funding mechanisms coming from the selling of Assigned Amount Units (AAUs), also known as Green

Investment Schemes³, which are implemented under the Kyoto Protocol and have been used for funding financing schemes for building renovation.

Each support instrument contributes in a different way to overcoming the significant market barrier which is financing. As it was mentioned in several previous studies, despite the cost-effectiveness over the lifetime of a building, the investments in low-energy buildings are high and this is very often a major barrier to undertake major **improvements of buildings' energy performance**.

Overall, the most common economic instruments used in Europe are:

- **Direct grants or subsidies**: can be offered from public funds and are directly allocated by the authorities or, more typically, accessed through banks or foundations.
- **Preferential loan schemes** encourage energy efficient practices by subsidising interest rates or credit risk support. Typically, national and local authorities support these schemes by regulatory measures, by sharing the risks with the banks and/or by covering a share of the loan interest.
- **Value Added Tax (VAT)** normally affects the final consumer but not the producer – who passes the cost onto the consumer. Differential VAT rates can be used to influence the choice of energy efficient technology or energy performance upgrade measures by householders.
- **Taxes, tax incentives or tax rebates** which can take three forms: a) a tax on energy, b) sales tax incentives to promote market penetration, or c) tax rebates given in recognition of energy savings investments. These are accessed either through the tax office or at point of sale. The energy and/or climate taxes may be used to create a fund for financing measures that contributes to the reduction of the energy consumption and associated GHG emissions (e.g. a levy on electricity sales to fund renewable energy schemes).

Less common economic instruments include energy supply obligations (white certificates) or energy performance contracting (and energy services companies-ESCOs). Energy performance contracting has been around since 1980s and energy supply obligations since 1990s, at least in Europe. An important consideration for policymakers is that, unlike the previously mentioned schemes, these innovative instruments normally rely on private financing and not government budgets, although there are exceptions.

³ The Green Investment Scheme (GIS) is a mechanism in the framework of the International Emission Trade (IET). It is designed to achieve greater flexibility in reaching the targets of the Kyoto Protocol while preserving environmental integrity of the IET. Under the GIS, a Party to the Protocol expecting that the development of its economy will not exhaust its Kyoto quota, can sell the excess of its Kyoto quota units (AAUs) to another party. **The proceeds from the AAU sales should be "greened", i.e. channeled to the development** and implementation of the projects either acquiring the greenhouse gases emission reductions (hard greening) or building up the necessary framework for this process (soft greening). Several Green Investment Schemes in the Central and Eastern EU countries allocated (partially or entirely) the revenues from AAU sales to buildings renovation activities.

A BPIE review in 2011 identified more than 130 major on-going programmes in the European Union, out of which around 100 programmes⁴ used conventional financial instruments, 18 used innovative ones, 8⁵ have been supported through the EU Structural Funds, and 6 funded by international institutions such as EBRD, the United Nations Development Programme, etc⁶.

Considering the broad category of conventional programmes, 26 Member States out of 27 had on-going incentives in 2011 for a total of 100 running programmes using different types of instruments. Figure 1 depicts the number of identified programmes by type of instrument and country.

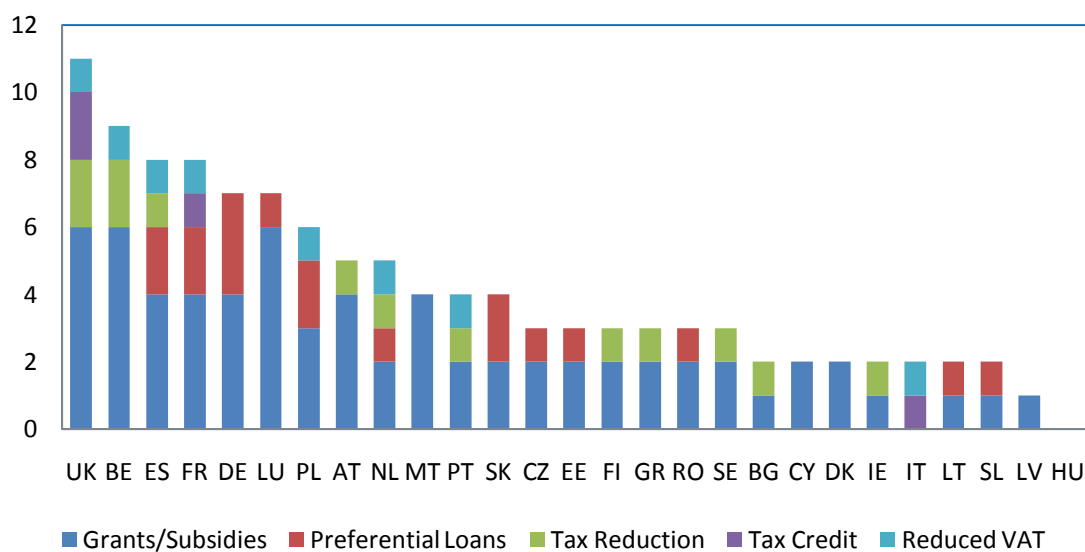


Figure 1: Number of financial instruments in place in 2011 by country. Source: BPIE, 2012

Within these support programmes for building renovation, 68 grant and subsidies schemes, 18 preferential loans, and 25 tax-related instruments (13 Tax reduction, 4 Tax credit, 8 Reduced VAT) have been identified. Ten programmes (CZ, DE, ES, LT, PT, SK, SL, UK) have been implemented together with more than one kind of instruments **in place**. **Most commonly “grants and subsidies” were combined with “preferential loans”, and “tax reduction” with the “tax credit” measure. Grants and subsidies are apparently the most widespread types of schemes, followed by preferential loans and tax reduction. Reduced VAT is of growing importance while only a few Member States use a tax credit.**

⁴ 10 programmes using Structural Funds were included in conventional.

⁵ Structural Funds reported by MS, excluded the 10 programmes in conventional.

⁶ There can be some double counting but as much as possible, programmes funded under, for example, the Structural Funds, were categorised as conventional programmes of the Member States or programmes really led by Structural Fund support.

Belgium and UK have the greatest number of identified instruments (n.b. in 2010-2011), mostly because the majority of the programmes in these countries are developed and implemented at regional level. Italy had only fiscal programmes on-going nationwide during 2011 (Figure 2). In addition, there are numerous support programmes implemented at local or regional level. While it was impossible to take into account all these local initiatives, some of them developed with the support of EU Structural Funds, such as those of Italian regions, were considered in the present study.

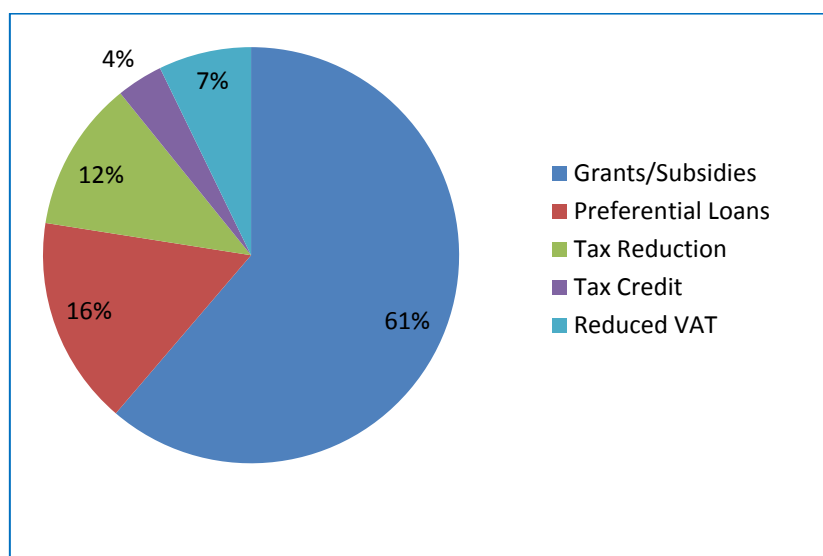


Figure 2: Share of different types of instruments (n.b. share in number of instruments and not in terms of budgets). Source: BPIE, 2012

7. BUILDING RENOVATION REQUIREMENTS IN SELECTED EU COUNTRIES

Within the scope of the present study, BPIE carried out an extensive analysis of renovation regimes and relevant financial support mechanisms across the EU. The focus was on several countries with advanced building policies that have already introduced or planned mandatory energy renovation requirements and/or other ambitious renovation policies and support programmes. Therefore, nine EU countries were considered in our survey: Austria, Belgium, Germany, Denmark, Finland, France, Italy, The Netherlands and the United Kingdom.

Within individual MS, there are some existing or planned (semi-) mandatory renovation requirements. Most address complete renewal of building

components or major renovation of buildings, while taking into account the cost-effectiveness of measures. Most requirements refer to the improvement of roof insulation, which is a relatively cheap renovation measure (short payback time) with significant energy savings potential.

In particular, in **Belgium-Flanders Region**, a new standard will come into force in January 2015 setting minimum requirements for roof insulation in residential buildings (single-family and apartments), when the building is to be rented out. If a residential building does not meet the minimum requirements, it will receive penalty points. If a building or apartment receives more than 15 penalty points, it will be declared as unsuitable and it will be illegal to rent it out. Furthermore, from 2020 onwards, if the floor insulation fails to meet specified minimum requirements, then the building will be characterised directly as unsuitable and it will be illegal to rent it out.

In **Denmark** there are minimum energy requirements for building components in case of a) change of building use, b) renewal of a building component or boiler, or c) in case of partial renewal of a building component (e.g. roof and floor). All these energy upgrading measures have to be economically feasible, except for the complete renewal of building components (i.e. external walls, doors, windows, roof structure) when minimum energy performance requirements apply regardless of cost-effectiveness.

In **Germany**, the Energy Saving Ordinance contains retrofitting obligations which must be fulfilled by the building owners within a specific timeframe. For example, the Ordinance stipulates that the un-insulated top floor ceilings of heated rooms, above which there is an accessible but non-walkable space, have to be thermally insulated. The obligation also applies to top floor ceilings above which there is an attic. However, all retrofitting measures should be cost-effective (i.e. with short payback periods).

Meanwhile, in the **United Kingdom**, the Government announced that from April 2016 landlords of residential properties will not be able to unreasonably refuse requests from their tenants for consent to energy efficiency improvements, where financial support is available, such as the Green Deal and/or the Energy Company Obligation (ECO). In addition, from April 2018, private properties with an energy rating below E energy class will not be allowed to be rented. In this case, the landlords will be allowed to rent their properties either if they improve **the building's rating to E energy class** or better, if they carry out the maximum package of measures funded under Green Deal and/or Energy Company Obligation schemes.

While a more detailed analysis of the existing renovation framework in the examined countries will be presented in the following sub-sections, Table 3 shows an overview of the most relevant and ambitious energy policies and regulations.

Table 3: Overview table of the most important renovation policies in selected EU countries

Overview of ambitious renovation policies and regulations in the examined EU countries	
AT	Requirements related to the maximum heating energy demand of renovated buildings. North Austria: Additional requirements regarding the maximum externally induced cooling demand. Since 2012, major renovations should achieve at least the B rating ($\leq 50\text{kWh}$) . Expected to change to A+ rating ($\leq 10\text{kWh}$) before 2020.
BE	<p>[Brussels region]: Since 2010, major renovation of public buildings should achieve low energy standards. From 2015, all buildings that undergo major renovations should comply with the very low energy standard.</p> <p>[Flanders]: 1. For renovation of residential buildings (with extension) $\leq 800\text{m}^3$:</p> <ul style="list-style-type: none"> • When a building permit is required -> energy performance requirements exist for parts of building envelope being replaced or with extension: <ul style="list-style-type: none"> ◦ maximum R-values or minimum U-values ◦ certain requirements for ventilation • Control and compliance through EPB-system (EPC-declaration done by an independent energy expert) <p>2. When expansion or renovation of a 'protected volume' $\geq 800\text{m}^3$ -> same requirements as for a new building. New standard for roof insulation from 2015: if a dwelling has a roof that does not meet the minimum required standard, it will receive a penalty point during the evaluation of the building. From 2020 and on, it will be illegal to rent out buildings with inadequate roof insulation.</p>
DE	<p>Target: 2050- climate neutral building stock.</p> <p>Component-specific minimum efficiency requirements which have to be fulfilled when changing or modernising a building component. However, where no renovation takes place there is no requirement to fulfil any performance standard at all.</p> <p>OR</p> <p>Holistic assessment analogous to the calculations for new buildings. All retrofitting obligations are also subject to the precondition of cost-effectiveness.</p>
DK	<p>Minimum energy requirements for building components in case of a) change of use of building, b) complete renewal of elements, c) partial renewal of elements. However, all energy upgrading measures must be economically feasible (payback time $\leq 75\%$ of expected lifetime of the measure).</p> <p>In the case of a replacement of floors, external walls, doors, windows or roof structure, the minimum energy performance requirements apply regardless of cost-effectiveness. In the case of renewal of an installation in an existing building, the requirements are the same as for the installations in new buildings. From the beginning of 2013, the installation of oil-fired and natural gas heating units in new buildings will no longer be allowed.</p>
FI	<p>Minimum requirements for energy efficiency concerning renovations that are subject to a licence, a change in use or the renewal of technical systems. The decision to start renovation work remains voluntary, according to the regulations. The property owner decides when and to what extent he or she will make the repairs, and what are the best methods to improve energy efficiency within the regulatory framework.</p> <p>There are three alternatives to improve energy efficiency:</p> <ol style="list-style-type: none"> 1. improving the heat retaining capacity of the building parts that need repairing or renewing so they conform to the required standards

	<p>2. improving the energy efficiency of the building according to the level defined for that type of building</p> <p>3. calculating the building's E-number</p>
FR	<p>Targets:</p> <ul style="list-style-type: none"> • Renovate 400,000 housing units per year starting in 2013. • Renovate the 800,000 most energy-consuming social housing units by 2020. • Undertake work on energy efficiency in public and private tertiary sector buildings between 2012 and 2020. • Start the energy renovation of State and public buildings before 2013. <p>For major renovation of buildings > 1000 m²: global energy performance target for renovated buildings, built after 1948 (dwellings: 80-165 kWh/m²/year from 2010 onwards. Non-residential buildings: the savings should be 30%)</p> <p>For major renovation of buildings < 1000 m², or buildings > 1000 m² undergoing minor renovation: a minimum performance level for elements replaced or installed (for insulation, heating, hot-water production, cooling and ventilation equipment)</p>
IT	<p>Energy performance requirements regarding major renovations.</p> <p>Additional requirements for the installation of RES systems for heating and PV.</p> <p>[Bolzano county]: By the end of 2019, owners of buildings will be allowed to expand the surface of their dwelling by up to 20% or up to 200m³, only if the building achieves heating consumption below 70kWh/m²/yr.</p> <p>[Region of Valle D'Aosta]: in case of expansion by 20% of buildings with a floor area higher than 2000m² or in case of new dwellings, the energy performance of the building must comply with the local energy class B level (≤50kWh/m²/yr for heating).</p> <p>[Trento Province]: the minimum requirement is energy class B+, while for an expansion of the building up to 30%, the minimum energy performance requirements are more restrictive.</p> <p>[Torino city]: Energy and environmental requirements for the improvement of the façade and the roof thermal insulation when undertaking major renovation activities. Criteria based on ITACA protocol. Voluntary scheme assessing the energy performance of the building based on these criteria. Based on the points collected through the ranking criteria, buildings are eligible for different public financing incentives.</p>
NL	<p>For new skylight windows, or renovation of existing ones, new insulation requirements apply</p>
UK	<p>When a thermal element (i.e. a wall, floor, roof etc.) is subject to a renovation and its U-value is below a required threshold, the performance of the whole element should be improved to achieve specific U-values, provided the area to be renovated is greater than 50% of the surface of the individual element or 25% of the total building envelope. However, the upgrading of a thermal element should also be technically, functionally and economically feasible. Moreover, when 50% or more of the roof area is being refurbished, the whole of that roof must be brought up to the thermal efficiency demanded by the current regulations. Furthermore, from April 2018, private rented properties must be brought up to a minimum energy efficiency rating of 'E'. This provision will make it unlawful to rent out a residential or business premise that does not reach this minimum standard.</p> <p>[Scotland]: Homes must meet a tolerable standard, which includes certain energy performance requirements.</p>

7.1 AUSTRIA



In Austria there are no national obligatory requirements for renovating buildings. An interview with a national expert (May, 2013) revealed that there is a theoretical obligation of applying thermal improvement measures in case of building renovation. However, this obligation has no real impact due to the lack of compliance and effective control mechanisms.

Moreover, regarding the EED requirement for the annual renovation rate of 3% in central government buildings, no measures have yet been put in place (ENTRANZE, 2013).

Nevertheless, there are requirements related to the performance of buildings that have undergone renovation. Hence, there are requirements regarding the maximum heating (87.5 kWh/m²/yr for residential and 30 kWh/m³/yr for non-residential) and cooling energy demand of renovated buildings. In particular, in the region of upper-Austria there are legal measures for reducing the cooling demand:

- Either “proof of prevention of summer overheating” (Nachweis ONORM-B 8110-3).
- Or “maximum externally induced cooling demand”:
 - Max ≤ 1kWh/m³a (new construction).
 - Max ≤ 2kWh/m³a (renovation) (Dell, 2010).

Furthermore, regarding major renovations, the energy performance requirements are related to the Energy Performance Certificates. Until 2010, **major renovations had to achieve at least the lowest C rating (≤100 kWh/m²/yr for heating)** to be approved at the planning stage (the exact requirement depended on the building code of the province). The requirement for major **renovations changed in 2012 to B rating (≤50kWh/m²/yr for heating)** and is **expected to change to A+ rating (≤10kWh/m²/yr for heating)** sometime in or before 2020 (CONCERTED ACTION, 2010).

Finally, in order to support building renovation, Austria has introduced a series of financial subsidies. Subsidies are provided for measures improving thermal insulation (building shell, windows and doors). For households, the maximum subsidy level amounts to 20% of the thermal renovation costs, while for companies, subsidies cover 30% of the investment. More details can be found in the Appendix.

7.2 BELGIUM



Federal government

In Belgium, the drawing-up and implementation of policy guidelines relating to energy efficiency and buildings energy efficiency largely fall within the competence of the regional governments.

Regarding energy renovation of buildings, there are no national mandatory regulations.

To promote building renovation, the Federal government provides national financial support measures. However, since January 2012, all financial support measures for buildings energy improvement have been removed, except for the measure of tax deduction for roof renovation in dwellings. The tax reduction amounts to 30% of expenses for the work actually performed (Private communication with national expert, May, 2013). For taxation year 2013 (income 2012), the reduction amounts to **2,930€ maximum per dwelling**.

Brussels Capital Region

In Brussels Capital Region (BCR), there are no mandatory requirements for building renovation.

However, there are different requirements about the energy performance of buildings undergoing major renovation.

Regarding public buildings, Brussels Regional Parliament sets as requirement that from 2010, all major renovations by public authorities must achieve low energy standards, while any new public building should be passive (NEEAP-BCR, 2011).

Additionally, from 2015, all buildings that undergo major renovation⁷ should comply with the very low energy standard (NEEAP- BCR, 2011).

Another important regulatory measure that will take place in Brussels Capital Region from 2015 is the introduction of a minimum performance threshold for rented homes (threshold for energy fitness), by amending the Brussels Housing Code. The threshold will enable tenants in homes with excessive energy consumption to be protected. Overall, the measure aims to reduce energy use of

⁷ Major renovation: buildings > 1 000 m² with an urban development permit and works covering more than 25% of the heat-losing surface area OR buildings > 1 000 m² with an urban development permit and involving technical installations with a power of more than 500kW after replacement or alteration.

dwellings while protecting low-income people from high rental costs (NEEAP-BCR, 2011).

One organisation that plays a key role in providing information about building renovation in Brussels is the Institute “Bruxelles Environnement”, which is responsible for managing different projects related to energy and buildings. Regarding building renovation, the organisation provides information and assistance with all financial subsidies available for citizens of Brussels wishing to renovate their buildings (Bruxelles Environnement, 2013b). Overall, there are premiums for energy studies and audits, passive house or low-energy renovations, as well as insulation and ventilation improvements.

In addition, Brussels Capital Region has introduced different support programmes and actions, as for instance the Local Energy Management Action Programme (Programme d'Action Locale pour la Gestion de l'Energie – PLAGE), which provides an energy reduction action plan on public buildings that consume large amounts of energy. Additionally, there is the programme “Exemplary Buildings” (Bâtiments Exemplaires), which is a competition which has been held several times since 2007 with the aim of constructing or renovating buildings that are at the forefront in terms of energy and environmental performance.

Flanders Region

In Flanders, energy performance requirements for new and renovated buildings started in January 2006. Each new or renovated building has to fulfil requirements on energy performance (E-level), on insulation (U-values and **global insulation 'K-level')** and on the indoor climate (risk of overheating and ventilation).

The minimum energy performance requirements related to building renovation were tightened in 2012. The latest update of the requirements imposed in case of renovated buildings in Flanders Region are summarised in the following points⁸:

1. For a renovation of residential buildings (with extension) lower or equal to 800m³
 - When a building permit is required, then energy performance requirements exist for parts of the building envelope being replaced or with extension:
 - maximum R-values or minimum U-values (see Tables in Appendix).
 - certain requirements for ventilation (in case of expansion or replacement windows, supply of air has to be foreseen).
 - Control and compliance through EPB-system (EPC-declaration done by an independent energy expert).

⁸ Source: private communication with VEA, Flemish Energy Agency, May 2013

2. When there is an expansion or renovation of a 'protected volume' higher than 800m³, the same requirements as for new building will be applied

In addition, from 2015 and on, there will be system requirements from building permits (art. 8 EPBD). When a building permit is required, and installations and systems are replaced or added, there will be minimal system requirements.

Furthermore, a new standard comes into force in Flanders from January 2015, regarding roof insulation. According to the regulation, if a dwelling has a roof that does not meet the minimum required standard (R-value= 0.75 W/ m²K), it will receive a penalty point during the evaluation of the building. If a building collects 15 penalty points, it will be characterised as unsuitable and it will be unlawful to rent it out (VEA, 2013).

The standard will apply to all houses located in the Flemish Region:

- The roof insulation standard will also apply to independent houses inhabited by the owner.
- The roof insulation standard will be applied to single-family homes, studios and apartments, but not to rooms.

From 2020 onwards, the absence of adequate roof insulation (alone) will be enough to declare a building as being unsuitable and it will be illegal to rent it out.

Table 4 presents the gradual tightening of the penalty points given in case of absence of roof insulation in a dwelling. A distinction is made between roofs smaller or larger than 16 m².

Table 4: Gradual tightening of the penalty points given to a dwelling in Flanders in case of absence of adequate roof insulation

Period	Penalty points for roofs <u>smaller than 16m²</u>	Penalty points for roofs <u>larger than 16m²</u>
	with R-value < 0.75 m ² K / W	with R-value < 0.75 m ² K / W
1/01/2015 till 31/12/2017	1	3
1/01/2018 till 31/12/2019	3	9
From 1/01/2020	9	15

If a building receives more than 15 penalty points, it will be declared as being unsuitable.

It is important to stress that if the roof of a multi-apartment building does not meet the minimum required standard, all apartments in the building have the same penalty from January 1, 2015. The roof is indeed a common part of the building and defects are passed on to all dwellings in the building. To put it simply, this means that an apartment on the ground floor also receives penalty points if it turns out that the apartment under the roof insulation is inadequate, regardless of ownership.

Finally, in order to promote building energy renovation, the Flemish government offers different financial support schemes. For new buildings in Flanders, subsidy mechanisms are based on the global energy performance of the building. For renovations of buildings though, subsidies are provided for individual measures. **Currently, the possibility of subsidising the “global energy performance” (global EP) of major renovations of buildings, instead of individual measures is being analysed⁹.**

So far, there are subsidies for roof insulation, external wall and cavity wall insulation, floor insulation and high performance glazing. Moreover, there are subsidies for low-energy heating installations (e.g. heat-pumps) and use of solar thermal panels and PVs.

7.3 DENMARK



Danish Building Regulations include certain semi-mandatory requirements for energy upgrades in case of building renovation.

In the previous Danish Building Regulations, BR08, energy upgrades were only mandatory in case of a major renovation - the 25% threshold as specified by the EPBD. Then, all economically, technically and architecturally feasible measures needed to be implemented. This rule kept some house owners from investing in energy savings, as the required investments might exceed their financial means.

In the current Danish Building Code (BR10 version), the 25% threshold was extended with requirements for most building components (component requirements) when they are renovated individually.

The minimum energy requirements for building components are valid in case of:

- Change of use of the building (e.g. barn or industrial building being converted to dwelling, commercial or institution).
- Complete renewal of elements (e.g. new windows or new boiler).

⁹ Private communication with VEA, Flemish Energy Agency, May 2013

- Partly renewal of elements (e.g. new roofing or new floor).

To put it simply, when a window is replaced with a new one, the new component should comply with the energy performance requirements (e.g. U-values or Linear losses) mandated by the BR10 Code. Similarly, in case of roof renovation (partial renewal of building envelope), the new roof should comply with the energy performance requirements.

However, all energy upgrading measures must be economically feasible (cost-effective), meaning that the annual savings multiplied by the expected lifetime of the measure divided by the investment should be bigger than 1.33, or, put in another way, the measure must have a simple payback time of less than 75% of the expected lifetime of the measure. If the implementation of the full requirement is not profitable for the owner, lower or no requirements need to be implemented. In these cases though, the financial unviability must be verifiable (BR10, 2010).

The BR10 Code provides examples of cost-effective construction works and services for retrofitting insulation. A few of them are:

- Laying of new felt roof in the form of a new roof membrane or top felt on an existing roof.
- A new tiled roof.
- A new steel sheet roof on top of an old felted roof or a roof of fibre cement sheets.

Nevertheless, in the case of replacement of floors, external walls, doors, windows or roof structure, the minimum energy performance requirements apply regardless of cost-effectiveness. However, due to constructional factors (for instance in case of change of use), it may be difficult to comply with the requirements for linear loss for existing windows and foundations. As an alternative, a corresponding amount of energy can be saved, for example by additional insulation or installation of solar heating, a heat pump or solar photovoltaic cells (BR10, 2010).

Furthermore, in the case of the renewal of an installation in an existing building, the requirements are the same as for an installation in a new building.

Finally, for renovations of buildings outside district heating zones with expected daily hot water consumption over 2000 litres, solar heating systems must be provided and able to meet 95% of the demand (BUILD-UP_DK, 2012).

The Danish building code is expected to be tightened in the future:

- From the beginning of 2013 the installation of oil-fired and natural gas heating units in new buildings will no longer be allowed, but exceptions will be possible if there are no other alternatives available.

- After 1 January 2015, when replacing a window, the energy gain during the heating season must not be less than -17 kWh/m² per year (in 2013: -33 kWh/m² per year).
- After 1 January 2015, when replacing a roof window, the energy gain during the heating season must not be less than -0 kWh/m² per year (in 2013: -10 kWh/m² per year).
- After 1 January 2015, when replacing a skylight, the U-value must be less than 1.40 W/m²K (in 2013: 1.60 W/m²K).

Regulations regarding surface temperature of window frames in exterior walls will be re-evaluated (BUILD-UP_DK, 2012).

Lastly yet importantly, the Danish government has developed a financial scheme for supporting renovation of dwellings. The *Bolig Job Plan*, as it is called, is a research scheme which offers tax deductions on wage costs incurred for help and renovation work in dwellings. The scheme is in force from 1 June 2011 until 2013. The grant accounts for approximately one third of the wage costs and is applicable both inside and outside the dwelling. The deduction is available to persons aged over 18 years and can be up to a maximum of DKK 15 000 per person per year. The scheme is designed as an eligible deduction in the tax assessment and offers a simple administrative solution that is no more difficult than an Internet transaction. The *Bolig Job Plan* agreement includes, among other things, the following energy related improvements in the dwelling: repair and replacement of windows and glazing, repair and replacement of oil-fired or gas-fired boilers and central heating systems, roof and loft insulation, insulation of external walls and installation of solar panels and solar cells.

7.4 FINLAND



Finland's Ministry of the Environment issued new regulations on 27.2.2013 for improving the energy efficiency of buildings during renovation and alteration works. The regulations will come into effect on 1.6.2013 for buildings in public use and on 1.9.2013 for other buildings (Invest in Finland, 2013).

The regulations define the minimum requirements for energy efficiency concerning renovations that are subject to a licence, a change in use or the renewal of technical systems. This includes extensive basic repairs, renovation of **a building's façade and the renewal of technical systems that usually require a building permit or a planning permit for minor construction.**

The decision to start renovation work remains voluntary, according to the regulations. The property owner decides when and to what extent he or she will

make the repairs, and what are the best methods for improving energy efficiency within the regulatory framework.

There are three alternatives for improving energy efficiency:

1. The first alternative is to improve the thermal insulation properties of the building parts that need repairing or renewing so they conform to the required standards (Maximum U-values for building elements).
2. The second alternative is to improve the energy efficiency of the building according to the level defined for that type of building. This means **examining the building's annual computable energy consumption relative to its surface area**.
3. The third alternative is to calculate the **building's E-number** (total energy consumption in the building) based on the solutions adopted when the building was first constructed, or according to the solutions from its latest change in use. The aim is to reduce the E-number according to the level defined for the type of building in question.

Requirements for technical building systems have to be applied in all cases. It is **important to ensure that a building's technical systems like heating and ventilation** are functioning and their basic settings are always checked when insulation is added to the building or its air-tightness is improved or the systems are renewed. This is very important in order to assure good indoor air and living comfort. The regulations make it possible to take into consideration, in a flexible way, different kinds of technical issues such as damp or mobile devices during the planning (Invest in Finland, 2013).

The improvement of existing buildings in Finland has been supported by repair and energy subsidies intended for detached houses, apartment buildings and **terraced houses**. **Energy subsidies for the improvement of buildings' energy economy** can be sought from the Housing Fund of Finland or municipalities. Energy repairs for detached houses are primarily supported by more favourable terms for tax deductions for home improvements; with respect to low-income individuals. These are supplemented with means-tested energy assistance.

7.5 FRANCE



In France, such as in the EU, buildings account for around 43% of the final energy consumption and one fourth of the GHG emissions. This largely shared statement led to the implementation of ambitious targets for buildings renovation, as well as to a series of measures to achieve them.

The national debate “Grenelle de l’ Environnement” that took place in 2007 resulted in the creation of the 1st Loi Grenelle, which says explicitly that the French State has to reduce energy consumption in existing buildings by at least 38%, by 2020. The Loi Grenelle 2, a more detailed and applied law which complemented the first text, goes further by stating that energy retrofitting work has to be carried out on existing commercial buildings within 8 years, from 1st January 2012.

Regarding building renovation, “Grenelle de l’environnement” has introduced as a main objective the creation of a plan for the large-scale energy and thermal renovation of existing buildings, with the aim to reduce the energy consumption of the existing stock by 38% by 2020.

The main objectives related to building renovation defined by the “Grenelle de l’environnement” are summarised as follows:

- Renovate 400,000 housing units per year starting in 2013.
- Renovate the 800,000 most energy-consuming social housing units by 2020.
- Undertake work on energy efficiency in public and private tertiary sector buildings between 2012 and 2020.
- **Start the energy renovation of State and public buildings before 2013”.** (BUILD-UP_FR,2013)

By the end of 2012, France had not yet put in place the right tools in order to reach these objectives- the pace of energy renovation of existing buildings is still far from the one set by the Grenelle Law. In 2013, the current government reaffirmed the previous ambitious and especially stressed the goal to achieve a renovation rate of 500 000 buildings per year, by 2017.

To help achieve this objective, a new plan was announced in March 2013, the Plan to Renovate the Energy of Households (PREH), in the frame of the Housing **Investment Plan (Plan d’Investissement pour le Logement)**. Three axes were developed:

1. Encourage the decision making process with better support for home owners
2. Make renovation financing an easier process through the adaptation of support programmes
3. Mobilise professionals to ensure an affordable quality

According to the Grenelle Law, the dialogue about the housing sector in France pertains to the Plan Bâtiment Durable (Sustainable Building Plan). The plan foresees regular meetings between the stakeholders of the whole sector, in order to facilitate dialogue and stimulate the exchange of ideas and proposals.

Regarding the EED requirement for the annual renovation rate of 3% in central Government buildings, *Grenelle 1* states that, from 2009, all of the state

buildings, as well as those of its public establishments, should be subjected to an energy audit by the end of 2010. The aim was to begin renovation of these buildings by 2012, at a rate of 3% per year, using the diagnosis produced.

This renovation should achieve a reduction of at least 40% in energy consumption and 50% in greenhouse gas emissions in the State building stock by 2020 (ENTRANZE, 2013).

In France, the building code reference document is the 2012 Thermal Regulation (RT)¹⁰. Thermal Regulation requirements covering energy retrofitting are separated into two categories:

- Global Thermal Regulation (RT Globale) - For major renovation¹¹ of buildings > 1000 m²: the global Thermal Regulation sets a global energy performance target for renovated buildings, built after 1948. The target for dwellings was to reach a range of energy consumption of 80-195 kWh/m²/yr between 2005 and 2010, and a range of 80-165 kWh/m²/year from 2010 and on, compared to an average of 240 kWh/m²/yr for the existing stock. The range depends on the climatic zone and heating fuel. For non-residential buildings, the savings should be 30% (ENTRANZE, 2013).
- Thermal Regulation per element (RT par element) - For major renovation of buildings <1000 m², or buildings > 1000 m² undergoing minor renovation: The element-by-element Thermal Regulation sets a minimum performance level for elements replaced or installed; this concerns, in particular, insulation, heating, hot-water production, cooling and ventilation equipment (ENTRANZE, 2013).

Moreover, certain regulatory requirements were eased in order to facilitate buildings energy renovation:

- Majority requirement for co-ownership groups for energy-saving work.
- COS bonus (land use ratio) (BUILD-UP_FR, 2013).

Finally, France has introduced a variety of financial measures supporting buildings retrofitting, as for instance interest-free loans, special loans for social housing as well as a measure mandating the distribution of energy savings between owner/landlord and tenant. According to the last measure, which was adopted in 2009, owners will be able, at the end of the energy renovation work, to require from the tenant to contribute half of the estimated costs saved and pay it through the rental. Furthermore, a relief from property tax measure exists for low-cost housing agencies or SEM (mixed investment companies). Ultimately, **there is the "Live Better Programme for Thermal Renovation of Dwellings", which provides aid (€1 100 to €1 600) additional to that provided by ANAH to low-income owner-occupiers carrying out works that enable an energy gain of at**

¹⁰ <http://www.rt-batiment.fr/batiments-neufs/reglementation-thermique-2012/presentation.html>

¹¹ Only apply to renovation that costs more than 25% of the value of the building, excluding land cost, i.e. 322 €/m² for dwellings and 275 €/m² for non-residential buildings (cost without taxes).

least 25%. These plans have been reinforced in the frame of the new Housing Energy Renovation Plan, they started implementing them in September 2013.

7.6 GERMANY



In Germany, there are certain retrofitting obligations (such as the insulation requirement of top floor ceilings), that are further explained below. Like in other EU countries, there are requirements regarding the energy performance of buildings undergoing major renovation.

Germany has ambitious targets for the overall energy performance of the building stock. The German Federal Government's target for 2050 is to have a building stock that is almost climate-neutral. To achieve this target, the heating requirement is to be reduced by 20% by 2020, with primary energy demand dropping by 80% by 2050. The annual refurbishment rate is to be increased from 1% to 2% by 2020.

The comprehensive package of measures includes a wide-ranging building modernisation offensive. To establish a long-term refurbishment strategy with reliable framework conditions, the Energy Concept ("**Energiewende**") foresees the compilation of a refurbishment roadmap for Germany's total building stock covering the period 2020-2050 (BUILD-UP_DE, 2012). The roadmap shall be available in 2013 and will comprise the order and the technical level of the renovations until 2050. Furthermore, a detailed time plan to 2015 will be spelt out (ENTRANZE, 2013).

For the renovation of buildings, the German building regulation (EnEV) sets component-specific minimum efficiency requirements which have to be implemented when changing or modernising a building component (e.g. the roof, the windows or the exterior wall). However, there is no obligation to conduct upgrade measures. This means that, where no renovation takes place, there is no requirement to fulfill any performance standard (with the exception of some obligatory refurbishment measures such as the insulation of the heat distribution and hot water pipes as well as fittings, or the insulation of top floor ceilings) (ENTRANZE, 2013).

As an alternative to complying with individual requirements for structural elements, a holistic assessment can also be made – analogous to the calculations for new buildings. The requirements are met if modified residential or non-residential buildings exceed the relevant requirements for similar new buildings by no more than 40% (Concerted Action, 2010).

In the case of single measures, modifications are to be designed in such a way that specific heat transfer coefficients of the exterior components are not exceeded (ENTRANZE, 2013).

Apart from the conditional requirements which result from refurbishment or replacement of a structural element, the Energy Saving Ordinance also contains retrofitting obligations which must be fulfilled by the building owners within a specific time frame. All retrofitting obligations are also subject to the precondition for cost-effectiveness. According to legal requirements, these are measures with short-payback periods.

In detail, the retrofitting cost-effective obligations are:

- Insulation requirement of hot water pipes: It exists since 2004 and requires the insulation of all previously non-insulated and accessible hot water distribution pipes and fittings in unheated rooms.
- Insulation requirement of top floor ceilings: The requirement was introduced in two steps. First, from 2009-2011, it had been required to insulate non-insulated top floor ceilings of heated rooms (i.e. non-insulated floor ceilings with $U\text{-value} > 0.24 \text{ W}/(\text{m}^2\text{K})$), above which there is an accessible, but non-walkable space. Then, as from December 31, 2011, the obligation applies to all top floor ceilings, above which there is either walkable or non-walkable space. Moreover, the obligation also applies to top floor ceilings, above which there is an attic. As an alternative, the roof located above can be insulated instead of the top floor ceiling (Concerted Action, 2012). However, there is no control/compliance mechanism for this requirement; it is used by the industry as an incentive to promote ceiling insulation.
- Retrofit of HVAC systems: Retrofitting automatically operating control devices with separate reference values for the room humidity is mandatory for larger air conditioning and ventilation systems, insofar as these systems are intended to affect the humidity of the indoor air (Concerted Action, 2012).
- Replacement of electrical heat storage systems: Because of the high primary energy expenditure in electric power generation in Germany, the Energy Saving Ordinance requires that electrical heat storage systems must be gradually taken out of operation, if the heating of the building is provided exclusively by electrical heat storage systems. This applies to larger residential (e.g. apartment buildings with more than 5 flats) and non-residential buildings, with more than 500 m² total useful floor area, which are heated for more than 5 months/year to 90°C or more and whose thermal insulation does not comply with the (former) Thermal

Insulation Ordinance '95¹² (Concerted Action, 2012). Nevertheless, it should be stressed that this requirement is currently under discussion, since it contradicts the overall German strategy for electricity generation from renewable energy sources. According to the non-official paper that has become available (Lesefassung_EnEV2012, 2013), it is likely that the requirement will not be included in the future version of the German Thermal Insulation Ordinance.

Furthermore, Germany has adopted financial measures and mechanisms to support building retrofit, such as the successful **"KfW Energy-efficient Refurbishment programme"** (former KfW CO₂ Building Rehabilitation Programme). The programme is intended to promote measures for saving energy and reducing CO₂ emissions in residential buildings by financing corresponding measures, both at low interest rates and in the long-term. The support can take the form either of a low-interest loan or a non-repayable grant. The level of support is dependent on the chosen refurbishment standard. A refurbished building which requires, for instance, 115% of the primary energy of a comparable new building- (therefore only 15% more)- is assigned to the **promotion standard "KfW efficient building 115" and receives a 2.5% credit and subsidy, while a "KfW efficient building 55"** (i.e. 55% of the comparable new building) receives a much higher subsidy of 12.5% (Concerted Action, 2010).

7.7 ITALY



Italy has not adopted any mandatory requirements regarding buildings' energy upgrade.

Moreover, there are no specific and already defined measures concerning the EED target to renovate 3% of public central buildings. Given the historical value of many of these buildings it will be complicated to implement effective renovation actions (ENTRANZE, 2013).

As in other countries, there are energy performance requirements regarding major renovations. These include maximum U-values for building envelope elements, minimum thermal efficiency for the heat generation system and maximum annual total primary energy consumption for space heating. Other additional requirements related to major renovation are: obligatory solar thermal plants designed to cover at least 50% of the thermal energy consumed annually,

¹² Detailed values of thermal insulation requirements of Ordinance '95 can be found in Table 1, page 9, in: <http://www.bbsr-energieeinsparung.de/EnEVPortal/DE/Archiv/WaermeschutzV/WaermeschutzV1995/Download/WaermeschutzV95.templateId=raw,property=publicationFile.pdf/WaermeschutzV95.pdf>

20% coverage of thermal energy uses with thermal RES systems and installation of 1kW of electric renewable systems for every 80 m² of floor area.

One of the most important incentive mechanisms for the renovation of **residential buildings in Italy is the “55% tax credit for energy efficiency improvements”**. The measure allows building owners to recover 55% of the investment costs (with maximum limits) in 10 years within the income declaration procedure. The programme finances measures such as: renewal or improvement of the efficiency of the heating system, and retrofitting of building envelope components and building renovations works that are able to achieve a building energy performance 20% more efficient than the values set by law. This mechanism, positively judged by ENEA¹³, has been renewed for 2013 but there are no guarantees for further renewals¹⁴ (ENTRANZE, 2013).

RENOVATION REQUIREMENTS IN ITALIAN REGIONS AND CITIES

The Regions (n.b. there are 20 regions in Italy subdivided into provinces and municipalities) have the competence in environmental, planning and building control matters. Therefore, while there are several building provisions set by national laws, each municipality (n.b. *comune* in Italian) implements its own building regulations and sustainable buildings codes, which are nevertheless based on regional guidelines. Especially for sustainability and energy performance of buildings, the Italian regions and municipalities set specific **standards, i.e. ‘norme per l’edilizia sostenibile’**. These building standards are **related to the Italian initiative ‘Piano casa’**¹⁵, an economic recovery measure, which since 2009 offers support to Italian Regions for improvements of existing residential buildings. While there are no mandatory requirements for energy renovation of existing buildings, regions and municipalities set minimum sustainability requirements as criteria to qualify for receiving subsidies from the Piano Casa programme.

A good practice in promoting energy performance improvements through the use of Piano Casa incentives is in Bolzano County. According to this practice, by the end of 2019, owners of buildings will only be allowed to expand the surface of their dwelling by up to 20% or up to 200m³, if the building achieves heating consumption below 70kWh/m²/yr (i.e. CasaClima C, based on the local energy performance certification scheme). Moreover, since January 2005¹⁶, the

¹³ Italian National Agency for New Technologies, Energy and Sustainable Economic Development

¹⁴ <http://efficienzaenergetica.acs.enea.it/doc/rapporto%20mercato%20v3p.pdf> (Italian Version only)

¹⁵ Piano Casa is an initiative comprising a set of legislative measures and economic incentives (e.g. tax reduction) launched in 2009 as an economic recovery measure which incentivizes the expansion or demolition and reconstruction of existing buildings (PianoCasa, 2013).

¹⁶ According to local regulation DPGP 29/09/2004, nr. 34

minimum standard for new buildings is expected to tighten to B level (see Table 5).

Table 5: Energy labels within CasaClima certification scheme from Bolzano

CasaClima	Gold	A	B	C
Energy for heating	<10 kWh/m ² yr	<30 kWh/m ² yr	<50 kWh/m ² yr	<70 kWh/m ² yr

Furthermore, in the Region of Valle D’Aosta, in case of expansion by 20% of buildings with a floor area higher than 2000m² or in case of new dwellings, the energy performance of the building must comply with the local energy class B level (legge regionale 11/1998), i.e. below 50kWh/m²/yr for heating (RE, 2011). For the same cases, in Trento Province, the minimum requirement is energy class B+, while for an expansion of the building up to 30%, the minimum energy performance requirements are more restrictive.

In addition, the City of Torino introduced in the building code specific energy and environmental requirements¹⁷ for the improvement of the façade and the thermal insulation of the roof when undertaking major renovation activities related to them, as well as minimum NOx requirements for the replacement of heating systems.

Moreover, Torino’s building regulation foresees a voluntary scheme which assesses the energy performance of the building according to a set of energy and environmental criteria. Based on the points collected through the ranking criteria, buildings are eligible for different public financing incentives.

This set of criteria is based on the ITACA Protocol for evaluation and environmental sustainability (ITACA, 2013), adopted by many Italian regions and introduced in their building regulations. The methodology of the Protocol establishes 12 criteria and 8 sub-criteria, including energy consumption for heating, U-values of thermal envelopes, domestic hot water, natural lighting, renewables, environmental impact etc.

Another example of implementing the ITACA Protocol is the Region of Toscana¹⁸ (PRC, 2011), and more specifically the city of Pisa, which has set an evaluation system based on the ITACA Protocol with scores from -2 to +5 (Comunedipisa, 2011). Accordingly, all projects for new buildings and major refurbishment of existing ones have to reach at least 0 points on this scale, with financial incentives for higher scores in terms of subsidies and reduction of the fees

¹⁷ Allegato Energetico – Ambientale al Regolamento Edilizio della Citta di Torino, Adeguato alle Recenti Disposizioni Normative Statali e Regionali in Materia di Rendimento Energetico Nell’Edilizia. Allegato alla deliberazione n. 2010-08963/38

¹⁸ Regional law: LR 1/2005 “Norme per il governo del territorio”, and the guidelines “Linee Guida per l’edilizia sostenibile in Toscana”, approved by D.G.R. no. 322 of 28/02/2005 and D.G.R. no. 218 of 30/04/2006

payable for approvals. Among the requirements, there are minimum levels of energy efficiency, while outside the historic centre of Pisa all new and replaced heating systems must use at least 50% renewable energy sources.

7.8 THE NETHERLANDS



The Netherlands has not applied any mandatory requirements for energy renovation of buildings, but has put, instead, more focus on a series of support programmes and collaboration initiatives that facilitate building energy retrofits.

The Dutch building legislation sets an integral requirement for the energy efficiency of new buildings and major renovations of existing buildings. Included in the integral requirement is the calculation of the building performance, taking into account the current level of insulation (roof, walls, floor, windows) and installation (heating, cooling, hot water, ventilation, lighting). This is expressed in an energy performance coefficient (EP), which is calculated with the new energy performance of buildings methodology (EPG), expressed in terms of primary energy.

Next to the integral building requirements, minimum requirements for building components are also in place. The current minimum requirement for all building envelope components is $R_c = 3.5 \text{ m}^2 \cdot \text{K}/\text{W}$. For windows (including frame) a maximum U-value of $1.65 \text{ W}/\text{m}^2 \cdot \text{K}$ currently applies (CA, 2012).

Stricter efficiency requirements for heating, hot water, cooling and ventilation systems are expected to apply from 1 July 2013 in existing homes and large residential buildings (offices, schools, shops, hospitals, etc.) (Rijksoverheid, 2013). The Amendment of the Dutch Building Decree, which came into effect on March 1, 2013, introduced changes as:

- The minimum insulation requirements for windows, doors and frames for new construction are tightened.
- For new skylight windows, or renovation of existing ones, new insulation requirements apply.
- A new regulation on the conditions under which a building can be built without connection to the heat network (Rijksoverheid, 2013).

Additional support programmes are introduced in The Netherlands backing up energy renovation of existing buildings. First, the Energy Leap programme (Energiesprong) is designed to implement the Energy Innovation Agenda for the Built Environment (IAGO, 2009). It involves research into how existing buildings can be transformed to become nearly energy-neutral.

Second, the programme More with Less (Meer Met Minder) is a joint initiative between Dutch ministries and associations, which aims to achieve a 20% to 30% energy efficiency improvement for 3.2 million homes by 2020. Up to 2011, the aim was to increase energy efficiency 20% to 30% for approximately 500.000 existing buildings. As of 2012, the annual target is to improve energy efficiency in 300,000 buildings. The programme sets a target of 100 PJ additional savings in existing homes and utility stock.

Third, the Covenant for Energy Saving in the Corporate Housing Sector is an agreement signed by Dutch housing corporations and the Ministry of Housing, Spatial Planning and the Environment, aiming to improve the energy performance of existing and newly built rented houses. The covenant aims to achieve a 20% reduction of energy use in existing dwellings for the period 2008-2018, and respectively a 25% (in 2011) and 50% (in 2015) lower energy use of newly built dwellings. These goals should lead to energy savings of 24 PJ in the period of 2008-2020.

Another financial measure aiming to support building renovation is **the "Green Funds"** scheme. With the "Green Funds Scheme", stakeholders can invest in **'green funds'**, also called **'green investing'**. "Green funds" offer a relatively low return, but instead allow investors to receive tax advantages, which makes green investing attractive. This is the so-called **'green financing'**. **For sustainable projects in the built environment a 'green mortgage' is available. The interest rate of a "green mortgage" is approximately 1% lower than the market interest rate (for a regular mortgage or loan). The amount of the loan is based on the energy performance of the building achieved by renovation. For instance from 1 January 2013, houses with energy saving measures or a label A++ can also get 8000 EUR extra financing space in loans.**

Finally, on the latest building Decree that was published on February 28, 2013, the State Secretary for Finance introduced the application of a reduced 6% VAT rate for rebuilding, renovation and repair of owner-occupied dwellings from March 1, 2013 until March 1, 2014.

The reduced rate will apply to employment costs made, including those of architects and gardeners, but not to the materials used. Furthermore, the Decree specifies that the reduced rate will only apply to the rebuilding, renovation and repair of dwellings, which take place at least 2 years after the first use of the owner-occupied dwelling. The reduced rate applies if the works are completed on or after March 1, 2013 and before March 1, 2014.

7.9 UNITED KINGDOM



The United Kingdom has introduced a series of requirements for building elements that are being renewed.

In order to specify and regulate building renovations, remodels and extensions, **the British Building code has introduced the term "thermal element" to address the types of applicable work.**

A "thermal element" is defined for instance as a wall, floor or roof (not including windows, doors, roof windows or roof lights).

When a thermal element is subject to a renovation and its U-value is under a required threshold, the performance of the whole element should be improved to achieve specific U-values, provided the area to be renovated is greater than 50% of the surface of the individual element or 25% of the total building envelope.

However, the upgrading of a thermal element should also be technically, functionally and economically feasible. A reasonable test of economic feasibility is to achieve a simple payback of 15 years or less (L1b, 2010).

These are examples of renovation work, under which the energy performance requirements should be fulfilled:

- Re-tiling the roof or providing a new covering or sarking felt.
- Renewal or replacement of ceilings under a roof space or flat roof (with or without the renewal of the supporting structure).
- Renewal of cladding to external walls and/or dormer cheeks.
- Renewal of internal wall finishes to an external wall (excluding decoration) or where you are applying a finish for the first time e.g. re-plastering or dry lining of walls.
- Replacement of solid or timber floor at ground level or over an unheated space.

More specifically, for the case of roof renovation and repair the following key issues should be considered:

- The regulations come into effect when 50% or more of the roof area is being refurbished. In simple terms, it means that the whole of that roof must be brought up to the thermal efficiency demanded by the current regulations.
- A strip and re-roof or even just the provision of a new layer of waterproofing, for example when stripping and re-felting a flat roof, will usually require the upgrading of the thermal performance of the roof.

- This will, in most refurbishment instances, require the provision of additional thermal insulation to achieve an improved thermal efficiency (U-value) in accordance with the regulations. If such an upgrade is not technically or functionally feasible or would not achieve a simple payback of 15 years or less, the element should be upgraded to the best standard that can be achieved (NFRC, 2013).

Furthermore, the government has announced certain provisions for the future regarding building renovation:

- From April 2016 landlords of residential properties will not be able to unreasonably refuse requests from their tenants for consent to energy efficiency improvements, where financial support is available, such as the Green Deal and/or the Energy Company Obligation (ECO).
- Following this, from April 2018, private rented properties must be brought **up to a minimum energy efficiency rating of 'E'**. This provision will make it unlawful to rent out a dwelling or business premise that does not reach this minimum standard.
- This requirement is subject to there being no upfront financial cost to landlords. Therefore, landlords will have fulfilled the requirement if they **have either reached "E" or carried out the maximum package of measures funded under the Green Deal and/or Energy Company Obligation schemes (even if this does not take them up to an 'E' rating)**.
- The Energy Act 2011 allows the Secretary of State to exempt certain types of properties from the private rented sector requirements. These exemptions will be consulted upon as part of the secondary legislation ahead of 2016 and 2018.
- Local authorities will enforce the domestic minimum standard regulations, with the ability to impose a civil fine of up to £5000. A Local Weights and Measures Authority will enforce the non-domestic minimum standard regulations; the level of civil penalty will be defined in secondary legislation (Department of Energy & Climate Change, 2011).

In Scotland, homes must **meet a "Tolerable Standard"**. The **"Tolerable Standard"** has been the principal measure of housing quality in Scotland for almost 40 years. The **"Tolerable Standard"** is a "condemnatory" standard; a dwelling that falls below is not acceptable as living accommodation. Local authorities have a statutory duty and specific powers to deal with dwellings that fall below the tolerable standard ("BTS"). One of the requirements to meet the tolerable standard is satisfactory thermal insulation.

Finally, an important financial support programme in the UK is the **"Green Deal"** programme launched in January 2013 as a primary mechanism for improving the energy efficiency of households and non-domestic properties in Great Britain.

The “Green Deal” programme aims to fund energy-saving upgrades for buildings without any upfront costs. Instead, the costs are added to the energy bills and recouped over time, like a loan. “Green Deal” applications are reliant on the Golden Rule, which specifies that expected savings will have to be equal to or greater than the cost of improvements, including interest payments.

There are 45 measures or areas of home improvement approved to receive funding under the “Green Deal”, covering insulation, heating and hot water systems, glazing and micro-generation. For the non-domestic sector, lighting, mechanical ventilation and heat recovery measures can also be covered. More areas may be added in the future as technology advances.

“Green Deal” financing is tied to the building rather than the owner, so if the occupants move out the debt is passed on to whoever lives there next. The loan is paid back through the electricity bill over a 25-year period. Unlike many other building improvement initiatives, the “Green Deal” **is not dependent on people’s** income and the loans are available to everyone (USwitch, 2013).

Where homes fail to achieve the Golden Rule, and where householders are particularly vulnerable, the UK Government has introduced a support mechanism, the new Energy Company Obligation (ECO) (BUILD-UP_UK, 2012). Through ECO, the government aims to help 230,000 low-income households or those in low-income areas. Of the expected investment by suppliers of £1.3bn per year, there will be a 75:25 split between the carbon saving and affordable warmth obligations.

The ECO scheme involves the big six energy suppliers and was launched in early 2013, and replaces past policies such as the Carbon Emissions Reduction Target (CERT) and the Community Energy Saving Programme (CESP) (Energy Saving Trust, 2013). It is split in three parts:

- Affordable Warmth Obligation: dedicated to heating and insulation improvements for low-income and vulnerable households (but social housing tenants are not eligible for affordable warmth).
- Carbon Saving Obligation: provide funding to insulate solid-walled properties (internal and external **wall insulation**) **and those with ‘hard-to-treat’ cavity walls. This scheme can be used in conjunction with the “Green Deal”.** The aim is to provide enough support to make these relatively expensive measures cost-effective.
- Carbon Saving Communities Obligation: provides insulation measures to people living in the bottom 15% of the UK's most deprived areas. It is expected that this element of ECO will particularly benefit the social housing sector (Energy Saving Trust, 2013).

8. EXAMPLES OF BUILDING RENOVATION REQUIREMENTS AT GLOBAL LEVEL

USA

Momentum is building in USA for deep energy retrofits of buildings. President Obama has ordered \$2 billion worth of federal building retrofits and has partners for another \$2 billion of work in the private sector (Rocky Mountain Institute, 2012).

The average age of commercial buildings in the United States is 41.7 years, and 80% of the housing stock in this country is 15 years old or older. Making up the vast majority of the building stock, buildings that aren't brand new also offer significant potential for energy savings through upgrades (IMT, 2012).

Every building undergoing renovation is likely to trigger mandatory energy conservation measures under the International Energy Conservation Code (IECC) and ASHRAE Standard 90.1. However, these measures are often overlooked because of low awareness about how energy codes apply to building renovations.

The requirements for additions, alterations, renovations and repairs in buildings are summarised in the following points (IMT, 2012):

- Any garage, warehouse or other non-conditioned space that is altered to become conditioned space shall be brought into full compliance with the IECC.
- When replacing a whole window, it must comply with the IECC requirements for U-factor, SHGC and air leakage. When only replacing the glass in an existing sash and frame, the glass is not required to comply with the IECC.
- If a cavity within the building thermal envelope is exposed and contains no insulation, or the insulation does not completely fill the cavity, the **exposed cavity is required to be "filled" with insulation. Note: insulation installed on a suspended ceiling with removable tiles is not considered part of the minimum thermal resistance of the roof insulation. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during re-roofing shall be insulated either above or below the sheathing.**
- The replacement of an HVAC unit is required to comply with the IECC including minimum equipment efficiency requirements and equipment and system sizing.

California State

In California, State Controller John Chiang is pushing for legislation to jump-start retrofits (Rocky Mountain Institute, 2012).

California has been at the forefront of the building efficiency movement, setting a goal of net zero energy for all new residential construction by 2020 and for new commercial construction by 2030. In addition, the state has an aggressive goal to generate 30% to 70% of energy savings through retrofits of its existing buildings—commercial and residential—by 2020 (Rocky Mountain Institute, 2012).

According to California Energy Efficiency Standards for Non-residential Buildings, all new and renovated commercial buildings must achieve at least a LEED Silver rating (Clean Energy State Actions, 2011).

Financial barriers have typically made it difficult to fund energy retrofits even though they often pay for themselves over the life of the improvement. Current loan mechanisms, when available, often do not offer a low-enough cost of capital to make the investment attractive. In addition, the amount of time required to pay back the loan may be longer than the owner's plans to hold the building. **Chiang's proposed state-controlled mechanism** would funnel the debt into revenue bonds issued by the state, which are secured by a lien on the deed of the building. This structure offers increased security for financiers to lend, and the burden of repayment transfers to whoever holds the building deed. The financing is designed to cost the state nothing.

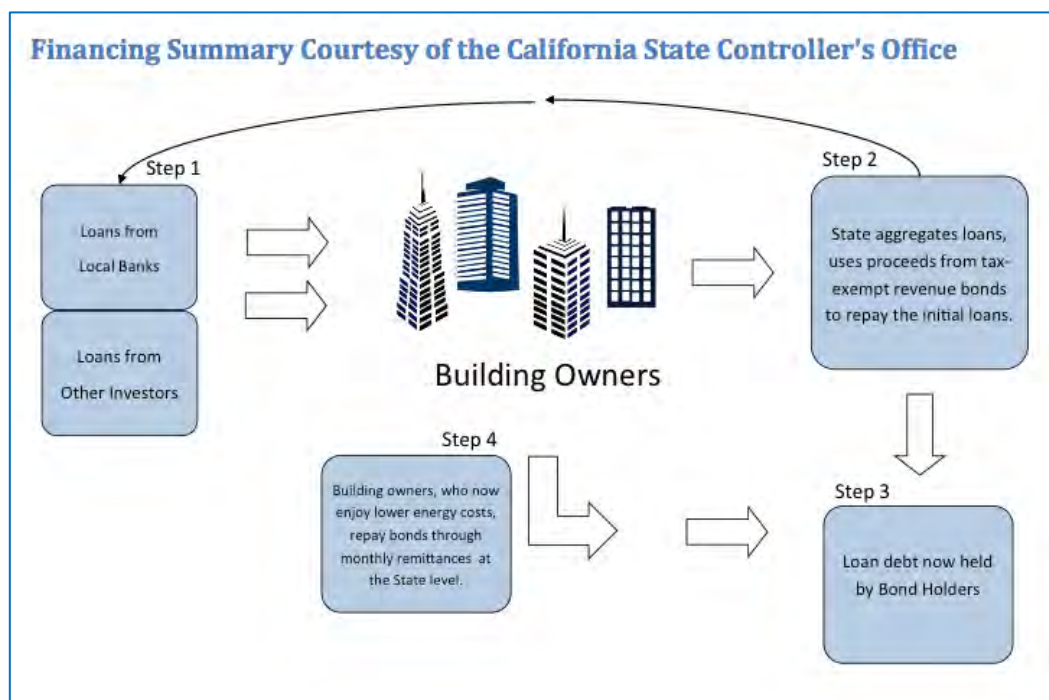


Figure 3: Financing mechanism in California for buildings energy retrofits (Source: Rocky Mountain Institute, 2012)

The legislation, introduced in both the California Senate and Assembly, is an effort to align incentives. It is touted as a method to unite environmentalists, building owners, and the construction industry.

Of the few who are currently doing energy retrofits, many merely switch out lighting or HVAC motors with more efficient versions of the same size. This misses bigger saving opportunities stemming from deeper measures like new windows, which can reduce loads to the point where major items of plant can be reduced in size and cost. These types of strategies are typically not considered because of high up-front cost and perceived higher risk (Rocky Mountain Institute, 2012).

New York City

To reach its aggressive sustainability goals, New York City aims to address energy waste of its existing structures. Whilst this comprises almost a million buildings, the city's square footage is highly concentrated in less than 2% of its properties; 2% translates into 15,000 properties over 50,000 square feet, which account for half of New York City's square footage and 45% of New York City's total greenhouse gas (GHG) emissions. These larger buildings also tend to have more sophisticated management and more financial and technical resources than do smaller buildings (NYC-Local Law 85, 2009).

Consequently, New York City enacted a comprehensive effort, called the Greener, Greater Buildings Plan (GGBP), which targets energy efficiency in these large existing buildings.

The Second Law of GGBP (Local Law 85) refers to requirements for renovation of existing buildings. Before this law came into force, the New York State Energy Conservation Construction Code only required buildings to upgrade to current **code standards during renovations where more than half of the building's** systems were being replaced. In New York City, nearly all renovations affect less than 50% of the building, and as a result, these projects were not required to upgrade to the most up-to-date standards, therefore foregoing significant efficiency gains. The new law requires upgrades to meet the current code standards for any renovation or alteration project, instead of those only affecting more than 50% of the building system.

The requirement should be fulfilled for all additions, alterations, renovations and repairs to an existing building or building system, the work must meet the current standards of the NYC Energy Conservation Code (NYCECC) at the time of construction.

Unless building energy use is increased as a result, the following building alterations need not comply with this code: storm windows installed over

existing fenestration, replacements of glass in an existing sash and frame, construction where the existing roof, wall or floor cavity is not exposed, and existing ceiling, wall or floor cavities exposed during construction if filled with insulation (NYC-Local Law 85, 2009).

Boulder City, Colorado State

In 2011 the **City of Boulder, Colorado enacted its “SmartRegs” ordinances that require all single family and multifamily rental properties to meet a minimum energy efficiency standard by January 2019.** The SmartRegs initiative is designed to help the city achieve its ambitious carbon emissions reduction goals **and to improve the quality, safety, and marketability of Boulder’s rental housing stock.**

The SmartRegs development process involved extensive collaboration with community and technical working groups that solicited input from market-rate and affordable housing rental property owners, property management and rental associations, rental inspectors, student housing advocates, environmental organisations and other community interests. The effort also incorporated online surveys, social media channels and official public processes.

SmartRegs proposals were initially met with concern and resistance from many property owners. The final ordinances ultimately won community support by including an eight-year compliance period that will allow rental owners sufficient time to budget for energy improvements over several years, by offering financial **incentives and technical assistance through the city’s Energy Smart programme,** and by including two paths for compliance – a streamlined prescriptive path and a custom, energy assessment-based path.

The performance path requires a comprehensive energy audit: measurements of all building dimensions and individual components, air leakage and duct leakage testing, and energy modelling to produce a Home Energy Rating System (HERS) Index. If the rental unit achieves a HERS Index of 120 or less, it is considered to be in compliance with the ordinance. A HERS rating can only be performed by a RESNET-accredited energy rater.

The prescriptive path involves a checklist and a slightly less comprehensive audit: fewer measurements are required, duct leakage testing is not required and energy modelling is not necessary. Points are awarded for energy efficient features, with minimum compliance score of 100 points, which is roughly the equivalent of a HERS rating of 120 (USDE, 2012).

One of the goals in creating the SmartRegs checklist was to design a tool that would naturally lead property owners to the most cost-effective and highest impact improvements. For example, many more points are awarded for

insulating a non-insulated attic to R-38 (26 points) than are given for insulating a slab foundation to R-10 (8 points). Assuming both assemblies are poorly insulated, attic insulation will save much more money, be more cost-effective and is generally easier to install than slab insulation. Points for each improvement were also weighted with respect to carbon emissions reductions: the more points that a home can earn for a measure, the more impact that measure **has on the home's overall carbon emissions**.

Table 6 shows an extract of the prescriptive SmartRegs checklist. It is an example of Walls section of the checklist, for a home where 50% of the walls are not insulated and 50% are insulated to R-13. This home would gain 10 points from the walls section.

Table 6: Example of walls section of SmartRegs checklist for a home where 50% of the walls are not insulated and 50% are insulated to R-13.

SmartRegs prescriptive pathway				
Walls Section				
R-value	25%	50%	75%	100%
No Insulation	0	0	0	0
R-3 Continuous (must be at least R-3)	3	6	9	12
R-5 Continuous	4	8	12	15
R-13 or Uninsulated Basement Wall	5	10	15	20
R-19 or Better	5	11	16	21
Shared Wall or Insulated Basement Wall	6	13	19	26

At the same time that SmartRegs went into effect, Boulder County launched the American Recovery and Reinvestment Act-funded EnergySmart programme, which provides rebates, low-cost energy assessments, and technical assistance to encourage residential and commercial property owners to invest in energy efficiency. The City of Boulder complemented these County initiatives by launching the Energy Smart Service, a streamlined one-stop-shop for helping residential property owners through the Prescriptive Path SmartRegs compliance process by providing one-on-one assistance as well as financial incentives specifically for properties required to make upgrades (LBNL, 2012).

Australia – Victoria State

From 1 May 2011, all new homes, home renovations, additions, alterations and relocations in the Australian state of Victoria will need to comply with the 6 Star Standard.

The 6 Star Standard applies to the thermal performance of a home, renovation or addition, as well as requiring the installation of a solar hot water system or a rainwater tank for toilet flushing.

As a flexible, performance-based standard, 6 Star allows homeowners, builders and designers a big choice in meeting the requirements.

From 1 May 2011 the 6 Star Standard applies to all new houses and townhouses (Class 1 buildings), new apartments (Class 2 buildings), and enclosed garages (Class 10a buildings) attached to class 1 buildings. The requirement also applies to new work done on existing buildings, such as additions, alterations or relocations.

A 6 Star energy efficiency rating applies to the building envelope - its roof, walls, floor and windows. The installation of a solar hot water system or a rainwater tank for toilet flushing is not mandatory for Class 2 buildings. The 6 Star requirements also include efficiency standards for fixed lighting but not plug-in appliances provided by homeowners.

The 6 Star Standard can be achieved with certain adjustments to design and construction, and by including a combination of the many options to improve the building's energy-efficiency, such as:

- Orientation: passive solar design.
- Insulation.
- Draught-proofing and sealing of the building's envelope
- Better window design (including size, location, quality thermal performance of frames and glazing).
- Shading.
- Building fabric (including selection of cladding materials, flooring).

If an alteration to an existing home takes place and its volume is 50% or more of the volume of the existing home, the whole house needs to be brought up to 6 Star Standard (Building Commission, 2012).

China

In North China, a set of policies have been implemented since 2007 through the “Existing Buildings Retrofit and Heat Metering Reform”.

This policy set aims at improving energy performance in existing residential buildings by introducing heat metering and energy-efficient retrofitting as well as the heat pricing system reform in the North China heating area. Implemented policies include target and planning, financial incentives, provision of information, and legal requirements. By the end of 2011, the retrofitted floor area reached 310 million m², resulting in energy savings of 293MJ/m² per heating period. By 2020, the target is to retrofit a total of 1.3 billion m² of floor area (BigEE, 2013).

In detail:

Policy 1: Specifies the target groups for gaining the subsidy for energy-efficient building envelopes, installation of heat meters and temperature control equipment, retrofitting of heat generation and heat supply network, and other measures related to heat metering and energy-efficient retrofitting. Besides, it also provides the rewarding principles and detailed calculation method, instalment and subsidy use, as well as supervision and management requirements.

Policy 2: Formulates the overall implementation strategy of energy-efficient retrofitting and heat metering reform. Firstly, it stresses the work principle and targets for the heat metering and energy-efficient retrofitting work for each province and city in North China. Secondly, it lists concrete tasks to be done to achieve the targets, including investigating current energy consumption, formulating implementation plans for the reform, retrofit implementation, improving ex-post evaluation, and summarising and disseminating lessons learnt. Finally, it also specifies the support measures needed for the reform, such as institutional reform, pursuing multiple financing sources and developing a market mechanism, improving organisational structure, formulating technical standards.

Policy 3: Provides a technical guide for heat metering and energy-efficient retrofitting for existing residential buildings in the heating areas of North China. The contents of the guide include building energy efficiency diagnosis, basic principles of building energy efficiency retrofitting, retrofitting regulations, and methods of achieving the energy efficient building envelope. Heating system retrofitting, heat metering and the testing and evaluation of retrofitting results are also included.

Policy 4: Directs the assessment of heat metering and energy-efficient retrofitting projects, including the reference, condition, scope, and procedure of accepting the projects.

Policy 5: Seven tasks were specified in this policy: (1) to widely promote heat metering prices and charges based on consumption; (2) to improve the supervision of heat metering installation in new buildings; (3) to reach the target of 150 million m² for existing residential building retrofitting work set by State Council; (4) to reinforce the responsibility of the heat supply company; (5) to complete the heat metering technology system; (6) to strengthen the quality supervision and inspection of the heat metering products; (7) to strengthen the management of energy efficiency of the heat supply network.

Policy 6: To ensure the accomplishment of the target for the 11th Five-Year period (as set in Policy 1) by the end of 2010, Policy 6 was released at the beginning of 2010 to push progress. It specifies the work requirements of existing building retrofits for the local construction and financial bureaux: so as to ensure the accomplishment of the retrofitting work in 2010 with good quality, and to conclude the retrofitting mode by the 12th Five-year period (BigEE, 2013).

The retrofitting work focuses on the following three areas:

- 1. Heat metering and temperature control equipment:** 'installation of heat meters in boiler and heat stations; meter installation in the entrance of the heating network of a building or of a building group (if the buildings have very similar characteristics); and method development for disaggregating the heat use of each dwelling'.
- 2. Retrofitting the heat supply network for heat balance:** 'energy-efficient improvement for heat supply, such as boilers and heating substations; retrofitting the heat network and installing hydraulic balance valves if needed; and installation of thermostat valves and regulating valves with an automatic temperature control function together with pipe system replacement to improve the indoor heating system'.
- 3. Energy-efficient retrofitting of building envelope:** 'exterior windows, walls, and roofs with measures such as double-glazed windows, window frame sealing, more efficient windows, external insulation of the walls, and direct inverted roof insulation.' In accordance with the specifications of the accounting method, U-values of components must meet the local energy-saving design standards.

9. CONCLUSIONS AND RECOMMENDATIONS

The deep and almost complete renovation of the existing EU building stock by 2050 is an essential component for meeting the long-term energy and climate goals. Moreover, the renovation of existing building stocks to low-energy standards will achieve important socio-economic benefits to society, like improvement of the quality of life, new jobs generation and saving investment in new energy supply capacities.

To stimulate renovation, the EPBD introduced energy performance requirements for major renovations of buildings or building elements and all EU MS transposed these requirements into national policies. Consequently, in almost all EU MS, there are either specific thermal performance requirements for building elements or requirements for the energy performance of a building as a whole (or a combination of the two). There are pros and cons attached to each of the approaches. The primary advantages of requirements for building components are that they are easier to explain, verify and enforce. On the other hand, they are difficult to regulate and for instance indoor works are especially difficult or even impossible to check (CA, 2012). Applying whole-building requirements, on the other hand, makes it easy to set ambitious energy performance requirements for major renovations, change of use and extensions, as well as to avoid costly measures that only have a small effect on the energy demand of the building (CA, 2012). The regulatory approach used in EU Member States (MS) depends on many factors, including local building culture and tradition, historical development, national building regulations, capability of enforcing energy requirements and checking compliance at the design and construction phases of buildings with the requirements (CA, 2012).

Furthermore, energy performance certification of buildings is widely implemented among EU MS and is used not only as a market awareness instrument but also as a tool to establish rules and control renovation activities. However, the recast EPBD is still under transposition, and not all EU MS have yet abolished the threshold of 1000m² floor area above which the major renovation requirements apply in their national policies and regulations. Moreover, only a few EU MS have introduced specific renovation requirements for existing buildings and it is not foreseen that similar requirements will be introduced in the coming years.

National policy frameworks differ from one country to another. In many cases, the secondary legislation is not very stringent and thus implementation does not always have the anticipated impact. Therefore, the consistency and commitment to implement the existing regulatory framework and set effective compliance checks is key for reaching the estimated energy and carbon savings and to ultimately transform the renovation market.

In addition to national regulations, the settlement of the renovation requirements at regional and local level becomes increasingly important. In certain regions and cities, like in Italy, good relevant practices have been established. Similar examples can also be found in the United States and Australia. It should be stressed that this kind of bottom-up process of improving the renovation practices at city or region levels and strengthening accordingly the local regulatory framework allows leading players to move beyond the ambitions at national level and catalyse the development of similar measures in neighbouring regions by proving the socio-economic effectiveness of programmes and initiatives.

Nevertheless, the need of fostering deeper renovation of the existing building stock is sometimes **much higher than buildings' owners affordability**. Moreover, the energy renovation of buildings has to be economically viable and while deep renovation may be cost-effective over the lifetime of the measures, the relatively high up-front capital cost acts as a significant barrier for market uptake. Therefore, in virtually all EU MS the renovation requirements are accompanied by support programmes and measures offering economic incentives in varied forms, like grants, preferential loans, tax deduction and rebate, environmental and/or energy taxes and soft measures such as voluntary agreements, one-stop-shops offering advice and professional support. More innovative financing measures are energy savings obligations for energy suppliers (sometimes referred to as White Certificates schemes), Third Party Financing/Energy Performance Contracting and Energy Services Companies (ESCOs). The economic support is offered through varied instruments, like dedicated investment banks or credit lines, revolving funds, national programmes implemented through private banks or local administrations etc. The effectiveness of these economic incentives varies largely and is determined by the attractiveness of the economic support on a given market for different building types, ownership and purchasing power and by the ability to secure a predictable evolution of the instrument through long-term policy agreements and through the right integration of benefits at macro-economic level.

However, the economic support should gradually lead to market based activities and once again the long-term design and periodic evaluation of the overall policy, regulatory and market framework are important conditions for accomplishing an effective market transformation. This is also the objective of the Energy Efficiency Directive stipulating EU MS to elaborate long-term renovation strategies and plans.

Hence, in order to develop functional and effective renovation plans, MS should consider several important elements such as:

- To elaborate a stable and predictable policy and regulatory framework based on periodic evaluation and improvement within a consultation process involving all relevant stakeholders.

- To have enough accurate data concerning the existing building stock for shaping the right policy and investment framework as well as for properly monitoring the impact of implemented measures.
- To have dynamic building codes, with a predictable constant evolution towards more stringent requirements and supported by an effective compliance system.
- To introduce the right support measures, properly addressing different building types and owner categories, offering a stable business framework and able to catalyse investments.
- To avoid potential conflicts and overlaps of varied support instruments and to create a simple administrative framework by eliminating the existing barriers.
- To increase the knowledge and skills of architects, designers and the workforce in the construction sector in order to be able to deliver cost-effective solutions for low-energy renovation.
- To increase the awareness of all relevant stakeholders and especially of building owners by offering one-stop-shop points that offer information concerning economic support and basic technical advice as well as administrative support for renovation activities.
- To stimulate research and the local supply chain industry as an important factor for minimising the costs and maximising the macro-economic impact of renovation activities.
- To stimulate and keep high the public perception concerning the need for renovation of the existing building stock. Motivation and self-commitment are vital in securing market transformation. Offering a clear image of economic benefits to the market may consequently contribute to a faster and more complete transformation of renovation practices.

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