Energy retrofit of historic and existing buildings. The legislative and regulatory point of view

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ABSTRACT

The building sector is one of the key consumers of energy in Europe; consequently, European Union has enacted several directives dealing, directly and indirectly, with energy efficiency in building aiming to reduce the buildings energy use. Those directives, while dealing with existing buildings, do not take care of the Architectural Heritage in a specific uniform way adopting the derogation regime: exceptions are available at the national level to exclude from their application buildings listed in the Architectural Heritage as historic buildings. Thus any country can adopt its own rules to include or exclude buildings from respecting the energy efficiency requirements for existing buildings. Consequently, up to now no general rules, codes and standards are available for energy retrofit of historical and architectural valuable buildings. On the other side, no international act, in the field Architectural Heritage conservation, deals with energy and energy retrofit. Furthermore, the European Union Treaty does not comprise the Cultural Heritage as matter of European legislation. Thus to cover this gap between historic/historical building and energy retrofit a lobbying action is needed, managed by the national Cultural Heritage authorities, which can steers EU policy in a more effective way towards energy retrofit of historic/historical buildings.

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1. Introduction

The building sector is one of the key consumers of energy in Europe where energy use in buildings has seen overall a rising trend over the past 20 years. It is estimated that there are 25 billion m^2 of useful floor space in the EU27, Switzerland and Norway with a gross floor space equivalent land area to that of Belgium (30,528 km^2). Non-residential buildings account only for 25% of the total stock in Europe, but comprise a more complex and heterogeneous sector compared to the residential sector.

In 2009, European households were responsible for 68% of the total final energy use in buildings. Energy in households is mainly consumed by heating, cooling, hot water, cooking and appliances where the dominant energy end-use (responsible for around 70%) in homes is space heating [1].

Several actions have been taken by the European Commission to reduce this energy consumption through two Energy Performance Building Directives: Directive 2002/91/EC [2] and Directive 2010/31/EU [3], shortly EPBD and EPBD recasting. While the first directive was more focused on methodologies and new buildings

(i.e. new constructions), the second is giving more importance to the existing buildings not only when subject to major renovation but also when building technical elements and/or technical systems are retrofitted or replaced.

This major attention to the existing buildings relates to the low annual growth rates of new constructions, which in the residential sector are around 1% while most countries encountered a decrease in the rate of new build in the recent years, reflecting the impact of the current financial crisis on the construction sector [1]. Nowadays it is very evident that, to reduce fossil fuels consumption and CO_2 production in the building sector, the challenge is to reduce existing buildings energy needs.

In fact, a substantial share of the stock in Europe is older than 50 years with many buildings in use today that are hundreds of years old. More than 40% of our residential buildings have been constructed before the 1960s when energy building regulations were very limited. A large boom in construction in 1961–1990 is also evident through our analysis where the housing stock, with a few exceptions, more than doubles in this period [1] (Figs. 1 and 2).

Data on typical heating consumption levels of the existing stock by age shows that the largest energy saving potential is associated with the older building stock where in some cases buildings from the 1960s are worse than buildings from earlier decades. The lack of sufficient insulation of the building envelope in older buildings

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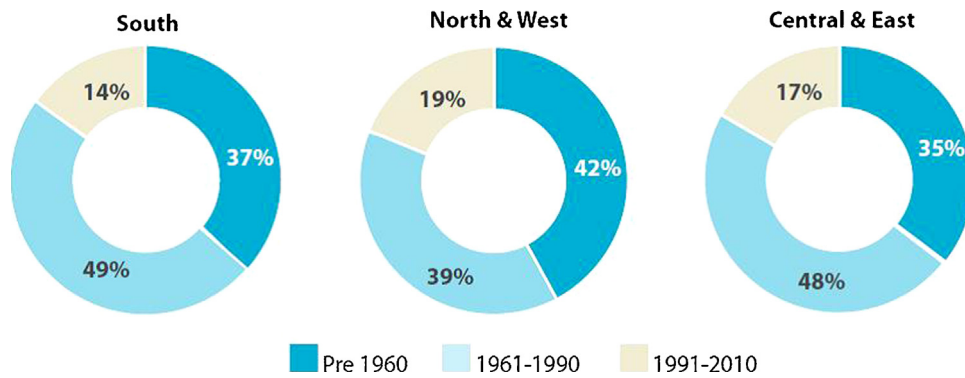E-mail address: livio.mazzarella@polimi.it

Fig. 1. Age categorisation of housing stock in Europe.
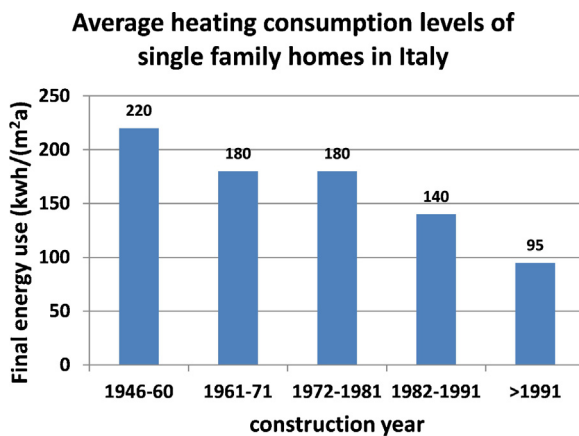
Adapted from [1].

Fig. 2. Average heating consumption levels in terms of final energy use of single family homes by construction year in Italy.

Adapted from [1].

was also reflected through the historic *U*-value data, which comes with no surprise, as insulation standards in those construction years were limited [1].

The average specific energy consumption in the non-residential sector is 280 kWh/m^2 (covering all end-uses), which is at least 40% greater than the equivalent value for the residential sector. In the nonresidential sector, electricity use over the last 20 years has increased by a remarkable 74% [1].

After the EPBD and the EPBD recasting entered into force, member states have shown an increased interest in interventions aimed to obtain energy saving in existing buildings. This resulted in an explicit article on building renovation in the Energy Efficiency Directive 2012/27/EU [4].

All these considerations drive to the conclusion that energy retrofit of existing buildings is a very important challenge in reducing energy consumption, but such opportunity has to be managed carefully. The wide variety of existing building, age by age, does not allow having a unique approach to the problem as it is possible for new constructions. This is mainly the case of historic buildings, which, while belonging to the existing building category, have to be treated in a very specific way, usually case by case. For instance, an open question is the definition of "historic building" itself and the reasons for which it has to be treated differently or not from an "ordinary" existing or "historical" building. Another important point is that there is variety of terms used in the building sector which may overlap; thus it is important to clarify what exactly is a retrofit, and how it differs from a renovation or a refurbishment.

While in Appendix A definitions are reported to clarify the meaning of such last terms, the question of what a historic building is will be addressed in the following.

2. Historic buildings versus historical and contemporary existing buildings

"Historic" is an adjective that means something important or influential in history, while "Historical", on the other hand, it is an adjective that refers to anything from the past. Thus, a historical building is one that is related to history but may be not important at all from the History's point of view, whereas a historic building is important by definition.

The simplest definition of a historic building is that related to three essential attributes [5]: to be considered "historic," *a property must have sufficient age, a relatively high degree of physical integrity, and historical significance.*

2.1. Age

A property must be "old enough" to be considered historic. Generally speaking, this means that a property must be at least 50 years old, although this is just a general rule of thumb. Another way of looking at it is that a property must be old enough to have been studied by historians, architectural historians, or archaeologists so that its place in history is clear. This latter perspective allows some types of properties that are less than 50 years old to be considered "historic."

2.2. Integrity

In addition to having sufficient age, a property must retain its historic physical integrity. For a building, structure, landscape feature, historic site, or historic district, this means that the property must be relatively unchanged. Its essential character-defining features relative to its significance must still be present. For an archaeological site, integrity means that the site must be relatively undisturbed, with its patterns and layers of artefacts and other archaeological evidence relatively intact. For a traditional cultural property, integrity means that the site must be recognizable to today's affiliated cultural group, evidenced through tradition, and still used or revered in some way.

2.3. Significance

Finally, and most importantly, a property must be significant to be considered historic. Significance is defined in three ways: (1) through direct association with individuals, events, activities, or developments that shaped our history or that reflect important