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## Energy efficiency and renewable solar energy integration in heritage historic buildings

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### Abstract

When facing a retrofitting project which tries to improve the energy performance of a cultural heritage building it is necessary to weigh carefully different aspects such as: energy efficiency, modernization and comfort. These energy improvements are desirable, but are not always possible without compromises. The situation may become slightly problematic when solar energy systems should be installed in historic buildings. The first step to overcoming barriers successfully, is to better understand the processes for both, historic preservation and solar PV project implementation, and to foster working with professionals in each sector to receive appropriate support and guidance. Establishing an assessment criterion for each step was the top priority of the research project presented here to assist in achieving a successful result.

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### 1. Introduction and general framework

#### 1.1. Energy efficiency in historic buildings

Historically significant buildings are listed on local, national or international register providing certain degree of protection. Any physical alteration, including repairs, additions, refurbishment, energetic renovation, etc. to these

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important properties requires review and approval by the corresponding official body. When designing an intervention aimed at improving the energy performance of a historical building, the project development process must consider a number of factors: the historical features to be protected, the final use of the building as a whole, the energy and comfort requirement for people and artworks. High performance window frames, well-insulated opaque surfaces and claddings, efficient thermal installations and passive techniques for heating and cooling are all interventions aimed at reducing the consumption of the building, and which must be assessed in the early stages of the design. For protected historic buildings it is not possible to operate freely especially if one considers that the attitude related to the necessity of intervening “energetically” may thwart the desire for conservation and in some cases be almost irreconcilable. Solutions such as high performance window frames, well-insulated opaque surfaces and claddings, efficient thermal installations and passive techniques for heating and cooling to reduce the consumption of the building must be assessed in the early stages of the design.

The construction standards to which these buildings were built differ from those in place today, and often do not meet current energy and comfort needs. Only rarely it is possible to vary the envelope’s elements of protected buildings, since the aesthetic appearance would be affected, but these elements perform a fundamental role in ensuring a good level of thermal insulation. In fact, the objective of a historical building energy adaptation project is to improve the levels of comfort and to reduce the energy consumption required for heating, lighting and other purposes. Historical buildings often represent interesting construction models associated with the local area, the financial use of materials and local building methods. Historical buildings often require specific micro-climatic conditions. It is sometimes necessary to find a balance to satisfy the requirements of the building, the occupants and the exhibited objects, also considering that the “well-being” of people does not usually correspond with the “well-being” of objects and collections [1].

In order to cope with the challenges set by today’s society, and to meet local and international legal/regulatory requirements towards energy efficiency and zero energy consumption [2], there must be more in-depth discussion between all the technical field experts and all the involved parties. Just a few of European [3, 4] and national [5, 6] research projects have already proposed innovative approaches to raise energy efficiency through urban development and the refurbishment of the building stock. It is also important to consider that future action in our cities will involve the redevelopment of existing buildings, with the aim of reducing the extent of land coverage. For now, and for the near future in the construction field, it will be even more necessary to execute work on the existing heritage, in order to use the ground in a sustainable manner by means of more effective use of zones that have already been built. In order to slow down the process of messy city expansion, the issue of densification is now under discussion. Furthermore the need for high-quality densification of urban settlements is also gaining ground in public opinion [7].

It is therefore necessary, to develop a working method that is as objective as possible and that will reduce the possibility of contradictions based on personal and arbitrary appreciations. Moreover, to identify the best ways for energy saving while at the same time, respect the historical, and cultural value and its environment, a correct approach that evaluates all parameters in an integrated assessment studying the building components as well as the typological and functional parameters in order is needed. By “cultural approach”, we mean close collaboration between those appointed to execute the work, under the careful direction of the institutions responsible for protecting the building.

### *1.2. Solar energy resources*

As highlighted before, the new regulatory framework together with the increasing densification of cities, lead to consider the importance on using solar technology also for historical buildings [8]. This option has not been properly utilized yet because of psycho-social barriers and lack of information [9]. Furthermore, there are worthy examples, based on meticulous research aimed at appropriate integration, and that demonstrate the enormous potential of integrating these elements into historical buildings.

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