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The impact of the energy performance improvement of historic buildings on the environmental sustainability

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Abstract

The historic buildings represent an important part of the built environment. The possibility to reuse spaces that represent the local cultural heritage plays an important role in maintaining the identity of a population and its traditions. The steps to be faced for smart renovation of historic buildings and recent constructions are not the same, as in the first case artistic and architectural constraints have to be respected. The most classic intervention technologies are not always applicable and different solutions must be taken into consideration, to be less invasive and not to disturb the constructive materials, the shapes and lines harmony of the existing structures. In this context, the sustainability of the energy renovation solutions is analysed, verifying if they lead jointly to good rating both in the energy performance and in the environmental sustainability certification.

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Keywords: energy audit, monumental historical architecture, energy performance, energy management process, environmental sustainability, energy sustainability

1. Introduction

Changes in contemporary age force the scientific community to face the challenges of sustainable growth, even within the historical Cultural Heritage, tangible or intangible, a crucial issue for human activity and behavior, strictly linked to the three main pillars of future development [1]. Heritage often becomes the driving force for commerce, business, leisure and tourism: numerous economic processes are based on the re-development or re-significance of the term «territoriality», starting from the consciousness of its cultural values (economic pillar). The global Cultural Heritage, moreover, strengthens identities, well-being, and respect for culture and societies and an appreciation of diverse inheritance and its

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continuity for future generations promote mutual understanding between people, communities and nations (social and cultural pillar). Traditionally, historical architecture is the complex and stratified product of a building culture, necessarily careful to environmental conditions and characters, to natural materials, to building morphologies that dialogue and safeguard with the territory (water regulation and storage, oversight of the slopes, soil erosion protection, governance of forest resources and agricultural etc..) (environmental pillar).

Nevertheless, the relation between Sustainability and Heritage is often reduced to the mere Energy Efficiency of the buildings, simplifying a complex problem into the exclusive item of energy saving. Consequently, technical innovation remains still largely a process of the application of products and technologies. This often leads to a greater emphasis on the technical components that do not correspond to effective cultural advancement. Neither do they improve the capacity to assimilate and modify the technology to achieve higher long-term objectives [2]. A new and different approach can then be investigated and practiced in the relationship between Heritage and Sustainability, to help overturning objectives and cultural references almost exclusively of technical nature, returning to consider the technique a mean and not the end of our actions.

Within this framework, the assessment of environmental sustainability of historical buildings, in an early stage of the energy improvement design, may help to recognize potential ways of enhancement, and this is specifically the aim of the work presented in this paper.

To make an appropriate choice, firstly, the available international and national tools have been analyzed, and the most suitable among them applied on a case study (a large complex built between the XVII and the XIX Century, not currently used in a significant part, almost 70%). Actions to reduce energy needs are considered and are evaluated in terms of sustainability, jointly with constraints and possibilities of intervention. Finally, the levels of sustainability are compared before and after the considered actions, to analyse how to enhance them more, and up to which point.

As in the sustainability protocols, in general, the energy aspects weights account for about 30%, the score improvement of the energy sustainability may not be particularly relevant. However, since the energy improvement interventions can also affect issues related to other sections of the assessment method, there can be positive impacts on a larger part of the criteria, according to the indications and constraints of the Cultural Heritage official body that guarantee the protection of the historical features.

Moreover, the growing interest given to the energy efficiency could increase also the attention to renewable energy adoption in historical contexts and valuable landscape. The support of renewable energy sources is often difficult to be considered, as their impact on the ancient structures may be not allowed, even if, in some cases, also photovoltaic systems have been incorporated in old structures [3], effectively supporting the energy-efficiency improvement [4]. Although the contribution of renewable energy sources can be, in the case study, very small, it could be nevertheless useful to a demonstration level, such as to show a greater sensitivity to energy conservation and renewable energy exploitation.

2. Methodology

The Environmental Sustainability protocols are promoted by some international organizations such as USGBC, iiSBE, BREEAM, etc.

The USGreen Building Council (USGBC) has, as its purpose, the promotion and the development of a comprehensive approach to sustainability, giving recognition to virtuous performances in key areas of human and environmental health. Its methodology, LEED - Leadership in Energy and Environmental Design, is a system of certification of buildings, born on a voluntary basis and applied in more than 140 countries worldwide [5]. Five rating systems that address multiple project types are considered: Building