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ScienceDirect

Energy Procedia 133 (2017) 401–411

Energy Procedia

www.elsevier.com/locate/procedia

Climamed 2017 – Mediterranean Conference of HVAC; Historical buildings retrofit in the Mediterranean area, 12-13 May 2017, Matera, Italy

Evaluation of refurbishment alternatives for an Italian vernacular building considering architectural heritage, energy efficiency and costs

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Abstract

Despite the majority of legislative requirements in terms of energy performances is not addressed to historical buildings, there is an increasing consciousness on their relevance to reach the European CO_2 emissions' reduction goals. This paper engages the theme of traditional buildings' refurbishment, with a view to the necessity of a conscious intervention in terms of heritage preservation, energy efficiency and financial viability. In particular, the research analyzed a real case study of a rural building located in North Italy; the main objective of the study is to compare two different refurbishment scenarios by simultaneously considering architectural, energy and financial aspects.

Peer-review under responsibility of the scientific committee of the Climamed 2017 – Mediterranean Conference of HVAC; Historical buildings retrofit in the Mediterranean area

Keywords: Energy retrofit; cost-optimal analysis; vernacular architecture, architectural heritage.

1. Introduction

The necessity to conserve historical buildings have always been dictated by the moral commitment to transfer the knowledge of what history left to future generations. Today, the conservation of this kind of historical evidences

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1876-6102
Peer-review under responsibility of the scientific committee of the Climamed 2017 – Mediterranean Conference of HVAC; Historical buildings retrofit in the Mediterranean area
10.1016/j.egypro.2017.09.370

is usually conceived with a view to their valorization that involves the adaptation of these buildings to the current necessities, both in cultural and legislative terms. In this framework, conservation and valorization have nowadays to deal with the current financial crisis and the environmental emergency. To comply these necessities, international authorities has already elaborated operative plans and legislative measures at several levels. The European Union (EU) handled the issue of sustainability by providing a long-term framework to Member States (MS). In 2011, the "Roadmap for moving to a competitive low-carbon economy in 2050" was released, expressing the view to achieve an 80% reduction of EU's GHG emissions by 2050 (compared with 1990 levels) [1]. For this purpose, the contribution of buildings is crucial; indeed, the same document showed that in this sector GHG emissions could be reduced up to 90% by 2050 (compared to 1990 levels). Despite the majority of legislative requirements in terms of energy performances are not addressed to historical buildings, they have a great influence to reach these goals. Indeed, several statistical data show that 14% of the European building stock dates from before 1920 and this percentage could dramatically grow in some historical cities. In Bologna (Italy), for example, around 80% of city center's buildings was built before 1949 [2]. Beside general long-term strategies, EU Commission set out specific targets to achieve high energy performances in buildings. In particular, two legislative measures have been taken; the Energy Performance of Buildings Directive 2002/91/EC [3] and its recast version (2010) [4]. Specifically, EPBD recast introduced the concept of nearly-zero energy building (nZEB) and a methodology to define national targets for this kind of buildings, called cost-optimal analysis. The cost-optimal analysis was described in 2012 by EU's Guidelines [5] and allowed Member States defining national requirements adopting a similar approach but also following their specific building stock features and financial situations. Moreover, EPBD recast set out the minimum energy performance requirements should be set with a view to achieve cost-optimal levels for buildings and building elements. A cost-optimal level represents the energy performance level which leads to the lowest cost during the estimated economic lifecycle. According to EU instructions, it has to be calculated through the global cost method from the European Standard EN 15459:2007 [6]. The great potentiality of this methodology lies in the possibility to individuate an ideal solution that considers both energy and financial evaluation. For this reason, recently some studies explored the possibility to use it as a decision-making tool for single design cases, but there are not experimentations on historical buildings yet. Currently, heritage preservation and energy efficiency measures are often conceived as mutually exclusive purposes. Instead, it should be considered that energy retrofit measures could contribute to historical buildings' preservation by enhancing their livability and financial sustainability, improving structural protection and enhancing comfort for occupants. The main objective of this study is to compare two different refurbishment scenarios by exploiting the potentialities of cost-optimal analysis in order to simultaneously consider architectural, energy and financial aspects [7], [8]. The research adopted a real case study, a traditional rural building located in North Italy for which the private owner asked for an energy retrofit and a building's refurbishment to open a small lodging establishment. The refurbishment alternatives were elaborated in order to obtain a large discrepancy in investment costs and design solutions. In particular, the “high investment scenario” aimed at obtaining high energy performances with a less architectural conservative approach, while the “low investment scenario” aimed at accomplishing the national energy requirements minimizing the interventions on the architectural fabric. Regarding the energy and financial characteristics of the alternatives, the comparison between the scenarios was made through the cost-optimal methodology. In particular, the energy performances were assessed by a dynamic simulation software, while the financial analysis was developed using the global cost method according to the EU standard 15459:2007 [6]. In a second phase, a partial review of the global cost formula was proposed and applied in order to include specific peculiarities of the case study. This modification proposal was made for two main reasons. First, since this methodology was conceived for national authorities, its use as decision-making tool for specific cases could request a more holistic approach. Moreover, historical buildings are usually characterized by specific necessities and conservation priorities, so cost-optimal levels identified at national level will not be necessarily cost-optimal for every single building or investor. In this case, using the cost-optimal methodology as decision-making tool, the analysis should include other elements of evaluation. Indeed, considering the lodging activity, beyond the environmental implication the private investor will be interested in recovery the initial investment, privilege the more financially-convenient solution and the future possible incomings. Finally, by comparing the results of the previous analysis, some considerations were made about the use of cost-optimal methodology as a decision-making tool for single design cases and regarding the two design scenarios by focusing on conservation, architectural heritage, energy and financial aspects.

2. The case study