Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 133 (2017) 412–423

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

The "Cost Optimality" Approach for the Internal Insulation of Historic Buildings

Elena Lucchi[a]*, Magdalena Tabak[b], Alexandra Troi[a]

[a]*Eurac Research, Viale Druso 1, 39100 Bolzano, Italy*
[b]*Sapenza Università di Roma, Piazzale Aldo Moro 5, 00185 Roma*

Abstract

The Directive 2010/31 UE (EBPD) introduced the "Nearly Zero Energy Buildings" linked to cost optimality, where energy benefits are related to economic benefits. The "Cost Optimality" methodology is applicable both to new and existing buildings, as introduced in the Regulation 244/2012. This methodology was largely applied to existing building, but the literature on historic buildings lacks. However, given the potential of energy retrofit of this kind of buildings, it would be appropriate to develop a specific methodology for the economic valorization of the heritage, considering also the conservation and the historic value of the patrimony. In fact, on the one hand this methodology could be useful for the "energy valorization" of a historic building in relation to the minimum requirements of European and national legislations and budgets. However, on the other hand, we noted the absence of shared information at national level and examples of the "historic reference buildings". For this reason, case studies on historic buildings become an important starting point to create common typological and repeat-able models for applying this methodology. This research aims at evaluating the economic benefits of energy retrofit of a traditional historic masonry, using the "Cost Optimality" methodology. This method is structured into the following parts: (i) definition of the type of masonry; (ii) selection of the insulation systems; (iii) assessment of the energy benefits related to the insertion of various insulation materials; (iv) evaluation of the Life Cycle Costing; (v) evaluation of the optimal insulation performance and cost-effectiveness; and (vi) comparison of energy consumption and Life Cycle Cost to de-fine the most appropriate interventions for the historic wall.

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

* Corresponding author. Tel.: +39-0471-55653; fax: +39-0471-055699.
E-mail address: elena.lucchi@eurac.edu

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.2017.09.372

Keywords: Cost Optimality, Historic Building, Nearly Zero Energy Building

1. Introduction

European policies on energy efficiency in buildings gave a high effort for obtaining ambitious requirements of energy performance and use of renewable energy sources, to get strong benefits for the reduction of greenhouse gas emissions, both on new and existing buildings. They suggested increasing the rate of the total renovation of the existing buildings, which represent the sector with the greatest potential for energy savings and environmental sustainability (1). In line with the European programs, several studies confirmed that is not enough to build new high-performance buildings for reducing the carbon dioxide emissions (CO_2) and for improving the energy efficiency (2; 3; 4). In this context, the European Directive 2010/31/EC set the minimum requirements of energy performance, both for new construction and existing buildings. Particularly, it defined the target of the nearly Zero Energy Building (nZEB) as "(…) *a building that has a very high energy performance (...). The nearly zero or very low amounts of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby*" (5, art. 2). This ambitious target concerns also existing buildings that require major renovations in order to meet the minimum energy performance requirements, to reduce the greenhouse emissions related to construction and to make the construction market independent from imports. The directive promotes with the Cost-Optimality considerations minimum requirements, which target not only short-term payback, but promote long-term convenience and economic optimization. This methodology is called cost-optimality approach and aims at reducing the costs over the estimated useful life of the building, maintaining high-energy performance standards. The high potential of this method encouraged its use as a decision making tool for selecting the optimum intervention in different energy scenarios. The Directive defined the "cost-optimal level" as "(…) *the energy performance level, which leads to the lowest cost during the estimated economic lifecycle*" (5, art. 2). It is determined taking into account the energy-related investment, maintenance, and operating costs (5, art. 2). Each Member State has to estimate the economic lifestyle for the whole building or the building element. In general, the "building" is considered as a "product" with a programmable and predictable life cycle over a period of 20 or 30 years. The Regulation 244/2012 set out the methodology for comparing energy efficiency measures and costs for new constructions and building renovations (6). The Regulation defined two schemes for the calculation of global costs to be applied in the cost-optimality approach: (a) "financial calculation" and (b) "macroeconomic calculation". The relevant criteria to be taken into account for the financial calculation are: (i) energy needs and (ii) overall costs in terms of Net Present Value (NPV). The overall costs to be considered are: (i) initial investment costs; (ii) running costs such as costs for periodic replacement of building elements; (iii) energy costs that reflect the overall energy cost, including energy price, capacity tariffs and grid tariffs; and (iv) disposal costs if appropriate. In addition to the energy needs and the overall costs, the macroeconomic calculation included the (v) costs of the greenhouse gas emissions. However, specific suggestions for cultural heritage buildings are missing. In Italy, the law 63/2013 set the minimum requirements for nZEB, both for new and existing buildings. Listed buildings are excluded, while existing buildings (also, historic but not listed buildings) are fully subjected to the legislation (7). In general, it considers the same requirements of the Regulation (6).

The cost-optimality approach started in the industry sector and only in a second time was applied to the building sector. In the last case, the Regulation was investigated at European (8) and national levels (4; 9; 10) mainly for new buildings or for the energy retrofit of post-war buildings. BPIE (8) studied the energy benefits related to different energy efficiency solutions for residential buildings in Austria, Germany and Poland. At national level, ENEA (4) applied the cost-optimality approach to the energy retrofit of typical residential buildings located in the climatic zones B and E. Typical buildings were selected from the European Project Tabula. The energy retrofits regarded building envelope and systems, and respected the national standards for energy efficiency. The University of Salento (9) applied this methodology to an office building, comparing different energy efficiency solutions with the macroeconomic calculation scheme. This comparison showed a potential reduction of energy consumptions (39 %) and greenhouse gas emissions (41 %), also demonstrating the suitability of this approach for the design process. The University of Sannio (10) applied this approach to a historic building, using the macro-economic calculation scheme. The building is located in Benevento and was refurbished with different interventions on building envelope