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Proposal for a modified cost-optimal approach by introducing benefits evaluation

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Abstract

The recast of the Energy Performance of Buildings Directive introduced the concept of nearly-zero energy building and encouraged setting the nearly-zero energy target with a view to cost-optimal level - the energy performance that leads to the lowest cost during the building estimated economic lifecycle. To searching this regard, the cost-optimal methodology based on the global cost was defined providing a tool to assess different nearly-zero energy scenarios. Nowadays, the cost-optimal analysis is used as a decision-making tool between different energy design alternatives mostly on a theoretical level; but it has spread little among the professional field. The aim of this paper is to give a more holistic and all-comprehensive approach to the cost-optimal methodology. This paper proposes and applies a modified approach of the cost-optimal evaluation, which will lead to the achievement of more interesting results for all the actors involved, including investors and final users. This study highlights the usefulness of including not only costs but also benefits that can derive from each energy design scenario. Choosing different energy efficiency solutions, the related benefits evaluation could turn the tables. Different kinds of benefits could be considered as the increase of the real estate market value, the enhancement of the indoor comfort, the reduction of CO_2 emissions and others. Thus, a proposal of how quantifying these qualitative benefits in monetary terms is shown to introduce them in the global cost formula. Actually, benefits conversion into monetary values is the most challenging issue. Precisely, this paper shows a list of benefits that can affect the choice of different envelope and HVAC system solutions, pointing out their influence on the global cost evaluation. Certainly, introducing benefits in the global cost formula means using a more holistic and complete approach, while the already complex degree of the cost-optimal methodology – due to the numerous input data –increases. To validate the reviewed global cost formula, it will be necessary to apply it to various case studies.

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Keywords: cost-optimal approach; benefits; HVAC systems; nZEB targets

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1.Introduction

Reducing energy consumption and CO_2 emissions is among the main goals of the European Union. Precisely, the recast version of the Energy Performance of Buildings Directive (EPBD) led moving towards new and retrofitted nearly-zero energy buildings (nZEBs) and introduced the cost-optimal methodology to compare different energy scenarios and set the minimum energy requirements for buildings.

Considering both energy and economic evaluation, this methodology represents an efficient decision-making tool in preliminary energy design phases. However, currently cost-optimal analysis is used mostly at a theoretical level by scientific researchers. Indeed, the methodology was conceived for national authorities to develop regulations at national level. Cost-optimal levels identified at national level will not be necessarily cost-optimal for every single building or investor [1], so the possibility to calculate specific cost-optimal conditions could be crucial. Referring to the current literature, different researches outlined the importance of including not only costs but also benefits to evaluate different energy design scenarios referred to both new and retrofitted nZEBs. [2]. Some studies considered as benefits the added real estate value [3,4], others the environmental impact, indoor comfort conditions and indoor air quality (IAQ) [5]; other studies illustrated the possibility to incorporate additional gains such as increased productivity and reduced sick leave in life cycle cost calculation (LCC) [6]. Despite several researches took into account different types of benefits in their evaluation, only a few arrived at their quantification in economic values [7]. Since until now benefits evaluation has not been included in the cost-optimal analysis, thus this paper aims to individuate, propose and summarize several benefits related to different energy design scenarios and shows different methods to convert them into monetary values. In this way, cost-optimal methodology could acquire a more holistic approach useful for choosing among different design configurations and give back results more interesting for all the actors involved in the design, construction and operation phases. The study began focusing on the identification of some benefits, evaluating their prerogatives and chances to monetize them. In particular, the current global cost formula was analyzed to individuate chances, lacks and opportunities and modified.

2. Benefits evaluation

An energy efficiency design is more and more important in the construction sector. Different design scenarios determine a variety of consequences in terms of esthetics, comfort, vendibility, sustainability and investment costs. Generally, design solutions, which are energy efficient, are considered as the most expensive. This is because considering an economic appraisal of an energy-saving investment for a building, the only benefit normally monetized is the energy cost saving, yet doing so undervalues the full impact. The next paragraphs attempt to list some benefits and examine how they were quantified or in case converted into money. In particular, real estate value, reduction of greenhouse gases (GHG), enhancement of indoor comfort, chance to access subsidies and incentives and possibility to obtain a low level of embodied energy were analyzed through a literary review and introducing a proposal for their economical quantification.

2.1 Real estate market value

Emerging evidences show that buildings with high-energy performance are more valuable in terms of resale or rent comparing to their less efficient counterparts as demonstrated by a study led in the Netherlands [2]. Regarding to the residential sector the increase in the real estate market value after the application of energy efficient design configurations has already been individuated by many studies. Probably, to reach a real awareness on this topic, a more in-depth study has to be conducted about the