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NZEB, cost- and comfort-optimal retrofit solutions for an Italian Reference Hotel

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Abstract

Building upon the implementation of EBPD recast in the large majority of EU Member States, this paper studied how far cost-optimality is from the Nearly Zero Energy Building (NZEB) performance level for an Italian Reference Hotel (RH) undergoing major renovations. The energy performances of retrofit options for the RH were compared with the Italian NZEB requirements. Simulations results confirmed that the Italian NZEB target is reachable. However, the financial analysis of these retrofit options denounced a worrying gap between financially interesting solutions and NZEB ones.
Then, through a novel comfort-optimal approach, the comfort-related consequences of the proposed retrofit options were investigated.

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Keywords: NZEB; Hotel; Cost-optimal; Thermal Comfort.

1. Introduction

In 2010, the EPBD recast [1] introduced the NZEB concept and by January 2021 all over Europe new private buildings will have to comply with nationally defined NZEB standards. Accordingly, most of MSs have now endorsed EU requirements in their regulations and set numerical indicators for new and existing buildings aiming to

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reach the NZEB level [2]. In the EU view, these national figures should also represent the cost-optimal level of energy performance from 2021 on, meaning that NZEB design options should be those leading to the lowest global cost during the estimated lifecycle of buildings. Indeed, EPBD recast also introduced cost-optimal methodology as the guiding principle for setting building energy requirements.

However, the envisaged full match between cost-optimal and NZEB energy performance level remains an open issue. Studies investigating the possible energy/financial performance gaps between the two levels can inform policy-makers about how demanding the forthcoming market transition towards an energy efficient building stock will be. To serve the cause, in the present paper the matter was investigated for the proposal of retrofit solutions for a Reference Hotel located in Italy, where NZEB minimum requirements are available since June 2015.

Several reasons led the authors to deal with hotel buildings. Primarily, hotels well represent a wide spectrum of non-residential buildings where multiple functions are in place. While cost-optimal and NZEB studies have flourished in recent years for residential (e.g. [3]) and office buildings (e.g. [4]), other non-residential categories have been rarely investigated. Nonetheless, the mixed energy uses of multi-functional non-residential buildings represents an interesting challenge for the simultaneous achievement of cost-optimal and NZEB performances. Additionally, hotels are highly regarded by the international community for their role in the transition towards a low-carbon society. This building category ranks third for specific energy uses of the non-residential EU stock [5]; given the drastic reduction in CO_2 emissions that is expected for the building sector by 2050 in Europe [6], high performing design solutions for hotel buildings have been strongly promoted by the European Commission in the last years, for instance through the neZEH project [7]. The role of tourism accommodations in sustainable development gained further attention in 2017, which was nominated “International Year of Sustainable Tourism for Development” by the United Nations General Assembly. Accommodation structures are accounted to be responsible for more than 20% of the total tourism-related emissions [8] and a drastic shift in the management of these businesses could significantly contribute the economic, social and environmental dimensions of sustainable development [9]. In this framework, the focus of the paper on the retrofit of an Italian Reference Hotel can represent an interesting case study at a broad scale, as Italian hotels represent 18% of the EU hotel stock [5].

Finally, the specific nature of hotels, buildings and businesses at once, gives the chance of coupling cost-optimal analysis with investigations on comfort conditions. Indeed, in order to run a successful accommodation business, reduced operational costs (e.g. energy costs) must be coupled with guests’ satisfaction, which chiefly requires comfortable indoor conditions [10]. Moreover, indoor comfort is widely recognized as an important co-benefit of energy efficient buildings from the macroeconomic perspective as well [11].

Building upon these premises, in the followings of the paper the Reference Hotel is introduced and investigation methods and results are presented for the performed energy, financial and comfort analyses.

Nomenclature

U	Thermal transmittance, W/(m^{2}K)
H'_T	Transmission heat transfer coefficient, W/(m^{2}K)
$A_{sol,est}/A_{net\ area}$	Normalized summer effective solar collecting area of glazed elements, ND
$EP_{H,nd}$	Heating energy need index, kWh/(m^{2}y)
$EP_{C,nd}$	Cooling energy need index, kWh/(m^{2}y)
$EP_{gl,tot}$	Total global primary energy index, kWh/(m^{2}y)
η_H	Heating plant and system efficiency, %
η_W	Hot water production plant and system efficiency, %
η_C	Cooling plant and system efficiency, %
RES_{DHW}	Share of renewable energy sources for DHW production, %
$RES_{DHW+H+C}$	Share of renewable energy sources for DHW, heating and cooling energy uses, %
PMV	Predicted Mean Vote, ND
PPD	Percentage of People Dissatisfied, %