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Building monitoring system in a large social housing intervention in Northern Italy

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Abstract

Within the framework of the well-known problem of the performance gap, the paper demonstrates how a building monitoring system is able to provide feedback data instrumental to address the ongoing management issues of multi-family buildings in social housing: the need to have a good understanding of what works and what does not in building operation, the need of bills controlling and allocation of individual costs between the occupants, the facility and energy management requirements including the understanding of occupant's behavior. It adopts a case study approach, discussing the case of a large environmentally friendly social housing intervention consisting in 323 flats, in which a building monitoring system was installed.

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Keywords: performance gap; building monitoring; asset and operational rating; occupant behavior; energy management; facility management; energy savings; water savings;

1. Introduction

In Europe the energy consumption of the residential sector accounts for 25% on the overall building sector energy consumption. Considering the strict path established in the 2030 climate and energy framework at European level for reaching a 40% (below 1990 level) of CO_2 carbon reduction by 2030, strong efforts are needed into the adoption of actions for understanding the complexities related to the building actual operation. As widely reported in literature,

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buildings rarely perform as predicted during the design stage. The mismatch between the expectations around the energy performance of new buildings and the real energy bills has been addressed as " performance gap" [1,2]. A similar phenomena, addressed in literature as "rebound share" or "energy savings deficit", interests the refurbishment of existing buildings, where energy savings achieved in practice (and thus the reduction in CO2 emissions) due to building retrofit measures is lower than those calculated in engineering conservation studies [3].

Generally, the reasons causing the performance gap are categorized into three main groups: causes that pertain to the design stage, such as wrong assumptions in the energy models and inadequate predictions, causes rooted in the construction stage, such as difference between design and real construction, and causes that relate to the operational stage, such as not correctly operating systems as commissioned (including deficiencies in equipment installation and proper maintenance) or building occupants not behaving as supposed [4].

The minimization of the performance gap is a key issues in case of public-private social housing project where energy performance measures are a crucial driver of feasibility. It has been demonstrated that high energy performance of buildings is a leverage for the provision of affordable housing; lower energy bills turns into tenants willingness to pay higher rents, increasing economic benefits for the investor [5].

Given the state of the art, it is evident that bridging the gap between predicted and measured, especially when delivering high energy efficient building, is a complex problem that involve all the building industry chain. Lots of improvement opportunities can be found in each building delivery stage. But an emerging interest in the field of building performance monitoring has aroused. Efforts are increasingly underway to link prediction and measured data in integrated building information systems; while this does not necessarily bridge the gap, it at least works towards increasing the stakeholders (designers, users, facility manager, etc.) awareness about the problem. Refer for example to the CarbonBuzz project launched in 2008 by the Royal Institute of British Architects (RIBA) and the Chartered Institution of Building Services Engineers (CIBSE); it is a free online platform allowing practices to share and publish building energy consumption data anonymously, comparing that to predicted and benchmark values. A similar data gathering tool is Arc, an online where any project can participate and immediately start measuring energy and sustainability performance across any rating system or standard and benchmark against the industry values.

It's important to note that, as minimum energy requirement becomes more stringent, housing are becoming more complex in terms of installed engineering systems. In these cases, the building monitoring is strongly recommended [6], as it could provide objective data to:

- better understand the real performance of buildings monitoring the energy consumption, the behavior of occupants and their interaction with new technologies;
- assess the usability, reliability and acceptance of new technologies;
- address operation and maintenance activities.

In recent years, the implementation of building energy monitoring and management systems has been indirectly addressed by the European Directives, such as the Energy Performance of Building Directive recast (EPBD recast 2010/31/EU) and the Energy Efficiency Directive (EED 2012/27/EU). The first has encouraged the use of intelligent metering systems for new or renovated buildings; the latter has fostered the customer access to real-time and historical energy consumption data and has introduced for large companies energy audit obligations and annual energy reporting. In Italy, the D.lgs. 102/2014, in response to the EED 2012/27/EU, requires, in multi-family buildings, the installation of energy metering devices able to track the "voluntary" energy consumptions for heating, cooling and domestic hot water of individual units for energy costs allocation.

The selection of metering and environmental sensors can be a challenging task due to recent developments on accuracy, robustness, data storage, miniaturization, ability to connect using multiple communication protocols, integration with building energy management system and the Cloud [7].

Within this framework, the paper aims at presenting the implementation of a building monitoring system (BMS) installed in a large social housing intervention in Italy. The architecture and the capabilities of the BMS are presented, as well as possible outputs useful for energy management activities, allocation of the individual expenses and the occupant's behavior analysis.