



Energy efficiency in buildings: What drives the investments? The case of Lombardy Region



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ABSTRACT

In recent years, following an agreement with the Italian Ministry of the Environment, Lombardy Region has promoted numerous initiatives for energy efficiency and use of renewable energy sources. These initiatives covered a large spectrum of technologies and practices. Energy efficiency in buildings has a fundamental role in the regional energy balance and pollutants emissions, including CO_{2eq}. Local energy efficiency programs aimed at supporting these interventions have to be designed, managed and monitored to clearly identify the real energy, economic and environmental benefits derived by them. In this paper, the monitoring and analysis process performed within the topic of energy efficiency in the building sector is presented, referring to the program named *Design and realization of interventions for energy retrofit in public buildings and realization of zero emissions buildings* (i.e. buildings that have zero emissions of greenhouse gases related to their operation). In recent years, several research studies were carried out in the same field related to achieving cost-optimality. For this reason, the presented economic analysis was enhanced also taking into account the cost optimality methodology and the nearly zero energy building standards. The main results of the research are described in the present paper by energy, environmental and economic point of view.

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1. Introduction

The European goals for the years 2020 (European Parliament, 2009), 2030 (European Commission, 2014) and 2050 (ECF, 2010) along with other European Directives focused on energy efficiency, like the Energy Performance of Buildings Directive, so called EPBD recast (European Parliament, 2010) and the Energy Efficiency Directive (European Parliament, 2012), are clear signs of an increasing commitment to energy sustainability. Despite the substantial improvements made at the technological and regulatory level in recent years, a significant potential for energy efficiency remains unexploited (IEA, 2008a, 2008b). The statistics regarding energy consumption highlights the buildings in Europe (residential and tertiary) are responsible for about 40% of the primary energy consumption (BPIE, 2011). New and existing buildings are key objectives to tackle in view of future energy and environmental goals, because of their high saving potential and the general implications related to the efficiency of the built environment (Wilkinson, Smith, Beevers, Tonne, & Oreszczyn, 2007). Despite the large availability of efficient “off

the shelf” technologies, the cost of efficiency measures remains, in many cases, one of the most important barriers, as underlined in the EPBD recast (European Parliament, 2010), which states that “energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels”. Besides costs, there exist also various types of non-technical barriers, related, for example, to non-uniform regulations between national and local governments, rapidly changing requirements, inability to attract investments, management issues, etc. (Caputo & Pasetti, 2015).

In Italy building sector accounts for the 35% of the overall national energy balance. Residential buildings represent the 57% of this quantity and space heating alone is responsible for about the 66% of energy consumption in this sector (ENEA, 2012).

Lombardy Region in the last years promoted several programs and projects towards energy efficiency and REs (Renewable Energy sources) integration. Among them, one was the Framework Program Agreement in the field of Environment and Energy. This was firstly launched in 1999 by the Italian Ministry of the Environment and focused on regional scale programs for energy efficiency measures and renewable energy technologies. In particular, Lombardy Region defined interventions aimed to the provision of subsidies to public and private property owners and the sectors by following measures:

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- improvement of heating systems by efficient natural gas boilers (D.G.R., 2004a, 2005);
- development and upgrading of district heating plants fueled by fossil fuels and biomass (D.G.R., 1999a, 1999b, 2004b);
- implementation of solar thermal plants (D.D.G., 2006a, 2006b, 2010; D.G.R., 2001, 2002, 2004c);
- improvement of the energy efficiency in the buildings sector (D.D.G., 2010a, 2010b).

After the realization of the projects subsidized in the overall program, the Italian Ministry of the Environment and Lombardy Region financed a monitoring campaign, carried out by Politecnico di Milano, with the scope of analyzing the results achieved and providing useful insights for future programs and projects. The results of the monitoring campaign related to efficient natural gas heating systems, district heating plants and solar thermal plants were documented in Aste, Buzzetti, Caputo, and Manfren (2014), Aste, Buzzetti, and Caputo (2015a) and Aste, Del Pero, Adhikari, and Marenzi (2015b), respectively.

In this paper, the monitoring and analysis process performed within the topic of energy efficiency in the buildings sector is presented. In particular, the two calls launched by Lombardy Region in 2010 are considered:

- design and realization of interventions for energy retrofit in public buildings (D.D.G., 2010a), cited as “energy retrofit”;
- design and construction of zero emissions buildings (D.D.G., 2010b), cited as “zero emissions buildings”.

At the end of the process, these initiatives permitted a global funding of about 14.3 M€, involving the energy refurbishment of 40 buildings and the promotion of 13 so called zero emissions buildings (this is the definition provided by Lombardy Region at the time of the call; they meant buildings that have nearly zero emissions of greenhouse gases related to their operation).

At the time of the calls, the measures were defined for improving energy performance in the buildings sector ensuring also environmental benefits, anticipating the measures suggested by the European and national regulation. In fact the European Parliament, with the Energy Efficiency Directive (European Parliament, 2012), imposed a yearly requalification by at least 3% of existing public buildings in all the member states. Further, the EPBD recast Directive (European Parliament, 2010) imposed to achieve the nearly Zero Energy Buildings (nZEB) target for public buildings within tight deadlines. The Italian government accepted this Directive by a national law in 2013 (Legge 90, 2013). This law imposed the achievement of the nZEB target for new public buildings by the end of 2018.

After the EPBD recast (European Parliament, 2010), several research programs were carried out in the field of energy performance requirements for buildings with a view to achieving cost-optimal levels. For this reason, the economic analysis carried out during the monitoring of the effects of the two mentioned calls was extended also taking into account the cost optimality methodology in the framework of nearly zero energy standards for new buildings and for retrofit of existing buildings (Adhikari, Aste, Del Pero, & Manfren, 2012; Ballarini, Corgnati, & Corrado, 2014; Ferrante, 2014).

The main results of the research are described in the present paper by means of energy, environmental and economic indicators.

These results can be a valid support for the evaluation of the cost effectiveness of the mentioned energy efficiency interventions in retrospect and for addressing new interventions in the same field in the next future. This topic is particularly important in the

framework of the current economic crisis in which investors have to operate.

2. Monitoring campaign of local energy efficiency programs for retrofitting existing buildings and for promoting new zero emissions buildings

As underlined previously the mentioned calls date back to 2010, before the official European definition of nZEB. In fact the call referred to zero emissions buildings, as also proposed by the Code for Sustainable Homes introduced at the end of year 2006 by the UK Government and to be applied from 2016 (Dawood, Crosbie, Dawood, & Lord, 2013; Kennedy & Sgouridis, 2011; Reeves, Taylor, & Fleming, 2010; UK Green Building Council).

The following sections will explain the main results referred to the two related regional calls:

- design and realization of interventions for energy retrofit in public buildings;
- design and construction of zero emissions buildings.

The analysis of these interventions provided the opportunity to manage data related to the actual conditions of energy retrofit of existing buildings and low energy buildings design in northern Italy. In fact, despite the exiguous number of buildings included in the analyzed sample (Lombardy has about 1.7 million buildings, as reported in ASR Lombardia), the authors had the opportunity to face different typology of buildings and interventions that can be considered as representative of the actual praxis in relation to the energy improvement of the built environment.

The present analysis helped also to understand the local evolution of the energy performance of buildings in Lombardy towards the recently defined standard of nZEB and in addressing similar policies in the next future.

2.1. Energy retrofit in public buildings

The call was focused on energy retrofit of public buildings (residential and tertiary) and refers to a preliminary budget of about 4.7 M€ to be shared among the beneficiaries with a maximum of 400 k€ each on the basis of precise criteria defined within the call. Due to further increase of availability in the overall regional budget, the final contribution was of about 7.8 M€.

At the time of the call, 77 requests were initially received and 40 of these were selected. Among these 40, works related to 23 results currently as completed, 8 are still in progress, 2 were revoked and 7 failed due to waiver by the beneficiaries.

Furthermore, in the analysis 2 interventions were not considered because of inconsistency of data revealed during the elaborations and the indicators calculation. So all the figures reported in the following sections are related only to 29 of the 40 retrofit projects initially selected.

Considering the 29 projects described in this paper, the total investment cost is about 17.8 M€ and the total regional subsidy is about 7 M€.

The collected documentation shows that at the end of 2014, 3.6 M€ of the total contribution were provided to beneficiaries for concluded projects.

In order to participate in the public selection, each candidate provided a wide description of the project, interventions and energy features of the building before and after the interventions, including also the energy certification and an energy audit, as defined by the national and regional regulation (D.Lgs. 192, 2005; L.R. 24, 2006). In particular, the energy performances were carried out by the standard regional tool for energy certification, Cened+

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