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# Italian local codes for energy efficiency of buildings: Theoretical definition and experimental application to a residential case study



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## ABSTRACT

The environmental concern in light of anthropogenic climate change is directly concerning the building sector as one of the major energy consumers and CO<sub>2</sub> producers. To reduce the environmental impact of new and refurbished buildings, one of the most promising policies is the widespread adoption of Building Energy Regulation Codes (BERC), since they have a direct impact on the everyday work of local planners, architects, engineers and building companies. This article will look at how BERCs were implemented in Italy, where Regions and municipalities have developed in recent years a number of local regulations trying to drive the market towards more energy efficient practices. This happened in a legislative vacuum because the Italian Government implemented the European Directive on the Energy Performance of Buildings (2002/91/EC) only in 2005 and defined the related National Guidelines only in 2009. This article provides an overview on EPBD implementation in Europe and a Geocluster Italian distribution of BERCs in order to show their geographical distribution and their influence on the construction sector practices, focusing in particular on the region of Lombardy. Then the article describes the methodology followed for the definition of BERCs in nine municipalities in the same region. In conclusion, the paper presents the practical application of one of the nine BERCs to a NZEB residential case study as an example of what the EPBD recast define as nZEB.

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*Abbreviations and acronyms:* EE, energy efficiency; IPCC, International Panel Climate Change; EPBD, directive on energy performance of buildings; BERC, building energy regulation code; LR, Lombardia region; EMS, European Member States; GHG, green house gas; EC, European Commission; EPH, primary energy consumption for heating; EMS, European Member States

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## 1. Introduction

Energy efficiency (EE) in buildings is an important objective of energy policy and strategy in Europe. National and international bodies recognize the threat from human-induced climate change as a major concern [1–3]. The IPCC's Fourth Assessment Report [4] confirms that “warming of the climate system is unequivocal”, with the primary concern being that greenhouse gas emissions from human activity have risen “by 70% between 1970 and 2004”.

According to the European Energy Efficiency Plan (2011) [5], buildings are one of the greatest potentials for energy saving and moreover the implementation of adequately energy policies in construction sector could promote: drastic reductions of energy consumption and the common use of renewable sources as stated in a series of researches on the topic [6–8].

At European level, legislation has been already set out a cross sectional framework of ambitious targets for achieving high-energy performance in buildings. Key parts of this European regulatory framework are the Energy Performance of Buildings Directive 2002/91/EC (EPBD) [9] and its recast [10]. There is significant potential for reducing consumption in building sector with cost-effective measures [11], and in this scenario, the energy efficiency is clearly the “first fuel” in the delivery of energy services in the coming low-carbon energy future. The majority of the energy consumption of building sector could be simply avoided by providing mandatory energy standards, which are an effective means to reduce greenhouse gas emissions and slow down depletion of non-renewable energy resources. Higher standards for buildings have the highest potential to lower the related primary energy consumption and greenhouse gas emissions [12]. With reference to the mitigation of carbon dioxide emission from buildings, at the global scale, Levin et al. [13] highlight there is a risk, with no strict regulation, that carbon dioxide emissions will nearly double. Lee and Yik [14] present the importance of such norms and regulations promoting energy efficiency in buildings on a voluntary basis. Beerepoot and Beerepoot [15] conduct an analysis evaluating the necessity, as a next step of improvement on government regulation on energy efficiency, of promoting innovation in building technology. Summarizing, EE is increasingly recognized as a tool to decouple economic growth from the increase in energy consumption and thus to reduce greenhouse gas (GHG) emissions by cutting the amount of energy required to accomplish a particular amount of genuine energy service and moreover EE improvement is by nature a decentralized activity; so “municipal authorities” (term used interchangeably with municipalities, local authorities, and local governments) have an essential role to play in ensuring appropriate conditions and applying measures for EE improvements. In this scenario, municipalities must become leading actors for implementing sustainable energy policies throughout building energy regulations code (BERC) providing mandatory rules in term of energy efficiency in buildings coupled with subsidize measures. Moreover, BERCs are proving to be an excellent key to describe the evolution towards sustainable construction and valuable tools to sustain building innovation practices.

### 1.1. Aim and research setting

The paper aims to investigate current state of the art of EE policies and EE improvements for building sectors in Italy starting from European level, passing thorough Italian scale to a local municipality level. In recent years, extensive literature has been devoted to the subject of the energy policies to implement the EPBD into the EMS [16–19], but regarding the Italian implementation, no consistent literature has been produced: only few researches [20–47] have

already described examples of BERC in Italy. The main two questions addressed in this paper are:

- (1) How the municipality can design local building energy regulation code; which are the concrete measures to encourage energy efficiency?
- (2) Does the BERC have impact on designing and diffuse building practices towards nZEB?

In order to reply to the first question the building energy regulation code of 9 municipalities of Lombardia region (LR) was analyzed. The study carried out an analysis on a sample of BERCs in nine Italian municipalities of LR to highlight the geographical distribution of these local regulations and their potentialities to drive the market and sustain the improvement of EE practices in the construction sector. The second question is argued considering a case study building as example of building energy regulation code application towards nZEB. This paper is structured as follows: Section 2 presents a EE policies framework at European and Italian scale, providing also a Geocluster Italian distribution of BERCs in order to show an overview on their application and their influences on the sector; Section 3 focuses on LR highlighting the policies in force for EE building sectors and the energy consumptions for the existing building stock; Section 4 describes the methodology followed for the definition of BERCs in nine municipalities in LR with a practical application of the BERC of Selvino (Bergamo, Italy) to a residential case study and Section 5 provides conclusions and policy implications, and offers some directions for future research.

## 2. EE policies framework at European level: An overview

At European level a significant number of directives and laws related to energy efficiency have emerged in EU, among these the main policy driver related to the energy use in buildings is the Energy Performance of Buildings Directive (EPBD, 2002/91/EC), implemented in 2002 and updated in 2010 (EPBD recast, 2010/31/EU) with more ambitious provisions. The main two mechanism identified to articulate the participation of energy assessment in the building sector are energy regulation (e.g. building codes) and energy certification [22]. Under the EPBD the energy certification of buildings become compulsory in Member State and thus has a vital role in energy saving [23]. The use of mandatory codes for controlling energy use in buildings emerged in the mid-70s [24]. It is by far the most widely adopted means to enhance building energy efficiency, and a large number of countries and regions in Europe has adopted it. Increasing the energy performance of buildings is the key to secure the transition to a low-carbon economy and to achieve the EU Climate and Energy objectives, specifically a 20% reduction in GHG emissions by 2020, 20% energy savings by 2020, and a 20% renewable energy share in the EU gross final consumption. The European policy framework for buildings has been evolving since the early 1990s, but it did not truly gain momentum until the Directive on the Energy Performance of Buildings (EPBD). Particularly, several studies have looked into its implementation in different European countries showing characteristics and potential in increasing the energy efficiency e.g. the study performed by Dascalacki et al. [25] in Greece, by Tronkin and Fabbri [26] in Italy, by Ekins and Lees [27] in UK or Araùjo et al. [28] in Portugal. As stated by Andaloro et al. [32], the EMS adopted the Directive at various times and with differences between EMS, so that the situation became quite fragmented even if there is a common frame [33]. An analysis of current barriers and instruments for the improvement of energy efficiency in European buildings also shows significant differences in terms of commitment, financial potential and market conditions [34]. The commitment of each EMS should be supported not only by some isolated policy

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