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On the use of an energy certification database to create indicators for energy planning purposes: Application in northern Italy

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HIGHLIGHTS

- A methodology in order to obtain energy performance indicators from an energy cadastre.
- Data contained in the energy certificates can be used to understand the thermo-physical properties of an existing building.
- Energy indicators on existing buildings are used as a tool for energy planning.
- The analysis of the energy cadastre (official register) can detect errors in the registered energy certificates.
- The energy indicators are used in order to quantify the energy retrofit potential in existing building stocks.

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ABSTRACT

Energy certification of buildings, mandatory under the European Directive EPBD provides interesting data on the thermo-physical properties and geometry of existing buildings. Although the energy certificate is intended to provide the characteristics of individual buildings, so stimulating the real estate market toward ever better energy performance, data management of the certificates issued over time, using a national or regional energy cadastre, makes available a data base which is useful for energy planning in the building sector.

This paper provides the needed results of a benchmarking study on data from the energy cadastre of the Lombardy Region, northern Italy. By integrating data from the energy cadastre (175.778 energy certificates) with the statistical data obtained from the national census, indicators were obtained on the energy performance of existing buildings.

The energy indicators obtained, characterised by building type and construction period, normalised as a function of Degree-Days, become an effective tool for energy planning at local and regional scales. In the specific case, the energy indicators have been used to estimate the potential for energy retrofit of existing buildings in the Lombardy Region. The same indicators can also be used by municipalities for energy planning at the municipal or district level.

1. Introduction

Of all the recognised economic zones worldwide, the European Union is that whose legislators are most dedicated to measures taken to attenuate climatic change effects. Europe is indeed responsible for close on 40% of world energy consumption (Commission of the European Communities, 2006) and the strategic programming instrument employed to ensure the promotion of energy efficiency in buildings is Directive 2002/91/EC (Council of the European Union, 2002). This important Directive, named Energy Performance of Building Directive (EPBD), had the merit of introducing for the first time in the EU the energy certification of buildings which all Member States have transposed into national or regional legislation.

Buildings' energy certification is principally aimed at providing clear guidelines for their energy performance so that an improvement is ensured for the quality of the energetics both of new and of existing buildings in a given area.

In existing buildings for which the energy performance is normally known to be poor, users and citizens have found therein the stimulus to implement strategies for energy retrofits (i.e. thermal insulation of the building envelopes, installation of high performance systems, use of renewable energy sources, etc.) in order to reduce energy consumption.

The impact of energy certification on the building sector is

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currently a key issue. Amecke (2012) analyses, to what extent Energy Performance Certificate (EPCs) have assisted purchasers of owner-occupied dwellings in Germany in adding energy efficiency to their purchase decision priorities. The result of the study, while emphasising the critical aspects of this tool, points out the potentials of the EPCs once some barriers are removed. The impact of EPCs, albeit limited to the rental and capital values of commercial property assets in the UK, is the focal point of a paper of Fuerst and McAllister (2011). The study is based on a cross-section of 708 commercial properties. The conclusion of the authors is that energy labelling is, as yet, not obtaining the desired effect on Market Values and Market Rents. The study's conclusions must however be put in the context of 2011 when the culture of energy certification was not yet widespread. Similar findings are reported in the study of Parkinson et al. (2013) which investigates whether energy performance certification is an indication of workplace quality.

The EPCs have had a greater impact in northern Italy. As regards new buildings (i.e. those buildings constructed after the implementation of energy certification) the possibility, and in some cases the obligation, to exhibit the energy label with the energy class of the buildings indicated, have orientated the real estate market towards buildings with higher performance: Class A, Class A+ up to Nearly Zero Energy Building (NZEB) standard.

Lombardy (northern Italy) represents an interesting case since a regional policy firmly directed at the promotion of energy efficiency in buildings has been implemented. In this region within a few years (from 2007 to 2013) the market associated with high energy-performance of buildings had already grown substantially: in fact close on 7500 EPCs for buildings of Class A and Class A+ have now been issued (Dall'O' et al., 2013a).

Considering that the existing building stock is numerically significant, and that the energy quality of existing buildings is very low, it is precisely within this context that the instrument of the energy certification is able to offer its full potential. Although energy certificates are intended to provide the characteristics of individual buildings, data management of the certificates issued over time, using the national or regional energy cadastre (the term "Cadastre" denominates the official register of energy certificates), makes available a database useful for energy planning in the building sector. The management of data coming from energy certificates which are produced over time can become an input database tool to support energy policies i.e. energy planning at national, regional or local level.

The issue of energy certification of buildings, its applications in various sectors, even within the energy planning at various scales, is of current interest and the subject of several studies.

Ascione et al. (2013) propose a particular analytical method whose aim is to characterise energy performances for both new and existing buildings, in the winter and in the summer season. With reference to the complete urban context, the method is transferred into Geographical Information Systems (GIS). The key objective of their work, applied to the entire historical centre of the city of Benevento in southern Italy, is the evaluation of its building stock for the identification of critical aspects, in order to encourage effective building design for new structures and proper, suitable refurbishment of those already existing.

Energy certification of buildings has been applied without homogeneity by different countries. In a recent paper some authors (Choongwan et al., 2014) propose a system of energy certification of residential buildings starting from the analysis of the different certification schemes used. The proposed system can allow a policymaker to establish a reasonable and fair energy efficiency rating system for existing residential buildings and can encourage the voluntary participation of all residents in the energy saving campaign.

A much debated point is the accuracy of data from energy certificates. The hypothesis of their possible use does in fact bring to the fore this important issue. Tronchin and Fabbri (2012), in their research work, state that the EPC's effectiveness is dependant upon two elements: the accuracy of independent experts' evaluation of energy performance and the capabilities of the energy classification and of the energy performance scale to really control the fluctuations in the energy index which arise from differences in input measurements. The results of the work (162 independent technicians examined the same building) reveal which part of confidence intervals depends upon a misunderstanding of software and the tolerance that the energy certification ranges have for the fluctuations that arise in energy indices. A similar issue was investigated in the paper of Corrado and Houcem (2008).

The evaluation of the potential of energy savings of retrofitting residential building stock is an important issue in the framework of the energy policy to be applied in the building sector. Some authors (Dall'O' et al., 2012) propose a methodology characterised by an innovative approach that considers the actual technological and economic constraints of the implementation of feasible energy efficiency measures. The analysis was applied to five municipalities in the province of Milan (Italy) which have signed the Covenant of Mayors, committing to meet and exceed the 20% CO_2 reduction objective of the EU by 2020.

A paper by Weiss et al. (2012) addresses the question of how to improve or supplement the political instruments in Germany for increasing refurbishment rates and tap these potential savings, considering the barriers responsible for the differences between potential and actual energy retrofit rates. Megalhaes and Leal (2014) investigate the characterisation of thermal performance and nominal heating gap of residential building stock using EPBD-derived databases. The results of the study, conducted in Portugal, confirm the viability, usefulness and richness of using the EPBD-derived databases. In the specific case the authors show a mix of natural improvement with boosts from regulations, with crucial developments observed after 2006, reflecting the positive impact of the EPBD.

Other studies covering the issue of energy performance evaluation of building stock, using energy indicators also coming from certification schemes, are proposed by many authors: Caldera et al. (2008), Dascalaki et al. (2010, 2011), Pérez-Lombard et al. (2009), Reis and Escórcio (2012), McKenna et al. (2013), Tsanas and Xifara (2012).

A methodology orientated towards the identification of building energy quality at the urban scale is described in the work of other authors (Dall'O' et al., 2011). The methods presented in this study-paper were substantially based on pre-existing, available information about the building stock i.e. that from cartographic documentation, thematic maps, geometric data and other such sources. Data on building energy performance were collected by means of energy audits on sample buildings, which were selected through a statistical analysis. Using the instruments of a GIS platform, the integration of two data sources provides an economical but comprehensive framework of building energy performance.

The authors, at that time, did not have data available from the energy cadastre and the feedback on the energy performance of the buildings was made by detailed analysis, through energy audit, of a number of statistically representative sample buildings. The availability of data coming from the energy cadastre opens new opportunities for the development and application of new methodologies.

This paper provides the needed results of a benchmarking study on data from the energy cadastre of the Lombardy Region, northern Italy. By integrating data from the energy cadastre (850.970 energy certificates) with the statistical data obtained from the national census, indicators were obtained on the energy