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# The Influence of Energy Performance Certification the Market Value of Residential Buildings

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**Abstract.** The market value of the physical assets over the time varies as a function of different factors related, for instance, to the correct execution of buildings and systems; the conformity with procedures defined for the use phase of the systems; the implementation of maintenance plan, defined in order to maintain the building and its parts in good conditions. Nevertheless, there is not a clear evidence of how the market value is affected by the energy performance measured by the Energy Performance Certification in Italy. The aim of this research concerns the definition of an assessment methodology of the impact of the energy performance on the market value of assets. The methodology has been developed and tested in a case study on the city of Milan, Italy. At first, an investigation of homogeneous income areas has been carried out, afterwards an analysis of the market values of assets has been done. The results have been integrated in a Geographic Information System and gaps in the market values have been associated to the energy performance. Despite the methodology has still to be refined, it has been demonstrated its validity. To conclude, further parameters representing the energy performance of the buildings could be encompassed in the assessment, in order to achieve a more precise energy profile of the building under analysis.

## 1. Introduction

The process of urbanization that is taking root worldwide will lead in 2050 to a people concentration in urban areas of 80% with consequently new urbanisation dynamic processes and need of new buildings [1]. Nevertheless, the new constructions are a 1.5–2% of the building stock [2] in Europe and retrofit interventions are crucial to promote energy efficiency. The most attractive areas for people living in the cities are the central ones or, zones which are connected by public transportation to the centres of life and work. The cost of the city centres is higher than other parts of the city because of the historical character of the European cities and the proximity to the services. In Asia multicentre cities are developing trying to promote a multi polar situation in which the transportation is reduced, and autonomous communities are supported by local economies. In the European context the historical centres need of maintenance, renovation in case of architectural heritage or protected assets. The process towards energy efficiency and retrofit for the building asset, therefore is strongly local and partitioned into zones of the cities, while new peripheral settlements and city developments are increasingly promoted with high levels of efficiency to compensate the distance to the city centre. The European Directives [3–5] have been a strong driver for energy renovation and increased quality of the built



environment, boosting the concepts of Nearly Zero Energy Building and before the energy certification of buildings. At international level, assessment protocols (e.g. LEED, BREAM, CASBE, EnergyStar, etc.) [6] include the energy issue as a crucial criterion to evaluate the quality of the building, despite these tools are adopted on a voluntary basis. The market is slowly aligning to these standards and increased efficiency levels are registered especially in public buildings and in new construction and settlements. Nevertheless, the energy declarations provided by the energy labels should be evaluated carefully. Moreover, energy calculations required for the certification provide data of consumption often not reliable and with low level of accuracy and performance gap in the actual energy behaviour of the building. The present research adopts a critical vision, but it is not underestimating the extensive potential of a wide database of energy information and the possibility to connect such information about performance with geo-localization maps to understand the dynamics underlying the choice of buildings in urban contexts. The territorial flows of cash underlying the asset market could increase the knowledge of processes that allow to implement local policies to increasingly promote a higher level of efficiency. The idea is to assess how the European policies and Directive have been able to steer the real estate market by attributing an energy class to the building as had previously been done with energy-efficient products (i.e. appliances and equipment).

## 2. State of the art

The Energy Performance of Buildings Directive (EPBD) 2002/91/CE stated sixteen years ago the need of energy certification (art. 7) of the buildings which had been introduced in the '90 by Law 10/91 (art.8) [7] that tried to introduce at national (Italian) level the energy efficiency concepts and calculations in the assessment procedure. The Law 10/91 still lasts today as a reference for the energy certification report. The main goal of the European Directive EPBD is to define a label for buildings to drive the market towards energy efficiency and provide a reliable instrument to the stakeholders to pursue the energy saving of the asset, to promote the culture of efficiency for the construction companies that in the first objective of the initiative would move from a BAU (business as usual) procedure to advanced and more efficient technologies and procedures. Moreover, the consciousness of the users about the operational life of the buildings would be increased.

The energy certification at national level has been enabled by D.L. 192/2005 [8] and 311/2006 [9] and thus it is possible to verify if twelve years of energy certification could boost the direction of energy efficiency in the real estate market. The real estate market rules have not been historically influenced by Law 10/91 and that law always remained as a milestone in the process of energy improvement for envelope and thermal plants but has always been unfulfilled. The areas in the cities have different value related to the proximity to the city centre, the services availability in the area, the public transportation to connect the area to the city centre and services, the maintenance of the building, the quality of the area. For most people, real estate represents a significant portion of their wealth especially in market as in US, Europe or Italy where 65.2%, 73% and 72.3% own their own primary residence (note that in Italy the last years data show a decrease of almost 1% from the 2015 data and 6.5% referred to 2017) of the homeowners. The analysis of the topic is not new and studies in the '80 based on data on residential construction practices in 1975–1976, together with climatic data, construction costs and fuel costs, have been used to calculate discount rates implicit in homeowner's decisions to invest in energy-saving measures in new homes [10]. This process is repeated for ten cities for three heating fuels in each city. The resulting discount rates are significantly higher than market rates of interest, suggesting market imperfections which reduce the level of investment in energy efficiency below the socially optimal level, but the market rules and the regulations are improving and defining a new concept of energy efficiency in the operational life of the building that could suggest a change of vision. More recent results of researches (2013) in US suggest that Energy Star certification increases the sales prices of homes built between 1995 and 2006 but has no statistically significant effect on sales prices for newer homes. The local certifications appear to have larger effects on sales prices, and that effect holds for both newer and older homes. The estimated home price premiums from certification imply annual energy cost savings that are sizeable fractions of estimated annual energy costs for homes in the considered sample, in some

cases even above 100%. This suggests that the certifications either embody other attributes beyond energy efficiency that are of value to homebuyers or that buyers are overpaying for the energy savings. Further research is needed to better understand how consumers interpret home certifications and how they value the combination of “green” characteristics that many of those certifications embody. The paper wants to focus on the Italian and Regional context of Lombardy region using the database of CENED [11] which collects the regional energy certification.

### 3. Methodology

The Lombardy region is the most populated and urbanized region of the national territory, it is located in northern Italy and the population is 10.036.258, approximately 16,5% of the total national population. The following regions are Lazio, (5.896.693, 9.7%), Campania (5.826.860, 9.6%), Sicily (5.026.989, 8.3%) and Veneto (4.905.037, 8.1%) [12]. These five regions represent the 25% of the total Italian regions with the 52.2% of the total amount of population [13]. The present research considers three cities in Lombardy Region with different size according with Central Place Theory (CPT) [14] and considering the two main principles of the theory:

- *Threshold*: the minimum population that is required to bring about the provision of certain good or services;
- *Range* of good or services: the average maximum distance people will travel to purchase goods and services.

In table 1 the cities and the classification related to Christaller model are reported.

**Table 1.** Case studies cities and Christaller’s model classification.

Levels	Level of hierarchy	City	Equivalent number of central places dominated by higher order centre	Equivalent number of marker areas dominated by higher order centre
1	Metropolis	Milan	1	1
2	City	Brescia	3	4
3	Town	Varese	12	16

The methodology adopted uses the three cities as centres of three main areas of territory, the provinces, in which multiple municipality are grouped in order to understand the influence of the three main cities and the distance of influence in the case of the cost of the assets. The use of open data allows to interrelate data coming from the regional databases and cartographic information organized by Geographical Information Systems (GIS). The data about real estate market costs are derived by public databases [15] while the energy certification come from the CENED public database. The space analysis has been performed to correlate the average specific indicator of performance EPH – Energy Performance for Heating [kWh/m<sup>2</sup> year] of the dwellings with the assets’ costs in the real estate market as Euro per surface [€/m<sup>2</sup>].

### 4. Case study

The case studies are the three provinces of the three cities that are the exemplification of three size of aggregation of value on the territory related to services and quality for the house buyers. Milan is the main city centre and the province has the higher density. The average market values of residential buildings in each municipal area have been calculated through GIS. The average EPH has been calculated with the same approach. For the investigation of the correlation between the average market value and the average EPH for each municipality, three range of costs have been identified. This has been done to remove as much as possible the effect of the distance of the single municipality form the place of attraction (city centre, touristic resorts, etc.) on the market value. In table 2 the information about the three urban case studies are detailed.

**Table 2.** Case studies cities data and basic information

Levels	Level of hierarchy	City	Population	Surface [km <sup>2</sup> ]	Density [p/km <sup>2</sup> ]	Altitude [m amsl]
1	Metropolis	Milan	1'372'075	181.67	7'552.57	122
2	City	Brescia	196'750	90.34	2'177.88	149
3	Town	Varese	80'634	54.84	1'470.35	382

The main cities are considered as attractive centre of the provinces that is the territory scale adopted for the geographical analysis. In table 3 the data about the three provinces are summarized.

**Table 3.** Case studies provinces data and basic information

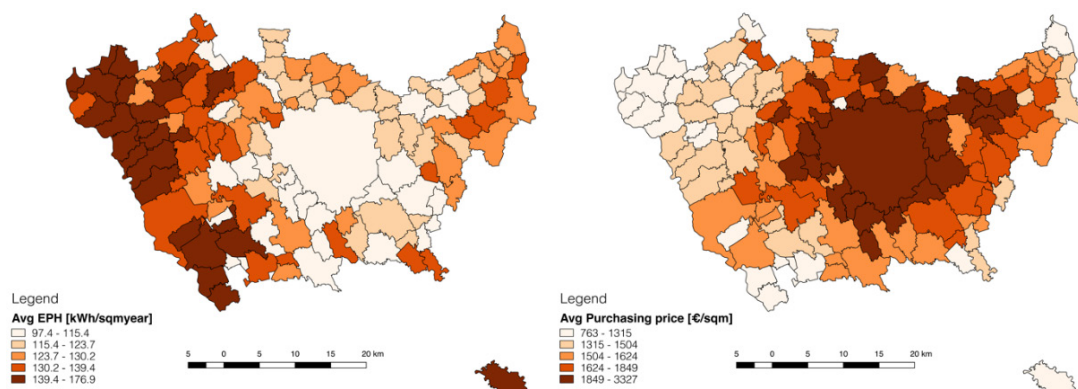
Levels	Reference city	Number of Municipalities	Population	Surface [km <sup>2</sup> ]	Density [p/km <sup>2</sup> ]	GDP [€] [16]
1	Milan	134	3'195'629	1'575.65	2'028.13	47.327
2	Brescia	205	1'262'396	4'785.62	263.79	29.154
3	Varese	139	890'116	1'198.11	742.93	27.109

## 5. Results

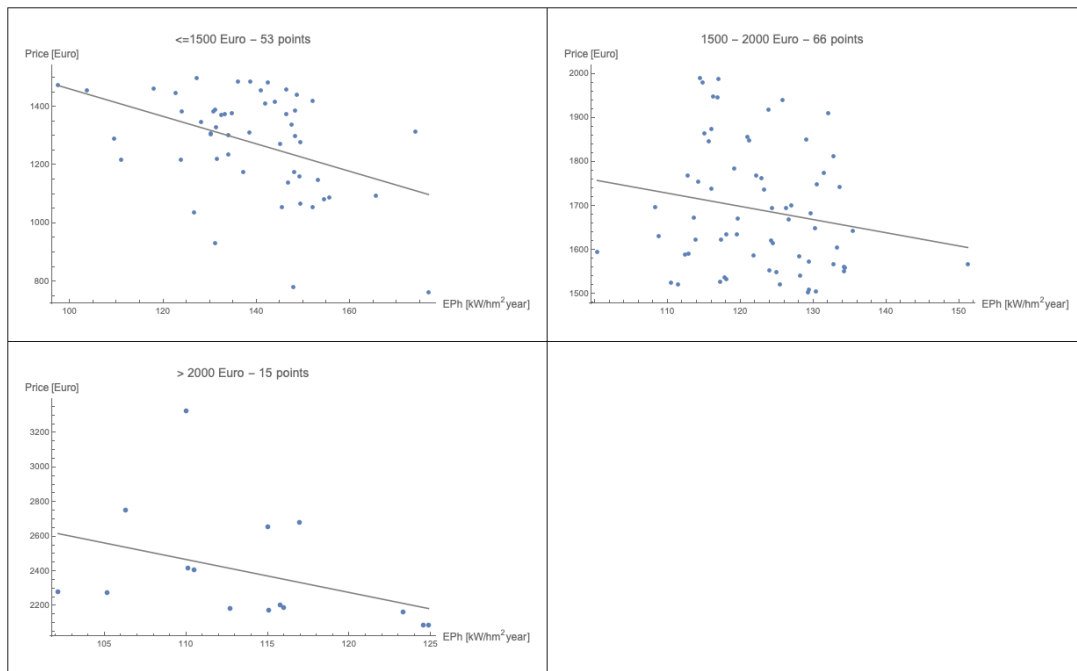
The results are maps in which the EPH and the average cost of the dwellings are displayed for the different municipalities of the province and diagrams where the average market value per municipality is coupled with EPH. The effect on the price produced by the geographic distance from a point of attraction has been considered as homogeneous in the three clusters for each analysis by province. The closer the municipality is to a point of attraction (the “Capoluogo di provincia”, the Garda Lake, ski resort locations, etc.), the higher is the price. Therefore, creating 3 classes of purchasing prices for each of the considered provinces allows to make some considerations on the spatial organization of the average prices and EPH.

### 5.1. Milano

Figure 2 shows that in this case there is a significant, though low, correlation between the location, the price and the energy consumptions. In this case, the inverse correlation is confirmed in the three price classes. Nevertheless, the largest municipality is not representative since it could be further divided in sub-areas to be actually representative of the correlation between market value and energy consumptions.



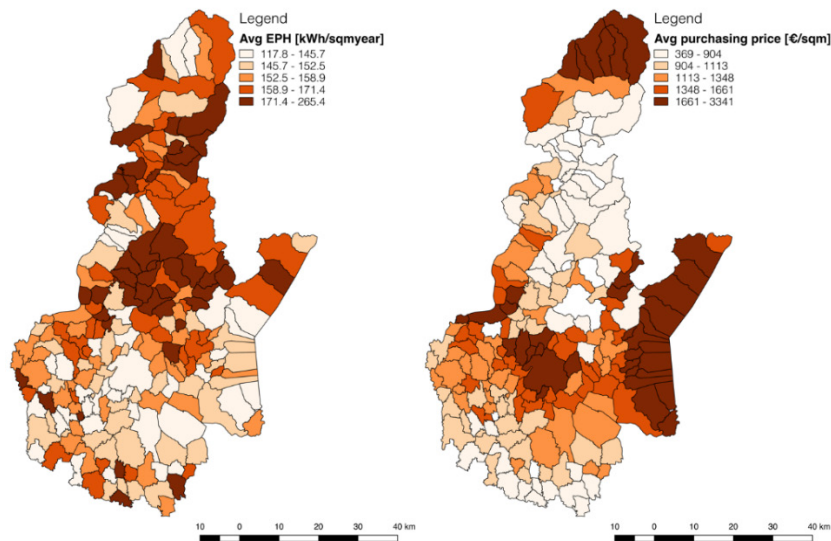
**Figure 1.** Milano province. Average EPH values and Average Purchasing price by municipality categorised by 5 quantiles.



**Figure 2.** Milano province. Correlation between average EPH and average purchasing price by municipality.

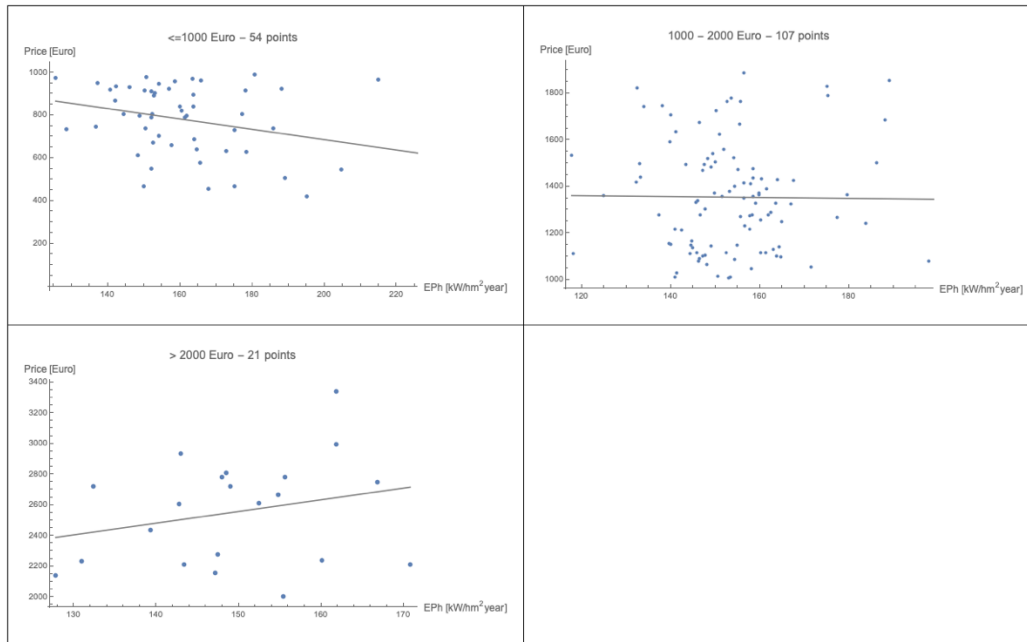
5.2. *Brescia*

Brescia is the second province adopted as a case study and it has specific attraction on the territory. In this case it is clear as the spatial price distribution follows the criterion described above. The closer we are to a valuable place (e.g. lake, main city, mountain), the higher is the price of houses. The small inverse correlation exists for price classes  $\leq 1000$  €.



**Figure 3.** Brescia province. Average EPH values and Average Purchasing price by municipality categorised by 5 quantiles.

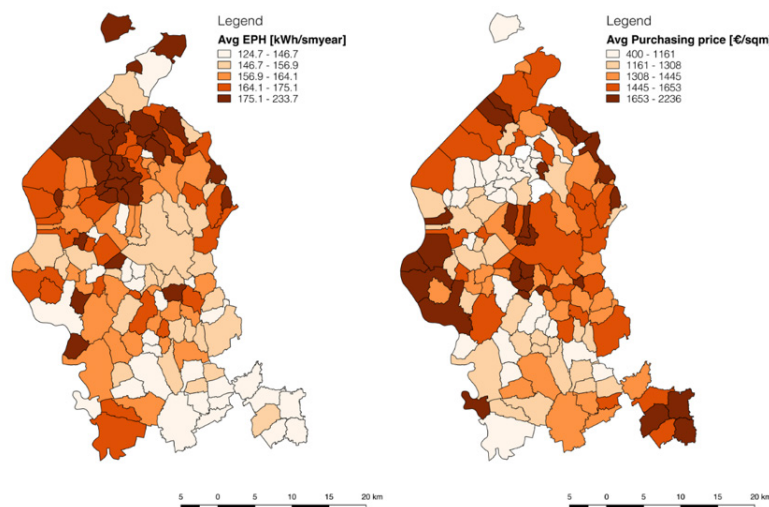
For the intermediate class the correlation seems to be flat and for the highest class  $\geq 2000$  €, there is a positive correlation that is hard to explain without considering that probably the correlation EPH/Price is dramatically influenced by the presence in the area of many core points of interests (i.e. famous vacation spots for mountain, lake, in addition to the main city) which influence severely the average price of dwellings by municipality.



**Figure 4.** Brescia province. Correlation between average EPH and average purchasing price by municipality

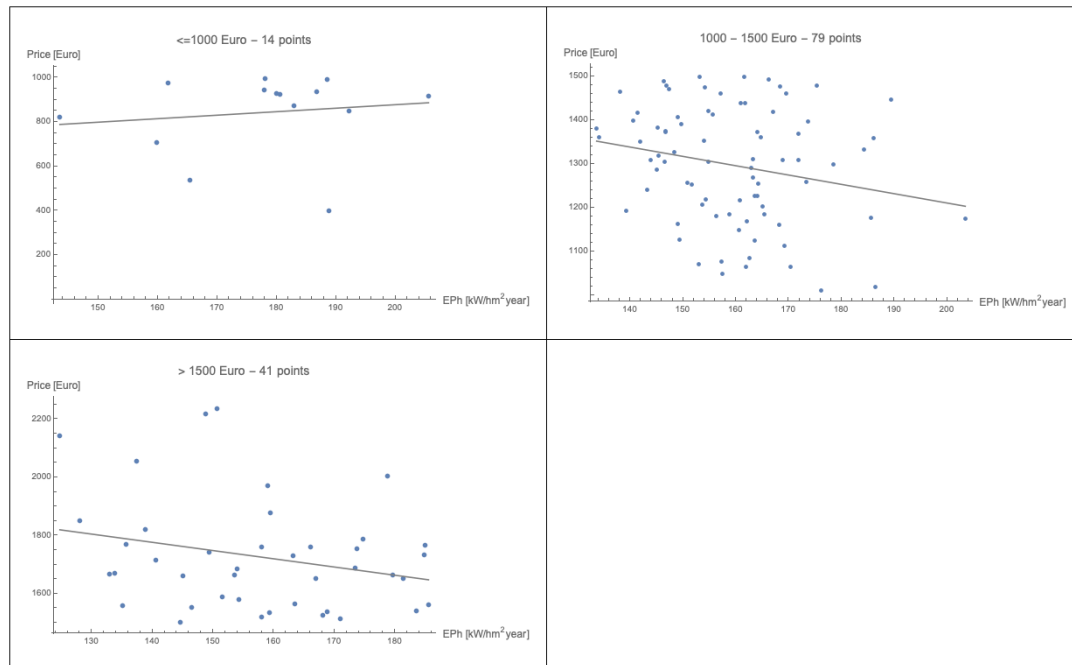
### 5.3. Varese

Varese is the third province adopted as a case study and it has “minor” attraction on the territory.



**Figure 5.** Varese province. Average EPH values and Average Purchasing price by municipality categorised by 5 quantiles.

Also, in this context the spatial distribution of prices follows the criterion described above: the closer we are to a valuable place (e.g. lake, main city), the higher is the price of houses, with an anomaly on the border with the province of Milan, where there is a significant rise in prices.



**Figure 6.** Varese province. Correlation between average EPH and average purchasing price by municipality.

The correlation is not strong despite an inverse correlation can be noticed. Nevertheless, the correlation is stronger if we consider the class of purchasing values 1000–1500 and >1500 Euros, while for low market values the energy certification does not seem to show any effect, perhaps in consideration of the fact that they can be related to sales and purchases of dated buildings and in poor condition, for which these factors are not relevant.

## 6. Discussion and conclusions

The analysis of the results shows how the metropolitan context of Milan, though showing not a very strong correlation, sits in the regional context with a constant correlation between the market value and the energy performance of residential buildings. Nevertheless, the analysis is being improved and the classification of the prices further expanded. Though excluding the effect of the distance on the energy performance and the market value, still the metropolis is the major factor of attraction. The greater mobility of the market in the main city (Milan) and in the nearest municipalities means greater need for energy certifications, thus for better energy performance to be competitive on the market.

In the context of the province of Brescia there is a similar, albeit less pronounced, concentric trend in the increase of the values around the main city, with a greater concentration of good energy performance levels. This is due factors of attractiveness widespread throughout the territory. It should be noted that the range of lower commercial values shows a focus on the search for low EPH, thus better energy performances. For average distance from the attractive places a neutrality is appreciated, while for residential buildings locate far from the attractive places there is a lack of attention towards an evaluation of adequate EPH. Nevertheless, in this case the correlation market value/EPH is very low.

For the province of Varese, characterised by specific points of attraction on the territory, there is a situation similar to Brescia (influence of the capital, the border with Switzerland and proximity to the lake), with a stronger correlation along the axis of Malpensa Airport-Milan. This situation must be linked



to the development of new construction (and therefore presence of better energy performances) and increase in the real estate market value as the province of Milan is approached.

To conclude, it can be stated that a first policy survey has been carried out according to the proposed methodology, providing insights on a large scale. For a more in-depth evaluation of the actual correlation between market values and certifications an in-depth mathematical modelling of the correlation is ongoing. Moreover, a detailed survey at the level of the single building is being developed. This will lead to a more specific and detailed assessment of the impact of the energy certification on the market value of residential building, within the framework of energy efficiency pledged by the European Union.

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