Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Engineering 21 (2011) 303 – 310

Procedia Engineering

www.elsevier.com/locate/procedia

2011 International Conference on Green Buildings and Sustainable Cities

Real Estate market, energy rating and cost. Reflections about an Italian case study

Kristian Fabbri[a], Lamberto Tronchin[b*],Valerio Tarabusi[b]

[a]*Faculty of Architecture – Alma Mater Studiorum University of Bologna - Italy*
[b]*DIENCA – Alma Mater Studiorum University of Bologna - Italy*

Abstract

The Directive EPBD introduced Energy Performance Certificate (EPC) an energy policy tool. The aim of EPC is to inform building buyer about energy performance (and energy cost) of buildings. They represent a specific energy policy tool to orientate building sector and retail market toward higher energy efficiency building. The Real Estate market was built in different periods, and in each of these periods the building envelope or the heating plant had different kinds of energy performance. Therefore, in real estate, each building-period has a determinate incidence respect total existing buildings, and they have different energy consumption incidence respect total energy national consumption. The EPBD recast highlight the relation between building elements or technical building system, energy rating and cost-optimal levels of minimum energy performance requirements. In present paper a discussion about Directive's news, Italian EPC and real estate market prospective is presented. Furthermore we proposed a reflection about link between energy cost, energy rating and building property value.

Keywords: sustainable economic development policies; real estate; thermo-economic evaluation; energy rating; energy performance certificate; net present value, simple payback period

1. Introduction

The Directive 2002/91/Ce [1] (EPBD) introduces Energy Performance Certificate (EPC) of building in European Union member States. The aim of Energy Performance Certificate is: The energy performance

* Corresponding author.
E-mail addresses: lamberto.tronchin@unibo.it

doi:10.1016/j.proeng.2011.11.2019

certificate for buildings shall include reference values such as current legal standards and benchmarks in order to make it possible for consumers to compare and assess the energy performance of the building.

With Directive 2010/31/UE (EPBD recast) [2] on the European Council of March 2007 reaffirmed the Union's commitment to the Union-wide development of energy from renewable sources by endorsing a mandatory target of a 20 % share of energy from renewable sources by 2020. Directive 2009/28/EC [3] establishes a common framework for the promotion of energy from renewable sources.

In preamble (15) of Directive 2010/31/UE Recast (EPBD recast) remark home many building have an impact on long-term energy consumption. "Given the long renovation cycle for existing buildings, new, and existing buildings that are subject to major renovation, should therefore meet minimum energy performance requirements adapted to the local climate". EPBD recast targets are ambitious and resolute, especially for new buildings. The directive introduces the National Plans for increasing the number of "Nearly zero energy buildings", also defines a building with "zero, or very low, amount of energy required, should be covered to a very significant extent by energy from renewable sources" (Article 2 comma 2 Directive 2010/31/EU - EPBD recast).

However new buildings are a small percentage of all existing building stock. The new "urban units" for year in Italy are about 230.000 – 250.000, [4] compared with 20.441.788 existing "urban units" [5]. New building incidence is 1.1% - 1.2% of existing building stock: any "nearly zero building" energy policy could be incisive without energy policy for energy building retrofit through energy saving, energy efficiency and/or renewable energy integration.

Another interesting aspect of EPBD is the introduction of "cost-optimal level" concepts. "Comma 14. 'cost-optimal level' means the energy performance level which leads to the lowest cost during the estimated economic lifecycle". Cost-optimal level evaluation takes into account each "building elements" and "technical building systems" cost, lifespan and related energy saving. For example cost-optimal level of window or boiler depends on: lifespan, cost, maintenance cost (for boiler) and energy saving relate to windows or boiler installation.

The Economic evaluation should be specified with not many and brief economic indicator, for example Net Present Value (NPV) and/or Simple Pay Back Period (SPB). These indicators aren't related to market.

In the Energy Performance Certificate are reported the Energy Classification of building from worst performance (Class G) to better energy performance (Class A or A+) in order to explain saving energy and/or relative economic cost for owner and/or building users

The Energy Labeling is a good tool for real estate market and for defining several benchmarking value in order to address the development policies by legislator, town planning or long term planning [6].

Cost optimal levels could be used:

- 1) To define minimum energy requirements for new buildings;
- 2) To define technical solution to increase energy efficiency scheduled in Energy Performance Certificate.

About the last item will be studied economic and social indicator to support technological choices [7].

The Energy Performance Certification of building has done by "*independent expert*" (Article 10 Directive 2002/91/CE), therefore several subjects could evaluate energy performance and apply Energy Classification.

In European Union Directive 97/75/CE [8] introduced Energy Labeling for household appliance, with result to eliminate household appliance with energy performance worse. The labeling to communicate energy performance of building with Energy Classification, is an "Energy Policy tool", to stimulate real estate market toward low or zero energy performance building (in case of new building) or to stimulate energy retrofit.

2. Aim of this paper

The aims of this paper are:

- 1) To reflect upon existing building and related Real Estate market in Italy and "*Energy Performance Certificate effect*";
- 2) To verify if NPV is a good indicator.

The construction sector and real estate market are more complex than household appliance sector, because they have several actor (builder, entrepreneur, building contractor, project developer, architect, engineer, local administrative, etc.) included energy services companies, energy distributor, and retail energy sales company.

The economic value of building related to energy classification depends on the role and capacity of "independent expert" to attribute energy classification. In the other hand energy cost are linked with to energy classification and cost-effective improvement of energy performance. Energy costs are linked with energy class. Thermoeconomic analysis has been object of several studies about heating plant, power plant and other energy appliance, include building. [9]. The Italian case study reported in this paper could be apply in other European State Members. [10], [11]. The present discussion may be a decision support models to set bottom-up or top-down analysis [12].

3. Italian regulation framework to transporting Directive 2002/91/CE

The Italian Organization for Standardization UNI [13] and CTI [14] transposed CEN Standards in Italy, selected "Quasi-steady-state-methods" and monthly period for Italian procedure to evaluate energy use for space heating and cooling following EN ISO 13790 [15] and primary energy. The Italian standards to evaluate energy performance of buildings are UNITS 11300 part 1 [16] and part 2 [17].

The Italian legislator has transposed Directive 2002/91/Ce with Dlgs 192/2005 *recepimento della Direttiva 2002/91/CE sul rendimento energetico in edilizia*" [18], and DPR 59/2009 about "*minimum requirements on the energy performance*" [19], DM 26 June 2009 "*Italian guideline to energy performance certification of building*" [20]. The Italian Constitution article 117 allows the Regions to legislate and to define role about energy (excluding energy production and energy net distribution). Some Regions like Lombardy, Emilia-Romagna, Piedmont and Liguria has adopted owner laws and rules to transposition of Directive 2002/91/CE. In this paper we adopt the energy rating by Emilia-Romagna Region legislation.

4. Real Estate Italian Market

Real Estate Italian market is made up 10.947.000 buildings, about which 26.681 new buildings for each year [21]. Dwelling Real Estate urban units is 27.268.800 (ISTAT Census 2001 [5]), of which 17.639.801 built before 1971 (61 % of total), without any energy requirements (the first Italian law about energy requirements is Law 373/1976 [22]); and 25.107.535 built before 1991 (92 % of total), before to come into force Law 10/1991 [23] which adopt maximum energy performance requirement for heating building.

From 2001 until 2008 about 260.000 new urban units for each year were built, about 1.800.000 new dwelling urban units [24]. At 2010 in Italy Dwelling Real Estate urban units is assessable at 29.350.000, of which about 3,50 % built after transposition of Directive 2002/92/CE with Dlgs 192/2005 [25]. In this context new buildings are just only 1.0 % or 2.0 % of total. It stands to reason which energy policy must be oriented in order to promote energy retrofitting, also to suggest through Energy Performance Certificate (EPC).

Table 1. Dwelling Real Estate Italian market, new building divided by period

Period (from – to)	Numbers of urban units (ISTAT)	Incidence (%)
before 1919	3,893,567	13,15%
from 1919 to 1945	2,704,969	9,14%
from 1946 to 1961	4,333,882	14,64%
from 1962 to 1971	5,707,383	19,28%
from 1972 to 1981	5,142,940	17,38%
from 1982 to 1991	3,324,794	11,23%
from 1991 to 2001	2,161,345	7,30%
from 2001 to 2010	2,328,778	7,87%
Total	29,597,658	100,00%

The Italian Real Estate market have sale of about 800.000 urban units for each year, 2.7 % of total, and only 30% concerning new building or urban units [26]. The average value of energy performance index EP for existing buildings is estimable at 160-180 kWh/m^{2}year. If we suppose 80 m^2 of floor for each units, the amount of energy object of EPC for existing is nearly 400 - 600 ktoe for year. If only 5% of owner choose to realize the EPC recommendations for improvement of the energy performance, with a 10% of energy saving, the total amount of energy saving for each year could be about 17-27 ktoe/year.

Table 2 . Dwelling Real Estate Italian market, *Existing Dwelling urban units* for period

Existing Dwelling urban units existing	Numbers	Incidence (%)
until at 1919	3,893,567	13.15%
until at 1945	6,598,536	22.29%
until at 1961	10,932,418	36.94%
until at 1971	16,639,801	56.22%
until at 1981	21,782,741	73.60%
until at 1991	25,107,535	84.83%
until at 2001	27,268,880	92.13%
until at 2010	29,597,658	100.00%

Table 3. Urban units Real Estate Italian market, Existing urban units existing and building energy requirement law

	Numbers	Incidence (%)
Units built without energy regulations (include heritage buildings)	21,782,741	73.60%
Units built after Law 373/1976, with transmittance and heating plant efficiency minimum.	3,324,794	11.23%
Units built after Law 10/1991, with energy consumption heating maximum (estimate)	3,325,734	11.24%
Units build after Dlgs 192/2005 Directive 2002/92/CE Trans-position, with minimum level of energy performance requirements (estimate)	1,164,389	3.93%

5. Energy Cost, Energy Rating and Real Estate Market

The 45% national energy consumption (190 millions of toe) depends on energy use in buildings and building constructions: material production, new building and retrofitting [21]. The Energy Performance Certificate is an energy policy tool to inform and to orient the building purchaser. On this way EPC is a Real Estate market and building sector tool. To estimate market value of building EPC energy information are in addition on city location and geometry or other kind of characteristic of building.

5.1. EPC rating and energy cost

The EPC end-users are not technical professionals but everyone citizens, and they depend on local Real Estate market, user behavior and climate data. Then EPC is a tool to determine market value and to choose whether to take urban units or not, so energy performance is one of parameter, like building location, or architectonic and technological characteristic and optional.

Table 4. Dwelling urban units Real Estate Italian market, Existing Dwelling urban units and building energy requirement law

		Incidence (%)
Units built without energy regulations (include heritage buildings)	17,889,174	60.44%
Units built after Law 373/1976, with transmittance and heating plant efficiency minimum.	3,324,794	11.23%
Units built after Law 10/1991, with energy consumption heating maximum (estimate)	3,325,734	11.24%
Units build after Dlgs 192/2005 Directive 2002/92/CE Transposition, with minimum level of energy performance requirements	1,164,389	3.93%

5.2. Energy cost evaluation

To evaluate energy cost incidence, for each year and during building lifespan, energy performance index EP, in kWh/m^{2}year, must be converted in natural gas consumption, in Sm^3/m^{2}year (in Italy the highest percentage of building uses natural gas for heating and domestic hot water), and energy bills, €/m^{2}year.

The parameters to evaluate energy cost are:

- Gross Calorific Value (GCV) of natural gas in Modena by small retail distributor and energy sales company HERA is 9.59 kWh/Sm^3, where Sm^3 is Standard meter cube of natural gas. This is an average value, for exactly evaluation it is necessary to use GCV by natural of Gas distributor or trader;
- average value in Italy for energy rate is 73.41 €/Sm^3 in case of dwelling use without tax and excise tax; for example a dwelling user consumption in 2009, is 1400 Sm^3/year (by AEEG [27], and see also). To adopt average value not in accordance with the scale and rates by energy distributor, it could be assigned an confidence interval of 15 ± 30%;
- heating plant active 24 hours on day according to UNITS 11300 part 1 and 2 procedure.

For example a building with index EP_{tot} 150 kWh/m^{2}year in apartment with 80m^2 of surface, the primary energy need is 12000 kWh/year, equal to 1251.30 Sm^3/year. The energy cost is 1251.30 Sm^3/year; By multiplying the energy bill 73.41 €/Sm^3 gives an energy bill of 918.58 €/year.

In order to evaluate the relation between Energy class in Emilia-Romagna Region and Energy class, in table 5 the equivalence between Energy Class in kWh/m^{2}year an energy cost in €/m^2 are reported.

6. Thermo-economic and EPC

The thermo-economic studies evaluate connections between energy cost, energy performance and technological cost to improve energy performance, for example, with adoption of solar heating [28], or depending on energy use in case of residential or commercial buildings [29], or schools [30].

About energy cost evaluation and building lifespan is possible to run some thermo-economics simulation at least to introduce a debate about it. In present paper the relation between building cost and energy cost are highlighted, which are depending, for example, of inflation rate or materials cost, and real

estate market, which are related to city economy and development, geometry and intern finished and also EPC.

Table 5. Energy Cost and Energy Classification in Emilia-Romagna Region

Energy Class in kWh/m^{2}year			Energy Consumption in Sm^3/m^{2}year			Energy Cost in €/m^{2}year		
	A+ ≤	25.00		A+ ≤	2.61		A+ ≤	1.92
25.00	≤ A ≤	40.00	2.61	≤ A ≤	4.17	1.92	≤ A ≤	3.06
40.00	≤ B ≤	60.00	4.17	≤ B ≤	6.26	3.06	≤ B ≤	4.60
60.00	≤ C ≤	90.00	6.26	≤ C ≤	9.38	4.60	≤ C ≤	6.90
90.00	≤ D ≤	130.00	9.38	≤ D ≤	13.56	6.90	≤ D ≤	9.95
130.00	≤ E ≤	170.00	13.56	≤ E ≤	17.73	9.95	≤ E ≤	13.02
170.00	≤ F ≤	210.00	17.73	≤ F ≤	21.90	13.02	≤ F ≤	16.08
	G ≥	210.00		G ≥	21.90		G ≥	16.08

Table 6. Case study: Apartment of 80m^2 floor surface

Energy Class	Natural gas consumption (Sm^3/year)	Energy cost without tax (€/year)	Error gap ±
A+ ≤	208.55	≤ 153.10	30.62
≤ A ≤	333.68	≤ 244.96	48.99
≤ B ≤	500.52	≤ 367.43	73.49
≤ C ≤	750.78	≤ 551.15	110.23
≤ D ≤	1.084.46	≤ 796.10	159.22
≤ E ≤	1.418.14	≤ 1.041.06	208.21
≤ F ≤	1.751.82	≤ 1.286.01	257.20
G ≥	1.751.82	≥ 1.286.01	257.20

In table 5 and 6 the relation between energy rating and energy annual cost are reported. But energy annual cost must be compared:

- with "*building cost*" or retrofitting cost, which depend on building material market;
- with "*real estate cost*", which depend on real estate market.

The buildings material and real estate market depend on different prices variables. On this way it is possible to confront building value, based on real estate market, with "*energy cost*" during building lifespan (or mortgage loan).

In table 7 energy cost is evaluated in Net Present Value (NPV) during 20 year, average term of mortgage loan in Italy, with a 3% of inflation rate. The NPV assumes that all the annual costs are paid in the year "zero" of investment. Therefore the total initial cost is the sum of real estate cost and total energy cost. Note: in real estate cost, the real interest rate of mortgage loan are not included, they are included in initial real estate value. The hypotheses are:

- 200.000 € economic building value, by Real Estate market;
- 20 years useful of building;
- inflation rate of 3%;
- energy cost explained in paragraph 5.1
- Net Present Value (NPV) in 20 year.

How we can see in table 7 a building in Energy Class A+ have a 2.45% of energy cost incidence; on the other hand an Energy Class G has an 12.86% of energy cost incidence.

Table 7. Thermo-economic evaluation: energy class, energy cost and NPV

Energy Class	Natural gas consumption (Sm^3/year)	Annual energy cost €/year	NPV (20 year and 3% inflation rate)	Building cost and NPV	Percentage of increase of energy cost during 20 year
A+	208.55	≤ 153.10	3,061.94	203,061.94	about + 1,53%
A	333.68	≤ 244.96	4,899.10	204,899.10	about + 2,45%
B	500.52	≤ 367.43	7,348.65	207,348.65	about + 3,67%
C	750.78	≤ 551.15	11,022.98	211,022.98	about + 5,51%
D	1.084.46	≤ 796.10	15,922.09	215,922.09	about + 7,96%
E	1.418.14	≤ 1.041.06	20,821.19	220,821.19	about + 10,41%
F	1.751.82	≤ 1.286.01	25,720.29	225,720.29	about + 12,86%
G	1.751.82	≥ 1.286.01	25,720.29	225,720.29	about ≥ + 12,86%

7. Conclusions

The building sector and real estate market, and each actor: builder, entrepreneur, architect, engineer, owner, etc. need rules and tools to promote the virtuous behavior. Forcing by law to adopt specific technologies, could be of an effect. In the other hand to use the same specific technologies to promote building in real estate market could be an incisive way.

The case study presents one problem related to the implementation of energy policy in "energy action", with communication tool to oriented retail market toward energy efficiency increase. The Energy Performance Certificate is an incisive tool, but it has some problems regarding energy performance evaluation, especially about independent expert practices in order to respect standard procedures and to understand and to verify the results of energy performance of building evaluation, notably in order to confront EPC classification to energy costs. The energy classification range is correct to reduce the effects of value fluctuation.

The EPC introduction in Italian retail market is too recent to evaluate its impact in building sector. The thermo-economics evaluation applied at retail market could be a way to make EPC like an effective tool of energy policies.

References

[1] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002. *On the energy performance of buildings* (EPBD).

[2] DIRECTIVE 2010/31/EU of the European Parliament and of the Council of 19 May 2010. *On the energy performance of buildings (recast)* (EPBD recast).

[3] Directive 2009/28/CE of the European Parliament and of the Council of 23 April 2009. *On the promotion of the use of energy from renewable sources and amending and subsequently repealing Directive 2001/77/EC and 2003/30/EC* .

[4] *Report by CRESME Le costruzioni al 2010 (Building sector in 2010) Lorenzo Bellicini*. CRESME Research Centre is a non-profit association in favour of promotion and information on construction industry and territory transformations - http://www.cresme.it/english.asp

[5] ISTAT. *Italian Population Census 2001*.www.istat.it

[6] Luis Pe´rez-Lombard, Jose´ Ortiz, Rocı´o Gonza´ lez, Ismael R. Maestre. A review of benchmarking, rating and labelling concepts within the framework of building energy certification schemes. *Energy and Buildings* 2009;**41(3)**: 272-278.

[7] Diana Gallego Carrera, Alexander Mack. Sustainability assessment of energy technologies via social indicators: Results of a survey among European energy experts. *Energy Policy* 2010; **38(2)**:1030-1039.

[8] Council Directive 92/75/EEC of 22 September 1992. *On the indication by labelling and standard product information of the consumption of Energy and other resources by household appliances.*

[9] Zafer Utlu, Arif Hepbasli. Thermoeconomic analysis of energy utilization in the residential–commercial sector: An application. *Building and Environment* 2008;**43(5)**:896-904.

[10] F.M.B. Asdrubali, M. Battisti, M. Venegas.Comparative study of energy regulations for building in Italy and Spain. *Energy and Buildings* 2008; **40(10)**:1805-1815.

[11] C Karkanias, SN Boemi, AM Papadopoulos, TD Tsoutsos, A Karagiannidis. Energy efficiency in the Hellenic building sector: An assessment of the restrictions and perspectives of the market. *Energy Policy* 2010;**38(6)**:2776-2784.

[12] M Kavgic, A Mavrogianni, D Mumovic, A Summerfield, Z Stevanovic, M Djurovic-Petrovic. A review of bottom-up building stock models for energy consumption in the residential sector. *Building and Environment* 2010;**45(7)**:1683-1697.

[13] UNI Ente Nazionale Italiano di Unificazione - Italian Organization for Standardization.

[14] CTI, Comitato Termotecnico Italiano -Italian ThermoTecnical Committee.

[15] EN ISO 13790:2008 *Energy performance of buildings - Calculation of energy use for space heating and cooling.*

[16] UNI TS 11300 *parte 1 Energy performance of buildings- part 1 Calculation of Energy use for space heating and cooling.*

[17] UNI TS 11300 *parte 2 Energy performance of buildings- part 2 Calculation of Energy Primary and energy performance for heating plant and domestic hot water production.*

[18] Dlgs 192/2005 (modified by Dlgs.311/2006) *Attuazione della direttiva 2002/91/CE relativa al rendimento energetico nell'edilizia* (Adoption of Directive 2002/91/CE Energy performance of buildings).

[19] DPR 59/2009 *Regolamento di attuazione dell'articolo 4, comma 1, lettere a) e b), del decreto legislativo 19 agosto 2005, n. 192, concernente attuazione della direttiva 2002/91/CE sul rendimento energetico in edilizia - Decree which fix the Italian minimum energy requirements.*

[20] DM 26 giugno 2009 *Linee guida nazionali per la certificazione energetica degli edifici - Italian guideline to energy performance certification of building.*

[21] ENEA – FINCO. *Libro Bianco Energia Ambiente* Edificio*(White Book: Energy, Environmental, Building).*Roma;2005.

[22] Legge 30, n.*373 Rules for saving energy consumption for heating in building;*1976.

[23] Legge 10 Gennaio 1991, n. 10 *Rules of rational use of energy, energy conservation and developing renewable sources of energy*.

[24] CRESME. Elaborazioni dati CRESME Congiunturale Cresme/Saie 2010.

[25] Decreto Legislativo 19 agosto 2005, n. 192 .*Transposition of Directive 2002/917CE on energy performance of buildings*.

[26] Agenzia del Territorio. *Rapporto Immobiliare 2008 (Land Registry – Real estate report 2008).*

[27] AEEG. *Autorità per l'Energia Elettrica ed il Gas*. Regulatory Authority for Electricity and Gas.

[28] F. Calise. Thermoeconomic analysis and optimization of high efficiency solar heating and cooling systems for different Italian school buildings and climates. *Energy and Buildings* 2010;**42(7)**:992-1003.

[29] Zafer Utlu, Arif Hepbasli. *Thermoeconomic analysis of energy utilization in the residential–commercial sector: An application*. *Building and Environment* 2008;**43(5)**:896-904.

[30] U.S.P. Desideri. Analysis of energy consumption in the high schools of a province in central Italy. *Energy and Buildings* 2002;**34(10)**:1003-1016.