Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 45 (2014) 434 – 442

Energy Procedia

68th Conference of the Italian Thermal Machines Engineering Association, ATI2013

Check-in and control activities on the energy performance certificates in Emilia-Romagna (Italy)

Cosimo Marinosci[a,b,] *, Gian Luca Morini[a]

[a]*Department of industrial engineering (DIN), School of Engineering and Architecture, Alma Mater Studiorum - University of Bologna, viale del Risorgimento 2, Bologna, Italy*

[b]*Interdepartmental centre for Industrial Research - Building and Construction (CIRI-EC), via del Lazzaretto 15/5, Bologna, Italy*

Abstract

Because of the transposition of the European Directive 2010/31/EU, Italy will also be forced to adopt systems and procedures aimed at verifying and checking buildings' energy performance certificates.
Through the compliance clause, some regions and autonomous provinces have already realized a certification and control system that, consistent with the European Directive, has achieved excellent results.
Since 2011 the Emilia-Romagna region has foreseen and experimentally started a verification and control system on the energy performance certificates in order to check their completeness and correctness. In this way, certificates' data are examined from the point of view of adequacy and coherence, and the quality of the information about the energy efficiency of buildings can be improved.
The results of the verifications carried out on the certificates have proved to be interesting: a considerable amount of the energy certificates registered in 2011 contained at least a technical, even serious, inconsistency.
Therefore, the purpose of this work is to analyse the results obtained by the authors during the experimental campaign focusing on the recurring mistakes during compilation and on the wrong interpretations of the relative standards (both regional and national) by the energy certification bodies.

Selection and peer-review under responsibility of ATI NAZIONALE

Keywords: Energy Performance Certificate; Control and verification activities.

* Corresponding author. Tel.: +39 051 2090566; fax: +39 0512090544.
E-mail address: cosimo.marinosci@unibo.it

Selection and peer-review under responsibility of ATI NAZIONALE
doi:10.1016/j.egypro.2014.01.047

Introduction

The energy certification of buildings consists in an evaluation procedure done in accordance with the European Directives 2002/91/EC [1] and 2006/32/EC [2]. This procedure has been accepted through the Italian Legislative Decree no. 192 [3] of 19 August 2005 (implementing Directive 2002/91/EC), and through the Italian Legislative Decree no. 311 [4] of 29 December 2006. The latter lists a series of operations connected to the energy certification carried out by the bodies empowered to issue the Energy Certificate (EC). The energy certificate is drawn up following the rules and criteria of the relative legislation and attests the energy performance, efficiency and yield of a building. Moreover, this document contains all the recommendations aimed at improving the energy performance of the building. Because of a delay in the issue of the national decrees, some Italian regions have provided themselves with specific regulations to control the energy performance and certification of their buildings. In a few cases, these rules differ from the national code and the energy classification system. The regions that made this choice are: Lombardia, Liguria, Piemonte, Emilia-Romagna, Valle D'Aosta, Bolzano Province and Trento Province. As a consequence, in these regions there is a specific legislation which rules the energy certification and defines the qualifications technicians must have to certify a building.

Through the latest revision of the European Directive 2010/31/UE [5], the legislator has modified some contents and the approaches to the energy efficiency and certification. To sum up, the most relevant novelties concern the definition of nearly zero-energy buildings, the definition of the energy performance, the Energy Performance Certificate (EPC) and, at last, the control system of the energy performance certificates and the inspection reports.

Emilia-Romagna, together with Lombardia, has been one of the first regions to create a system of energy certification of buildings and to further introduce and test a control and monitoring method of such system [6].

In this piece of writing the technical procedure adopted to control the buildings' energy certificates issued and registered in Emilia-Romagna is described. Furthermore, the results of the experimental campaigns led in 2011 and 2012 are analysed.

1. Verification process

In order to find the most frequent anomalies in the certificates and to evaluate the reliability of the data in the EPCs registered by the certifying technicians, all energy certificates registered in the Emilia-Romagna SACE [7] database up to May 2011 have been analysed. The outcome has shown that many certificates (about 61%) contained inconsistencies due to a wrong application of calculation methods and/or to proper calculation mistakes.

This considerable amount of incorrect or partially correct information reveals that a verification activity on the issued certificates is necessary to improve the quality of the information collected.

Thank to this analysis, three different types of mistakes have been defined:

- numerical mistakes (e.g. the certificate contains out-of-range numbers);
- mistakes in the application of rules (e.g. a simplified calculation method compared with the situations indicated in the norm in force is used);
- technical inconsistencies (e.g. in a certificate the contribution of renewable energy resources is said to be null even if the building has heat pumps or biomass plants).

Bearing this situation in mind, the current report shows the verification scheme adopted to check the energy certificates registered during the experimental phase. Below it is possible to find the methodology used to monitor and control the activities aimed at the buildings' certification and done by the accredited subjects in accordance with the resolution of the Regional Legislative Assembly no. 156/2008 [8] and subsequent amendments.

This control system introduces examinations by an independent third party, in order to safeguard the following principles:

- impartiality during the technical and management operations of the verification and control process, during the relative sampling activities and thus the impartial treatment of the subjects involved;
- independence of the verification process and thus the absence of a conflict of interests;
- cultural, technical and professional competence of the personnel charged with the verification and control activities.

In general, checks concern management aspects and technical ones. The first type of controls affects the certification body. It must possess all the requirements set by the application and maintain them. Moreover, it must respect the certification procedures. Secondly, the technical controls concern the completeness and correctness of the energy performance certificate.

The control system is divided into two types of examinations:

- 1st-level examinations: these technical checks are automatically done by the SACE system on the energy performance certificates issued by the certification bodies before their final validation.
- 2nd-level examinations: these technical and management checks are mostly carried out by qualified inspectors at the certification body's office and, if that is the case, at the buildings to be certified.

The proposed verification scheme is described through the flowchart given in Figure 1.

2. 1st-level examinations

1st-level examinations are split into three types:

- immediate checks (type A)
- checks on the certificate's data (type B)
- checks on extensive data (type C)

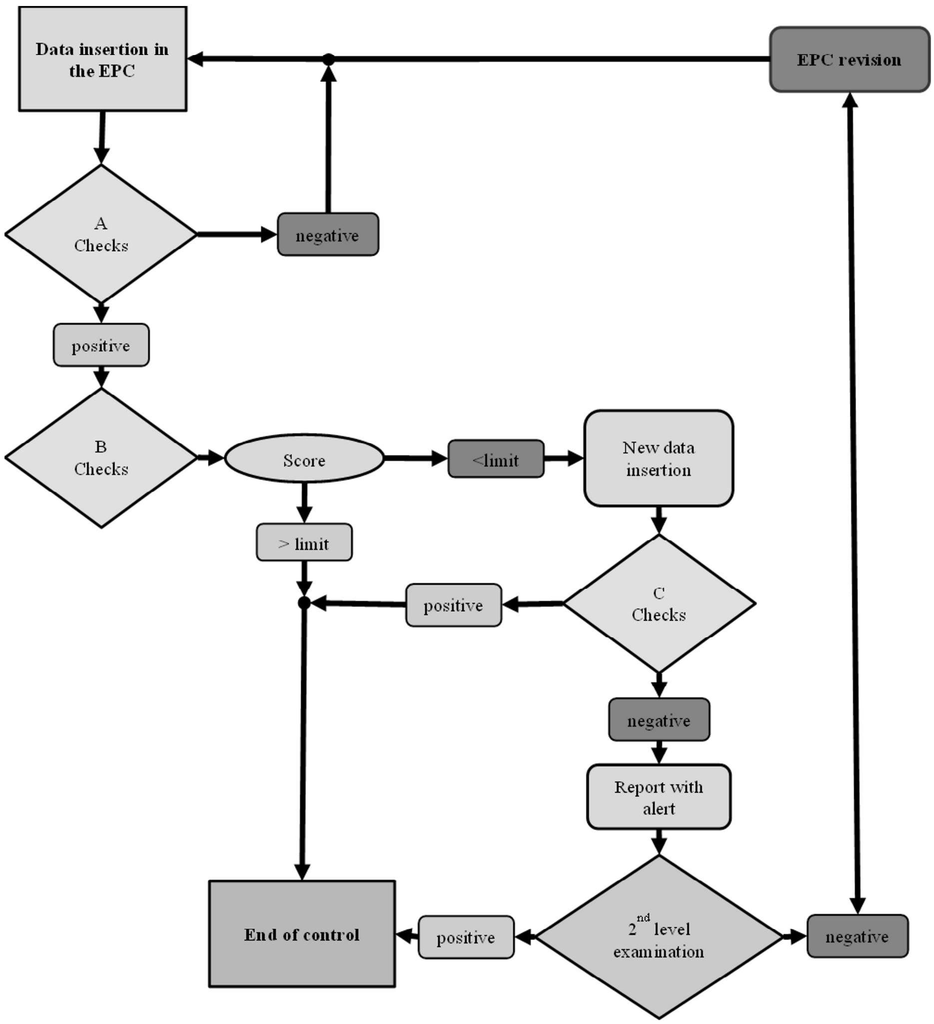

Fig. 1. EPC verification scheme followed in Emilia-Romagna during the experimental phase (2011-2012).

2.1. Type A checks

The first type of checks (type A) is conducted when the technician fills in the EPC. Thank to this type of examinations, it is impossible to register an EPC with data not complying with the current standards or with incoherent or wrong values. Type A checks are to be considered "preventive" measures and they do not affect the subsequent verification steps.

The system immediately detects the inconsistent data, since every inserted number is compared with a range of possible values. To this end, a complete range from the minimum to the maximum acceptable value is created for each parameter to be inserted in the certificate. If the inserted datum is outside the range, the system asks to insert the datum again (Fig. 1). This system of immediate checks on the single datum allows the technician to correctly draw up the certificates on-line. In this way, in fact, he/she avoids typing wrong characters or inserting senseless data.

2.2. Type B checks

The second type of checks (type B) is intended to draw attention to the eventual anomalous data in the certificate which require a more detailed investigation. On the basis of the results obtained in each type B check, the EPC is given a score going from 0 to 100. 0 means the EPC does not comply with any of the verifications conducted, while 100 means the EPC complies with all type B checks. In this way, type B checks are useful to assign a "coherence degree" to the data inserted in the EPC. The achieved score permits to identify the sample that has to be checked through the 1st-level examinations. The EPC with a score under the limits of the type B checks' parameters are subjected to the type C checks (Fig. 1).

On the ground of the data inserted in the present EPC, the system controls the technical coherence of the document by mainly cross-checking the following data:

- useful energy demand and primary energy demand;
- domestic hot water (DHW) production demand;
- thermal transmittance of opaque and transparent components (of the building envelope);
- special plants using renewable energy resources in high performance buildings;
- buildings with particularly high running costs.

Nowadays the number of type B checks is 19, but in the future the amount of verifications could increase or decrease in accordance with the eventual regulatory adjustments.

Checking the technical coherence of the data inserted in the certificate allows to single out all the certificates containing mistakes from the technical point of view and thus deserving a more accurate research.

2.3. Type C checks

In order to carry out type C checks, the certification body is asked to add a further set of data. This additional information permits a more complete examination on the coherence of the certificate's results. On the ground of these extra data provided by the certification body, the results and the building/plant input data are cross-checked from the technical point of view. As a consequence, type C checks reveal the main criticalities contained in the EPC's data and, through the automatic creation of a report, forthwith inform if the EPC needs factual, 2nd-level examinations or not. The report shows the items that need primary control during the concrete examinations (since the checks have pointed out the inconsistencies that have to be analysed in detail). An energy certificate must be subjected to type C checks when its global score is under the settled minimum threshold. Type C checks allow a more detailed and careful investigation than type B checks. In fact, the latter involve the data verification only, whereas type C checks also affect the EPC's content and reliability.

In order to conduct type C checks, the certification body is asked to add via web a series of additional information on the certificate to be examined. In this way, the control process is based not only on the data written in the certificate, but also on more detailed information (extensive database) giving a clearer idea on the certificate's correctness. Type C checks include the analysis of at least 100 data and start from the moment the certification body provides the supplementary data. Nevertheless, the aim of the collection of additional data is not to calculate the

certificate again. It just supplies a wider database where information can be cross-checked and verified from the point of view of coherence.
On the basis of the comprehensive data provided by the certification body, the system carries out deepened controls especially on the following points:

- thermal transmittance of opaque and transparent components (of the building envelope);
- the average of the thermal transmittances;
- heating and cooling setpoint temperatures;
- air change per hour (ACH);
- internal heat gains;
- temperature difference between DHW and cold water;
- DHW supply temperature;
- plant efficiency;
- energy performance index.

The full list containing the certificate's extensive data (where criticalities are properly highlighted) can be communicated to the inspector who will take upon himself/herself to audit the certificate during the factual, 2nd-level examinations. So, on the ground of the type C checks' results, the inspector will be able to adequately audit the building/plant system and list the aspects in order of priority that need close investigation during the 2nd-level examinations.

3. 2nd-level examinations

When 1st-level examinations produce negative results, the IT system automatically informs the certification body that a further control step (2nd-level examinations) will be necessary and stops the release of the certificate. 2nd-level examinations will then be organized by the control body within 48 hours from the certificate stop.
A first, automatic notification is conveyed to the certification body. Such notification informs that the certificate subject to registration has been selected by the system to be further examined. 2nd-level examinations will be taken at the certification body's office and, if that is the case, at the building to be certified. Through the notification, the certification body also learns that the team charged with the fulfilment of the control process will contact him/her to plan and do the activities within 24 hours.
Before the audit the certification body also receives some documental and operational check-lists indicating the evidences that will have to be available on the spot. During the inspection, evidences are gathered through conversations with the certification body, documents' examinations and activities' observations. Important non-conformities (also if not related to the elements in the check-lists) must be written down and afterwards studied in deep to verify their adequacy. The information obtained through interviews should be confirmed by objective evidences or independent sources like measurements or recordings. The regional control body will decide the consequent actions taking into account the results of these activities.

4. Analysis of results

In this paragraph the main results of the inspections on the energy certificates of the buildings subject to registration with the SACE system in 2011 and 2012 will be analysed. More precisely, those certificates were registered from 30 November to 23 December 2011 and from 15 October to 20 December 2012. The number of the examined certificates appears in table 1.

Table 1: numbers of examinations conducted on the EPCs registered in 2011 and 2012.

Year	Issued EPCs	1st-level examinations	2nd-level examinations
2011	109356	9407	60
2012	104971	18609	124

1st-level examinations (both type A and type B checks) were automatically performed on all energy certificates for which a registration during the monitoring period was required. On the contrary, type C checks were only carried

out on the certificates not fulfilling type B checks.
In 2012, type C checks were conducted on:

- buildings belonging to A+, A and B energy classes (7%);
- buildings belonging to C and D energy classes (17%);
- buildings belonging to E, F, and G energy classes (76%).

4.1. Type B checks' results

For the sake of conciseness, this work mentions only the examinations made in these years that reveal the most significant criticalities. Table 2 shows the percentages of certificates that did not pass type B checks compared to all certificates issued during the monitoring periods in 2011 and 2012

Table 2: type B checks – the incidence of examinations compared to the EPCs registered during the monitoring periods.

Code	Type B checks	2011	2012
B_01	QHwin+DHW <> QPwin+DHW	5.2%	10.2%
B_06	Residential buildings - DHW demand	30.6%	46.4%
B_08_a	Opaque components' transmittance	6.7%	10.7%
B_09_b	Transparent components' transmittance	26.8%	13.9%
B_13	High EPtot values	16.4%	6.5%

In order to better explain the following analysis, the inspections reported in table 2 are briefly described from the technical point of view.
The check named B_01 consists in a mere comparison between the useful energy demand for heating and DHW ($QH_{win+DHW}$) and the relative primary energy demand ($QP_{win+DHW}$). Both these values can be easily found in the filled EPC.
The check named B_06 consists in a comparison between the useful energy demand for DHW indicated in the EPC and that obtained using the calculation method reported in UNI/TS 11300-2 [9].
B_08_a and B_09_b checks examine the thermal transmittance values (of both opaque and transparent components) indicated in the EPC. The aim of these controls is to deeply analyse very high thermal transmittance values with reference to the building components' type of construction quoted in the certificate. A typical example is the case of very low thermal transmittance values connected with walls without thermal insulation or single glazed windows.
The last check, named B_13, is conducted only if the building energy performance index (EP_{tot} value) indicated in the EPC is more than 250% higher than the limit value corresponding to class G.
By comparing the number of certificates that did not pass one among the type B checks with the number of all certificates registered in 2011, from table 2 it can be seen that 2012 data confirm the figures collected in 2011.
The most frequent incoherence concerns the value indicating the useful energy demand for DHW (B_06 check). In 2011, in fact, 30.6% of certificates did not comply with the legislation in force and in 2012 the percentage was 46.4% [9]. The B_01 check reveals incoherence by mainly compare two numbers. This comparison is made when special plants using renewable energy resources or generators with yield greater than 100% (condensing boilers, heat pumps, etc.) are absent. In all other cases useful energy demand must be lower than primary energy demand. Table 2 shows instead that this phenomenon does not occur for many EPCs subject to control in the indicated periods. Some cases of incoherence are to be attributed to the technician's incompetence, whereas others are related to incorrect data entries in the system even if the calculation was correct. Other inconsistencies concern the thermal transmittance of the building components indicated in the EPCs during the monitoring periods. It is important to underline that since these inconsistencies refer to the external envelope, they lead to a deceptive evaluation of the energy consumption of the building. The last check points out the very high EP_{tot} values typical of class G buildings. In a few cases, the inserted index was not even calculated. Because of the modifications introduced to the threshold values, the percentages of certificates that did not pass B_13 check drop from 2011 to 2012.

4.2. Type C checks' results

Table 3 contains the results of type C checks carried out in the 2011 and 2012 verification campaigns. In particular, the number of certificates that did not pass type C checks can be seen. As for type B checks' results, only the most frequent and interesting examinations are reported.

Table 3: type C checks - the incidence of examinations compared to the EPCs registered during the monitoring periods.

Code	Type C checks	2011	2012
C_11	Internal cooling setpoint temperature	6.4%	5.5%
C_12	Number of air exchanges (expressed in hours)	10.4%	9.0%
C_14	Internal heat gains	11.8%	12.5%
C_15	DHW supply temperature	7.4%	6.2%

A brief description of the checks reported in table 3 precedes the proper analysis of the examinations.
The C_11 check inspects the value of internal setpoint temperature used to calculate the energy demand for cooling (for example, the setpoint temperature for E.1(1) categories [10] is 26 °C [11]).
The C_12 check compares the number of air exchanges (natural ventilation expressed in hours) in residential buildings and in industrial/commercial ones. In these cases the number of hourly exchanges is 0.3 [11].
The C_14 check matches the internal heat gains used to do calculation with the ones compliant with the standards [11].
Finally, the C_15 check analyses the DHW supply temperature used to calculate the energy demand. The norm [9] clearly states that a temperature of 40 °C has to be used.
As for type B checks, the results obtained in 2012 confirm the ones collected in 2011. More precisely, the number of certificates that did not pass one among the type C checks - with respect to all registered certificates - mainly coincides in the two verification campaigns. It appears from table 3 that the value of cooling setpoint temperature (C_11 check) was declared to be non-compliant in about 6% of certificates. The same happened to internal heat gains in the 12% of cases. C_12 checks on the number of air exchanges (expressed in hours) and C_15 checks on DHW supply temperature deserve more attention.
In fact, some inspections suggest that the 0.5 air exchange/hour value was still used even if the norm UNI/TS 11300-1 [9] has recently lowered the correct value to 0.3. More erroneously, in unused buildings the number of air exchanges was 0.
The examination on the DHW supply temperature (C_15 check) points out a wrong evaluation of the DHW demand. And the DHW demand calculation is incorrect since the assumed DHW supply temperature is in turn miscalculated (6.2% of certificates).

4.3. On-the-spot checks' results

The number of 2nd-level examinations carried out during the 2011 verification campaign was 60, whereas the same figure for the following year was 124. In particular, during the 2012 verification campaign 256 examinations were declared to be invalid because of the following reasons:

- the 2nd-level examinations were not planned by the control body within 48 hours from the certificate stop and so the SACE system blocked them (190 cases);
- the certification body was not available for the examinations (63 cases)
- the control body was not available (3 cases).

124 2nd-level examinations concerned:

- buildings belonging to A+, A and B energy classes (11%);
- buildings belonging to C and D energy classes (20%);
- buildings belonging to E, F, and G energy classes (69%).

2nd-level examinations conducted during the 2012 experimental campaign presented the following management aspects:

- 14% of the examined certification bodies was unable to show the professional indemnity insurance required to certify the energy efficiency of buildings;
- 54% of the examined certification bodies was unable to show the information letter (one of the organizational, management and operational requirements imposed to certification bodies pursuant to point 7.2 of the resolution of the Regional Legislative Assembly no. 156/08 and subsequent amendments and additions);
- 29% of the examined certification bodies was unable to show the letter of engagement;
- 48% of the examined certification bodies was unable to show the control procedure of the evaluation process concerning the energy yield [6];
- 32% of the examined certification bodies was unable to show the documentation control procedure [6].

Moreover, 12% of the certification bodies subject to 2nd-level examinations declared that no inspection of the involved building was carried out (the percentage in 2011 was 16%). 88% of the certificates was issued without adjusting the thermal bridges used in the calculations and the thermo physical properties used to calculate the envelope components' transmittance.

Focusing on the verifications' effect, no objections to the inspectors' technical assessments were raised by the certification bodies. All certificates' non-conformities were also acknowledged and considered as relevant.

Nevertheless, in spite of the close cooperation ensured by the certification bodies during the verification process, 62% of them decided not to modify the certificates' mistakes discovered during the on-the-spot investigation. Such a high percentage can be explained by the fact that in the monitoring periods no fine was levied on the monitoring bodies.

On the basis of its importance and nature, each verification result was classified as:

- Major non-conformity: one or more requirements is not satisfied and therefore, on the ground of available objective evidences, the certification body's actions and the certificate's contents are seriously questioned.
- Minor non-conformity: one or more requirements is not satisfied but, on the ground of available objective evidences, the certification body's actions and the certificate's contents are only slightly questioned.
- Recommendation: the verification result does not belong to the previous categories and can help to improve the certification body's actions in order to ensure the certificate's compliance.

From the analysis of the results obtained during the 2011 and 2012 verification campaigns it can be gathered that the most frequent non-conformities concerned the management and organizational requirements. Among the technical verifications, the most frequent non-conformity was related to the useful energy surface. In particular, the datum reported in the certificate did not coincide with the value found on the spot.

Conclusions

The topic of this article is the analysis of the results of the verifications done by the authors during the 2011 and 2012 experimental campaigns. This work has pointed out the most frequent incoherencies connected with the compilation of the buildings' energy certificates. Some technical inconsistencies were due to an incorrect data entry in the SACE system on the part of the certifying technician. In order to reduce this type of mistakes, immediate checks (type A) to guide the technician's actions were implemented on SACE. Other non-conformities were related to a partial transposition or wrong interpretation of the norm by the certification bodies. A few on-the-spot controls revealed both the presence of elements that could change the building's energy class (upward or downward) and the lack of management documents necessary to the energy certification of buildings.

In this variety of contexts, training bodies (and lecturers) play a fundamental role in providing support in the indication of the necessary requirements to be accredited to the list of certification bodies and in the indication of the technical and regulatory professional updating.

Acknowledgements

This work was made possible thanks to support from both the Cermet S.cons.r.l. and the NuovaQuasco, the authors gratefully acknowledge for their support.

References

[1] European Directive 2002/91/CE of the European Parliament and of the Council of 16 December 2002, on the energy performance of buildings.
[2] Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.
[3] Decreto Legislativo n. 192 del 19 Agosto 2005: "Attuazione della direttiva europea 2002/91/CE relativa al rendimento energetico dell'edilizia".
[4] Decreto Legislativo n. 311 del 29 dicembre 2006: "Disposizioni correttive ed integrative al Decreto Legislativo 19 agosto 2005, n. 192, recante attuazione della direttiva 2002/91/CE, relativa al rendimento energetico nell'edilizia".
[5] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast).
[6] DGR 409 2012. Disposizioni concernenti il sistema di accreditamento dei soggetti preposti alla certificazione energetica degli edifici. Affidamento delle funzioni di organismo regionale di accreditamento di cui al punto 6) della D.A.L. 156/08 alla società NuovaQuasco s. cons. r. l.
[7] SACE, Sistema Accreditamento Certificazione Energetica per la Regione Emilia-Romagna (http://energia.si-impresa.it/).
[8] Delibera Assemblea Legislativa Regione Emilia-Romagna n° 156 del 04/06/2008 – Atto di indirizzo e coordinamento sui requisiti di rendimento energetico e sulle procedure di certificazione degli edifici.
[9] UNI/TS 11300-2:2008 – Energy performance of buildings. Part 2: Evaluation of primary energy need and of system efficiencies for space heating and domestic hot water production
[10] D.P.R. n. 412 del 26/08/1993 – Regolamento recante norme per la progettazione, l'installazione, l'esercizio e la manutenzione degli impianti termici degli edifici ai fini del contenimento dei consumi di energia, in attuazione dell'art. 4, comma 4, della L. 9 gennaio 1991, n. 10.
[11] UNI/TS 11300-1:2008 – Energy performance of buildings. Part 1: Evaluation of energy need for space heating and cooling