ENERGY CERTIFICATION OF BUILDINGS: PARAMETRICAL STUDY ON THE INCREASING CERTIFICATION CLASS OBTAINED IN RESIDENTIAL BUILDINGS IN SPAIN

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Summary

The aim of Directive 2002/91/EC on the energy performance of buildings (EPBD) is to promote the improvement of the energy performance of buildings within the Community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness. Amongst the requirements of the Directive, mandatory energy certification of buildings, carried out by recognised experts, is included. To the extent possible, the certificate should describe the actual energy-performance situation of the building and may be revised accordingly. Central to the EPBD is the principle of subsidiarity, since buildings and other local technical, market, social and climatic conditions vary widely across Europe. Spanish Technical Code for Buildings has assumed the EPBD requirements, and the certification of buildings procedure also follows the CEN EN 15217 recommendations. For residential buildings, small single-family and blocks, the energy efficiency indexes are heating and cooling demand, CO_2 emissions of heating, cooling and domestic hot water, and primary energy consumption of heating, cooling and domestic hot water. Certification scale ranges in 7 classes, from A to G, for every one of the energy efficiency indexes. Within the context of the NIMSEC European project, this paper presents a study carried out on the main parameters of influence on the energy performance of the building versus the increase of the certification class obtained. Influence of the local climate, type of residential building, degree of insulation and type of heating and cooling system on the energy class are determined. The study can serve as comparison for certification of buildings procedures in other European countries.

Keywords: energy certification of buildings, energy performance

1 Introduction

The control of European energy consumption and the increased use of energy from renewable sources, together with energy savings and increased energy efficiency, constitute important parts of the package of measures needed to reduce greenhouse gas emissions and comply with international greenhouse gas emission reduction commitments. The European Council of March 2007 endorsed a mandatory target of a 20 % share of energy from renewable sources in overall Community energy consumption by 2020 and a mandatory 10 % minimum target to be achieved by all Member States for the share of biofuels in transport petrol and diesel consumption by 2020, to be introduced in a cost-effective way [1]. Those targets exist in the context of the improvement in energy efficiency set out in the Commission communication entitled 'Action Plan for Energy Efficiency: Realising the Potential'. The improvement of energy efficiency is a key objective of the Community, and the aim is to achieve a 20 % improvement in energy efficiency by 2020. That aim, together with existing and future legislation, has a critical role to play in ensuring that the climate and energy objectives are being achieved at least cost, and can also provide new opportunities for the European Union's economy.

The buildings sector – i.e. residential and commercial buildings - is the largest user of energy and CO_2 emitter in the EU and is responsible for about 40 % of the EU's total final energy consumption and CO_2 emissions. The sector has significant untapped potential for cost-effective energy savings which, if realized, would mean that in 2020 the EU will consume 11% less final energy. This in turn translates to a number of benefits, such as reduced energy needs, reduced import dependency and impact on climate, reduced energy bills, an increase in jobs and the encouragement of local development.

Buildings essentially correspond to the needs and preferences of all European citizens in their specific environments and are therefore often regarded as a key matter of competence for local, regional and national authorities. At the same time, construction products, appliances and services are an important part of the EU internal market and nowadays many workers and businesses are not limited to a single country. Furthermore, the building sector is crucial to meet the energy and climate objectives at the least possible cost to individuals and society in all countries and the added value of common efforts is significant.

The 'Novel and Integrated Model of Sustainable Energy Communities', NIMSEC project [2], is a granted project of the Intelligent Energy – Europe Programme focused on improving and surpassing the local level energy efficiency, and increasing the overall share of renewable energy production, especially in public buildings and/or industry and agriculture. This international project, with ten partners from four central and southern European countries, includes local or regional Energy Agencies, Universities, installers and manufacturers of renewable energies appliances, and Municipalities and related institutions. Based on an analysis of the local framework conditions and on data collected in energy audits, concrete pilot actions are planned and implemented towards building integrated model of sustainable communities. Within the NIMSEC project, training courses on energy efficiency and renewable sources of energy in buildings will be addressed to engineers and technicians usually involved in the heating, cooling and electricity supply projects in buildings. This paper presents a case study of energy certification of buildings study which should be used to promote a better understanding of the energy efficiency factor as a main contribution to the sustainable community model.

2 The Energy Certification of Buildings

The Directive 2002/91/EC of the European Parliament and of the Council on the energy performance of buildings [3] (EPBD), is the main Community legal tool that provides for a holistic approach towards efficient energy use in the buildings sector. The EPBD's main objective is to promote the cost-effective improvement of the overall energy performance of buildings. Its provisions cover energy needs for space and hot water heating, cooling, ventilation and lighting for new and existing, residential and non-residential buildings. Most of the existing provisions apply to all buildings, regardless of their size and whether in residential or non-residential use. Some provisions only apply to specific building types. The Directive combines, in a legal text, different regulatory (such as the requirement for Member States to set energy performance requirements for new and large existing buildings that undergo major renovation) and information-based instruments (such as energy performance certificates, inspection of heating and air-conditioning requirements).

The EPBD approach considers national/regional boundary conditions, like outdoor climate and individual building traditions fully into consideration. Member States can go beyond the minimum requirements set in the Directive and be more ambitious. At present 22 Member States declare full transposition [4]. One of the main contributions of the EPBD so far, has been in bringing energy efficiency in buildings onto political agendas, its' integration into building codes and to the attention of citizens.

Among other objectives, the EPBD contains the requirement for a building energy performance certificate as ‘‘a certificate recognised by the Member State which includes the energy performance of a building calculated according to a methodology . . .’’. The EPBD approach to an energy certification definition left two unresolved issues: how to define and how to measure building energy efficiency. It also introduced a new term energy performance referring to building energy use. In this context, energy performance indicators are ratios of energy use input to energy service output (site energy per square meter, CO_2 emissions per home, etc.).

The new European standard EN 15217 [5] is an attempt to describe methods for expressing energy efficiency and certification of buildings. Energy Performance Certificates are redefined within the development of a certification scheme which must contain at least:

- An overall energy performance index stated in terms of energy consumption, carbon dioxide emissions or energy cost, per unit of conditioned area to allow the comparison between buildings.
- An overall minimum efficiency requirement to be established by the legislation as a limit of the energy performance index. The standard recommends its correlation with other parameters (such as climate and building type) or a self-reference method.
- A label based in the A–G bands to achieve a suitable grading of buildings. A key issue is the definition of the scale that should make reference, at least, to the building energy regulations (R_r), the existing building stock (R_s) and the zero-energy building (R_0).
- Energy consumption by the main building components, such us building envelope and services, together with recommendations of energy efficiency measures for building owners’ consideration.

Recently, the European projects Euroclass [6], Europrosper [7], EPlabel [8] and ENPER-EXIST [9] have studied the complexity associated with the elaboration of a database of building energy consumptions in Europe and with identifying suitable reference levels as intermediate steps for the development of an energy performance certificate for existing buildings.

Energy efficiency certification schemes for new buildings are usually implemented by asset ratings. The asset ratings use the calculation procedure within standard usage patterns and climatic conditions not to depend on occupant behaviour, actual weather and indoor conditions, and are designed to rate the building and not the occupant. Asset ratings can be shaped to buildings during the design process (as designed), new buildings (as built) or to existing buildings. In accordance with CEN recommendations, a building energy certification scheme for existing buildings should be implemented by the use of operational ratings with reference values (benchmarks) taken from the building stock in order to establish the classification system. In like manner, for new buildings, an asset rating should be used in comparison with the references values set by the regulation, the building stock and the zero energy building. A deeper review of energy certification schemes can be found in reference [10].

3 The Energy Performance of Buildings Regulations in Spain

In Spain, the EPBD transposition was effected by Royal Decree 314/ 2006 of 17 March [11] approving the Technical Building Code (CTE) which modifies the previous energy code NBE-CT-79, and Royal Decree 47/2007, of 19 January [12], approving the basic procedure for certification of the energy performance of new buildings.

The energy performance of building regulation implemented in Spain concerns both new and renovated existing buildings and requires the use of the same procedure for both cases. The assessment method is based on the asset rating approach and the energy efficiency indicators include primary energy and CO_2 emissions.

The Technical Building Code CTE includes a Basic Document on Energy Saving (HE). The appropriate use of HE guarantees compliance with the basic requirements of the EPBD. This document contains procedures, technical rules and examples of solutions for determining whether a building complies with the stipulated performance levels. The document HE that concerns Energy Saving and consists of the following topics:

- HE-1: Energy demand limitation
- HE-2: Efficiency of thermal installations
- HE-3: Energy efficiency of lighting installations
- HE-4: Minimum solar contribution to domestic hot water
- HE-5: Minimum photovoltaic contribution to electric power

Section HE-1 states that buildings shall feature a set of characteristics capable of adequately limiting the energy demand necessary to ensure human thermal comfort in accordance with the local climate, the use of the building, and the summer and winter regime as well as their characteristics of insulation and inertia, air permeability and exposure to solar radiation, reducing the risk of superficial and interstitial humidity that may affect their characteristics, with appropriate treatment of the thermal bridges to limit heat losses or gains and to avoid any hydrothermal problems therein. The rest of HE documents require a minimum contribution of solar thermal and photovoltaic systems based on the type and size of the building, and minimum energy efficiency of lighting and thermal installations.

Both the new energy performance requirements established by CTE in Section HE-1 on Energy Demand Limitation of Buildings and the procedure for certification of the energy performance of buildings are determined according to the climatic variability of 12 different climatic zones. Climatic zoning in Spain has been carried out in accordance with a variable expressly defined for such purpose which is known as climatic severity [13], calculated as the comparison between the heating/cooling demand of a certain building and that which the same building would have in a reference locality. Where the demand used in the calculation is heating demand, the variable calculated is characterised as winter climatic severity. Meanwhile, where the calculation uses the cooling demand, the variable calculated is characterised as summer climatic severity. In both cases, the reference locality used is Madrid, and it has been shown that the variable is independent to the type of building used in the calculation, although it is necessary to define the type of building. Following this procedure, the Spanish energy regulations classify the 52 provincial capitals into 12 climatic zones, identified by a letter from A to E and a number from 1 to 4. The letter refers to the winter climatic zoning, while the number refers to the summer climatic zoning.

The energy demand of the building is determined as function of the local climate where the building is located, according to the climatic zoning and the internal load of the indoor spaces. The energy demand of the building should be lower to a reference building in which the characteristic parameters of the envelope and the interior spaces have specific values that fully described in the HE-1, according to the climatic zone where the building is located. Requirements are established in terms of U-values and solar factors, according to the climatic zone where the building is located.

The compliance with the requirements of HE-1 can be checked using either a simplified procedure, following a prescriptive approach (to be used in the case of dwellings and within certain limitations), or by a general performance approach, implemented by a software tool, LIDER programme [14]. Figure 1 shows the scheme of both options.

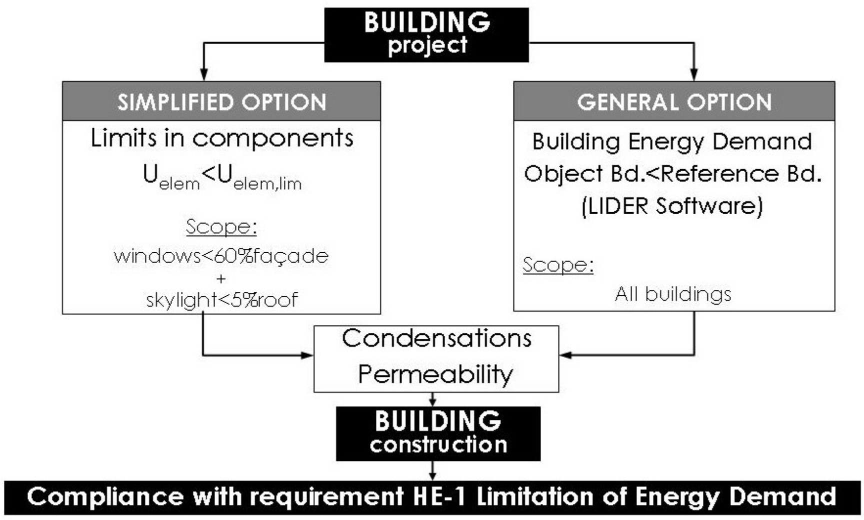


Fig. 1 Compliance procedures for Spanish HE-1 Energy Demand Limitation of Buildings regulation.

In a similar approach, the Spanish procedure for certification of the energy performance of buildings can be performed using either a simplified procedure, (to be used in the case of dwellings and within certain limitations in the heating/cooling systems), or using a general process implemented by a software tool, CALENER [15]. So far, there are two different versions of CALENER: CALENER-VYP (for dwellings and small tertiary sector buildings) and CALENER-GT (for big tertiary sector buildings). Spanish energy certification of buildings procedure follows in part the EN 15217 guidelines, and uses primary energy performance indexes such as Annual Emissions CO_2, (kg/m^2) and Annual Primary Energy Consumption (kWh/m^2). As secondary indexes, Annual Emissions CO_2, Annual Primary Energy Consumption and Building Annual Energy Demand for every energy system of the building (heating, cooling, domestic hot water) are used. Figure 2 presents an example of energy label including energy performance indicators.

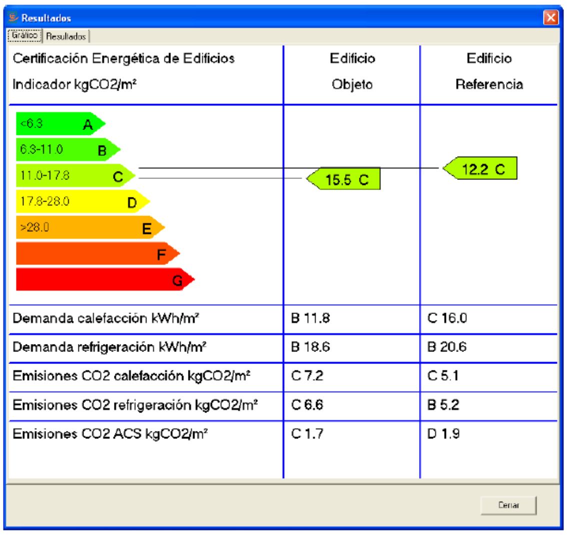


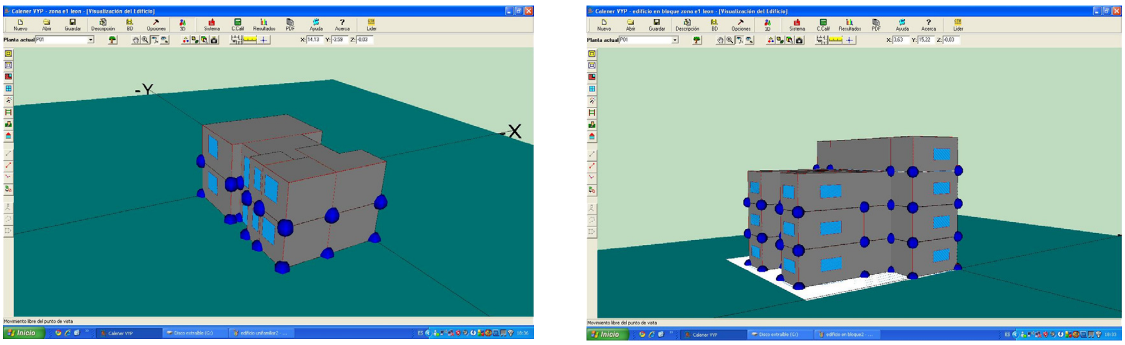
Fig. 2 Energy performance indicators included in the Spanish Energy certificate of buildings label.

Some general criteria for development of the A-G range certification scale have been taken into account:

- The scale must differentiate clearly efficient from non-efficient buildings. It would be a non-sense that all the buildings obtained the same class.
- The scale must be sensitive enough to improvements. If a building improve enough its envelope or energy systems over CTE-HE requirements, its rating should improve one or more class level.
- It must be possible, in any climate, to build Class A buildings. Class A buildings would be deserved to extraordinary energy efficient buildings.
- The scale must remain stable enough in time (at least during two updating of regulation).
- The scale must provide criteria to take steps to achieve energy and environmental long-term objectives.
- The scale must be the same for any certification procedure (reference or alternative).
- Though the scale is developed for new buildings, it must be possible to extend it to existing buildings, if it would be considered convenient to use only one scale for all building.

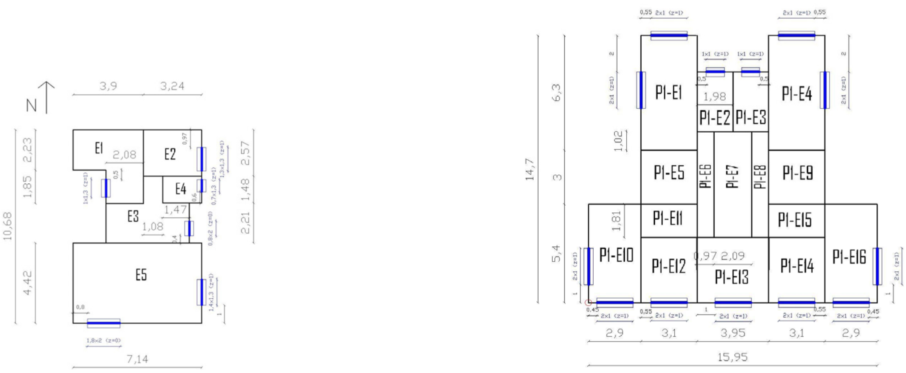
4 Case study: the energy performance of dwellings by improving the building envelope.

This section presents a case study of the influence of the insulation thickness in the percentage of heating energy demand reduction, considering two types of dwellings. The first type is a single-family house, while the second is a multi-family residential building in block. A general view of size and shape of both type of buildings as represented in the LIDER software is shown in Figure 3. Figure 4 presents the view of the internal partition for each building. To study the cross influence of insulation and outdoor conditions, buildings have been placed in 5 different climatic zones, within the 12 climatic zones in which Spain is divided. Selected cities are Málaga (climatic zone A3), Murcia (B3), Granada (C3), Salamanca (D2) and León (E1), including the five winter climatic zones, A to E.



(a) (b)

Fig. 3 Size and shape of case buildings as represented in LIDER software: (a) single-family house; (b) multi-family building in flats.



(a) (b)

Fig. 4 Internal partition of case buildings: (a) single-family house; (b) multi-family building in flats.

As outlined in the previous section, the LIDER software is the general option to check the compliance of the requirements of Energy Demand Limitation of Buildings, HE-1. Results obtained by the software are presented in terms of the percentage reduction of energy demand (heating and cooling) of the objective building with respect a reference building, as shown in Figure 5. The reference building is a building, placed in the same location, which possess the same shape, size, internal partition, use and neighbour obstacles as the building object, but change the elements of façade, roofs, floors and shadow elements like in the prescriptive option of HE-1.

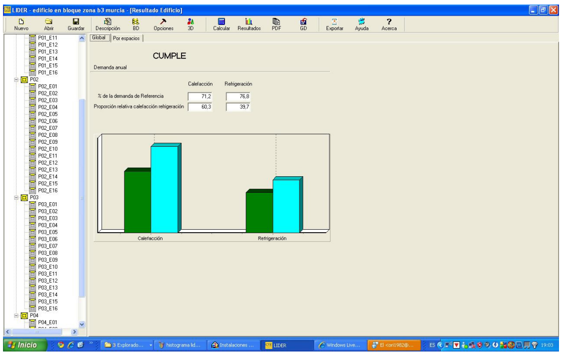


Fig. 5 LIDER software: appearance of the screen of results for heating and cooling demand.

The limit U-values considered by the LIDER software for every type of element as part of the building envelope are described in Table 1. It can be observed that the general trend is the decreasing value of the maximum limit of U-value as the winter climatic severity increases from A to E. With respect to the elements, the lower limit is required for the roof element, as an expression of its greater influence in the total winter energy demand of a given building.

Tab. 1 Maximum U-values (W/m^2K) of some envelope components for the winter climatic zones

Element	Zone A	Zone B	Zone C	Zone D	Zone E
Façade walls	1.22	1.07	0.95	0.86	0.74
Floors	0.69	0.68	0.65	0.64	0.62
Roofs	0.65	0.59	0.53	0.49	0.46

An analysis of the influence of the U-value of each considered element of the envelope, while the other U-values remain constant, on the reduction of heating demand has been carried out with the help of the LIDER software. Tables 2 to 6 present, for each location, the range of U-values considered for every element and the percentage of reduction of heating energy demand for both types of building.

Tab. 2 Location: Málaga.
Element U-values (W/m^{2}K) and reduction of reduction of heating energy demand (%).

Climatic Zone: A3							
Single-family house							
Element: Walls façade	Heating demand	Element: Only North Wall façade	Heating demand	Element: Floor	Heating demand	Element: Roof	Heating demand
U-value	Reduction	U-value	Reduction	U-value	Reduction	U-value	Reduction
1.09	9.2	1.09	9.2	0.65	9.2	0.66	9.2
0.79	27.9	0.79	12.3	0.55	9.2	0.57	10.3
0.62	40.2	0.62	13.8	0.48	9.3	0.50	11.1
0.51	47.2	0.51	14.6	0.43	9.3	0.44	11.8
0.43	52.3	0.43	15.4	0.39	9.3	0.40	12.3
0.38	57.2	0.38	15.8	0.35	9.4	0.36	12.7
Multi-family house (block)							
Element: Walls façade	Heating demand	Element: North Wall façade	Heating demand	Element: Floor	Heating demand	Element: Roof	Heating demand
U-value	Reduction	U-value	Reduction	U-value	Reduction	U-value	Reduction
0.69	42.1	0.69	42.1	0.59	42.1	0.59	42.1
0.58	47.5	0.58	43.8	0.51	42.2	0.51	43.2
0.51	51.1	0.51	44.8	0.45	42.2	0.46	44.0
0.45	54.2	0.45	45.8	0.40	42.2	0.41	45.3
0.40	57.1	0.40	46.9	0.37	42.3	0.37	45.8
0.36	59.5	0.36	47.4	0.33	42.3	0.34	46.6
0.33	60.9	0.33	47.9	0.31	42.3	0.32	46.8

Tab. 3 Location: Murcia.
Element U-values (W/m^{2}K) and reduction of reduction of heating energy demand (%).

Climatic Zone: B3							
Single-family house							
Element: Walls façade	Heating demand	Element: Only North Wall façade	Heating demand	Element: Floor	Heating demand	Element: Roof	Heating demand
U-value	Reduction	U-value	Reduction	U-value	Reduction	U-value	Reduction
0.79	17.5	0.79	17.5	0.78	17.5	0.57	17.5
0.62	28.5	0.62	20.1	0.65	17.5	0.50	18.4
0.51	35.9	0.51	21.0	0.55	17.6	0.44	19.0
0.43	40.9	0.43	21.6	0.48	17.6	0.40	19.6
0.38	44.8	0.38	22.1	0.43	17.6	0.36	20.1
0.33	47.8	0.33	22.4	0.39	17.7	0.33	20.5
Multi-family house (block)							
Element: Walls façade	Heating demand	Element: North Wall façade	Heating demand	Element: Floor	Heating demand	Element: Roof	Heating demand
U-value	Reduction	U-value	Reduction	U-value	Reduction	U-value	Reduction
0.69	28.8	0.69	28.8	0.59	28.8	0.59	28.8
0.58	34.8	0.58	30.5	0.51	28.9	0.51	29.8
0.51	39.6	0.51	31.7	0.45	29.0	0.46	30.5
0.45	42.9	0.45	32.7	0.40	29.0	0.41	31.2
0.40	45.4	0.40	33.5	0.37	29.1	0.37	31.8
0.36	47.3	0.36	34.1	0.33	29.1	0.34	32.3
0.33	49.0	0.33	34.6	0.31	29.2	0.32	32.6

Tab. 4 Location: Granada.
Element U-values (W/m^{2}K) and reduction of reduction of heating energy demand (%).

Climatic Zone: C3							
Single-family house							
Element: Walls façade	Heating demand	Element: Only North Wall façade	Heating demand	Element: Floor	Heating demand	Element: Roof	Heating demand
U-value	Reduction	U-value	Reduction	U-value	Reduction	U-value	Reduction
0.79	8.5	0.79	8.5	0.78	8.5	0.50	8.5
0.62	19.4	0.62	9.8	0.65	8.6	0.44	9.2
0.51	26.8	0.51	10.8	0.55	8.7	0.40	9.7
0.43	32.1	0.43	11.4	0.48	8.8	0.36	10.2
0.38	36.0	0.37	11.9	0.43	8.8	0.33	10.6
0.33	39.2	0.33	12.3	0.39	8.9	0.31	10.9
Multi-family house (block)							
Element: Walls façade	Heating demand	Element: North Wall façade	Heating demand	Element: Floor	Heating demand	Element: Roof	Heating demand
U-value	Reduction	U-value	Reduction	U-value	Reduction	U-value	Reduction
0.69	15.8	0.69	15.8	0.59	15.8	0.51	15.8
0.58	21.0	0.58	17.3	0.51	15.9	0.46	16.6
0.51	24.8	0.51	18.4	0.45	16.0	0.41	17.3
0.45	28.0	0.45	19.3	0.40	16.1	0.37	17.7
0.40	30.3	0.40	20.0	0.37	16.1	0.34	18.1
0.36	32.3	0.36	20.7	0.33	16.2	0.32	18.5
0.33	34.0	0.33	21.1	0.31	16.2	0.29	18.8

Tab. 5 Location: Salamanca.
Element U-values (W/m^{2}K) and reduction of reduction of heating energy demand (%).

Climatic Zone: D2							
Single-family house							
Element: Walls façade	Heating demand	Element: Only North Wall façade	Heating demand	Element: Floor	Heating demand	Element: Roof	Heating demand
U-value	Reduction	U-value	Reduction	U-value	Reduction	U-value	Reduction
0.62	11.6	0.62	11.6	0.65	11.6	0.50	11.6
0.51	18.7	0.51	11.8	0.55	11.7	0.44	12.2
0.43	23.8	0.43	12.4	0.48	11.9	0.40	12.8
0.38	27.7	0.38	12.9	0.43	12.1	0.36	13.2
0.33	30.7	0.33	13.2	0.39	12.3	0.33	13.6
0.30	33.1	0.30	13.5	0.35	12.4	0.31	13.9
Multi-family house (block)							
Element: Walls façade	Heating demand	Element: North Wall façade	Heating demand	Element: Floor	Heating demand	Element: Roof	Heating demand
U-value	Reduction	U-value	Reduction	U-value	Reduction	U-value	Reduction
0.40	20.2	0.40	20.2	0.59	20.2	0.46	20.2
0.36	22.0	0.36	20.7	0.51	20.3	0.41	20.7
0.33	23.5	0.33	21.1	0.45	20.4	0.37	21.2
0.30	24.8	0.30	21.5	0.40	20.5	0.34	21.6
0.28	25.9	0.28	21.8	0.37	20.6	0.32	21.9
0.26	26.8	0.26	22.0	0.33	20.7	0.29	22.2

Tab. 6 Location: León.
Element U-values (W/m^2K) and reduction of reduction of heating energy demand (%).

Climatic Zone: E1							
Single-family house							
Element: Walls façade	Heating demand	Element: Only North Wall façade	Heating demand	Element: Floor	Heating demand	Element: Roof	Heating demand
U-value	Reduction	U-value	Reduction	U-value	Reduction	U-value	Reduction
0.62	3.7	0.62	3.7	0.48	3.7	0.44	3.7
0.51	11.3	0.51	4.6	0.43	3.9	0.40	4.3
0.43	16.8	0.43	5.2	0.39	4.1	0.36	4.8
0.38	20.9	0.38	5.7	0.35	4.2	0.33	5.2
0.33	24.1	0.33	6.1	0.32	4.4	0.31	5.5
0.29	26.7	0.29	6.4	0.30	4.5	0.29	5.9
Multi-family house (block)							
Element: Walls façade	Heating demand	Element: North Wall façade	Heating demand	Element: Floor	Heating demand	Element: Roof	Heating demand
U-value	Reduction	U-value	Reduction	U-value	Reduction	U-value	Reduction
0.40	16.9	0.40	16.9	0.59	16.9	0.46	16.9
0.36	18.8	0.36	17.2	0.51	17.0	0.41	17.5
0.33	20.3	0.33	17.7	0.45	17.1	0.37	18.0
0.30	21.7	0.30	18.0	0.40	17.2	0.34	18.4
0.28	22.8	0.28	18.4	0.37	17.3	0.32	18.7
0.26	23.8	0.26	18.6	0.33	17.4	0.29	19.1

As an example, a graphical representation of the trends of the percentage of energy reduction as a function of the elements U-value for climatic zone A3 is shown in Figure 6.

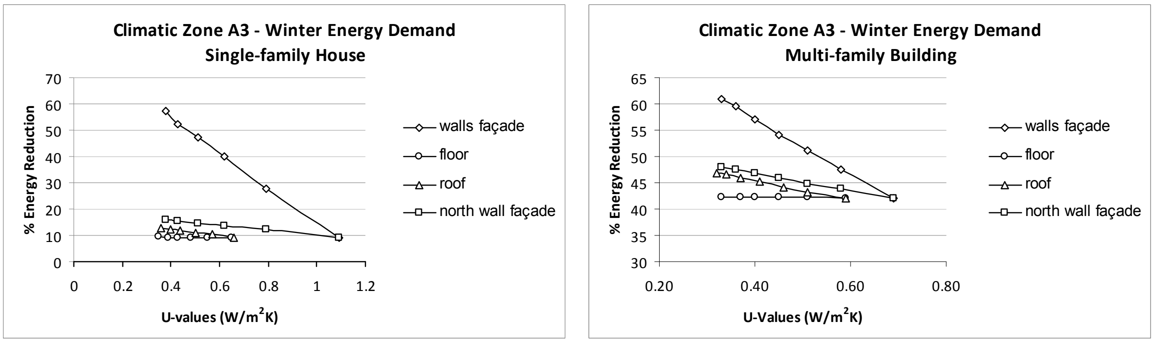


Fig. 6 Evolution of the percentage of winter energy demand vs. the elements U-values for every type of building.

With respect to the influence of insulation on the reduction of heating energy demand, an increase of insulation, it is to say, a decrease of the U-value, leads to a rise of the heating demand of each building, as expected. In all cases the greatest reduction is obtained when the insulation increase occurs in the walls façade, and is lower when floor' and roof reductions. And the influence of the north wall façade is shown to be the most critical factor of influence in the general walls insulation when high U-values, but becomes less important when low U-values. For the same climatic zone, this phenomenon is always higher for the multi-family building than for the single-family house. For the same wall U-value, the amount of energy demand reduction decreases when the winter climatic severity increases, which means that it would be easier to obtain a better energy certification rating in low severe winter climate locations than in high severe ones.

Data for the floor insulation show that, in each case, lower values of transmittance U has no significant effect on energy demand reduction. When comparing the single house to the block for the same climatic zone, the amount of reduction is always higher in the multi-family building. However, when comparing climatic zones, floor insulation influence fluctuates with no general trend. Roof insulation follows the same behavior as the one described for the floor insulation.

5 Conclusions

The existing Energy Performance of Buildings Directive, adopted in 2002, is a key element to improve buildings' energy performance. Some Member States have made promising progress in recent years, but the majority of them still have an enormous untapped potential for improvements. To this end, the Commission sees further room for strengthening the effectiveness and the impact of this Directive. Energy certification of buildings is a key factor to ensure effective energy consumption reduction, and it requires a rating scale for comparison of energy indexes of the objective building with those of reference.

In the Spanish transposition of EPBD energy certification for residential buildings, small single-family and blocks, the energy efficiency indexes are heating and cooling demand, CO_2 emissions of heating, cooling and domestic hot water, and primary energy consumption of heating, cooling and domestic hot water. Certification scale ranges in 7 classes, from A to G, for every one of the energy efficiency indexes.

With respect to the limitation of the energy demand of buildings to reduce energy consumption and CO_2 emissions, the Spanish regulation establishes maximum U-values for the envelope elements to prevent of thermal unbalanced buildings. The Spanish energy regulations classify the 52 provincial capitals into 12 climatic zones, identified by an alphanumeric code which combines winter and summer climatic severity. An analysis of the influence of envelope U-values and climatic zones on the potential of energy demand reduction has been carried out. Results show that the walls façade insulation is the most critical factor in reduction of the energy demand, and that energy demand reduction is more difficult to reach when buildings are located in severe winter climate zones.

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