Critical assessment of the EU labeling scheme for buildings

Master thesis

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Abstract

The aim of this study was to investigate the whole procedure followed for issuing an Energy Performance Certificate (EPC) and to indicate the barriers that emerge throughout this procedure. A literature review showed that more research should be done regarding the quality of the certificates and the whole procedure in which buildings are certified as well as the way in which their energy efficiency can be improved. Greece and the United Kingdom were chosen to be investigated due to the different geographical location and, thus, the different climate between them.

Mainly qualitative research methodology was utilized in this study. A quantitative analysis was carried out as well but not extensively due to lack of data. The information and data used in this research were collected through a literature review. A comparative assessment was conducted in order to present similarities and differences between the two countries. A SWOT analysis was carried out to identify the strengths and weaknesses and, thus, the barriers to issue EPCs.

The comparative assessment showed that the EPCs that are issued in the United Kingdom are stronger than those in Greece as they are based on more accurate calculations and the various building categories (new/existing and domestic/non-domestic) affect the form of the certification. A qualitative analysis showed that the ambition level in the United Kingdom is higher. In turn, the outcome of the SWOT analysis was that again the United Kingdom outweighed as there was found stronger features than in Greece even though the weaknesses did not differ much.

Finally, the barrier that was found to hamper more the proper implementation of the EPCs lies within the regulations. In particular, the recommendation reports that accompany the EPCs contain non-mandatory measures on improvements of the energy efficiency of a building. What is recommended is that the owners should be in a way legally bound to follow the advice that is given in the reports. Additionally, concerning the audits, stricter penalties is recommended to be given in cases where EPCs are not available.

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Contents

1 INTRODUCTION

The intensive use of conventional energy sources and their negative impact on the environment has increased the urge of finding alternative resources that are less damaging. For this reason, the European Commission has set targets to be fulfilled by 2020 focusing on a clearly environmental and sustainable perspective. In particular, the greenhouse gas emissions must be reduced by 20% compared to 1990, 20% of the energy ought to be produced by renewable resources and, finally, energy efficiency has to be increased by 20%(European Commission, 2012).

An effective way to deal with the energy issue is to focus on the building sector. The reason for this is that among the other major sectors, industry and transportation, buildings are responsible for the majority of the energy that is consumed globally and thus, for the CO_2 emitted in the environment. Figure 1 presents the contribution of the various sectors in the global energy consumption.This figure shows that the residential and commercial buildings together represent almost 40% of the final end use of energy. Final end use is the final form of energy that reaches the consumers (that is end users such as households, transport and industry) to provide them with certain services for instance, lighting, heating, transporting a person in a car or making steel (Blok, 2009).

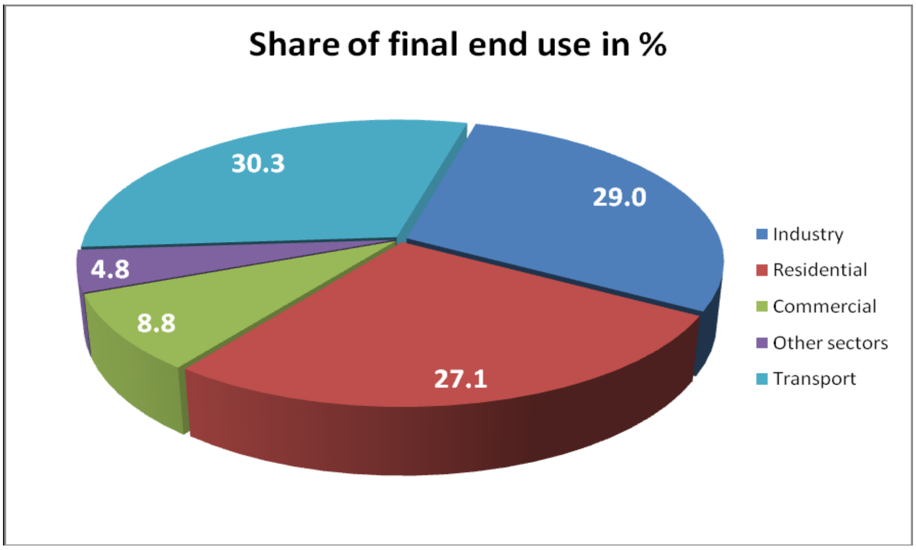


Figure 1: Share of final end use in % for various sectors **(Laustsen, 2008)**.

Considering that the built environment has a share of around 40% of the total energy consumed in Europe, more research should take place about the design and construction of buildings (DIRECTIVE 2010/31/EU). The fact that the lifetime of such a construction is many decades or even more than a hundred years, adds extra weight to the importance of energy efficiency enhancement.Next to the beauty and comfort that a building can offer, the issue of energy saving comes along which results not only in the elimination of emissions and thus the pollution of the environment but, in long term, in saving money as well.

Although buildings consume large (40% as mentioned above) amounts of energy, their potential of energy savings can be improved when the required measures are implemented. In order to achieve a desired and allowable level of energy performance of buildings, many factors have to be taken into account during the construction or afterwards.Figure 2 presents the way buildings can contribute to dealing with the energy issue. Buildings' energy use can be reduced by improving energy efficiency. This can be realized by using existing technologies such as HVAC systems with which energy can be recovered. Solar heaters can be used for the production of hot water and by applying solar panels, generating electricity for own use is feasible.

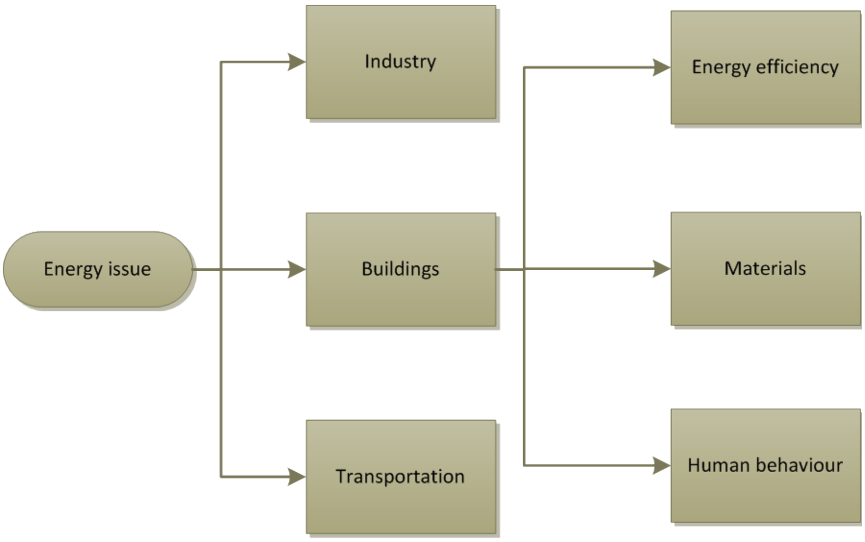


Figure 2: Schematic representation of the way energy issue can be dealt with.

In turn, using the appropriate materials aids to a better energy management. For instance, when more efficient insulating materials, that is, materials with low coefficient of thermal conductivity, are harnessed, energy can be saved. Human behavior could, also, be part of the energy solution. People have to become more responsible about this issue and be aware of the impact their actions have to the environment.

1.1 BACKGROUND

To cover the need for energy efficiency in buildings,the energy certification was introduced in the early 1990s (Peres-Lombard et al., 2008). In this way, the energy consumed by the buildings and the impact this has on the environment can be regulated. Moreover, this had to be realized by maintaining a high level of both health and comfort(Peres-Lombard et al., 2008). Three main instruments are used to promote energy savings; regulations, auditing and certificationin a way as indicated in Figure 3.

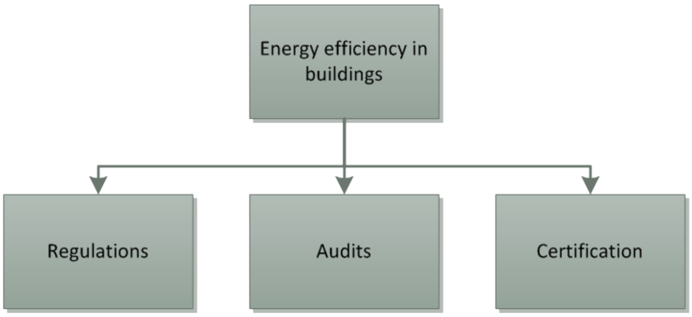


Figure 3: Schematic representation of the procedure followed for improving the energy efficiency in buildings.

A first approach to energy certification for improving energy efficiency in buildings was made by the European Council Directive 93/76/CEE(SAVE, 1993). Due to the lack of clarity and the fact that it did not bind the EU members to a commitment, it resulted in being ineffective(Mlecnik& van Hal, 2010). Directive 2002/91/CE came into force approximately ten years later to regulate the energy performance of buildings. This directive set as a requirement the presentation of a certificate showing the energy performance of a building. The term energy performance emerged in this way in order to indicate the energy used by the building. More specifically, it is defined as “the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting” (DIRECTIVE 2010/31/EU). The energy performance indicators and energy use intensities are used in Europe and United States, respectively, to measure the energy use. They are defined as the energy use input over the energy service output for instance, site energy per m^2.

The main instrument used by the European Commission in order to ensure that the target of increasing energy efficiency by 20% until 2020 is the Energy Performance of Buildings Directive (EPBD).This Directive sets as requirement that each of the EU Member States presents *Energy Performance Certificates (EPCs)*indicating the current energy performance of buildings. More specifically, Directive 2010/31/EU states that minimum energy performance requirements for new and existing buildings have to be set and also heating and air-conditioning systems have to be inspected on a regular base.

EPCs are produced not only in cases of new buildings but also when they undergo a major renovation, are sold or rented out. The acquired certification which works as an energy label has to be shown to the new tenant or owner and be displayed on a prominent place in public buildings. Furthermore, recommendations on ways of enhancing the energy performance of the dwelling could also be made afterwards based on the EPC assessment.

Figure 4 shows a breakdown of the energy certification. More specifically, a certification scheme for the EU labeling scheme for buildings must contain at least (Peres-Lombard et al., 2008):

- An overall energy performance index (EPI) that facilitates the comparison among buildings. This can in the form of energy used per m^2, energy cost, etc.
- An overall minimum efficiency requirement determined and stated by the regulations as to confine the energy performance index (EPI_{MAX}).
- The determination of a scale concerning the grading of buildings. A label should be attributed to buildings based on that scale (A-G bands).

- The energy that is consumed by the building envelope, boilers and air-conditionings and other building components. This should be accompanied by recommendations towards the building owner to improve the energy performance of their property.

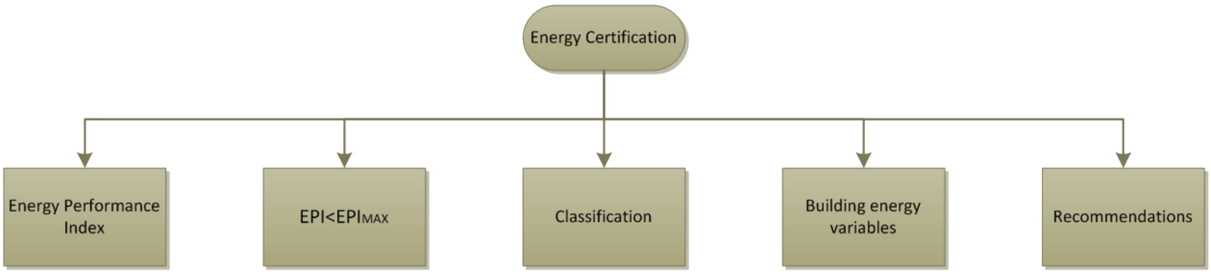


Figure 4: Schematic representation of the main parts of the energy certification.

When referring to energy classification of buildings it is meant that the energy status of the building can be evaluated and it can be compared to other buildings. As shown in Figure 5, the comparison is done by benchmarking and concerns buildings with similar characteristics. The indicator for this is the EPI which is usually expressed as annual energy use per unit area. Benchmarking is done as follows:(Peres-Lombard et al., 2008)

- A database is developed where information regarding the energy performance of the building is recorded. A rather big sample of buildings is needed in this case where these are grouped according to the building type (e.g. dwellings or public buildings) and the size (e.g. total floor area higher than $50m^2$ or higher than $500m^2$).
- Information is gathered to assess the EPI of the actual building.
- A comparative analysis is conducted to evaluate the way the building under investigation performs compared to the other buildings in the database. Thus, the energy quality of the building can be determined.
- Advice should be provided on the measures that can be taken to enhance the energy efficiency of the building.

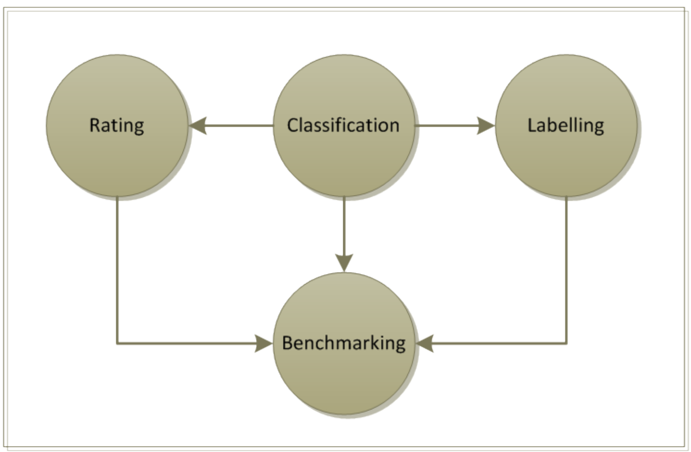


Figure 5: Schematic representation of the way classification is done.

The comparative analysis as mentioned above is doneusing the energy rating system and labeling. The energy rating system is of great importance when referring to the building energy classification. This is defined as "a method for the assessment of predicted energy use under standard conditions and its potential for improvement" (Stein & Meier, 2000).

As far as the energy labeling is concerned, an energy scale was developed where the building acquires a label indicating its energy performance. In the classification procedure, when it is difficult to compare to other buildings, a reference building is used having the same characteristics as the actual building, conformed to standard rules. In this case, a labeling index (LI) is used which is calculated as follows(Perez-Lombardet al., 2008),

$$LI = EPI / EPI_{RB}$$

Although EU Member States are trying to comply with the rules set by EU and adopt all requirements by implementing them into their national law, it seems that in some cases the result is not very satisfactory, for example this is true in the case of the United Kingdom as it was found by the IDEAL-EPBD project(Tigchelaar et al., 2011). As already mentioned, the tool used for the enforcement of the rules is the EPCs. Nevertheless, Tigchelaar et al. (2011) mention thatpeople hardly show some eagerness to accept and implement the recommendation given via the certification of buildings for improving their energy efficiency and thus, reducing their energy consumption.

After a literature review was conducted, it was found that researchis needed regarding the low acceptance of the EPCs by people. The aim of this study is to investigate the whole procedure followed for issuing an EPC. By this, an attempt is made to indicate the barriers that emerge throughout this procedure.Recommendations on how this situation could be improved are provided.

1.2 PROBLEM DEFINITION

In the present research, the energy performance certificates that are provided when buildings are constructed, renovated, sold or rented out are studied. These certificates were introduced in order to improve the energy performance of buildings. Nevertheless, they are said not to be very effective as the owners do not always follow all the recommendations set by the certificates (Tigchelaar et al., 2011). A literature review has showed that more research should be done regarding the quality of the certificates and the whole procedure in which buildings are certified as well as the way in which their energy efficiency can be improved.

1.2.1 Research question

What barriers exist in the actual energy performance certificates, in the United Kingdom and in Greece?

In order to give an answer to the main research question, four sub questions are formulated. In this way, a more structured and complete understanding of the topic and the issues emerging from it can be achieved. Also, this shall help understand the manner in which the entire research will be developed. In particular,

1. What is the procedure followed for issuing the EPCs in the United Kingdom and in Greece?
2. What are the factors taken into consideration when determining the energy performance of buildings in the United Kingdom and Greece?
3. What are the strengths and weaknesses of the issued EPCs?
4. What steps could be taken to improve the entire procedure of certification and the overall effectiveness of the EPCs?

2 METHOD

The countries in which this research is applied are Greece and the United Kingdom. The reason for choosing these two countries is the different geographical locationand, thus, the different climate between them. Furthermore, another incentive for studying Greece and the United Kingdom is the fact they use a different system. In order to answer the research question, an in-depth investigation is required as to how these EPCs are provided. The same analysis is done for both countries so that at the end a comparison can be made between them.

When referring to EPCs there are some aspects to be taken into consideration. Firstly, the buildings are divided into new and existing, domestic and non-domestic. For each category all the requirements regarding building orientation, insulation, the use or not of renewable sources, etc. is stated. The various kinds of calculations related to the way a building performs in terms of energy is presented including the coefficients that are of high importance and the climatic zones the countries are divided in. This gives an idea on how calculations are made when an energy assessment of a building is carried out in order to be certified.

Another step of the research is the quality control of air-conditioning and boilers. The procedure for the inspection of such systems is described as detailed as possible according to the information available.

In turn, the steps followed as to become an expert to perform energy auditsare investigated. The qualifications required and other information relevant to this issue is presented as well. Moreover, the incentives provided by the State are studied. These include the subsidies and the various programs that are implemented and that motivate the citizens to follow the recommendations suggested by the EPC.

The indicator used to determine the ambition level in the two countries is the number of EPCs that have been issued per month during a specific period of time. This reveals the way the certification of buildings evolves in time. It can also be an indication of how certain strengths or weaknesses affect the evolution of EPCs.

At the end of each chapter a comparative assessment is made to distinguish similarities and differences between the schemes in Greece and the United Kingdom.A SWOT analysis is carried out to find the strong features as well as the weaknesses of the respective schemes. In this way the barriers that hampertheir proper applicationcan be identified.More specifically, the country which presents fewer barriers throughout the study is said to be more effective when applying EPCs. At this point recommendations can be madeon the way to tackle the barriers that hinder the implementation of the EPCs.

All the information needed for this research project is acquired through literature review. This includes grey and scientific papers posted by governments' sources and research institutions. Moreover, the websites of the governments are searched in depth in order to find all the laws that are imposed regarding this particular subject.

3 CERTIFICATION OF BUILDINGS

3.1 Greece

3.1.1 Introduction of EPCs in Greece

The Ministry of Environment, Energy and Climate Change (MEECC) is responsible for the implementation of the EPBD in Greece(TEE, 2012). Up to January 2006 the country was forced to comply with this Directive. The promulgation of the new law established for the implementation of the EPBD involves a set of orders called "Greek Regulation for the Energy Efficiency of Buildings" (KENAK) (TEE, 2012). This regulation was introduced in April 2002 and relates the minimum technical and energy performance standards of new and renovated buildings and the method in which the energy efficiency of a building is calculated. An EPC is issued in cases where a building (or part of it) of more than 50 m^2 is sold, rented out, constructed or used for business purposes.

The audit of the energy performance of buildings is done by the Energy Auditors Body (Markogiannakis et al., 2011). After the control of the dwelling is fulfilled, the Ministry of Environment, Energy and Climate Change (MEECC) provides the respective certificates (EPC). The selection of the professionals to be included in this Body is realized under the jurisdiction of the Hellenic Technical Chamber. The latter is an institute involving all the Greek engineers and providing them with professional licenses. It also serves as the official consultant to the Greek State for technical issues.

The Technical Chamber in collaboration with the state has produced the Technical Guidelines with which all standards are harmonized to Greece and its climate. Additionally, there has been developed a software tool named TEE-KENAK and financed by the Hellenic Technical Chamber. The specific tool can be integrated into other tools developed by various companies. The most important criterion that software has to meet is that it uses the computational engine for calculating the energy performance of buildings according to the EU and national standards as well as the Technical Guidelines. TEE-KENAK uses the technical and geometrical characteristics of the structural elements of a building envelope and the technical characteristics of the electro / mechanical installations and classifies the building into energy categories based on the calculation of the energy that is consumed by the building. (TEE-KENAK Software, 2012)

3.1.2 Energy Performance of Buildings Certificates (EPC)

The following table presents the categories in which buildings are classified based on the primary energy that they consume. The classification process begins by setting a reference building.This is a fictional building with the same geometrical characteristics, location, orientation, usage and operational characteristics as the building under investigation. The reference building is in accordance with the minimum standards and has specific technical characteristics concerning all the structural elements as well as the electrical/mechanical systems regarding heating, cooling and air conditioning of the internal space, the production of hot water and lighting.

The indicator R_R represents the primary energy consumption of the reference building while T is the ratio of the primary energy consumption of the building under investigation indicated by EP over the primary energy consumption of the reference building (where T equals one). At the certificate model there are two additional levels, A+ and B+. The reason for this is to raise competition and construct very efficient buildings in the future (Markogiannakis et al, 2011).

Table1: Energycategories (TOTEE 20701-1/2010).

Category	Limits	Limits
A+	$EP \leq 0{,}33R_R$	$T \leq 0{,}33$
A	$0{,}33R_R < EP \leq 0{,}50R_R$	$0{,}33 < T \leq 0{,}50$
B+	$0{,}50R_R < EP \leq 0{,}75R_R$	$0{,}50 < T \leq 0{,}75$
B	$0{,}75R_R < EP \leq 1{,}00R_R$	$0{,}75 < T \leq 1{,}00$
Γ	$1{,}00R_R < EP \leq 1{,}41R_R$	$1{,}00 < T \leq 1{,}41$
Δ	$1{,}41R_R < EP \leq 1{,}82R_R$	$1{,}41 < T \leq 1{,}82$
E	$1{,}82R_R < EP \leq 2{,}27R_R$	$1{,}85 < T \leq 2{,}27$
Z	$2{,}27R_R < EP \leq 2{,}73R_R$	$2{,}27 < T \leq 2{,}73$
H	$2{,}73R_R < EP$	$2{,}73 < T$

Figure 6 shows the first page of the form of the EPC that is provided in Greece. This includes the general characteristics of the building, the yearly total primary energy consumption of both the reference building and the building under investigation, the yearly energy consumption per energy resource as well as the final energy use.

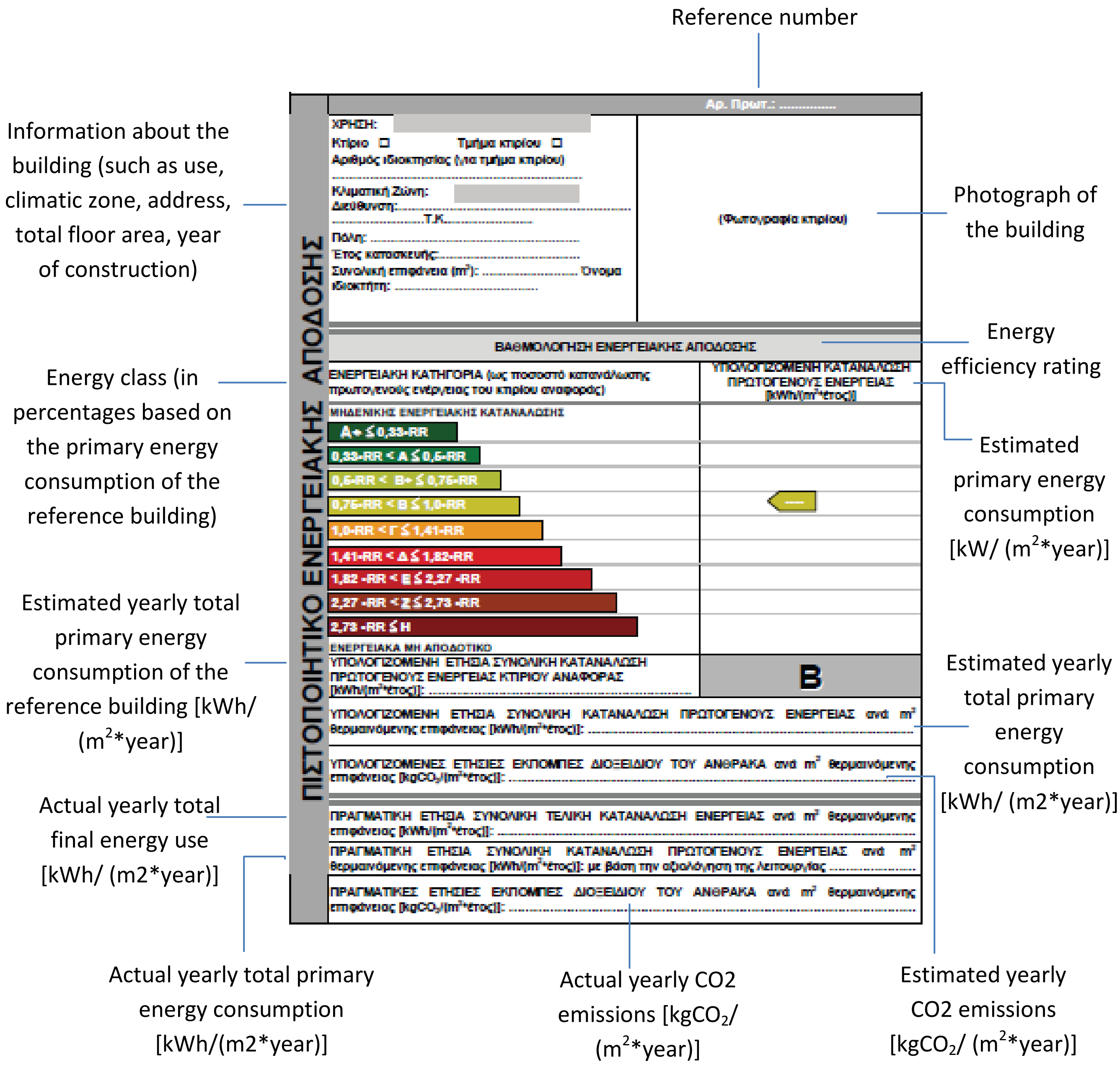


Figure 6: Representation of Energy Performance Certificates of Greece (TOTEE 20701-1/2010).

In case a building is divided into various parts where each of them is used for different purposes (for example in the same building there may be a store in the ground floor and apartments above it) then an energy assessment has to be conducted for each part and a separate EPC is provided. Table 2 shows the way in which buildings are categorized. The performance requirements vary among the building types but they are the same for buildings with the same uses (TOTEE 20701-1/2010).

Table 2: Classification of buildings according to their uses as distinguished in EPCs (TOTEE 20701-1/2010).

Basic building types	Uses of the buildings that are included in the basic building categories
Residential	Houses, Apartment buildings (buildings with more than one flat)
Temporary residence	Hotels, Hostels, Boarding schools and Cubicles
Meeting places	Meeting places, Exhibition places, Museums, Concert places, Theatres, Cinemas, Courtrooms, Closed gyms, Closed swimming pools, Restaurants, Patisseries, Banks, Multipurpose rooms
Educational	Kindergarten, Primary education, Secondary education, Higher education, Classrooms, Tuition centers
Health and Social Welfare	Hospitals, Clinics, Rural clinics, Health stations, Health centers, Doctors' offices, Psychiatric clinic, Institution for the disabled, Institutions chronically ill, Nursing homes, Nurseries, Day nurseries
Correction	Penitentiary, Borstal, Prisons
Trade	Stores, Shopping centers, Markets and supermarkets, Pharmacies, barber's shop and hairdresser, Institute of gymnastics
Offices	Offices, Libraries

3.1.3 Procedure Followed for Issuing the EPCs

The energy performance assessment of a building is conducted by experts and intends to estimate the primary energy consumption of a building per end use as well as in total. The assessment involves the classification of the building according to its energy performance and the issuance of the respective certificate. Furthermore, itcontains certain recommendations that are provided to the owner in order to improve the energy performance of the building and also the selection of additional characteristics of the building and the electrical/mechanical facilities that must be included in the electronic database(TOTEE 20701-4/2010).

The information to be gathered during the assessment regard the building envelope, the heating and cooling systems, the ventilation and lighting systems, the system for renewable energy,cogeneration, water supply systems, drainage and irrigation and parameters that provide a good quality of indoor comforts(TOTEE 20701-4/2010).

The beginning of the assessment is realized by the first meeting between the owner of the building and the energy auditor where the owner provides the auditor with all the necessary documents. Such documents are the designs regarding the architecture and the electrical/mechanical facilities of the building, the voucher of the central heating installation,maintenance sheet and sheet adjustment of central heating and other facilities,and also general information such as the ownership. In case some of the above mentioned documents are not available or they aremissing it is not the responsibility of the energy auditor to gather them.

After the general information of the building is registered electronically in the Building Inspection Portfolio, the Special Agency of Energy Auditors provides an electronic Protocol Number. Therefore, the EPC and the final assessment of the energy audit will be registered in that Portfolio under this Protocol Number.(TOTEE 20701-4/2010)

In turn, the expert conducts an energy assessment in the building in order to evaluate all the information he has been provided with by the owner. The Form of Energy Assessment of the Building is completed in this phase according to the architectural and electrical/mechanical designs, the study on energy or thermal insulation, the facilities maintenance portfolio, the information provided by the owner of the building and all the technical items of data that are gathered by the expert during the inspection.

Suitable equipment is available if a building has a large surface and more complex electrical/mechanical facilities.Therefore, certain additional parameters need to be estimated as they influence the conditions under which the building's facilities operate. Such parameters are indoor space conditions like the temperature, the air circulation and humidity. Other parameters are geometrical and thermal characteristics, the energy consumed by the electrical/mechanical systems, the voltage, the absorbed power, the power factor and the quality of the current density, the lighting and the power absorbed by the lighting systems.(TOTEE 20701-4/2010)

All data is processed according to the methodology set by the "Regulation of Energy Performance of Buildings" (KENAK) (Ministerial decision D6/B/5825 National Gazette 407/9th of April 2010) to determine the energy consumption of the building for heating, cooling, ventilation, lighting and domestic hot water and its classification to the respective category. When this step is completed, the EPC is composed again as it is stated in the "Regulation of Energy Performance of Buildings" (KENAK) (Ministerial decision D6/B/5825 National Gazette 407/9th of April 2010) and is then issued and provided to the owner together with the form of Energy Inspection of the Building, sealed and signed by the Energy Auditor. These are also registered electronically in the Building Inspection Portfolio.

As mentioned before, the EPC is accompanied by recommendations to improve the current energy performance. For this reason the Energy Auditor uses a list of advised recommendations. When a new building or an existing building that undergoes majorrenovation does not meet the minimum requirements and therefore is classified in a category lower than B, the owner is obliged to comply with the recommendations given by the Energy Auditor. In other words, the necessary improvements must be made within a year after the EPC was issued, so that the building can then be characterized as at least class B.After this year, a new energy inspection is conducted and a new EPC is issued. In case the building still does not meet the requirements, then the arrangements stated in the article 382 of PD/580/D/1999 (National Gazette A 210) "Basic Urban Planning Legislation Code"are set into force.

3.1.4 Climatic Zones

According to the Hellenic National Meteorological Service, the climate of the country is Mediterranean that is, winters are mild with lots of rains so that heating may be needed and summers are dry and warm rendering cooling necessary during these periods. Also, there are many sunny days throughout the year. Given this, there is a potential of energy savings when heating, air-conditioning and lighting are managed properly and measures are taken for upgrading the energy efficiency of the buildings(The Climate of Greece, 2013).

Greece is divided into four climatic zones based on their degree-days. This division is taken into account in the calculation methodology of the energy performance of buildings as the coefficient of thermal conductivity differs among the four climatic zones. In Figure 7 the map of Greeceis shown where it can be seen how this division is made:

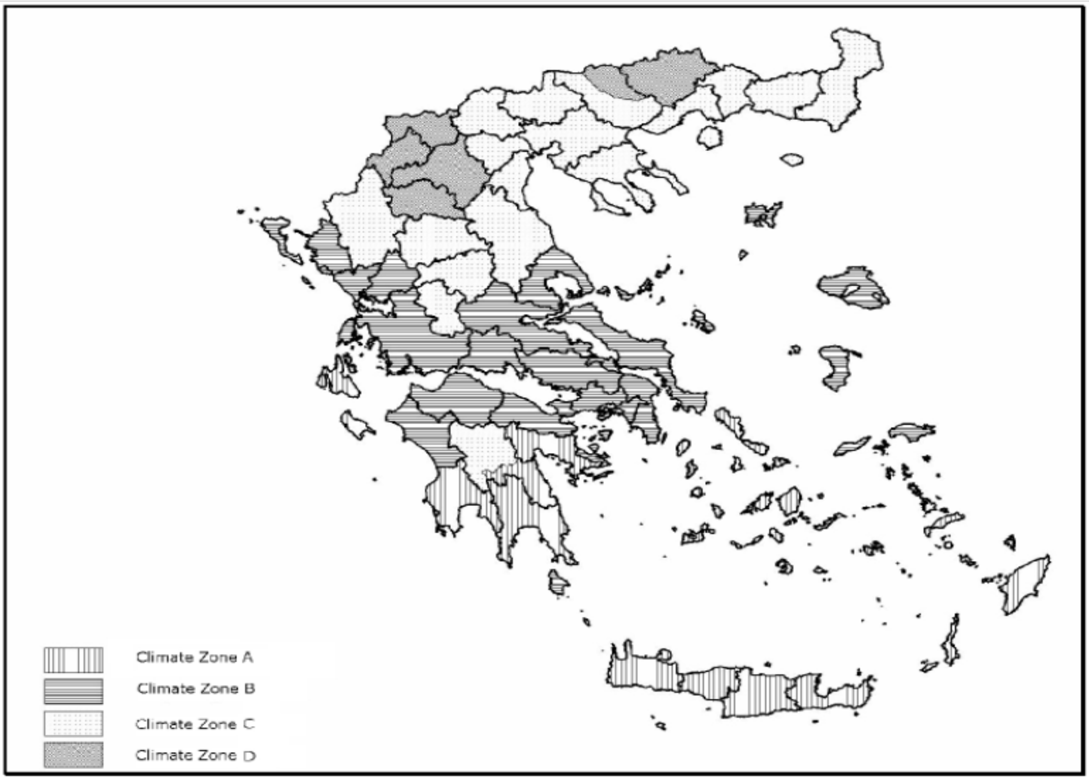


Figure 7: Representation of the climatic zones Greece is divided in (TOTEE 20701-3/2010).

In each prefecture, if there is an area with altitude higher than 500m, then it is integrated in the colder climatic zone than the one it is supposed to belong to according to Table 3 except for the prefectures in zone D. Table 3 shows in detail the way the Greek prefectures are grouped in the four climatic zones.

Table3: Climatic zones of Greece and the respective Greek prefectures**(TOTEE 20701-3/2010).**

CLIMATIC ZONE	PREFECTURES
ZONE A	Heraklion, Chania, Rethymno, Lasithi, Cyclades, Dodecanese, Samos, Messenia, Laconia, Argolis, Zakynthos, Kefallinia& Ithaca, Kythira& islands of Saronicos (Attica), Arcadia (lowland)
ZONE B	Attica (besides Kythira& islands of Saronicos), Corinthia, Elis, Achaea, Aetolia-Acarnania, Phthiotis, Phocis, Boeotia, Euboea, Magnesia, Lesbos, Chios, Corfu, Lefkada, Thesprotia, Preveza, Arta
ZONE C	Arcadia (highland), Evrytania, Ioannina, Larissa, Karditsa, Trikala, Pieria, Imathia, Pella, Thessaloniki, Kilkis, Chalkidiki, Serres (except for NE part), Kavala, Xanthi, Rhodope, Evros
ZONE D	Grevena, Kozani, Kastoria, Florina, Serres (NE part), Drama

3.1.5 Minimum Building Energy Performance Requirements

In order for a building to be certified as an adequately performing building in terms of energy and therefore be classified as category B it has to meet certain standards. First of all, during the design procedure, there must be a proper selection of the location and the orientation of the building as to take full advantage of the existing climatic conditions. Also, the openings should be designed in a way to take advantage of sunlight and good ventilation. When designing the building, protection from the sun, techniques of natural ventilation, passive solar systems (e.g. Trombe wall, thermal mass) and securing optical comfort via natural lighting methods must be incorporated. (Ministerial decision D6/B/5825, 2010)

Regarding the requirements that the building envelopehas to meet, Table 4 shows the maximum thermal conductivity valuesfor the different structural elements according to the various climatic zones. These limit values are not taken into account in cases where the structural elements form passive solar systems.

Table 4: Maximum allowable coefficient of thermal conductivity of structural elements per climate zone **(Ministerial decision D6/B/5825, 2010)**.

STRUCTURAL ELEMENT	**SYMBOL**	**Coefficient of thermal conductivity [W/(m²K)]**			
		CLIMATIC ZONE			
		A	**B**	**C**	**D**
Exterior horizontal or inclined surface in contact with the exterior air (ceilings)	U_D	0.50	0.45	0.40	0.35
Exterior walls in contact with the exterior air	U_W	0.60	0.50	0.45	0.40
Floors in contact with the exterior air (pilotis)	U_{DL}	0.50	0.45	0.40	0.35
Floors in contact with the ground or with closed non heated spaces	U_G	1.20	0.90	0.75	0.70
Exterior walls in contact with non-heated spaces or with the ground	U_{WE}	1.50	1.00	0.80	0.70
Openings (windows, balcony doors, etc.)	U_F	3.20	3.00	2.80	2.60
Non opening and partial opening glass building facades	U_{GF}	2.20	2.00	1.80	1.80

Table 5 and Figure 8 present the limits within which the mean coefficient of thermal conductivity of a new building or a building undergoing a major renovation has to be, where the factor F/V indicates the total floor area in m^2 over the volume in $m^3$of the space under investigation. Again, the passive solar systems that are installed on the building envelope are not accounted for the determination of the mean coefficient of thermal conductivity. Instead conventional elements with the thermal characteristics presented in Table 4 are used.(Ministerial decision D6/B/5825, 2010).

The energy classification of a building which fulfills the requirements given in Table 4 is not easy to be determined when only this information is taken into account. This has to be combined to the requirements shown in Figure 8 and Table 5, as the building has toabide by these requirements at the same time. Additionally, the electro / mechanic facilities should also be taken into account because these can influence the energy efficiency of the building. As a result, the combination of these three parameters, that is U, F/V and electro / mechanic facilities, determine the label of the building.

Furthermore, buildings which do not comply with the maximum allowable values and the rules set for the electro / mechanic facilities then it is classified in a category less than B. For existing buildings there is no obligation for further improvements. On the contrary, new buildings have to be at least class B. If this is not fulfilled then the owner is obliged to follow the recommended measures to upgrade it in class B within a year.(Ministerial decision D6/B/5825, 2010).

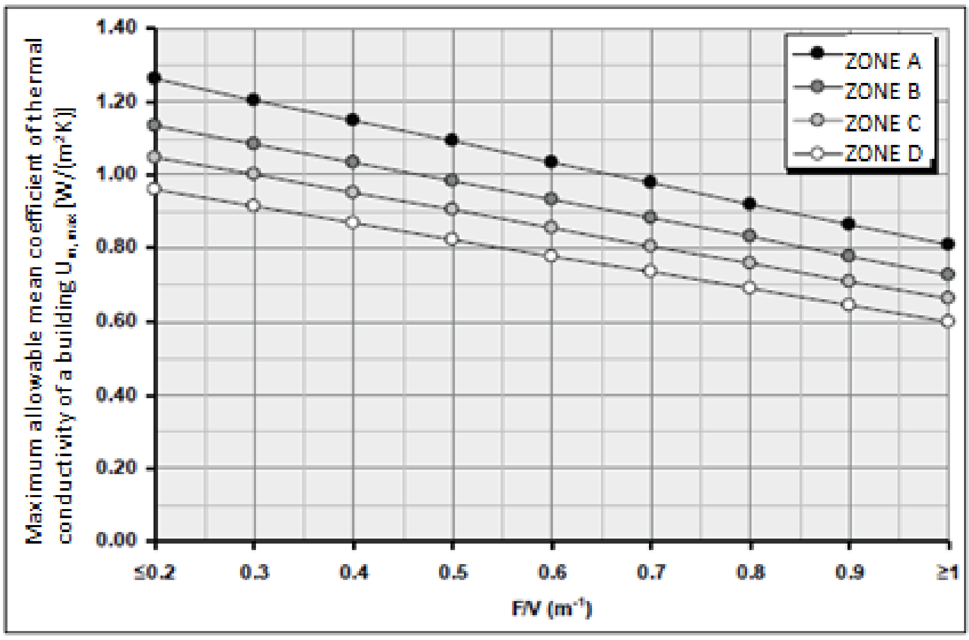


Figure 8: Maximum allowable mean coefficient of thermal conductivity (U_m) per climate zone **(Ministerial decision D6/B/5825, 2010)**.

Table 5: Maximum allowable mean coefficient of thermal conductivity (U_m) per climate zone**(Ministerial decision D6/B/5825, 2010)**.

F/V (m^{-1})	Maximum allowable mean coefficient (U_m) in W/m^2K			
	Zone A	Zone B	Zone C	Zone D
≤0.2	1.26	1.14	1.05	0.96
0.3	1.20	1.09	1.00	0.92
0.4	1.15	1.03	0.95	0.87
0.5	1.09	0.98	0.90	0.83
0.6	1.03	0.93	0.86	0.78
0.7	0.98	0.88	0.81	0.73
0.8	0.92	0.83	0.76	0.69
0.9	0.86	0.78	0.71	0.64
≥1.0	0.81	0.73	0.66	0.60

The electro/mechanic installations have to meet certain standards as well. To begin with, each central air conditioning unit providing more that 60% of the fresh air should be able to regain 50% of the heat of the outgoing air. Also, all distribution systems (for example central heating or cooling systems) must have thermal insulation, especially where parts are outdoors. (Ministerial decision D6/B/5825, 2010).

In all new or fully renovated buildings, it is obligatory that a percentage of the needs for domestic hot water are covered through solar thermal systems. On an annual basis this percentage, is 60%. However, there are exceptions to this rule such as when renewable resources or electro/thermal systems are used.(Ministerial decision D6/B/5825, 2010).

When referring to lighting a building in the tertiary sector, the existing natural light in parts of the building must be adequate as to decrease use of light lamps by 50%.(Ministerial decision D6/B/5825, 2010).

3.1.6 Calculation of Energy Performance of Buildings

According to the Article 3 of Law 3661-“Measures for buildings’ energy consumption reduction”, the methodology followed to calculate the primary energy consumption and the energy performance of a building differs between domestic and non-domestic buildings(KENAK, 2010):

To determine the primary energy consumption, the following parameters are taken into account:

a) Domestic buildings
- Airtightness
- Heating
- Cooling
- Domestic hot water
- Thermal characteristics of the structural elements of the building

b) Non-domestic buildings
   - Heating
   - Cooling
   - Air-conditioning
   - Ventilation
   - Lighting

Regarding airtightness, it is not possible to measure the air exchanged through openings. For this reason, nominal values are used which differ between doors and windows. As far as the heating system is concerned, this is distinguished into smaller parts. When referring to the burner, the distribution system which should be properly insulated to eliminate heat losses and thermal units e.g. fancoil units, the energy efficiency is the parameter that contributes more to the result than the power. The opposite occurs in the case of the auxiliary systems, such as circulators, where power is more important than the efficiency. Another parameter to be taken into consideration is the automation category. When a heating system is used for the production of hot water, the same principles are applied when domestic hot water is taken into account in the calculations. As for the ventilation, the specific power supply factor in kW/m^3/s is to be taken into account. (TOTEE 20701-1/2010)

Table 6: Conversion factors used to convert final energy consumption of the building into primary energy **(Ministerial decision D6/B/5825, 2010)**.

Energy source	Conversion factor of primary energy	Emissions per unit of energy (kgCO2/kWh)
Natural gas	1.05	0.196
Oil	1.10	0.264
Electrical energy	2.90	0.989
Biomass	1.00	-

Table 6 presents the conversion factors with which the final energy that is consumed by a building can be converted into primary energy. The information given in Table 6 combined with the parameters to be taken into account mentioned above determine the primary energy consumption of a building. The energy performance is calculated by dividing the primary energy used for the actual building over the primary energy used for the reference building. The latter is estimated by taking into consideration the same parameters as for the respective actual building.

Furthermore, other factors that can have a positive impact on the energy performance of a building are also taken into consideration. Such factors are building's location, orientation and the climatic conditions this is located in, as well as the indoor climatic conditions that already exist and the desired ones. Moreover, insulation, sunshades, passive and active solar systems that are based on renewable energy sources for heating, cooling and electricity production as well as cogeneration.Also, other considerations can be systems for heating and cooling on a region scale or building blocks such as district heating and cooling and natural lighting(Ministerial decision D6/B/5825, 2010).

3.1.7 Incentives and subsidies provided in Greece

In this way, people are motivated to act towards upgrading their properties. More specifically, in Greece the *'Energy Saving at Home'* program can be found. It concerns houses, apartment buildings or flats that meet two criteria: a) the property should be located in a territory where the prices are equal or less than 2,100€ / m^2 and it has been certified with an EPC which states that the property is characterized as class D or even lower. (Ministry of Environment, Energy and Climate Change, 2010)

Table 7: Criteria and subsidies provided(Ministry of Environment, Energy and Climate Change, 2010).

Beneficiaries	**A1**	**A2**	**B**
Personal income	PI ≤ 12000€	12,000€ < PI ≤ 40,000€	40,000€ < PI ≤ 60,000€
Family income	FI ≤ 20,000€	20,000€ < FI ≤ 60,000€	60,000€ < FI ≤ 80,000€
Incentive	70% Subsidy for final eligible budget 30% Interest-free Loan	35% Subsidy for final eligible budget 65% Interest-free Loan	15% Subsidy for final eligible budget 85% Interest-free Loan

Table 7 shows the incentives provided to the citizens who are classified in three categories according to their income. Only natural persons who meet the requirements mentioned in Table 5 and also they have the right of full ownership or usufruct to an eligible ownership can participate in this Program. Moreover, a low rate bank loan can be obtained with which the remaining amount of the investment can be paid. Two EPCs are necessary in such case, one before and one after the implementation of the energy efficient measures. In this way the upgrading of the building can be checked.

3.2 United Kingdom

3.2.1 Introduction of EPCs in the United Kingdom

In England and Wales the Department for Communities and Local Government (CLG) is responsible for the implementation of the EPBD (Woods, 2011). This is patronized by the Department for the Environment, Food and Rural Affairs (Defra) and the Department of Energy and Climate Change (DECC) (Woods, 2011). The Building (Amendment) Regulations 2012 and the Building (Approved Inspectors etc.) Regulations 2010 are the main instruments for complying with the requests set by the EPBD (Department for Communities and Local Government, 2012).

Apart from the Energy Performance Certificates (EPCs), England and Wales have also introduced the Display Energy Certificates (DEC).DECs are issued for buildings whose total floor area is higher than 500 m^2(Department for Communities and Local Government, 2012) and are entirely or partly occupied by public authorities and by institutions providing public services and thus, are visited by a large number of people.The energy audit of a building is conducted by professionals who are members of an Accreditation Scheme that the Government has authorized. More specifically, this is achieved by a Local Authority Building Control Body or an Approved Inspector (Woods, 2011). Moreover, there are certain Local Authority Trading Standards Officers that make sure that EPCs and DECs are implemented properly (Woods, 2011).

As far as Scotland is concerned, the implementation of the EPBD is reviewed by the Building Standards Division (Woods, 2011), part of the Directorate for the Built Environment. The Building (Scotland) Amendment Regulations 2010 was introduced in October 2010 (The Scottish Government, 2012). This had an effect on the standards that were on issue until that time. Responsible for imposing the regulations is the Local Authority. The latter has created a special body of experts to perform energy assessment.

In Northern Ireland, the Department of Finance and Personnel (DFPNI) coordinates the implementation of the EPBD with the contribution of the Department for Social Development (DSDNI) (Woods, 2011). The basic instruments to conform to the Directive are the Building Regulations (Northern Ireland) 2012 and The Energy Performance of Buildings (Certificates and Inspections) Regulations (Northern Ireland) 2008 (Department of Finance and Personnel, 2012). Concerning the experts to perform energy assessment, Northern Ireland follows a pattern similar to that of the Accreditation Schemes in England and Wales. Responsible for the control of the implementation is district councils apart from the cases of council buildings in which the Department of Finance and Personnel is the one to address to (Woods, 2011).

3.2.2 Energy Performance of Buildings Certificate (EPC)

The EPCs provided in the United Kingdom are distinguished into those certified for domestic buildings and those for non-domestic buildings and they are issued for ten years. In general, they include a reference number which is unique for every certificate and the date that this was issued. Moreover, information about the energy assessor is given and a way to check whether or not the certificate is genuine. The cases of England and Wales, Scotland and Northern Ireland are investigated separately.

England and Wales

a) Domestic EPCs

The energy performance of the dwelling is rated on a scale from A to G with A being the most efficient and G the least efficient. This forms an asset rating according to the dwelling's characteristics, services and occupancy. Such EPCs include as well an environmental impact rating that shows how the dwelling affects the environment in terms of carbon dioxide (CO_2) emissions. In this case the higher it is rated, the less its impact to the environment is. Furthermore, the EPC shows how the energy efficiency rating and the environmental impact rating would change if all cost-effective recommendations were followed. A new property should be rated at least as B while an average existing house is rated as E.

Cost-effective measures in a report are provided together the EPC. Such measures intend to improve the energy performance of the house and are divided into lower cost (up to £500 capital cost) and higher cost (over £500 capital cost).

b) Non-domestic EPCs

Likewise, the non-domestic EPCs use a scale from A to G and the energy performance is indicated as a single CO_2 based index. In addition, two benchmarks are used, the energy rating of new properties and the energy rating of existing properties.

Again, cost-effective measures are used which are grouped as short term (payback less than three years), medium term (payback between three and seven years) and long term (payback more than seven years).

c) Display Energy Certificates (DECs)

These DECs are provided in cases of public buildings over $500m^2$.The term total floor area involves the area of all enclosed spaces measured to the internal face of the external walls. Staircases, raked auditoria and, generally, spaces whose surface is sloping should be accounted for as their area on the plan. Not enclosed areas like balconies are not taken into account. When referring to a part of a building intended to be used for separate occupation, it means that it should have its own entrance and the owner should be able to control heating and ventilation independently.(Display energy certificates and advisory reports for public buildings, 2008)

The energy performance of such buildings is based on an operational rating which involves the actual energy consumption for the current year. More specifically, it is an indicator of the actual CO_2 emissions a building emits annually. The performances of buildings can be compared with each other when a common unit exists and this was decided to be CO_2 emissions. Building's CO_2 emissions are rated on a scale from A to G, the higher the rating, the better it performs and the less CO_2 it emits. DECs also contain information about the building's performance over the last three years in order to show whether and how much it has been improved. When an EPC is provided, an asset rating is also presented on a DEC.(Display energy certificates and advisory reports for public buildings, 2008)

The classification of the building is made after compared to a reference building with the same characteristics. The operational rating of the reference building's performance is 100. The operational rating of a building with zero CO_2 emissions would be zero whereas,an operational rating of 200 is given to buildings which emit CO_2 twice as much as the reference building does. (Display energy certificates and advisory reports for public buildings, 2008)

DECs have an issue of one year and must be renewed on an annual base. They have to be displayed in a place that can be accessed by people visiting the building and receive information about the energy performance of the building. Private organizations are not required to obtain a DEC. (Display energy certificates and advisory reports for public buildings, 2008)

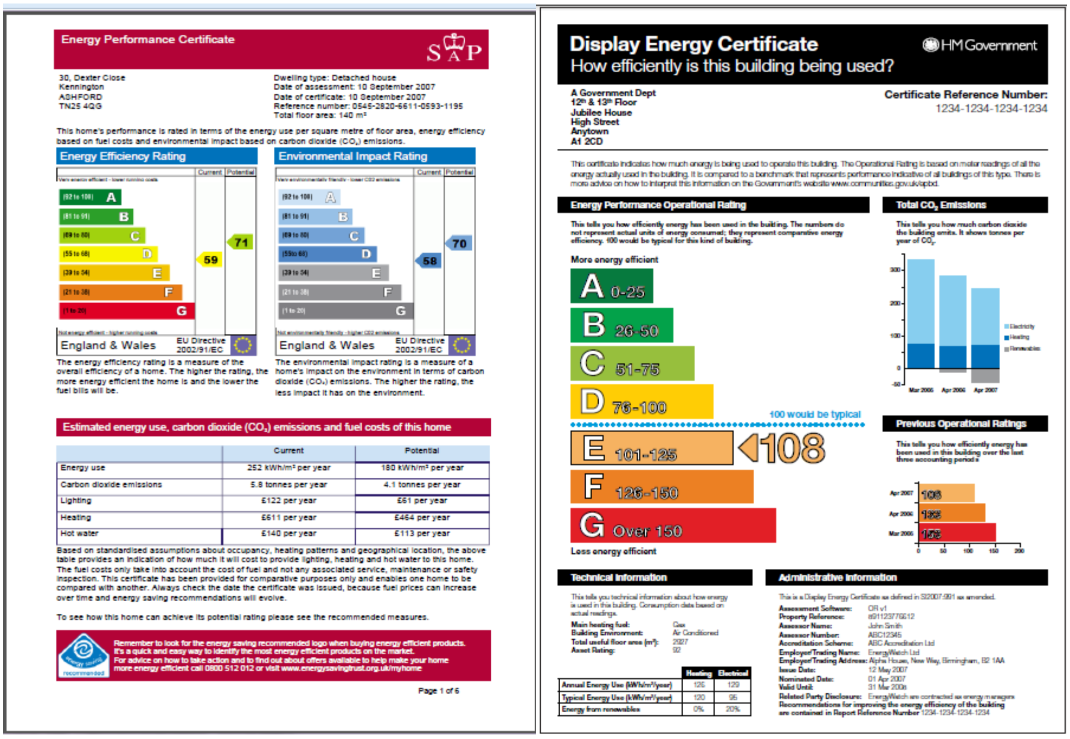


Figure 9: An EPC sample (left side)**(Energy performance of buildings, 2012)** and a DEC sample (right side)**(Display energy certificates and advisory reports for public buildings, 2008)** forEngland and Wales.

All EPCs and DECs issued are stored in a central electronic register (http://www.epcregister.com)

Furthermore, the DEC contains a reference number unique for each certificate. Information about the building, such as the address and the total useful floor area, and about the energy assessor, that is, their name and address and their employer are also shown. Moreover, the DEC presents the accreditation scheme that was used, the nominated date and the date of issue of the DEC and, finally, the name of the approved accreditation scheme of which the energy assessor is a member.

DECs are accompanied by an advisory report that contains recommendations on how the building can be improved and be classified to a better energy category. It has a value of seven years. In this way the owner of the building has time enough to implement the recommended measures. The recommendations are not binding so as to give the occupier the opportunity to search other solutions to change their building into being more efficient in terms of energy.

The advisory report includes cost-effective measures and also zero and low cost operational and management improvements, possible upgrades to the building fabric or services and opportunities for the installation of Low and Zero Carbon (LZC) technologies.

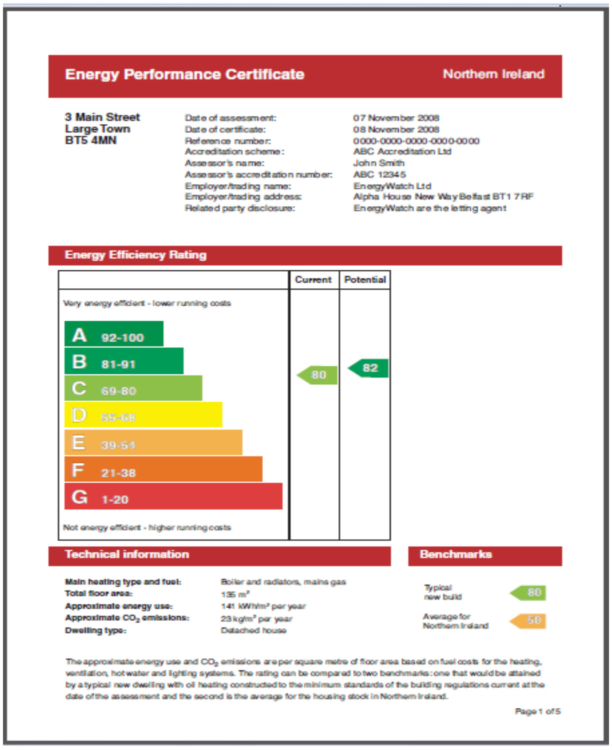
Scotland

The EPCs as well as the cost-effective recommendation reports produced in Scotland are similar to those in England and Wales. The difference lies in the benchmarks used for the non-domestic EPCs. These benchmarks refer to a building whose type built is similar to that in the Building Regulations. They also refer to a building which would perform as if the cost-effective measures were taken.

EPCs are also produced for public buildings. For this reason, there are no DECs in Scotland. The buildings are certified for a period of ten years. Domestic EPCs are stored in the electronic Home Energy Efficiency Database.

Northern Ireland

In Northern Ireland the energy performance rating, the potential rating, the recommendation report and the storage of the data are done in the same way as in England and Wales. The form of the certificate for non-domestic buildings and the DECs are also similar. What differs is the EPC for dwellings.


Energy Performance Certificate — Northern Ireland

3 Main Street
Large Town
BT5 4MN

Date of assessment:	07 November 2008
Date of certificate:	08 November 2008
Reference number:	0000-0000-0000-0000-0000
Accreditation scheme:	ABC Accreditation Ltd
Assessor's name:	John Smith
Assessor's accreditation number:	ABC 12345
Employer/trading name:	EnergyWatch Ltd
Employer/trading address:	Alpha House New Way Belfast BT1 7RF
Related party disclosure:	EnergyWatch are the letting agent

Energy Efficiency Rating

	Current	Potential
Very energy efficient - lower running costs		
A 92-100		
B 81-91		82
C 69-80	80	
D 55-68		
E 39-54		
F 21-38		
G 1-20		
Not energy efficient - higher running costs		

Technical information

Main heating type and fuel:	Boiler and radiators, mains gas
Total floor area:	135 m^2
Approximate energy use:	141 kWh/m^2 per year
Approximate CO_2 emissions:	23 kg/m^2 per year
Dwelling type:	Detached house

Benchmarks

Typical new build	80
Average for Northern Ireland	50

The approximate energy use and CO_2 emissions are per square metre of floor area based on fuel costs for the heating, ventilation, hot water and lighting systems. The rating can be compared to two benchmarks: one that would be attained by a typical new dwelling with oil heating constructed to the minimum standards of the building regulations current at the date of the assessment and the second is the average for the housing stock in Northern Ireland.

Page 1 of 5

Figure 10: Energy Performance Certificate sample for a new dwelling in Northern Ireland (Energy performance of buildings, 2012).

3.2.3 Calculation of Energy Performance of Buildings

England and Wales

The National Calculation Methodology (NCM) presents the procedure followed to calculate the energy and environmental performance ofbuildings. More specifically,in the case of new dwellings, DECC uses a new methodology called Standard Assessment Procedure (SAP). It was deployed by the Building Research Establishment (BRE) to mobilize policies for improving energy efficiency. It is based on the BRE's Domestic Energy Model (BREDEM) with which the energy consumption of dwellings is determined. (Standard Assessment Procedure (SAP), 2012)

With SAP the energy a dwelling consumes and the amount of carbon dioxide emitted is estimated so that a desired comfort level is reached. The indicators of performance used by SAP are the energy use per unit floor area, the energy cost rating (SAP rating) and the CO_2 emissions. These are based on the evaluation of the energy that is consumed annually for space heating, domestic hot water, ventilation and lighting. (Standard Assessment Procedure (SAP), 2012)

Next to SAP the Reduced data SAP (RdSAP) was displayed to evaluate the existing dwellings' performance as a lower cost method (Standard Assessment Procedure (SAP), 2012). For non-dwellings the tool used by the Government to calculate the energy performance is called Simplified Building Energy Model (SBEM) (National calculation methodology modelling guide (for buildings other than dwellings in England and Wales), 2008).

According to the Notice of Approval, the following methods have been approved for the production of EPCs and DECs (Method for calculating the energy performance of buildings: notice of approval, 2008):

- the Standard Assessment Procedure for the Energy Rating of Dwellings (SAP 2005)
- approved software applications of SAP 2005 and RdSAP 2005
- the Government's Simplified Building Energy Model (SBEM)
- approved software interfaces to SBEM
- approved Dynamic Simulation Model (DSM) software packages
- the Government's Method for Calculating Operational Ratings for buildings (MCOR) and its software application
- approved software applications of MCOR

Domestic buildings

For dwellings under construction the indicators to be taken into account are the Target CO_2 Emission Rate (TER), the Dwelling CO_2 Emission Rate (DER) and also the Asset Rating which is calculated by SAP 2005. For dwellings to be sold or rented out the Asset Rating is calculated by SAP 2005 or RdSAP 2005.(Notice of approval, 2008)

Non-domestic buildings

For the determination of the energy performance of non-domestic buildings the indicators used arethe Target CO_2 Emission Rate (TER), the Building CO_2 Emission Rate (BER) and the Asset Rating. The latter is calculated by SBEM or an approved DSM. In case of a DEC the Operational Rating of a building is determined by using MCOR. (Notice of approval, 2008)

Five criteria must be fulfilled so that a building meets all the necessary requirements:

1. DER and BER must be lower than the TER. The unit of these indicators is kg CO_2/m^2 of floor area per year. In cases of domestic buildings, TER can be calculated by determining the CO_2 a notional building emits, which has the same size as the actual dwelling, constructed to the reference values set out in Appendix R of SAP 2009 when the proposed fuel is used.As the heat loss through party walls is taken into consideration in the calculations, when a property contains a swimming pool, the heat that is lost through the pool basin should be confined. A minimum value for the coefficient of thermal conductivity of the pool basin is set at 0.25 W/m^2K.
   Regarding non-domestic buildings, the TER is put equal to the emissions of a notional building with the same characteristics as the actual building. The difference is that now the notional building is constructed to a series of reference values for a property that would meet the requirements of the 2010 NCM modeling guide.

Table 7: U-values in a notional building (National calculation methodology modelling guide (for buildings other than dwellings in England and Wales), 2008).

Exposed element	**U-value (W/m2K)**
Roofs (irrespective of pitch)	0.25
Walls	0.35
Floors and ground floors	0.25
Windows, roof windows, rooflights, curtain walling and pedestrian doors	2.2
Vehicle access and similar large doors	1.5
Internal walls	2.0
Internal window	3.85
Internal floors (viewed from room above)	1.25
Internal floors (viewed from room below)	1.23

2. The U-values and permeability of the building fabric should be no better than the given design limits (Table 7). Moreover, energy efficient fixed building services with efficient controls should be used for improving the performance of heating and hot water, pipework insulation, mechanical ventilation, mechanical cooling, fixed internal and external lighting.
3. During summer the temperature of the interior of a building increases. For this reason, passive control measures should be taken in order to keep the temperature within the desired levels. This should be achieved without decreasing the levels of day lighting.
4. After the construction of a building, it must perform in a way it was predicted to do so when designed. This is considered through continuity of insulation, air-permeability and pressure testing standards and evidence of satisfactory commissioning of fixed building services.
5. Information regarding the operation and maintenance of the building services must be clearly given.

3.2.4 Incentives and subsidies in the United Kingdom

In the United Kingdom, the incentive used to motivate people towards upgrading their properties is called Green Deal. This is long term loan that is repaid through electricity bills. In this way when the owner moves they stop paying for the improvements as they no longer benefit from them and the electricity bills pass to the new owner. In case the property is rented out, the landlord has to get their tenants permission to proceed and vice versa. This loan is provided when energy efficient improvements are needed to be done. Such improvements include (Green Deal, 2012):

- insulation,
- heating,
- draught-proofing,
- double glazing and
- renewable energy technologies.

The procedure starts with having the property assessed in terms of energy in order to estimate what the savings will be when the necessary improvements are implemented. In turn, a Green Deal provider is chosen who will execute all the steps that need to be followed. When the person concerned and the provider agree on all terms and conditions then they both sign up a contract call Green Deal Plan which states what improvements will be made and the respective cost. A Green Deal installer then will do the work. At the end, the money is paid off in installments through the electricity bill.(Green Deal, 2012)

Green Deal offers a high interest rate of more than 7%. This fact has raised concerns about the effectiveness of the scheme and many Green Deal providers state that it could even fail if the interest rate did not drop. (Gosden, 2013)

3.3 Ambition level in Greece and in the United Kingdom

In this section a quantitative analysis is carried out in order to present the ambition level in the two countries. Figure 11 shows the number of EPCs that are issued per month in Greece from January 2011 to September 2012. The data were taken from statistics that were published by the Ministry of Environment, Energy and Climate Change. It can be seen that during the summer and the autumn of 2011 the number of the certificates that were issued is quite small. The reason for this is that the incentives that were provided by the Government at that time were not strong enough to motivate people. The implementation of the 'Energy Saving at Home' program mentioned in section 3.1.7, started in 2011 but the incentives that were offered, were not very attractive (35% subsidy at most and for a family income up to 40,000 euro). The small numbers could also be justified by the fact that the regulation regarding the certification of buildings is rather new in Greece and, therefore, some time is needed for its proper implementation and for the society to adjust to the change. Another explanation could be the fact that the country has been suffering an economic crisis for few years and, thus, people hesitated on going through such a procedure.

On the other hand, in 2012 the number of EPCs increases noticeably. Such a behavior is attributed possibly to the fact that the 'Energy Saving at Home' program was amended and more attractive incentives were given (70% subsidy for family income up to 20,000 euros). This means that if a certain work cost 10,000 euro, someone with a subsidy of 70% would sign up for a loan from the bank of only 3,000 euro. The rest would be covered by the program.

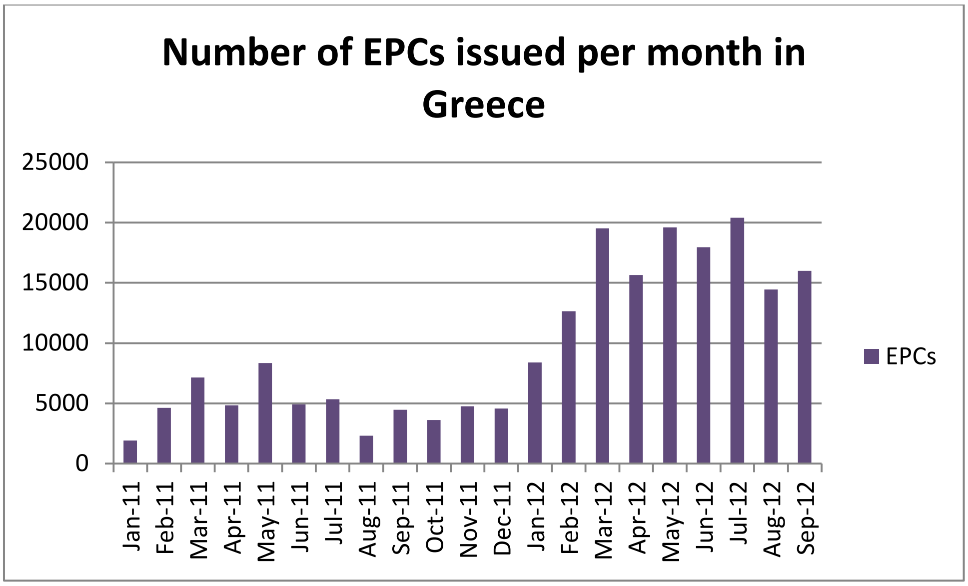


Figure 11: Number of EPCs issued per month in Greece.

Figure 12 presents the number of the EPCs that are provided per energy class. From the graph becomes obvious that the energy performance of the buildings in Greece is not very satisfactory. Most of the buildings are classified in an energy category less than level B. This is probably due to the fact that there are many old buildings in the country and the construction of new buildings has frozen for the moment due to the economic crisis. The graph contains the EPCs that were issued both for new and for existing buildings. It was not possible to find respective data for the case of the United Kingdom and, thus, a comparison between the two countries regarding the EPCs that were issued per energy class is not possible.

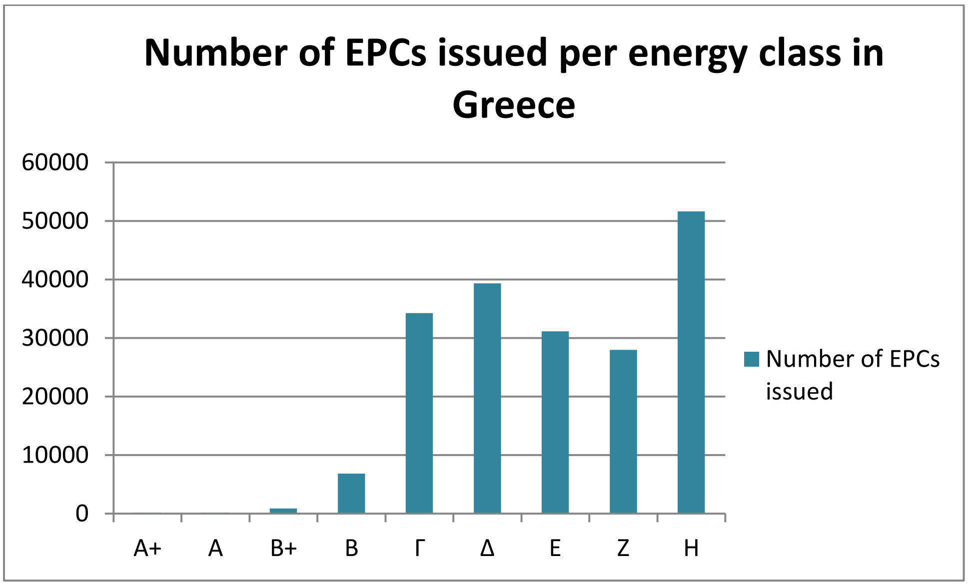


Figure 12: Number of EPCs issued per energy class in Greece.

Figure 13 shows the number of EPCs that has been issued in the United Kingdom in the year 2012 for new and existing dwellings. The data were collected from the Domestic Energy Performance Certificate Register. It is obvious that there is a big difference between the number of the EPCs that have been provided to the existing and new dwellings. A comparison between Figure 11 and Figure 13 reveals that the ambition level in the United Kingdom is much higher than this in Greece as the EPCs that have been issued in the first country are much more than these issued in the latter country. The fact that Figure 13 contains only EPCs on domestic buildings while Figure 11 includes EPCs on both domestic and non-domestic buildings enhances the result.

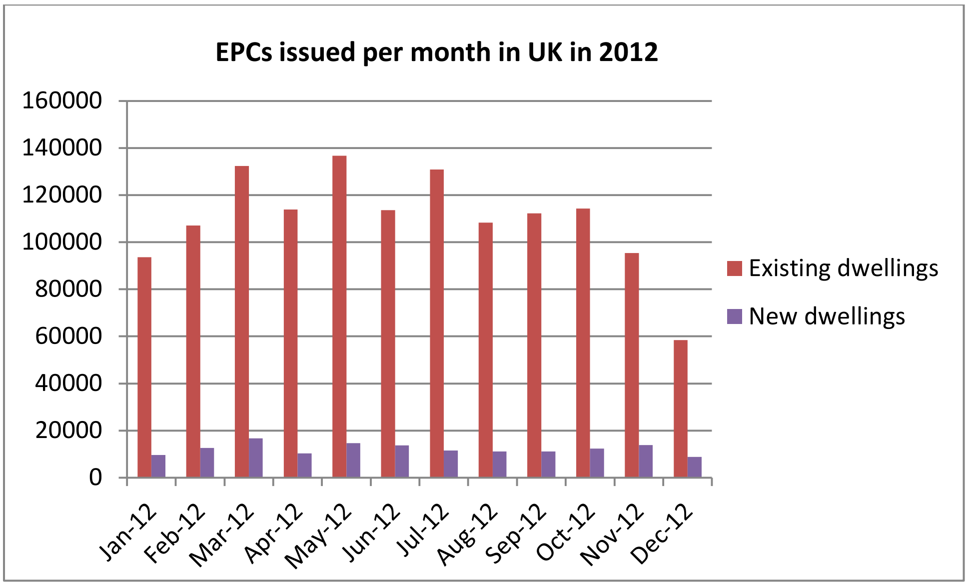


Figure 13: Number of EPCs issued per month in the United Kingdom.

The tables that Figure 11, 12 and 13 were based on can be found on the Appendix B.

3.4 Comparative assessment of Certification of Buildings

In sections 3.1 and 3.2 the certification of buildings is investigated. In section 3.1.1 and 3.2.1 the presentation of EPCs is studied. Sections 3.1.2 up to 3.1.4 describe the procedure followed for issuing the energy performance certificates,the division into climatic zones and the minimum building energy performance requirements, respectively. The methodology for the calculation of the energy performance of buildingsis explained in sections 3.1.5 and 3.2.2. Below the main similarities and differences are presented:

Similarities

- In both countries the certificates are valid for ten years.
- A recommendation report with measures for energy efficiency improvement accompanies the EPC in both Greece and the United Kingdom.
- The calculations are based on a self-reference method that is, the performance of the actual building is compared to a reference/notional building in both cases.
- The reference building in the two cases is defined in the same way.

Differences

- In the United Kingdom, that is England and Wales, Scotland and Northern Ireland, the certification of buildings differentiated between new and existing buildings, dwellings and non-dwellings and public buildings. In the case of Greece, the form of EPCs was the same regardless these distinctions.
- In England, Wales and Northern Ireland a Display Energy Certificate is required for public building with a total floor area higher than $500m^2$. In Scotland and Greece there is no such requirement and an EPC is issued for cases like this.
- The manner in which labeling is done differs between the two countries. Whereas in both cases there are A-G bands, in Greece the scaling consists of two more energy categories, A+ and B+ classes. The purpose of the two additional classes is to make efficient building designs more competitive in the future.
- An Environmental Impact Rating is included in the EPC form of the United Kingdom but not in Greece.
- Table 8 shows the indicators used to evaluate the energy performance of a building.

Table 8: Differences in the energy labeling index between Greece and UK.

<table>
<tr><th></th><th>Greece</th><th colspan="2">UK</th></tr>
<tr><td rowspan="3">Energy labeling index</td><td rowspan="3">PEC_{AB}/PEC_{RB}</td><td>Dwelling</td><td>Non-dwelling</td></tr>
<tr><td colspan="2">TER</td></tr>
<tr><td>DER</td><td>BER</td></tr>
</table>

Where PEC_{AB} is the primary energy consumption of the actual building, PEC_{RB} is the primary energy consumption of the reference building, TER is the target CO_2 emission rate, DER is the dwelling CO_2 emission rate and BER is the building CO_2 emission rate.

- The division in climatic zones is taken into account in the methodology in Greece as it influences the value of the coefficient of thermal conductivity while, in the United kingdom it was found that climatic zones are not included in the methodology.

Figure 13 and Figure 14 summarizes the differences found between the four building categories (new/existing, domestic/non-domestic). More specifically, Figure 13 shows how new and existing buildings differentiate in the two countries under investigation. In Greece the difference lies within the requirements that need to be met. New buildings have to be labeled as class B after their construction and when the requirements in Figure 13 are fulfilled. Otherwise, the necessary improvements have to be made. According to the policy the Greek government follows, the existing buildings do not need to meet such requirements. Only buildings that undergo major renovation have to be upgraded to level B. In the United Kingdom, the calculation of the energy performance is what makes new buildings differ from the existing. SAP method is used in the first case while RdSAP is used in the latter one.

Requirements for new buildings in Greece
- Design
- Max U-values
- At least 50% heat recovery in central AC units
- Min levels of insulation of heating/ cooling distribution network
- At least 60% hot water production from solar panels
- Min requirements for lighting installations in tertiary sector buildings (55lm/W)

Requirements for existing buildings in Greece
- Major renovation
  - Upgraded to class B

Existing dwellings in UK
- Energy performance calculation
  - RdSAP method (SBEM for non-dwellings)

New dwellings in UK
- Energy performance calculation
  - SAP method

Figure 13: Differences between new and existing buildings in Greece and in the United Kingdom.

Figure 14presents the characteristics which make domestic buildings differ from non-domestic ones. In the United Kingdom the differences concern the information provided in the certification form with the way rating is done being the most notable difference. In Greece, although the certification form is the same for the two building types, the difference is found in the factors that are taken into account when calculating the primary energy consumption. These factors can be seen in Figure 14.

Domestic Buildings in UK

- Assert based rating
- Environmental impact rating
- Cost-effective recommendations
  - Lower cost < £500cc
  - Higher cost > £500cc
- Average existing property: E class
- Average new house: B class

Domestic Buildings in Greece

For the primary energy consumption:

- Heating
- Cooling
- DHW
- Air-tightness
- Thermal characteristics of structural elements

Non-domestic Buildings in UK

- Assert based rating
- Environmental impact rating
- Operational rating
- Benchmarks
  - If newly built
  - If typical of existing stock
- Cost-effective recommendations
  - Short term: PB < 3yrs
  - Medium term: 3yrs < PB < 7yrs
  - Long term: PB > 7yrs

Non-domestic Buildings in Greece

For the primary energy consumption:

- Heating
- Cooling
- AC
- Ventilation
- Lighting

Figure 14: Differences between domestic and non-domestic buildings in Greece and in the United Kingdom.

4 INSPECTION OF BOILERS / AIR-CONDITIONING SYSTEMS

4.1 Greece

4.1.1 Boilers / Heating systems

The inspection of boilers depends on the fuel that is used, the rated power and the age of the boiler. The energy auditors conduct an assessment on boilers operating onliquid or solid fuels every five years when their effective nominal rated power ranges between 20kW and 100kW. For cases where the rated power is greater than 100kW, the inspection occurs every two years, except for boilers using fuel gas where the inspection is repeated every four years.Boilers that have been in operation for more than fifteen years and whose nominal power is higher than 20kW undergo an assessment in relation to the heating system as a whole regardless the fuel.(KENAK, 2010)

Tables 9 and 10 present the minimum requirements boilers and heating systems have to comply with.

Table 9: Limits within which boilers are allowed to emit in cases of new installations**(KENAK, 2010)**.

Factor	Liquid fuels		Fuel gases
	Nominal thermal power ≥ 400kW	Nominal thermal power < 400 kW	All installations disregarding power
Maximum allowable heat loss, with emissions in %	12	14	10
Maximum allowable carbon oxide (CO) content in emissions, in ppm	60	60	60
Maximum allowable amount of nitrogen oxides (NOx) content in emissions, in ppm	75	75	60
Maximum allowable value of soot index, in Bacharach	1	1	0
Minimum allowable emissions temperature, in ◦C	160	160	160
Maximum allowable emissions temperature, in ◦C	250	280	250
Minimum allowable carbon dioxide (CO_2) content in emissions, in %	11	10	LPG 11 Natural gas 9

Table 10: Limits within which boilers are allowed to emit in cases of existinginstallations**(KENAK, 2010)**.

Factor	Liquid fuels		Fuel gases
	Nominal thermal power ≥ 400kW	Nominal thermal power < 400 kW	All installations disregarding power
Maximum allowable heat loss, with emissions in %	14	15	11
Maximum allowable carbon oxide (CO) content in emissions, in ppm	60	60	60
Maximum allowable amount of nitrogen oxides (NOx) content in emissions, in ppm	80	80	65
Maximum allowable value of soot index, in Bacharach	1	1	0
Minimum allowable emissions temperature, in ◦C	180	180	180
Maximum allowable emissions temperature, in ◦C	280	280	280
Minimum allowable carbon dioxide (CO_2) content in emissions, in %	10	9	LPG 11 Natural gas 9

During the assessment of boilers in both new and existing buildings and boilers aged more than 15 years, their technical characteristics should meet the provisions made when designed as well as the reference system (Tables 9 and 10). Moreover, they should be compared to the type reference boiler. All measurements are recorded in the Energy Audit Form. The energy auditors carry out a report based on the thermal efficiency and the capacity of the boiler in relation to the energy needs of the building. They provide recommendations indicating the way the boiler should be maintained, repaired or even replaced if necessary. (KENAK, 2010)

When the inspection of a boiler takes place,the following information is recorded in the energy audit form(KENAK, 2010):

- General information regarding the building. This includes the utility, the location of the building and the name of the professional responsible for the installation of the heating system.
- The current condition of the boiler using maintenance sheets, fuel invoices and guidelines regarding the boiler's operation.
- The identification of the boiler (fuel type), the purpose for operating such a system and information given by the boiler's manufacturer.
- The identification of the burner and information provided by the manufacturer of the burner.
- The results of the measurements.
- The operational factors of the boiler.
- The operation of automation systems.
- The result of the control over proper operation of the boiler.
- Settings of the boiler.
- Advice given by the inspector for the specific installation.

Regarding the assessment of the entire heating system, the information to be identified is(KENAK, 2010):

- Information about the person who installed the heating systemand about the building such as the location, the utility, the surface covered by the building, etc. Moreover, the characteristics of the heating system are mentioned, for instance the total installed power, the number of boilers, the type of the control system for the production of heat, etc.
- The fuel consumption and the end-use of the produced heat.
- The type of the radiators and the way these are hydraulically connected to each other.
- The control systems.
- The distribution system, the circulators and the parts of the network.
- The type of the boiler and the fuel that is used and the characteristics of the boiler and the burner provided by the manufacturer.

4.1.2 Air-conditioning systems

The specific term refers to every system with cooling or heating effect including all the relevant components that are necessary for the operation of the system. These involve the refrigerant, the air distribution and ventilation system and also the control systems with which the function of air-conditions can be adjusted. Mechanical ventilation systems with no cooling effect and components that are used only for providing heat are excluded. (KENAK, 2010)

The energy auditors proceed to the inspection of air-conditioners whose effective nominal rated power is higher than 12kW.The assessment is repeated every five years. For new or renovated buildings the assessment is conducted after the construction is completed whilst, for existing installations the inspection is realized five years after the system was installed or five years after it was last inspected. In both cases, a report is conducted indicating the efficiency and the capacity of the system in relation to the energy needs of the building. All the characteristics of the system and the measurements that are made are recorded in the energy audit form and they are compared to the model system.Guidelines and certain advice regarding the maintenance of the system and opportunities for improvement are also given in this form. Such recommendations include measures for reducing the cooling load and for improving its maintenance and also the replacement of parts of the system, or even the entire system, in case it does not operate properly.(KENAK, 2010)

Table 11presents the minimum values the energy efficiency ratio (EER) and the coefficient of performance (COP) must have. These standards place the system in class B of the energy categories.

Table 11: Minimum efficiency for air-conditioning systems**(KENAK, 2010)**.

Air-conditioning systems	**EER**	**COP**
Air cooled air-conditioning split &multisplit units	> 3.00	> 3.40
Air cooled air-conditioning package units	> 2.80	> 3.20
Water cooled air-conditioning split &multisplit units	> 3.30	> 3.70
Water cooled air-conditioning package units	> 4.10	> 4.40
Air cooled chillers	≥ 2.9	≥ 3.0
Air cooled / water heat pumps for infloor heating / cooling	≥ 3.65	≥ 3.9
Water cooled chillers	≥ 4.65	≥ 4.15
Water cooled / water heat pumps for infoor heating / cooling	≥ 4.9	≥ 4.25
Water cooled chillers with outside (or distant) condenser	≥ 3.4	

As a first step, the inspector has to collect certain information from the owner of the building in order to be able to proceed with the assessment. This information concerns(KENAK, 2010):

- A detailed list including all the installed systems with a total cooling power higher than 12 kW.
- A description of the control system.
- A description of the systems which controls the temperature.

- A description of the method with which the operational time is controlled.
- The maintenance sheets of the cooling systems including fixings that have been made on the heat exchangers and also controls and changes that have been made on the refrigerant.
- The maintenance sheets of the air inlets systems including fixings of the filters and the heat exchangers.
- Documents which show the calibration work and the maintenance that have been made on the automation and control systems as well as the sensors of the building.
- Additional systems of air supply and discharge.
- Estimation of the cooling load each system was designed to provide. If something like this is not available, then the capacity of the rooms to be cooled and the equipment used for this reason should be mentioned.
- Energy consumption meters, values that have been set for consumption and documents which show how much energy has been consumed and comparisons between the actual consumption and the energy that was foreseen to be consumed.
- Documents regarding various issues or complaints that may have been made concerning the indoor comfort of the building.
- Where a BMS is used, the inspector should be provided with a technical description of the system.
- When a monitoring system exists, a report covering the parameters to be checked and a report which states the efficiency of the equipment covering all the years of operation, should be available.

During the inspection the energy auditor uses the air-conditioning system maintenance sheet to gather information regarding the characteristics of the system or takes some measurements himself. In case such a maintenance sheet does not exist then the owner shall contact the maintainer. The following aspects should be taken into account to ensure that the energy efficiency of the system is evaluated correctly(KENAK, 2010):

- The system was installed according to the initial design and relevant modifications, the real requirements and the current condition of the building.
- The correct operation of the system.
- The operation and settings of the various control systems.
- The operation and application of the various components.
- The power input and output.

Finally, in Greece when referring to an air-conditioning system both air-condition and ventilation is taken into consideration. This happens because the ventilation system is considered to be part of the air-conditioning system. For this reason, the two systems undergo an energy audit together. Thus, all information given for air-conditionings has the same application on ventilation systems as well.

4.2 United Kingdom

4.2.1 Boilers / Air-conditioning systems

England and Wales

Inspection of boilers is not mandatory. Contrary to air-conditioning inspections, the UK has decided to make provisions of advice on boiler efficiency.

An inspection of an air-conditioning system is required when the effective rated output is higher than 12kW. The energy assessment shall be repeated every five years. If the system comprises smaller units, each of them less than 12kW, an inspection is still necessary as long as the total power output is more than 12kW. (Improving the energy efficiency of our buildings; A guide to air-conditioning inspections for buildings, 2012)

The definition of an air-conditioning system involves all the components it is composed of in order to provide a good quality of air, the temperature of which and also the ventilation, humidity and air cleanliness can be controlled. The components whose only purpose of existence is to provide heating or mechanical cooling are not taken into account. Inspections are also carried out on air-conditioning systems that provide refrigeration for process applications, such as server rooms. (Improving the energy efficiency of our buildings; A guide to air-conditioning inspections for buildings, 2012)

The assessment of the air-conditioning systems involves the refrigeration and air moving equipment as well as their controls. Any available documentation that provides more insight on the way the system operates, its condition and maintenance, is also used. In case there is limited access to the equipment forinstance, if it is placed on rooftops, or if inspection is requiredon specific components such as fan coil units or the interior of air ducts, then the presence of the building manager or maintenance agent is necessary to ensure a safe access to the system. After the inspection the energy assessor carries out a report about the results of the assessment indicating the current condition of the system and provides recommendations to improve its performance. In summary, such a report may contain(Improving the energy efficiency of our buildings; A guide to air-conditioning inspections for buildings, 2012):

- The efficiency of the system and measures of improvement.
- Any defects that were found and ways to be rectified.
- Whether the maintenance of the system is sufficient and advice to meliorate it.
- The sufficiency of the control systems and control settings and suggestions for improvement.
- The size of the system, whether this is suitable for the cooling load and advice on possible ways to improve it or on whether the entire equipment or parts of it should be replaced.

The cooling demand varies from building to building as there is a dependence on factors such as the fabric, location and the way the building is oriented towards the sun, the activities taking place within it and the number of people occupying it. Given that the technology develops with time, it is expected the older systems to have higher rated output for a given area. Typical values for installed capacity in offices and shops for various cases are shown in Table12. For a larger office building of, for example, a total floor area of 2,000 m^2, the capacity of its central cooling system could be 250 kW. The cooling demand is likely to exceed the 250 kW when the space to be cooled, although having a smaller floor area, is occupied by a large number of people. Such rooms can be meeting rooms, for example, council chambers. (Department for Communities and Local Government, Improving the energy efficiency of our buildings; A guide to air-conditioning inspections for buildings, 2012)

Table 12: Installed capacity in offices and shops (Improving the energy efficiency of our buildings; A guide to air-conditioning inspections for buildings, 2012).

Activity	**Likely area requiring 12kW of cooling (in m^2)**
Air-conditioning general office spaces Assuming typical levels of electrical equipment and 8-10m^2 per person	200
Air-conditioned offices with high levels of IT electrical equipment	100
Office, call center or dealing floors with high occupation densities of 6m^2 or similar and high levels of IT, communication or lighting loads may well fall within the scope at smaller areas.	
Retail spaces with average levels of display lighting	250
Retail spaces with high levels of display lighting and illuminated cabinets	150

Scotland

The implementation of inspections of air-conditioning systems began after 1 May 2007 for all new systems under a building warrant application that was submitted after the aforementioned date. Systems in this category with an effective rated output of more than 12 kW have to be inspected five years after its installment. As far as existing systems is concerned, whose effective output is rated more than 250 kW, the inspections started on 4 January 2009 until 4 January 2011 when inspections on systems of more than 12 kW commenced,with first inspections fulfilled by 4 January 2013.The efficiency and the size of the building are to be assessed and they are compared to the energy needs of the building. Existing systems that are not well maintained and have low efficiency should be inspected at least every three years while, those that are very efficient and undergo a proper maintenance are assessed every five years.More specifically, inspections are carried out more frequently than five years when(Inspection of Air Conditioning Systems over 12kW, 2012):

- the system is inefficient,
- the size of the system is much larger than what is necessary to cover the cooling requirements of the building,
- there is evidence that the design of the system is not appropriate for the purpose it is being used.
- there is evidence that the system was not properly installed,
- the maintenance is not adequate,
- the control system is not adjusted,
- the system is old.

The experts who have the right to perform inspections on air-conditionings have to beaccredited and be members of an organization with which the Scottish Government has entered into protocol.

Inspectors who do not meet this requirement have no legal rights to proceed to energy inspections. There are five professional organizations / institutions with which the Government has entered into a protocol agreement to undertake inspections(Inspection of Air Conditioning Systems over 12kW, 2012):

- Sterling Accreditation Limited
- BESCA (Building Engineering Services Competence Accreditation Ltd)
- CIBSE (The Chartered Institution of Building Services Engineers)
- STROMA
- BRE (Building Research Establishment)
- ECMK
- QUIDOS

Northern Ireland

Similarly to England and Wales, inspection of air-conditioning systems of effective rated output higher than 12 kW is carried out every five years. In cases where systems have not been inspected or there is no copy of the inspection report available then a Penalty Charge Notice may be issued as this report is a proof of evidence that you comfort to the EPB Regulations. If the person who controls the technical functioning and operation of the system changes, then the inspection report has to be handed over to the new person in charge. If such a report does not exist, a period of three months is given to proceed to a new inspection. (Department of Finance and Personnel, 2008)

In general, Northern Ireland follows the same pattern as England and Wales on the inspection of air-conditioning systems. In brief, the equipment, the air movement systems and the controls are to be checked and the inspector needs to have a safe access to plant rooms and rooftops if the equipment is placed there. (Department of Finance and Personnel, 2008)

To become an inspector of air-conditioning systems, experts have to be members of an accreditation scheme approved by the Government. The content of the inspection report and other information regarding air-cooled systems are the same as in England and Wales.(Department of Finance and Personnel, 2008)

4.3 Comparative Assessment of Boilers/Air-conditionings

In section 4.1.1 the inspection of boilers and heating systems in Greece is studied. No such section was included for the United Kingdom as the respective inspections are not mandatory there. In sections 4.1.2 and 4.2.1 the way air-conditioning systems are inspected was investigated. The similarities and differences between the two countries concerning this section are presented below:

Similarities

- The same definition of an air-conditioning system is used in the two countries and the same parts of it are to be inspected.

- In both countries, an air-conditioning inspection is necessary when the effective rated output is higher than 12kW and the inspection is repeated every five years.
- In both cases, a recommendation report is provided together with the certification which includes advice of maintenance and measures for improvement.

Differences

- In Greece inspections of boilers/heating systems is mandatory whereas in the United Kingdom provisions of advice is provided by the Government.
- The minimum standards (EER, COP) for the air-conditioning in Greece set the system in class B while, this is not clear for the United Kingdom due to lack of information.

5 ENERGY AUDITORS

5.1 Greece

All the energy assessors must be registered in the National Registry for Energy Expertsand they must have in their possession the necessary license to conduct energy assessments. This license is provided to them by the Minister of Environment, Energy and Climate Change. When these two requirements are met the expert gains the right to perform inspections. Moreover, regarding the requisite qualifications, the experts wishing to become energy auditors have to(Energy Auditors of Buildings, Boilers, Heating Installations and Air-conditioning installations, 2010):

- Be engineers and architects who are members of the Hellenic Technical Chamber, Graduate Engineers of Technological Educationand graduates of Technical University or a Polytechnic School who got their diploma in Greece or an equivalent degree obtained abroad.
- Have attended the necessary training for their specialization.
- Have successfully passed the relevant examinations.
- Provide evidence that they have professional or scientific experience of at least four years on supervision or construction or energy planning of buildings or of electro / mechanical installations.

In case of a master's degree acquisition which content is relevant to building, boilers, heating and air-conditioning systems, the years spent on these studies are counted as years of professional experience. Regarding the energy auditors who have acquired their certification in one of the Member States of the European Union, they have the right to be registered in the Energy Auditors Registry and to be provided with the respective license to perform energy audits as well.(Energy Auditors of Buildings, Boilers, Heating Installations and Air-conditioning installations, 2010)

The National Registry for Energy Experts is an electronic database where all legally certified inspectors are registered under a certain identification number. The Building Inspection Fileis another electronic database used by the energy auditors. All EPCs, the Energy Audit Forms and the reports conducted after the inspection of boilers and heating and air-conditioning systems are registered there. These two databases are under the control of the Hellenic Energy

Inspectorate.(Energy Auditors of Buildings, Boilers, Heating Installations and Air-conditioning installations, 2010)

Experts in order to become energy auditors have to undertake training courses which last for 120 hours. The whole procedure is held by the Hellenic Technical Chamber. Other academic institutions can perform such training courses as long as these are in accordance with the program set by the Technical Chamber.(Energy Auditors of Buildings, Boilers, Heating Installations and Air-conditioning installations, 2010)

There are three categories of experts(Energy Auditors of Buildings, Boilers, Heating Installations and Air-conditioning installations, 2010):

1. for building inspections for which the required training lasts for 60 hours,
2. for boilers and heating systems inspections for which 30 hours of training are necessary and
3. for air-conditioning inspections the training for which is 30 hours.

A practical training is also part of the procedure to acquire a legal license. This should have duration not less than 30% of the respective three categories. When these courses are completed examinations take place. Two classes of licenses are also distinguished according to the experts' academic background(Energy Auditors of Buildings, Boilers, Heating Installations and Air-conditioning installations, 2010):

1. Class A. This license is provided to experts who are Graduate Engineers of Technological Education and also to energy auditors who have been certified in a country of the European Union and whose certificationhas been recognized in Greece. The experts have the authorization to carry out assessments and produce EPCs for buildings where the capacity of the systems for heating and air-conditioning is lower than 100kW.
2. Class B. The experts must have a diploma in Engineering and be members of the Hellenic Technical Chamber. Energy auditors who have obtained their certification abroad and it has been recognized by a special authority in Greece are also included. These expertsare licensed to conduct energy audits covering all three abovementioned categories, to all buildings no matter the size of the systems being used.

Licenses of class A can be upgraded to class B by an advisory committee when inspectors have carried on that occupation for at least four years. All types of licenses have an issue of ten years. After this, they have the right to renew their certificate only if they have been practicing the profession of energy auditors during these ten years.(Energy Auditors of Buildings, Boilers, Heating Installations and Air-conditioning installations, 2010)

The penalties that the energy auditors undergo forinspections and EPCs that are of poor qualitydepend on the severity of the error for instance, recording incorrect data and inaccurate information on the EPCs and the reports on boilers and air-conditioners. Such penalties can be fines of 500€ - 20,000€ depending on the mistake or temporary (one to three years) and even permanent suspension of their qualification for repeated mistakes and mistakes of high importance.(Energy Auditors of Buildings, Boilers, Heating Installations and Air-conditioning installations, 2010)

In order to boost the beginning of the procedure for the certification of buildings a Provisional Body of Experts was erected for a period of time of eight months. The members of this Body have the permission to perform inspections and their certificate had an issue of twelve months at most. The provisional inspectors wishing to follow this career after their temporary license has expired, they should renew it by attending the necessary courses and successfully pass the exams. The provisional experts should be engineers or architects and should have at least 10 years of experience. They were registered in a provisional registry without any training or examinations but up to the end of 2011 they should had gone through training courses and exams.(Energy Auditors of Buildings, Boilers, Heating Installations and Air-conditioning installations, 2010)

As far as the payment of the energy auditors is concerned, there is no standard tariff. This makes the market more competitive(National Gazette 177, 2010):

5.2 United Kingdom

England and Wales

There are two ways in which someone may be considered for an Energy Accreditation Scheme(Department for Communities and Local Government, Energy Assessors; Accreditation of prior experiencial learning (APEL) framework, 2008):

- After succeeding in being both qualified on approved EPBD-related National Occupational Standards and the National Qualifications Framework (NQF)
- Through Accreditation of Prior Experiential Learning (APEL)

The latter has been formed and evolved by taking into consideration the existing requirements and needs of the energy assessors who are already working in the market place. Moreover, Accreditation Schemes are responsible for the way this Framework is made for use, paying attention on each individual application. This Framework determines(Energy Assessors; Accreditation of prior experiencial learning (APEL) framework, 2008):

- The basic principles to be followed throughout the way
- The criteria based on which the applications will be examined
- The necessary procedure needed for the application

To continue with, within the Framework there are plenty of annexes with templates that cover different cases. More specifically(Energy Assessors; Accreditation of prior experiencial learning (APEL) framework, 2008):

- Annex 1: Domestic Energy Assessors
- Annex 2: On Construction Domestic Energy Assessors

- Annex 3: Operational Rating Energy Assessors
- Annex 4: Non-Domestic Energy Assessors, Levels 3,4 and 5
- Annex 5: Air Conditioning Systems Inspectors (in case of Air Conditioning Inspectors, the APEL arrangements could differentiate a little compared to the other strands)

Firstly, an APEL candidate is not required to be qualified as an energy assessor by the Government as to start the accreditation process. However, the candidate regardless the strand for which they apply it is prerequisite that certain performance, knowledge and understating standards are reached. Also, according to the apprentice with the relevant strand of energy assessment, the candidate is allowed to take certain amount of top-up training over specific elements of the National Occupational Standards (NOS).

In order to ensure that only capable candidates follow the procedure after being admitted, the accreditation schemes are required to maintain a high level of judgment.

After having achieved the accreditation, the Energy Assessors have the ability of trying for a membership in one or more alternative schemes. However, the decision is determined by the “receiving” Scheme which sets the standards over the future performance of their accredited assessors.

The training required for acquiring the accreditation does not stop once the candidate fulfills the route successfully. On the contrary, all Energy Assessors are obliged to participate in Lifelong Learning (CPD, Continuing Professional Development). Individual and specific accreditation schemes will set the requirements for every Energy Assessor concerning CPD. Lifelong Learning is developed in accordance with important updates or revisions to the Energy Performance of Building Directive, as well as other important topics that may come up.

In order to acquire accreditation via APEL, all candidates are required to(Energy Assessors; Accreditation of prior experiencial learning (APEL) framework, 2008):

1. Demonstrate high competence in using the procedure concerning the provision of Energy Performance Certificates, energy reports or even Display Energy Certificates specifically for the strand they are interested in.
2. Achieve maximum of what is required in Performance Criteria, Knowledge and Understanding as determined in the respective NOS

For certain parts of APEL Route, the candidate is given the ability of claiming some professional body memberships or other qualifications. This ability is realized only with the support of Communities and Local Government.

The candidates must have a combination of experience, knowledge and skills that show acquired competence in all of the NOS concerning the strand on which they aim to get the accreditation for. Also, the schemes offer the ability of letting the candidate to have a good idea of what the chances are in succeeding to get the accreditation via APEL even before completing the full application.

It must be mentioned that before acquiring the accreditation, the candidates may not be free to present evidence of the way EPCs, DECs, relevant recommendations and energy reports are made. For this reason, top-up training is realized as to cover certain pre-determined elements of the NOS. These elements can be found in the appendices for the respective strand of the energy assessment.

Some certain rules to be followed are(Energy Assessors; Accreditation of prior experiencial learning (APEL) framework, 2008):

- If a candidate has evidence of possessing all the required skills and knowledge by the NOS concerning the field of Building Services, then he or she will be given the ability of moving forward to top-up training in Building construction and pathology. This procedure can work likewise
- Candidates that are not considered fully competent in both Building Services and Building construction and pathology, cannot be accredited via APEL.
- In order to comply with the NOS, the candidates must give evidence of minimum two years' experience over the last five years, related to field of energy assessment targeting for the accreditation .Moreover, a member of a relevant professional body who has had at least for two years a good knowledge of the applicant's capacity, must confirm this experience.
- It is obligatory for the candidate to present record of Lifelong Learning, much preferably acquired over the last two years. Other Lifelong Learning of similar nature should be submitted too.

As far as the procedure of applying for APEL is concerned there are certain steps that need to be followed(Energy Assessors; Accreditation of prior experiencial learning (APEL) framework, 2008):

Firstly, all applicants must:

- Submit an APEL application form completing all required information
- Submit acquired Qualification certificates (if relevant)
- Submit the APEL template concerning the strand for which they aim for accreditation, presenting that all minimum requirements for all of the NOS where top-up training is not allowable have been met and stating the intention to undertake top-up training where this is possible and necessary

In this stage, the Accreditation Scheme via an APEL Assessor examines all the documentation and determines whether it is acceptable and relevant which parts of the NOS. In this case, the candidate will be given partial APEL and invitation to top-up training.

On a second phase, the applicants must then continue in order to realize the top-up training as stated on the Template for the strand for which they are interested to get the accreditation. Any provider may be responsible for this training but Accreditation Schemes are free of making any recommendations.

The following step is prerequisite to continuing to accreditation.

In this stage of the process, all candidates will be asked to present evidence that top-up training has been fulfilled as to submit the following(Energy Assessors; Accreditation of prior experiencial learning (APEL) framework, 2008):

- For level 3 accreditations: three completed EPCs accompanied with recommendations on cost - effectiveness, as well as energy reports concerning air conditioning assessors or DECs followed by an advisory report in compliance with the requirements for energy certificates of the relevant strand. Moreover, a maximum of two may be created according to the basis of stimulated data.
- For level 4 and 5 accreditations there are two possible options: 1) Five completed EPCs followed by cost-effective recommendations, of which a maximum of three can be on the basis of stimulated data. 2) Three full EPCs with cost-effective recommendations followed by proof of satisfactory completion of a test. For the second case, the scheme must make sure that both the EPCs and the assessment cover a cross-section of property types and sizes. Also, only one EPC can be on the basis of stimulated data.

The APEL Assessor has to check and assess all the above documentation and it then gets quality assured by the Accreditation Scheme. At this point, the documents cannot be lodged with Landmark due to the fact that the energy assessors haven't got accredited yet.

Finally, based on the fact that the EPCs, DECs or air conditioning reports meet the standards of the Accrediting Body, the Assessors will be considered accredited. As a result, he or she is allowed to prepare energy assessments subject to the usual QA requirement of their Accrediting Body.

In the case that not all the assessments meet the QA standards of the Accrediting Body, the APEL Assessor suggests further top-up training.

The assessment of applications is realized based on the criteria set out on the above paragraphs. Accreditation schemes have the liberty of determining their own methodology of making the assessment of the applications. However, the people responsible for that should own themselves the title of APEL Assessor as defined below.

The manner of assessment of the applications is as follows(Energy Assessors; Accreditation of prior experiencial learning (APEL) framework, 2008):

By a representative coming from the Accreditation Scheme

1) All the relevant documents have been submitted
2) Proof that all requirements are met concerning the criteria stated on the previous paragraphs as well as on the relevant Annex
3) The APEL Assessors has chosen the appropriate way to approach the assessment

By the APEL Assessor

1) The applicant must meet the requirements for APEL as set even from the beginning

2) The candidate has carried through top-up training and has provided competently fulfilled energy assessments over the relevant strand.

APEL Assessors are chosen by Accreditation Schemes and they must comply with the following requirements(Energy Assessors; Accreditation of prior experiencial learning (APEL) framework, 2008):

1) Their working experience over the field of energy assessment, as an APEL Assessor, should be at least three years

2) Be qualified, have a certificate or have passed an approved test concerning the methodology and software needed for the relevant energy assessment

3) Have an in depth and extended knowledge of the relevant National Occupational Standards. This fact must become obvious to the satisfaction of Accreditation Scheme.

4) Present evidence that organized Continuing Professional Development/Lifelong Learning activities have been realized consistently over the last two years concerning energy assessment and building energy performance

5) Have attended a workshop taken place by the Communities and Local Government or by an APEL Assessor who has done the above himself/herself. In this way, it will become clear that apart from the technical skills, the Assessors own the ability of judging in a consistent and valid manner. Furthermore, if external QA monitors judge that a current accreditation scheme lacks proper and consistent judging on APEL applications, then the APEL Assessor must undergo further training.

6) Finally, all names must be included on list of APEL Assessors created by their accreditation scheme. As a result, in case of inspection, this list can be found on Communities and Local Government or their appointed representatives.

Scotland

In Scotland all inspectors must be members of a professional body that is approved by the state and with which the government has entered into a protocol agreement. It is these bodies' jurisdiction to secure that their experts are well trained and capable to produce certificates of good quality.

Northern Ireland

The procedure to become an energy assessor in Northern Ireland is similar to that in England and Wales. Accreditation Schemes approved by the Secretary of State in England and Wales are responsible for ensuring that the energy assessors have all the qualifications and technical skills required to produce EPCs. The same Accreditation Schemes have been approved by the Minister for Finance and Personnel in Northern Ireland. In case of individual experts they need to have a qualification in energy inspection recognized by the Qualifications and Curriculum Agency or approved prior experience and learning that meet the National Occupational Standard requirements. The accredited expert can then proceed to the certification of buildings and the production of recommendation reports which together with the EPC has to be handed over to the owner of the building after they have been entered on the national register.(Air-conditioning inspections, 2013)

5.3 Comparative Assessment of Energy Auditors

In sections 5.1 and 5.2 the procedure followed to become an energy assessor was studied. More specifically, it was found that:

Similarities

- In both cases, the experts are categorizedaccording to the type of inspections they can perform (such as domestic, non-domestic buildings, boilers/air-conditioning systems).
- The experts have to successfully have passed an approved test in all cases.
- The energy auditors have to be members of a professional body approved by the respective Government.
- A national registry exists in both countries where energy auditors are registered.

Differences

- An energy auditor, who obtained their diploma in a country within the EU, can perform inspections in Greece when their diploma and qualifications have been approved by a certain authority. It is not very clear whether the same policy exists in the United Kingdom as well.
- In Greece, an energy auditor has to be an engineer or an architect whereas, in the United Kingdom there is no such a limitation as long as the expert can prove that they cover the required knowledge.

6 IDENTIFICATION OF BARRIERS TO ISSUE EPCs

In chapters 3, 4 and 5 the main differences between the different countries are presented. At this point of the study the barriers that are met throughout the certification of buildings are identified by carrying out a SWOT analysis the outcome of which is summarized in Figure 15 and Figure 16. It can be seen that even though the number and type of threats and weaknesses is almost the same in the two cases, the strengths of the EPCs in the United Kingdom seem to outweigh the disadvantages and render this country more effective as to the way they implement the EPCs.

To begin with, the first barrier that was found lies within the regulations. More specifically, the recommendation reports contained only advice of measures that can be taken to improve the energy efficiency of the building. The owners are not legally bound to implement these measures. For this reason, people will act mainly when an important deficiency requires immediate rectification or the recommended measures are cost effective.

SWOT Analysis for Greece

Strengths
- Calculation methodology
- Recommendation reports
- Nine energy classes
- Energy Saving at Home

Weaknesses
- Non mandatory recommendations
- No strict penalties

Opportunities
- Incentives to invest

Threats
- Lack of knowledge of energy auditors
- Lack of information provided by EPCs
- Small range of professionals have the right to become an energy auditor

Figure 15: A SWOT analysis done for the case of Greece.

In turn, the barrier that was found to intercept the audits concerns the penalties that are given when a building is not certified. In Greece, there is an exemption concerning the non-mandatory measures that are recommended. This lies in cases where a new building is classified below class B.The owner is then forced to take all measures to upgrade it. The inspection is repeated one year later to check whether the owner has conformed to the recommendations and the building should then be classified at least in classB. This is not applied on the existing buildings. In the United Kingdom such a regulation was not found. Furthermore, the distinction between domestic and non-domestic buildings in Greece is not realized as in the UK. The form of the EPC is the same no matter the building type. Nevertheless, a distinction into new and existing buildings is taken into account when it comes to the calculation of the energy performance. Additionally, in the United Kingdom, the inspection of boilers is not mandatory but provisions of advice are made on the efficiency.

Regarding the certification of buildings, as mentioned before, EPCs are accompanied by recommendations for improvement of the energy efficiency of the building. Nevertheless, they do not contain information about the various sources where additional advice on various options of improvements can be found and the way these can be implemented. This discourages people from being motivated as they do not wish to lose time with searching for alternatives. Furthermore, the asset rating is done in a different way in the two countries under investigation. For this reason, it is difficult to conclude to whether a building that would be class A in Greece, it would be classified in the same way in the United Kingdom. Nevertheless, more accurate calculations seem to follow the British EPC and this renders the EPC more effective in this country.

SWOT Analysis for UK

Strengths
- Calculation methodology
- Recommendation reports
- Distinction between domestic/ non-domestic buildings
- EI rating is included
- DECs are issued (not in Scotland)
- Green Deal

Weaknesses
- Non mandatory recommendations
- No strict penalties
- Inspection of boilers is advised

Opportunities
- Incentives to invest
- Wider range on the background of experts is approved

Threats
- Lack of knowledge of energy auditors
- Lack of information provided by EPCs

Figure 16:A SWOT analysis done for the case of UK.

7 DISCUSSION

The present research dealt with the issue of EPCs. There may be a proportion of people that would simply ask why we need to produce EPCs. Is their existence really necessary? People, who wish to take measures for energy savings and thus, savings in monetary terms, will proceed to such a procedure anyway. The fact is that the majority of people are not able to estimate the amount of energy that can be saved when the appropriate measures are taken and therefore, the amount of the expenses needed to reach a comfort level that can be avoided. Furthermore, they are not aware of the damage that is caused to the environment due to the poor energy performance of their properties. Consequently, by introducing the EPCs, the society gets informed about the necessity of such certificates and, thus, about the fact that they can increase the energy efficiency of their buildings by just implementing some certain measures.

In turn, some people would argue the fact that the problem regarding the energy performance of buildings could be solved by imposing taxes to the conventional fuels. In this way, people would switch to alternative sources and would try to find other ways to ensure a good comfort level.Part of this statement is true but the fact is that only a small proportion of people would act rationally as there is a lack of knowledge on this issue. People who can afford paying the taxes would continue using conventional fuels as they do not always find very attractive the idea of paying more at present and benefit from it in the long run. Moreover, those who do not have the financial ability to pay the taxes would try to find cheaper ways which are not always environmentally friendly. For instance, for heating up the indoor space people would first thing of burning wood instead of improving the insulation of the building envelope or buying other technologies that are costly. This is a rather simple, easy and much cheaper way for people to solve their problem regarding heating but on the other hand this could cause a great damage to the environment as the level of CO_2 emissions would increase. For this reason, wiser policy instruments should be used in order to motivate people to enhance the energy performance of their buildings.

8 CONCLUSION

The goal of this research was to investigatethe certification of buildings in Greece and in the United Kingdom in order to evaluate the whole procedure and identify barriers that intercept the proper implementation of EPCs and recommendation reports. The motivation for conducting such a research was the fact that not many relevant studies have been carried out in this subject.

In chapter 3 the procedure for issuing EPCs in the two countries was studied giving in this way an answer in sub-question 1. More specifically, it was found that in Greece the form of the EPC is the same for all types of buildings but the factors taken into account in the calculation of the energy performance differs between new and existing buildings. In the United Kingdom the form of the certification depends on the buildings type (e.g. dwelling, non-dwelling). Furthermore, in England, Wales and Northern Ireland, public buildings with a total floor area higher than $500m^2$ providing public services, shall display a DEC in a prominent place.The labeling of the buildings was found to be different between the two countries. Greek EPCs are based on an asset rating and the labeling consists of nine classes whereas, in the United Kingdom, an environmental impact rating is included in the EPC and seven classes constitute the energy labeling. In all cases a recommendation report is provided to improve the energy efficiency of the building.

In the same chapter the factors to have an influence on the energy performance of buildings that are taken into account during the inspection were presented as detailed as possible in order to answer sub question 2. Such factors are the type of the building and its orientation, the climatic zone within which it is located, the total floor area it covers and the coefficient of thermal conductivity of the structural elements of the building envelope. In particular, the energy performance depends on the combination of these factors and it is not possible to draw a conclusion about the building's labeling when these are treated separately. Additionally, the energy requirements were found to be different for the various building types having different uses.

The energy inspection of boilers, heating systems and air-conditioning systems were treated separatelyin section 4 due to the fact that the Energy Performance of Buildings Directive requires these systems to be assessed separately. It was found that while in Greece the inspection of boilers / heating systems is mandatory, this is not the case in the United Kingdom where only provisions of advice on boiler efficiency is made. Regarding air-conditionings, inspections are performed when the effective rated output is higher than 12kW and they are repeated every five years. A recommendation report accompanies the certification which contains advice on maintenance and measures of improvements. Regarding boilers and heating / air-conditioning systems, the size of the system, that is the effective rated output, the energy efficiency ratio, the coefficient of performance and the size of the space to be heated up or cooled down according to the requirements of the building are taken into consideration while the systems are inspected. At this point the answer of sub-question 2 was completed.

Furthermore, the requirements to be an energy assessor were examined in chapter 5 to ensure that inspections are carried out by suitably qualified experts. It was found that in order to become an energy auditor, experts are required to successfully have passed the necessary exams and be members of a professional body approved by the respective Government. The energy auditors are categorized according to the type and level of inspection they perform and they are registered in a national registry. An expert who obtained their qualification in a country within EU can perform inspections in Greece only if their expertise is approved by anofficial authority and their background and experience comply with the Greek regulations. From the information obtained for the United Kingdom it was not easy to draw a similar conclusion.

In chapter 6 the barriers on the implementation of the EPCs was identified giving in this way an answer in sub-question 3. This was done by conducting a SWOT analysis to present strengths and weaknesses and, thus, barriers of the EPCs. The first barrierthat was met regarding the regulations was the fact that the recommendation reports are not mandatory. As far as the audits are concerned, penalties are not given in all cases. For instance, in Greece no penalty is given for existing buildings that do not display an EPC. Last but not least is the barrier met in the certification of the building. EPCs do not contain information regarding sources where people could find measures for further improvements and the way these can be implemented. In the same section, actions taken by the governments such as providing subsidies and other incentives were checked to detect how people can be motivated to upgrade the energy efficiency of their properties.

8.1 Recommendations

In this part an answer to sub-question 4 is given regarding the actions that should be taken in order to improve the procedure of certification and the effectiveness of the EPCs. To begin with, in both countries, the recommendation reports accompanying the EPC should bind the owners in a way to implement the measures that are necessary for the improvement of the energy performance of their properties. Furthermore, more penalties should be issued when an EPC is not available. At this point, it could be stated that the combination of the two recommendations mentioned above sounds rather strict and irrational. The fact is that by following such a policy people would benefit from it in the long run. For this reason it should not be judged before investigating the impact of such a policy. The majority of the people do not have the necessary knowledge and this is why they need certain guidance and in some cases even stricter measures in order to change their mentality considering that this is to their benefit. As for the energy auditors, to evaluate the entire training and the examinations they undertake, these should be compared to the other Member States.

As far as the United Kingdom is concerned, the methodology used to determine the energy performance of a building does not include the division of the country into climatic zones. More research should be done as to whether this factor can make any difference or not as it occurs in Greece where climatic zones are taken into account. Moreover, the inspection of boilers should become mandatory as set by EU.

To continue with, regarding Greece, an environmental impact rating should be integrated in the certification form as it could stimulate people to follow the recommended measures in order to reduce the negative impact their property has in the environment. In turn, another factor that could be set as a barrier for the implementation of EPCs in Greece is the financial crisis. The income of the citizens have reduced significantly while, their expenses remain the same or even increased. For this reason, improving the energy efficiency of their properties is not one of their priorities. More research could be done regarding this issue to identify whether and to what extent the financial crisis has influenced the implementation of the EPCs.

To sum up, it was found that the two countries under investigation do not follow exactly the same pattern but many differences between them were identified. For this reason, it is quite difficult to draw a conclusion as to which country produces stronger EPCs. A suggestion would be that all Member States should adopt the same system and they should adjust it to their own climate. In this way, a better comparison across the countries is possible to be done and the real barriers that intercept their implementation can be identified.

In conclusion, following the specific steps mentioned above the main research question was possible to be answered. More details about this can be found in chapter 6. Regarding the comparison between the two countries, the analysis showed that almost the same number of barriers was identified which makes it difficult to decide which one manages to implement the EPCs in a more effective way. However, the SWOT analysis showed that the United Kingdom seems to outweigh as more information is provided in the certification form (such as the environmental impact rating) and different forms are produced for different building types (domestic, non-domestic, public buildings). Also, the calculation of the energy performance is done in a more accurate way. The same result was found in the comparative assessment that was carried out.The EPCs that are issued in the United Kingdom are stronger than those in Greece for the same reasons. Furthermore, a decision making analysis such as a multicreteria decision analysis made in combination with several stakeholders from the different countries is advised in order to decide which barriers to tackle first.

APPENDIX A

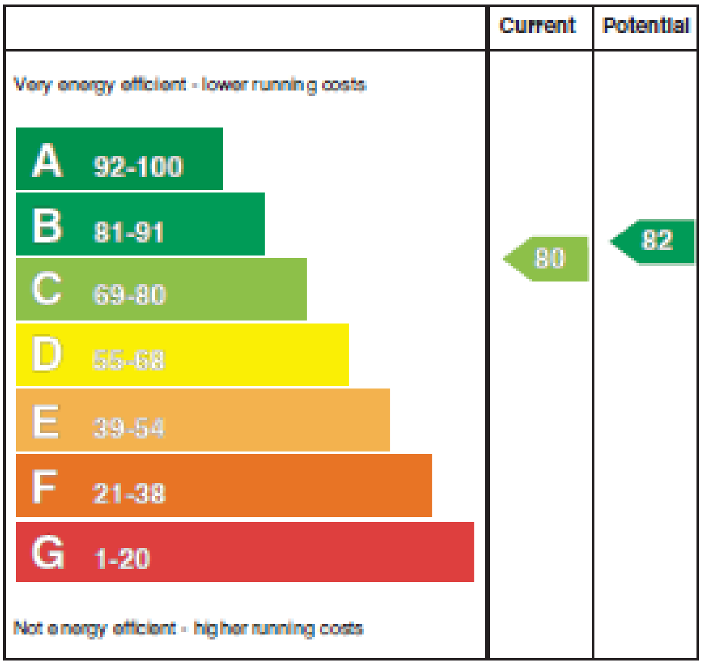
EPC for new dwellings in Northern Ireland:

Energy Performance Certificate — Northern Ireland

3 Main Street
Large Town
BT5 4MN

Date of assessment:	07 November 2008
Date of certificate:	08 November 2008
Reference number:	0000-0000-0000-0000-0000
Accreditation scheme:	ABC Accreditation Ltd
Assessor's name:	John Smith
Assessor's accreditation number:	ABC 12345
Employer/trading name:	EnergyWatch Ltd
Employer/trading address:	Alpha House New Way Belfast BT1 7RF
Related party disclosure:	EnergyWatch are the letting agent

Energy Efficiency Rating



Technical Information

Main heating type and fuel:	Boiler and radiators, mains gas
Total floor area:	135 m²
Approximate energy use:	141 kWh/m² per year
Approximate CO_2 emissions:	23 kg/m² per year
Dwelling type:	Detached house

Benchmarks

Typical new build	80
Average for Northern Ireland	50

The approximate energy use and CO_2 emissions are per square metre of floor area based on fuel costs for the heating, ventilation, hot water and lighting systems. The rating can be compared to two benchmarks: one that would be attained by a typical new dwelling with oil heating constructed to the minimum standards of the building regulations current at the date of the assessment and the second is the average for the housing stock in Northern Ireland.

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EPC for non-dwelling in Northern Ireland:

Energy Performance Certificate
Non-Domestic Building

HM Government

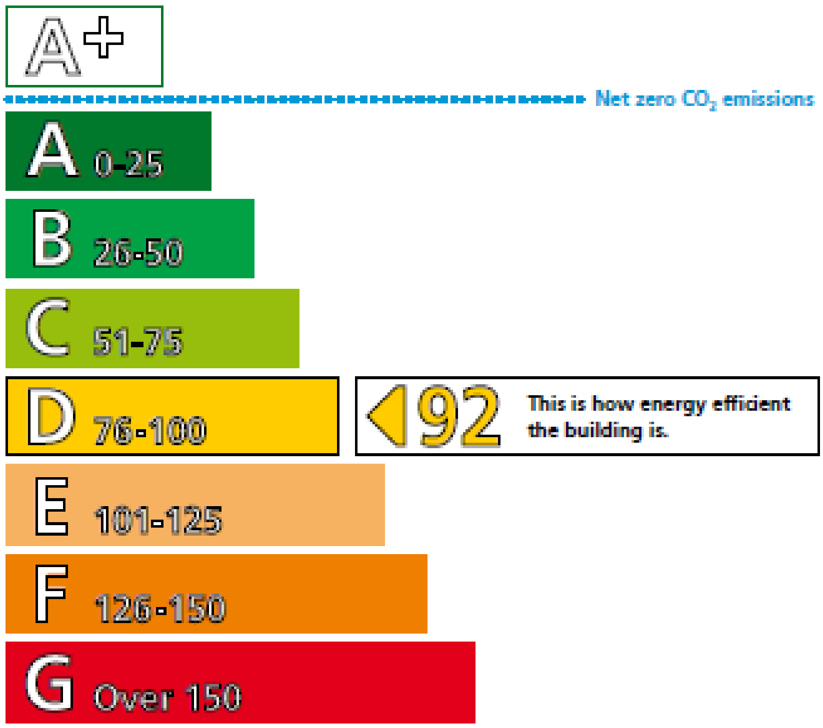
Jubilee House
High Street
Anytown
A1 2CD

Certificate Reference Number:
1234-1234-1234-1234

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one that is newly constructed and one that is indicative of the existing stock. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Asset Rating

More energy efficient



Less energy efficient

Technical information

Main heating fuel:	Gas
Building environment:	Air Conditioned
Total useful floor area (m²):	2927
Building Level:	4

Benchmarks

Buildings similar to this one could have ratings as follows:

58	If newly built
84	If typical of the existing stock

Administrative information

This is an Energy Performance Certificate as defined in SI2007:991 as amended

Assessment Software:	SBEM 2.1a
Property Reference:	891123776612
Assessor Name:	John Smith
Assessor Number:	ABC12345
Accreditation Scheme:	ABC Accreditation Ltd
Employer/Trading Name:	EnergyWatch Ltd
Employer/Trading Address:	Alpha House, New Way, Birmingham, B2 1AA
Issue Date:	08 Dec 2008
Valid Until:	07 Dec 2018

Related Party Disclosure:

Recommendations for improving the property are contained in Report Reference Number 1234-1234-1234-1234

If you have a complaint or wish to confirm that the certificate is genuine

Details of the assessor and the relevant accreditation scheme are on the certificate. You can get contact details of the accreditation scheme from our website at www.communities.gov.uk/epbd, together with details of their procedures for confirming authenticity of a certificate and for making a complaint.

CARBON TRUST
Making business sense of climate change

For advice on how to take action and to find out about technical and financial assistance schemes to help make buildings more energy efficient visit www.carbontrust.co.uk

APPENDIX B

Table 13: Number of EPCs issued per month in Greece **(Statistics of issued Energy Performance Certificates (EPCs), 2013)**.

Month	Number of EPCs issued	Month	Number of EPCs issued
Jan-11	1907	Dec-11	4573
Feb-11	4618	Jan-12	8384
Mar-11	7153	Feb-12	12659
Apr-11	4839	Mar-12	19521
May-11	8346	Apr-12	15649
Jun-11	4908	May-12	19613
Jul-11	5331	Jun-12	17949
Aug-11	2321	Jul-12	20407
Sep-11	4460	Aug-12	14463
Oct-11	3614	Sep-12	15993
Nov-11	4758		

Table 14: Number of EPCs issued per energy class in Greece **(Statistics of issued Energy Performance Certificates (EPCs), 2013)**

Energy Class	Number of EPCs issued
A+	164
A	162
B+	908
B	6822
Γ	34273
Δ	39357
E	31133
Z	27985
H	51641

Table 15: Number of EPCs issued per month in the United Kingdom(**www.epcregister.com**).

Month and Year	Existing dwellings	New dwellings
Jan-12	93617	9661
Feb-12	107110	12664
Mar-12	132413	16635
Apr-12	113949	10355
May-12	136782	14705
Jun-12	113668	13662
Jul-12	130821	11510
Aug-12	108284	11126
Sep-12	112326	11140
Oct-12	114294	12327
Nov-12	95394	13832
Dec-12	58416	8872

APPENDIX C

List of Accreditation Schemes Approved by the UK Government:

Energy Performance Certificates for existing dwellings:

NES - www.nher.co.uk
BRE - www.bre.co.uk/accreditation
Elmhurst – www.elmhurstenergy.co.uk
Northgate - www.northgate-dea.com
Stroma - www.stroma.com
RICS - www.rics.org
ECMK Ltd - www.ecmk.co.uk
Quidos - www.quidos.co.uk
Heating and Ventilation Certificated Associates - www.hicertification.co.uk
Sterling Accreditation - www.sterlingaccreditation.com

New build:

NES - www.nher.co.uk
BRE - www.bre.co.uk/accreditation
CIBSE - www.cibse.org
Elmhurst - www.elmhurstenergy.co.uk
Northgate - www.northgate-dea.com
Stroma - www.stroma.com
RICS - www.rics.org
CIAT - www.ciat.org.uk
ECMK Ltd - www.ecmk.co.uk
Quidos - www.quidos.co.uk
NAPIT - www.napit.org.uk
Heating and Ventilation Certificated Associates www.hicertification.co.uk
Sterling Accreditation - www.sterlingaccreditation.com

Energy Performance Certificates for commercial buildings:

NES - www.nher.co.uk
BRE - www.bre.co.uk/accreditation
CIBSE - www.cibse.org
Elmhurst - www.elmhurstenergy.co.uk
Northgate - www.northgate-dea.com
Stroma - www.stroma.com
RICS - www.rics.org
ECMK Ltd - www.ecmk.co.uk
Quidos - www.quidos.co.uk
BESCA - www.besca.org.uk
NAPIT - www.napit.org.uk

Heating and Ventilation Certificated Associates www.hicertification.co.uk
Sterling Accreditation - www.sterlingaccreditation.com

Display Energy Certificates:

NES - www.nher.co.uk
BRE - www.bre.co.uk/accreditation
CIBSE - www.cibse.org
Elmhurst - www.elmhurstenergy.co.uk
Northgate - www.northgate-dea.com
Stroma - www.stroma.com
RICS - www.rics.org
ECMK Ltd - www.ecmk.co.uk
Quidos - www.quidos.co.uk
BESCA - www.besca.org.uk
NAPIT - www.napit.org.uk
Heating and Ventilation Certificated Associates - www.hicertification.co.uk
Sterling Accreditation - www.sterlingaccreditation.com

Air Conditioning:

CIBSE - www.cibse.org
BESCA - www.besca.org.uk
ECMK Ltd - www.ecmk.co.uk
RICS - www.rics.org
Quidos - www.quidos.co.uk
Heating and Ventilation Certificated Associates - www.hicertification.co.uk
NAPIT - www.napit.org.uk
Sterling Accreditation - www.sterlingaccreditation.com

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