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IENE Working Paper No21

"Greece's Experience in Using EU Structural Funds for Improving the Energy Performance of Buildings"

This paper summarises the findings and conclusions of IENE's Assessment Study on the use of EU Structural Funds for improving the Energy Performance of Buildings in Greece for the period 2009-2014 (IENE Study M13)

Athens, December 2014

The IENE Working Papers

The series of Working Papers published by IENE refer to selected and topical subject areas in the broad energy and environmental domain and are written by specialists in their particular field.

The main objective of the IENE Working Papers is the updating of its members but also of the energy community at large on key energy issues which are of general interest and therefore warrant a much wider public discussion. At the same time the Working Papers are useful to both IENE and the authors as an initial sounding board for the ideas and concepts which they present, prior to their publication in learned journals or as part of the books.

The present Working Paper refers to Greece's experience in utilizing EU funds for improving the energy performance of its building stock. It is based on an exhaustive study undertaken by the IENE during 2012-2014. The contributing authors of this WP are Mr. Costas Theofylaktos and Mr. Costis Stambolis, both partners of IENE.

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Authors: C. Stambolis and C. Theofylaktos

Institute of Energy for SE Europe (IENE)
3, A. Soutsou str, 106 71-Athens, tel.:0030 210-3628457, fax: 0030 210-3646144
web: www.iene.gr, e-mail: info@iene.gr

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Message by the Minister of Environment, Energy and Climate Change Mr. Ioannis Maniatis

Energy saving is a major priority in the national energy strategy since it is a sector displaying an intense growth dimension which harmoniously combines the attempt to enhance the national economy and the protection of the environment.

In Greece, the potential for energy saving is significant with the building sector recording perhaps the biggest dynamic which could be translated into respective investment interest. The upgrading of the country's public buildings in particular is a long-lasting and continuous initiative by the Ministry for the Environment, Energy and Climate Change, not only because of the impeccable character that the public sector must present but mainly for the reduction of the state's energy expenditure.

Numerous invitations and programmes have been issued over recent years for the improvement of the energy performance of residential buildings, hospitals, schools, administrative buildings, etc., with a total budget of around 500 million Euros. These actions concurrently contribute to the promotion of sustainable local development, the improvement of the quality of life of citizens and the creation of new jobs magnifying the added value of these programmes and enhancing the potential of the local economy.

The efforts are continuing with greater intensity through the exploitation of all possible funding sources and providing the motives for the attraction of further investment. At the same time, via information and educational actions the contributory benefits of the improvement of energy efficiency to society, the environment and the economy are now being clear.

A necessary precondition for the achievement of the above target is the coordination and collaboration of the entire administrative mechanism for the implementation of the relevant legislative framework but also, mainly for the consolidation of the appropriate energy conscience.

For this reason we recently initiated the energy auditing of public buildings via Energy Supervisors appointed for every building used by the public and broader public sector, who are responsible for monitoring and the energy consumption of the buildings and check the correct operation and maintenance of heating and cooling systems but also to suggest the necessary interventions for the improvement of energy efficiency and saving.

The great innovation we are introducing is the chance to reward organisations and their Energy Supervisors that will be able to prove the reduction in the energy consumption of their building infrastructures. In this way, the notion of the contributory rewarding of civil servants as a recognition of the positive results they achieve for the public office they work for and, consequently for society is being introduced for the first time. Motives can include financial recompense as a percentage of the overall saving ("green bonus"), honorary leave, free training, award, etc.

We are seeking to achieve an important reduction in the energy costs of the Greek state and, at the same time, return part of this financial saving to the employee who achieved it. International experience has proved that for every Euro of monetary reward towards the handler of the initiative the respective benefits for the public sector is tenfold.

Great emphasis is also being placed on the exploitation of new practice and alternative funding models, such as Energy Service Companies (ESCOs) that will reduce the fiscal burdening of public organisations and the respective investment risk for energy improvement in the public sector. The fact that these investments will be paid off by the energy saving achieved (which can reach up to 40%) makes the operation of the proposed mechanism quite attractive. The aim is the overall increase of available funding via appropriate leveraging of the investment s so that as many public buildings as possible can be upgraded.

The aim of the Ministry for the Environment, Energy and Climate Change is to make the public sector a model for the implementation of modern practices that save energy and resources, secure our energy future and respect the environment.

Athens, December 2014

1.0 Introduction

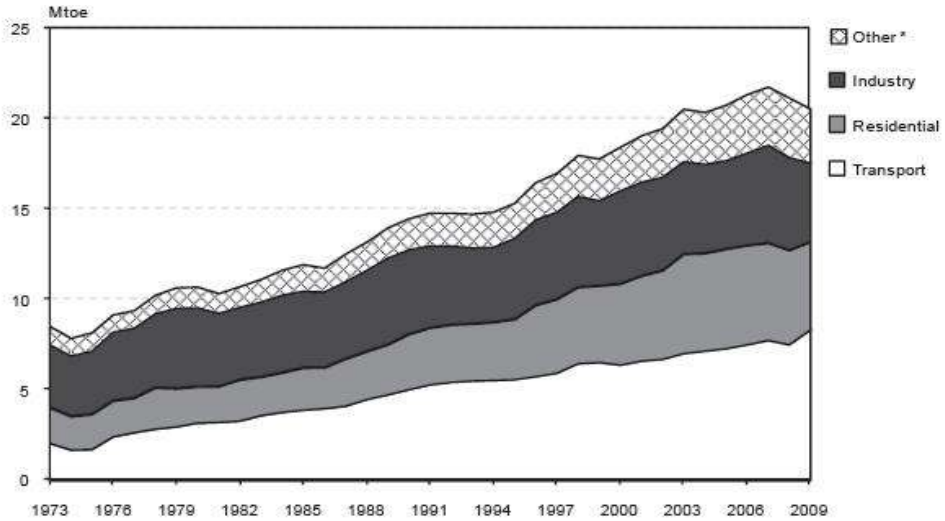
The building sector in Greece corresponds to a significant portion of the country's energy balance, responsible for almost 30% of Final Energy Consumption (TFC). Given EU's drive and ambitious targets of achieving energy savings in the building sector and the problematic nature, in terms of energy performance, of the vast majority of Greece's buildings there is considerable scope in introducing EU funded programmes (mainly using structural funds)with the explicit purpose of improving the energy performance of buildings. The main aim of the present study is to assess the usefulness and impact of these programmes, which were first introduced in 2009 and are still running (end of 2014). The study also considers the potential benefits to the economy of the country from the continuation and large-scale use of such programmes. So far experience has been positive in terms of EU fund absorption, the application of energy efficiency techniques, the overall improvement of energy performance of buildings where EU finds were used and related job creation. The study has also determined that there is wide scope in expanding such EU funded programmes in view of anticipated energy savings and the improvement in living standards and thermal comfort. The setting up and management of these programmes proved effective judging from the high degree of public acceptance, the amount of EU fund transfers, achieved and the actual response from households for participation in the programmes, which were actually subsided in carrying out a pre-approved schedule of work with the explicit aim of improving energy efficiency.

The EU funded energy efficiency improvement programme so far focused on the residential building sector. There is wide scope in attempting to introduce energy saving measures in houses since these correspond to 78% of Greece's 4.3 million building stock. More importantly 75% of these houses were built before 1981 which means that they lack any form of thermal insulation or other energy conservation feature and therefore are suitable for the application of energy efficiency measures, which if integrated properly could substantially improve their energy performance (40%-60%). It should be noted that 1.0% to 2.0% of the building stock, i.e. some 45.000 to 90.000 buildings were constructed annually in Greece, until 2009. After that new building construction was sharply reduced because of the economic crisis, and is currently accounting less than 0.5% annually.

2.0 Greece's energy mix and the role of the building sector

As in most developed economies, the building sector in Greece is responsible for a fair amount of the country's energy demand and consumption. According to latest statistics, Greece's domestic sector, which covers both residential and commercial buildings, accounted to approximate 25% of the country's total final consumption (TFC), which was 20.6 Mtoe in 2009, down 3% from 2008, but 42% higher than in 1990[1]. Figure 1 shows how TFC has developed from 1973 to 2009. Transport took the lion's share of TFC, responsible for around 41%. The services sector, which also covers commercial buildings, consumed some 10% of TFC and agriculture just 5% in 2009. In comparison, the IEA average in the above year was 32% for transport, 20% for residential, 31% for industry and 16% for other sectors. These normally include commercial, public service, agricultural, fishing and other non-specified sectors.

Figure 1: Total final consumption by sector in Greece, 1973 to 2009



* *Other* includes commercial, public service, agricultural, fishing and other non-specified sectors.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Whatever the case is, as far as the exact proportion of energy demand related to the building sector, which obviously is not limited to 25% but is more likely 28%-30% if we take into account public services and commercial establishments, the fact remains that this corresponds to a substantial

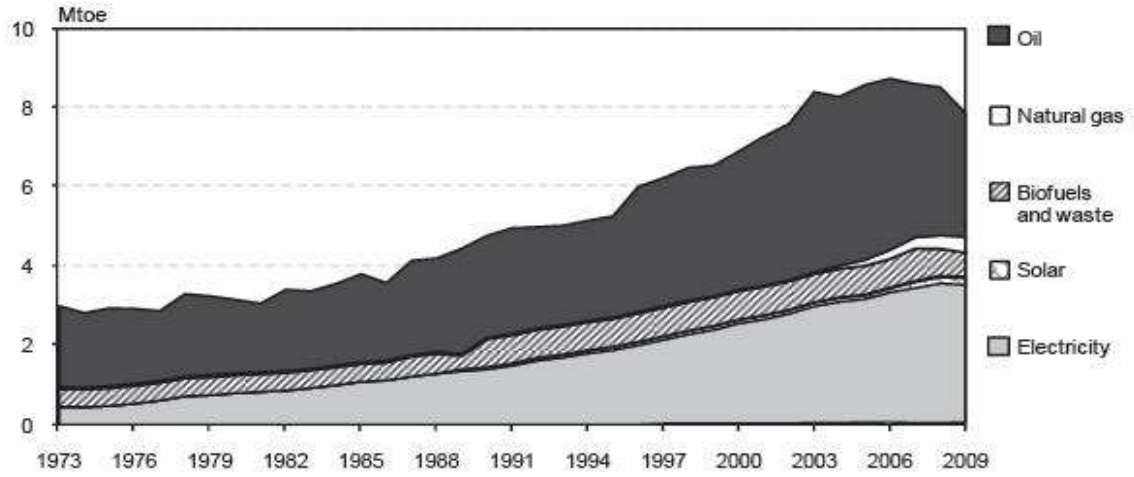
[1] International Energy Agency (IEA), "Energy Policy of IEA Countries: Greece" Review, 2011

amount of national energy consumption. And as such every effort should be made to conserve energy by maximizing energy efficiency measures especially in the building sector.

Energy Intensity

Since 1990, TFC in Greece has increased in all sectors (see Figure 2), driven by strong economic growth to 2008. Reflecting the economic downturn, however, TFC fell from 2008 to 2009 and beyond that. The sectorial breakdown of TFC has changed in a manner typical to developed economies. Industry has seen its share decline from one-third to less than a quarter, while the residential and service sectors have increased their share of the total. The share of transport in TFC has more or less remained stable from 1990 to 2008.

Figure 2: Residential/commercial sector consumption in Greece, 1973-2009

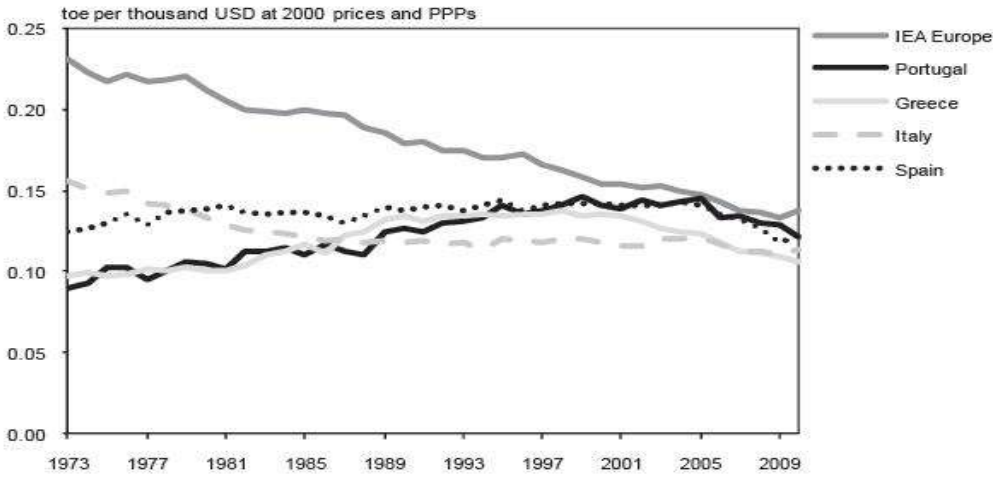


In the projections included in the July 2010 National Renewable Energy Action Plan[2], the government expected gross TFC (including losses in power and heat generation and distribution) to increase by between 7% and 14%, from 2010 to 2020, depending on the pace of economic recovery and the implementation of energy efficiency measures.

[2] National Renewable Energy Action Plan, 2010

According to IEA[3], in 2010, Greece required 0.11 tonnes of oil equivalent (toe) of primaryenergy for each thousand US dollars of gross domestic product (GDP). This is the second-lowest among the IEA member countries, and clearly below the IEA Europe average of 0.14 toe (see Figure 3). The relatively low energy intensity of the Greek economy is explained by the predominance of services and lack of large energy-intensive industry. The heating requirement is also lower than in most IEA member countries. Energy intensity in Greece has improved on average by 1.1% per year from 1990 to 2010, compared with the IEA member country average of 1.3%.

Figure 3: Energy intensity in Greece and other selected IEA member countries, 1973 to 2010



'Estimates for 2010.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2011 and *National Accounts of OECD Countries*, OECD Paris, 2011.

Energy Efficiency of Buildings

Several studies[4] and observations of many years attest to the fact that the average building in Greece, whether single properties or apartments in residential blocks, are well below standard in terms of energy efficiency. A combination of factors including wrong orientation, poor design, lack of or incomplete thermal insulation and external shading make the average

[3] International Energy Agency (IEA), "Energy Policy of IEA Countries: Greece" Review, 2011

[4] See various studies conducted by Centre of Renewable Energy Studies (CRES) between 1997-2003 (www.cres.gr)

habitation space cold in winter and extremely warm during the hot summer months. External appliances used to both heating and cooling, such as heat pumps and air conditioners, are normally oversized or downsized thus contributing to energy losses.

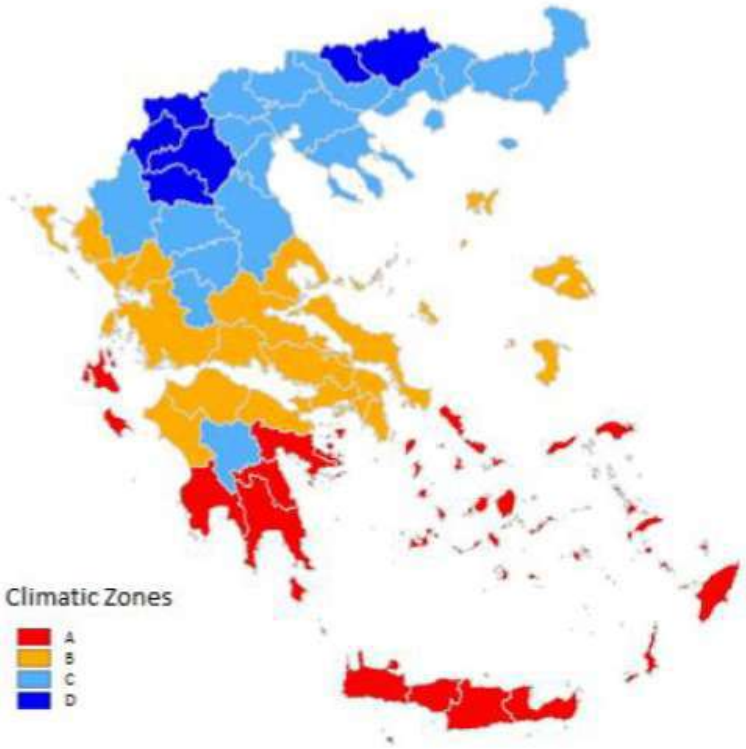
Lately, as we shall see in following chapter, a number of measures have been introduced by the state in order to improve the energy performance of new buildings but also intervene in existing buildings where the scope of improved energy performance is even greater. These measures have not yet started to bear fruits and it will take few more years in order to observe marked improvements in the energy performance of buildings. As part of the overall effort to improve the energy performance in buildings in Greece the various EU backed energy efficiency programmes for buildings, which have been running over the last five years, are extremely useful and well timed and are expected to have a very positive impact for the whole building sector.

3.0 The case for improved energy efficiency in Greece's building sector

Physical Environment – Climate Zones

The Greek territory has been divided into four (4) climate zones, as shown in Figure 4, taking into consideration winter and summer climatic parameters and based on the heating degree-days, HDD. Until then, the climate zones had been defined according to the existing Thermal Insulation Regulation, TIR, described in a later section of this study which was introduced in 1979. The climate zones are crucial in how weather conditions influence the energy behaviour of a building. So, the purpose of the division in different zones is to facilitate the design process of the minimum and maximum capacity of heating and cooling systems individually, in order to cover the extreme seasonal temperatures presented in each different zone.

Figure 4: The climate zones in Greece



It should be added that for each Prefecture, each area that is in an altitude above 500 m falls into the next coming climate zone, according to the above mentioned figure. For climate zone D, all areas fall in this zone.

Laws and regulations for energy efficiency in buildings, up to 2010

Greece has long tradition in enforcing regulations for energy efficiency in building, with the most characteristic one the PD 362/4.7.1979, titled «*Approving regulation for the thermal insulation of buildings-TIR*", which lasted almost unchanged, until the implementation of EPBD, in 2010 (L.3851/10). The Thermal Insulation Regulation required the consultant engineer to achieve low U-values for building's envelope, considering that as smaller the U-value is, less thermal loss exists and better the insulation of the building. The U-value had to be lower than the value that the regulation indicated.

At this point, it is important to note Ministerial Decision No. 21475/4707/1998 signed by the Ministers of Interior, Public Administration and Decentralization, National Economy, Development, Environment - Planning and Public Works, titled "*Reducing carbon dioxide emissions, measures and terms for the improvement of energy efficiency of buildings*", known with the acronym as KOXEE, in conformity with the European Community Directive SAVE 93/76/EE, which was published in the Gazette 880/B on 19.08.1998. The adoption of this joint ministerial decision, where policy measures were included to improve the energy efficiency of buildings and microclimate, marked a very important instant for the country's energy policy, especially as it introduced methods that promoted the rational use of energy resources and the use of renewable energies, improving construction quality, aiming to a sustainable design. Also, the MD provided information to citizens on energy characteristics of the buildings, where they live and work. According to the MD, KOXEE would have replaced the existing thermal insulation regulation and it would have minimized the energy requirements of buildings. Unfortunately, this MD was left inactive for years, despite the fact that European legislation on energy efficiency on buildings evolved, along with the market and the country was lagging on energy efficiency policies for buildings.

In the coming years, and until 2010, the main legislation, in Greece, in the form of Laws, Ministerial Decisions-MD, Presidential Decrees-PD and

Legislative Acts, adopted for introducing energy efficiency and rational use of energy in buildings, are presented in chronological order, as:

- "*Measures to reduce energy consumption in buildings and other provisions*" (L.3661/2008). The main articles of this law, implementing Directive 2002/91/EC in Greece, concern building codes and minimum requirements for energy efficiency in new and existing buildings. More analytically, it introduced buildings energy performance certificate in all existing buildings, energy auditing of the building envelope and inspection of boilers and air condition systems. In addition, this law requires that passive solar systems as well as heating /cooling/electricity production systems, utilizing RES and micro-CHP must be considered in the heating/cooling study, submitted in the licensing procedure of buildings, promoting the installation of small-scaled RES and micro-CHP technologies.

- Decisions 16094/08-04-2008 (OG B917) and 16095/08-04-2008 (OG B925) of the Deputy Minister of Ministry of Environment, Public Works and Urban Planning: These decisions integrate PV systems, in the provisions already applicable for hot-water producing solar collectors.

- "*Measures to improve energy efficiency and energy savings in the public and broader public sector*" (MD 14826/17.6.2008), where the connection with the natural gas network became mandatory.

- Ministerial Decree, MD13068/11.06.2009 (OG 1249/B/2009) defines and facilitates the licensing procedure and framework for the exploitation of geothermal resources for own use, through energy systems (i.e. ground source heat pumps) for space heating cooling and DHW of a building.

The existing legal framework for energy efficiency in buildings, after 2010

- With the MD 5825/9.4.2010, titled "*Adoption of Energy Performance of Buildings Regulation*" the **"***Energy Performance of Buildings Regulation***"** or as it is known, in Greek, asKENAK, stressed out the

obligation for new or refurbished buildings to meet 60% of their needs for hot water through solar thermal systems. For the proper implementation of this regulation, in relation also with domestic RES systems, the Technical Chamber of Greece, TCG, had the obligation to issue a guidebook, as a technical directive, about the technical instructions for "*RES installations in buildings*".

- "*Accelerating the development of Renewable Energy Sources to deal with climate change and other regulations in topics under the authority of YPEKA-MEECC*" (L.3851/2010). The law complemented the existing L.3661/2008, by setting new requirements that stipulate the coverage of 60% of the need of new buildings for hot water by solar thermal systems, after 1st of January 2011. Additionally, all new buildings' construction or major renovation requires, from this time and onwards, a full energy analysis study that including energy conservation and cost/benefit analysis of the utilization of RES, micro-cogeneration, district heating or/and heat pump systems. Additionally, L.3851/2010 stipulates that by 31.12.2019, all new buildings must cover the total of their primary energy consumption with RES, micro-CHP and district heating on a large area scale, as well as heat pumps. This requirement is extended to all new public buildings, by 31.12.2014 at the latest.

- "*Measures to improve energy efficiency in end-use, energy services and other provisions*" (L. 3855/2010), and in particular, Article 8 promoting energy efficiency measures in the public sector and Article 16 on the energy performance contracting framework. The law, which transposes Directive 2006/32/EC, foresaw specific measures for the buildings of the public sector in order to improve their energy performance and achieve energy savings. Also, it sets the framework for the establishment of the Energy Service Companies, ESCO market, in Greece, through Energy Performance Contracts, promoting the use of domestic RES & m-CHP systems and energy efficiency measures in buildings.

- "*Energy Inspectors of buildings, boilers and heating and air conditioning*" (PD 100/2010).

- "*Financing Environmental Interventions, Green Fund, Ratification forests maps and other provisions*" (L.3889/2010).

- "*ESCOs-Functioning, Registry, Code of conduct and related provisions*" (MD13280/07.06.2011).

- "*Framework methodology for measuring and verifying energy savings to achieve the national indicative energy savings target in the final consumption - eligible list of indicative measures to improve energy efficiency*" (MD 7094/23.6.2011).

- Law 4122/19.2.2013 titled **"***Energy Performance of buildings***"** where their provisions harmonizing the Greek legislation to the EU Directive 2010/31/EU, titled "*For the energy performance of buildings (recast)*" (OJ L153 of 18.06.2010)

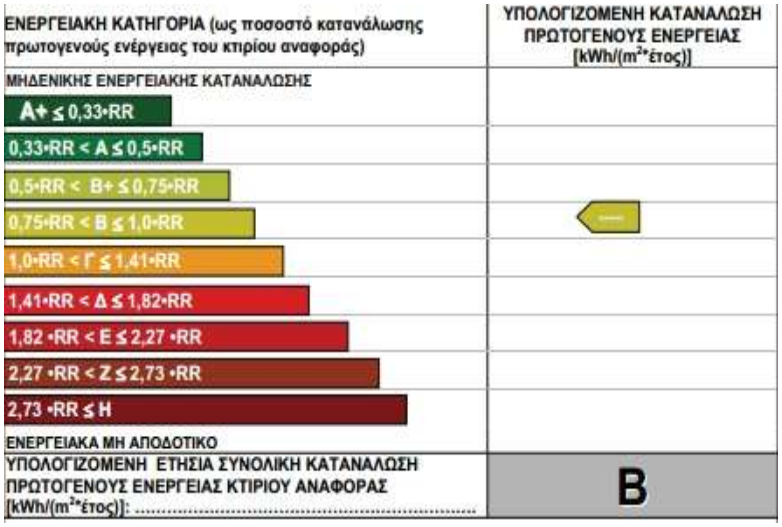
4.0 Current energy conservation measures for buildings, in Greece

In Greece, today, the regulation of energy efficient buildings, called KENAK, refers to the standard ISO 13790, as well as other international standards that define all the parameters related to the Greek requirements. Since the implementation of EPBD, there were not any specific regulations defined in Greece, regarding the energy performance and the evaluation of buildings, except the Thermal Insulation Regulation (TIR), introduced in 1979, and the five (5) Technical Codes, related, among other issues, with the installation of heating and cooling systems and of distribution of natural gas to buildings, issued by the TCG, in 1987.

In April of 2010, in compliance with the Directive 2002/91/EC, the Ministry of Environment, Energy and Climate Change, YPEKA-MEECC, which is responsible for the national EPBD, and the Technical Chamber of Greece, TCG, launched the "Regulation on the Energy Assessment of Buildings-KENAK", in accordance with the L.3661/2008, adopted in 2008. According to KENAK, the energy evaluation of the building determines the energy efficiency, following a series of detailed analysis. Following the MD 5825/2010, the concept of "a reference building" was introduced, as a building having the same shape, orientation, and usage and operation characteristics, with the building under consideration. The rating of the building in the energy efficient indicator is defined by an energy performance certification that specifies different energy level classes, related to the different climatic zones and the type of use of the building. This indicator is expressed in kWh/m² per year.

Nine different categories, from A+ to H, classify the energy efficiency of the examined buildings. Three categories above category B (B+, A, A+) indicate the most competitive energy efficient buildings. The classification of the building in the rating scale is calculated based on the primary energy consumption of the examined building. Figure 5 represents an example of the energy scale indicator, in Greek.

Figure 5: Energy scale indicator



Moreover, each certificate provides the total CO_2 emissions of the building, the actual energy consumption, based on the energy bills and a qualification on the thermal visual and acoustic comfort of the building. Recommendations of alternative options for energy saving and information related to the improvements on the energy efficiency of the building are suggested by the energy inspectors, in order to inform the owners for upcoming energy efficiency investments, in order to improve the energy performance of their building. Buildings under energy inspection would be new buildings, existing buildings, under major renovation and buildings or apartments in sale or leasing.

For the implementation of EPBD, it was necessary to create a special software tool, in order to calculate the energy performance, rate the building and finally lead to the "Energy Efficiency Certificate". The Technical Chamber of Greece, with the partnership of National Observatory of Athens NOA, developed the software TEE-KENAK, today at its 1.29 version. KENAK software is an upgrade of the software product, called EPA-NR "Energy Performance Assessment of existing Non-Residential buildings", developed to accomplish the need of EPBD and is adapted to the local requirements of Greece.The software incorporates four (4) Technical Guidelines, TOTEE 20701-1, 20701-2, 20701-3, 20701-4 of 2010 and the regulations of KENAK as electronic libraries installed in the software to collect all the information required for the design of the existing building. The calculation methods have

been certified by the European standard EN ISO 3790 and by ELOT (Hellenic Organization of Standardization).

The certificate lasts for ten years. Buildings under major renovation are required to be certified again at the end of the work programme in order to evaluate their energy efficiency. In case that false information is observed, by the specified authorities of YPEKA, a penalty is applied to the energy inspector and the owner too. The penalization for the inspectors, depending on the severity of their offence, could be their exclusion as energy reviewers for a couple of years or their total exclusion as inspectors. Regarding the owners, in case the construction does not meet the requirement of the certification, the building would be considered as an illegal construction and the building has to be reviewed and upgraded, in order to improve its performance, according to the minimum requirements of the KENAK.

With the recent adoption of the L.3851/2010, Greece is ambitious to increase, by 2020, its national energy consumption from Renewable Energy Sources (RES) by 20%, 2% above the mandatory level of 18%, set by Directive 2009/28/EC. This objective will be achieved through collaborations and energy efficiency measures known as "green development" that will increase the penetration of RES technologies in electricity production. Based on the L.3851/2010 specific regulations have been established for the use of RES in KENAK. Regarding the new legislation, new initiatives encourage the use of RES in energy consumption, electricity production and contribution in heating and cooling. Additionally, special programmes and financial incentives for photovoltaic installation up to 10 kW_e in the household sector and small businesses will encourage the development of RES use.

The new buildings and the ones under major renovation must stipulate a minimum required level of energy from renewable sources. According to the new regulations, 60% of the Domestic Hot Water production should be covered by using solar thermal collectors or alternative renewable energy production systems.

KENAK, also, defines the inspection of boilers and of the air-conditioning systems of the building, in order to promote the overall improvement of energy performance of buildings, in Greece.

The role of Energy Inspectors for Buildings

As mentioned earlier, KENAK requires the inspection of the building envelope, of the heating and air-conditioning systems. Specialized persons, referred to as "Energy Inspectors", inspect and ensure the correct application of KENAK in different building categories. Energy inspectors are responsible to issue the energy efficient certificates.

The licensed Inspectors are categorized as:

(a) Energy Building Envelope Inspector,

(b) Energy Inspector for heating boiler systems and

(c) Energy Inspectors for Air Conditioning systems.

The Energy Inspectors must be architects or engineers (i.e. civil, mechanical, electrical, etc.) registered members of the Technical Chamber of Greece (TEE) and graduate engineers from technological institutions, with four years minimum of professional experience. These are the prerequisites when applying to become an energy inspector. The accepted inspectors should then follow specialized training programmes and successfully pass the qualification examinations, before they get the permission to perform energy audits. Furthermore, they are under the supervision and control of a national department for licensed experts, under the auspice of YPEKA-MEECC. Based on their academic background, the inspectors would be certified to carry out different types of audits, divided into two different license categories.

The first category (A) authorizes inspection for the building envelope, with a total floor area less than 1000m² while category (B) concerns the inspection of buildings that exceed 1000m². There are also energy inspectors for the inspection of boilers and heating system and of the air-conditioning systems of the building.

5.0 Review of EU nationally-funded energy efficiency programmes

The Greek Government, during the 2007-2013 Community Support Framework period, called ESPA, launched numerous programmes, aiming towards the improvement of energy efficiency in buildings. More analytically, during the period 2007-2009, two major programmes provided economic incentives for improving energy efficiency in the residential sector, namely:

- The programme "*Changing your Air-Conditioner*", aimed for the replacement of old and energy-consuming split air-conditioning units, which run on summer 2009 and led to the replacement of more than 140,000 split-units, all over Greece, with new ones with inverters;
- The "*Energy Efficiency at Household Buildings*" programme for the insulation of walls and roofs, the replacement of windows/doors (frames/glazing), and the upgrading of heating and hot water supply equipment. This co-financed programme concerns buildings, with a building permit or other legalization document, which are located in areas with an average zone price lower than or equal to 2,100 €/m^2, and are used as residences, with their owners meeting specific income-related criteria and are classified as low energy efficiency buildings. The programme offers incentives to citizens to carry out the most important interventions, aiming to improve their houses' energy behaviour, while, at the same time, contributes to the achievement of Greece's energy and environmental targets.

  There are also programmes for improving the energy efficiency of public buildings under Priority Axis 1 "*Protection of the Atmospheric Environment & Urban Transport – Tackling Climate Change–RES*" of the Operational Programme "*Environment and Sustainable Development*", under YPEKA-MEECC.

In particular, the following funding actions have already been promoted:

- Installation of high-efficiency CHP units, operating with natural gas, in conjunction with cooling systems, in hospitals, with a budget of 15,000,000 €.
- Demonstration projects for the use of RES and energy-saving

measures in existing public primary and secondary school buildings, with a budget of 40,000,000 €.

- Demonstration projects for the use of RES and energy saving in public buildings, with a budget of 40,000,000 €.

The most characteristic programmes under ESPA, promoting energy efficiency in buildings, in Greece are presented analytically below:

I."Exikonomo" - Energy Efficiency measures in municipal buildings

The (former) Ministry of Development, in 2009, introduced a programme named "Exikonomo" ("Let's Save Energy") for municipal buildings, for municipalities with a population of more than 10,000. This programme aims in the application of actions and proven good practices for the reduction of energy consumption in local urban environment, on municipal buildings sector and on upgrading of communal areas. Secondarily, the programme, through the implementation of technical interventions and actions, promotes the sensitization and mobilization of local citizens, local government and entities on the benefits of energy efficiency.

The actions of the programme include:

- Interventions on existing municipal buildings
- Interventions in public spaces of the urban environment
- Pilot interventions in urban transport
- Interventions in other technical urban (municipal) infrastructure
- Dissemination, networking on the importance of and information on energy efficiency.

Eligible municipalities are requested to submit for evaluation an "Integrated Action Plan "and an "Implementation Plan" on energy efficiency measures in their municipalities in order to be financed, as:

- 70% of the National Strategic Reference Framework (NSRF) 2007-2013
- 30%ofown contribution of municipalities. Due to the financial recession, this percentage changed, and NSRF is covering now the 100% of the total budget of the proposal.

The programme's total budget amounts to100 mil €.The maximum eligible total budget proposal for each municipality is a function of the population (based on 2001 census), for municipalities, with a population of:

- Municipality>10,000 <45,000 inhabitants, up to € 700.000
- Municipality>45,000<90,000 inhabitants, up to € 1.000.000
- Municipality>90,000<150,000 inhabitants, to€ 1.500.000
- Municipality>150,000<300,000 inhabitants, to€ 3.000.000
- Municipality>300,000 inhabitants, to€ 6.000.000.In the above budgets include VAT.

The distribution of the budget for an eligible Municipality follows the following breakdown:

1. EE measures in municipalbuildings:55-65% of the total budget
2. EE measures in communal Areas: 15-25%
3. Energy efficient transportation: 10-15%
4. Technicalinfrastructure:0-4%
5. Actions for dissemination, networking and information: 0-4%
6. Actions to support the preparation and implementation of the proposal 0-10%

This programme was evaluated in 2012 and now is under implementation, with success.

II. Exikonomo II

This invitation,in mid-2011, under of the "Environment and Sustainable Development" programme, relates to energy saving measures in existing municipal buildings and infrastructures for municipalities which did not participate in the "Exikonomo" programme.

The interventions were carried out along the following axes:

A. Interventions in buildings and infrastructure (energy renovation of the building envelope, energy upgrade of the electrical & mechanical installations,

upgrading of artificial lighting system and installation of energy management systems), and

B. Support of other actions (i.e. technical consultant and engineering services, energy efficiency studies, energy audits and publicity).

The maximum eligible total budget proposal for each municipality is a function of the population (based on 2011 census), for municipalities, with a population of:

- 1-10,000 inhabitants to 200.000 €
- 10.001-45.000 inhabitants, to 400.000€
- 45001-90000 inhabitants, to 600.000€
- 90,001 to 150,000 inhabitants, to 800.000€
- 150,001 to 300,000 inhabitants, to 1.500.000€
- 300.001 inhabitants, to 3.000.000€

The submission of proposals was completed on 31.07.2013 and the total budget amounts to 75 mil Euros. The evaluation process was completed and a total of 139 proposals from municipalities was to be financed for 70% of their budget out of progamme funds and 30% from the municipalities. In December 2014, 39 proposals were eliminated from the programme, due to a variety of reasons. In general, the programme is in an on-going progressive process.

III. "Exikonomo Kat'Oikon" - Energy efficiency for home buildings

The Ministry of the Environment, Energy and Climate Change (YPEKA-MEECC), having completed the legal framework on buildings' energy efficiency, has developed a set of financial incentives, with co-financing from the European Union, for the implementation of energy efficiency upgrading interventions in residential buildings. Therefore, this programme is based on the European energy efficiency in buildings legislation and regulations, whereby the possibility exists for funding, provided through the European Regional Development Fund, to improve energy efficiency measures and

renewable energy use in the residential sector and whereby the possibility of spending from the structural funds to finance funds or other incentive schemes related to these tasks. So, this co-funded programme provides incentives to citizens to improve the energy efficiency of their home, saving money and energy and increasing their market value.

Eligible homes are all the houses, apartment buildings and individual apartments that satisfy only the following criteria:

- The building is situated in an area, with market zone price lower or equal to 2.100 €/m^2.
- The buildings must have been classified under the Energy Performance Certificate (PAA) in a category lower than or equal to D.

The project's total cost is approximately 400 mil Euros. Based on these funds, each region is entitled to a different economic enrolment in it. Owners will be eligible for funding based on their personal incomes. The incentives include free or low-interest loans and grants up to 30% of the eligible budget.

The following table shows analytically the three main categories of beneficiaries and their incentives in order to participate in the programme.

Table 1. Categories of Beneficiaries for House Energy Improvement Financial Support Schemes

Beneficiaries	**A1**	**A2**	**B**
Personal Income	P.I. ≤12.000€	12.000€ <P.I. ≤ 40.000€	40.000€ <P.I. ≤ 60.000€
Family Income	F.I. ≤ 20.000€	20.000€ <F.I. ≤ 60.000€	60.000€ <F.I. ≤ 80.000€
Incentives	70% Subsidy 30% Interest-free loan (interest rate subsidy 100 % to 31.12.2015)	35% Subsidy 65% Interest-free loan (interest rate subsidy 100 % to 31.12.2015)	15% Subsidy 85% Interest-free loan (interest rate subsidy 100 % to 31.12.2015)

The programme is providing 4/5/6-year loans, with or without a guarantor, without mortgaging the property, direct loan repayment without charges, and immediate payment of suppliers/contractors through the banking system, without the involvement of householders. With the inclusion in the programme, the bank deposits 40% of the total budget of the beginning of the works. For admission to the programme an energy audit is required, before and after intervention, the cost of which is covered 100% by the programme after the successful implementation of the project. Moreover, the programme covers expenses for a project consultant fee up to 250 €, without VAT.

The savings achieved by the interventions of the programme should correspond to an upgrade of the energy class or savings of 30% of the energy consumption of the reference building.

Eligible interventions concern:

1. Installing insulation in the building envelope including the roof and the pilotis.

2. Replacement of the frames and glazing, including new fitting shading systems.

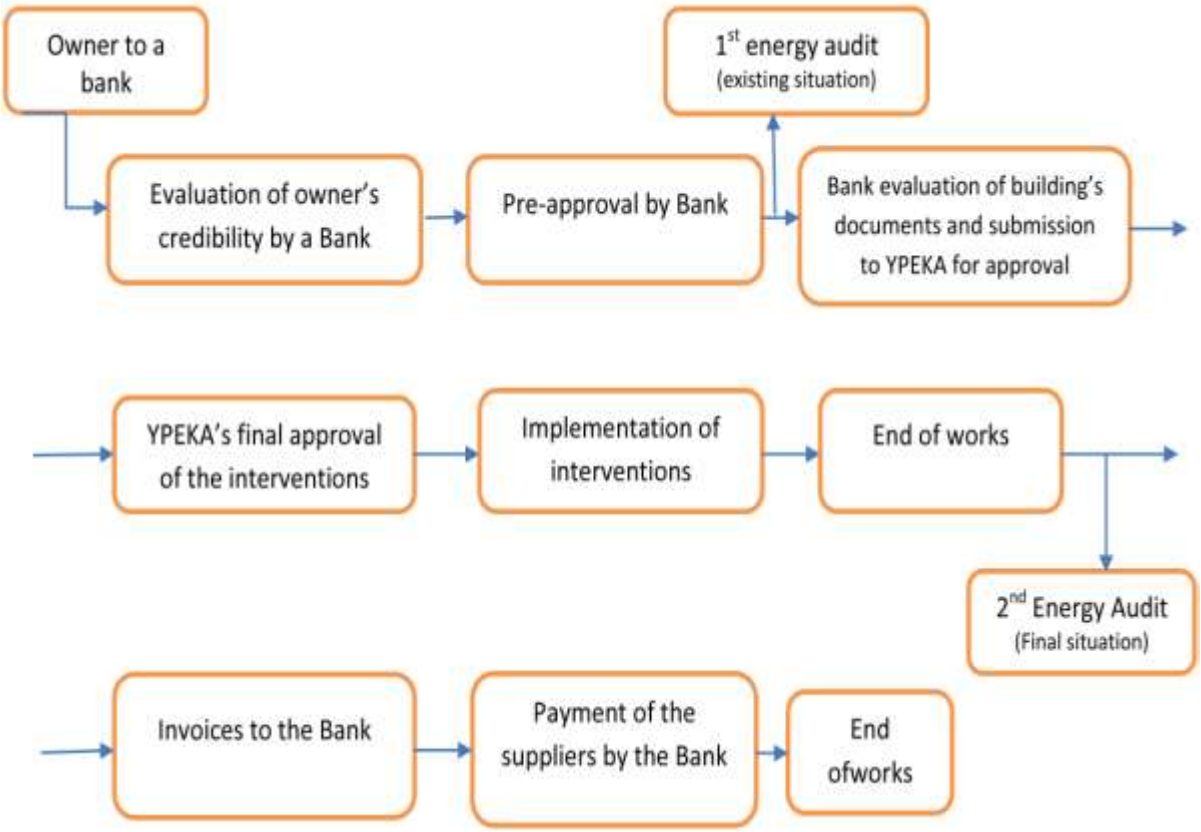
3. Upgrade the heating and hot water heating system.

For the implementation of interventions no license is required, except in very special cases.

The maximum eligible budget of interventions, including VAT cannot exceed 15.000 € per property. The admission to the programme is a continuous process until the exhaustion of resources by each region.

The appropriate steps for participation in the programme are presented in the following diagram:

Figure 6. Householder's Application Procedure for Obtaining Financial Support for House Energy Performance Improvements



IV. "Prassina Domata" - Green Roofs

The programme "*Green Roofs in Public Buildings* " is a separate initiative of the Ministry of Environment and the Centre for Renewable Energy Sources and Saving (CRES), under Priority Axis 1 "*Protecting the Atmospheric Environment & Urban Transportation-Managing Climate Change-Renewable Energy*" Operational Programmes, OP, "*Environment and Sustainable Development*" 2007-2013" (EPPERAA), co-financed by the Cohesion Fund. The actions include:

- Energy savings in public buildings, throughout the year (summer and winter)

- Improvement of thermal, visual and environmental conditions in public buildings
- Improving the microclimate of the wider area, in which the building is part of the intervention
- Reduction of air pollution
- Minimise and, eventually, reverse the urban climate change.

Target groups are the ministries, the 13 regions, municipalities, other public entities and private legal entities non -profit public benefit, with a total budget of 20.mil €.The programme is developing on an on-going progressive process basis.

V. "Building the Future" Programme

An ambitious programme to improve the energy efficiency of the building stock of Greece, the "Building the Future", has been initiated by the YPEKA-MEECC. In the framework of this programme, which started in 2011 and will last until 2020, there will be 3,100,000 energy interventions in buildings (houses, apartments, commercial buildings), while the benefit of savings for citizens will be about 9 billion€. These resources allow the country to achieve its goals of 20% energy saving by 2020 and offer a driving force for further development of the sector of building construction, materials and energy products. The main idea behind the programme is that the companies selling building construction materials and related goods can voluntarily offer discounts to property owners carrying out energy efficiency upgrades of their homes and business premises. YPEKA-MEECC is also pressing ahead with procedures for implementing greater tax relief for this form of investment through certificates to be submitted along with one's tax statement and issued by CRES, which has both the technical and financial administration of the programme. In the "integration of advanced and mature technology actions" of the Programme incentives are given for six categories of home improvement for residences and five in other types of buildings. Among these are the following:

1. Replacement of windows and doors with higher specification types in 20,000 dwellings;
2. Replacement of single- with double-glazing in 25,000 dwellings;

3. Installation of 5,000 solar panels for water heating;
4. Installation of 'green' roofs on 20,000 dwellings;
5. Insulation of roofs for 20,000 dwellings, and insulation of facades in 20,000 dwellings;
6. Replacement of 20,000 conventional heating systems with new high-efficiency systems.

Envisaged works on commercial and other buildings include:

1. Instalment of integrated facades (double-glazing windows, shading systems) on 3,000commercial buildings;
2. External insulation on 5,000 buildings;
3. Installation of high-efficiency HVAC systems on 5,000 commercial buildings;
4. Replacement of artificial lighting systems in 10,000 commercial buildings;
5. Installation of advanced energy monitoring systems in 1,000 commercial buildings.

VI. Green Urban Neighbourhood Pilot Programme at "Agia Varvara"

The demonstration project, entitled "Green Neighbourhood", with a budget of €7 mil €, involving an energy upgrade of four residential apartment building blocks, situated in a suburb of Athens to almost zero energy consumption with the optimization of the local micro-climate. The programme is a pilot innovative project, targeted to low income citizens of Agia Varvara, living in 4 x 4-level block of flats, in order to transform them into an integrated green urban unit. The technologies to be applied are, namely:

- Energy saving in buildings including building shell insulation, new window
  frames, with low emission double glazing & shading, application of cool materials and green roofs
- Renewable energy systems, such as PV panels in roofs, for "green electricity", ground source heat pumps, for heating, cooling and solar collector systems for DHW, and,
- Intelligent energy monitoring.

The programme is in its initial stages of implementation.

VII. Green Island "Agios Efstratios"

The objective of this programme, with an initial budget of 9 million €, is to stimulate research, innovation and entrepreneurship, through a combination of actions:

- Use technologically mature RES technologies and energy saving technologies in local public buildings,
- Coverage > 80% of island energy needs with RES.
- Intervention projects in the fields of:
  - electricity generation
  - heating and cooling of buildings using renewable energy technologies using: Ground Source Heat Pumps (GSHPs), for heating and cooling, Solar Thermal Systems and Seasonal thermal energy storage in tank with zeolites
- Energy savings in buildings, including thermal insulation, double-glass windows, etc
- Transport

The programme is in its initial stages of implementation.

The following table analytically presents the status (up to December 2014) of all the above described Programmes, regarding energy efficiency in the building sector.

Table 2: Summary of EU funded Energy Efficiency Programmes in Greece (2009-2014)

Programme Description	Number of building units	Funds disbursed (in million Euros)
Exikonomo at Local Authorities (2012-2014)	64	32.7
Exikonomo II at Local Authorities (2013-2014)	15	6.13
Exikonomo kat' Oikon (save at home), 2011-2014	39.210[(1)]	392.8
Green Roofs in public buildings (2012-2014)	36	9.42
Replacement of Air Conditioning units with more energy efficiency ones	136.000 installed units	45.25
Total Funds disbursed	**486,3 million Euros**	

(1) Number of houses which actually introduced measures to improve their energy efficiency

6.0 Energy efficiency improvement prospects for Greece's building sector

Experience acquired over the last five years, a time period during which an organized effort to improve the energy performance of buildings was undertaken, shows that the overall problem associated with the poor energy performance in the building sector is mainly organizational due to institutional and societal factors rather than technical ones. The way in which the construction and ownership of houses is financed, the poor spatial organization of buildings within the urban environment, the poor design of most buildings the dominant apartment type habitation model and the general lack of concern by the population at large for the maintenance of communal space are among other the main factors which contribute to a widespread indifference as far as building and living standards are concerned.

Wrong building orientation, lack of open and green spaces in the vicinity of houses, poor and indifferent design practices, disregard of thermal insulation and shading practices, combined with the installation of inefficient heating and cooling devices, are additional factors which has led to the construction of buildings largely characterized by poor energy performance. Therefore in order to improve the performance of buildings in Greece a much broader effort needs to be undertaken focusing on education, social development, improved design practices and effective inspection methods.

Energy Efficiency in the building sector

When it comes to applying energy efficiency measures and techniques in Greece's building domain, there are certain serious obstacles, and apparently some of them insurmountable, which should be identified and discussed. In short we have to deal with the following problem areas when tackling energy efficiency in the built environment in Greece.

(i) There appears to be a serious lack in energy education and energy awareness among large parts of the population. With the exception of few examples in secondary education there have never been a consistent government effort aiming at energy efficiency, especially in the building sector.

(ii) There is a widespread notion that electricity should be provided free of charge to all households and to that end the government's latest policies are not helpful. A year ago a special "social" low tariff (highly subsidized) is offered to supposedly needy households which currently exceed 500,000 as this measure is extensively abused. Such government policies contribute in cultivating an anti-energy efficiency mentality so that the householder is not bothered to find out, let alone apply, energy conservation measures.

(iii) Greece's post war construction model based on the typical apartment block (polikatikia i.e. multihabitational building) where individual apartments are owned by different families and householders, is not supportive for a communal type decision making process which is necessary if energy efficiency measures, in order to be effective, need to be applied for the whole building structure and not just to individual apartments. Given the highly selfish and suspicious character of the average Greek house owner a consensus among the different apartment owners cannot usually be reached and therefore plans to apply for available grants cannot proceed.

(iv) Bioclimatic considerations are completely lacking in the design and construction of 99.5% of building stock in Greece. Even if the architect or engineer involved is favorably inclined to use bioclimatic criteria in most case their initiatives in this respect are overridden by the ill-defined financial considerations of the house owner. Only very lately such myopic attitudes have started to change under pressure from economic distressful conditions, as a result of the present economic downturn, which has made the public more aware of the high energy costs involved in running a modern household.

(v) A widely acclaimed mandatory thermal insulation measure applied to all new constructions introduced by the government in 1979 and hence in force through the General Construction Code (TOK) is not applied as prescribed- due to lack of in situ inspection provisions- with the result that most buildings only have sub-standard insulation. Usually engineers, architects and building contractors in order to avoid costs,

do not apply the full insulation procedures while house owners rarely insist on adequate thermal insulation practice.

Proposed Remedies

1. Introduce legislation with regard to the management of apartment blocks in order to tackle approval procedures for the management of heating- cooling and improvement of energy performance.
2. Update and enforce in situ inspection of buildings during construction or renovation stage in order to ensure the application of energy efficiency measures.
3. Simplify and streamline grant application and approval procedures for EU backed financial assistance, while broadening at the same time the applicant base of eligible households.
4. Organizelarge scale information campaigns on a regular basis in order to increase public awareness on matters related to energy efficiency and energy conservation.

Outlook – Further Work

In view of the serious shortcomings in terms of energy performance of the extensive building stock in Greece, the serious organizational and societal problems, and general lack of interest on matters of energy efficiency, the outlook for major improvements in the energy performance of buildings looks bleak. However, this may change with time if assisted improvement and renovation programmes, such as the ones reviewed in this report, are introduced and undertaken more or less on a permanent basis. In this context the experience derived over the last five (5) years from the application of housing energy conservation programmes is most valuable and further analysis and study should be undertaken focusing on specific examples.

What needs to be studied is the energy performance, before and after energy upgrading and renovation programmes, of a series of selected buildings, in the different climatic zones of the country. The following are some suggestions of the type of buildings which could be selected.

1. A typical apartment block in selected urban and semi urban areas, for the three climatic zones

2. A single apartment in all three climate zones
3. Two office buildings one in greater Athens and another in the Thessaloniki area
4. A hospital
5. Two hotels: One small to mid-size and the other of a large scale category

The above proposed case studies should focus on the thermal characteristics of the buildings, the cost of the energy performance upgrade and the new energy performance profile of each one of the selected buildings. A cost benefit analysis should also be included in each one of the case studies. Furthermore and on the basis of the results from the above proposed analysis estimates should be prepared of the anticipated energy savings from the large scale improvement of the energy performance of buildings and their impact on the country's energy balance. More specifically a number of scenarios, should be prepared on the anticipated energy saving in the building sector at national level at five year increments until 2050. The parameters to be used in the proposed scenarios will be determined from the analysis of the four-five different types of buildings as described above. In addition a number of other parameters should be taken into consideration related to anticipate economic growth, estimates for the construction of new buildings, renovations of existing stock, demolitions etc. The results of these scenarios, to be conducted using standard computer simulation techniques, will be most useful in assessing the exact role of building energy efficiency and improvements in the energy performance of buildings within a broader national energy strategy in line with latest EU provisions and goals.

7.0 Conclusions – Key messages

Over the last five years (2010-2014) Greece has made an organised and consistent effort to improve the energy efficiency of its existing building stock but also introduce rigorous energy conservation measures for all new buildings. The cornerstone of this effort was the energy certification of buildings following the launching and implementation of the "Regulation on the Energy Assessment of Buildings" (KENAK)in 2010 in compliance with Directive 2002/91/EC. Pursuant to this regulation and equally important was the introduction of the practice of Energy Inspection for Buildings, who are responsible for classifying buildings according to their energy-efficiency status but also for supervising schemes of energy efficiency improvement.

Successive governments in Greece from 2009 and late 2014 recognizing the great importance of energy efficiency in the building sector sought the necessary advice and support from the European Commission in implementing various changes both at legal, institutional and practical level. In this context successive Greek governments applied to EU's structural funds and obtained the necessary support which enabled them to provide wide ranging incentives for energy efficiency in the building sector as part of a series of specific programmes. These programmes are described in detail in this Working Paper. The overall result of these programmes in terms of completed projects and amounts of funds absorbed from the EC can only be described as positive. **During the five years of running these programmes Greece absorbed almost 486 million Euros with more than 40,000 successful applications in various types of buildings for Energy efficiency improvement and 136.000 replacement air conditioning units**.

In reviewing these programmes one is tempted to make a number of observations:

(i) The impact from the execution of the above EU funded programmes for improving the energy efficiency of buildings, especially in the residential sector, has been considerable and has helped mobilize a much broader interest in energy efficiency techniques and their application in newbuilts. Consequently huge interest has resulted in

households on how they can benefit from the introduction of energy efficiency improvement techniques with or without subsidized financial support.

(i) The introduction and application of well organised and well coordinated programmes aimed at mass audiences for the energy efficiency improvement of buildings has proved that if a financial assistance programme is well planned and with minimum state interference it can be implemented fairly quickly with actual results delivered. Therefore the decision to appoint a single intermediary, ie banks, for the management of the programmes proved, in retrospect, a wise decision for all concerned.

(ii) There is scope for further work in the building energy efficiency sector in Greece with or without EU financial support. The usefulness of EU funding has been amply demonstrated in energy saving terms and therefore it would be for the benefit of the state to encourage the spread of energy efficiency improvement in the building sector by allocating certain state funds, primarily to support soft loans and cover energy inspection costs.

(iii) There is a clear need for the measurement of energy efficiency gains in different types of buildings by undertaking specific studies on a series of buildings which have benefited from the application of energy efficiency measures as part of the above described programmes (in the residential and public buildings sector). This is of vital importance in the context of the formulation of a national energy strategy and the need to account for potential energy savings in the building sector at country level.

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About the Authors

Costas Theofylaktos *is a USA trained Mechanical Engineer, with a BSc and an MSc from the University of Evansville, Indiana, and has 28-year experience in the energy sector. Costa's special interests include Energy Policy, Energy Efficiency, RES and Cogeneration of Heat and Power. He is currently the President of Greece's Association for Cogeneration, HACHP, and also partner and member of the executive committee of IENE. In 2013, he was chairman and CEO of the Centre of Renewable Energy Sources (CRES) and he has an extensive experience in EU- and EBRD-funded energy projects in SE Europe, Asia and Russia.*

Costis Stambolis *studied Physics and Architecture at the University of London, the NE London Polytechnic and the Architectural Association. He holds a Graduate Diploma in Architecture from the AA and a professional practice license in Architecture from the Technical Chamber of Greece (TEE). He has consulted widely on solar energy building applications, natural gas and energy policy. He has lectured and published extensively on energy issues and is currently the Deputy Chairman and Executive Director of the Athens based Institute of Energy for SE Europe (IENE), being one of its founding members.*