Towards the incorporation of the Energy Spot of Buildings in the Property Market in Greece

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Key words: Energy, KENAK, Greece, Property market

SUMMARY

In this paper, the applied steps on the basis of the European regulations concerning the energy issue of buildings are initially described for the case of Greece. Greece has repeatedly delayed the implementation of the European energy regulations and today is one of the last countries concerning the harmonization with the European legislation. Starting from the enactment of the Energy Performance of Buildings Regulations (KENAK), the concept of the energy of the buildings of the residential and the tertiary sector changed. Thus, new technical specifications harmonized with the European legislations were established for the old and the new buildings. The energy inspections and the energy studies are done by the energy inspectors. All the specialties of engineers (and not only) have the possibility to be energy inspector. Training seminars are also carried out by specialists aiming to the familiarity and in-depth investigation for non-expert and expert specialties respectively. On the other hand, for the wider public acceptance and therefore for the successful implementation of the KENAK, subsidized programs were provided. This movement was an important motivation not only for the homeowners but also to the prospective buyers and the investors. Towards the implementation of the European regulations concerning the energy issue of buildings, the aforementioned efforts of Greece are considered to be satisfactory. However, improvements and motivations are proposed for the optimal application of the relevant regulations in accordance with the international policies. Also, the impact of the energy spot of each building in the broader property market is discussed.

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1. INTRODUCTION

Greece has repeatedly delayed the implementation of the European energy regulations and today is one of the last countries concerning the harmonization with the European legislation. The nodal periods up to the enactment of the Energy Performance of Buildings Regulations (KENAK) are three. In the first period (before 1979) there was not a regulation for the thermal insulation of buildings. The building thermal insulation regulation came into force in 1979 determining the maximum thermal limits of the various building components. However, during the first decade of the building insulation regulation, its implementation was incomplete and only after 1990 was systematically applied. Thus, the majority of Greek buildings had significant energy losses, which in combination with the unfavorable climatic conditions (climatic zones C and D), led to high levels of energy consumption for heating. Although the enactment of the European Directive EPBD 2002/91 which took care of the energy performance of buildings, its delayed implementation in Greece in the second period (1979-2010) was the main cause of the current situation, i.e. its delay adjustment at the directive 31/2010. Based on the law 3661/2008, the KENAK was legislated in October 2010. After the revision of the European directive 31/2010, the incorporation of the energy performance of buildings in Greek legislation was occurred through the law 4122/2013 in the third period (2010-today). The aforementioned directive regards on the energy performance of buildings and requires the minimum energy performance requirements in order to achieve optimal levels of costs. This framework has not yet been implemented in Greece and is currently in the study process. Also, provides as prerequisite the "nearly zero energy" for the new public buildings by the end of 2018 and for all the other new buildings by the end of 2020. This framework is also in the study process. Finally, a recent legislation (4409/2016) repeals some provisions of previous legislations and redefines the required qualifications for the energy inspectors of buildings as well as of heating and air conditioning systems.

In this paper, the defined technical specifications as well as the target of the training seminars are initially described. Then, the applied steps on the basis of the European regulations concerning the energy issue of buildings are described for the case of Greece. Finally, improvements and motivations are proposed for the optimal application of the relevant regulations in accordance with the international policies; the impact of the energy spot of each building in the broader property market is also discussed.

2. TECHNICAL SPECIFICATIONS

For the full implementation of the KENAK, the corresponding writing group of the Technical Chamber of Greece – TEE (http://web.tee.gr/) wrote four technical instructions named TOTEE. The first TOTEE (TEE, 2010a) includes the detailed national specifications for calculating the energy performance of buildings and the issuing of energy performance certificates (EPCs). In this instruction, the basic objectives are the determination of the parameters concerning the calculation of the energy performance of the buildings, the detail determination of the parameters of the reference building and the determination of typical values of parameters for several technologies. The second TOTEE (TEE, 2010b) describes the thermophysical properties of building materials and the necessary check of the thermal efficiency of buildings. More specifically includes the consideration of the thermal bridges to the thermal efficiency of the building and tables of properties, parameters, heat transfer and thermal bridges coefficients. Also, describes how the thermophysical properties of each material should be calculated. The third TOTEE (TEE, 2010c) describes the climatic data of four divided zones of Greece including the design conditions for summer and winter, the climatic data on average monthly temperatures and solar radiation, etc. The fourth TOTEE (TEE, 2010d) includes instructions and forms for the energy inspections of buildings, boilers and heating and air conditioning systems.

2.1 Methodology for the energy performance of buildings

The calculations of the energy performance of the buildings are performed via the semi-solid status method of monthly step. The mentioned method is based on the corresponding European standards. The basic parameters during the calculations are the following: (1) the geometry of the building shell, (2) the thermophysical properties of the building's materials, (3) the climatic conditions of the area (4) the existing passive solar systems and the renewable energy sources systems, and (5) the existing heating, cooling and hot water for use systems. The energy classification of the building in the classes of A+, A, B+, B, Γ, Δ, E, Z and H is carried out compared to the reference building in terms of the final reduced consumption of the building in primary energy. The corresponding yearly emissions of CO_2 and other energy consumptions and requirements are also calculated. The reference building is classified in the category B and has the same geometry, geospatial position/orientation and use/operation profile with the corresponding under examination building. Also, has predefined thermophysical attributes and electromechanical systems according to KENAK.

2.2 Education and training seminars

Concerning the education, energy inspectors are able to implement energy inspections and studies based on the presidential decree 100/6/10/2010. The recent legislation (4409/2016) redefines the required qualifications for the energy inspectors of buildings as well as of heating and air conditioning systems. In early 2011, the first building energy inspections and studies were carried out for the first time in Greece. At the 31 October, 2011 the training seminars of the energy inspectors, implemented by approved operators, were established for all the specialties of engineering (and not only). Also, within four (4) years from the entry into force of law 4122/2013, the initial inspection of heating and air conditioning systems was required accelerating the establishment of the corresponding inspectors. In practice, the training seminars initially aim to the familiarity and then to the in-depth investigation of the energy issue for the buildings and the heating and air conditioning systems. Also, the training seminars aim to introduce the energy inspectors at the existing legislation on energy studies and KENAK and to the corresponding European energy policies.

2.3 TEE KENAK Software

The first official software for the calculation of the energy performance of the buildings provided by TEE is the TEE KENAK. The TEE KENAK takes account the aforementioned method and parameters towards the calculation of the energy performance of the building. Figure 1-top and Figure 1-bottom are indicatively depict the input data for the geometry of the building shell (intransparent surfaces) and the heating system for a typical building with an area of 70 m^2 (build in 1978 in Athens, Greece) respectively. It should be noted that, in general, even a single apartment may be considered as building under the condition that constitutes an individual thermal zone.

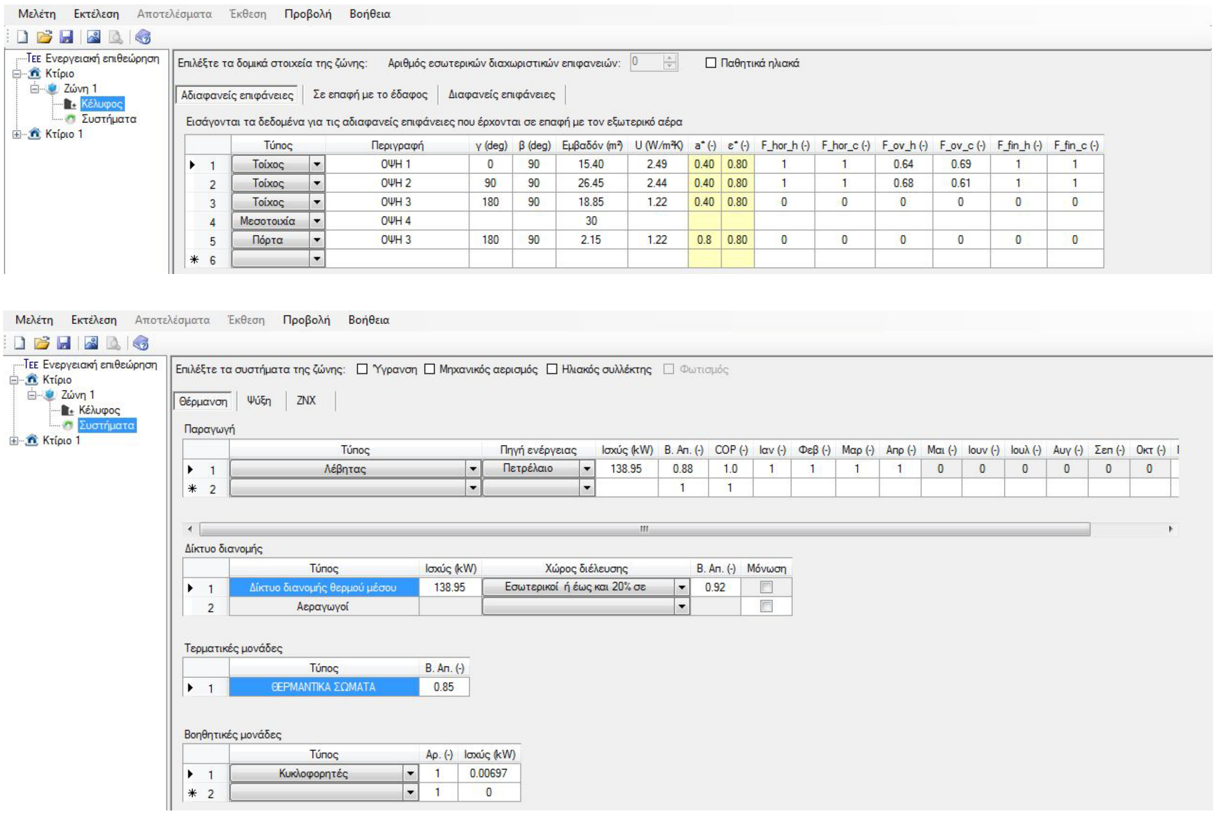
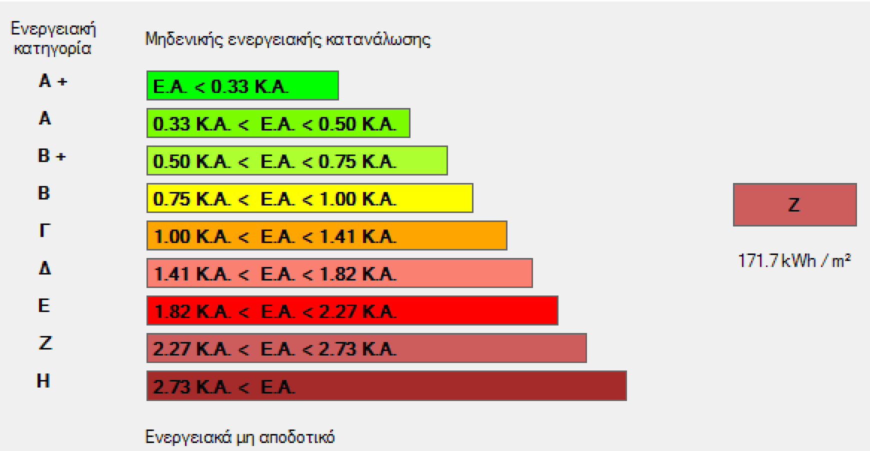


Figure 1. Input data for the geometry of the building shell (top) and for the heating system (bottom) at the TEE KENAK software

The corresponding results concerning the energy classification are shown in Figure 2. The calculated primary energy per final use (rows) for the reference building, the examination building and the energy improved examination building (columns) respectively are also depicted. The energy inspector may suggest energy improvement scenarios of the building aiming to the improving of its energy class. The energy interventions may be occurred either at the building shell (e.g., replacement of joinery, placing of internal or external insulation, etc), or at the electromechanical systems (e.g., gas use as a heat source, replacing of the old boiler, automations, compensation thermostats, etc) and hot water for use systems (insulation of the reservoir and the corresponding tubing, etc). The energy interventions associated with renewable energy sources such the installation of solar collectors, geothermal heat pumps and photovoltaic (P/V) systems to cover part of the electric charges of the building, etc, are also strongly recommended. The reduction of the final primary energy for the scenario (third column) and therefore the change of the energy class Z to Δ based on the energy interventions (replacement of joinery, placing of external insulation and installation of a solar collector) in Figure 2 is considered satisfactory.



Πρωτογενής ενέργεια ανα τελική χρήση (kWh/m²)

Τελική χρήση	Κτίριο αναφοράς	Υπάρχον κτίριο	Σενάριο 1
Θέρμανση	32.2	114.6	80.5
Ψύξη	19.5	20.4	18.3
ΖΝΧ	14.5	36.7	2.8
Φωτισμός	0.0	0.0	0.0
Συνεισφορά ΑΠΕ - ΣΗΘ	0.0	0.0	0.0
Σύνολο	66.2	171.7	101.6
Κατάταξη	-	Ζ	Δ

Figure 2. Energy classification results and the calculated primary energy per final use for the reference building, the examination building and the energy improved examination building at the TEE KENAK software

3. ENERGY MAPPING OF THE GREEK RESIDENTIAL SECTOR

In Greece, the final energy demand increased by 27.4% during the 1990s, reaching 19.5 Mtoe in 2002 (EC, 2004; Balaras et al., 2007;). During the past decade, the largest increase in final energy demand was observed in the Greek residential and tertiary sector buildings as a result of the increasing number of buildings and the use of electromechanical equipment (HMD, 2004; Balaras et al., 2007;). For the period up to 2020, the European energy policy is focused on achieving specific individual targets for all the Member-States. More specifically for

Greece, the decrease by 4% of the greenhouse gas emissions for all the sectors except the commercial is pursued compared to the corresponding of 2005. Furthermore, the exploitation by 18% of the renewable energy sources to the gross final consumption is also pursued. Concerning the latter, Greece introduced the law 3581/2010 and thus achieved 20%. Based on the European directive 2012/27/EE, Greece harmonized its energy policy setting as target the reducing of its energy consumption in the period of 2014-2020. To achieve this, the energy conservation in the building sector may play an important role. Assistive ordinances such energy service companies (ESCO), energy efficiency and financing agreements from third parties (TPF), “Green Loans” from banks, etc, contribute to the promotion of the appropriate energy interventions for the energy upgrading in the domestic sector.

The knowledge of the energy characteristics of the building stock not only contribute to the developing of strategies at local and national level but also to the continuous monitoring of the effectiveness of the energy interventions for the energy upgrading. Thus, targeted actions may be implemented aiming to the optimum performance of cost-benefit. Based on the pilot study (Daskalaki et al., 2016) and the Hellenic Statistical Authority (http://www.statistics.gr/), 60% of Greek buildings constructed before 1980 (i.e. belong to the first period) which mostly do not have sufficient thermal insulation.

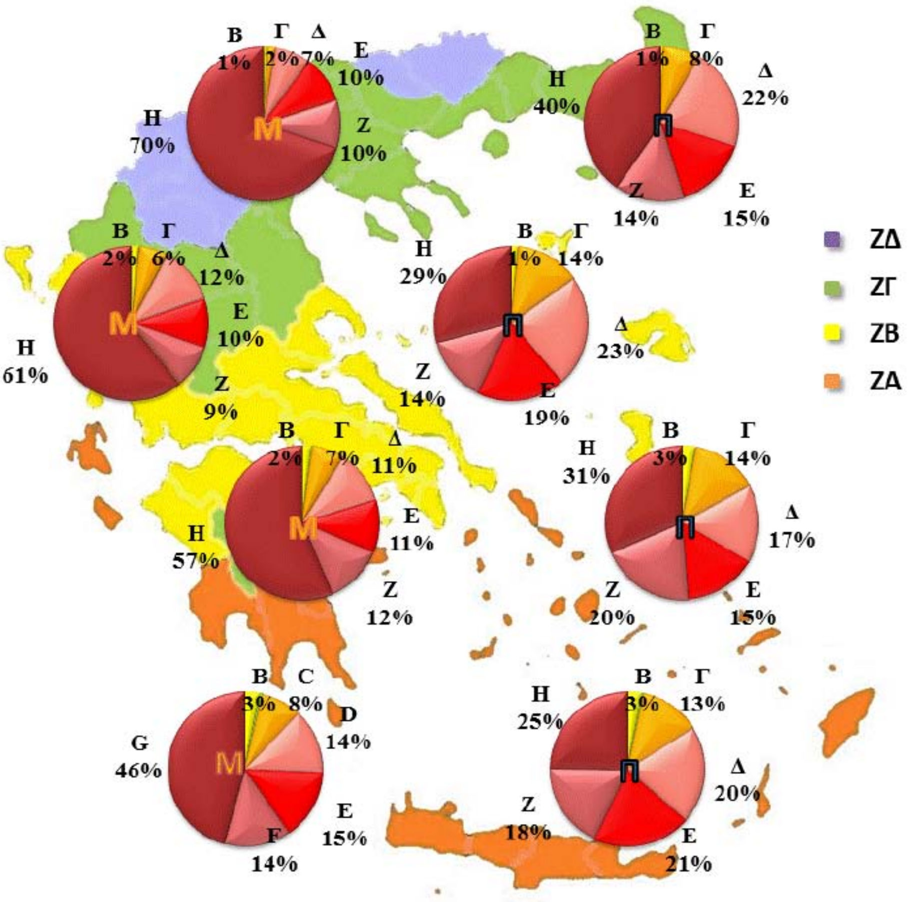


Figure 3. Distribution of the energy classes of the detached houses (M) and block of flats (Π) in Greece per climatic zone (ZA, ZB, ZΓ and ZΔ). Source: (Daskalaki et al., 2016; buildingcert - https://www.buildingcert.gr/)

Also, they are equipped with old electromechanical systems and thus present low energy performance. Further, the fuel that mostly used to cover the total yearly energy thermal energy needs in Greek households is oil (60%). The firewood used in smaller percentage (23.8%) while gas used in even less percentage (7.4%). However, a combined local heating system using simultaneously air-conditioning systems is often utilized. Concerning the hot water for use, the 74.5%, 37.6% and 25.2% of the Greek households uses electric water heaters, solar water heaters and central heating (boiler) respectively. Up to August 2015, about 650,000 EPCs have been issued for various uses of buildings. The vast majority of these concerns residential buildings (85%) while the other 15% concerns tertiary sector buildings. Figure 3 depicts the energy classes of the detached houses (M) and block of flats (Π) in Greece per climatic zone (ZA, ZB, ZΓ and ZΔ). Although the observed high percentage of low energy classes, especially for the detached houses where the predominant energy class is H, the Greek buildings have the potential to reduce them energy consumption by investing to the appropriate energy interventions. A detailed analysis of the actual performance of energy conservation measures and the typical energy interventions at buildings per period of construction is described by (Daskalaki et al., 2016). In the same study, an interesting approach is performed for the creation of a model building stock through which energy conservation measures are implemented towards the achievement of national targets of 2020 and 2030. The ranking of energy conservation measures for the Greek non-residential and residential stock of 2010 have also been calculated (Balaras et al., 2007; Gaglia et al., 2007).

4. MOTIVATIONS FOR THE IMPLEMENTATION OF KENAK

Some selected policy measures planned to be implemented for the achievement of the national target of 2020 of the National Energy Efficiency Action Plan/2014 are indicatively depicted in Table 1.

Table 1. Some policy measures from the National Energy Efficiency Action Plan of 2014

Policy measure	Duration of implementation	Calculated final energy conservation (ktoe)
M1 - Program " Conservation at Home"	2011-2015	83.8
M4 - Energy upgrading of buildings	2015-2020	239.5
M5 - Energy upgrading of public buildings	2015-2020	12.8
M9 - Education and training schemes to managers in the tertiary sector	2015-2020	76.8
M17 - Netting of fines of illegal buildings with energy interventions	2014-2020	107.8

The subsidized programs were an important movement through which incentives for homeowners, prospective buyers or investors were provided. The program "Conservation at Home" of the Ministry of Environment, Energy and Climate Change has managed to offer a package of economic incentives to make energy upgrading interventions in buildings of the residential sector that fulfil certain conditions. Similarly, the "Special Photovoltaic Development Program Power Systems to 10 kWp in buildings" concerning the P/V installation at existing buildings used for housing or micro businesses for electricity production and disposal of the Public Power Corporation (PPC). The main motive of this program was the high price of electricity produced by the P/V systems. At the same time, the clearing of payments for the energy upgrade and the static design of buildings prior to 2003 with the amounts of the specific penalty based on the law 4178/2013 was set ("Confrontation of the illegal construction - Environmental Balance and other provisions"). The aforementioned clearing is carried out for an amount (not exceeding the 50% of special fines) excluding the related fee, which consists of revenue of the state budget.

Enhancements and motivations for the further improvement of this effort under a unified policy framework and structural reforms are proposed. Some of these improvements are:

- The fully mandatory energy audit of consumption and devises during the energy inspections. Thus, reliable policies and interventions may be established as well as comparisons in terms of cost-benefit may be occurred.
- Acceleration of the training and certification of the energy inspectors of heating and air conditioning systems as well as the creation of new specialties in the secondary and post-secondary education as technical assistants.
- Connection of the energy interventions of the subsidized programs with intergraded solutions utilizing alternative forms of energy such as district heating or biomass in entire city blocks or cities. This simply requires the implementation of the law 3661/2008 specifying: (a) the implementation of the active solar systems and other heating, cooling and electricity, based on renewable energy sources, (b) the use of cogeneration systems of electricity and heat, (c) the use of district systems of heating/cooling in entire city blocks and (c) the exploitation of the daylight.

5. CONCLUSIONS

All over Europe, the buildings account for the largest proportion of energy consumption and carbon emissions. The European energy policy has already launched several actions by establishing regulations and creating incentives for energy upgrading of existing buildings. Greece seems that goes in this direction and is synchronized with this European energy policy; the aforementioned efforts of Greece are considered to be satisfactory. Having already this background, a further step may be done incorporating the energy spot of buildings in the property market. Taking account the energy class of each building as an additional indicator to the various properties (e.g. property price, area, geospatial position, etc) of each building that affect the property market, a most complete and representative overview of the building is constituted. Thus reliable conclusions by homeowners, potential buyers or tenants may be extracted. Also, the cadastral and urban planning offices or other national or local institutions may exploit this integrated information. Interesting studies have been implemented that combine energy characteristics and semantic information of buildings (Carrión et al., 2010; Krüger and Kolbe, 2012; Kaden and Kolbe, 2013). Further, sophisticated multi-dimensional land information systems (Ioannidis et al., 2015; Ioannidis et al., 2016) are capable to incorporate the energy class of each building. On the other hand, attractive financing programs or “green” investment funds associated with the energy conservation measures for the energy upgrading of each building may play a major role in the property market. These programs not only may mobilize the market e.g. activation of the technical professions, creation of new jobs, reinforcing of the commercial sector, raising interest of the investors, etc, but also can bring significant social and economic benefits to the state. Thus, the incorporation of the energy spot of buildings can redefine the property market adding more dynamic characteristics.

REFERENCES

Balaras, C., A., Gaglia, A., G., Georgopoulou, E., Mirasgedis, S., Sarafidis, Y., Lalas, D., P., 2007. European Residential Buildings and Empirical Assessment of the Hellenic Building Stock, Energy Consumption, Emissions & Potential Energy Savings. *Building and Environment*, vol. 42(3), pp. 1298-1314.

Carrión, D., Lorenz, A., Kolbe, T. H., 2010. Estimation of the energetic rehabilitation state of buildings for the city of Berlin using a 3D City Model represented in CityGML. Proceedings of the *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences,* Berlin, Germany, vol. XXXVIII-4/W15, pp.31-35.

Daskalaki E.G., Balaras, C., A., Droutsa, K., Kontogiannidis S., 2016. Possibilities and prospects for the energy upgrade of Greek building stock. Final Report of the Programme 'Energy Performance Indicator Tracking Schemes for the Continuous Optimisation of Refurbishment Processes in European Housing Stocks (EPISCOPE)', 47 p. (in Greek)

EC., 2004. European Union energy and transport in figures 2004 edition, Part 2: Energy. Brussels: Directorate General for Energy and Transport, European Commission.

Gaglia, A., G., Balaras, C., A., Mirasgedis, S., Georgopoulou, E., Sarafidis, Y., Lalas, D., P., 2007. Empirical Assessment of the Hellenic Non-Residential Building Stock, Energy Consumption, Emissions and Potential Energy Savings. *Energy Conversion and Management*, vol. 48(4), pp. 1160-1175.

HMD, 2004. National energy balance data. Athens: Hellenic Ministry for Development. (in Greek)

Ioannidis, C., Verykokou, S., Soile, S. and Potsiou, C., 2015. 5D Multi-Purpose Land Information System. Proceedings of the *UDMV 2015*, Delft, The Netherlands, pp.19-24.

Ioannidis, C., Potsiou C., Soile, S., Verykokou, S., Mourafetis, G., Doulamis, N., 2016. Technical aspects for the creation of a multi-dimensional land information system. Proceedings of the *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences,* Prague, Czech Republic, vol. XLI-B2, pp.115-122.

Kaden, R., Kolbe, T., H.,2013. City-wide total energy demand estimation of buildings using semantic 3d city models and statistical data. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences,* Istanbul, Turkey, vol. II-2/W1, pp.163-171.

Krüger, A., Kolbe, T., H., 2012. Building analysis for urban energy planning using key indicators on virtual 3d city models - The energy atlas of Berlin. Proceedings of the *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences,* Melbourne, Australia, vol. XXXIX-B2, pp.145-150.

TEE, 2010a. Detailed national standards of parameters for calculating the energy performance of buildings and the issuing of energy performance certificates. Technical Report 'TOTEE 20701-1/2010', 153. (in Greek)

TEE, 2010b. Detailed thermophysical properties of building materials and check of the

thermal efficiency of buildings. Technical Report 'TOTEE 20701-2/2010', 96. (in Greek)
TEE, 2010c. Climatic data of Greek regions. Technical Report 'TOTEE 20701-3/2010', 78. (in Greek)
TEE, 2010d. Instructions and forms for the energy inspections of buildings, boilers and heating and air conditioning systems. Technical Report 'TOTEE 20701-4/2010', 159. (in Greek)

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