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Research Paper / *Araştırma Makalesi*

Investigation of Ideal Buildings in terms of Energy Performance Value and Energy Identity Certificate in Antalya and Erzurum

Antalya ve Erzurum'da Enerji Performans Değeri ve Enerji Kimlik Belgesi Açısından İdeal Binaların İncelenmesi

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ABSTRACT

In this study, ideal buildings located in different climate regions and different altitudes of Turkey (Erzurum and Antalya) have been investigated in terms of energy identity certificate and energy performance value by using BEP-TR software (Building Energy Performance) developed by Ministry of Environment and Urbanization. In this context, the project data of the buildings (building geometry, mechanical, lighting, heating and ventilation technical values) have been entered into the BEP-TR program. In the light of these data, the amount of net energy required for heating & cooling of the building, the energy requirement for lighting of the building by taking into account the effect of daylight on the building, and consumption of lighting for the areas where the daylight is not utilized have been calculated. The emissions of greenhouse gas from the building have also been determined. The energy performance of the buildings was determined as Class C for Erzurum and Class D for Antalya.

Keywords: *Energy, energy performance, energy identity certificate, Turkey.*

ÖZ

Bu çalışmada, Türkiye'nin farklı iklim bölgeleri ve rakımlarda bulunan illerde(Erzurum ve Antalya) inşa edilen ideal binalar Çevre ve Şehircilik Bakanlığı tarafından geliştirilen BEP-TR (Bina Enerji Performansı) Programı ile binaların enerji kimlik belgesi ve enerji performans değeri açılarından değerlendirilmiştir. BEP-TR Programı'na bina geometrisi, mekanik, aydınlatma, ısıtma, ve havalandırma teknik değerleri gibi binalara ait proje verileri girilmiştir. Bu veriler ışığında binanın ısıtılması ve soğutulması için ihtiyaç duyulan net enerji miktarı, binada günışığının etkileri ve günışığından yararlanılmayan süre göz önünde bulundurularak aydınlatma için gereken enerji ihtiyacı ve tüketimi hesaplanmıştır. Ayrıca, binaya ait sera gazı emisyonu da tespit edilmiştir. Binaların enerji performans değeri Erzurum için C, Antalya için ise D sınıfı olarak tespit edilmiştir.

Anahtar Kelimeler: *Enerji, enerji performansı, enerji kimlik belgesi, Türkiye.*

INTRODUCTION

The energy demand has increased in the last decades in line with rapid population growth and technology developments. Depletion of world energy resources has attracted the attention on efficient and sustainable energy technologies for survival of the future generations (Yaka et al., 2015). For the efficient and economical utilization of energy resources, studies have been expanded from macro-scale to micro-scale in time to cover basic life activities of people. A variety of energy saving measures have been implemented on the energy usage of basic human living activities, such as accommodation, nutrition, transportation and general consumption.

Several studies have been conducted to find out how energy can be used more effectively and how to energy savings can be achieved. Studies in this field have

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mainly used simple hourly calculation method and detailed dynamic calculation method in determination of energy performance levels of complex buildings. As far as complex buildings are concerned, there are zones with the highest values in terms of effective internal gains in the thermal behavior of building zones, and investigations have mainly been performed on hospital buildings with huge energy consumptions (Atmaca et al., 2011). Şener et al. (2011) investigated the influence of energy consumption of lighting in buildings in terms of building performance under different climatic characteristics of Turkey. Five pilot cities have chosen to analyze the lighting energy performance of sample office floor plan and values and lighting energy class have calculated by BEP-TR program. Rey et al. (2007) provided information on building energy legislation and directives implemented at the European Union (EU) level. These directives describe the requirements to reduce CO_2 emissions of buildings and to ensure energy savings at the highest possible level. In the study, a new method has been proposed as “Building Energy Analysis” which provides energy certification to the buildings. Al-Homoud (2001) emphasized the importance of computer simulation programs that can take into account energy saving or energy wasting factors such as the location and structure of buildings especially during the design process of buildings. It was underlined that an alternative of energy simulation analysis in the design process of buildings shall be improved to increase the thermal performance and thus energy consumption shall be reduced. In addition, the most common energy analysis methods in buildings and potential applications of computer technology for simulation and optimization of energy in buildings have also reviewed. The building management has great impacts on performance and occupant satisfaction of the buildings (Borgstein et al., 2018).

It is stated that approximately 40% of energy consumption and 36% of CO_2 emissions in Europe are caused by buildings (European Commission (EC), 2018). In 2002, the EC has published the Energy Performance Directive of Buildings 2002/91 / EC, which aims to improve energy performance in buildings, taking into account the impact of the climate and local conditions. This directive has been further developed and has been transformed into a Green Energy Efficiency Book in 2005 in order to identify the obstacles faced to increase energy efficiency and to solve the problems. In 2006, an Energy Efficiency Action Plan was prepared to emphasize that the buildings are in an important position in terms of energy efficiency. With the Energy Performance of Buildings Directive published in 2010 and the 2012 Energy Efficiency Directive are the EU's main legislative instruments have aimed to enhance improvement of the buildings energy performance.

According to Intended Nationally Determined Contribution covering the period 2012-2030, Turkey aims to contribute to climate change combat in line with its capabilities and national circumstances. Turkey purposes to reduce its energy consumption by taking extensive energy efficiency measures in all strategic sectors such as buildings, industry and transport. Turkey has given impetus to energy efficiency concept by 2007 Energy Efficiency Action. In the Tenth Development Plan (2014-2018) and Energy Efficiency Strategy Paper (2012-2023) at least 20 % energy intensity reduction by 2023 compared with 2010 has targeted. In the building sector, Energy Efficiency Strategy Paper provides for the transition of minimum 25 % of building stocks to sustainable forms of energy by 2023. Turkey's Energy Performance Regulation on Buildings has been published in 2008 by the Ministry of Environment and Urbanization. Within the scope of the Energy Performance Regulation in Buildings, it is legally mandatory for existing buildings over 1000 m^2 to obtain Energy Identification Certificate. Within the scope of this regulation, the calculation method which will be used for the issuance of the energy identity certificate for the buildings was published in 2010 as the BEP-TR Program.

Improving the energy efficiency in buildings can provide economic, social and environmental benefits. In this study, it is aimed to determine the energy consumption of the buildings that meets the housing needs of the people and to provide energy saving by reducing the energy consumption in buildings. In this study, heating, air-conditioning, lighting and greenhouse gas emissions in the buildings were calculated and interpreted within the framework of the BEP-TR program developed by Ministry of Environment and Urbanization of Turkey.

MATERIALS AND METHODS

The BEP-TR software has prepared by the Ministry of Environment and Urbanization and has completed in 2010. The program is based on the Energy Performance Regulation on Buildings for buildings larger than 1000 m^2. The program compares the calculated values of the building with annual energy consumption, CO_2 emission, air conditioning and lighting with a reference building and categorizes the results in an energy class of A-G. BEP-TR program provides the evaluation of the energy performance of new and existing buildings in buildings typologies such as offices, residences, hospital buildings, educational buildings, hotels and shopping malls and commercial buildings.

The main inputs of the energy requirement calculations are ventilation, lighting, heating and cooling Climate data, building geometry, ventilation and thermal properties of the building, building materials and building components, internal comfort conditions related to building function such as temperature and humidity values are the zoning methods and zone information related to building typology.

All areas of the building can be considered as a single zone or can be divided into various zones, so it can be divided into various areas for multiple zoning. This information, which is required to reveal the energy analysis of the building, is made available by the user who uploads the data to the system (all information related to the project's project and regional location). It is the technical data calculated by the relevant engineer who examines the architectural, static, mechanical and electrical files of the project.

Energy performance of buildings are classified into groups. These energy classes are composed of seven letters starting with the letter A followed by the letters B, C, D, E, F, G respectively. The class A class represents the least energy consumption and the class G is the most energy consumption class. Building data is entered in the BEP-TR program and the energy class of the building is determined by the program. Buildings must have at least class C to be acceptable in terms of energy performance. These energy classes and energy performances are given in Table 1.

Table 1. Energy performance classification

Class	Energy Performance, E_p
A	0-39
B	40-79
C	80-99
D	100-119
E	120-139
F	140-179
G	>179

In this study, the data required for the aforementioned energy calculation is determined by examining the static, architectural, mechanical and electrical projects of the building. Energy performance calculated for building with 4 floors. Each building consists of 16 flats. The building is considered to use energy in the whole zone from the outer shell of the building to the other outer shell. For the same building, energy performance was calculated based on the climatic conditions of Antalya and Erzurum. Antalya province represents the Mediterranean climate with cool, mild winters and warm, dry summers and while Erzurum province represents semi-arid climate with cold, snowy winters and hot, dry summers. The indoor usage area of the building is 2.669,88 m^2.

The process description of the energy identification document is as follows: The BEP expert, authorized by the Ministry of Environment and Urbanization, inserts the building data into the BEP-TR program with the password and user name given by the ministry. Then the data entered into the database of the BEP-TR program are calculated resultant form of the energy performance. After the conclusion form is approved by the system, Energy Identity Certificate (EKB) is prepared. The prepared document is delivered to the relevant municipality and the transaction is terminated. The energy calculation of the building in the BEP-TR program is shown in Figure 1.

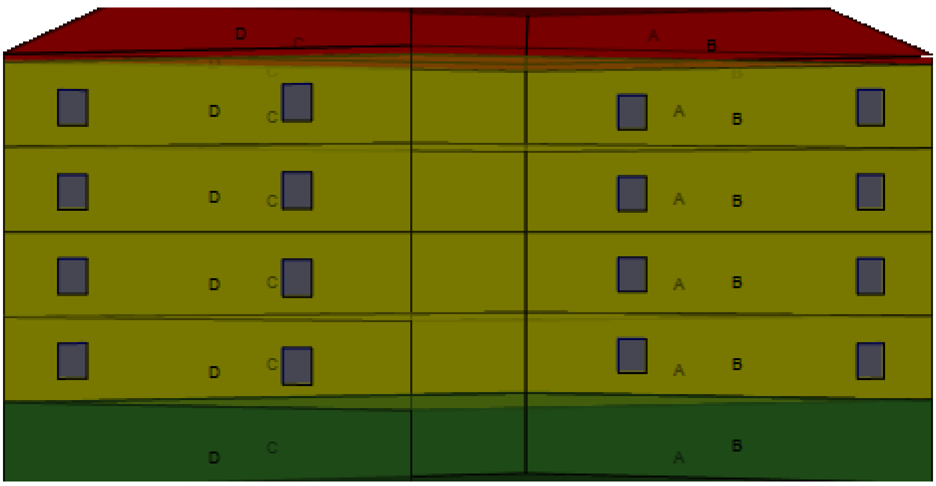

Figure 1. Image of the building in BEP-TR program

RESULTS AND DISCUSSION

The output of BEP-TR program, the energy performance of the building is calculated according to the characteristics of Antalya and Erzurum provinces shown in Table 2 and Table 3, respectively. In the energy performance values calculated by the program are heating, sanitary hot water, cooling, ventilation, lighting, greenhouse gas emission and total energy consumption. Energy usage area, system used, final consumption, primary consumption, consumption values per m^2 are also given in the table. The final energy consumption refers to the sum of consumption of energy and electrical energy from fuels (solid, liquid or gaseous) in the building or independent section by the end user. Primary energy consumption refers to the total consumption of the energy consumed by the end user in the building or in the independent section of the solid, liquid or gaseous fuels and the energy consumed during the production and distribution of the consumed electrical energy.

Table 2. Energy performance program output for Antalya province

Energy Usage Area	Purpose of the System	Final Energy Consumption, kW_h/year	Primary Energy Consumption, kW_h/year	Energy Consumption per m^2	Energy Class
Heating	Heating	20,971.63	20,971.63	7.85	A
Hot water	Hot Water	154,147.68	154,147.68	57.74	D
Cooling	Cooling	466,551.12	1,101,060.64	174.75	D
Ventilation	Ventilation	127.21	300.22	0.05	G
Lighting	Fluorescent	28,448.04	67,137.38	10.66	B
Greenhouse gas emission				101.11	C
TOTAL		670,245.68	1,343,617.54	251.04	D

Table 3. Energy performance program output for Erzurum province

Energy Usage Area	Purpose of the System	Final Energy Consumption, kW_h/year	Primary Energy Consumption, kW_h/year	Energy Consumption per m^2	Energy Class
Heating	Heating	558,627.14	558,627.14	209.23	B
Hot water	Hot Water	154,147.68	154,147.68	57.74	D
Cooling	Cooling	164,388.49	387,956.82	61.57	E
Ventilation	Ventilation	277.64	655.22	0.10	G
Lighting	Fluorescent	28,448.04	67,137.38	10.66	B
Greenhouse gas emission				107.08	C
TOTAL		905,888.98	1,168,524.24	339.30	C

The results obtained from the BEP-TR program revealed the energy levels of the buildings with energy performance calculated are C for Erzurum and D for Antalya. The level C indicates that the building provides the desired energy performance at the basic level, while the D level indicates that the building cannot achieve the desired energy performance.

When the energy performance results have examined in detail, it was observed that heating energy performance for Erzurum was B and for Antalya, it was determined as A. Ventilation and hot water energy performances were the same for both provinces. Ventilation performance was found to be at G level and hot water performance was determined as D. According to the other parameters, the cooling system performance was determined in D level. Greenhouse Gas and Lighting energy performances are the same for both provinces. Greenhouse gas performance was obtained as C class and lighting performance was determined in B class.

When the average temperature of the provinces (Table 4) are considered to evaluate the Energy Performance in Buildings; the heating energy performance in Erzurum province, which is much colder compared to Antalya province, was found to be B, while in Antalya province, the highest performance value A was found. The fact that the heating energy performance for the cold cities is class B indicates that the heating and insulating performance of the buildings is satisfactory. The energy performance in terms of heating is in A class in Antalya due to its geographic location closer to the equator and thus has warmer climate than Erzurum. Heating performance of Erzurum can be increased by applying high quality and thicker insulation.

Table 4. Average Temperature Values (°C) of the provinces

Months	Antalya	Erzurum
January	9.9	-9.3
February	10.4	-7.9
March	12.7	-2.3
April	16.2	5.5
May	20.5	10.6
June	25.4	14.9
July	28.4	19.3
August	28.2	19.4
September	24.8	14.5
October	20	8
November	14.9	0.7
December	11.4	-6.1

Hot Water energy performances are the same for both provinces and D energy performance level has determined. This low performance is achieved because solar energy is not used to as renewable energy sources. None of the buildings examined in this study have solar hot water systems. Especially for Antalya province this performance value is found to be very poor. Because the city of Antalya is exposed to more solar radiation than Erzurum, and thus is expected to benefit more from solar hot water systems.

Ventilation energy performance is the same for both provinces and is determined as G class. Although the energy consumption of ventilation system per m^2 is very small, the energy level G is obtained due to the fact that the results compare the existing building with the building of the BEP-TR program. When comparing the existing building with the virtual building, the program cannot be expected to calculate the ventilation energy performance in a reliable way because the program cannot apply all the features of the existing building to the virtual building. In order to obtain a more accurate and rational result, the program needs a new update.

According to the cooling system energy performance, Erzurum province has Class E and Antalya has Class D performance. Antalya reaches high temperatures especially in summer months. In particular, Antalya is a very touristic region because of high temperature in summer, the usage of air conditioners increases to high levels and therefore the need for energy increases. This promotes energy consumption and consequently lowers the energy performance. In order to avoid this situation, it should be given more importance to choose more energy efficient air conditioning systems and using renewable energy sources in order to meet the energy needs. Although energy consumption Erzurum is lower compared to Antalya, the emergence of energy class E has revealed the necessity to update of the BEP-TR program at certain points.

Lighting energy performance is found to be class B and the same for both provinces. This value is satisfactory and can further be improved. The best way to achieve effectiveness is to use lower electricity consuming lamps such as led technology and to make various arrangements to make use of more daylight.

Greenhouse gas emission energy performance is found to be the same for both provinces and it is in class C. Greenhouse gas value is determined from emission of harmful gases released into the atmosphere. Carbon dioxide gas is the most pronounced greenhouse gases produced from fossil fuel resources. The use of electricity in an efficient manner and the generation of electricity from renewable energy sources will reduce the carbon dioxide emissions and will lead to higher energy performance class. In this sense, Dereli et al. (2013) stressed that the use of distributed solar photovoltaic systems is growing more common as solar energy conversion efficiencies increase while costs decrease.

CONCLUSIONS

In this study, energy performance calculations were performed by BEP-TR program for Antalya and Erzurum provinces in order to investigate the climatic conditions on energy performance of buildings. As a result of the evaluations, it was seen that the buildings could not achieve the desired energy performance values. This shows that there is not enough energy savings in the buildings where energy performance is calculated in comparison with the reference building. In addition, deficiency of using renewable energy sources in the buildings is one of the main factors affecting the energy performance. Building energy-saving applications and the use of renewable energy resources in the building makes the building more energy efficient and greener. Energy efficiency is very crucial for achieving sustainable energy and environment for future generations.

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