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The Importance of Heat Insulation of Dwellings in Turkey for Energy Efficiency

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ABSTRACT

Minimum energy use and minimum environmental pollution are two important basic criteria for achieving environmental sustainability and raising awareness of "design for everybody" approach. Investigating suitable ways of decreasing energy use in life-cycle of buildings gains great importance especially in developing countries. Turkey is an outstanding example of developing countries with its increasing rate of industrialization and urbanization.

Although these processes cause more energy to be used, in the last decade it is an accepted fact that the amount of energy and resource use has to be decreased as much as possible. There are some restrictive measures such as Law no 5627 on the Energy Efficiency in order to limit the large amount of energy usage especially in residential areas. According to this Law every building having a total area more than 1000 m^2 has to have an Energy Identification Card which includes knowledge about the energy performance of the building. In the light of these, the aim of the study is to evaluate the experiences of Turkey in the field of energy efficiency in order to develop some proposals for further research.

The study consists of four sections including a brief introduction about the importance of energy efficiency for a sustainable future. The second section explains the vital importance of heat insulation for the efficient use of energy via some examples. The third section investigates the related Laws and legislations in Turkey and examines the studies undertaken. The paper lasts with a conclusion discussing the real situation in Turkey and proposing some strategies for the future studies in the field of energy efficiency both in physical and socio-cultural terms.

KEYWORDS: heat insulation, energy efficiency, dwelling, energy

1 INTRODUCTION

The buildings' responsibility for %30 of the consumed energy all around the world shows that efficient usage of energy is important from the design of structures to each process. The necessity of "to meet today's needs without compromising the next generation's chance to fulfil their own needs" states that it is essential to aim the efficient usage of energy throughout the processes of architectural design and implementation .building sector as in every field (Brundtland Report,1987).

Meeting the comfort requirements that affects positively the psychological and physiological health is one of the main principles of "design for all" approach. The criterions to consider to adopt and carry out the "to leave a liveable world to the next generation" design philosophy with the principle "design for people" must be minimum cost, minimum energy usage and minimum environmental pollution.

2 ENERGY EFFICIENCY OF BUILDINGS AND INSULATION

The energy efficiency is defined as minimizing the consumed energy amount without prevention of the economic development and social welfare. Global warming, the consumption of limited sources and increasing energy need cause the depletion of natural resources. The precautions intended to provide the environmental, social and economic sustainability can ensure the efficient energy usage. Among these precautions, energy saver architectural detailing and building material selection emerge as an important topic (Figure 1). With an accurate insulation applied in the building envelope, the energy consumption in buildings reduces greatly.

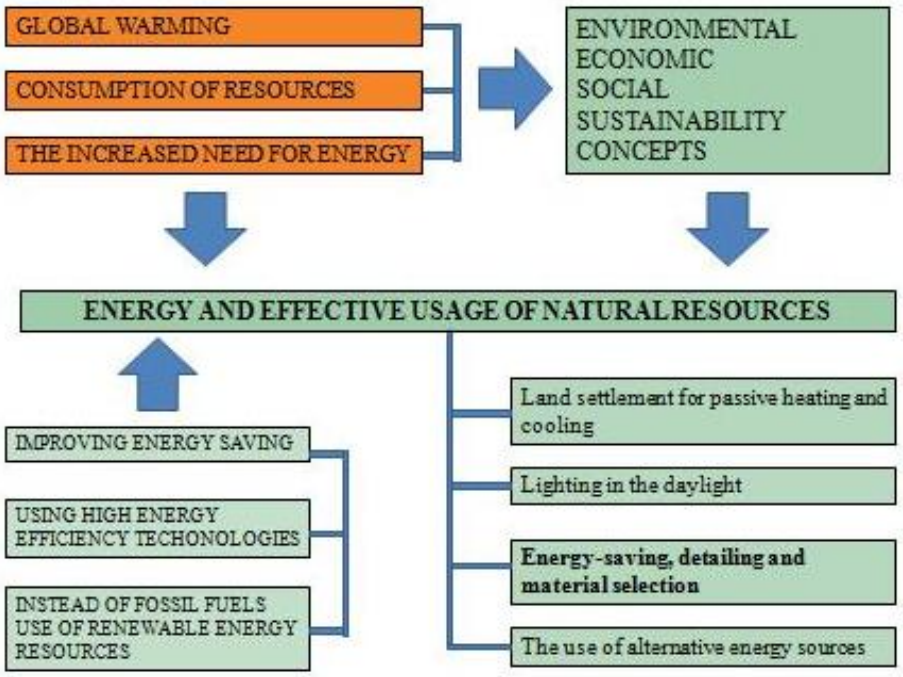

Figure 1: Energy and efficient use of natural resources

Some standards are developed to present sustainable buildings and construction products by various non-governmental organizations, private and public institutions all over the world. Point scoring systems are formed to identify in what degree these standards in buildings have been met. These systems have an important part among the energy assessment criterions.

Criteria-based assessment and certification programs stand out in terms of assessing structures in a more comprehensive and objective way, being easy to be implemented and having results easy to understood. Today, the main systems that many member countries of World Green Building Council (WGBC) have accepted are BREEAM, LEED, CASBEE and SBTool (BREEAM, LEED, SBTool and CASBEE Proceedings, 2005; Kawazu Y., Shimada N., Yokoo N., and Oka T. 2005; Haapio, A., Viitaniemi, P., 2006; Scofield, J. H., 2009; Schimit, A., 2012).

Building Research Establishment Environmental Assessment Methodology developed by Building Research Establishment (BRE) in England is the first example of criteria-based assessment (Grace M. 2000). For the assessments that are going to be carried out in countries other than England; BREEAM International (including Turkey), BREEAM Europe and BREEAM Gulf for countries in the Gulf region are developed (Ayçam, and Tuna, 2010).

The aim of the program Leadership in Energy and Environmental Design" (LEED) developed by the United States Green Buildings Council (USGBC) is to put stress on the environmental affects that have been created during the life cycle of the buildings and lead all the people and institutions' having roles in the building sector to develop their products and activities to decrease these affects to . (Forsberg and von Malmborg, 2004).

SBTool is a general assessment framework that is not applied directly to the buildings alone.It proponents to various countries to adopt this template and adapt it to their own national and regional conditions.

Comprehensive Assessment System for Built Environment Efficiency (CASBEE) developed by Japanese Sustainable Building Consortium (JSBC) and Green Building Council has been prepared by considering the sustainability principles of Asian countries as well as Japan. Different assessment tools are used for design, new buildings, existing buildings and renewal degrees notwithstanding the building function. In Table 1 the main characteristics of these systems are provided.

Table 1 The World's Major Sustainable Building Certification Systems and Assessment Areas (Web-4, Web-5, Web-6, Web-7)

	BREEAM England – 1990	LEED USA – 1996	SBTool Asia - 1998	CASBEE Japan – 2002
Assessment Area	• Management •Health and Wellbeing • Energy (19%) • Transport • Water • Waste • Pollution • Land Use and Ecology • Contamination • Materials • Innovation	• Sustainable Sites • Water Efficiency • Energy and Atmosphere (33%) • Materials and Resources • Indoor Environmental Quality • Innovation in Operations • Regional Priority	• Site Location, Available Services and Site Characteristics • Site Regeneration and Development, Urban Design and Infrastructure • Energy and Resource Consumption (21.6%) • Environmental Loadings • Indoor Environmental Quality • Service Quality • Social, Cultural and Perceptual Aspects • Cost and Economic Aspects • Total System	● Built Environment Quality: • Indoor Environment • Outdoor Environment and Site ● Built Environment Load Reduction • Energy • Resources and Materials • Off-Site Environment
Rating	<30 Unclassified > 30 Pass > 45 Good > 55 Very good > 70 Excellent > 85 Outstanding	40-49 Certified 50-59 Silver 60-69 Gold > 80 Platinum	-1: Negative 0: Acceptable 3: Good 5: Top	Q: Excellent A: Very Good B +: Good B-: Fairy Poor C: Poor

In Table 2, energy consumption for heating purposes in buildings and gain changes rate are provided. It is estimated that the existed buildings In European countries will use up the 2/3 of the energy that Europe will use in 2050 (Henderson et al., 2001). In light of all these data, world countries are giving more importance to insulation every day. Sweden put into action a thermal insulation regulation to provide %50 energy saving in buildings up to 2050. Germany provides low-interest loans to residential users for restoration and maintenance in existing and new buildings. France has made regulations to provide %25 less energy consumptions. Denmark, Ireland and England provide financial supports for insulations of existing and new buildings to be done.

Table 2 Energy Consumption for Heating Purposes In Buildings and Gain Changes in 20 century (B. Edwards, D. Turrents, 2000)

Date:	Consumption Rate:	Gain ratio (passive + insulation):
1900	%75	%25
1950	%60	%40
2000	%40	%60

3 ENERGY EFFICIENCY STUDIES IN TURKEY

The effectiveness of insulation material in energy savings in energy-efficient building design process is a known fact. Insulation materials have high thermal resistance used to decrease heat gain and heat loss. The importance of heat insulation is undisputed in energy efficiency.

When the regulations on insulation applications in Turkey are analysed; it is seen that "TS825 Thermal Insulation Requires in Buildings" was prepared by Turkish Standards Institute in 1970 for the first time. However, the implementation of this regulation was not mandatory at that period. With " Regulation of Abatement of Air Pollution and Heating Steam Plant Fuel Consumption" made by the Ministry of Energy and Natural Resources in 1977 have been broken important ground on this topic. "Regulation of Thermal Insulation" was brought into force on 30.10.1981 and was made various changes on it on 16.01.1985. "TS 825 Thermal Insulation Requires in Buildings" revision studies were begun by the Ministry of Energy and Natural Resources in 1995 and it was brought into force with the consent of TS Technical Board on 29.04.1998. TS 825 Standard was published in the Official Gazette No. 23725 14/06/1999. It has been enforced as a mandatory standard for new buildings to be constructed since 14.06.2000. However, any legal application has'nt been made in existed buildings. After completion of revision studies continued since 2003, the new TS 825 standard published by TSI in May 2008 the most recent amendment has been brought to the calculations of heat loos of buildings (TS 825, 2008). With this regulation it is allowed to lessen the heat loss, annual heating energy requirement is reduced.

Energy Efficiency Law (AB 2002/91/EC framework directive) No: 5627 was made in 2007 with the aim of determination of the principles for protection of environment, prevention of energy waste and effective and efficient use of energy and energy resources. After this law the Regulation of Energy Performance in Buildings (regulation: 05/12/2009) stepped in 2008.In parallel to these developments Kyoto protocol was signed on 26 August 2009.

The Regulation of Energy Performance calculates the amount of annual energy consumption per m2 of existing and new buildings larger than $1000m^2$ and related CO_2 emissions. This internet-based hardware determines the energy performance of a building and accordingly generates the "energy identity card" of the building. "Energy Performance Certification" system began on 01.01.2011 in Turkey. Energy Performance Certificate aims the classification of energy consumption and minimum energy needs of a building. Existing buildings larger than $1000m^2$ (up to 02.05.2017) and the new buildings are

obliged to take the Energy Performance Certificate. In Table 3, energy efficiency studies in Turkey are summarized.

Energy Performance Certificate is a document that contains information about the building, building's energy consumption class, CO_2 emission class, minimum energy need of building, renewable energy rate, heating, hot water, cooling, ventilation, lighting energy consumption class and insulation condition. According to the calculation results, the building is placed in an energy class between A-G (Class A, B, C, D, E, F, G) (Figure 2).

Table 3 Energy Efficiency Studies in Turkey

Date:	**Regulation:**
1970, 1977, 1981, 1985, obligation: 1998, 2000, last revision: 2008	TS 825 Thermal Insulation Requires in Buildings, Turkish Standard
18.07.2007	5627 Energy Efficiency Law
2008 (obligation: 05.12.2009)	Regulation of Energy Performance in Buildings
2009, 2010 (obligation / new building: 01.01.2011 /existing building: up to 02.05.2017)	Energy Performance Certificate

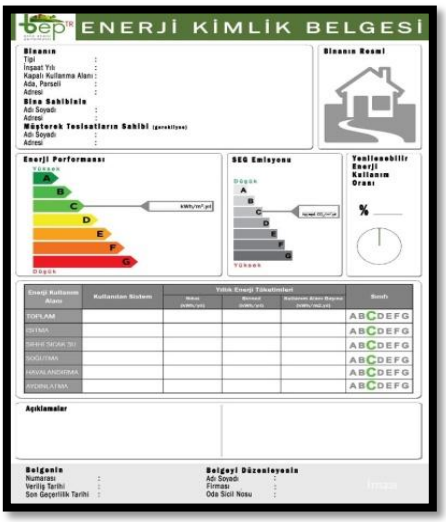

Figure 2: Energy Performance Certificate

Energy Performance Certificate is an important assessment tool in terms of improving the energy efficiency of buildings whose energy class is D and under D, determining the amount of greenhouse gases emitted to environment by buildings and determining the use of renewable energy sources in buildings. As a minimum, it contains information about the classification of the building's energy need and energy consumption, insulation conditions and heating and/or cooling system efficiency. It is valid for 10 years from the date of arrangements. At the end of this time Energy Performance Certificate is reorganized in accordance with a report.

Energy Performance Certificate career education is made by universities, professional associations, related organizations and institutions authorized by the General Directorate of the Ministry of Renewable Energy according to the protocol to do with these institutions and organizations. In 2013 the number of authorized institutions reached 100, which were 18 in 2010.

4 RESIDENTAL ENERGY EFFICIENCY MEASURES IN TURKEY

Considering the situation in Turkey, it is expected that energy consumption will reach 47.5 million tones but 22 % of the total energy demand can be met by domestic production in 2020 (TEVEM, 2012). It is aimed to reduce the annual energy consumption by 10% by 2015, %20 by 2023 by Directorate General for Energy. Among the performance targets of the Ministry of Public Works and Settlement, the topic "Increasing Measures for Energy Efficiency in Buildings" has a great importance.

Ministry of Energy and Natural Sources accepted "Energy Efficiency Strategy 2012-2013" in accordance with the provisions published in the Official Gazette dated 02.20.2012 isolation of housing stock is stated as an aim to reduce the energy consumption of existing buildings for heating and cooling.

Building inventory studies were last made in 2000 in Turkey. According to the data from the 2000 DIA, there are 7 million 858 thousand buildings and 16.2 million houses. As the year 2012, it is estimated that the number of houses is 20 million (Web-2). It is discussed that 5% of the existing housing stock has heat insulation application and only %20 of the building insulation applications are appropriate even after TS825. (TEVEM, 2012). In the light of all these data, it is seen that, it is very important to make attempts in order to improve energy performance of existing buildings, especially in residential areas.

Quick and proper solutions are required to accelerate the return of uninsulated residential buildings to insulated ones. The increase of energy consumption for heating and cooling of houses is the main reason of this need. Up to 2023, it is estimated that with the heat insulation in 10 million houses 2400 GWh cooling and 2.3 million tone fuel saving will be achieved (General Directorate of Renewable Energy, 2012). At this point, an inventory must be prepared about energy efficiency of existing housing stock and minimum source usage. In Table 4, the values of CO_2 emission in Turkey can be seen (Web-1).

Table 4 The Values of CO_2 Emission in Turkey (Web-1)

CO2 Emission	**Million tons**
2009	53.4
2020	> 100

In existing houses, it is determined that CO_2 emission and fuel consumption can be reduced at the rate of almost 30% with insulation applied in wall and roof in accordance with the regulations. This gain's contribution to national economy, users' budget, the protection of houses and environment is significant.

Since 2011, it has been obligatory to have a C class energy performance certificate for all of the new buildings before their occupancy permits. Another obligation is the necessity of having an energy performance certificate for all the buildings in stocks disregarding their classes, till 2017. The aim of these precautions is to improve the physical conditions of the ¼ of the existing buildings in order to make them appropriate for sustainability criteria till 2023. They have to have C Class energy performance certificate in order to be appropriate for sustainability criteria. Validity period of these regulations will begin in 2017. However, this dateline causes the residents to ignore the requirements about their residential buildings. Another factor affecting this negligence is the economic cost of getting these certificates. The number of residential units built since 2011 in Bursa and the number of energy performance certificates they have got can be seen in Table 5. The numbers are according to 2014 data of Ministry of Environment and Urban Planning.

Table 5 Data of built residential units and their certificates in
(Ministry of Environment and Urban Planning,2014)

Type	Number of Buildings	Number of Certificates
Detached House	660	599
Flat in Apartment Block	7096	6867
Flat in Residences	26	25

5 CONCLUSIONS AND RECOMMENDATIONS

Especially as a country having too much housing stock, some solutions are required to provide maximum energy performance from existing houses. At this point, it is highly important that public and private institutions and organizations come together and make necessary law and regulations.

With inclusion of local government, it is possible to prepare Energy Performance Certificates for buildings and initiate the required studies about promoting insulation. However, at this point the parameters affecting the efficiency of the insulation must be kept in mind to get the expected output of insulation applications.

It is estimated that the number of housing units in Turkey will be 25.56 million in 2023. It is supposed that approximately 7.56 million new built housing units will have C class certificate. Another presumption is that, with the help of the refurbishment studies 12.06 million housing units will be energy efficient (Association of Real Estate Investment Companies, GYODER, 2014). Having been conscious about the validity of the situation, the authors put stress on the necessity of stimulating measures for this regulation about the energy efficiency certificate systems in Turkey, where there is a high demand of low and middle income housing units.

Under the Energy Performance in Buildings Regulation, the preparation of energy identity documents of buildings is a narrower-scoped study according to the accepted systems all over the world. It is necessary to be edited a certification system required for various building types. That the regulation is only mandatory for new buildings is not enough. As long as excessive consumption is not reduced, reduction of environmental impacts will be difficult. To be successful in energy saving will be possible with the acceptance of consciousness by the society as a whole. In the next studies, it is aimed to increase of studies including users' consumption of natural sources and share the conclusions with the public to contribute to improving public awareness.

We can indicate the priority works to be done with collaboration of the related actors with a participative approach as follows;

- Design of different certification systems for different regions of Turkey with different types of climates as well as for different types of buildings,
- Development of the related laws and legislations in order to make them be able to describe the things to do not only for the new buildings , but also the existing ones,
- Development and implementation of educational programs for raising the level of awareness about the importance of energy efficiency for a sustainable world,
- Development of collaborative projects in order to raise the public consciousness about minimum natural resource use and minimum energy use

The priority task of the authors is to undertake various case studies and share the outcomes of these case studies with public and local authorities in order to support the studies about raising public awareness. Being conscious about the importance of collaboration, the authors share their knowledge and experiences with people and local authorities within the context of their research projects.

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