Relation of Sustainable Energy and Certification Systems In High-Rise

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Abstract*— Energy efficiency is the system of being able to supply the required energy amount without decreasing the quality of comfort. In this system, in which first our lives and then the whole environment is being affected, there is a wide range from mechanical equipment inside a place to construct of high-rise residential buildings. As the result of apparent increase of population along with progress of technological developments, observing the energy efficiency –by using new construction techniques in the design and construction phases of high-rise residential buildings- has gained importance. The change of construction technique at high-rise residential buildings is also affecting the performance efficiency in the same direction. The factors that affect the performance efficiency of a building may be listed in a wide scope such as air-conditioning (heating - ventilation) systems within the space, lightening management, acoustic quality and noise control techniques, security, use of ecological (sustainable) materials, building fitting (sanitary system) systems, use of central management unit in the building, and intending to make saving in operating costs and to have increase in the building's value. Building's energy efficiency value, that arise as the result of effective design and implementation of performance efficiency at high-rise buildings, is being assessed and certified through green building certification systems such as BREEAM, LEED, GREENSTAR, CASBEE, SBTool, DGNB and BEP-BUY which are valid in the whole world. In this research, the heading of use and conservation of efficient energy –which is one of the main assessment criteria of certification systems having international validity level- has been examined, and the systems' equivalence and differences have been assessed within this frame. As calculation criteria of certification systems –which are loadstar as from the phase of design of and technical decisions regarding high-rise residential buildings– have different percentages, it is being observed that the arising results are also different. As the result of this study, the energy usage percentages of certification systems in different countries regarding green building performance values have been compared. In the assessment made over this comparison, it has been intended to examine the building –being the candidate of obtaining certificate- in respect of energy performance at its project design phase.

Keywords - sustainability, green-building, energy, high-building, design

I. INTRODUCTION

Since the Industrial Revolution, energy recovery has been among the most significant objectives of the countries. Energy recovery and conservation have become the basis of government's economic resources and development policies. The whole world has turned to a factory which is trying to obtain energy in order to meet its national needs, and which is consuming it very rapidly. Energy conservation and recovery has transformed to the most significant parameter not only for the countries' individual objectives, but for the whole world's humanity. In this context, regulations and sanctions have been formed regarding international energy conservation and alternative (sustainable) energy.

According to the decisions made at the International Conference on Human Environment in 1972 at Stockholm, it had been revealed that the whole world is required to make common decisions and to be in cooperation. And the Rio Conference, which was held in 1992, had been carried to a different dimension through the United Nations Framework Convention on Climate Change (UNFCCC) [2]. A 3 years' transition period has been initiated in the energy process of member states of European Union through the publication of Energy Performance of Buildings Directive (EPBD) [3] on January 4, 2003, and each state has started operations for energy recovery – conservation, sustainable energy and national certification programs. Within the scope of this directive, it has been made obligatory for the member states of European Union to form a certification system calculating the energy consumption of buildings.

In the researches made to be able to bring under control the energy consumption, the conservation of the gained energy and necessity to produce alternative (sustainable) energy systems have arose.

II. MATERIALS AND METHOD

Most of the buildings in the world consist of residential buildings, and it has been determined that about half of the energy consumed in the whole world is being consumed for residential buildings.

And in this research, it has been intended to examine the energy consumed at high-rise residential buildings by the certification systems at international validity level, and to compare the data obtained as the result of use of calculation criteria of certification systems that are loadstar during the design of residential buildings.

A. History of Energy Consumption at Residential Buildings

Lodging, which is the first space started to exist in the life of humanity along with the arise of sheltering requirement, has varied as per the requirements and physical conditions of the location of societies. When the residential building, in which different construction techniques and materials are used in order to meet the requirements of the

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user, is considered, we are observing the development steps of the architecture principle.

Two sharp transition periods had occurred in the history of humanity. The first one is transitioning to settled life from nomadism in the prehistoric period, and the second one is transition to industry from settled life (from agriculture economy) in 1760s. In both periods, the sociological life and economic conditions of the society had undergone a radical change, but while the first transition period was a very slow progressing process that lasted for centuries, the second transition period (industry period) had occurred very fast as affecting the whole world. The prosperity, fast production and consumption brought by industry and mechanization had given rise to the requirement of making significant decisions which will affect the whole humanity. As the result of rapidly progressing industry and technological changes, requirement for worker lodgings had arisen due to industrial buildings and migration to cities. As seen in "Fig. 1", lodgings (worker lodgings) built in order to meet the arising lodging requirement had been built very fast without considering the comfort level.

Fig. 1. Worker Lodgings in Industrial Period (Brooklyn public Library-1892)

Along with the industrial revolution, importance had been attached to low cost structure of the lodgings built. In order to decrease the cost of façade, the building had been built back to back or as attached. These lodgings, which could relate the outer environment only from a single facade, had been very unhealthy in terms of living conditions as air circulation couldn't be ensured and as it couldn't be sufficiently benefited from sun. At these buildings, which were planned to be used only for sleeping, solid fuel had been used as heating system.

The lodgings, which were built rapidly and in an unplanned manner, and in which solid fuel was used, had brought along air pollution and various diseases in the whole city. As the result of this condition, the first physical environment control, and inspection of heating and ventilation had again been made in that period [4]. The buildings, which were being warmed up with solid fuel, had started to be warmed up with mechanisms operating with steam, and ventilation systems -by which the air warmed up with such mechanism is circulated inside the building- had been produced. Later on, it had been discovered that hot water could be used in warming up the spaces, and it had started to be used in a widespread manner. And in public buildings, central heating system had been used for the first time, and it had been tried to provide thermal comfort. Central heating systems had then started to be used also in residential buildings. By the mids of 19th century, central heating and ventilation systems had spread to a large part of Europe and North America. Thus, the purpose of sustainability of artificial atmosphere –which is the initial and most significant objective of architecture- had been attained. Also, the foundations of sustainable architecture had been laid in that period. The perspective regarding design and construction of buildings had changed, and buildings which are sustainable, and which don't harm the environment had started to be produced.

In 19th century, the use of coal for heating had brought along the environmental pollution, and the cities had suffered from unclean atmosphere. In that period, it had been started to dwell on alternative energy. Especially along with the energy crisis of 1970, many industrialized countries had verged to renewable resources. The systems, which don't harm the environment and people, and which also don't decrease the comfort level, had entered to our lives within the frame of such conditions.

After the industrial revolution, the conscious of architecture had detached from its traditions, and it had been built on a system trying to solve aesthetical and technical requirements together. By the 20th century, electricity, heating and installation systems -used to plan the energy consumption of the buildings- had arisen. The arising new systems had increased the energy amount to be required during the design, construction and use of buildings.

B. Energy Consumption Systems in Residential Buildings, and Their Development

The new systems (electricity, heating and installation, operating costs etc.), which had in 20th century, had increased the energy amount to be required during the design, construction and use of buildings. The increasing energy requirement had brought along the questioning of the type of energy being used.

Along with the International Conference on Human Environment held in Stockholm in 1972, Rio Conference held in 1992, and publication of Energy Performance of Buildings Directive (EPBD) on January 4, 2003, common decisions and sanctions have started to be formed in the whole world. It has been decided to form energy certification systems for the inspection of current buildings and for the sustainability of the building which will be constructed, and such systems have been supported by the incentive packs declared by the governments.

In the researches performed in order to learn at which points the current energy is being consumed the most, it has been revealed that half of the energy generated is being used at residential buildings in the whole world as seen in "Fig. 2" In this context, the measures taken for residential buildings have gained great importance. Especially the subject of energy consumption arising in recent years has become a criterion which is required to be considered in high-rise residential buildings. Large energy conservation is able to be obtained through a small decision made in the design phase.

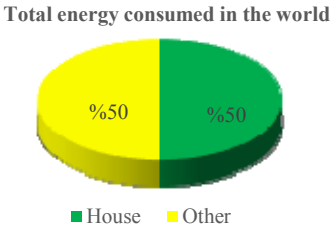

Fig. 2. Energy consumption at high-rise buildings in the whole world.

Changes are being observed in the purposes of the energy policies of each state in the world. As the result of decisions made among member states of European Union and developing countries, different percentages are being observed in terms of energy consumption at residential buildings [6]. As seen in "Fig. 3", 57% of the energy consumed during use of residential buildings in member states of European Union is being used for c, 25% of it is being used for warming up the water, 11% of it is being used for use of electrical appliances, and 7% of it is being used for cooking. And in Turkey, 81% of the energy consumed during use of residential buildings is being used for warming up the space, 11% of it is being used at bathroom and kitchen, and 8% of it is being used for use of electrical appliances [7].

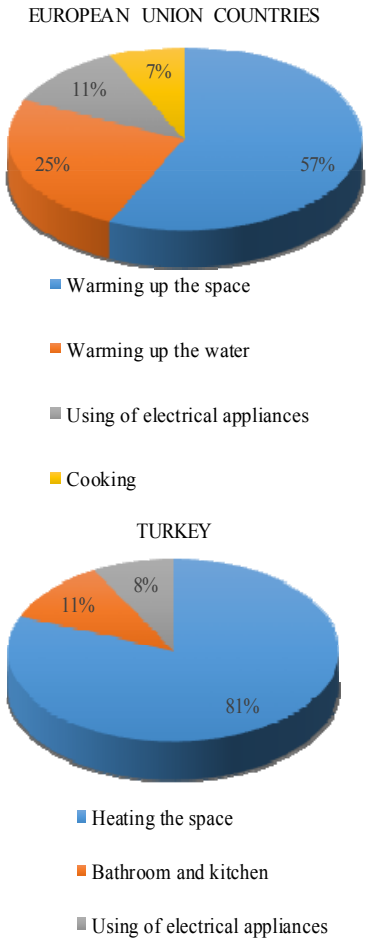

Fig. 3. Energy consumption at high-rise residential buildings in the whole world

All the decisions made from the design phase of a building to its construction phase and to the selection of lightening fixture are directly affecting the energy consumption. The certification systems, which arise in order to keep all this system under control, have different calculation techniques and differentiation as per the headings that they give score. The most significant reason of this difference is the fact that the certification systems have been formed as per criteria of different countries, and the obligation that the initial purpose of each country is to have their system valid in their country. The certification systems' formation year, reference standards, validity period, category types and percentages (scoring) assigned to such categories are the main points that create difference. Despite these local differences, the common purpose of all the green building certification systems has been shown in Table 1.

TABLE I. COMMON PURPOSES OF GREEN BUILDING CERTIFICATION SYSTEMS

	Common purposes
Green building certification systems	For the buildings being in design phase, comparing the energy performance of various alternatives
	Calculating the energy level of current buildings
	Determining the energy certification classes of new buildings
	By calculating energy consumption at regional, national and international scale, preparing preliminary plans for the future
	Intending the formation of national constituent and building inventory in time
	For the buildings being in design phase, comparing the energy performance of various alternatives

C. Green Building Certification Systems

Following the International Conference on Human Environment held in Stockholm in 1972, and the Rio Conference held in 1992, common decisions and sanctions have started to be formed in terms of energy in the whole world. Following the use of BREEAM (BRE Environmental Assessment Method) certification system in England in 1990, SBTOOL has started to be used in Canada by 1996, LEED (Leadership in Energy and Environmental Design) has started to be used in USA by 1998, GREENSTAR (Green Building Council of Australia) has started to be used in Australia by 2003, CASBEE (Comprehensive Assessment System for Built Environment Efficiency) has started to be used in Japan by 2004, DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) has started to be used in Germany by 2008, and BEP-BUY (Energy Performance in Buildings) has started to be used in Turkey by 2010. And by these dates, transition to green building certification systems has been ensured as seen in "Fig. 4".

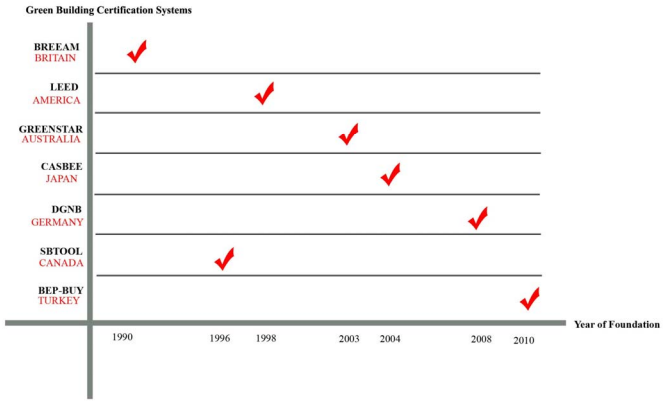

Fig. 4. Establishment dates of green building certification systems in the whole world

The transition of green building certification systems has been ensured as being adhered to currently used standards such as BS (British standards), ISO (International Organization for Standardization), EN (European Norm), CISBE (The Chartered Institution of Building Services Engineers), ASHRAE (American Society of Heating, Refrigeration and Air-conditioning), ASTM (American Standard Test method), JAPON STB (Japan Standards), DIN (Deutsches Institut for Normung), EU STD (European Union Standards) and TR STD (Turkish Standards) as seen in "Fig.5" In the green building certification systems, designed in order to keep the system of the whole building under control, a new construct has been formed which conform to the criteria of the country by combining various standards.

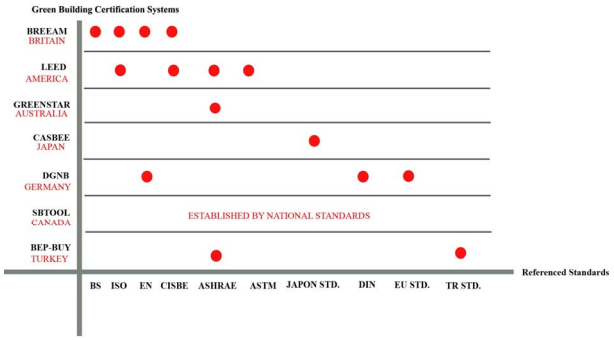

Fig. 5. Relation of green building certification systems with the reference standards in the whole world

Each green building certification system has formed a scoring system by determining sub-headings in the direction of the requirements of the relevant country. And the category of energy is being faced as the common and initial heading of these certification systems. Percentages in the category of energy of BREEAM, LEED, GREENSTAR, CASBEE, SBTOOL, DGNB and BEP-BUY (being the certification system of our country) –from among the internationally valid green building certification systems- are being shown in "Fig. 6"

Each of the green building certification systems has its own different percentages in order to calculate the results based on its purpose of formation and incentives of the country where it is formed. This difference is causing changes in the obtained results. Thus, correct selection of the system that the building –which is required to be calculated- will refer will increase the success of the result. For instance, while BREEAM certification system has assigned a value of 20 percent to the heading of energy, when the same building refers to LEED certification system it will face a system which will be calculated by 50 percent, and when it refers to BEP-BUY certification system it will face a system which will be calculated by 100 percent. As a difference will arise in the obtained value as the result of this difference, a correct result will not be able to be obtained when the proper certification system is not preferred.

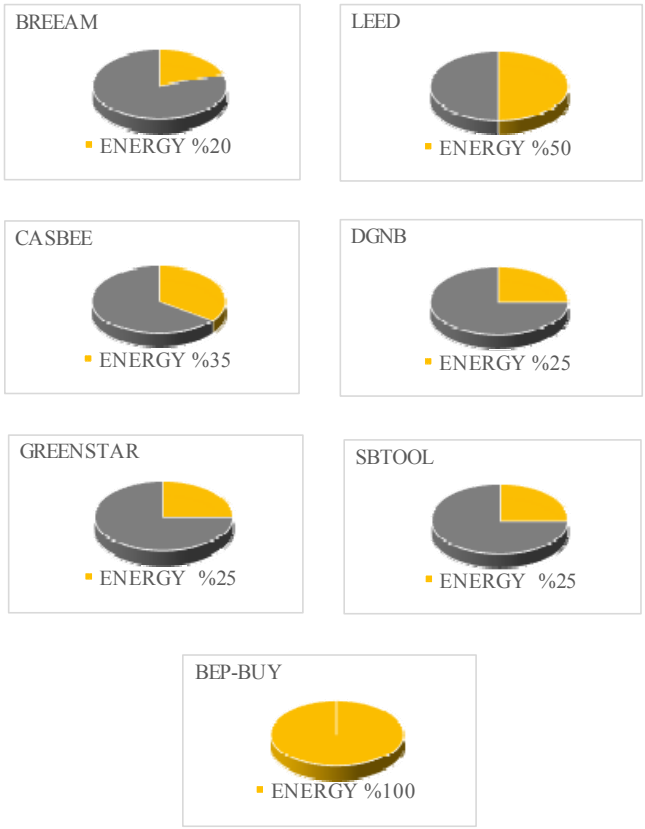

Fig. 6. Percentages of green systems at high-rise residential buildings in the category of energy in the whole world

III. CONCLUSION

In this research, the heading of use and conservation of efficient energy –which is one of the main assessment criteria of certification systems having international validity level- has been examined, and the systems' equivalence and differences have been assessed within this frame. As calculation criteria of certification systems –which are loadstar as from the phase of design of and technical decisions regarding high-rise residential buildings– have different percentages, it is being observed that the arising results are also different. As the result of this study, the energy usage percentages of certification systems in different countries regarding green building performance values have been compared. In the assessment made over this comparison, it is being deemed proper to primarily design the building –being the candidate of obtaining certificate- in respect of energy performance at its project design phase. In addition, selection of the certification system which assigns the highest score to the heading of energy from among the assessment criteria, and the

assessment of the building by such system will enable the building to obtain the highest-class certification certificate that it can obtain.

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