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## THREE BUILDINGS IN ISTANBUL IN THE CONTEXT OF SUSTAINABLE CONSTRUCTION

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### ABSTRACT

The most important aim in terms of sustainable buildings is to deal with the relationship between environment and build-up environment in a new and integrated approach and in a way to enable sustainability. This approach means redefinition of the relationship among all of the urban environment, building and indoor building in the context of environmental (ecosystem), economic and social sustainability. In this context, performance measurement is carried out by creating different environmental assessment methods in many countries. Measurement results are presented as numeric values, and this situation provides easily understood, evaluated and compared results to be offered. In this study, the assumption that there is a complementary relationship among sustainable development, sustainable urbanization and sustainable buildings unlike a clear contrast is taken an essential acceptance.

**Keywords:** Sustainability, Sustainable Construction, Green Building, Environment Assessment Method, LEED,

### 1. INTRODUCTION

It is possible to say that sustainability practices in Turkey are quite new both in the construction sector and in the social public. However, the use of passive and active solar heating systems in small-scale residential buildings, encountering green roof applications in important projects from time to time, local or imported ecological building materials or environment-friendly materials being sold in construction market, and the relative interest in them appear as indicative developments of positive sustainable approach in the architecture and building sector. In addition, buildings such as Siemens Gebze Organized Industrial Zone Facilities, Philips Istanbul Office, Turkish Airlines - Turkish Engine Center, Eser Holding Building and some projects starting to get LEED certificate and Istanbul Varyap Meridian housing project's registering for LEED reveal the increased interest in the subject. Apart from these, many major companies such as Soyak, Tekfen, Metro, Eczacıbaşı, Ağaoğlu have been investing in sustainable design and green building issues. Certificate systems are usually used as a prestige and marketing tool in our country. If it is considered that one of the common purpose of certificate systems is to take building market to ecological structure design, it can be seen as a positive approach to this goal.

However, deficiencies especially in the ecological material sector and high initial investment costs of energy-efficient systems cause green building costs to exceed the market conditions (Çelik, 2009). Applications should be increased and necessary analysis should be carried out in order to make realistic cost analysis in Turkey. The project team formed by Siemens in Gebze in 2008 and which applied to LEED Gold certificate has announced that cost is 1% higher than a standard building. However, there is no operation relating to the green building environmental performance assessment which considers the national conditions in Turkey so far. Lack of evaluation model which can be a reference to sustainability in Turkey, undetermined basic criteria and the absence of a national green building certification system which can carry out environmental performance evaluation are the important factors preventing sustainable building practices.

In a legal sense, however, entries such as "to ensure the protection of environment, agricultural areas and water basins in accordance with the principle of sustainable development, to afforestation, to take measures, make the necessary arrangements concerning waste management " which can provide positive results in terms of sustainable urban development are listed among the duties, powers and responsibilities of metropolitan municipalities in accordance with the Metropolitan Municipality Law no. 5216 (Resmi Gazete/25531,2004). In this regard, the "Energy Efficiency Law" no. 5627 enacted in the charge of Ministry of Energy in order to ensure energy management and efficient use of energy and energy sources is a significant and positive law in terms of a sustainable approach and was issued for effective use of energy, waste prevention, alleviating the burden of energy costs on the economy and to ensure productivity to increase in the use of energy and energy sources for the protection of the environment (Resmi Gazete/26510, 2007). The "Notification Concerning the Tourism Management Certified Accommodation Facilities to be Given the Certificate of Environmentally-Friendly Accommodation Facility" (Green Star Symbol) published by the Ministry of Culture and Tourism is another positive attempt which encourages, promotes sustainability and regulates principles and procedures relating to the "classification of environmentally-friendly accommodation facilities for the protection of the environment, development of environmental awareness, encouraging and promoting touristic facilities for a positive contribution to the environment within the scope of sustainable tourism" (Resmi Gazete/27005, 2008a).

Ecological structure and sustainable architecture are tried to be promoted with the studies carried out in a legal sense in our country. In this context, the Ministry of Energy and Natural Resources, the Ministry of Environment and Forestry, the Ministry of Tourism and Culture, Ministry of Public Works and Settlement and Municipalities have been operating. Although legal infrastructures such as 2008 ÇED Regulations (Environmental Impact Assessment) (Resmi Gazete/26939, 2008b), Green Star Symbol of the Ministry of Tourism, Energy Efficiency Law which will make sustainability possible, and sustainable approaches envisaged in the Law of Metropolitan Municipalities and in the Regulation Concerning the Principles of Environmental Master Plan Making" are modest but initial positive progress for the beginning, it would be appropriate to make more comprehensive and forward studies [8. In this regard, NGO (Non-Governmental Organization) has a great importance, and ÇEDBİK (Eco-Friendly Green Building Council) has been organizing monthly meetings for the realization of this process by creating a certification committee and making plans about how the process should be directed with the support of experts, academics and local governments (Arslan, 2011).

## 2. METHODOLOGY

In this respect, sustainability research is conducted in public mass housing by examining the international green building certification systems primarily in the context of sustainable construction. Environmental performance values of Istanbul Halkalı TOKI Residences which was selected as the material concerning this subject will be evaluated in comparison with the Siemens Gebze Organized Industrial Zone which is a building having the International LEED certificate and the LEED-registered housing project Istanbul Varyap Meridian.

## 3. SUSTAINABLE BUILDING AND LEED CERTIFICATION SYSTEM

The significance of the development of "sustainable human settlements" in Agenda 21, section 7 which was created as an international plan for sustainable development in the Earth Summit in 1992 is especially emphasized (UN, 1992). Presenting "sustainable settlement" as a concept in reaching sustainable development in almost all the result documents of all the global summits and international meetings including 1992 Rio "Earth Summit" and 1996 Istanbul "Habitat II Summit" revealed the sustainable urban development (UN, 1996). Green Building Certification Systems are organized with criteria in order to measure the environmental performance and sustainability of structures in many developed countries at a process which has begun quite recently. There have been different assessment methods largely accepted by many of countries which are members of World Green Building Council (WGBC). Certification systems which envisage measuring the environmental performance of structures has started in England carrying out pioneering studies on this issue by creating BREEAM (2017). Then, certification systems such as LEED/USA (USGBC, 2009), Green Star (2013), SBTool, (2007), CASBEE (2005), HQE (France GBC, 2015), DGNB, (2016), Green Mark/ BCA (2015), (C2C, 2013),

Green Globes (2004, 2008), CSH, (2008), CEEQUAL (2007), BEAM, (2016) were established (Osmanoğlu, 2019).

**Table I.** The Main Issues (Categories) Of Environmental Assessment Methods (Osmanoglu,2019)

	BREEAM	BEAM	LEED	Green Globes	Green Star	CASBEE
<b>I S S U E S</b>	*Management *Health and Wellbeing, *Energy, *Transport, *Water, *Materials, *Waste, *Land use and ecology, *Pollution, *Innovation.	*Management, *Site Aspects, *Materials and Waste Aspects, *Energy Use, *Water Use, *Indoor Environmental Quality.	*Sustainable Sites, *Water Efficiency, *Energy And Atmosphere, *Materials And Resources *Indoor Environmental Quality, *Innovation, *Regional Priority.	*Project Management, *Site, *Energy, *Water, *Materials & Resources, *Emissions, *Indoor Environment.	*Management, *Indoor Environmental Quality, *Energy, *Transport, *Water, *Materials, *Land Use And Ecology, *Emissions *Innovation	1.Environmental Quality; -Indoor Environment, -Quality of Service, -Outdoor Environment on Site, 2.Environmental Load Reduction; -Energy, -Resources& Materials, -Off-site Environment.
	Green Mark	CSH	HQE	DGNB	Estidama	C2C
<b>I S S U E S</b>	*Climatic Responsive Design, *Building Energy Performance, *Resource Stewardship, *Smart and Healthy Building, *Advanced Green Efforts.	*Energy and CO2 Emissions, *Water, *Materials, *Surface Water Run-off, *Waste, *Pollution, *Health and Wellbeing, *Management, *Ecology.	*Energy, *Site, *Components, *Worksite, *Water, *Waste, *Upkeep-Maintenance, *Hygrothermal, *Acoustic, *Visual, *Olfactory, *Quality Of Spaces, *Air Quality, *Health Quality Of Water.	*Ecological Quality, *Economical Quality, *Sociocultural and Functional Quality, *Technical Quality, *Quality of the Process, *Quality of the Location.	*Integrated Development Process, *Natural Systems, *Liveable Communities, *Precious Water, *Resourceful Energy, *Stewarding Materials, *Innovating Practice	*Material Health, *Material Reutilization (Design for Environment), *Renewable Energy Carbon Management, *Water Stewardship, *Social Fairness.

Although the criteria created were developed in accordance with the requirements of each country's conditions, their socio-economic and cultural characteristics, structure, techniques and standards and environmental, and climatic data, some of them such as LEED and BREEAM has gained an international corporate identity. These systems provide a certificate by scoring buildings according to their performances in various categories. All of the international systems reveal the results of performance measurement practices as numerical values, and this situation provides an easily understood, evaluated, and comparable result to be revealed. Key issues and points used by LEED (Leadership in Energy and Environmental Design) to control environmental performance about whether a building has a sustainability approach or not are determined as sustainable sites-26p., water efficiency-10p., energy & atmosphere-35p., materials & resources-14p, indoor environmental quality-15p., innovation in design-6p., regional priority-4p. (USGBC, 2009). Leed has been carrying out building evaluation in 9 different categories, and LEED Green Building Rating System has 4 basic levels. "LEED Certified" is obtained with at least 40-49 points, the Certificate of LEED Silver with 50-59 points, LEED Gold with 60-79 and LEED Platinum with 80 and above (USGBC, 2009). Rating could vary according to certification categories. The requirements as prerequisite are indicated among the criteria, and points are obtained with criteria which are other than the prerequisite criteria (USGBC, 2009):

- Sustainable Sites: A building's site selection and site management is very important for the sustainability of the project. Sustainable sites avoid structuring in lands whose category is not treated before, and aim at minimizing the effect of structures on ecosystem. They encourage landscape

appropriate for the region and intelligent transportation systems, reduce erosion, light pollution and heat island effect, and control rain water,

- **Water Efficiency:** The target of the water efficiency category is to enable water use more intelligently both indoors and outdoors. Water use reduction is achieved with the often use of saving devices, use of plants which need less water for desert areas in green fields and reusing treated water,

- **Energy and Atmosphere:** According to the U.S. Ministry of Energy, buildings in the U.S. use 39% of energy and 74% of electricity which are produced each year. This is the reason why energy and atmosphere category encourages innovative strategies such as efficient use of equipment, monitoring of energy use, the use of renewable energy, efficient design and construction,

- **Materials and Resources:** Many waste materials occur in the stages of building's construction and application. This category encourages reduction of waste materials, reuse and recycle, and the use of recycled materials in designs. It also supports the local material usage,

- **Indoor Environmental Quality:** This category encourages matters such as benefiting from natural daylight, cigarette smoke control, use of materials having a low content of volatile organic compounds indoors, efficient use of air conditioning systems,

- **Innovation in Design:** This criterion seeks to encourage environmentally beneficial activities other than the criteria mentioned above,

- **Regional Priority:** The regional councils, chapters and affiliates of USGBC have identified the locally most important environmental concerns for each region of the country, and have chosen six LEED criteria addressing the local priorities for each region. A project winning regional priority credit gets an additional point in addition to the credit taken by deserving that credit.

## 4. THREE BUILDINGS IN İSTANBUL

### 4.1. Siemens Gebze Organized Industrial Zone (OIZ) Facilities

Siemens OIZ Facilities built in two phases in Organized Industrial Zone (OIZ) in Gebze, Kocaeli has 85.000 m<sup>2</sup> construction living area and approximately 120,000 m<sup>2</sup> closed construction area. For such an investment, an environmentally friendly, healthy and economical building was created by taking green building criteria into account in the design, procurement and construction stages. The building having the green building certification considers the criteria of the Leadership in Energy and Environmental Design (LEED) New Construction ver2.2 and has obtained LEED Gold by taking 42 points in total (Yaman, 2009).



**Figure 1.** Siemens Gebze OIZ Facilities, Kocaeli

### 4.2. Varyap Meridian Residence

For The project consisting of 1500 houses, five-star hotels and business center in Ataşehir, Istanbul is designed as Turkey's first major combined ecological construction project and designed according to LEED certification system. Having a total construction area of 374,000 m<sup>2</sup> including parking spaces and a land area of 107,000 m<sup>2</sup>, 90% of the project consists of green space and 13.000 m<sup>2</sup> of it consists of buildings (Varyap, 2018).



**Figure 2.** Varyap Meridian Residence, İstanbul

### 4.3. Halkalı TOKİ Mass Housing Project

7158 houses were built by Mass Housing Development Administration (TOKİ) 7 regions between 2003-2009 in the field of public housing which is located in the Istanbul Metropolitan Area and subjected in current public mass housing practices. Halkalı mass housing area is 16.9 km away from the center of Eminönü as radius, 20.3 km away as the transport route. The project area is 550 Parcel located in Halkalı mass housing area. The project consists of 560 houses in 12 blocks in total having 11 and 12 floors. There are 4 apartments on each floor. It consists of 10 different type flats and 866 houses in total whose sizes ranging from 52 m<sup>2</sup> to 128 m<sup>2</sup>. The size of the project site approximately 46,500 m<sup>2</sup>. Living area is 7800 m<sup>2</sup>. The total open space including car parks is 38700 m<sup>2</sup>. The parking area is 9500 m<sup>2</sup>. Open green space 29 200 m<sup>2</sup>. Housing blocks are located facing northeast-southwest and southeast-northwest in parallel to the edge of the land over. The middle of the housing blocks is arranged as green space (living-recreation, children's playgrounds and sports fields, plant arrangement, etc.). The area is surrounded by car parks and ways all around its four direction (TOKİ, 2018).



**Figure 3.** Halkalı TOKİ Mass Housing Project, İstanbul

## 5. COMPARISON OF THE BUILDINGS ACCORDING TO THE LEED CRITERIA

### 5.1. Sustainable Sites

Many measures have been taken in Siemens Gebze OIZ Facilities under the "Erosion and Sedimentation Plan," a preliminary criterion for LEED, in order to reduce pollution resulting from construction activities, to prevent the dissolution of dust particles and to prevent erosion. Some of these are "screening to be done with textile material throughout the area, washing of truck tires and application of soil sedimentation systems in water channels. During site selection, OIZ was chosen as a location for the purpose of the protection of productive agricultural land. Shuttle buses have been placed in order to reduce the use of personal cars and reduce the amount of carbon dioxide into the air, the use of bicycles have been encouraged as an alternative transportation source, and bicycle parking spaces has been

located for this purpose. In addition to the park spaces, showers and changing rooms are designed for external personnel's. Again, vehicles used by more than one person and preferential areas for cars with low emissions and high fuel efficiency are reserved in the parking lot in order to reduce fuel consumption and carbon dioxide emissions. As a part of the project, open areas has been left above the standards for the protection of green areas in order to reduce the heat parcel effect, and an intensive greening strategy has been followed with local plants and tress consuming less water in these areas. Perforated blocks have been used in parking lots in order to protect underground water resources and their qualities, to ensure rainwater coming from the field to pass into the soil and to ensure its being absorbed by the soil. Again for the same purpose, re-use of rainwater accumulated on the roof within the building after being stored has been projected. To protect and improve water quality, rainwater coming to the hard landscaping areas (especially paved roads) is directed to the soil instead of rain channels, and filtering is provided here. For the prevention of lighting pollution, building lighting automation is benefited indoors in order to preserve the naturalness of the night. The system is also controlled with the lighting automation outside working hours in order to prevent unnecessary lighting. For outdoor lighting, facade lighting is not used, and Ashrae standards accepted by LEED are considered in environmental and landscape lighting (Yaman, 2009).

For Varyap Meridian housing area, E-5 Highway, Tem Highway and a central location close to airports are chosen as a location, so that convenience of transportation is provided. Together with the bicycle parks designed within the scope of the project, alternative transportation is encouraged in the area. During the field work, the protection of both the upper soil and minimization of the harmful gases coming out from labor, the use of fossil fuel and construction machines which will be spent for both the excavation and filling are ensured by treating the topography of the land as little as possible. Project's preferring indirect lighting for the prevention of light pollution is an appropriate approach in terms of sustainability. Again, not dark and pastel colors are chosen for building facades in order to reduce heat parcel effect. Leaving 90% of the project area as a green space also provides a great benefit in reducing the heat parcel effect. Buildings are located in a way to provide maximum benefit from daylight and landscape to be seen from each floor at the same time as a result of detailed analysis. In addition, contribution to natural ventilation of buildings is provided through the rising current of cool air thanks to the water elements used in environmental regulations.

Although the separations of bicycle and pedestrian paths have not been made to encourage the use of bicycles in TOKI 550 Parcel Mass Housing Area, there are bicycle paths that can be used in housing parcel. But there is no bicycle path or park in the whole area of mass housing. This is not the right approach in terms of sustainability since it causes the use of fossil fuel-powered cars and increase in the amount of carbon dioxide emitted into the atmosphere. Approximately 63% of the project area is left as a green space to reduce the heat parcel effect and for recreational activities. Preference of light-colored paint for more than half of the outer facades of buildings is favorable for reducing the heat parcel effect. There is not a plan for managing rainwater. For the lighting issue in the project, there is no effort about saving the energy used for indoor and outdoor lighting, prevention of lighting pollution and avoidance of unnecessary lighting in order to preserve the naturalness of the night with lighting automation and its being achieved from renewable sources.

## 5.2. Water Efficiency

When we look at the Siemens Gebze OIZ Facilities, local plants have been chosen instead of imported grass and drip irrigation system has been applied instead of sprinkler irrigation system to reduce water consumption. Water obtained from treatment is used for garden irrigation. The use of roof rainwater and water obtained from purification system in landscape areas is a a positive approach in terms of sustainability. 50% water savings has been achieved in landscape irrigation with the implementation of these strategies. Roof rainwater has been sent to the raw water tank by filtering. This water can be both used directly in garden irrigation or in fire extinction equipment and as a utility water by the whole campus. 50% savings has been achieved in building utility water by selecting low-flow toilets, high-efficiency and sensed batteries and waterless urinals. (Yaman, 2009). The most important implementation in terms of efficiency of water supply under the Varyap Meridian Project is rainwater's being collected and used in garden irrigation and re-use of treated sewage-free domestic wastewater with the establishment of the gray-water treatment facilities. Another positive approach to water

efficiency in the project is landscape plants' being selected from more maintenance-free and drought-resistant species. Again within the scope of botanical regulation, natural grassland cover has been used instead of grass due to the fact that it does not need intensive irrigation, mowing, fertilizing or requiring maintenance so often, and overlaps with the ecosystem area. 50% water-saving is expected with the use of natural grassland vegetation.

Watering in landscape areas of Halkalı TOKİ 550 Parcel Mass Housing Area planned to be done manually or with semi-automatic irrigation system. There is no attempt of low-flow toilets, high-efficiency and sensed batteries and waterless urinals as for the reduction of water use. There is no attempt for collecting and reusing roof rainwater either. Therefore, it can be said that there is no positive approach towards water efficiency.

### 5.3. Energy and Atmosphere

In Siemens Gebze OIZ facilities, minimizing the energy consumption per square meter and studies for comfort and quality at the same time has been made by considering the importance of lighting systems in structures and cost-benefit analysis has been prepared in this regard. Ashrae standards has been taken into account in the design of electrical and mechanical systems in the project, and 30% energy savings has been provided thanks to the Ashrae standards. While daylight and motion-legged fixtures have been used in offices, luminaries with DALI ballast (in a way to set the light intensity) are used in production areas. Apart from these, motion-sensor lighting elements are used in corridors and wet areas in terms of energy efficiency. Glass curtain-wall and bright halls which is coming from roof to the floor as a gallery and serving as an indoor garden at the same time are used in offices in order to get the daylight inside in the highest level, and skylights are located on the roof for the production areas in order to reduce electricity consumption. In addition, sunblinds have been used in office facades in order to reduce air-conditioning cooling loads and to increase employee productivity by making an effective shading. Direction, angle and size of the sunblinds are designed as a result of the computer-aided engineering studies. The outer shells of the buildings are designed to make heat insulation in an optimum level. Office building windows are covered with special glasses which let harmful ultraviolet sun rays and energy inside in a minimum level and useful daylight in a maximum level (Yaman, 2009). Roof elements and layers of buildings are also designed in a way to minimize the heat conduction. A lightweight, flexible, resistant to the sun's UV rays, easily used in hot climates and light-colored roofing material, TPO which is used as a roof coating material prevents heat from entering inside by reflecting 85% of solar energy. In air-conditioning, variable air flow air conditioning systems which meet the need of offices for cooling are used with minimum energy consumption with the help of building automation when external air temperature is between 14-20 degrees.

These systems do not only provide energy savings, but also allow different climatizing in different zones in office areas. During the cooling process of buildings, hot water is obtained with waste-heat emerging from Chiller groups. In this way, natural gas savings will be provided by using boilers less. Hot water is obtained with waste heat of pressure air compressor used in the production. Natural gas savings will be provided in this system as well. Energy savings are provided by conditioning (heating) the heat of dirty hot air accumulated in offices and thrown out in the winter and external cooling air, and by conditioning (cooling) cool dirty air accumulated in offices and thrown out in the summer and external hot air. Hot water is obtained by making use of solar energy on roves. An effective natural ventilation is implemented by making indoor heat simulation with the help of computer in order to cool production areas and provide the need of fresh air in summer. Building automation system activating and inactivating automatically heating-cooling and electrical-mechanical systems of all the building will take place in the building. Thanks to this system, not consuming too much energy and operating of systems in the highest performance are targeted (Yaman, 2009).

In the project area of Varyap Meridian, wind and solar energy which are renewable energy sources are used. In this sense, detailed analysis on wind direction, wind speed and for sunbathing have been made, and wind turbines and solar panels have been carried out as a result of these calculations. Since the use of renewable energy sources does not damage the nature and reduces the energy costs, it is a right approach in terms of sustainability. By designing all buildings as intelligent buildings as a part of the project, the latest technologies in plumbing, electrical, heating, cooling and ventilation have been used,

and so energy savings are intended to be ensured. In positioning buildings, orientation has been made in a way to benefit from natural lighting and natural ventilation in a maximum level. By taking daylight inside, savings in energy and cost which will be spent on lighting are aimed to achieve.

Placement of housing blocks in Halkalı TOKİ 550 Parcel Mass Housing Area in a way to face northeast-southwest and southeast-northwest in order to take advantage of the solar radiation more effectively is a positive attitude, positioning of three flats out of four on the floors are provided to be directed to south-east, south, southwest. One flat faces north-east, north, north-west. In this case, it is possible to say that maximum benefit is provided from south direction, and that the design is built in order to benefit from passive solar system more. One of the other ways of passive solar energy utilization is the walls storing heats. This kind of massive walls facing south can be used for heat storage in winter and natural ventilation in summer. But in this example, any massive wall was not built for this purpose. However, hear and water insulation is applied in order to provide the minimization of thermal energy needs of building although it is not very ecological. An application of a passive solar energy system which optimum efficiency is obtained can be possible with an ecological architectural design, but it is understood that architectural approach of this project is not formed in this way. There is no attempt for energy savings according to the Ashrae standards by minimizing energy consumption per capita in buildings, daylight and motion-sensitive faucets or luminaries with DALI ballast (in a way to set the light intensity). Windows are left enough in housing areas in order to take advantage of maximum daylight and reduce electricity consumption, but bright hallways or roof skylights which will receive the highest level of daylight inside in common use areas. Providing optimal thermal insulation of the outer walls of buildings and designing of the roof elements and layers in a way to minimize heat conduction in the same way is positive. However, the use of dark perlite-based concrete tile or marseille type tile as a roofing material causes an effect of heat retention by absorbing UV rays. There is no ventilation and cooling system in buildings. There is no attempt for obtaining hot water making use of solar energy on roves. Building automation system activating and inactivating automatically heating-cooling and electrical-mechanical systems of all the building and also enables the avoidance of excessive energy consumption does not take place in the building.

#### 5.4. Materials and Resources

In Siemens Gebze OIZ Facilities, waste landfill has been created in accordance with the construction waste management plan in order to prevent damage to natural resources and the environment, 75% of construction waste was evaluated by collecting recyclable waste separating. Due to reevaluation of waste in the construction field, less waste was sent to municipality waste area, and contributed to the protection of the environment by providing carbon dioxide which may arise during the waste transportation. In order to protect natural resources, it is considered that materials used in buildings are produced by previously used materials as soon as possible. In this sense, the fly ash in concrete, all kinds of steel material made from recycled iron and increased use of material produced from recycled wood are preferred. Thus, 35% of the total construction materials were used from products made from recycled materials, and prevented consumption of fossil-based fuels arising from the production of new resources and environmental pollution. As a part of the project, local materials were used in 40% of the total construction materials since it is economically advantageous, easy to provide and to prevent air pollution resulting from transportation (Yaman, 2009).

When we look at the materials used in the indoors of flats in Varyap Meridian Project, a natural material "laminated flooring" was used on the ground in halls and rooms. The doors of the interior space are made of wood since it is a natural and recyclable material. Windows are designed as heat-insulated aluminum curtain wall. Aluminum, again, is a suitable material in terms of sustainability because of its being a natural material. By producing windows with double glazing, preventing heat loss and noise pollution were intended. However, satin paint used on the walls can be considered as a bad choice in terms of sustainability because of its being inorganic origin. Ceramic which is a first class organic material has been used on the ground of entrance, hallway, bathroom and kitchen. Materials used on doors, windows and walls are the same with materials used in the living room and rooms.

Since construction technique is "reinforced concrete" in Toki Halkalı 550 Parcel mass housing blocks, the carrier system (structure) consists of concrete (0.2%), sand which has low-energy materials (% 0.01)



and concrete steel (14%) which is a high-energy material. In rough construction, brick which is a medium-energy raw material (1.2%), XPS / EPS thermal insulation board (3.9%), cement (2.2%), lime (1.5%) and low-energy sand (0.01%) have been used. As the finishing materials, plaster consisting of the mixture of cement, lime and sand, and acrylic exterior paint and paste. PVC (10%) which is known not ecological and having high-energy in windows. Materials used in window joinery and insulation are inorganic materials having high-energy and cannot be disappear in nature. As a part of the project, it can be said that carrier system and steel reinforced concrete of rough building materials' being low and medium energy other than PVC and insulation materials are appropriate in terms of ecological structure approach. Common building materials such as sand, cement, concrete, steel, brick are materials that are easily available from the local environment, so that it is possible to prevent air pollution arising from the transportation, to ensure ease of supply and to provide economic advantages. Since these construction materials are organic origin, they can be recycled, and it is possible to say that their resistance is quite good. High resistance prevents additional costs by prohibiting deformation in a short time. Within the scope of the project, an application of separating the recyclable materials and non-recyclable waste as for the use of waste materials has not planned. There is also no study on the use of recycled materials in the project.

### 5.5. Indoor Environmental Quality

In Siemens Gebze OIZ Facilities, indoor air quality management plan has been prepared for indoor air quality problems due to construction activities in order to protect the health and welfare of employees and building users, and has been applied on the area during construction. Materials such as devices and carpet which has been stored in the field and can be affected by humidity has been kept in appropriate places. During the installation of ventilation ducts, brim of the ducts kept closed in order to prevent them to be filled with construction dust. MERV8 (Minimum Efficiency Reporting Value) filters has been used in air-conditioning plants operated during construction. All filters are replaced by a new one before the use of the building. After the completion of construction activities and all internal furnishing (furniture has been established) and before moving, air-conditioning plants are planned to provide fresh air into the building for 10-15 days until approximately 4300 cubic meters of air is achieved for each m<sup>2</sup>. So that the internal environment will be completely free from construction dust, chemical emissions spreaded by materials around the environment and the other harmful substances. The quality and quantity of fresh air is designed on the basis of ASHRAE 62.1 - 2004 in order to provide employees to work in a healthy and productive environment.

Smoking indoors is prohibited by the management in order to prevent employees to be exposed to smoke. In addition to the main branch pipes, flow meters and carbon dioxide sensor screens heavily used indoor are preferred in order to maintain the continuity of fresh air, to ensure employees' comfort and make them feel good, and to monitor the performance of ventilation systems regularly. These devices which are capable of giving audible and visual warning are also connected to the building management system. In case the 10% change in the amount of fresh air from the value set before, intervention by a technical team will be possible with employees there and signal received by the building management system. Considering the sensitivities of human and environmental health, waste and toxic substances (VOC)-free materials have been preferred in buildings. All adhesives and silicones, paints and coatings, carpet and adhesive and the amount of VOC (Volatile Organic Component) in indoors are used within the limits permitted by the relevant standards. Thermal comfort indoors and the interior parts of the outer shell of the building are designed by takins ASHRAE 55-2004 standard as a basis in order to protect workers' health and to ensure their comfort (Yaman, 2009).

As the entire project, the use of materials which are organic origin and do not cause harmful gas discharge is largely taken into consideration for the indoors of Varyap Meridian in order to increase the quality of indoor space. Although applications such as polish, etc applied on wood causes a small amount of gas discharge, this situation is kept in a minimum level which is within the limits allowed by LEED criteria. Buildings have been positioned in a way not to block one's view in terms of visual comfort indoors, so that a panoramic view from each floor has been provided. Together with the positioning of buildings designed in a way not to close other one's views, sunlight coming inside and formation of wind corridors are obtained. In addition, system auditability in closed areas is facilitated with the design of buildings as intelligent buildings.

When we look at the interior design of Toki Halkalı 550 parcel mass housing blocks, it can be seen that ceramics which are a natural material are used on the floors of bathroom, kitchen, hall and balconies. Like the other natural origin materials obtained from underground, ceramics makes the release of radon gas. The first quality wood laminate used in living room and bedrooms are organic and ecological building materials as well. But the wood constitutes the source of some pollutant compounds such as pentachlorophenol, vinyl chloride because of the protective chemical materials used on it. Again protective chemicals used on wooden doors emit volatile organic compounds in inner spaces. Plastic paint is used on satin plaster for interior wall and ceiling. In stair and floor corridors, marble is used on floors, acrylic paint on satin plaster on walls, and plastic whitewash on walls. It can also be mentioned about the careful use of natural materials except for PVC and insulation materials indoors in the light of all this information, and the general negative impact of indoor air quality is kept in a minimum level. Although there are adequate windows in indoors of houses to get fresh air, there is not any arrangement to provide cross-ventilation. In addition, wet areas such as bathroom, we can be vented only by benefiting from chimneys.

### **5.6. Innovation in Design**

Siemens Gebze OIZ campus has been designed with a little intervention to 150,000 square meter plot in the topography as possible, using the existing slopes and turn land structure into an advantage. Protection of the environment, energy and water savings and the use of environmentally friendly materials have been taking into consideration in the project. A healthier, environmentally friendly, high-performance building which is more economical and profitable with its operating expenses has been targeted than the existing building structure, so project planning and construction phases have been carried out in this regard. The project was planned by taking local data into consideration in the detailing stage, a detailed cost-benefit analysis was made for in-source heat pumps, photovoltaic solar panels and roofing issues. However, it was not seen appropriate for the first phase due to high investment costs in Turkey's conditions and long return periods, so that it was decided to re-examine the issue for the second phase in the future again (P. Arslan, 2011).

Performing the project in Varyap Meridian, both landscape of buildings and environment are aimed to be entegrated under the common denominator of ecology together with the main concept of sustainability. Elements of water, children's playgrounds, sports fields, squares, walking-jogging, car and bicycle parking spaces, cafes and social facilities have been designed in landscape arrangements surrounding housing, so that many areas for recreational activities allow the residents to perform in landscape arrangements surrounding housing. A natural habitat was created for birds, butterflies, insects and so on together with the open green spaces which constitute 90% of the project area and waterfront plantation created around the pond, contribution to the sustainability of the ecosystem was intended. The latest technology was used with an innovative approach to all systems such as heating, cooling, ventilation, plumbing by designing buildings as intelligent building. It can be seen that there is no adequate effort (design and detail) for forming creative and innovative designs and which will provide the identification and resolution of the problems created by the building' on then environment in TOKI Halkalı 550 parcel mass housing area, take microclimate and ecosystem into account, support the use of environmentally friendly materials with its recycling, energy, water and resource conservation.

### **5.7. Table of Results**

According to the findings of this study, it appears that the majority of the Varyap Meridian and Siemens OIZ criteria are at a good level. However, TOKI Mass Housing project does not meet the criteria.

**Table II.** Comparison of Three Architectural Projects" According to The Leed Criterias

LEED CRITERIAS	SIEMENS GEBZE OIZ				VARYAP MERIDIAN				TOKİ HALKALI			
	L	M	G	VG	L	M	G	VG	L	M	G	VG
Sustainable Sites (26 p)				O			O			O		
Water Efficiency (10 p)				O				O	O			
Energy & Atmosphere (35p)			O					O	O			
Materials & Resources (14p)				O			O			O		
Indoor Environmental Quality (15p)				O			O			O		
Innovation in Design (6p)		O					O		O			

**Symbols:** L: Low; M: Medium; G: Good; VG: Very Good

## 6. DISCUSSION AND CONCLUSIONS

It can be viewed that there is great progress about sustainable urban development in the context of architecture, construction and housing in developed countries, and that legal, administrative and technical infrastructure is established about issues concerning, and that it has been even more progressing. In this respect, green building rating systems and certification programs are developed are developed for the introduction of comprehensive and objective environmental impacts of buildings and houses in many developed countries. Thanks to these systems, sustainability of architectural and construction sectors of the country where they are developed has been progressing, and manufacturing and service sectors which are related to these sectors show significant progress on this issue as well. Although the discussion of these issues has been made in Turkey for a long time, sensitivity of professionals, building owners and users about the issue can be considered quite new. Even though it is highly debated in public, it is difficult to say that enough policies concerning sustainable urbanization and housing are being developed.

However, it is understood that the concepts of sustainability and ecology are brought to the agenda as a prestige-enhancing and sale-orienter case by the perception of many important companies and real estate manufacturer about this issue in public. Thus, many companies reveal environmentally sensitive, "ecological" or sustainable projects since they realize the increased awareness in society and the rise in the market value for green buildings. In this context, it can be observed that many major companies such as Siemens, Philips, THY, Soyak, Tekfen, Varyap, Metro, Eczacıbaşı, Ağaoğlu have been making investment in the issue of sustainable design and green building.

When the environmental, social, cultural and economic effects of sustainability are considered, it is seen as a concept that should be included in both single-structure design and public housing design processes inevitably. However, as shown by the research in TOKI houses which is responsible for developing and implementing housing policies in Turkey and has the power to affect the housing production directly, sustainable housing strategy is not a basic policy that is taken into account by TOKI. Criteria and the principles of sustainable design are rarely applied or applied without being aware of them such as using insulation and double glazing, etc., and apart from these, it can be understood that there is almost no decision that meets any sustainability criteria. It is also confirmed in the project that the use of recycled materials is not provided, and the use of materials that can harm the environment is available, and there is no study for reusing of treated waste water and regaining solid waste by separating them from recyclable ones. It can be viewed that there is no study for the identification and solution of known problems of the relationship between building and the environment, and the impact of structure on the environment. No creative and innovative trace was found for the effort which takes microclimate and ecosystem into account and supports recycling, energy, materials, resources, water efficiency and economy. Again, when we look at the general design style of TOKİ public housing, no serious effort stands out for sustainable and ecological design in the landscaping works. Roof gardens, balconies and terrace planting, not designing vertical gardens, not preferring grassland which needs less care and water, not purifying and using rain water and waste water for garden irrigation are considered as the

most important outstanding deficiencies in the context of ecological landscape design. Setting the number, the cost and time and even sales income of the houses produced as a target is another aspect of the problem. However, researches reveal that a sustainable building can be constructed with small cost increases as a result of a right design, whereas environmental, economic and social return, and earnings are quite high. Another problem is TOKİ's applying the same type housing projects in regions having very different ecological and environmental conditions such as climate, topography, orientation, sun, geology, etc, socio-cultural characteristics, and TOKİ ignored all this data. This attitude appears to be a very serious and unacceptable faulty policy which consciously or unconsciously ignores environmental, social and cultural continuity. In addition, it would be appropriate if solution which will make unsustainable urban development and the existing building stock in Turkey sustainable is found as soon as possible and traditional solutions produced in the past should be seen as an important reference.

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