



RESEARCH ARTICLE

Assessment of Yalova University Campus according to LEED V.4 certification system

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ABSTRACT

In this paper, a detailed literature review on the LEED Certification system is embedded in to green building certification case study. Within the study, information about the parameters of the LEED system and the algorithm that should be applied in order to get full score from the audit were compiled. The conditions of Turkey were taken into account through the study. The study was presented in an analytical order for scientists to easily access information about the LEED Certification system. In addition, the evaluation required to get an appropriate score from the LEED certification system is given with a case study; analysis Yalova University Campus.

Keywords: Green buildings, LEED certificate, LEED V.4, green campus, sustainable buildings

1. INTRODUCTION

The need for technology and industrialization increases with the increasing population of the world. These needs increase energy consumption, while they also increase the amount of carbon dioxide emissions. The increase in energy consumption increases the interest in renewable energy sources. Alternative searches are considered in order to reduce carbon dioxide emission [1]. 30% of the total energy consumption is realized by the building sector. Residential buildings consume quarter of the energy and the remaining is consumed in public and commercial buildings. According to the data between 2010 and 2017, the energy demand of buildings has increased by 20% worldwide [2].

The green building concept is constantly being developed in order to reduce the negative effects buildings on the environment. The most common green building certification systems used in the world are BREEAM (Building Research Establishment Environmental Assessment Method), LEED (Leadership in Energy and Environmental Design), Greenstar and CASBEE (Comprehensive Assessment System for Built Environment Efficiency), SBTOOL (Sustainable Building Tool) and DGNB (Deutsche

Gesellschaft für Nachhaltiges Bauen) [3]. Green building certification systems have been created to benefit the environment by maintaining the buildings consume less energy, generate less construction and demolition waste, and buildings to have improved water efficiency [4].

There is an increase in the number of efforts to construct and develop sustainable buildings around the world. It is seen that green building projects are designed in line with ecology, health and welfare, economy, CO₂, energy, innovation, indoor environmental quality, management, materials, land use, environmental pollution, transportation, waste and water management, renewable technology.

One of the most popular green building certification systems used in the world is the LEED (Leadership in Energy and Environmental Design) certification system. Figure 1 shows the emblem of the LEED Certification system [1].

In this paper, the LEED Certification system was examined, the parameters of the system were introduced and the action plan that should be done in order to get a full score from the system was studied. Research results in people living in Turkey to access more detailed information about LEED and could

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benefit from the system is targeted to reach potential. This paper is aimed to enable scientists to obtain more detailed information about LEED and reach the potential to benefit from the certificate system.



Fig 1. LEED certification system emblem

2. LEED CERTIFICATION SYSTEM

Extinction possibility of world's fossil fuels that are used for global energy production and human beings' day by day increasing dependency to the energy has affected all industrial sectors as well as construction sector adversely. Construction sector also has been searching new solution methods for this adverse effect. This solution methods were concerned in the past years for finding new energy sources, on the contrary in our day's main concern is to consume our energy by referring and searching energy saving methods. As the result of this searches; green building concept has been initiated by considering; low carbon emission processes, consuming natural resources in energy efficient manner, consideration of user health [5], [6]. Main environmental problems in our days; inefficient and unsuitable use of buildings (consumption of fossil fuels and CO₂ emission), negative trend of waste in energy use, energy losses suffered starting from the feasibility and design stages up to whole stages of production and construction of the buildings and life cycle processes. Because of this, Green Building certification systems are emerged in many countries.

LEED System has been developed by United States of America (USA) Green Buildings Council. Its proliferation has been assured by LEED president of Management Board, Mr Robert K. Watson, between 1995 to 2006 years. LEED Certification System provides knowledge on how to design, construct of a green building and how to manage it and to define the required types of maintenance solutions. As having been internationally recognized green building assessment system, the objective of LEED, to minimize the impacted harms onto environment of the private and state owned buildings in the construction sector and to sustain it by reviewing their life cycle assessment [1].

In order to maintain any building possessing green building features as having LEED certificate; the position of the building, its design, its waste and other pollutant details during the construction and demolition stages, has to be calculated and its productivity aspects have to be monitored. In addition, consideration of healthcare and environmental protection during the life cycle period and usage of natural resources during the construction stages toward affecting positively on human health has to be aimed. The differences between green buildings and classic buildings are given with Figure2.

LEED Certification System consists of various versions as V4, with 8 main credit categories and is distributed to 99 points in TOTAL. Extra 10 points is being taken from 'regional priorities' and 'innovation' categories. In addition to these, another 1 point could also be taken from 're-integrative process' category (this credits is assessed in terms of the maintaining project sustainability). In Table1, LEED system and V4 categories credits points are shown.

LEED point scoring system has certain stages. For any building, in order to obtain LEED green building certificate, it is necessary primarily to comply with the minimum program requirements. In case of the complying these requirements, in order to get certificate mandatory pre-requisites that are not included in the grading system also have to be maintained. For any building, in order to get green building certificate, program main requirements and pre-requisites have to be achieved and the minimum intended objective of 40 points has to be exceeded.

Table 1. LEED system V4 category rating points

LEED Credits	Score
1 Re-integrative process	1
2 Innovation	6
3 Location And Transportation	16
4 Energy and Atmosphere	33
5 Water Efficiency	11
6 Sustainable Sites	10
7 Indoor Environmental Quality	16
8 Materials and Resources	13
9 Regional Priority	4
TOTAL	110

Green Buildings may have 4 different certificate levels. LEED Certificate types are shown in Figure 2.



Fig 2. LEED certificate types

2.1. Advantages and disadvantages of LEED certification system

In a building that has LEED Certificate, in addition to building's compliance of all the legal requirements, it is also assured that the building is designed in comprehensive manner. Thus, more habitable buildings in terms of human health could be achieved by maintaining higher water saving and energy efficiency and less environmental pollution. The advantages of LEED system can be cited as follows;

- Reduces operational cost, maintains increasing asset values,
- Contributes into reduction of amount of wastes that are disposed into fields.
- Maintains energy saving as well as water saving,
- Renders healthier and safer habitable places to the building users.

- Maintains mitigating gas emissions.
- Provides having tax reduction, reconstruction permit, and also other incentives [2].

The disadvantages of LEED system could be cited as follows;

- Higher first investment cost,
- Prolonging the building construction period due to compliance with the mandatory procedures.

2.2. LEED V4 main credits

LEED main credits are consists of 8 headings in total. These headings are cited as follows;

1. Innovation (IN)
2. Location and transportation (LT)
3. Energy and atmosphere (EA)
4. Water Efficiency (WE)
5. Sustainable sites (SS)
6. Indoor environmental quality (EQ)
7. Materials and resources (MR)
8. Regional priority (RP)

Innovation (IN)

It is a category that is placed for encouraging and rewarding the concerned projects in order to exhibit innovative performance. Expectations and scorings under this category are shown in Table 2 [6 – 8].

Table 2. Innovation

No	Score	Credit	Objective
1	5	Innovation	To encourage performing projects having extraordinary or innovative performance features. The more the project having 100 % efficiency, profitability and effectiveness, the more innovative performance features are.
2	1	LEED Accredited Personnel	To encourage the coherence of group that is working for LEED project, furthermore to maintain easing the implementation and certification process.

While making assessments for these credits in Yalova University Campus, it is not possible getting grade from the no.1 and no. 2 credits. In order to get point grade from no. 1 credits, an innovative action should be maintained such as; meting the energy need of the university by utilizing solar power. In order to get point credits from no.2 point, at least 1 person from the university must obtain accredited LEED professional certificate.

Location and transportation (LT).

Expectations and point scorings under this category are shown in Table 3.

Table 3. Location and transportation

No	Score	Credit	Objective
1	between 5 to 9	Place Selection for Local Development	Enhances the development of settlements in urban areas by utilizing existing infrastructure in order to protecting natural resources, to reduce the vehicle traffic in transportation as much as possible, physical activity, walking and outdoor field of interest open air media [8].
2	1	Sensitive Field Protection	Protected areas such as lake, river, natural habitat protection areas, sea, water reservoirs, water resources, sporting areas, agricultural areas, must not be approached nearer than 15 meters and those areas must not be selected as project areas.
3	between 1 to 2	High Priority Field	The project has to be encouraged in such places that require further development and having low development means [9].
4	1	Environmental Density and Usage Diversity	By encouraging the urban areas that have existing infra structure, protecting green fields, habitable fields, and natural resources. To encourage voluntary walking, to increase transportation efficiency, and to reduce the transportation distance by vehicles [10].
5	between 1 and 2	Quality Access to the Mass Transportation	To reduce the vehicle usage as a result of the increasing the usage of transportation areas that having multi selection alternatives, to reduce carbon emissions and greenhouse effect, to mitigate the hazardous aspects onto society health and environment by reducing usage of motor vehicles [11].
6	1	Bicycle Facilities	To reduce vehicle usage by encouraging bicycle usage, to increase physical activity possibilities that affect human health positively. In this regard safer bicycle roads and storing units must be maintained [12].
7	1	To Reduce Car Park Areas	To minimize environmental harms that emerges due to car park activities, field location, automobile addiction and surface rain water.
8	1	Green Vehicles	To aim the usage of alternative fuel consumption vehicles instead of conventional vehicles in order to reduce the pollution [13].

Energy and atmosphere (EA)

It is important in green building design to reduce the energy costs and to increase the energy performance by reducing the energy needs [14]. The most important

and highest point grade providing category is Energy and Atmosphere among the LEED certificate main credits. In fact, buildings are responsible for the largest energy consumption among other sectors [15].

Energy and Atmosphere category, contains different sub-headings such as; the efficient design and construction, follow up of energy usage, usage of renewable energy sources, efficient implementations, efficient devices and illumination systems, energy production in-field or outer-field, and other innovative

strategies [2]. In this category while completing all credits, total 31 point grade can be obtained [16]. All credits and point grading are shown in Table 4. for Energy and Atmosphere.

Table 4. Energy and atmosphere

No	Score	Credit	Objective
1	Prerequisite	Fundamental Commissioning and Verification	It defines the auditing of operating conditions of defined energy consumption systems in buildings and compliance of technical capacity against the standards and technical specifications. The systems that are required to be audited; illumination systems, hot water systems, HVAC systems, renewable energy systems, mechanical, automation systems and electric of the building has been defined in this credits [4, 5, 15].
2	Prerequisite	Minimum Energy Performance	It is aimed to avoid the use of excessive energy, to reduce the potential harms that could be imposed on the environment and economy by considering the energy efficiency for the systems in the building [17]. To define energy performance point grade energy consumptions have to be measured at certain intervals. Energy counters have to be provided in order to measure the total building energy consumption [8, 17, 18].
3	Prerequisite	Building-Level Energy Metering	It is applied for energy management and saving in order to monitor the energy usage in the whole building [17]. The aim is to follow up the energy consumption for certain devices for how much energy is consummated in the building.
4	Prerequisite	Fundamental Refrigerant Management	It is applied to mitigate the harm into ozone layer and to reduce the thickness of ozone layer. If the mechanical coolant systems are used, it provides the usage of systems that do not contain chlorofluorocarbon (CFC) and hydro-chlorofluorocarbon (HCFC), and the products that do not harm the atmosphere [18].
5	6	Enhanced Commissioning	Test and start up systems contain; ventilating systems, heating systems, cooling systems, (HVAC) systems, illumination systems, water supply systems, and renewable energy systems as a whole. Main aim in this credits, to ensure the targeted energy efficiency values at the project commencing period, to be consistent with the resultant measurement values at the project completion period [19].
6	16	Optimize Energy Performance	It is applied for reducing environmental and economic effects due to use of excessive energy in order to increasing energy performance [18]. As per with TS 825 standard, energy consumption amount for building heating must be restricted and overall energy saving must be increased.
7	1	Advance Energy Metering	It is applied for supporting energy management, in order to ensure better energy saving by monitoring building system energy consumption and to catch up better opportunities.
8	2	Grid Harmonization	It is applied for rendering systems as more efficient, in order to maintain energy production and distribution systems more effective and to reduce the greenhouse gas emissions, and to increase the network reliability [7].
9	5	Renewable Energy	It is aimed here to reduce the dependency in the fossil fuel usage and to mitigate the harms on the environment and atmosphere due to the fossil fuel usage by increasing renewable energy usage [20].
10	1	Enhanced Refrigerant Management	It is aimed here, to support the compliance with the Montreal Protocol, to use the suitable fluid in the coolant systems by preventing ozone layer deployment and global warming [18].

It is assessed that only 8 points grade could be taken from credit no#6 from this section for Yalova University. There is not any existing set up for the other headings. Furthermore some point grade could be taken from #No. 7 heading, by integrating SCADA system into electric system. In addition, it might be possible for the University producing its own electricity by PV systems as in [21]. In this regard by utilizing the advantages provided by Ministry of Energy and Natural Resources, self-liquidating investments could be made and total point could also be taken from the No#9 credit point. Finally, coolant gases to be used in air handling unit could be replaced with the environmental friendly gases as per Montreal Protocol, total point could also be taken from #No.10 credit point.

Water efficiency

Reduction of water resources day by day, necessitates the more efficient use of water [22]. There is a category in LEED certification system for water efficiency. To reduce water consumption and re-use waste waters by recycling are also requirements in LEED certificate system. In the LEED certification, usage of water in more efficient manner in indoor and outdoor spaces, usage of more efficient bath tub faucets and toilet tanks are also required by considering the ecologic location of the building. In LEED certificate, water efficiency category consists of 7 credits [23]. In the scope of LEED certificate, while completing all credits, in water efficiency category, 12 credit points can be taken. Credits and credit points for water efficiency category are shown in Table 5.

Unfortunately, Yalova University is not able to score in this regard, due to lacking infra structure facilities in water efficiency. As of start-up of the specially designed rain water collection system operation for Yalova University Engineering Faculty building, under this heading, it is assessed that full point grade of (10) could be taken with the compliance of items 4, 5 and 7 [25]. Furthermore, with the usage of passive systems (non-energy consumption) in cooling towers, point

grade could also be taken from the credit no.#6. Another point grade could also be taken from the credit no.#7, by providing SCADA complied water meters in the campus buildings. In this way, all kinds of water consumption will be able to determined and recorded. In conjunction with starting the record keeping of water meters, further studies could also be initiated toward water regime definition and water consumption reduction.

Table 5. Water efficiency

No	Score	Credit	Objective
1	Prerequisite	Outdoor Water Use Reduction	It is applied for reducing outdoor water consumption reduction. There are some alternatives to reduce the outdoor water consumption. Overall water usage could be made in more efficient manner, such as; the selected plants may need less amount of irrigation water in landscapes. Rain water may be utilized for irrigation, waste water recycling could be made, by a careful selection of the floor coating materials [13].
2	Prerequisite	Indoor Water Use Reduction	Calculating the consumption amount from the water network according to the water users in the building, and planning the use of potable water as %20 or %30 less than the defined standards would help to get a higher score. In addition designing double sanitary water lines from alternative water sources such as drinking water, will help to reduce water consumption [24].
3	Prerequisite	Building-Level Water Metering	Water amount measurements must be made with required measurement equipment's during the construction stages of the building.
4	2	Reduction of outdoor water consumption	In this credit, the aim is to consume recycled grey water or rain water usage instead of potable network water in the irrigation of the plants. In the landscape arrangements due to irrigation efficiency, in case of reducing network potable water by 50% scores 1 point, not to use network potable water scores 2 points.
5	7	Reduction indoor water consumption	Indoor water consumption includes the water consumption inside the building. Selecting the fittings and fixtures from the low water consumption types, such as; selection of low flow rate shower head, provides an effect in water consumption reduction. Among the hot water distribution systems, central circulation cycles could be formed, grey water obtained from recyclable water or rain water, could be designed in order to use these waters for the needs such as toilet flush [13].
6	2	Cooling tower and process water consumption	These systems are utilized for disinfection in air conditioning water supply system, controlling corrosion, and saving in water consumption in cooling tower [19].
7	1	Water metering	This credit, as in line with this study, include installing permanent water meters at least two types or more of the water types such as irrigation, internal plumbing installation equipment, household type hot water, improved hot water, and other process waters [19]. The aim of installing these water meters is to measure water consumption to assist in determining alternative ways of water consumption.

Sustainable lands

Green buildings are environmental friendly structures and aims to minimize the energy consumption. While looking at the case from the sustainability point of view, selection of the land for building construction and land management during the construction stage, are the credits that deserve close care [26]. Sustainable

lands category is related with the effects of the intended building on the project environment and the eco-system. Land greening contains the credits such as, assessing and re-use of rain waters that are falling into project field, access means to the building, heat island effect, reduction of illumination pollution and reduction of overall pollution and wastes relevant to construction [23, 27]. In the LEED system, while complying all credits in the sustainable lands category,

a total of 12 point grades could be taken [28]. All credits and point grades in the sustainable lands category are shown in Table 6.

Since the Yalova University Campus has been designed in such a way not deteriorate the natural structure and to protect the local habitat, can take some points from credit #3, #4, and #5 and;

- i. Due to proper measures are taken with regard to release and discharge of surface

- ii. Due to provision of sufficient green fields and reduction of heat island effect, from credit #7
- iii. Due to provision of suitable illumination design, from credit #8 credit point can be taken.

It is estimated that Yalova University Campus could take 8 credit points out of 12 points from this section.

Table 6. Sustainable sites

No	Score	Credit	Objective
1	Prerequisite	Prevention of Construction Activity Pollutions	It aims to make and implement plans for prevention of construction activity pollutions in project field, any possible decadence in the area during the construction, and the cases such as erosion.
2	Prerequisite	Environmental Site Assessment	Environmental pollution around the construction environment must be controlled and assessed in terms of the human health. In order to define whether environmental pollution is evident or not around the field, first phase Environmental Field Assessment must be made as explained in the ASTM E1527-05 [29].
3	1	Site Assessment	Relevant assessments must be made in order to verify the building sustainability and exploring possible developments for the land. It has to be defined that how these assessments will affect the project after land selection. The assessment must contain the topography, hydrology, climate, flora, fauna, manpower employment, and effects on the human health [1].
4	2	Restore and protect habitat	It aims to protect the natural fields around the land or to repair some parts of the deteriorated fields due to building construction. It aims to impose minimum harm on the land environment due to project [1].
5	1	Open Fields	Open fields must be constructed for social and physical activities in order to maintain direct interaction with the nature. %30 of the total land must be provided as the open fields [28, 29].
6	3	Rain Water management	It is the credit that is used for protecting water balance of the land, controlling the water quality and disposing surface waters [1].
7	2	Reduction of Heat Island Effect	Heat islands are the fields that are warmer to a great extent than the surrounding rural areas due to human activities. The aim of this credit is to reduce the potential harm on the environment into minimum level by reducing heat island effect in the field [7].
8	1	Reduction of Lighting Pollution	This improvement must be made with considering the illumination and light proofing needs. Hence, illumination needs must be met and unnecessary environmental pollution must be avoided [1].
9	1-4	Site Master Plan	This credit includes health projects. In the Health Campus like projects, resting areas must be provided for the patients and visitors. Resting areas must be constructed outside the hospital building.
10	1	Joint Use of Facilities	The aim of this criterion is to provide benefits to the citizens by enabling direct access into open environment and natural fields. While constructing the required fields in this credit, the credit must be met for indoor air quality and outdoor air pollutants concentration strategies [29].

Regional priority

Since the LEED certification is a system of United States of America original, special local regulations has to be taken while being implemented by different countries. A wide scoped extensive study is being done in this regard by USGBC that will enable to achieve the regional integrations. Until the above mentioned study is finalized, this credit is named "Regional Priority" is considered a temporary credits.

Regional priorities are related with the relevant country and location in which the project takes place. For the concerned country that project is implemented, deserved credit points are gained by complying the special geographic priorities and environmental features that are defined by USGBC local councils [13]. 4 credits have been defined in this regard by USGBC regional councils. These credits can be cited as;

optimized energy performance, renewable energy, rain water design, consumption control, and heat island effect, framework. Each credit counts 1 point. While satisfying all credits in this category a total of 4 points can be taken.

Materials and resources (MR)

Effective use of structural materials enables the protection of natural raw materials. Therefore, during the selection of materials, effect on the environment and human health, endurance, economy, and aesthetics have to be taken into consideration [7, 23]. There are various effects of the production and consumption of the structural materials on the global and local environment. There might be some harms imposed on the environment during the extraction, processing, production, and transportation of the materials [30, 31]. One of the underlying credits on the basis of LEED

certification system is re-using of the materials. Possibility of recycling in the materials and use of local materials are the important factors in the evaluation of the materials. Selection of non-local materials causes the environmental pollution and excess energy consumption during their transportation. The review of LEED with regard to materials and resource credits; reveals the aim of minimization of energy consumption, and other adverse effects during the production, processing, transportation, maintenance, and disposal similar issues of the materials that are used during the construction of the buildings. Under

the ‘Materials and Resources’ heading, collection of recyclable materials is considered as pre-requisite. Expectations and relevant point credits under this heading is given with Table 7.

With consideration of this credit, the University Campus may take total points from the credit #3, due to light steel constructions of Energy Systems Engineering Department and Foreign Languages Department buildings, the other buildings may only take 2 credit points. Other buildings may not take credit points from the other issues.

Table 7. Materials and resources

No	Score	Credit	Objective
1	Prerequisite	Collection and storage of recyclable wastes	The aim is to reduce the wastes that are generated by householders, transported into storage areas, and disposed.
2	Prerequisite	Construction and demolition waste management planning.	The aim is to reduce the amount of wastes by recycling that are disposed in the field and in the incineration plants.
3	5	Reduction of the life cycle effects of the building	The aim is to analyse the environmental effects of the products and materials and to ensure their re-use [32].
4	2	Definition and optimization of building products-definition of environmental effects of the products	The aim is, in the Life Cycle Assessment, to maintain the usage of products that have recyclable features, with non-global warming potential, and economic with low cost.
5	2	Definition and optimization of building products-raw material resources	By selecting from ‘Approved Suppliers List’, to be published by raw materials suppliers, at least 20 different products from at least 5 different manufacturers must be procured and used. The raw materials extraction locations, must provide commitments for compliance and obedience to the long term ecologic land use, and minimization of environmental harms that are generated from production processes [33].
6	2	Definition and optimization of building products- material content	The chemicals contained in the products, is recorded into inventory with the defined method for ‘Name and Chemical Service Record No. (CASRN) and the project teams must select the products from ‘Approved Suppliers List’ in order to minimize the usage and harmful effects of the hazardous materials. This credits is used for improvement of life cycle effects of the materials and for encouraging the raw materials manufacturers to produce approved products [3, 34].
7	2	Construction and demolition wastes management	The aim is to reduce the construction and demolition wastes that are disposed in the storage areas and incineration plants, by re-gaining , re-use and recycling of the materials [35].

Indoor places and environmental quality (EQ)

For improving life quality of indoor places, indoor air quality has to be improved, and in order to maintain user health and comfort, low emission content materials have to be used [1, 36]. Providing suitable conditions for the sake human health and comfort in indoor places enhances productivity of humans, prevent stress accumulation, and affects human health in a positive manner. On the other hand, prevention of pollution and controlling indoor air quality is essential in order to improve the indoor places life quality [27]. Basic goal of the indoor places life quality system of LEED certificate is to protect the health and comfort of the house holders. Project equipment, reviews the resultant decisions on the indoor environment that are taken by monitoring indoor air quality, visual, thermal,

acoustic, comfort conditions. In the “Indoor Air Quality” category, there are two mandatory prerequisites that are imposed by LEED. One of them is “minimum indoor air quality performance” and the other one is “tobacco control”. In our days smoking is prohibited in indoor places, hence in the mandatory requirements scope, the requirements of this item have been complied. Expectations and credit points under this heading is given with Table 8 [37].

It is assessed that, about the indoor place quality Yalova University may score 2 points from each of the credits # 4, #5, and #7, may score 1 point from each of the credits #6, #8, #9 and #10, 0 point from credits #1, #11, and #12.

Table 8. Indoor environmental quality

No	Score	Credit	Objective
1	Prerequisite	Minimum indoor air quality	To achieve at least minimum indoor thermal comfort standards to satisfy occupants [38].
2	Prerequisite	Environmental tobacco smoke control	This item is applied for preventing or minimizing the exposure of building inhabitants to tobacco smokes that is received by indoor place surfaces and HVAC distribution systems.
3	Prerequisite	Minimum acoustic performance	Acoustic is accepted as prerequisite mandatory item in school buildings, it pays due care to the reduction of excessive sound severity in line with architectural material selection
4	2	Improved indoor air quality strategies	It is applied for ensuring the comfort, prosperity, and productivity of building house holders by improving indoor place air quality [39, 40].
5	3	Low emission materials	It is aimed for improving air quality, human health and productivity and reducing the chemical pollutants concentrations that might impose harms into environment.
6	1	Indoor air quality management plan in the construction	It is applied for protecting the employees and building house holders by preventing the harmful effects of the pollutants that are generated in the indoor places during the construction period.
7	2	Indoor air quality assessment	It is applied for providing better indoor air quality during the post construction and building occupancy period.
8	1	Thermal Comfort	It is applied for, improving building house holder's productivity, comfort and prosperity by providing better quality thermal comfort.
9	2	Indoor Illumination	It supports the productivity, comfort and prosperity of the building inhabitants in order to provide high quality illumination.
10	3	Daylight	It is applied for providing natural light to the building users and for reducing electric energy to be consumed for illumination.
11	1	Quality scenery	It is applied for providing beautiful scenery to the building inhabitants; it involves the house holder's relations with natural outdoor environment.
12	1	Acoustic performance	It provides, comforted working areas to encourage the prosperity productivity and communication of the house holders by an effective and improved acoustic design [28].

3. ADAPTATION OF LEED V.4 CERTIFICATION SYSTEM INTO YALOVA UNIVERSITY CASE; EVALUATION

In the evaluations, the building has been oriented according to atmospheric conditions such as sun, prevailing wind direction etc. in the design of installation and heat-water insulation systems, sustainable energy approach and ecologic features have been considered. The elements such as the ecologic features that are considered during the project design stage, solid and void volumes that are implemented on the facades, and access features are the important factors that are considered in formation of green buildings [26, 41, 42].

In this study, while assessment credits for the LEED green building are compared with each other, energy, ecology, indoor place environmental quality, environmental pollution and water issues are considered as important credits, on the other hand economy and waste issues are also taken into consideration [43].

The objective of LEED certification system; to reduce energy costs, to reduce carbon emissions, to provide more healthy environments, and to obtain high performance in the key fields of human health and

environment. Among the formed credits in LEED system; aim and requirements, and other requirements that needed for prerequisite and for credit demand are defined. The defined requirements enable the approval of assessed system via development process.

In the LEED certification system, in some cases different alternatives could be offered for different building types under a certain credits. The point grade of some credits may present different values with regard to building types. In some cases sub-headings are shown twice. The first one is prerequisite, the second one is considered as credits. While making selection, the sub-headings of LEED certificate system, is defined by giving references in the tables and figures for point scoring values [18, 43]. In the following section, we have discussed the possible scoring of Yalova University vs LEED credits.

The evaluation process took 6 months. All of the authors have participated in the evaluation process. One of evaluators of this study is International Lead Auditor (Quality environment Safety Energy and Management System). 3 of the auditors are energy system engineers and they have Certificate of LEED Green Building Certificate Systems. The last evaluator is an academician; areas of interest are energy efficiency, green buildings and he is also instructor in Energy Systems Engineering department. But still we cannot add the LEED Accredited Personnel score from

Innovation credit since none of the evaluators have accreditation. The campus scores 54/110 points (Table 9). Details are given as following;

Innovation (6 points)

In order to take full points from this category, at least one academic staff person from Yalova University, must obtain LEED accredited professional certificate and electrical energy needed for the University Campus must be provided from renewable energy sources (e.g Solar Power).

Location and transportation (16 points)

In the existing situation Campus Field takes 12 points out of 16 points. In order to take points from the credit #4, it is recommended that a pedestrian walking road by the sea side must be constructed between Campus and City Centre. By increasing the usage of green vehicles (electrical), encouraging voluntary physical activities by reducing the car park areas, protection of natural living quarters and providing suitable infra structure for bicycle usage, expected credit note could be increased as 3 points.

Energy and atmosphere (31 points)

Yalova University in this category is not able to get credit point from the "optimization of energy performance", "advance level energy measurement", "improved coolant management", "green power", and "carbon foot print" credits. In order to get more points from those credits, campus energy usage must be measured and monitored by SCADA system and alternative ways for better energy saving methods could be defined. On the other hand in order to measure energy consumption in advance level, SCADA system can be utilized. In order to improve energy performance, a general energy modelling for building and relevant simulation study for this modelling could be made. Furthermore, in order to reduce the greenhouse gases emissions, usage of renewable energy sources, e.g. construction of solar power fields over the sea could be provided, Refrigerant agreed in the Montreal Protocol can be used. For reducing the carbon footprint, energy efficient lighting, heating, cooling devices and smart network projects can be utilized.

Water efficiency (12 points)

Yalova University, in this category, has not taken any point from cooling tower water consumption and has taken low point grade from reduction of indoor places water consumption credits. In order to increase the grading of water efficiency category, pump driven passive systems could be used instead of electricity operated fan systems in cooling towers, in irrigation recycled grey water or rain water could be used instead of network potable water in the irrigation. Less water requiring plants could be preferred, water measurement could be provided for each building in order to follow up the water consumption. Higher grade can be achieved from this category, by using grey water that is obtained from recycled water or rain

water. The grey water and rain water can be utilized also in toilet flushes and similar needs.

Sustainable sites (12 points)

In this category, Yalova University has scored 7 points out of 12 points. The Campus has failed to take full point grade from rain water management, reduction of heat island effect, and reduction of illumination pollution. In order to take more point from this category, for reducing the heat island effect for providing shadows, renewable energy sources such as photovoltaics, solar heat collectors could be utilized. In order to increase the intended score, protection of regional habitat, rain water harvest system, covering the roofs with green vegetation could be advised.

Regional priority (4 points)

In this category, Yalova University could score full points due to its natural location. Yalova University's location has the potential to meet all general framework requirements, such as for optimized energy performance, renewable energy, rain water design-amount control and heat island effect. According to Pushkar (2018), by complying with; thermal comfort providing implementations, energy efficient illumination, green vegetation application on the roofs toward preventing heat island effect, and rain water harvest, 4 full score could be taken [45].

Materials and resources (13 points)

Yalova University, in this category, with regard to; life cycle effects reduction of the building, building products definition and optimization- raw materials resources, materials content, and flexible design credits has not been qualified to take any points. In order to increase the expected points from this category, waste materials that could be re-used in other fields, the building materials may have selected from bio-accumulation, having less toxic chemical content, coating materials to be used for internal and external facade of the building. Lead containing materials must not be used, building materials and products of having life cycle assessment info and life cycle assessment labels could be preferred. If the University may present some objective proofs that above specified materials are selected and used in the existing buildings, it may take some points from this section as well.

Indoor places and environmental quality (16 points)

Yalova University in this category, with regard to; thermal comfort, indoor place illumination, day light, and acoustic credits has not been qualified to take any points. In order to take full points from this credit, university may define a strategy for maintaining thermal comfort in winter months, in order to provide thermal comfort. A thermal management system that is connected to SCADA system may be utilized. High quality illumination systems may be preferred. The building design may be made in such a way to utilize the day light for a maximized period, and provide better sound insulation in the classrooms for preventing external noise. University may take some

points from this credit provided that full or partial compliance is made for the above mentioned issues.

Table 9. Evaluation of Yalova University according to LEED V4

LEED Credits	Score	LEED Score
Innovation	0	6
Location and Transportation	12	16
Energy and atmosphere	8	33
Water Efficiency	10	11
Sustainable sites	7	10
Regional priority	4	4
Materials and resources	3	13
Indoor environmental quality	10	16
Total Score	54	110

The certification systems, encourages the use of natural resources in proper and non-harming manner. In Turkey, scaling of all kind of new or existing buildings by LEED or similar certification systems has to be encouraged in order to use natural resources in right places and in suitable manner. Therefore, public institutions has to lead this implementation and to pose a good sample and publishing their annual gains in this regard every year could be useful for industrial encouragement. Besides, if the defined tax for these green buildings is kept fairly lower than the conventional buildings a promotive instrument can be gained as well.

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