YAŞAR UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
MASTER/PhD THESIS

PROPOSAL OF AN EVALUATION METHOD WITH COMPARISON TO INTERNATIONAL METHODS OF BUILDING ENVIRONMENTAL ASSESSMENT TOOLS IN TERMS OF CERTIFIED INDUSTRIAL STRUCTURES IN TURKEY

Hande KOÇ KAYHAN

Thesis Advisor: Asist. Prof. Dr. Ecehan ÖZMEHMET

Department of Architecture

Presentation Date: 10.09.2014

Bornova-İZMİR
2014

YAŞAR UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

PROPOSAL OF AN EVALUATION METHOD WITH COMPARISON TO INTERNATIONAL METHODS OF BUILDING ENVIRONMENTAL ASSESSMENT TOOLS IN TERMS OF CERTIFIED INDUSTRIAL STRUCTURES IN TURKEY

Hande KOÇ KAYHAN

Thesis Advisor: Asist. Prof. Dr. Ecehan ÖZMEHMET

Department of Architecture

Presentation Date: 10.09.2014

Bornova-İZMİR
2014

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a dissertation for the degree of master of science.

Assist.Prof.Dr. Ecehan OZMEHMET (Supervisor)

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a dissertation for the degree of master of science.

Assist.Prof.Dr. Gulnur BALLİCE

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a dissertation for the degree of master of science.

Assoc.Prof.Dr. Mujde ALTIN

Prof. Dr. Behzat GÜRKAN
Director of the Graduate School

ABSTRACT

PROPOSAL OF AN EVALUATION METHOD WITH COMPARISON TO INTERNATIONAL METHODS OF BUILDING ENVIRONMENTAL ASSESSMENT TOOLS IN TERMS OF CERTIFIED INDUSTRIAL STRUCTURES IN TURKEY

KOÇ KAYHAN, Hande

MSc in Architecture
Supervisor: Asist. Prof. Dr. Ecehan ÖZMEHMET
September 2014

In todays developing and changing world, changes in climate and environmental manhunt have been one of the most important problems that people are trying to cope with. These problems have been examined in the field of architecture and it has caused to necessarily include the concept of continuity in literature and practice of architecture. New construction systems that can work in harmony with the environment have started to appear with the need of sustainable development and sustainable architecture. Building environmental assessment methods like LEED, USA, (Leadership in Energy and Environmental Design), BREEAM, UK, (Building Research Association Environmental Assessment Method), CASBEE, Japan, (Detailed Assessment System for the Buildings Environmental Effectiveness) have started to be used with these applications in different climates, geographies and societies.

Industrial buildings which have heavier environmental load during construction, occupancy, demolishment stages compared to the other structure types due to their great sizes and dense user quantity residing in them have carried an important role in terms of applying the sustainability concept.

Within this scope in this thesis, it is aimed to analyze the international environmental assessment methods by means of their comparison. Basic environmental assessment methods have been analyzed and the assessment methods they use and their approach to the subject is released. With the methods analyzed, determination of the industrial structures, environmental performance, solution of the addressed problems, the points to be considered and assessment of these buildings in the process of creating environment sensitive structures are aimed.

Key words: sustainability, sustainable architecture, building environment assessment methods, industrial buildings, Turkey.

ÖZET

ULUSLARARASI BİNA ÇEVRESEL DEĞERLENDİRME YÖNTEMLERİNİN KARŞILAŞTIRILMASI VE ÖNERİLEN YÖNTEM ÜZERİNDEN TÜRKİYE'DEKİ SERTİFİKALI ENDÜSTRİ YAPILARININ DEĞERLENDİRİLMESİ

KOÇ KAYHAN, Hande

Yüksek Lisans Tezi, Mimarlık Bölümü
Tez Danışmanı: Yard.Doç.Dr. Ecehan ÖZMEHMET
Eylül 2014,

Gelişen ve değişen dünyada, yaşanan iklimsel değişiklikler ve buna bağlı yaşanan çevre tahribatı, insanların uğraştığı en önemli sorunlardan biri haline gelmiştir. Bu sorunlar mimarlık dünyasında araştırma kapsamına alınmış ve sürdürülebilirlik kavramının bir zorunluluk olarak mimarlık literatürüne ve uygulamalarına dahil edilmesine neden olmuştur. Sürdürülebilir gelişim ve sürdürülebilir mimarlığa duyulan ihtiyaçlar ile birlikte çevreyle uyumlu çalışabilecek yeni yapım sistemleri oluşmaya başlamıştır. Bu uygulamalarla birlikte farklı iklimlerde, coğrafyalarda ve toplumlarda LEED, ABD (Leadership in Energy and Environmental Design), BREEAM, Birleşik Krallık (Building Research Association Environmental Assessment Method), CASBEE, Japonya (Detailed Assessment System for the Buildings Environmental Effectiveness) vb bina çevresel değerlendirme yöntemleri kullanılmaya başlanmıştır.

Büyük ölçekleri ve barındırdıkları yoğun kullanıcı sayısı nedeni ile, yapım, kullanım, yıkım aşamalarında çevresel yükleri diğer yapı tiplerine göre çok daha fazla olan **endüstri yapıları** sürdürülebilirlik kavramının uygulanması açısından önemli bir rol üstlenmiştir.

Bu tez kapsamında, uluslararası çevresel değerlendirme yöntemlerinin karşılaştırılarak analiz edilmesi amaçlanmıştır. Başlıca çevresel değerlendirme metotları incelenerek, kullandıkları değerlendirme yöntemleri ve konuya yaklaşımları ortaya konulmuştur. İncelenen bu yöntemler ile de endüstri yapılarının çevresel performansının belirlenmesi, ele alınan sorunların çözümü, göz önünde bulundurulması gerekenler ve çevreye duyarlı yapılar oluşturma sürecinde bu yapıların değerlendirilmesi hedeflenmiştir.

Anahtar Kelimeler: sürdürülebilirlik, sürdürülebilir mimarlık, bina çevresel değerlendirme yöntemleri, endüstri yapıları, Türkiye

ACKNOWLEDGEMENTS

First of all, i would like to thank to my supervisor **Assist. Prof. Dr. Ecehan ÖZMEHMET** for her incessent help during my thessis study and guidneess since my undergraduate education. She was always available for my questions and she was positive and gave generously of her time and vast knowledge.

My thanks and appreciation also goes to my thesis committee members, **Assist.Prof.Dr. Gulnur BALLİCE** and **Assoc.Prof.Dr. Mujde ALTIN**.

I would like to thank, in addition, to Inci Aku Factory board member Ece EELBİRLİK and Technical Manager **Değer ÖZKÖK**, Siemens Factory, Gebze, General Manager **Unal ANAÇ**, Schnieder Electric Adh Factory, Adh Unit Facility Manager **Fuat ORS** and to Türk Telekominikasyon A.Ş., Manisa Electrical Engineer **Tayfun AYDIN**, to Construction Engineer **Cahit Ulaş Durlu** and to Construction Engineer **Yiğit BAĞDER** for help on my thesis study.

I would like to thank to my mother **Güler KOÇ**, my father **Mustafa KOÇ**, my brother **Halit Can KOÇ** and my best friend Lawyer **Pelin EVRANOS** for their unique support and encouragement.

And finally i would like to thank to my husband **Kerem Onur KAYHAN** for his unconditional support, unending love and understanding.

I wish that my study will be helpfull to all architects and other people in our sector.

TEXT OF OATH

I declare and honestly confirm that my study titled "**PROPOSAL OF AN EVALUATION METHOD WITH COMPARISON TO INTERNATIONAL METHODS OF BUILDING ENVIRONMENTAL ASSESSMENT TOOLS IN TERMS OF CERTIFIED INDUSTRIAL STRUCTURES IN TURKEY**", and presented as Master's Thesis has been written without applying to any assistance inconsistent with scientific ethics and traditions and all sources I have benefited from are listed in bibliography and I have benefited from these sources by means of making references.

10 / 09 / 2014

Hande KOÇ KAYHAN

TABLE OF CONTENTS

CHAPTER 3
INTERNATIONAL BUILDING ENVIRONMENTAL ASSESSMENT METHODS

CHAPTER 4

EVALUATION OF THE INDUSTRIAL BUILDINGS IN TERMS OF BUILDING ENVIRONMENT ASSESSMENT METHODS IN TURKEY

CHAPTER 5

CONCLUSION AND SUGGESTION

INDEX OF FIGURES

INDEX OF TABLES

INDEX OF ABBREVIATIONS

ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers

BEAM: Building Environmental Assessment Method

BEPAC: Building Environmental Performance Assessment Criteria

BRE: Building Research Enstitute

BREEAM: Building Research Enstitute Environmental Assessment Method

CASBEE: Comprehensive Assessment System for Building Environmental Efficiency

SBTOOL: Sustainable Building Challenge

HK-BEAM: Hong Kong Building Environmental Assessment Method

HVAC: Heating, Ventilating and Air-conditioning

LEED: Leadership in Energy and Environmental Design

USGBC: United States Green Building Council

CHAPTER 1

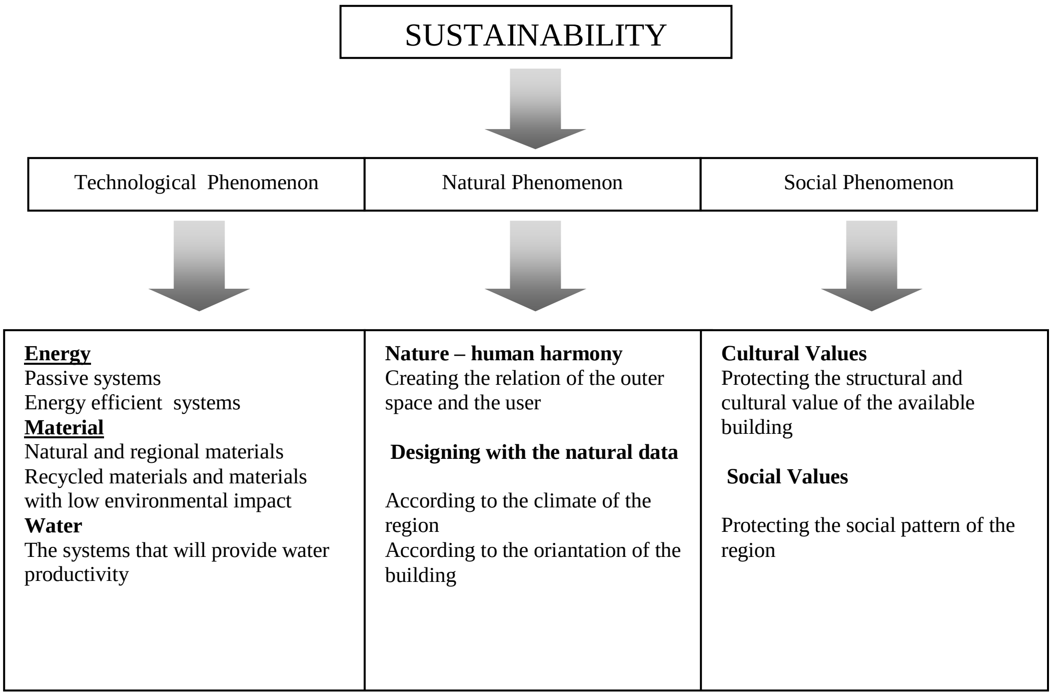
INTRODUCTION

Today, environmental conditions as well as the design of the buildings affect the quality of our lives directly. It is possible to positively assess these conditions that affect our quality of life by means of sustainable approaches. Global warming, water shortage, environmental pollutions and the rapid consumption of the natural resources have revived the construction of environment aim responsive in the building sector. As the interest in the construction of environment aim responsive has increased gradually, the buildings called as ‘sustainable buildings’ have appeared. Green buildings that are certified according to certain standards are considered to be more valuable, environmental friendly, ecological, comfortable and they reduces energy consumption.

Natural environment, which is the reason for humanity to exist, has been damaged by the interventions of the humans and it had to change as a result. It has been realized that building sector has played an important role in the energy consumption based on advancement of the technologies, environmental pollution and many global problems following these. At this point, architects and other professionals in the building sector have started to take into account the context of sustainability as seen in Figure 1.1, in order to be more respectful to the environment.

Realization of the aimed humanistic ecological life environment is strictly related to the geography of the building, architecture, and the furnishing qualifications inside the building. Building needs to take place within the ecological cycles of the climate and the topography it is in. It must not be a building unsuitable to its environment but it must be related to its place; also it should be respectful to the people residing in it.

Figure 1.1.: Fields in the study of sustainability issue (ADIGÜZEL, D., 2010).



Many production facilities and office structures have recently been standing out within the scope of sustainable green building. These environmentally responsive industrial structures aim to, use renewable energy sources, increase the interior air quality of the environment, provide water saving, use the rain water and have similar qualifications together with the advanced technology; thus many scientific researches in this direction are being devoloped. It is possible to standardize and certify these buildings by various organizations. Building Research Establishment (BRE) Environmental Assessment Method (BREEAM) in UK, Leadership in Energy and Environmental Design (LEED) in USA, Hong Kong Building Environmental Assessment Method (HKBEAM) in Hong Kong, Sustainable Building Tool (SBTool) in Canada, Eco-Quantum, National Australian Built Environment Rating System (NABERS), Comprehensive Assessment System for Built Environment Efficiency (CASBEE) in Japan are the leading assessment systems. Advancement of the environmentally responsive clean energy technologies, measures to reduce the greenhouse emission, the subjects such as providing the ecological materials and products and revival of the recycling sector are taken into consideration within the scope of these certificates.

Even there is not many in numbers, there are certified or about to be certified buildings amongst the environmentally responsive structures in Turkey. Inci Aku Factory in Turkey, Siemens Office and Production Facility in Turkey, Birleşim Engeneering Factory in Turkey, Turkish Motor Center and Schnieder Electric ADH Factory are the examples in Turkey which are certified as production facilities. Rain water control, water and energy productivity, light pollution, alternative access and similar consumption savings are provided in these industrial buildings.

In this resaerch, the criteria to get these international sustainability certificates and assessment of the industrial buildings in Turkey in terms of assessment methods are analyzed in scope of sustainable architecture studies. The contributions of the sustainable buildings to the environment and the humanity have been found out.

1.1. The aim of the study

In this study, analysis of the international environmental assessment methods have been aimed by comparison according to specified criteria. Basic environmental assessment methods have been examined and the assessment methods used and their approach to the subject are released. Determination of the environmental performance of the industrial buildings, solutions of the chosen problems, things to be considered and assessment of these building in the process of creating environmentally responsive buildings are aimed with the methods examined.

Comparative examination of the aforementioned building environmental evaluation methods with each other will help to offer a simple and easily applicable evaluation approach with the help of understanding the principles of basic environmental sustainability principles and analysis of the methods and criteria they use.

1.2. Scope and Method

Sustainable architecture, as well as sustainability, is the group of activities which are sensitive to the environment, give priority to the use of the resources of renewable energy, consume / comprehend / apply the energy, water, materials and environment, take into consideration the next generations in available conditions and in every period of the existence. From this point of view, in this research, the conceptual and contextual approaches in sustainability have been analyzed primarily in this study by considering the aims and reasons of its appearance and historical development. After the concept and context are defined, architecture and sustainability principles and applicability are analyzed globally.

Due to their great dimensions, huge energy consumption and the great number of workers and occupants of these structures, industrial buildings, which have more environmental loads than other types of buildings, have carried an important role in terms of applying the aim of sustainability during the life cycle stages. Assessment of the industrial buildings and determination of design criteria carry great importance for the application of environmental sustainability. From this point of view, industrial buildings are analyzed for their general specifications, historical development, and functionally in the scope of sustainable architecture.

In developed countries, there are provoking rules, regulations, laws, organizations and institutions to be able to apply sustainability in the field of building sector. Architects and the building designers aim to get certificates from the intermediary firms by applying the sustainability principles in design stage of design. Turkey is also a country that should use its energy and resources efficiently and it is possible to be certified by the environmental performance assessment organizations with the expansion of these kinds of provoking rules, regulations laws and organizations.

Within **the scope and aim of this study**, studies, articles and literature on sustainability, architecture, energy efficiency, environmental assessment methods are analyzed; respective documents on the methods that are widely used around the world are used. BREEAM, LEED, BEPAC, HK-BEEM, CASBEE and SB-TOOL which is one the international building environmental methods are analyzed.

In this study, it is aimed to evaluate the building environmental assessment methods within the scope of the determined criteria in terms of **industrial buildings of Turkey**.

While determining the assessment methods, building environmental assessment methods used in the world are taken into consideration. Discussed assessment methods are the ones that show difference in accordance with the regions they belong to and that are developed in accordance with their legal conditions and local environment; they are used by different countries today.

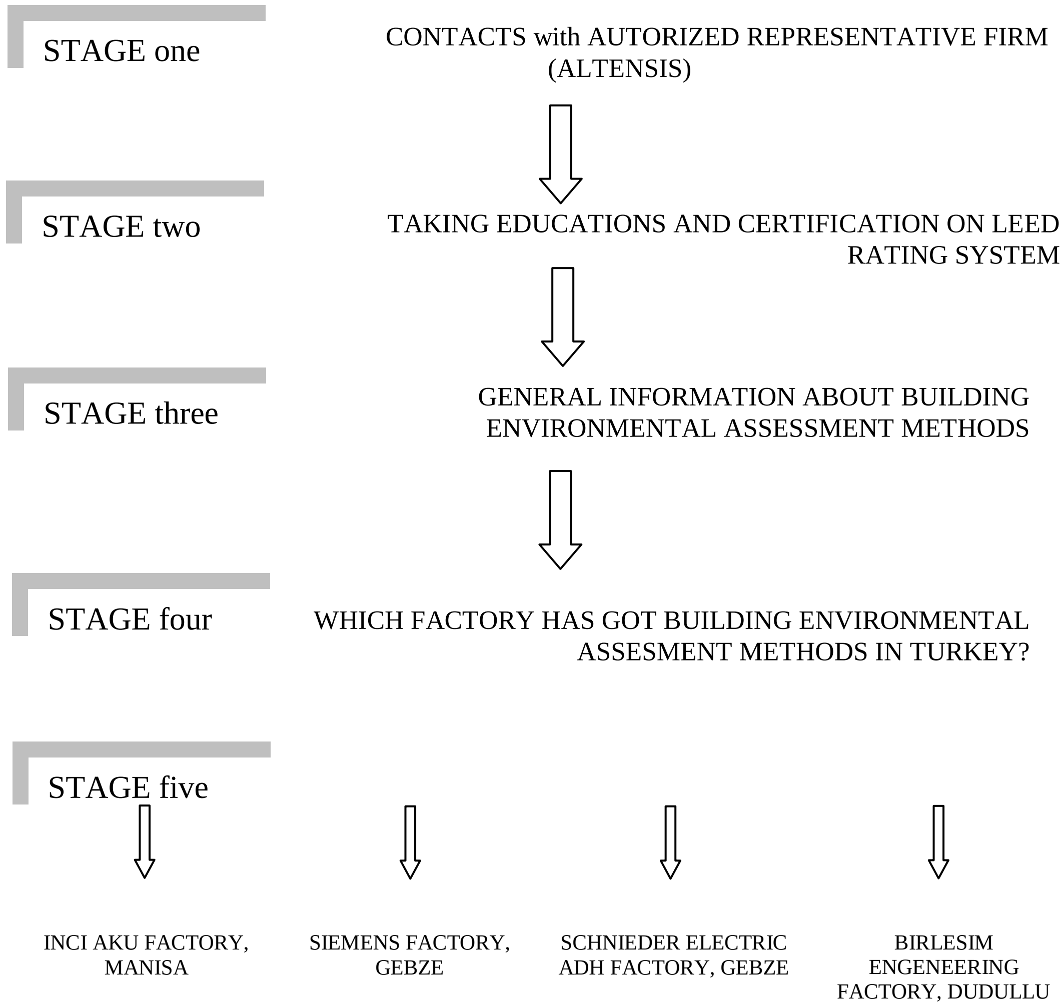
BREEAM, LEED, BEPAC, HK-BEEM, CASBEE and SB-TOOL from the available assessment methods used in the world are chosen by considering their appearance dates, countries developing them, criteria they examine, buildings they examine and their ways of use at an international level. These chosen methods are compared within the scope of their context and their criteria to assess the building.

By comparing the building environmental assessment methods, evaluation targets are decided by considering the common characteristics of these methods.

Application field is determined by means of the studies, interviews and examinations, industrial buildings that are consumed mostly in the energy sector are considered. Industrial buildings in Turkey certified with building environmental assessment methods are studied.

Application fields certified in the category of industrial buildings in Turkey are searched. Within the scope of this study, İnci Aku in Manisa, Schnieder Electricity in Gebze, Siemens Factory in Gebze and Birleşim Engineering Production Facilities in Dudullu, Istanbul are chosen. Building environmental assessment methods that these examples are certified with are examined. As a result of study, it is learnt that the product buildings found in Turkey are BREEAM environmental assessment method from England and LEED from America.

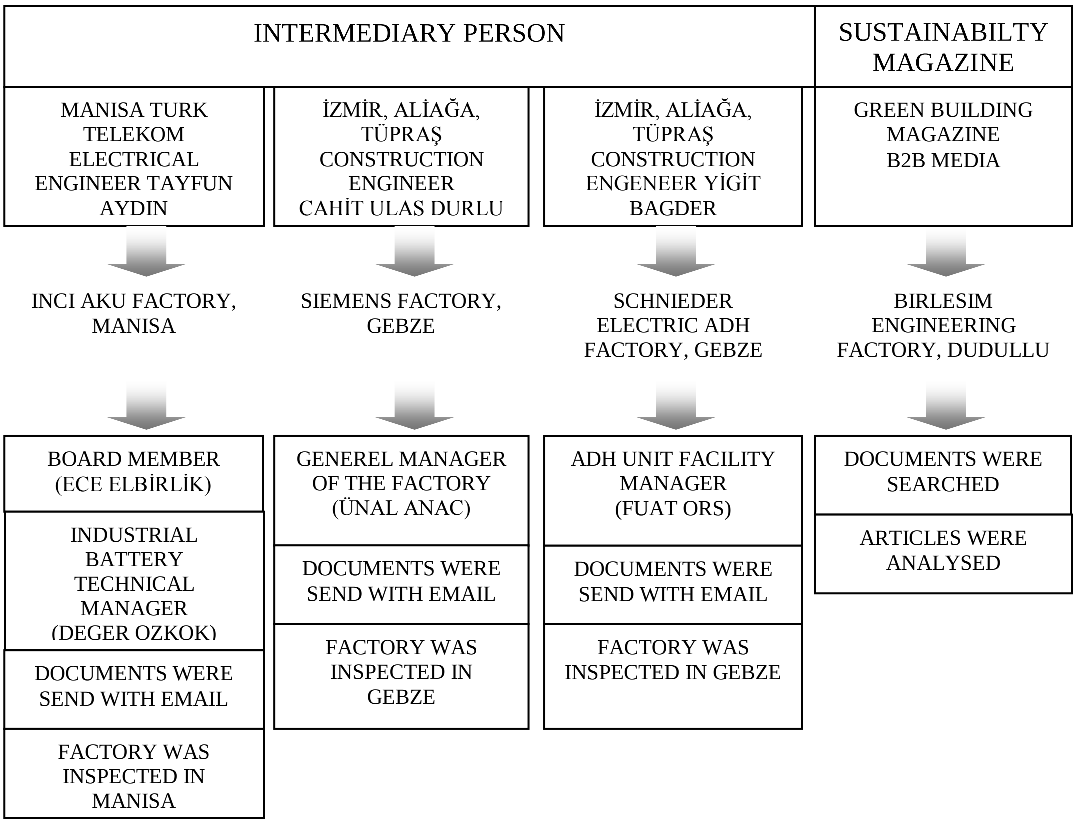
Figure 1.2.: Flowchart of Information Retrieval Stages for Certified Industrial Buildings in Turkey



1

2

Figure 1.3.: Examination of the Factory Process



BREEAM and LEED assessment criteria are chosen by handling the determined targets as a result of comparing the building environmental assessment methods.

Within the scope of this study, the chosen application fields are examined and documented in accordance with the criteria formed with the aims of site, energy, indoor air quality, material and water determined by comparing the building environmental assessment methods.

CHAPTER 2

SUSTAINABILITY APPROACHES IN ARCHITECTURE

2.1. Introduction

Today, as the advancements in technology and industry have reached to the peak point, the damage on the balance of environment the natural resources shortage are seen as the results of these advancements. Sustainability has taken its place as a point of view that aims to meet the economic, environmental and social needs without giving harm to the life conditions of the next generations (Görgün, B., 2012). In this part of this research, we will examine the set aims of sustainability within the scope of conceptual and contextual approach, architecture and the importance and perceptibility of sustainability.

2.2. Conceptual Approach in Sustainability Issue

Figure 2.1. : Ecological Life Cycle (Internet, May 2013)

Sustainability derives from its Latin root “subtenir’ which means protection (Muscoe, M., 1995). Sustainability means “ability to continue over a period of time’ and it is “soutenabilité” or “durabilité” in French, “nachhaltigkeit” in

German (Baykal, G., 2013). The definition widely quoted today as “development that meets the economic, environmental and social needs of the present without compromising the ability of future generations to meet their own needs” was presented in the report of Brundtland Commission of the United Nations on March 20, 1987 for the first time (Karslı, U.T., 2008). This definition can be explained in terms of time and space as follows as seen in Figure 2.2.

Figure 2.2. : Space and Time (Karslı, U.T., 2008)

In terms of space

Every humanbeing has got the equal privilege on
the resources of the earth.

In terms of time

Every humanbeing has the right to use the
resources of the earth, yet he is responsible to maintain
the sustainability of these resources for the future

The necessities to meet according to the definition of sustainability are “the needs to live” and “to put limit on the pressure created by the social regulations and technological standards that will meet the needs for the sustainability of life on the environment” (Göksal, T., 2003).

Avoiding the consumption of the resources of ecosystem or any sustainable system by the society to maintain its functioning for the future times can be defined as sustainability. In other words sustainability is to keep and maintain the present environmental, economic and social needs in a way to integrate them without risking the peace and health of the future generations. Sustainability is the unity of the activities to create buildings which are sensitive to the environment, give priority to the use of the renewable energy resources, use the energy, water, material and the space efficiently and protect the comfort of the humanity in the present conditions and every period of its existence by considering the future generations (Karslı, U.T., 2008).

2.2.1. Historical Development and Evolution of Sustainability

Conceptual Approach of sustainability has been examined and defended by many academicians, philosophers, non-governmental organizations and different associations for almost a hundred years. Sustainability issue existed due to two main reasons which started with the industrial revolution:

• The big socio-economic gap between the southern/northern countries and the search for human development

• Ecological crisis and the need for an emergency action to save the environment (Eryıldız, D., 2003)

The development criteria, based on the economy internalized in the 19th century, led the existence of many environmental and social problems. Under developed southern countries caused more environmental load by internalizing the development criteria of the developed countries. Before the industrial revolution, the people living in the cities consisted of 10 percent of the world population, whereas the rate is above 50 percent today (Eryıldız, D., 2003). Rapid and unplanned urbanization is source of the environmental problems. World's rapidly and constantly increasing population, the reduction in the natural resources even the possibility of running out of them in the near future (petrol almost 40 years, coal 200 years, natural gas 80-100 years), as well as the problems like global warming and environmental pollution that have been felt by means of natural disasters in the recent years have made the people to take action to leave clean, healthy and livable environment for the future generations. As these problems have gradually reached higher levels, it has been realized that it is a must to understand the ecological methods well and the science of ecology that is addressed as the solution of the problems started to attract attention in 1960s (Eryıldız, D., 2003).

Defining sustainability, creating its principles and the studies for the solutions of anticipated problems have been going on especially for the last few decades. The studies done in order to develop sustainability by various national and international organizations, institutions and associations and their results are given in items below chronologically;

• "The Club of Roma" was founded by a number of people who are in important positions in their countries in 1968 with the aim of searching to limit the growth borders of evolution problem in the globalizing world (Karslı, U.T., 2008).

• The Club of Roma published the report titled "Limits to Growth" *(Halte à La Croissance!)* prepared by a group of researchers of Massachusetts Institute of Technology in 1972. This report includes the computer simulations prepared on the relations between the increase of the population of human race and the management of the natural resources until 2100 and their results. According to the calculations made in the report, there will be a great decrease in the population due to pollution that will result from the economic growth, reduction of agricultural lands and shortage of the energy resources (Karslı, U.T., 2008)..

• During "Conference on United Nations Human Environment" (Stockholm Conference) which was held in Stockholm between 5 and 16 June 1972, many countries from different socio-economic structures and different development levels came together for the subject of "environment". By the end of the conference, "United Nations Declaration of Human Environment" was accepted (Odaman Kaya, H., 2012).

• In 1977, sustainability with the work "Sustainable Society" by Dennis Prages was discussed within the scope of all sciences (Baykal, G., 2013).

• The concept of sustainable development was released for the first time in the report "World Strategies for Protection" *(La Stratégie Mondiale Pour La Conservation)* published by World Conservation Association in 1980 (Karslı, U.T., 2008).

• The definition and the context of the sustainable development is described in the Brundtland report published by United Nations in April, 1987. Sustainability as a concept is defined as balancing economy and ecosystem as a whole without running out of the natural resources in the report titled "Our Common Future" by World Commission on Environment and Development (Baykal, G.,2013) .

• During the Rio Summit of June, 1992, the principles of sustainability were to be internalized and started to be used commonly in the world. Industrial disasters that have happened within the last 30 years (Nabil Cherni, Seveso, Exon Valdez etc.) have awakened to the realization of the environment in public and led the WWF, Greenpeace and similar environmentalist non-governmental organizations to work harder. Various governments and non-governmental organizations held the responsibilities for the global environment to put the decisions taken during World Environment Conference into action. Within this frame, the reduction in the production and the consumption, eliminating them at all and its importance on the environment are emphasized. An action plan named "Habitat 21" was accepted and preparation and application of a long term plan was aimed. Some titles like social and economic dimensions, protection and management of the resources, empowering the roles of various sectors and realizing the application systems also took place (Çelik, E. 2009).

• "The United Nations Conference on Human Settlements", also named as Habitat II, which was held in Istanbul in 1996, brought together the Habitat Agenda with the declaration of the UN Environment Conference. During Habitat II Conference, the subjects like non-sustainable structures of production and consumption in the first world countries, extreme population changes caused by the density of the population resulting from the structure groups, unemployment and social discrimination, insufficient resources, lack of substructures, safety and violence problems and the destruction of the natural environment were discussed.

• In Johannesburg summit that started in August of 2002 and in which almost a hundred presidents of countries and thousands of government representatives were conducting, treaty that contains the decisions for the conservation of biodiversity and natural resources was signed (Civan, U.,2006).

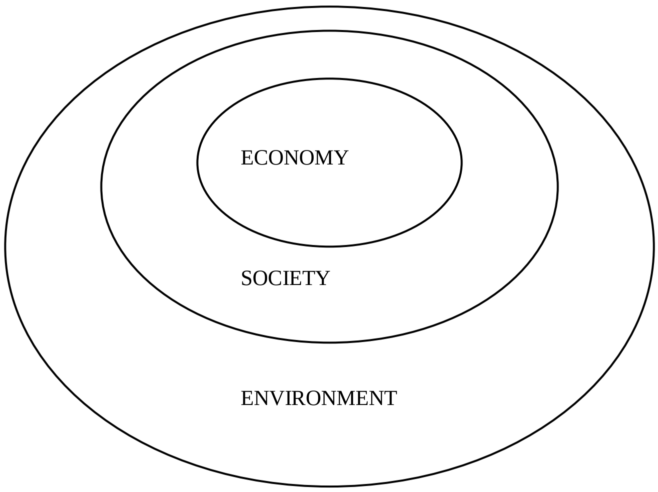
• In 2005, Kyoto Protocol that is on the reduction of the emissions of harmful gases that cause the greenhouse effect entered into force. Kyoto Protocol currently covers 160 countries on earth and more than 55% of oscillations of the greenhouse gases. The measures to be taken according to Kyoto Protocol need expensive investments. According to the agreement; greenhouse gas amount released into the atmosphere will be drawn to 5%, the legislation regarding reducing the greenhouse gas amount from industry, motor vehicles, heating will be considered again, technology systems like heating with less energy, travelling longer distances with the cars consuming less energy will be adapted in industry, environmentalism will be the main principle for the transportation and garbage stocking, alternative energy resources will be considered to reduce the marsh gas and carbon dioxide released into the atmosphere, bio diesel fuels, as an instance, will be used instead of fossil fuels, waste process will be re-organized in the organizations like cement, iron-steel and lime fabrics that consume high energy, the systems and technologies releasing less carbon will be installed in the thermic plants, solar power will be encouraged, as nuclear power includes zero carbon, this energy will be given prominence in the world, the ones who consume more power and produce more carbon will pay more taxes (Karslı, U.T., 2008).

2.3. Contextual Approach in Sustainability Issue

2.3.1. The Reasons of Sustainability

Sustainability approach and scale vary according to local conditions encompassing the resources, political structures, individual initiatives and unique historical and social structures (Figure 2.3). Sustainable urban development plans are the matter of discussion in many areas like the applicability of the design, economic development and growth, ecosystem management, agriculture, ecological architecture, energy conservation and prevention of environmental pollution. Basically, sustainability is based on the traditions and communities, and has developed in recent years as a result of various factors. The factors that are important are as follows;

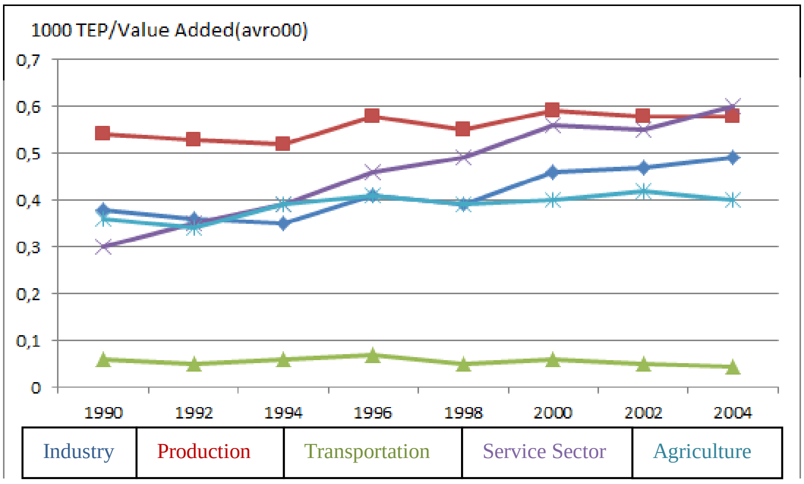
Figure 2.3.: The size of Sustainability (ÖZMEHMET, E., 2005).



2.3.1.1. Energy:

In the 20th century, excessive energy usage, mass production and rapid consumption of products have led to the formation of waste clusters and gradual reduction of natural resources. A comprehensive energy plan that can meet the need of the growing energy demand depending on world population growth and industrialization process is needed. While the rapidly increasing demand is met, it is also important to turn to environmentally compatible energy sources. Energy demand per capita in the world is in constant increase. It is necessary to determine the energy resources to meet the increasing energy demand (Sev, A., 2009).

Figure 2.4.: Energy Consumption According to Sectors (Türkay, M., Yılmaz Özbağcı, Ş., ve Şan Akça B., 2012)

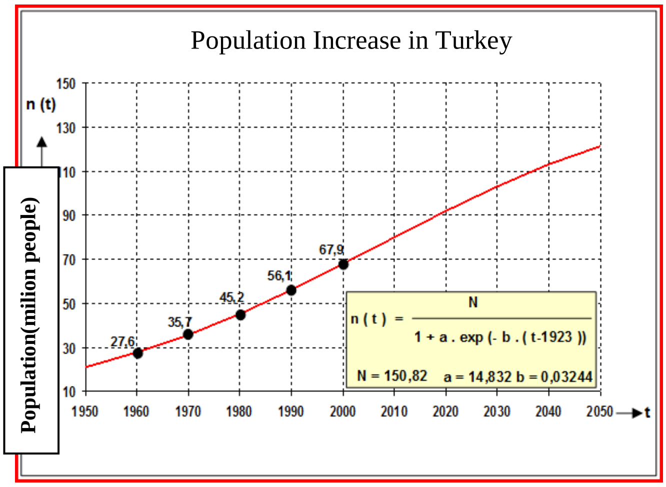


CO2 and other greenhouse gases released into the atmosphere as a result of lavish consumption of fossil fuels are accepted to be the main reason of global warming. Increase in the level of the seas as a result of global warming threatens the lives of the people and the other creatures (Figure 2.4.). In the 20th century, consumption of the fossil based energy increased 17 times all around the world (Uygun, V., 2012) . The acceleration in the energy consumption of primarily Asian countries and the others caused a great increase in the amount of CO2 in the atmosphere. The countries who could economically support themselves in the past managed to overcome these kinds of problems. However, today, even these countries look for the prospective strategies and methods to solve these problems and activate the use of resources. The reduction in the environmental damages needs technological developments and excessive socio-economic changes (Baykal, G.,2013).

2.3.1.2. Population:

Today 2% of the landscape is covered with the urban settlements and the people living in the cities consist 75% of the world population. With the rapid urbanization all around the world, the number of the cities and their population and the complexity also increase (Figure 2.5.). Immigration from country sides to the cities has accelerated and the density of the population in the urban areas rises gradually. Housing in the urban areas gradually causes the extinction of the green lands. At the same time, air pollution and the poisonous wastes occurring with the heavy energy consumption will become dense in the cities. Cities are responsible for a large portion of waste. 40-50% of global carbon emission results from the buildings, 25% from the transportation vehicles and 25% from the industrial activities. This situation leads to the gradual destruction and extinction of the vital ecological systems, negative effects on the social and economic processes of the cities. Economic and social imperatives will lead to more intensification of cities in the future. Modern urbanization will clearly bring out the crowd and the problems in great sizes that cannot be compared with the traditional settlements (Sev, A., 2009).

Figure 2.5.: Population Increase in Turkey (Ercan,A.,2008)



2.3.1.3. Technology:

Figure 2.6.: Technologic Devolopment (Internet, August 2014)

As technology is one of the most efficient ways to form an interaction with the environment, it plays an important role for sustainable recovery. Technology is used for the extraction of the raw materials from their resources and all the stages of gathering the product; it is also the most efficient tool to develop the life quality of the people (Figure 2.6.). However, despite the short term benefits of the technology, it is clear that also damages the environment at a considerable level. Therefore, great attention needs to be paid for the use of technology with aim of generating a sustainable future. The need for the material and the energy can be reduced with the help of the new technologies. Photovoltaic panels that produce electricity from the solar radiation are one of the most stunning examples of clean technologies. Benefitting from the infinite solar power is very reasonable instead of the exhaustible resources like coal and oil to generate electricity. The issues like how the natural ecosystems work and what kind of energy is used by them should be observed to develop new and clean technologies. Developments in the data collection and analysis methods as well as technologies have made it easier to make detailed research and examination on the social and environmental effects of planning and recovery studies. The developed new tools and scientific methods, decision making tools work much faster and more efficiently compared to the earlier ones. In this way, more solid and realistic results can be gathered on issues of the structure of the societies, how the people live, what jobs they do, how they are effected from the taken decisions, how they can manage these decisions in the future (Sev, A., 2009), (Baykal, G.,2013).

2.3.1.4. Health:

Figure 2.7.: Healty Environment (Internet, August 2014)

Insufficient health conditions in the 18th and 19th centuries, primitive treatment methods and the rapid increase of the human population led to the rapid collapse of the health sector in many societies (Sev, A., 2009). Besides, diseases resulting from the communal life, crowd and especially the spaces without natural air and light were realized. In this scope, the ways to live and work within healthier conditions are looked for (Baykal, G.,2013).

2.3.1.4. Economy:

Figure 2.8.: Effects of the economic power (Internet, August 2014)

Economic conditions that changed towards the end of 20th century caused the people to have different expectations from the circumstances that they work and live. With a general view, it proposes widening the available job opportunities and resources, increasing the life quality by reducing the unemployment, working and living in healthier circumstances, realizing the social aims with the opportunities provided by the economic power. Effects of the economic power on public must be known by the authorities to take and practice the decisions regarding the future. Benefiting from this power properly is of upmost importance to reach sustainable societies (Sev, A., 2009), (Baykal, G.,2013).

2.3.2. Dimensions of Sustainability

Sustainability is considered to be the common point of many disciplines including the environmental issues. The three dimensions of the sustainability come into prominence when the environmental issues are addressed.

Sustainable development which is the common point of social, economic and environmental disciplines comes to a conclusion by fully integrating with different goals and functions. Providing a balance in all areas with these three dimensions is an ideal situation for sustainable development.

Three dimensions of sustainability are as follows:

Social Development is based on principles as,

Cultural identity

Quality of life

Human health

Stability, justice and easy accessibility

Neutrality

Decarceration of disabled people into society.

Conservation of natural resources as well as transferring our cultural identity to future generations directly affects human health. Sustainable community development foresees preservation of health and safety of employees and improving the quality of life. (Sev, A., 2009)

Economic Development is based on principles such as:

Healthy growth and development

Production efficiency

Rational use of resources and energy,

Continuous economic cycle.

Sustainable economic development requires the creation of new markets, cost reduction by enabling energy and resource efficiency in production. (Sev, A., 2009)

Environmental Development is based on such principles:

Ecosystem integrity

Ecological artificial environment

Continuation of natural diversity

Waste management

Destruction of toxic materials

Use of recycled materials.

Sustainable economic development foresees the productions of the products from the recyclable materials and renewable resources, less waste material outcome, re-use of waste, less negative effect on human health, or abolishment of these negative effects completely, wide use of renewable energy resources, preservation and storage of energy, avoiding the use of toxic materials in the production and avoiding the environmental pollution. (Sev, A., 2009)

2.4. Architecture and Sustainability

Sustainable architecture is the group of activities that give priority to the renewable energy resources within its circumstances and throughout the period of its existence considering the next generations, is sensitive to the environment, uses the energy, water, material and the space it covers efficiently, builds the buildings protecting the health and comfort of the people. In another word, it is the art of meeting the need of place for the people without endangering the existence and future of natural systems.

Sustainable structures protect and improve the health and productivity of the users with the daylighting strategies and better indoor air quality; they are sensitive to the consumption of natural resources during the construction and occupany, they do not cause environmental pollution, they produce raw materials for the other constructions after demolishment end of their effective life or they go back to their place in nature without any harm. (Sev, A., 2009)

“Solar architecture” or “green architecture” definition are used before the sustainable architecture define the design approach to reduce the use of natural resources and fossil fuels by utilizing the solar renewable sources. However, sustainable architecture is not only to utilize solar power, wind, and geographical data, it also includes reducing the effects on ecological systems, effective use of energy, material and water resources, life cycle analysis, recycling the waste and grey water protecting the physical and mental health and comfort of the people. Besides, the positions of the buildings with the urban area and their effects on the substructure are important in terms of sustainability (Özmehmet, E., 2005).

Sustainable architecture is defined as the phenomenon of architectural design aiming to reduce the use of natural resources and to keep a balance of the production-consumption rates. This concept also is defined as an approach that should be considered as thinking climatic and topographical structure as input and paying attention to the efficient use of resources by holding a combination of human and nature relationship (Kremers, J., 1995).

Sustainable architecture, accelerating environmentally sensitive approach, has enabled to reconsider the building design standing out with its balanced distribution from generation to generation and regional subjectivity as a part of the system socio-culturally and physically in accordance with regional decisions, standards, society (Baykal, G., 2013).

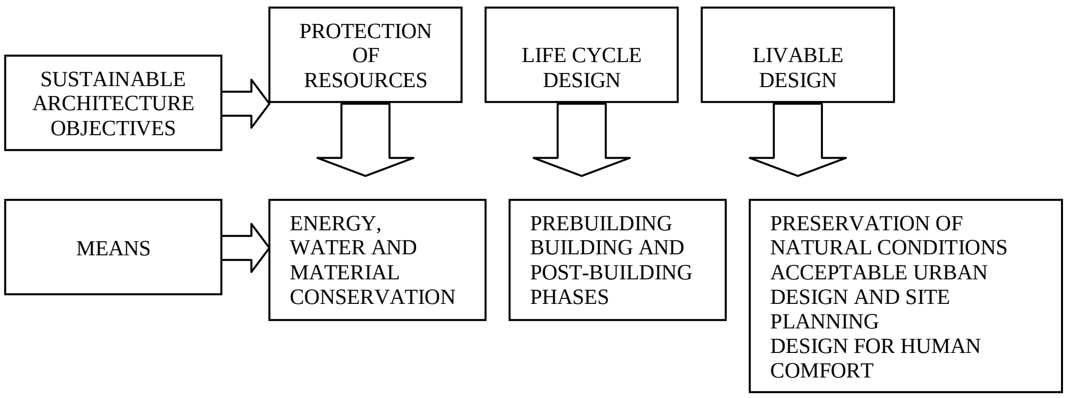
Structure is in continuous interaction with environment during its own formation process (design-implementation-destruction). Acquiring and production of the construction components to be derived from nature, various interventions made to the ecological environment force the ecological atmosphere to modify. Mankind that changes ecology and environment affects the naturel environment with this intervention. Approximately 50% of building materials used in the construction industry is acquired from the nature and this globally leads to the reduction of the forest areas, depletion of water resources, depletion of the ozone layer, destruction in global dimensions. Nowadays, the interrogator design approaches enable the cities to move towards the ecological planning. Environmentally compatible building models have been the source for environmental inputs, designs and applications. Building design effective on the environment shows two different orientations as controlling building functions with complex technology and environmentally compatible and perceivable life with natural and simple approaches (Baysan, O., 2003).

2.4.1. Principles of Sustainable Architecture

Building sector has numerous effects on the environment from the building to demolition stages. In the very early stages of the production, the first interventions on the construction field start to change ecological characteristics. Even temporarily, construction, machinery and the crowd of personnel and the construction work itself disturbs the local ecology. Collection and production of the construction materials from nature would irrevocably impact global ecology. Energy and water-consuming users producing the toxic gases and sewage, obtaining, preparing for use, transporting and using the resources in construction have many negative effects on the environment. (Baysan, O., 2003) The problems on environment and human health arising from the building directly affect the sustainable design components. Conceptual framework set by the concept of sustainable architecture develops solutions to all these environmental questions under three main principles.

These three principles are "**energy and natural resource conservation**" which develops solutions for the problems of energy, materials and water conservation, "**construction life cycle design**" which develops solutions for the environmental problems encountered in pre-construction, construction and post-construction phases and "**biological building design**" which develops solutions for the problems of human health and comfort as seen in Figure 2.9. (Çelebi, G., 2003).

Figure 2.9.: Conceptual Framework of Sustainable Design (Çelebi, G., 2003)

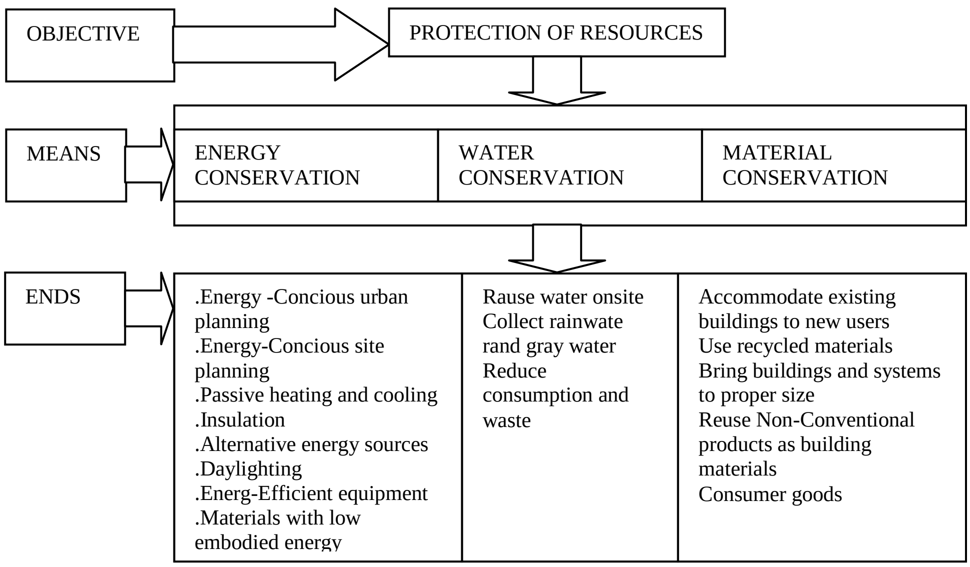


Protection of Resources

Sustainability for the buildings is directly proportional to their recyclability of the resources that is used to construct a building. The resources that are used change from the stage of constructing the building to the materials used and the destruction stage. The resources in a continuous stream continue throughout the life time of building. The great effect of construction industry on natural resources increases the importance of resource management. Resource management foresees to reduce the consumption of non-renewable resources.

Reduction of environmental pollution is aimed to be reduced with the reduction of resource input in the design of sustainable buildings, recycling or re-use of resource outcomes and an effective waste management. Three main sources to be protected mentioned here are **energy**, **water** and **material** (Figure 2.10). The principle of conservation of energy and natural resources is examined under the topics of energy conservation, water conservation and material conservation (Karslı, T., 2008).

Figure 2.10.: Application strategy of Protection of Resources (Çelebi, G.,2003)

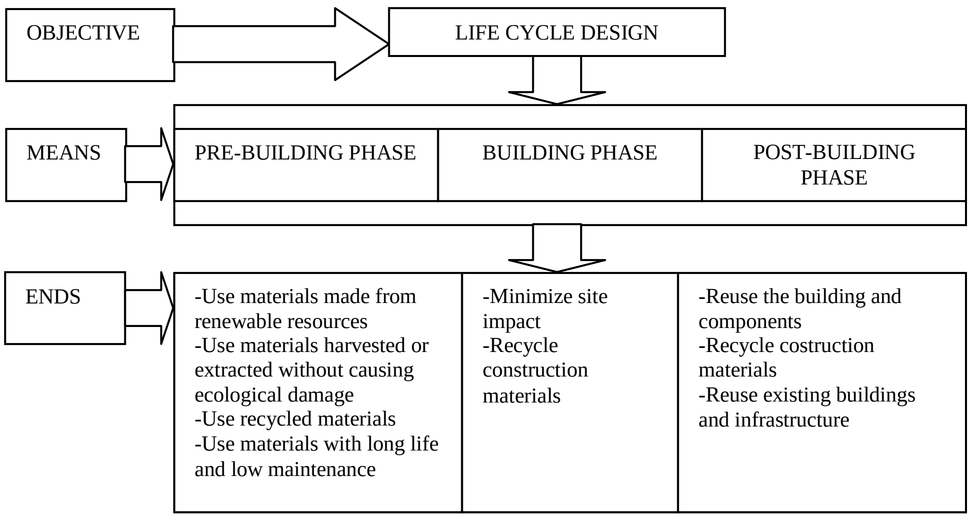


Life Cycle Approach of Design

Building life cycle design principle aims to bring social a comprehensive approach to the environmental and cultural problems by rearranging these issues (Figure 2.11.). The goal of a sustainable construction design is not to harm the biocycles in equilibrium with each other and to use these cycles as a part of the construction. It is important that the designs that are also the parts of this synthesis cycle support the natural process.

Life cycle design of the buildings is divided into three separate periods as pre-construction, construction and post structure (Kremer, J., 1995). In terms of ensuring sustainability, there are some measures and methods required. In this context, sustainable designs aim to give all of the materials that make up the structure back to nature and minimize environmental damage.

Figure 2.11.: Application strategy of Life Cycle Design (Çelebi, G.,2003)



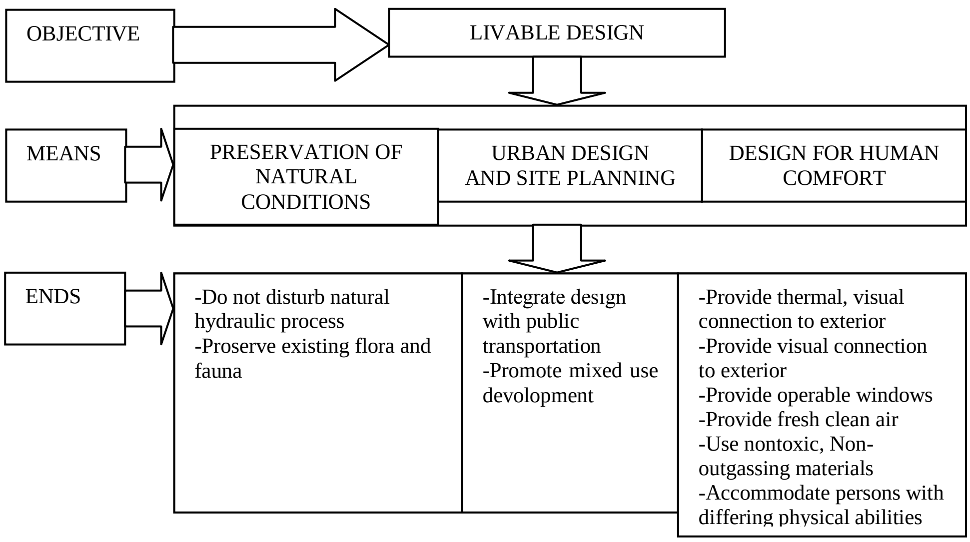
Livable Design

The goal of biological structure design is to protect health, comfort and safety of humanities. In addition, within the scope of sustainable architecture, the cultural pattern, life and comfort effects should be in the maximum level.

The most important mission of the built environment, besides providing a shelter and security, is to create a healthy and comfortable shell for those who live in it. Resourches Examination of the relationship between health problems and lower comfort conditions of the building users by the academicians has gained efficiency as "Sick Building Syndrome" cases has increased (Karslı, T., 2008).

Biological structure design which is among the criteria of sustainable design is analysed under the three strategies as **the preservation of natural conditions, urban design and site planning**, **design for human health and comfort** (Figure 2.12.). The designs based on these strategies aim to increase quality of life for the people and other living species.

Figure 2.12.: Application strategy of Liveable Design (Çelebi, G.,2003)



2.4. Conclusion

The main theme emerging as a result of researches and development from past to present in the scope of the sustainability and sustainable architecture is that a building needs to present a design approach which is respectful to both the nature and the people. Resource management examined for the buildings, designs made for the life cycle and biological building designs must be considered to be assessed individually for each structure and by means of specifically developed methods as well as the materials to be used, adverse impacts of the buildings on the environment and humanity should be minimized.

In accordance with the research done, building environmental assessment methods, which arise with the requirements of sustainability, assist in the formation of buildings that are respectful to the environment and human by adopting the principles of sustainable architecture.

From this point of view, industrial structures which have more environmental loads during construction- use- demolition stages compared to the other structure types due to their large scales and dense number of user occupancy carry great importance when the sustainable architectural principles are considered.

CHAPTER 3

INTERNATIONAL BUILDING ENVIRONMENTAL ASSESSMENT METHODS

3.1. Introduction

International building environmental assessment methods, that are developed to reduce the impact of the buildings on the environment, to provide a socially and economically better future to the humankind, lead to build environmentally responsive structures by adopting sustainable design principles. These methods, which are developed in many countries , are increasing every day and their use is getting wider and also popular as environment as well as a marketing strategy.

In this part, it is aimed to analysis environmental assessment methods are developed and the ones that are widely used in the world will be examined.

3.2. Description, Targets and Importance of Building Environmental Assessment Methods in the World

Construction and use of buildings cause environmental damage at many different levels. Carbon dioxide emerging from the use of fossil fuels causes global greenhouse effect, high buildings can cause dangerous winds in the neighbourhood, many buildings lose value due to being worn out, etc and they adversely affect the environment in the energy usage. These examples constitute just some of the damages on the environment. Hence, many academicias and experts adopt environmentally discreet sustainable design principles in order to reduce the human impact on the environment, both regionally and on a global scale. Nowadays tendency towards environmental protection gradually gains pace, and social and political forces make pressure to make more **environmentally healthy technological decisions**. Enterprises, institutions and industries as well realize that the steps like appropriate materials and waste management, efficient process and product design, energy efficiency and recycling are profitable as well as environmentally friendly.

Methods for the evaluation of the buildings sustainability and environmental performance have come out as a result of all the studies on the development of the buildings living with the environment in order to ensure the sustainability of the environment and human activities and to reduce the environmental effect of the buildings. The basis of these systems was founded when the environmental building assessment subject was handled in England. **First environmental assessment tool** used at an international level is BREEAM: Building Research Establishment Environmental Assessment Method which was set out by the Building Research Establishment in 1990. In the following years after the emergence of BREEAM, many different environmental assessment methods emerged as a result of similar studies. As seen in Table 3.1. Building Environmental Performance Assessment Criteria which was created by Canadian government in 1993, HK-BEAM Hong Kong Building Environmental Assessment Method which emerged in Hong Kong in 1996, LEED: Leadership in Energy and Environmental Design created in 1998 by the U.S. Green Building Council, SBTOOL: Sustainable Building Challenge which was created with the gathering of the developed countries in 1998 under the sponsorship of Canada, CASBEE: Comprehensive Assessment System for Built Environment Efficiency which is a building environmental assessment method developed for Japan in 2004 are the main methods.

These methods that are based on the evaluations of the buildings according to the grades as a result of their examination in accordance with some chosen environmental performance criteria are used for the buildings that are being newly designed as well as the buildings that are already available or being restorated. There are some methods that use a single assessment model for every type of building besides the ones that use different assessment methods for different types or the ones that are designed for the assessment of just a special type of building.

3.3. Building Environmental Assessment Method in the World

It is possible to define sustainable building assessment systems as a rating system including a kind of assessment process that allows to have a measurable reference to emerge the sensitivity to preserve the natural resources and the effects of the building-based projects on the environment.

As the sustainability of a building can only be assessed according the local environment in which it is, countries develop their own local green building assessment systems by referring to their legal documents, market situations and needs. Today, there are more than thirty local assessment systems used by the different countries. The table below shows the evaluation systems used by different countries in the world.

Comparative examination of the aforementioned building evaluation methods with each other will help to offer a simple and easily applicable evaluation approach with the help of understanding the principles of basic environmental sustainability principles and analysis of the methods and criteria they use. These methods offer different assessment systems depending on if the building is already in use or a new one. As the evaluation of industrial structures in terms of sustainability is aimed in the thesis, these methods are explained in details below.

Table 3.1.: Building Environmental Assessment Method Used in the World

COUNTRY	EVAULATION METHODS		
	NAME		YEAR
ABD	LEED	Leadership in Energy and Environmental Design	1998
	LIVING BUILDING CHALLENGE		2010
AUSTRALIA	ABGR	Australian Building Greenhouse Rating	2005
	ACCURATE		2006
	BASIX	Building Sustainability Index	2004
	EPBG	Environmental performance guide for building	
	GREEN STAR		2002
	NABERS	National Australian building environmental rating system	2001
BRAZIL	AQUA		2008
CANADA	BEPAC	Building environmental performance assessment criteria	1993
CHINE	3-STAR		2006
	GHEM	Green home evaluation manual	2001
FRANCE	HQE	High Quality Environmental	2005
GERMANY	DGNB		2008
HONG KONG	CEPAS	Comprehensive environmental performance assessment scheme	2001
	HKBEAM	Hong Kong building environmental assessment method	1996
INDIAN	GRIHA		2006
ITALY	PROTOCOLLA ITACA		2003
JAPONYA	CASBEE	Comprehensive assessment system for building environmental efficiency	2004
MALAYSIA	GBI MALAYSIA		2009
PHILIPPINES	BERDE		2009
PORTUGAL	LIDER A + SbTool-PT		2009
SWITZERLAND	MINERGIE		2008
TAIWAN	EEWH	Ecology, Energy Saving, Waste Reduction and Health	1999
UNITED ARAB EMIRATES	Estidama		2010
UK	BREEAM	Building Research Establishment Environmental Assessment Method	1990
	CPA	Comprehensive project evaluation	2001
	DQI	Design quality indicator	2002
INTERNATIONAL	SB-TOOL	Sustainable Building Tool	1995

3.4. Aim of the Analysis and Synthesis of the Building Environment Assessment Methods in the World

First environmental assessment tool used at an international level is BREEAM: Building research Environmental Assessment Method which was set out by the Building Research Establishment in 1990 in England. As seen as in Table 3.1. In the following years after the emergence of BREEAM, many different environmental assessment methods emerged as a result of similar studies. BEPAC: Building Environmental Performance Assessment Criteria created in 1993 by the Government of Canada, HK-BEAM: Hong Kong Building Environmental Assessment Method which emerged in Hong Kong in 1996, and LEED: Leadership in Energy and Environmental Design created in 1998 by the U.S. Green Building Council are among these ones. These systems are followed by Comprehensive Assessment System for Built Environment Efficiency developed by Japanese Sustainable Building Consortium in 2004, and Sustainable Building Tool developed by iiSBE (International Initiative for Sustainable Built Environment), an international non-profit organization, in 1995.

In this research, will be briefly examine and discussed the widely used evaluation methods in the world ;

3.4.1. Building Research Establishment Environmental Assessment Methods (BREEAM)

BREEAM®

BREEAM (Building Research Establishment Environmental Assessment Method) is an environmental load assessment method for buildings, which was developed in 1990 by the Building Research Establishment (BRE) of United Kingdom. By now it has been edited into versions for individual countries and is referred to in Canada, Hong Kong, Australia, New Zealand and Else where (BREEAM, May, 2012).

Development objectives

This assessment method was developed with the following seven objectives:

1. To educate and inform designers, giving them an awareness of environmental considerations.

2. To meet calls from developers, designers and occupants for environment-sensitive buildings, and to stimulate demand for the same.

3. To create a broader awareness of the major impact of buildings on global warming, acid rain and ozone depletion.

4. To set targets and indices to enable independent surveys, and to reduce erroneous assertions and perceptions.

5. To reduce the long-term impact buildings have on the environment.

6. To reduce the consumption of water, fossil fuels and other depletable resources.

7. To enhance the quality of indoor environments, thereby improving the health and comfort of occupants.

Assessment subjects

Assessments of offices, stores, residences and factories, both new and refurbished, are published. The method was basically developed for use in Britain. As the CO2 basic units for electrical power differ between Britain and Japan, and the methods included assessment items unsuitable for Japan, there were aspects that could not be applied to construction in Japan without modification.

Assessment Items

Assessment items can be broadly divided into global environmental problems and the use of resources, regional environmental problems and interior environmental problems If a building reaches all targets, it is awarded to maximum score of 42 points. There is no weighting between assessment items to reflect different perspectives. The final assessment is ranked fair, good, very good or excellent, depending on the lowest score in each of the three areas above, and the total point score.

For office buildings, the latest edition, published in 1998, revises the method to include seven broad categories'. A. Management, B. Health and Comfort, c. Energy, D. Transport, E. Water, F. Materials, G. Land usage, H. Site ecosystems, and I. Pollution (BREEAM, May, 2014).

Assessment system

Getting assessed is voluntary, but there is growing concern among British design offices and developers, so by now it is said that approximately 25% of new office buildings have been assessed. Assessments are carried out by qualified assessors; approved by the Building Research Establishment, of Britain.

The formal assessment is carried out by a third party agency, approved by the British Building Reseat Establishment, and as it stands, it is difficult apply to assessment at the design stage (Chung, W.Y., 2005).

Table 3.2.: BREEAM

Abbreviation	BREEAM
Name	Building Research Establishment Environmental Assessment Method
Country	ENGLAND
Development Organization	Building Research Establishment (BRE)
Year of release	Released in 1990
Official announcement	Office commercial facilities, school, meeting residence and others
Designated region	ENGLAND
Assessment Items	**A. Management (Possible Points: 11)** A1 . Commissioning A2. Constructors' Environmental & Social Code of Conduct A3.Construction Site Impacts A4. Building User Guide A5. Lifecycle Costing **B. Health and wellbeing (Possible Points: 5)** B1. Daylighting B2. High Frequency Lighting B3. Internal and External Lighting Levels B4. Volatile Organic Compounds B5. Microbial Contamination **C. Energy (Possible Points: 11)** C1. Energy Efficiency C2. Sub-metering of substantial energy uses C3. Sub-metering of high energy load and tenancy areas C5. Low or Zero Carbon Technologies **D. Transportation (Possible Points: 10)** D1. Provision of Public Transport D2. Proximity to Amenities D3. Alternative modes of transport D4. Pedestrian and Cyclist Safety D5. Travel Plan D6. Maximum Car Parking Capacity D7. Deliveries & Manouvreing **E. Water (Possible Points: 8)** E1. Water Consumption E2. Water meter E3. Major Leak Detection E4. Sanitary Supply Shut Off E5. Irrigation Systems E6. Sustainable Wastewater Treatment **F. Material(Possible Points: 13)** F1. Materials Specification F2. Hard Landscaping and Boundary Protection F3. Responsible Sourcing of Materials F4. Insulation F5. Designing for Robustness **G. Waste(Possible Points: 6)** G1. Construction Site Waste Management G2. Recycled Aggreagates G3. Recyclable Waste Storage G4. Compactor/ Baler **H. Land Use and Ecology(Possible Points: 10)** H1. Reuse Of Land H2. Contaminated Land H3. Ecological Value of Site H4. Mitigating Ecological Impact H5. Long Term Impact on Biodiversity **I. Pollution(Possible Points: 8)** I1. Refrigerant GWP B. Serv. I2. Preventing Refrigerant Leaks I3. Nox emissions from heating source I4. Flood Risk I5. Minimising Watercourse Pollution I6. Reduction of night time light pollution I7. Noise attenuation

3.4.2. Leadership in Energy and Environmental Design (LEED)

The LEED (Leadership in Energy and Environmental Design) rating system is an assessment tool proposed by the U.S. Green Building Council in 1995. its development followed study of BREEAM, BEPAC and others, and it was revised in 1997 and 2001. Assessment is divided into six categories:

1. Sustainable site (up to 14 points).
2. Effective use of water (up to 5 points).
3. Energy and the atmosphere (up to 17 points).
4. Conservation of materials and resources (up to 13 points).
5. Quality of interior environments (up to 15 points).
6. Design process and potential for refurbishment (up to 5 points). (Table 3.3)

The maximum score is 69 points, with point-based rankings of Approved (26-32 points), Silver (33-38 points), Gold (39-51 points) and Platinum (52 points and above) (LEED, Teknik Değerlendirme ve Uygulama Eğitimi, 2012, May.).

Table 3.3.: LEED

Abbreviation	LEED
Name	Leadership in Energy and Environmental Design
Country	USA
Development Organization	US Green Building Association
Year of release	Released in 1995, revised in 1997,2001
Official announcement	Office commercial facilities, school, meeting residence and others
Designated region	USA
Assessment Items	**A. Sustainable Site (Possible Points: 14)** A1 .Erosion & sedimentation control (prerequisite) A2. Site selection A3. Urban redevelopment A4. Brownfieid redevelopment A5-8. Alternative transportation A9-10. Reduced site disturbance A11-12. Landscape & exterior design to reduce Heat Islands A13. Light pollution reduction **B. Water Efficiency (Possible Points: 5)** B1-2. Water efficient landscaping B3. Innovative waste water technologies B4-5. AVater use reduction **C. Energy & Atmosphere (Possible Points: 14)** C1. Fundamental Building Systems Commissioning (prerequisite) C2. Minimum energy performance (prerequisite) C3. CFC reduction in HVAC&R equipment (prerequisite) C4-8. Optimize energy performance C09-11 . Renewable energy C12. Additional commissioning C13. Ozone depletion C14. Measurement & verification C15. Green power **D. Materials & Resources (Possible Points: 17)** D1 .Storage & collection of recyclables (prerequisite) D2-4. Building use D5-6. Construction waste management D7-8. Resource reuse D9-10. Recycled content D11-12. Local/regional materials D13. Rapidly renewable materials D14. Certified wood **E. indoor Environment Quality (Possible Points: 15)** E1. Minimum IAQ performance (prerequisite) E2. Environ mental tobacco smoke (ETS) control E3. Carbon dioxide (C02) monitoring E4. 1ncrease ventilation effectiveness E5-6. lncrease ventilation effectiveness E7-10. Low-emitting materials E11. Indoor chemical & pollutant source control E12-13. Controllability of systems E14-15. Thermal comfort E16-17. Daylight & views **F. Innovation & Design Process (Possible Points: 5)** F1-4. Innovation in design F5. LEEDTM accredited professional

3.4.3. Building Environment Performance Assessment Criteria (BEPAC)

BEPAC (Building Environment Performance Assessment Criteria) was developed by Raymond J. Cole of the Environmental Research Group at the University of British Columbia, Canada, as a tool for assessing building environmental performance in 1994. BEPAC 's aim regional and global scale, improvement of the environmental impact in the interior of the building. Approximately 30 criteria are grouped into five main environmental topics (ozone layer protection, environmental impact, quality of the interior environment, resource conservation and location and transport). The assessment items are weighted and assessment is based on the total point score (Peuportier, B., Kohler, N., Boonstra, C., Blanc-Sommereux, I., Hamadou, H., Pagani, R., Gobin, C., Kreider, J., 1997).

Official assessment is time consuming, so it is difficult to use the system as it stands for assessment at the design stage, but the assessment points can be used as a design checklist.

Table 3.4.: BEPAC

Abbreviation	**BEPAC**
Name	Building Environment Performance Assessment Criteria
Country	Canada
Development Organization	University of British Columbia, US Green Building Association
Year of release	Released in July 1994, revised in March 1994
Official announcement	New construction office, an existing office
Designated region	Canada
Assessment Items	**A. Ozone layer protection** A1. Making a full inventory of Ozone Depleting Substances (ODSs) A2. Paving care and attention to equipment selection and installation to minimize the release of refrigerants or fire suppressants A3. Making provision for future retrofit to non-ozone layer depleting substances A4. Commitment to building management which minimizes the release of ODSs **B. Environmental impacts of Energy Use** B1. Reducing the total amount of annual emission of greenhouse gases B2. Reducing the total amount of annual emission of regional pollutants B3. Reducing the total amount of electricity used in the building B4. Reducing the peak electrical energy demand in the building B5. Meeting or exceeding the envelope and system design criteria in ASHRAE/IES standards 90.1-1939 B6. Air-conditioning and ventilation system B7. Equipment of air-conditioning and ventilation B8. Energy management system B9. Lighting system B10. Hot water supply system **C. Indoor Environmental Quality** C1. Moisture control C2,Minimizing the use of mineral fiber C3-Minimizing the emission of toxic volatile gasses C4. Isolating potential sources of pollution C5.Providing and maintaining required ventilation rate C6. Locating and designing the air intakes for the ventilation system C7. Providing the best possible lighting quality with naturally fit interior C8. Providing the best possible acoustic quality **D. Resource Conservation** D1. The retention of existing building elements and landscape D2.Conservation of tropical and domestic wood use D3.The efficient control and use of site water D4.Factating water conservation within the building D5.Water conservation through water recycling system **E. Site and Transportation** E1. Regeneration on the site E2. Recharging ground water on-site E3. Building location where pedestrian access to services and public transportation systems is convenient E4. Provision of all-weather type shelters for public use E5. Affect of sunshine and daylight E6. Alternative solution of car parking (public car parking) E7. Provision of bicycle parking

3.4.4. Hong Kong Building Environmental Assessment Method (HKBEAM)

The BEAM scheme was established in 1996, largely based on the UK Building Research Establishment's BREEAM. There was a significant upgrade to the previous BEAM documents in 2004. In 2009, in response to the critical global environmental issue, BEAM was further developed to meet higher expectations of the public and community.

BEAM Plus (Building Environmental Assessment Method) is a comprehensive environmental assessment scheme recognized by the Hong Kong Green Building Council (HKGBC). The BEAM Plus Version 1.1 was introduced to the industry on April 2010. The current version, BEAM Plus Version 1.2, has been launched for formal registration since November 2012.

BEAM Plus is available for New Buildings (NB) and Existing Buildings (EB). New Buildings projects have to undergo Provisional Assessment (PA) and Final Assessment (FA) while Existing Buildings projects only have to undergo Final Assessment (HK-BEAM, December 2014)

BEAM Plus Version 1.1

The BEAM Plus for New Buildings and Existing Buildings was launched in November 2009. After reviewing feedbacks from industry stakeholders, the BEAM Faculty has made minor refinements to the assessment criteria, developing the new BEAM Plus Version 1.1 to replace the previous BEAM Plus in April 2010. The changes of credit allocation are summarized in the "Document Control" page in the two documents for easy reference.

BEAM Plus Version 1.2

The BEAM Plus Version 1.2 was launched in November 2012 for formal registration. This version introduces a holistic component of Passive Design for residential development as an alternative method for assessment. To add clarity to the assessment and its requirements, minor amendments are also made in BEAM Plus Version 1.2.

The BEAM Plus Assessment Scheme includes the six aspects of a project:

1. Site Aspects
2. Energy Use
3. Indoor Environmental Quality
4. Materials Aspects
5. Water Use
6. Innovations and Additions (HK-BEAM, December 2014).

Table 3.5.: HKBEAM

Abbreviation	**HK-BEAM**
Name	Hong Kong Building Environmental Assessment Method
Country	Hong Kong
Development Organization	UK Building Research Establishment's BREEAM
Year of release	Released in 1996
Official announcement	New Building and Existing Building
Designated region	Hong Kong
Assessment Items	**A. Site Aspects** A1.Minimum landscaping area A2. Site location A3. Site Planning and design A4. Emissions from the site **B. Material Aspects** B1. Timber used for temporary works B2. Use of non-cfc based refrigerants B3. Construction waste management plan B4. Waste recycling facilities B5. Efficient use of materials B6. Selection of materials B7. Waste management **C. Water Use** C1. Water quality survey C2. Minimum water saving performance C3. Water conservation C4. Effluent **D. Indoor Environmental Quality** D1. Minimum ventilation performance D2. Security D3. Hygiene D4. Indoor air quality D5. Ventilation D6. Thermal comfort D7. Lighting Quality D8. Acoustics and noise D9. Building amenities **E. Innovation and Additions** E1. Innovative Techniques E2. Performance Enhancements **F. Appendices** F1. Annual energy use F2. Baseline building model F3. Equivalent carbon dioxide emissions F4. Installation of air-conditioners F5. Provisions for energy management F6. Assumptions and Baselines for water consumption F7. Sampling protocol for indoor air quality assessments F8. Passive design assessment methodology

3.4.5. Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)

CASBEE is a comprehensive assessment and presentation method covering "environmental quality and performance of the building" and "environmental load of the building". With the assistance of Housing Bureau, Japanese Ministry of Land Infrastructure and Transport, it was developed by the Japan Sustainable Building Consortium (Chair: MURAKAMI Shuzo). CASBEE for New Construction was adopted by major local governments, such as City of Nagoya in April 2004, City of Osaka in October 2004 and City of Yokohama in July 2005, to promote sustainable buildings in each local context. This approach is now spreading fast nationwide **(**Chung, W.Y., 2005)**.**

<u>CASBEE for New Construction (CASBEE-NC)</u>

Published in August 2002, this design tool is used by the designer to conduct a comprehensive check of environmental aspects and explain environment action in the building to the building owner and others.

The environmental quality and performance of the building Q (its performance in enhancing amenity in the inhabited environment of the building) is broadly divided into Q1 Indoor Environment, Q2 Quality of Service and Q3 Outdoor Environment on site, and the assessment results for each sub- category are expressed numerically and as bar graphs. Also, the load reduction performance of the building L (its performance in reducing environmental loads imposed by the building) is broadly divided into LI Energy, L2 Resources & Materials and L3 Off-site Environment, and the assessment results for each sub-category are expressed numerically and as bar graphs.

The Building Environmental Efficiency (BEE) is defined as the environmental quality and performance of the building, divided by the building environmental load generated to achieve that quality (Kibert, C.J., 2007)**.** BEE is applied as an indicator that helps to realize buildings of higher quality with lower environmental load. Thus the greater the gradient, the more desirable the building's assessment, which enables labeling of buildings according to their environmental assessment results.

The quantitative figures that are the leading indices for the environmental assessment of buildings, such as primary energy consumption and water consumption for building operation, and the LCCO2 as the representative LCA result, are assessed. If possible, reduction values and rates should be assessed by comparison against reference buildings.

CASBEE for Existing Building (CASBEE-EB)

This tool takes the assessment results at the post-completion stage, produced by CASBEE- NC, and adds assessment of a year or more of recorded operation results, to assess and present the environmental performance of the building. Use by a third party other than the designer is envisaged. It was published in July 2003 (Chung, W.Y., 2005)

CASBEE for Renovation (CASBEE-RN)

There is a big number of growing building stock renovation; especially in Japanese market. In the same way as CASBEE-EB, Ml tool targets existing buildings. This can be used to generate proposals for building operation monitoring, commissioning and upgrade design with a view to ESCO (Energy Service Company) projects, which will be increasingly important in future, and building stock refurbishment. This tool is designed for ascertaining the degree of improvement (increased BEE), relative to the level that preceded renovation. Labeling is also possible by the third-party agencies. It was completed and published in July 2005 (Chung, W.Y., 2005)**.**

With a great success of the above assessment tools, the related CASBEE tools are now under development as extended members of the "CASBEE family". They include CASBEE-Heat Island to cope with heat island phenomenon, CASBEE for Urban District to assess BEE of an area with a group of buildings, CASBEE for Housing including detached houses, and CASBEE for Pre-design to assess the site as preconditions of building design (Krygiel, E. and Bradley, N., 2008).

Table 3.6.: CASBEE

Abbreviation	**CASBEE**
Name	Comprehensive Assessment System for Building Environment Efficiency
Country	Japan
Development Organization	Japan Sustainable Building Consortium
Year of release	Released in 2002
Designated region	Japan
Assessment Items	Q: Building Environmental Quality & Performance Q-1. Indoor Environment Q-2. Qualitiy of Service Q-3. Outdoor Environment on Site LR: Reduction of Building Environmental Loadings LR-1. Energy LR-2. Resources & Materials LR-3. Off-site Environment

3.4.6. Green Building Challenge (SBTool)

iiSBE

Green Building Challenge (GBC) is a development process involving international teams from various countries, which was originally advocated by Raymond J. Cole (Professor, University of British Columbia) and Nils Larsson (currently Executive Director, International Initiative for Sustainable Built-Environment). The overall goal of GBC is to develop, test and demonstrate an improved method for measuring building environmental performances. GBC is a process and SBTool is a building environmental assessment method and software, which is created by GBC process. A unique feature of SBTool is the provision of an international framework, which is adapted to national or regional areas.

The first meeting of International Framework Committee of GBC (GBC-IFC) was held in Warsaw in 1996 and decided primary goals and direction of GBC project. The Institute for Building Environment and Energy Conservation (IBEC) in Japan organized the Japan National Team and participate GBC from 1996 till now.

At this GBC-IFC meeting the following key aspects were determined;

1. IFC holds two meetings every year and an international conference in every two years (now every three years).
2. SBTool assesses building environmental performances relatively by using reference buildings and benchmarks, and it also assesses performances absolutely by introducing key absolute indicators within assessment results.
3. SBTool has a hierarchical structure constituted of Performance Issues, Performance Categories, Criteria, and Weighting System.
4. Reference values, Benchmark and Weighting values are decided by each national team based on local conditions. This is one of most important feature of SBTool to be applied in different regions and countries.
5. Scoring system ranges from -1 to +5. All performances are assessed relative to datum condition.

    -1: Negative,
    0: Minimum acceptable performance,
    3: Good practice and,
    5: Best practice.

The results of GBC activities, updated SBTool and assessment results of case study buildings have been exhibited in a series of international events; GBC in Vancouver, SB 2000 in Oslo. That latest activities will be displayed at SB2005 in Tokyo during 27-29 September 2005 (Chung, W.Y., 2005).

Table 3.7.: SBTool

Abbreviation	**SBTOOL**
Name	Green Building Challange
Country	Canada
Development Organization	Natural Resources Canada
Year of release	Released in 1996
Designated region	Canada
Assessment Items	**A. Site selection, Project Planning and Development** A1. Site selection A2. Project Planning A3. Urban Design and Site Development **B. Energy and Resource Consumption** B1. Total life cycle Primary non- renewable energy B2. Predicted electrical peak demand for building operations B3. Renewable energy B4. Commissioning of building systems B5. Materials B6. Potable water **C. Environmental Loadings** C1. Green House gas emission C2. Other Atmospheric Emissions C3. Solid Wastes C4. Rainwater, Stormwater and Wastwater C5. Impacts on Site C6. Other local and Regional Impacts **D. Indoor Environmental Quality** D1. Indoor Air Quality D2. Ventilation D3. Air Temperature and Relative Humidity D4. Daylighting and Illumination D5. Noise and Acustics **E. Functionality and Controllability of Building System** E1. Efficiency of space utilization E2. Design for maintenance of core functions outside of planned design conditions E3. Controllability **F. Long-Term Performance** F1. Flexibility and Adaptability F2. Maintenance of operating performance **G. Social and Economic aspects** G1. Cost and Economics G2. Social Aspects

3.5. Comparison of the environmental assessment methods

As a result of all the studies made on reducing the environmental effects of the buildings and developing buildings that conform to the environment to maintain the environment and the human activities, methods regarding the assessment of the sustainability of the buildings and the environmental performance are developed. These methods can be defined as a kind of rating system that tries to provide a measurable reference to reveal the environmental effects of the projects on the basis of the buildings and the sensitivity to protect the natural resources (Boran, D., 2009). The basis of these methods was first founded in England. They have been widespread and accepted around the world since 1990 when it was first applied. These methods all of which are based on the voluntary basis have clearly accelerated the building sector in terms of environmental sensitivity (Sev, A. and Canbay, N., 2009).

There are many building environmental assessment methods used in the world. These methods are used from the cold regions of North America to Eastern Europe, from Mediterranean countries living four seasons to the unstable climate of Japan (Erten, D., 2009). The most commonly used ones are found to be **BREEM, BEPAC, HK-BEAM, LEED, SBTOOL** and **CASBEE** as a result of the studies. When they are analyzed and compared in detail, these methods are found to show similarities in basis. Some of these methods are used in all the countries whereas some of them show differences as they are locally used in the country where they are developed.

Within the scope of this study, from the building environmental assessment methods, BREEAM (Building research Environmental Assessment Method) which was developed by BRE in 1990, BEPAC (Building Environmental Performance Assessment Criteria) which was developed by Canada Government in 1993, HK-BEAM (Hong Kong Building Environmental Assessment Method) which occurred in Hong Kong in 1996, LEED (Leadership in Energy and Environmental Design) which was developed by USGBC in 1998, SBTOOL building environment assessment method (Sustainable Building Challenge) which was created by gathering the developed countries under the sponsorship of Canada and CASBEE building environment assessment method (Comprehensive Assessment System for Built Environment Efficiency) developed for Japan in 2004 are researched by examining all of their specifications. For this **aim**, **targets** and **criteria**, the **dates when the assessment methods** appeared, the **countries to develop them**, **criteria they examine**, **buildings they study** and **their level of use at an international level** are pointed by considering them all.

Comparison tables are prepared by utilizing the general characteristics of these methods so as to define the common and different points of Building Environmental Assessment Methods.

These environmental assessment methods are compared in Table 3.8 and Table 3.9. in which they are handled with their basic sustainability principles and characteristics that show difference in accordance with the countries to develop them.

3.5.1. Proposed Building Environmental Assessment Approach

In this study, it is aimed to evaluate the building environmental assessment methods within the scope of the determined criteria and in terms of industrial buildings.

While determining the assessment methods, building environmental assessment methods used in the world are taken into consideration. Discussed assessment methods are the ones that show difference in accordance with the regions they belong to and that are developed in accordance with their legal conditions and local environment; they are used by different countries today.

BREEAM, LEED, BEPAC, HK-BEEM, CASBEE and SB-TOOL from the available assessment methods used in the world are chosen by considering their appearance dates, countries developing them, criteria they examine, buildings they examine and their ways of use at an international level. These chosen methods are compared within the scope of their context and their criteria to assess the building.

By comparing the building environmental assessment methods, evaluation targets are decided by considering the common characteristics of these methods.

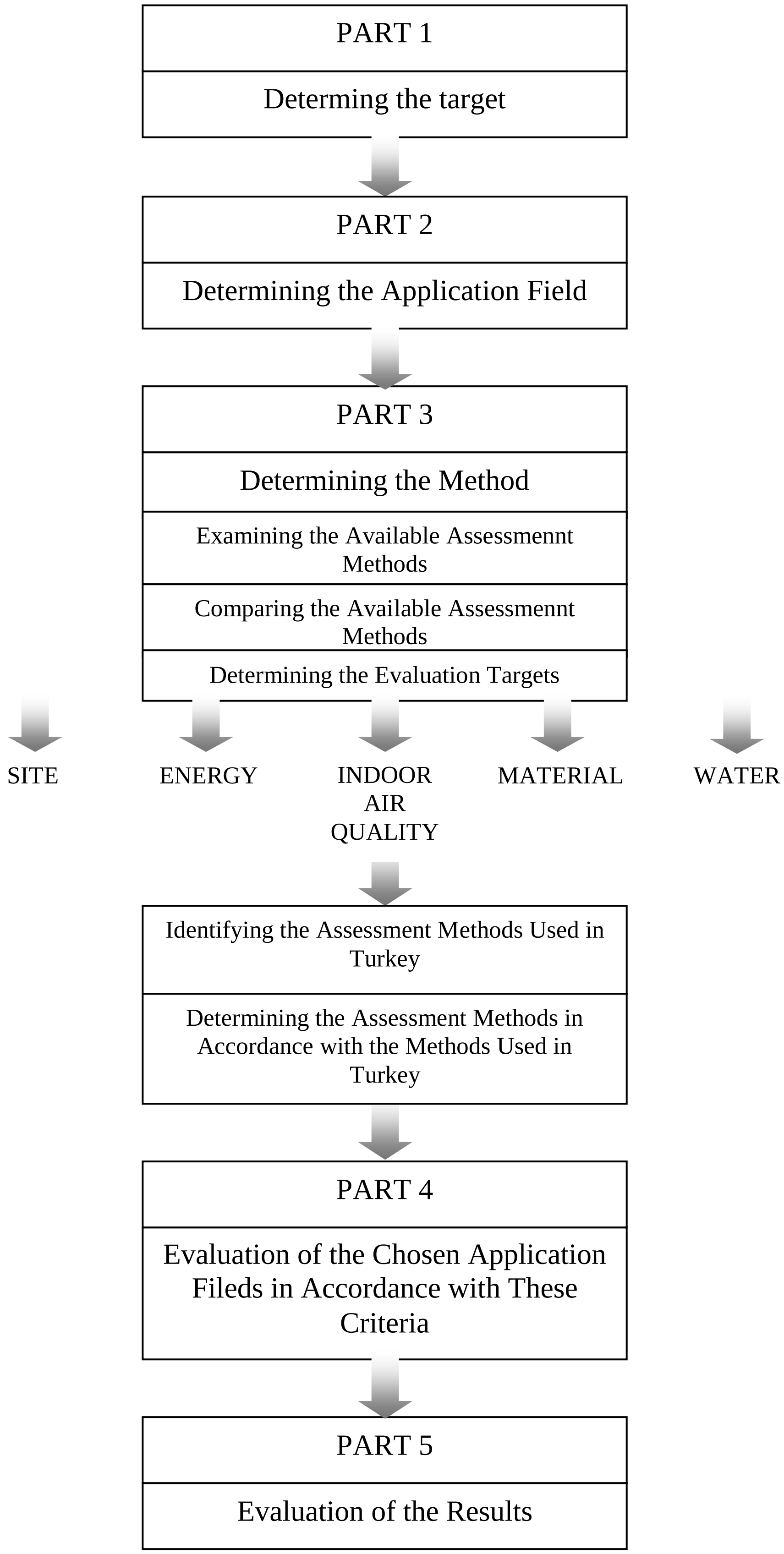
Application field is determined by means of the studies, intrerviews and examinations, industrial buildings that are consumed mostly in the energy sector are considered. Industrial buildings in Turkey certified with building environmental assessment methods are studied.

Application fields certified in the category of industrial buildings in Turkey are searched. Within the scope of this study, İnci Aku Manisa, Schnieder Electricity Gebze, Siemens Gebze and Birleşim Engineering production facilities are chosen. Building environmental assessment methods that these examples are certified with are examined. As a result of study, it is learnt that the product buildings found in Turkey are BREEAM environmental assessment method from England and LEED from America.

BREEAM and LEED assessment criteria are chosen by handling the determined targets as a result of comparing the building environmental assessment methods.

Within the scope of this study, the chosen application fields are examined and documented in accordance with the criteria formed with the aims of site, energy, indoor air quality, material and water determined by comparing the building environmental assessment methods.

Table 3.8.: Proposed Building Environmental Assessment Approach



3.5.2. Determination of evalutaion criteria of Building Environment Assessment Methods

Various assessment systems are used for the evaluation of the sustainable buildings all around the world. Each country shows differences in terms of climate, geographical conditions, energy consumption, cultural structures and each country uses different systems (Görgün, B., 2012). BREEAM which was first one served for use in England in 1990 is the mostly widely used international method. LEED which was served for use in The United Stated in 1998 is the second one to be used internationally (LEED, May, 2012). LEED and BREEAM are also accepted in Turkey as they have the widest use.

Determined assessment criteria are the **most common results** that will appear by comparing the six methods of BREEAM, LEED, BEPAC, HK-BEEM, CASBEE VE SB-TOOL. BREEAM, LEED, BEPAC, HK-BEEM, CASBEE VE SB-TOOL assessment methods are evaluated by handling them in terms of their contexts. Mentioned categories are the five most important main design principles in terms environmental sustainability and these principles are **efficient use of energy**, **efficient use of water**, **ecological material**, **indoor environment air quality**, and **efficient use of land**. Differences shown in parenthesis on the table show that assessment methods are examined under different titles in accordance with the countries they are developed.

Other environmental sustainability categories of the Assessment Methods of BREEAM, LEED, BEPAC, HK-BEEM, CASBEE ve SBTOOL that show differences in accordance with the countries are studied in Table 3.9. Criteria that are studied under different titles reveal the differences of the methods in the examination and they determine in accordance with which sustainability category they are assessed.

Table 3.9.: Comparison table in terms of Building Environmental Assessment Methods

EVALUATION CRITERIA	EVALUATION METHODS		BREEAM 1990	LEED 1998	BEPAC 1993	HK-BEAM 1996	CASBEE 2004	SBTOOL 1995
	MAIN CATEGORIES OF ENVIRONMENTAL SUSTAINABILITY	ENERGY	*	*	*	*	*	*
		SITE	(Site and Ecology)	*	*	*	*	*
		INDOOR	(Healt and Wellbeing)	*	*	*	*	*
		MATERIAL	*	(Resource and Material)	(Resource Conservation)	*	*	(Energy and Resource Conservation)
		WATER	*	*	(Resource Conservation)	*	(Resource and Material)	(Energy and Resource Conservation)

Table 3.10.: Comparison table in terms of Building Environmental Assessment Methods

<table>
<tr><td rowspan="6">EVALUATION CRITERIA</td><td>EVALUATION METHODS</td><td>BREEAM</td><td>LEED</td><td>BEPAC</td><td>HK-BEAM</td><td>CASBEE</td><td>SBTOOL</td></tr>
<tr><td rowspan="5">OTHER CATEGORIES OF ENVIRONMENTAL SUSTAINABILITY</td><td>BUILDING MANAGMENT</td><td rowspan="5">RENOVATION AND DESIGN PROCESS</td><td rowspan="2">OZONE CONSERVATION</td><td rowspan="5">RENOVATIONS</td><td rowspan="2">QUALITY OF SERVICE</td><td>ENVIRONMENTAL LOADS</td></tr>
<tr><td>HEALTH AND WELLBEING</td><td>ENERGY AND RESOURCE CONSERVATION</td></tr>
<tr><td>TRANSPORTER</td><td rowspan="3">RESOURCE CONSERVATION</td><td rowspan="3">RESOURCE AND MATERIAL</td><td>SOCIAL AND ECONOMIC</td></tr>
<tr><td>ENVIRONMET ECOLOGY</td><td>LONG-TERM PERFORMANCE</td></tr>
<tr><td>POLUTION</td><td>BUILDING SYSTEM FUNCTIONALITY AND CONTROLLABILITY</td></tr>
</table>

Five main principles handled in terms of environmental sustainability also have great importance in terms of building environmental assessment methods. These main principles that consist of sustainable architecture include the activities to produce buildings that give priority to the renewable energy resources, that are sensitive to the environment, use the energy, water, material and the land it stands on efficiently, protect the health and comfort of the people. In scope of is study, six methods shown in Table 3.8. are compared. As a result of the comparison, it has been realized that mentioned five main principles are common criteria in terms of the examined building environmental assessment methods.

The sectors which consume the energy at the maximum level in Turkey are industry, transportation, housing and energy production distribution systems (Keskin, M.T., ve Ünlü H., 2010). The field which consumes the most energy within the mentioned four items is found to be **industry** (Çalıkoğlu, E., 2007). Within this scope, industrial buildings in Turkey use 40 % of the energy and 47 % of the electricity (TEVEM, 2010). During the studies for this dissertation, it has been detected that the industrial buildings which are the most energy consuming buildings in Turkey are certified by LEED and BREEAM from the environmental effect evaluation methods.

BREEAM is the world's foremost building environmental assessment method and rating system for buildings, with 250,000 buildings with certified BREEAM assessment ratings and over a million registered for assessment since it was first launched in 1990. (BREEAM, May, 2014)

The aim of the system is to create an environmental criteria list to detect which building performances are controlled and developed. The system successfully warns the owners of the buildings and the professionals about which environmental issues are considered in the building **(**Crawley, D., Aho, I., 1999).

BREEAM sets the standard for best practice in sustainable building design, construction and operation and has become one of the most comprehensive and widely recognised measures of a building's environmental performance. It encourages designers, clients and others to think about low carbon and low impact design, minimising the energy demands created by a building before considering energy efficiency and low carbon technologies (BREEAM, May, 2014).

BREEAM examines the buildings in accordance with certain categories. As it is seen in Table 3, these criteria are evaluated under the titles of management, health and comfort, energy, transportation, water, material, waste, land use, ecology and pollution.

The main aim of LEED is to perform the activities and the products of the persons and the organizations in the building sector in a way to reduce the environmental effects by attracting attention on the environmental effects created by the buildings on the life cycle (Sev, A. ve Canbay, N., 2009). According to USGBC the aim of LEED is specified as to define the Green Building, develop a holistic building design method, creating an environmental leadership in the construction sector, encourage green competition, increase consumer awareness about the benefits of the green building and transform the building market by developing de facto assessment standards (LEED, may, 2014).

LEED marks the building by examining the buildings within the scope of environmental assessment criteria as seen in Table 3.10. These criteria are evaluated as sustainable land, efficiency in water use, energy and atmosphere, material and resources, indoor life quality and renovation in design.

Tablo 3.11.: BREEAM and LEED

		Building Environmental Assessment Methods	
		BREEAM	LEED
EVALUATION CRITERIA		Building Management	-
	*	**Health and wellbeing**	**Indoor air Quality**
		Pollution	**Energy and Atmosphere**
	*	**Energy**	
		Transporter	**Site**
	*	**Site and Ecology**	
	*	**Water**	**Water**
	*	**Material**	**Material and Resource**
		Environment ecology	
		-	Innovation

From this point of view, in accordance with this research, **certified industrial buildings in Turkey** are studied within the scope of the criteria of land use, energy efficiency, indoor air quality, efficient use of material and water which are the common assessment decision of BREEAM and LEED.

Assessment criteria determined as a result of this study are explained below:

1. Site
2. Energy
3. Indoor Air Quality
4. Material
5. Water

3.4.2.1. Site

Soil is one of the limited resources on earth and it is corrupted faster than it is actually thought. Other negative effects of building industry on the natural and ecological systems are inefficient use of fields in many regions and corruption of the agricultural fields to be used as construction sites. Protection of natural topography, mutual coherence between soil, water, plantation and creature have great importance in order to present sustainable designs (SEV, A., 2009).

It is very important to integrate design with public transportation. Sustainable architecture on an urban scale must be designed to promote public transportation. Thousands of individual vehicles moving in and out of area with the daily commute create smog, congest traffic, and require parking spaces.

Sustainable development encourages the mixing of residential, commercial, office and retail space. People then have the option of living in the circle near where, they work and shop. This provides a greater sense of community than conventional suburbs. The potential for 24-hour activity also makes an area safer (Çelebi, G., 2003).

As we can see in Coca-Cola China Concentrate plant example which was completed in Shanghai, China in 2009 and took **LEED** Silver certificate with the aim of land, while choosing the land, the fields which do not have any ecological importance are studied within the scope of the project. It is aimed to minimize the released pollution by means of alternative transportation opportunities. Within the framework of land development, it is aimed and applied to give minimum damage on the ecosystem, protect the available natural fields, and renovate the corrupted natural fields. With aim of increasing biological diversity, maximization of open fields and plantation with domestic plants are enabled. **Heat island effect** created from the heat density of the urban fields is reduced with the materials used on the roof. The damage on the environment is minimized by reducing the light pollution.

Western Power Distribution Unit which was built in Powys, UK in 2006 and certified with **BREEAM** Excellent certificate minimized the negative effects on the environment by aiming the reuse of waste or polluted fields within the scope of land criteria, increasing the ecological value of the land, protecting the available ecological structure and not endangering it, optimizing the building square meter and land settlement in the best possible way.

The industrial building with LEED and BREEAM Certificates are given below:

LEED Certified Industrial Building Example:

Figure 3.1.: Coca-Cola China Concantrate Plant (LEED, May 2014)

Building Name: Coca-Cola China Concentrate plant
Building Location: SHANGAI, CHINA
Building Function: Industrial Building
Total Area: 41.049 m²
Environmental Assessment Method: LEED
Certification level: LEED SILVER (36)
Certification date: 2009
Site: Site selection
Development density and community connectivity
Alternative transportation - public transportation access
Alternative transportation - bicycle storage and changing rooms
Alternative transportation - low emitting and fuel efficient vehicles
Alternative transportation - parking capacity

Site development - protect or restore habitat

Site development - maximize open space

Heat island effect - non-roof

Heat island effect - roof

Light pollution reduction

BREEAM Certified Industrial Building Example

Figure 3.2.: Western Power Distribution Unit (BREEAM, May 2014)

Building Name: Western Power Distribution Unit

Building Location: Powys, UK

Building Function: Industrial Building

Total Area: 210 m²

Environmental Assessment Method: BREEAM

Certification level: BREEAM EXCELLENT (76,06%)

Certification date: 2006

Site: The full quota of four credits were awarded under the issue of 'Construction Site Impacts', for monitoring, reporting and setting targets for energy use and water consumption arising from site activities. Site construction waste was also monitored and sorted and recycled into different waste streams. All temporary timber used on site was reused or obtained from an FSC certified source.

3.4.2.2. Energy

The type, location and size of the environmental effects resulting from the energy consumption depend on the energy used. Efficient use of energy is a strategy to reduce the input and to minimize the target energy use. Energy use during the period of extracting the raw material from the resource, processing it and transporting to the construction site is also considered. Energy is consumed at a big rate during the use as well as the construction of the building. Hence, efficient use of energy at every stage benefits at a minimum and maximum level (SEV, A., 2009).

Efficient use of energy starts from the urban design to be made. Settling on the land to utilize the natural heating and cooling systems, using the alternative energy resources, choosing energy saving materials, utilizing the daylight for lighting at the most efficient level help reduce the energy use.

It is aimed to reduce the total emission of CO2 resulting from the building management and to use low energy lighting elements by observing the energy consumption. Besides, determination of fresh air level and thermal comfort elements are examined within the scope of energy criteria with the use of renewable energy resources.

In terms of iconic technologies of the sustainable building movement, nothing has been as powerful as that of a solar panel or wind turbine next to a building. Generating energy cleanly through the sun and wind represents the holy grail of sustainable living. And yet, the paradox is that these technologies are still rarely used in most green buildings, and where used, they are often used in token amounts to raise awareness or make a statement or proclamation of sustainability rather than to really lower impact (Mclennan, J.F., 2004).

Within the framework of energy target, **IAIA Science and Technology Center** which was built as an industrial building in the USA in 2011 and certified with **LEED Gold** is studied. Energy systems in the building are examined as technical capacity and operation of the energy consuming systems in the scope of the project. Performance of the energy consuming systems in the scope of the project is traced. Optimization of the energy performance is done in accordance with ASHRAE Standards. Locally renewable energy use is considered. Heating and cooling systems aim to minimize their harms on environment in accordance with certain standards.

Foresterhill Energy Centre which was built in SCOTLAND in 2008 and certified with **BREEAM Excellent** aims to reduce total CO2 emissions resulting from building operation and construction by means of low energy lightenining, measurable systems, products from A energy class and a successful energy management within the scope of energy evaluation.

The examples from the world with LEED and BREEAM certificate are given below:

LEED Certified Industrial Building Example

Figure 3.3.: IAIA Science and Technology Center (LEED, May 2014)

Building Name: IAIA Science and Technology Center
Building Location: USA
Building Function: Industrial Building
Total Area: 6.680 m²
Environmental Assessment Method: LEED
Certification level: LEED GOLD (83.76%)

Certification date: 2011

Energy: Sustainable features like low-flow fixtures to save water, occupancy detectors to turn lights off if a room is empty, and better insulation for improved temperature control aided in the creation of an environmentally- and socially-responsible building for the IAIA. Though it was only expected to achieve LEED Silver, the use of daylighting to maximize natural lighting and reduce energy use, double layers of two-inch thick insulation to increase temperature control, and recycled and regional materials allowed the project team to push to LEED Gold.

Additional features of the Science and Technology building include preferred parking for low-emitting and fuel-efficient vehicles, a green cleaning plan, water use reduction and a controlled stormwater runoff system. IAIA also implemented a Ride Share Policy, and 5% of the building's total parking area is reserved for candidates who sign up to car or van pool under the Ride Share Program; another 5% of parking space is reserved for low-emitting and fuel-efficient vehicles.

IAIA Science & Technology Center is situated on 140 acres only fifteen minutes from the center of Santa Fe, New Mexico, one of the most cultural and artistic cities in the nation. The site has amazing views of mountains in all four directions and connects to biking and walking trails. Approximately 49,500 square feet of the site area has been devoted to habitat restoration and the maximization of open space, which amounts to 57.6% of the project site.

BREEAM Certified Industrial Building Example

Figure 3.4.: Foresterhill Energy Centre (BREEAM, May 2014)

Building Name: Foresterhill Energy Centre

Building Location: Foresterhill, SCOTLAND

Building Function: Industrial Building

Total Area: 828 m2

Environmental Assessment Method: BREEAM

Certification level: BREEAM EXCELLENT (83.32%)

Certification date: 2008

Energy: Following detailed assessment of potential options using criteria including lifecycle costs and value for money, it was decided to replace the existing boiler house with a new energy centre comprising more efficient plant on a brownfield site. The new plant includes a gas turbine combined heat and power plant, a biomass boiler and three dual fuel boilers.

These will provide heat, and around 90% at peak loads of the electricity requirement of the Foresterhill Health Campus. The key drivers were to:

Replace the current plant that was no longer capable of delivering against target cost, sustainability and reliability KPIs.

Meet increasing site energy demands from new and redeveloped facilities supporting new clinical services designed to improve patient treatment and care, together with additional medical teaching and research facilities for the University of Aberdeen.

Respond to NHS and government initiatives to implement more sustainable energy production methods to reduce CO_2 emissions by 15%.

Reduce site energy costs of £6.2m per annum by 15%.

3.4.2.3. Indoor Air Quality

A person spends 9% of his time indoors. Most of the time, the amount of pollution indoor is more than outdoors. For this reason, indoor atmosphere has a great impact on the human health. When a healthy indoor quality is not provided in the places to be lived, various physical and psychological disorders can be seen on the people due to indoor pollution. Healthy air quality is defined as the air which does not include the known polluters at dangerous concentration levels and at least 80% of the people living in it do not feel ant discomfort (Alptekin, O., 2007).

Indoor air quality must be provided initially to provide the indoor comfort in sustainable buildings. Indoor air quality is provided by gaining sufficient air naturally or mechanically. Bad indoor air quality increases the health risk as well. The point to be considered to provide air quality is to get healthy indoor atmosphere by gaining sufficient fresh air rate.

Green buildings provides a better indoor atmosphere which reduces the breathing problems, allergies, asthma, sick building syndrome rate and increases the comfort of the user and the performance of the worker. Carpets, glues to be used for the cabinetry, paint and other wall covers and similar materials which has zero or low amount of volatile organic materials effuse less gas and increase the indoor air quality. Daylighting, lighting heals the psychology of users and it is another element which increase the indoor atmosphere quality. Sufficient air conditioning and highly efficient filtration system must be provided in the green buildings. It must be ensured that there is sufficient air conditioning in the heating and cooling systems and it contributes to the indoor air quality (Görgün, B., 2012).

Within the scope of indoor air quality target, indoor air quality of **BASF Kanoo Polyurethanes LLC building, which is located in DUBAI**, United Arab Emirates and was completed in 2014, was able to be increases by considering the certain standards and freash air was controlled by tracing its entry to the indoor atmosphere. **LEED Certificate** which considers the health and comfort of the user aimed to use the materials with low emmision and volatile substances. Evaluations are made to ensure that the building benefits from the daylight and the users have visual contact with the outdoors.

South Gate Industrial Parkwhich was built in 2009 in Domodedovo, Moscow and has **BREEAM Very Good** certificate is evaluated under Industrial buildings coategory. Within the scope of health and comfort, indoor air quality of the building to be worked in directly affects the life conditions. Daylight is directly benefited in this building. Natural air conditioning is utilized as much as possible and there are some places with mechanical air conditioning. Lightening elements with high frequency provides visual performance and comfort. Entries for fresh air are traced to increase the indoor air quality. The materials used on human health are considered to consist of volatile substances thinking about the decrease of their effect on human health.

The examples with LEED ve BREEAM certificated are given below:

LEED Certified Industrial Building Example

Figure 3.5.: BASF Kanoo Polyurethanes LLC (LEED,May 2014)

Building Name: BASF Kanoo Polyurethanes LLC

Building Location: DUBAI, United Arab Emirates

Building Function: Industrial Building

Total Area: 5.333 m²

Environmental Assessment Method: LEED

Certification level: LEED SILVER (54)

Certification date: 2014

Indoor Air Quality: Indoor air quality best management practices - indoor air quality management program

Indoor air quality best management practices - increased ventilation

Indoor air quality best management practices - reduce particulates in air distribution

Occupant comfort - occupant survey

Daylight and views

Green cleaning - purchase of sustainable cleaning products and materials

Green cleaning - sustainable cleaning equipment

Green cleaning - indoor chemical and pollutant source control

Green cleaning - indoor integrated pest management

BREEAM Certified Industrial Building Example

Figure 3.6.: South Gate Industrial Park (BREEAM, May 2014)

Building Name: South Gate Industrial Park

Building Location: Domodedovo, Moscow

Building Function: Industrial Building

Total Area: 53,159 m^2

Environmental Assessment Method: BREEAM

Certification level: BREEAM VERY GOOD (63)

Certification date: 2009

Indoor Air Quality: High quality office space and indoor environment for staff with adequate views from windows, access to fresh air, occupant lighting and temperature controls.

The warehouse is heated only with mechanical ventilation. Mixed systems are used: air heating with heat recovery for operational areas and water heating systems for office premises. Heated water is provided from local heating plant with highly efficient boiler. Cooling relies on split systems and is provided for office premises only (less than 5% of the building). All systems are linked to Building manegemnet system (BMS).

3.4.2.4. Material

Ecological material is based on the basic that the materials to be used are made from the healthy materials that are suitable for human health, not from the industrial construction materials that contain toxic materials. Natural materials that do not have synthetic ingredients or that have minimum amount of them are the totally recyclable materials like natural stones, wood or wood fiber, clay, hay, mat, linen and reed (Kışlalıoğlu, M., Berkes, F., 1997.

With the development of the industrial production, environmental problems have been very important. This situation has made it a must to take some measures in architecture and design field. Being ecological for the design products means that they are recyclable, they include less harmful material for the nature, and they can be produced with little energy. Being ecological has been a prior condition for the design products (Berkes, F., 2012).

Effective use of material resources which is one of the most necessary resource groups to constitute a building carries a great importance for the protection of the natural resources. Besides, increasing the use of materials increases the environmental effects at local and global level. Taking the necessary measures regarding the material selection at design level affects the effective use of material at a great level (SEV, A., 2009)

Choosing the right materials, products and components for a building is not an easy task under any circumstances. Designers who specify environmental materials must know that production and consumption of building materials has diverse implications on the environment. Extraction, processing, manufacturing and transporting building materials all cause ecological damage to some extent. There are input and output reduction methods for materials conservation.

One of the most effective methods for material conservation is to make use of the resources that already exist in the form of buildings. Most buildings outlive the purpose for which they were designed. Many, if not all, of these buildings can be converted to new uses at a lower cost than brand-new construction.

Buildings that have to be demolished should become the resources for new buildings. Many construction materials, such as wood, steel, and glass, are easily recycled into new materials. Use recycled materials; During the process of designing the building and selecting the building materials, look for ways to use materials that can themselves be recycled. This preserves embodied energy during their manufacturing.

When a building is too large or small for the number of occupants, it must contain its heating, cooling, and ventilation systems, typically sized by square meter, will be inadequate or inefficient. Architects are encouraged to design around standardized building material sizes as much as possible. Excess trimming of materials to fit non-modular spaces generates more waste. Environmental Discourse and Conceptual Framework for Sustainable Architecture.

Building materials from unconventional sources, such as recycled tires, pop bottles, and agricultural waste, are readily available. These products reduce the need for new landfills and have a lower embodied energy that the conventional materials they are designed to replace.

Consumer goods lose their original usefulness in time. The useful life quantifies the time of conversion from the useful stage to the loss of original usefulness stage. For instance, a daily newspaper is useful only for one day. The shorter the useful life of consumer goods, the greater the volume of useless goods results. Consequently, more architectural considerations are required for the recycling of short-life consumer goods. The conventional term for consumer goods that have lost their original usefulness is waste. But waste is or can be a resource for another use (Çelebi, G., 2003).

DuPont Apollo Hi-Tech Industrial Park which was completed in 2011 in Shenzhen **HONGKONG** is evaluated within the industrial buildings in line with the material aim and it has got **LEED GOLD** certificate. the building which is examined under the title of material and resources title application are made considering the criteria that the materials used are sustainable materials from furniture to wood, recyclable resources are collected and stored, materials can be re-used, local materials are supplied and used.

South Gate Industrial Park building which was built in 2009 in Domodedovo, Moscow with **BREEAM** certificate prefers the material which has little environmental effect throughout its whole life cycle within the material category. Sustainable materials are chosen in accordance with the standards from the construction stage to the completion and covering stage of the building.

Examples with LEED and BREEAM certificates are given below:

LEED Certified Industrial Building Example

Figure 3.7.: DuPont Apollo Hi-Tech Industrial Park (LEED, May 2014)

Building Name: DuPont Apollo Hi-Tech Industrial Park
Building Location: SHENZHEN, HONGKONG
Building Function: Industrial Building

Total Area: 50.000 m²

Environmental Assessment Method: LEED

Certification level: LEED GOLD (63)

Certification date : 2011

Material: Sustainable purchasing - on going consumble

Sustainable purchasing- electric powered equipment

Sustainable purchasing- furniture

Sustainable purchasing- facility alterations and additions

Sustainable purchasing- reduced mercury in lamps

Sustainable purchasing- food

Solid waste management- waste stream audit

Solid waste management- on going consumables

Solid waste management- durable goods

Solid waste management- facility alterations and additions

<u>BREEAM Certified Industrial Building Example</u>

Figure 3.8.: South Gate Industrial Park (BREEAM, May 2014)

Building Name: South Gate Industrial Park

Building Location: Domodedovo, Moscow

Building Function: Industrial Building

Total Area: 53,159 m^2

Environmental Assessment Method: BREEAM

Certification level: BREEAM VERY GOOD (63)

Certification date: 2009

Material: Waste reduction through use of structural insulated panels, sustainable materials - steel, aluminum and mineral wool, all parts of the building are designed for robustness and protected from damage of internal and external vehicles.

3.4.2.5. Water

Turkey is developing and industrializing very fast. The problem which follows the increase of population closely and makes itself felt effectively is the constantly changing and increasing need for use water of this population. To able to meet the constantly increasing domestic and industrial need of water use from already restricted water resources, protection of this water resources from any kind of pollution and recycling and reusing the waste water are gaining importance everyday within the scope of long term programs and research and development studies are made on this issue (Kavaklı, M. and Civan Z., 1997).

Water is used for many different reasons in a building like drinking, using, cleaning and watering. Energy is consumed to purify water before use, distribution within the building and restoring to be re-purified. Methods for efficient use of water are not only for the reduction of amount of water used, it also reduces the indirect use of energy and amount of waste water (SEV, A., 2009).

Water conservation may reduce input, output, or both. This is because, conventionally, the water that is supplied to a building and the water that leaves the building as sewage is all treated by municipal water treatment plants. Therefore, a reduction in use also produces a reduction in waste.

Water consumed in buildings can be classified as two types: gray water and sewage. Gray water is produced by activities such as handwashing. While it is not of drinking-water quality, it does not need to be treated as nearly as intensively as sewage. In fact, it can be recycled within a building, perhaps to irrigate plants or flush toilets.

Water supply systems and fixtures can be selected to reduce consumption and waste. Vacuum-assisted and biocomposting toilets further reduce water consumption.

Biocomposting toilets, available on both residential and commercial scales, treat sewage on site, eliminating the need for energy-intensive municipal treatment. Indigenous landscaping reduce water consumption (Çelebi, G., 2003).

Effective use of water in the buildings is accepted as a critical matter for all the building environmental assessment methods and the importance of this element is gaining more importance within the assessment system. English BREEAM and American LEED systems which are the two basic building environmental assessment methods on earth evaluated the effective use of water in buildings with their own methods (Yağcıoğlu, M.H., 2006). In this way, vitrified elements are used to provide water saving in **Armstrong World Industries in USA** with **LEED platinum** certificate and **CHEP Service Centre in UK** with **BREEAM Very Good** certificate and water consumption is reduced at a considerable level. Leaking sensors and controlling the water consumption by tracking all the time, landscaping with water saving, use of rain water by recycling are evaluated in terms of effective use of water.

Examples with LEED and BREEAM certificates are given below:

<u>LEED Certified Industrial Building Example</u>

Figure 3.9.: Armstrong World Industries (LEED, May 2014)

Building Name: Armstrong World Industries

Building Location: USA

Building Function: Industrial Building

Total Area: 11705 m²

Environmental Assessment Method: LEED

Certification level: LEED PLATINIUM (64)

Certification date: 2007

Water: One of the goals for the LEED certification process was to dramatically reduce the building's use of water. As a result, the project team installed waterless urinals, dual-flush toilets, and water sensors for the faucets. The team also discovered a malfunction in the humidification process that was wasting more than 28,000 gallons of water each year. In all, the project team nearly halved the building's use of potable water, reducing annual use from 800,000 to 420,000 gallons.

<u>BREEAM Certified Industrial Building Example</u>

Figure 3.10.: CHEP Service Centre, Central Park (BREEAM, May 2014)

Building Name: CHEP Service Centre, Central Park

Building Location: Bristol, UK

Building Function: Industrial Building

Total Area: 4509 m2

Environmental Assessment Method: BREEAM

Certification level: BREEAM VERY GOOD (56.83%)

Certification date: 2011

Water: Cold water serving the individual toilet facilities is controlled by sensor operated solenoid shut off valves that reduce water waste in periods of low occupancy.

A rainwater harvesting tank meets the WC flushing needs of the building.

A 5000 litre rainwater harvesting system provides water for all of the building's flushing needs.

A water recycling and filtration system for pressure washing pallets. The system ensures that 100% of the water used is filtered and reused.

Within the scope of these criteria, industrial buildings in Turkey are examined in accordance with the parameters summarized in Table 3.1. Some evaluation matters are common whereas some differences at certain points can be seen.

3.6. Conclusion

Building environmental assessment methods which are described are among the ones which are accepted as the most developed ones. These methods are (BREEAM: Building research Environmental Assessment Method), (BEPAC: Building Environmental Performance Assessment Criteria), (HK-BEAM: Hong Kong Building Environmental Assessment Method), (LEED: Leadership in Energy and Environmental Design), (SBTOOL: Sustainable Building Challange), (CASBEE: Comprehensive Assessment System for Built Environment Efficiency). As it can be seen in these definitions, **the common conclusion is to provide an economic and ecological future for the humanity by producing sustainable and environmentally responsive buildings.**

Within the scope of the studies and investigation made in this part of the research environmental assessment methods are developed in accordance with the needs of the countries that are mentioned. **The methods which are common all around the world are detected by means of from general to specific research approach and these methods are synthesized and compared. BREEAM and LEED which are available in Turkey are taken basis from the determined methods. In this scope, in common and important criteria are chosen and our evaluation approach has appeared**.

There are in common basic design and planning principles that these methods developed in many countries of the world examine. In this scope, design principles that affect the sustainable architecture are effective use of energy, effective use of water, using ecological materials, indoor environmental quality and effective use of land.

As a result, five main aims and the criteria are stated in table 3.12. In this framework, **six criteria** for **site aim**, **ten criteria** for **energy aim**, **five criteria** from **physical comfort conditions** to **material toxicity** for **indoor air quality** are determined.

Four criteria are determined as main factor for the **life cycle assessment of the building components chosen for material. Four criteria** are determined for **water** in line with the effective use of water aim.

Table 3.12.: The Proposed Aims and Criteria for Analysing the Industrial Building in Turkey

	LEED	BREAAM
SITE		
Preparation of user manuals for the building		*
Re-use of land or rehabilitated land	*	*
Sparing fields for recycling of organizational waste	*	*
Green space maximization	*	
Prevention of pollution during construction	*	*
The calculation of the ecological value of the land	*	*
ENERGY		
Systematic commissioning (Commissioning)	*	*
Minimum lighting levels		*
Lighting elements of comfort	*	*
Fresh air levels	*	*
Thermal elements of comfort	*	*
Monitoring energy consumption	*	*
Reducing light pollution	*	*
Promoting the use of renewable energy out of the field	*	
Use of renewable energies in the field	*	*
Calculations of reducing CO2 emissions	*	*
INDOOR AIR QUALITY		
Acoustic performance		*
Use of low volatile organic component materials	*	
Daylight applications and anti-glare applications	*	*
High-frequency lighting		*
Prevention of indoor air pollution	*	*
MATERIAL		
Choice of sustainable materials	*	*
Choosing recycled materials	*	*
Re-use of the building skeleton and shell	*	*
Local supply of materials	*	
WATER		
Use of vitrify which enables water-saving	*	*
Leak sensors		*
Use of water-efficient landscaping	*	
Monitoring water consumption	*	*

Industrial buildings with LEED and BREEAM certificates in Turkey are analyzed and evaluated in accordance with this aim and criteria in chapter 4.

CHAPTER 4

EVALUATION OF THE INDUSTRIAL BUILDINGS IN TERMS OF BUILDING ENVIRONMENT ASSESSMENT METHODS IN TURKEY

4.1. Introduction

As the industrial buildings are among the important factors of the economy of our country, they have to keep the pace of development and technology rapidly. Industrial buildings are in a constant development stage to get their share from this competitive environment resulting from this necessity. It is possible to realize new industrial buildings ideas that are environmently responsive, can provide a better future for the human beings terms of society and economy and that internalizes the sustainable design principles by utilizing this competitive environment resulting from the developing technologies. In this section, characteristics of industrial buildings, their relation with the environment and industrial buildings that are evaluated with building environmental assessment methods within the scope of sustainable architecture are analyzed.

4.2. Industrial Buildings and Environmental Impacts

Industrial buildings are defined as a building or the collectivity of buildings that form a functional whole by organizing necessary industrial activities program to produce a product in the most efficient way according to a certain work and that contain necessary installments and management levels to meet the social needs of the workers (İlgürel, M.N., 2009). Industry includes the process of transforming the raw materials into the product by using human labor and machines (Velioğlu, 1992).

Human being need to produce and change the nature to survive. Production is also the action of creating material and intellectual products with human labor in general. It is the action of getting vital tools needed for the existence and development of the society. According to this wide definition, industry dates as back as the humanity as an activity to interfere nature. It has been in a historical process for the industry to come from this wide, cultural and anthropological context to its shallow, specific content. Tool has been taken from humans and placed on a mechanism. The word industry gets its meaning and content in colloquial language with the mechanical production (Batur, A., Batur, S., 1970).

Industrialization that came out with industrial revolution is the shift of production from the rural areas to the industrial production. However, it is a process depending on agriculture, transportation, economic structure and distribution of population besides the need for technology (Zeybekoğlu 2002).

Radical changes occurred in social and economic fields with some changes in industrial production methods in England in the end of 18^{th} century and towards the beginning of 19^{th} century. This change was defined as "Industrial Revolution" by Jerome Adolphe Blanqui for the first time in 1837; it was popularized by Arnold Toynbee from 1880 and it has been a context in use since then. This old change which is still valid as a context has witnessed revolutionary innovations with new inventions. However, current researches have shown that this old system was developed as a result of long and time consuming studies incrementally (Emre, Ş.B., 2008).

Foundation of Republic was the beginning of industrialization in Turkey, and after 1950 industry started to develop. Industry is the most important function in many cities in our country today, and it is especially directed towards the large cities. Population has risen with industrialization in the cities like İstanbul, Ankara, İzmir, Bursa, Eskişehir, Adana. In addition, physical, economic and social structures of the industrialized cities change as well (Alagöz Çaputçu, M., 2009).

Industrialization and opening new markets developing with industrialization has reached to big sizes with the rise in the population, creation of the scientific discoveries and development in transportation and communication. Positive effects of industrialization are finding new production methods in agriculture, ways to keep and protect the food, developments in communication, obeying the hygiene rules and rapid development of urbanization level. On the other hand, developing technology and industry leave negative effects as well as their positive effects. Consumption of the resources and environmental problems due to the production with the development of industry have increased.

Strategies and approaches serving for sustainable industrial buildings are in the forefront initially in developed societies in the world. Concepts like “sustainable consumption and production”, “green development”, “green economy”, “eco-innovation” and “industrial symbiosis” that are specially heard in the international platforms in the recent years are the reflections of sustainable development and necessity. Context like clean production or eco-productivity are also some of the basic principles of this approach and they are put into life for many years in the developing or under developed countries. As it is known, clean production means increasing the productivity with efficient use of the resources in the production stage, avoiding wastes in the resources, so decreasing the production and environment costs while decreasing the environmental effects (Ulutaş, F., 2013).

There are many buildings that are considered as sustainable industrial buildings in the world. One of these is The McLaren Production Centre which is the second building designed by Foster & Partners at McLaren’s rural site on the outskirts of London. The 34,500-square-metre facility is intended for the manufacture of a range of high-performance road cars and is located to the south-west of the existing McLaren Technology Centre. The two buildings are connected by a subterranean walkway, lined with interactive exhibition spaces. Sharing a common language of details and materials, the new building is clad in aluminum tubes, the rounded corners of its rectilinear plan reference the curves of the Technology Centre and the entrance, echoing the existing building, is a circular glass drum beneath the overhang of the roof canopy (Foster + Partners, June, 2014).

The MPC further develops an approach to industrial architecture that was first explored in some of the practice’s earliest projects for Reliance Controls and Renault.

The roof canopy is supported by a series of slender columns based on a standard grid with repeated components, and services are integrated with the painted steel structure. McLaren’s manufacturing processes are closer in spirit to an operating theatre than a factory and the new building, with its ceramic tiled floors, is designed to showcase this technology (Figure 4.1.). The linear arrangement of the two-storey structure mirrors the flow of the production line: components are delivered; the cars are assembled, painted and tested, and then pass through a rolling road and car wash, before leaving the building. Below this is a basement level for storage and above is a mezzanine floor with views over the production line. The expansion of the campus is a similarly discreet intervention in the landscape.

Figure 4.1.: MacLaren Production Centre Woking, UK, 2009-2011(Foster+Partners, June 2014)

Rising to just over 7 meters in height and embedded in the gentle incline of the site, the Production Centre is sensitive to its rural setting and will not be visible from the nearby road. Further screening is provided by the extensive planting of trees and excavated material helps to conceal the building within the hill. The new building is also designed to be sustainable the Technology Centre uses the lake for its cooling system, so the roof of the MPC supports this by collecting rainwater and implementing a low-energy system of displacement ventilation.

Gelsenkirchen Science Park is another example (Figure 4.2.). The building which was built in 1995 and designed by Kiessler & Partners has been used as a research center in Germany.

Gelsenkirchen Science Park was one of the most remarkable buildings in Emscher Park International Building Exhibition which was held between 1989 and 1999. Gelsenkirchen was the center of coal and steel industry for a long time; it has been a region where solar energy technologies are developed within the scope of ecological and social progress program. After the end of heavy industry, a rapid progress started in the city in terms of environment and culture; theater took the place of mine wells; in short, there has been an evolution from coal to culture.

Gelsenkirchen Science Park consists of nine pavilions that take place in it and that are added to the eastern side of a corridor in the length of 300 m. These pavilions serve as a healthy and comfortable working atmosphere in an environment suitable for the research institutes that major on solar energy, biotechnology and information technologies. The corridor faces a lake from a sloping side and it is used as an open social public place with the cafeteria and shops in it. Artificial lake remaining from the mine organizations is purified with the project and it is used as rain water storage.

Figure 4.2.: Gelsenkirchen Science Park(Internet, June 2014)

Industrial buildings of the 19th century with wide volume and their yard design is inspired for the design of the building which aims to develop an efficient energy management program with a limited budget. Glass corridor which is 10 meters wide functions as a set against the western sun. This facade is made from a heat isolated glass and it can be opened and closed according to the seasonal changes. Heating system under floor is used for cooling in the summer and heating in the winter.

Isolated windows are used behind the aluminum and wood framed around the pavilions used by the research institute. French windows are beneficial to cool down the concrete mass during the summer months. Besides, jalousies that can be controlled automatically are used for sun control.

One of the most remarkable characteristics of the building which has got 27,200 m2 construction area in Gelsenkirchen Science Park is **solar energy plant which has got the widest surface of the world on its roof.** Generators which consist of PV panels integrated to the building produce **200.000 KW of electricity per year**. The performance of the building is kept under control by energy management system. When the ventilation panels are open, heating automatically stops and artificial lighting level is controlled according to the daylight entering in the places. The building on which no strategy is applied regarding the recycled material is designed for an unknown user profile and it carries a lot of risks in the beginning. However, as various energy efficiency strategies are taken into consideration with passive solar design, it clearly shows the importance given to the issue of sustainability by the investor (Sev, A., 2009).

The issue of energy efficiency in industry sector is attracted attention in the recent years in Turkey. Industry sector which is thought to be one of the most important determiner on energy consuming both today and in the future in the increasing trend has been the target sector in terms of energy efficiency investment. Besides, it is thought that saving that be achieved in industry will have great benefits both to the investor and the economy of the country. In this scope, there are laws and regulations including the energy saving regarding the industrial buildings in Turkey. **"Energy efficiency law"** no 5627 dated 18/4/2007, "**Regulation regarding increasing the efficiency for the use of energy resources and energy**" no 28097 dated 27/10/2011 which came into force after being published in official gazette and "**Notice about the energy efficiency subsidies (Item No: 2012/3) no 28342 dated** 03/07/2012 which came into force after being published in official gazette include the items below for the industrial organizations;

1. Subsidies regarding the projects to increase efficiency applications.
2. Subsidies regarding decreasing the energy density by signing voluntary agreements.

Projects to Increase Efficiency (Verimlilik Arttırıcı Proje (VAP)):

The projects which includes the solutions regarding the issues of regaining the waste energy by means of avoiding or minimizing the unnecessary use of energy, waste energy, energy loss or leaks through the use of energy efficient equipment and system, fixing, isolation, modification, rehabilitation, process and similar ways and which are prepared in accordance with the procedures and principles published by **General Management (Genel Müdürlük)** as a manifesto are evaluated as **Projects to Increase Efficiency (Verimlilik Arttırıcı Proje (VAP))** .

The amount of subsidy to be paid for the projects which has 1.000.000 total maximum estimated project sum excluding VAP and repayment period of less than five years is maximum 300.000 TL. Projects to Increase Efficiency belong to the organizations and financing is provided by the industrial organizations. Industrial organizations have to complete the applications of the projects within 2 years and provide the estimated saving amount to have a subsidy for their project. If the projects are not applied within two years and the estimated saving amount is not provided or if the project is abandoned, subsidy is not paid to the industrial organizations.

Subsidy payments are made for the projects that are completed in accordance with the projects as a result of the measurements and controls in place after the projects are completed.

Voluntary Agreements:

Energy Density is the amount of energy consumed by the industrial organization to produce a piece of product. Government subsidy is paid as a donation to the organizations which reduce their energy density by means of voluntary agreements in the guaranteed rate, minimum 10% in average, compared to the reference energy density that is the average energy density in the past five years in the end of the three-year inspection period.

This energy produced by using **hydraulic**, **wind**, **geothermal** or **biomass** resources or in the cogeneration plants produced domestically and which has **80% cycle efficiency** in total in the facilities which turns the wastes in to heating and electricity energy with modern burning techniques from the consumed energy within the industrial organization of the persons signing the voluntary agreement is reduced from the annual total energy consuming of the industrial organization in the energy density accounts for one time only. In this case, renewable energy and cogeneration facilities are also supported indirectly.

The subsidy to be paid is increase from 100.000 TL to 200.000 TL with the arrangement of the regulation. 20% of energy cost in the year of the year of agreement for the industrial organizations of legal entities that meet the guarantee and sign a voluntary agreement with the General Management is provided from General Management budget under the condition that subsidies of the General Management is sufficient and it is not over 200,000 TL.

Voluntary Agreement applications are made in Renewable Energy General Management in October every year.

It has been seen within the scope of inspections and researches that methods regarding the sustainability and environmental performance evaluations are applied to reduce the environmental effects of the industrial buildings in Turkey. A lot of studies are found on the subject of developing environmentally responsive industrial buildings to maintain the nature and the human activities. **Siemens Factory, Schineider Electric Adh Factory, Inci Akü Factory** and **Birleşim Engineering Factory** from these studies are amongst the project evaluated as the environmentally responsive and they aim increasing the efficiency by means of efficient use of resources, avoiding the wastes in the resources, reducing the production and environment costs and reducing the environmental effects; they are certified by international building environmental assessment methods.

4.3. Analysis of Industrial Buildings with Certified Building Environmental Assessment Certificates in Turkey

4.3.1. Siemens Factory, Gebze

Climatic Type: Black Sea and Mediterranean climate

Total Area: 32.500 m²

Environmental Assessment Method: LEED, LEED GOLD (52,50%)

Certification Date: 2009

Figure 4.3.: Siemens Factory, Location in Turkey

Rating criteria for applications:

Siemens Production Facility is in Gebze Organized Industrial Zone and it is located on a land of 150.000 m² (Figure 4.3). Siemens Gebze Organized Industrial Zone Facility was completed in two phases and it is finalized as 85.000 m² of construction settlement site and approximately 120.000 m² of indoor construction site. At the first stage, 32.500 m^2 of construction site is built. After the completion of the first phase, Energy Transformation and Distribution Department moved. Following the completion of the second phase, Automation and Drivers Department with all the other departments moved to the new facility with offices and recreation fields.

Figure 4.4.: Siemens Factory, Gebze, Kocaeli, Turkey (February 2014)

Figure 4.4.a.: LEED Certificate

Figure 4.4.b.: Siemens Factory, Entrance

Siemens aims to be environmentally responsive with the systems it owns and with its design, healthy for its workers with its indoor quality and a example for many new facilities as building with a low management cost due to maximum energy saving. During the planning of the facility, it was aimed to be the first in our country. It started working for 2009 LEED GOLD certificate with these aims. Siemens Gebze Organized Industrial Zone Facility is especially important as for being the first building with LEED certificate in Turkey (Figure 4.4).

LEED green building rating system that helps define the the buildings that are healthier, environmentally response, more economical and profitable in terms of facility costs and high performance building compared to the available buildings is a voluntary-based standard in LEED system it is given by US Green Building Council. The mentioned scaling is made in 6 categories below which have different rating scale.

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Enviromental Quality
- Innovation in Design

We will examine Siemens Production Facility under the mentioned main titles;

Sustainable Sites

Following the master plan and all the design stages this, it was aimed to use the field as efficiently as possible and to create an environmentally responsive building as much as possible.

Siemens GOSB Campus is projected in a way that the topography on a field of 150.000 m² would be interfered at a minimum level as possible, the available gradients would be used and the structure of the land would be turned into an advantage. Besides, there is an effective landscape design (Figure 4.5).

Figure 4.5: Siemens Factory, Landscape(February 2014)

Vehicle and pedestrian traffic is completely divided into zones in the project. The trucks and the transportation vehicles arriving to the production facility enter the campus in a different gate and they reach the facilities without meeting the pedestrian traffic. Pedestrian traffic is designed systematically between the buildings and within the whole campus.

There is no personnel private vehicle traffic within the campus. The employees park their vehicle in the open parking space and they either walk or ride bicycles available for free for their transportation.

There are shuttles for the all personnel. In this way, public transportation is supported to save more.

Energy

Today, efficient use of natural energy resources has gained importance for many reasons. Siemens handles this subject with great care and it aims to use the natural energy resources the most efficiently in its Siemens GOSB Project. Various benefit – cost analysis have been made on this issue and the support of the expert organizations is asked. All the projects and the systems are organized within this scope.

The load of lighting on the energy consumption is calculated by considering the importance of lighting in the buildings and some measures are taken to keep the energy consumption/m² at a minimum level. The aim is to reach the minimum energy consumption per m² without decreasing the comfort and the quality. Special lighting equipment is used for this aim. Personal floor armatures sensitive to the daylight and the movement that are put next to the tables of the employees are used in the offices. 50% saving in the lighting is achieved by means of this system. Except these, lighting elements with movement sensor is used in the corridors and wet places.

Daylighting is utilized at a maximum level for lighting, and artificial lighting and energy consumption is kept at a minimum level. For this reason, cladding window sides to let the necessery daylighting level inside the offices at a maximum level, light halls that are also used as an indoor garden continuing as a gallery from the roof to the floor in the new offices, skylights on the roofs of the production fields and placing of the building to support all these are made (Figure 4.6).

Figure 4.6.: Motion and daylight sensored lighting fixtures (February 2014)

Figure 4.7.: Lighting fixtures (February 2014)

Sunshades are used on the sides of the offices to reduce the cooling air conditioning loads, increase the productivity of the workers by providing effective shading and avoid solar energy inside. The way, angels and the sizes of the sunshades are designed at an optimum level as a result of engineering studies supported by computer.

The outer covers of the building are designed to provide the best heat isolation (Figure 4.8.). In this way, heat transform is minimized in both ways. Especially the Office Building is covered with the special glasses that would let beneficial sunlight in at a maximum level and harmful UV sun rays and energy at a minimum level (U=1,1 W/m*K, SC=0,36 g=0.31).

Figure 4.8.: High Isolated Facade Systems(February 2014)

Roof elements and the layers of the buildings are also designed to keep the heat transfer at a minimum level. Thermoplastic Poly Olefin (TPO), a roof covering material, prevents the heat to come in by reflecting solar power at an amount of 85%. Considering the dimensions of space, it is seen that considerable amount of energy is saved.

Variable Air Volume (VAV) air conditioning plants are used to meet the need of cooling down for offices with minimum energy consumption with the help of building automation when the outer temperature is between 14 C and 20 C. These systems let different acclimatization in different zones within the office spaces besides energy saving.

Hot water is gained from the waste heat from the chiller groups during the cooling process of the buildings. In this way, heating boilers are used less and gas saving is provided.

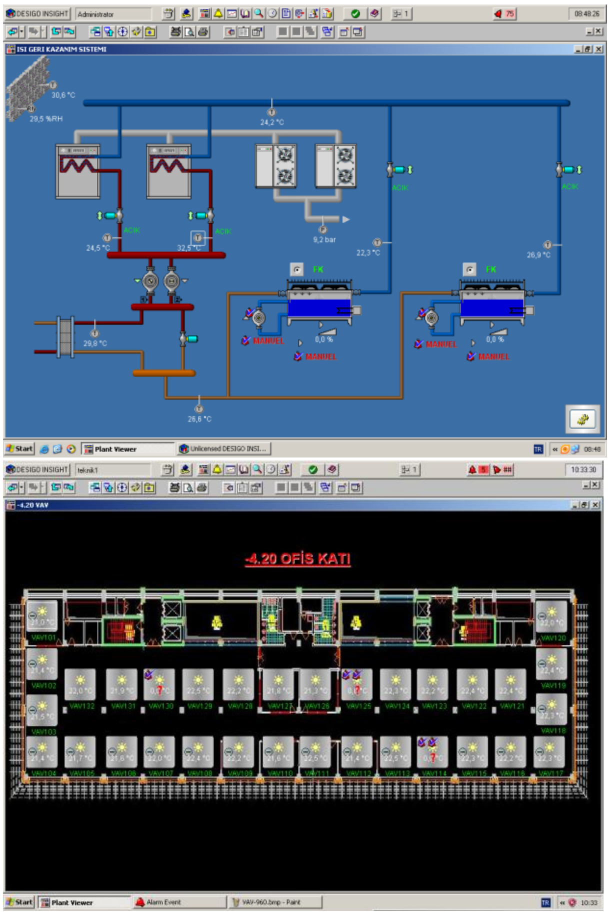
Hot water is gained with the waste heat of compressed air compressor used for the production. Natural gas is saved in the same way through this system as well.

Energy is saved by heating the cold weather from outside with the heat of the hot weather disposed to the outside and collected in the offices during winter and cooling the hot weather taken from outside with the cooled polluted air to be disposed and collected in the offices during summer.

Hot water is gained by utilizing the solar energy on the roofs.

A boiler which provides more efficiency, saves more fuel and has low emission value is chosen.

Figure 4.9.: Building automation system for lighting & HVAC (February 2014)



There is an automation system which automatically engages and unmounts all the cooling, electricity and mechanical systems of the whole building. It is aimed not to use energy more than necessary and to operate the systems with full performance with this system (Figure 4.9.).

Frequency converters are used to check the capacity control and to reduce the energy consumption on HVAC systems.

Indoor Environmental Quality

An interior decoration plan and concept is created with the general architectural design of the project and after that this concept is developed with an interior decoration project. A functional and aesthetic design is made to maximize the performance and satisfaction of the employees.

Indoor functions are determined clearly during the projecting studies and maximum performance solutions in optimum square meters are presented by studying the user profile and working conditions in detail. In this way, over construction is avoided by using the space in the building most efficiently. This leads to save natural resources and energy.

Visual and aesthetic quality is given importance in the project to increase the performance and productivity of the workers. The choices of colors and materials, concept studies, interior and exterior designs of the buildings are completed with this menner.

The spaces from the entrance of the building to the social places and the offices are projected in integrity. Open office system is common for the office buildings and the management rooms are separated with glass systems. The materials used for the design are recyclable and environmentally responsive.

All the production places are cooled and heated. Minimum air change parameter is calculated as 1.7 ach (air- change) to meet the heat loss. High interior air quality is provided in the production fields with this air change.

Loss of infiltration is prevented by keeping plus 0.5 ach pressure indoor for the ventilation installation application.

Creating 5 – 7 K difference of temperature from the environmental temperature in the places where the employees work densely will both provide energy saving and high comfort perception. Displacement diffusers are used for this aim. They provide comparatively better flow and bottom elevation supply air will not cause turbulence.

4 zone regions are created in the offices. Plants in the areas where 100% fresh air conditioning plants are used are chosen as heat recovery types to enable energy saving. VAV system with full air is installed according to plants and air

volumes, heat loss or heat gain of the building. When the load in the air conditioning is high in interior zones during winter, interior zones will work in cooling mode, exterior zones in heating zones and when needed it will work with re-heat coiller.

Acoustic and noise level in the offices and social places is examined and special measures are taken in places for this matter.

Materials

Using environmentally responsive material is highly important for Siemens GOSB Project. Using the light colored materials which will prevent the creation of heat island effect by reflecting the sun rays and energy at a maximum level is preferred. It is given importance to choose the materials inside the buildings made from the ones used before to keep the natural resources. Recyclable materials are used in the project to re-use the used materials in the building when they cannot be used anymore and in this way to consume natural resources less. During the design stage, these issues are considered and the aesthetical concerns are met.

Energy and natural resources used for the transportation and supply of the materials are thought to be minimized by using local materials as much as possible. Price advantage, supply periods and contribution to the local economy can be accepted as extra advantages.

Volatile organic compound materials (VOC) and well resolved systems are preferred as much as possible inside the buildings considering the issues of human and environment health. Designs are made by considering the aesthetical values and minimizing the material waste.

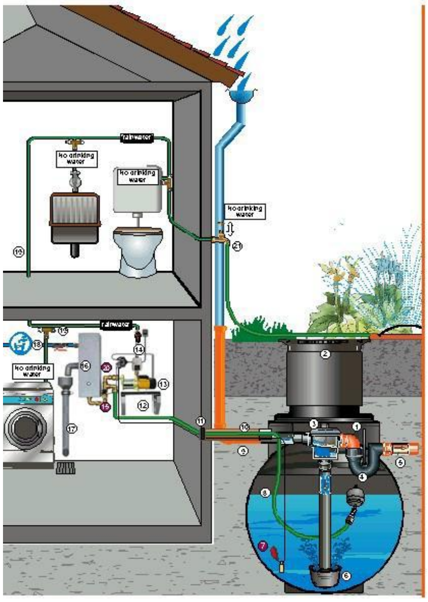
The waste materials as a result of the productions in the field are classified and stored to be sent to the concerning places to be evaluated and a part of them will be recycled.

Water Efficiency

Water is important for our daily life. It is aimed to use the water the most efficiently within the framework of Green Building.

Landscape design are made on the surrounding except the building settlement places. Plants that are green as much as possible and need minimum water are chosen.

Figure 4.10.: 70% Water Saving in Potable Water (Yaman, C., 2010)



Roof rain water in the buildings are filtered and sent to pure water store. This water is used for watering the garden or fire extinction and it can be softened to be used as campus use water (Figure 4.10.).

All the urinals in the building are the systems called as waterless urinals that can be cleaned without using the water. In this way, natural water resource use will be reduced. Besides the water saving, installation costs for the urinals will be eliminated. Biological Purification system will take place to reduce the consumption of the natural water resource, to recycle the used water and most importantly to protect the nature. Green fields will be watered with automatic drip irrigation systems in the project. Sufficient amount of water will be given to the plants with this system and water saving will be enabled. Water consumption will be at the minimum level by means of photocell armatures with heat and volume adjustment.

Table 4.1.: The Evolution of Siemens Factory in Terms of Proposed Aims and Criteria

	SIEMENS
SITE	
Preparation of user manuals for the building	
Re-use of land or rehabilitated land	*
Sparing fields for recycling of organizational waste	*
Green space maximization	*
Prevention of pollution during construction	*
The calculation of the ecological value of the land	*
ENERGY	
Systematic commissioning (Commissioning)	*
Minimum lighting levels	
Lighting elements of comfort	*
Fresh air levels	*
Thermal elements of comfort	*
Monitoring energy consumption	*
Reducing light pollution	*
Promoting the use of renewable energy out of the field	*
Use of renewable energies in the field	*
Calculations of reducing CO2 emissions	
INDOOR AIR QUALITY	
Acoustic performance	
Use of low volatile organic component materials	*
Daylight applications and anti-glare applications	*
High-frequency lighting	
Prevention of indoor air pollution	*
MATERIAL	
Choice of sustainable materials	*
Choosing recycled materials	*
Re-use of the building skeleton and shell	*
Local supply of materials	*
WATER	
Use of vitrify which enables water-saving	*
Leak sensors	
Use of water-efficient landscaping	*
Monitoring water consumption	*

4.3.2. Inci Aku Factory, Manisa

Climatic Type: Mediterranean climate and Continental climate of Central Anatolia

Total Area: 10,500 m2

Environmental Assessment Method: BREEAM, BREEAM GOOD (52.50%)

Certification Date: 2011

Figure 4.11.:Inci Aku Factory, Location in Turkey

Rating criteria for applications:

Inci Aku is in Manisa Organized Industrial Production Facility Manisa Industrial Zone and it is settled on 100,000 sq. m of land (Figure 4.11.). Planning of the facility started in 2009, and it consists of 55,000 m² covered area. The construction of the facility is currently ongoing; 10,500 m² of the covered area has been completed and battery production has started (Figure 4.12.).

Figure 4.12.:Inci Aku Factory

While making facility planning studies, building an environmentally responsive production facility was the target. For this purpose and as a result of researches, a decision for 2009 BREEAM certificate was choosen as target. At the first hand, a project team consisting of BREEAM inspector and the engineers of the firms responsible for the construction stage was formed. Project team started to work by creating action plans of BREEAM Commercial 2009 certification. BREEAM criteria have been discussed in the action plan. Management, health, energy, transportation, water, materials, waste, land use and ecology, pollution criterion are evaluated. The amount of scores to be taken in each area is considered. The projects are followed by means of regular meetings. The facility which was developed by considering all the stages of project, construction, finishing the construction, production and post-production was found qualified to get BREEAM Good Certificate on 10 November 2011 (Figure 4.13.).

Figure 4.13.:Inci Aku Factory, BREEAM Certificate


breeam

The Code for Sustainable Buildings

This is to certify that

**Inci Aku Manisa Factory,
Manisa Organize Sanayi Bolgesi 4.
Kisim Manisa,
Turkey**

has achieved an interim score of 52.50%, and a BREEAM rating of

GOOD

Pass

Outstanding

This Design stage assessment was carried out under the 2009 version of BREEAM Europe Commercial

Signed on behalf of BRE Global Ltd

10th November 2011

Date

Emre Ilicali

Licensed Assessor

Altensis Insaat Enerji San. Ve Tic Ltd. Sti.

On behalf of

Inci Holding

Developer / Client

Ece Paker

Architect

Kon-Kur A.S.

Main Contractor

breglobal

www.breeam.org

During the inspections of evaluating BREEAM criteria for the planning of Manisa Inci Aku Industrial production facility, the items below are considered to be inspected:

- Management
- Health
- Energy
- Transportation
- Water
- Materials
- Waste
- Site use and ecology
- Pollution

Inci Aku Manisa Industrial Production Facility is, as known, a battery manufacturing plant. The facility has many projects as environmentally friendly buildings suitable for the BREEAM criteria. The projects prepared in this context, construction and production stages are described within the scope of findings done onsite. We will share information acquired as a result of interviews with facility managers and project managers.

Some of the important points in terms of BREEAM criteria are that the construction site is safe and in good relation with the surrounding facilities, environmental protection measures have been taken, and the environment provides a clean working environment for the workers. In Inci Aku Manisa Industrial Production Facility, these criteria have been completed.

Inci Aku Manisa Industrial Production Facility is examineted in main titles;

The Use of Site and Ecology

Shown in the pictures Figure 4.15. and the additional documents that there was another building or a construction on the land of the current building. In the region determined to be soiled areas, rehabilitation work which was made in accordance with the BREEAM criteria has been shown and reported.

Figure 4.14.:Inci Aku Factory, Entrance (October, 2013)

Figure 4.14.a.:Inci Aku Factory, Entrance 1

Figure 4.14.a.:Inci Aku Factory, Entrance 2

It has been proven by an ecologist (or an equivalent expert accepted by BREEAM) that the field had low ecological value in accordance with the BREEAM criteria before the construction, calculations have been made and it is compared with the value after construction.

An ecologist employed for the project controlled that the ecology and habitat was protected in accordance with the international standards during construction activities, Sustainable Habitat and Landscape Plan was formulated in accordance with the future BREEAM criteria and the measures suggested by BREAM concerning the protection of the ecology during the construction are taken by the contractor.

<u>Energy</u>

The materials used in order to minimize harmful effects on the environment are determined according to this criterion. Energy efficiency applications have been made in the construction site. Energy-saving lamps have been used. Alternative energy sources enabled the efficient use of water and energy. Materials and equipment are stored in a careful and attentive way in a sheltered location to be protected against the events arising from theft and natural phenomenon.

The energy consumption of the main systems in the building can be measured by the automation system or separate counters. It includes:

Heating

Air Conditioning

Hot water for use

Big fans

Lighting and small loads are the other energy consuming systems.

The energy consumption of the different floors in the building can be measured with either an automation system or different counters.

For the exterior lighting, armature and lamp choices, BREEAM necessities have been considered.

Sign lighting: >25W => 60 lmn/W; <25W => 50 lmn/W

All exterior lighting is time-controlled or it is controlled with the day light sensors.

Figure 4.15.: Indoor Daylighting (October, 2013)

A feasibility analysis has been made for the use of alternative energy technologies during designing. As a result of the feasibility, suggested alternative energy system has been applied to the building and it is aimed to reduce the energy consumption up to 10-15%. Daylight is utilized for the interior lighting which is developed by considering the BREEAM criteria. For the interior and exterior lighting, preferable lighting elements are used by applying the necessary tests if needed (Figure 4.15.).

Regarding the heating and air conditioning systems, heating and air conditioning departments are built considering the summer and winter period in accordance with protection level of the battery.

Health

Daylight factor calculations of the areas to be used at all times are made after the determination of the area net floor sizes, height and the dimensions of the windows, average reflecting values of the area surfaces, light transmittance of the windows, light transmittance of the skylights and the light distribution rate.

Technical documents of the florescent and compact florescent lamp ballasts and data of systems working at high frequency are stated.

As the interior and exterior lighting illuminance must be in accordance with the lighting illuminance stated in TS EN 12464 standards, lighting design is made so as not to lead any glare on the computer screens and the uniformity ratio 0.7 around the desk top is made as minimum 0.4. Calculations and the reports of the designers showing that these conditions are provided are prepared.

As VOC ratio of the paints to be used must be lower than the values below 2004/42/CE and they must be tested in accordance with EN ISO 11890-8:2006 Paints and varnishes Determination of volatile organic compound (VOC) content standard, the choices were made in accordance with the criteria.

All the systems including water in it (cooling tower, sanitary installations etc.) are designed in accordance with the international standards and BREEAM criteria so as not to give possibility for legionnaire disease. Interior dampening has been considered in the designs.

Material

80% of the material used for the construction of building is bought from the material producers who have **Environment Management System (ISO 14001, COC etc.)** by examining the bedding and details of the materials to be used for exterior walls, windows, roof and flooring material, exterior hard surfaces and the walls to surround the area and the material to be used for the fence system.

Technical data about the insulation materials chosen for the building and the building systems and the places to be used are evaluated by the authorized people and the necessities of BREEAM are considered. XPS is avoided as a preference of insulation material. Rockwool, fiberglass and EPS are used instead.

Places with the high number of pedestrians (corridor, entry door, stairs, elevator etc.) are determined and the measures are taken to protect the coating materials.

In the places where the vehicles come closer than 1 meter to the exterior of the building, the measures suggested by BREEAM are taken against the potential crushes.

The materials to be used during the construction stage of the building are chosen in accordance with Breeam criteria by applying various tests and material measurements. Considering the materials like acid, lead used for the production of the batteries, epoxy is used on the interior floor of the building built as reinforced concrete.

Water

Materials are chosen as result of the studies with the energy consultants for the water, armature and vitrified elements. Considering the flow rates, strategies like urinal without water, productive armature, flush with double buttons, and reuse of rain water are evaluated.

Figure 4.16.: Clean water and dirty water channels(October, 2013)

Figure 4.16.a: Clean Water Channel Figure 4.16.b: Dirty Water Channel

Water meter or submeters to be used in the building are able to be connected to the building automation.

Water leak detection system suitable for the BREEAM criteria is integrated in the building and when there are big leaks, it gives alarms (Water Leak Detection system).

A solenoid valve is installed in the water inlet line of each toilet to cut the water in the conditions when it is not used and it is connected to the lighting system of the toilet. The water gained from the waste water system in the building is reused within the building.

Table 4.2.: The Evolution of Incı Aku FActory in Terms of Proposed Aims and Criteria

	INCI AKU
SITE	
Preparation of user manuals for the building	*
Re-use of land or rehabilitated land	*
Sparing fields for recycling of organizational waste	*
Green space maximization	
Prevention of pollution during construction	*
The calculation of the ecological value of the land	*
ENERGY	
Systematic commissioning (Commissioning)	*
Minimum lighting levels	*
Lighting elements of comfort	*
Fresh air levels	*
Thermal elements of comfort	*
Monitoring energy consumption	*
Reducing light pollution	*
Promoting the use of renewable energy out of the field	
Use of renewable energies in the field	*
Calculations of reducing CO2 emissions	*
INDOOR AIR QUALITY	
Acoustic performance	*
Use of low volatile organic component materials	
Daylight applications and anti-glare applications	*
High-frequency lighting	*
Prevention of indoor air pollution	*
MATERIAL	
Choice of sustainable materials	*
Choosing recycled materials	*
Re-use of the building skeleton and shell	*
Local supply of materials	
WATER	
Use of vitrify which enables water-saving	*
Leak sensors	*
Use of water-efficient landscaping	0
Monitoring water consumption	*

The facility manager, who states that the aim of BREEAM is to reduce the amount of the necessities first, then to make studies and find solutions to minimize that necessity, told that their main goal is to utilize recycling at a maximum level by reducing the amount of waste to the minimum and reach an environmentally responsive production facility in the end.

4.3.3. Schnieder Electric Adh Factory, Gebze, Kocaeli

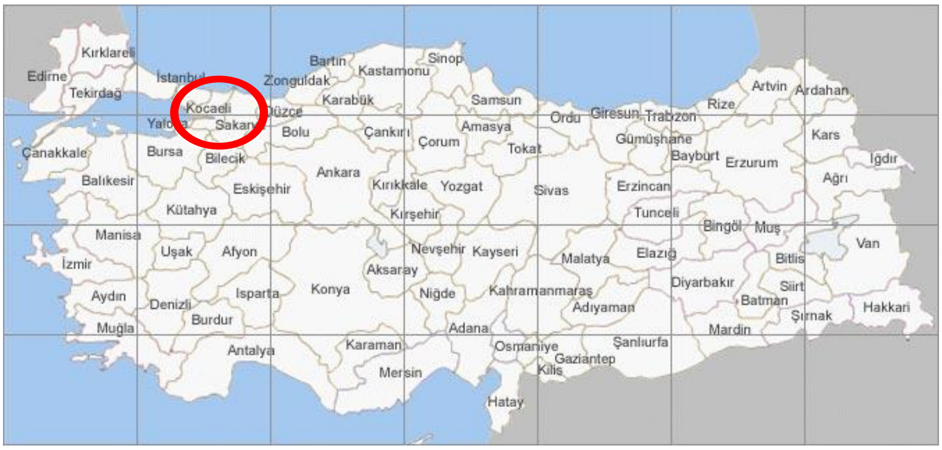
Climatic Type: Black Sea and Mediterranean climate

Total Area: 37.500 m²

Environmental Assessment Method: LEED, LEED GOLD (52,50%)

Certification Date: 2011

Figure 4.17.: Schnieder Electric Adh Factory, Location in Turkey



Rating criteria for applications:

The transformer factory of Schnieder Electric ADH Factory is in Taysad Organized Industrial Zone and it is located on a land of 50.500 m² (Figure 4.17). The facility which started to be planned in 2009 consists of 37.500 m² closed area and 13.000 m² open area (Figure 4.18.).

Figure 4.18.: Schnieder Electric Adh Factory, Entrance (February 2014)

The factory building which was awarded with LEED (Leadership in Energy and Environmental Design) in Golden Level in September 2011 is designed and constructed so as to complete the works of Schneider in the field of energy efficiency (Figure 4.19.). In the building which was designed to be 22% more efficient according to ASHRAE energy efficiency standard, it is enabled that the building can automatically provide energy efficiency depending on the changing internal and external conditions by means of an advanced automation system which can control the building from almost 1000 points and the energy used is traced in many different points to lead continuous increase in efficiency. The mechanical equipment is also chosen above the minimum efficiency level in ASHRAE standard to carry energy efficiency to the highest level. The presence sensors used in the lighting system, light bulbs in T5 and LED types and the use of daylight provide 36% efficiency in total for the internal and external lighting compared to the standard. Daylighting is utilized at a maximum level in the offices and in the production area; energy saving is provided my means of high performance windows, sides and skylight systems.

Figure 4.19.: Schnieder Electric Adh Factory, LEED Certificate (February 2014)

The mechanical equipment chosen are selected above the minimum productivity values of ASHRAE standard to carry energy efficiency to the maximum level. Due to utilizing the presence sensors used in the lighting system, T5 and LED type bulbs and the use of daylighting, 36% efficiency is achieved for internal and external lighting system in total compared to the standard. While daylighting is utilized at a maximum level in the offices and in the production area, high performance windows, side and skylight systems enable energy save.

For the health of the workers, fresh air rates are kept above the standard. Besides, the number of particles that spread in the air as a result of production has been reduced to 1/10 of Occupational Safety and Health Administration limits with air conditioning system developed specially for the transformer. In addition to this, constructional chemicals to be used in the building are chosen from those types that would not harm the human health.

In Schneider Electric ADH Factory, water efficiency has been an important part of green building design. Rain water collected from 18.000 m² of the roof is processed through a special filtering system to be used in the drinking water quality within the building; so that 3.600 m3 of water is saved. In addition to this, approximately 2.000 m3 of water gained from the dirty water system is used for watering the garden.

88% of the workers come to work with the shuttles provided free by the company aiming to provide a safe journey to the workers and to reduce CO2 oscillation.

138 tons of waste has been sent to recycling not to the trash bins thanks to the waste management policy applied during the construction. Additionally, as more than half of the chosen construction materials are produced in Turkey and supplying the raw material, both carbon emission resulting from the transportation is reduced and contribution to the economy of the country is provided.

LEED Green Building Rating System that helps define the buildings that are healthier, environmentally responsive, more economical and profitable in terms of facility costs and high performance building compared to the available buildings is a voluntary-based standard and it is given by US Green Building Council. The mentioned scaling is made in 6 categories below which have different rating scale.

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Innovation in Design

Schnieder Electrik ADH Factory is examineted in main titles;

Sustainable Sites

Erosion control plan is prepared and applied during the construction. Planning and studies are made and pre-construction and construction stages are documented with the photographs.

As there are no available housing area close to the project site, transportation is provided by means of shuttles. Shuttle policy is prepared by determining the shuttle routes.

Figure 4.20.: Schnieder Electric ADH Factory, Entrance (February 2014)

Considering the number of the users of the building, bicycle parking lots and changing cabins and showers are built inside the building.

Parking capacity is planned so as not to exceed the local policy, special parking places are allocated for the shuttles and low emission vehicles. These places are planned close to the entrance of the parking lot. These places are signed with signs and ground markings in the parking lot.

More than 20% of the land is designed as green open area. Local and adapted plants are chosen with great care for the yard. How to water the yard and all the fields are indicated.

Figure 4.21.: Schnieder Electric ADH Factory (February 2014)

Average annual rain rate for the region is calculated. A landscape planning is created showing the planted and concrete areas. A mechanical column scheme is created to show that the rain water is collected. A roof plan on which the parts to collect the rain water are signed for 18000 m² land of roof is created so it is enabled to re-use the rain water.

Because of the heat island effect, grass stone and light color concrete is used in accordance with certain standards on the concrete floors. Due to its harmful effects, tar is not used within the facility. Considering the same standards, light colored material is used for the roof coating.

In this way, 90% of efficiency has been achieved in the water used except the operation.

<u>Energy</u>

The equipment used is chosen in accordance with ASHRAE 90.1-2007 standard. Detailed examinations are made for the building isolation, electricity and mechanical systems. Energy modelling is made and the high efficiency equipment is preferred.

In accordance with the modellings arranged in accordance with ASHRAE and LEED standards, Ventilation systems with heat recovery, lighting equipment with high efficiency, building automation, high efficient sides (isolation, windows etc.) are used. 19,6% of energy is saved as a result.

Figure 4.22.: Schnieder Electric Adh Factory, Indoor Daylighting (February 2014)

With advanced automation and submetering, the main energy consumption of the building is measured separately in the operation. Energy consumptions separately traced inside the building except production at the first sight are:

- Heating
- Cooling
- Ventilation
- Use water heating
- Circulation (pumps)
- Lighting and small powers.

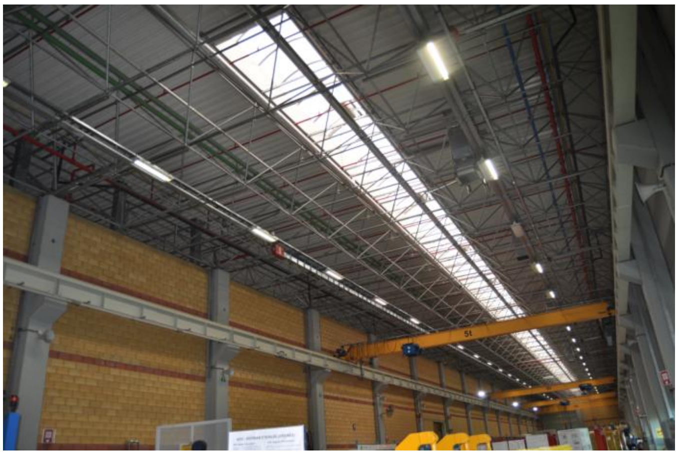
Cooling solutions are chosen according to LEED criteria as result of necessary measurements and examinations.

Indoor Air Quality

Fresh air amount given to all the volumes ventilated mechanically does not pass 30% over the minimum values claimed in ASHRAE 62.1-2007 standard. A table showing the number of the people in a place and the amount of fresh air given to this place has been prepared. Fresh air control in high density places (4m2/person) is made by means of CO2 sensors in the level of breathing.

Positioning plans are made showing the smoking areas far from the building air entrances. Smoking is not allowed inside the building.

Figure 4.23.: Schnieder Electric Adh Factory, Daylighting and Fresh air Equipment (February 2014)



Equipment is used to track the fresh air entrance inside the building. Fresh air control is traced connected to an alarm (Figure 4.23.).

Indoor air quality applications during the construction and before settling in are made in accordance with LEED criteria.

Paints, glue, paste and similar materials to be used are chosen in accordance with Greenseal, SCAQMD and Floorscore standards. Besides, wooden composite materials do not contain urea formaldehyde.

Thermal comfort is provided in accordance with ASHRAE 55.2004 standards. Calculations like heat, relative humidity and air distribution speed are made separately for four seasons.

A survey is applied for the workers to check if the building thermal comfort is provided.

Materials

Recyclable waste is separately collected in the waste collection field. Moreover, trash bins are placed in certain places inside the building for recyclable waste. The places to put the trash bins are shown as “recycled waste collection area” on the floor plans.

Using a recycled material and domestic material is considered for the evaluation of LEED criteria. As a result of research, suitable materials are chosen and used. In this way, 76% waste recycling during construction, 42% recycled material use in total and 51% domestic material use is provided (Figure 4.24.).

Figure 4.24.: High Isolated Facade Systems, outside (February 2014)

Figure 4.25.: High Isolated Facade Systems, inside (February 2014)

Water Efficiency

Landscape watering system is provided with the collected rain water. Average rain amount of the region is determined and mechanical projects showing the rain water collection system are prepared. Water consumption of the chosen plants is determined by the landscape architect.

Waste water purification plant is established and it is aimed to minimize water need that is not met from the rain water. Waste water is purified to be used for landscape watering.

By means of productive water armatures and re use of rain water as tap water, more than 90% of efficiency is provided for the water used except the operation.

Table 4.3.: The Evolution of Schnieder Electric ADH Factory in Terms of Proposed Aims and Criteria

	INCI AKU
SITE	
Preparation of user manuals for the building	*
Re-use of land or rehabilitated land	*
Sparing fields for recycling of organizational waste	*
Green space maximization	
Prevention of pollution during construction	*
The calculation of the ecological value of the land	*
ENERGY	
Systematic commissioning (Commissioning)	*
Minimum lighting levels	*
Lighting elements of comfort	*
Fresh air levels	*
Thermal elements of comfort	*
Monitoring energy consumption	*
Reducing light pollution	*
Promoting the use of renewable energy out of the field	
Use of renewable energies in the field	*
Calculations of reducing CO2 emissions	*
INDOOR AIR QUALITY	
Acoustic performance	*
Use of low volatile organic component materials	
Daylight applications and anti-glare applications	*
High-frequency lighting	*
Prevention of indoor air pollution	*
MATERIAL	
Choice of sustainable materials	*
Choosing recycled materials	*
Re-use of the building skeleton and shell	*
Local supply of materials	
WATER	
Use of vitrify which enables water-saving	*
Leak sensors	*
Use of water-efficient landscaping	
Monitoring water consumption	*

In accordance with in place inspections and documentations, transformer factory of Schneider Electricity provides many benefits to our environment and country as a sustainable building which can be an example in any ways. As a result of operational and spatial studies, it can be considered as an environmentally responsive production facility.

4.3.4. Birleşim Engineering Factory, Dudullu, İstanbul

Climatic Type: Mediterranean climate, Black Sea Climate and Continental climate of Central Anatolia

Total Area: 6.500 m^2

Environmental Assessment Method: LEED, LEED GOLD

Certification Date: 2012

Figure 4.26.: Birleşim Engineering Factory, Location in Turkey

Rating criteria for applications:

New management building and factory of Birleşim Engineering in Dudullu Organized Industrial Zone own LEED Gold Certificate (Figure 4.26). The building provides 21.5% energy and 100% energy saving. Besides, local material use rate is 38.5% and recycled material use rate is 29% in the building.

New management building and factory in Dudullu Organized Industrial Zone of Birleşim Engineering which gives projecting, manufacturing, supply, installation and training services in the fields of heating, cooling, air conditioning, protection from fire, automation and natural gas systems at home and abroad own LEED Gold Certificate (Figure 4.27.a.). The facility consists of 3000 m^2

production, 2500 m^2 storing and transportation field, five meeting halls, training and seminar hall for 100 people, lunch hall for 100 people and offices.

Figure 4.27.: Birleşim Engineering Factory (B2B Media, 2012)

Figure 4.27.a.: LEED Certificate Figure 4.27.b.: Entrance

High efficient boilers, pump and fans with frequency converter, low-e windows, hot water production from solar power, floor heating system, cooling system with VRV, air conditioning plants with heat recycling and highly efficient lighting armatures are prefered for energy gaining and saving in the building. Besides, sustainable building strategies under the title of material and resources stand out in Birleşim Engineering management and factory buildings.

Evaluations are made in 6 categories in accordance with Leed Green Building Rating System.

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Innovation in Design

We will examine Birleşim Engineering facility under five main titles:

Sustainable Site

LEED criteria are followed in environmental terms during the construction stage. ESC plan is applied for excavation. Various measures are taken not to let the vehicles leave mud on the streets while leaving the field and not to let the water inside field go out. A separate field is created to collect the wastes during the construction and they are separated according their types and they are sent for recycling.

A bicycle parking area is built outside for the ones who want to come to work by bicycle. The building is located 400 meters far from the bus stops.

Energy and Atmosphere

In order to have an energy efficient building, energy saving projects, which were taken into consideration during planning stage, were applied during construction. Energy modelling was made by ERKE, energy performance of the building was compared with ASHRAE 90.1.2007 standard and energy efficient systems are used to save 34.283 dollar (21%) is saved annually in order to reduce the environmental and economic effects and to provide maximum energy saving in the building.

Energy efficient systems in the building are;

Wall type boilers with high efficiency

Pumps and fans with frequency converter

Low-e windows

Hot water production from solar power

Floor heating

Cooling withVRV

Rooftop units

30% in average better heating transfer ratio in the out facades according to ASHRAE 90.1-2007 standard

Lighting armatures with high efficiency

R410A Cooling liquid which has got low negative effective on ozone layer and global warming is used on VRV system.

Indoor Air Quality

Priority for the energy use and the workers is to provide personal comfort in the open offices. Fresh air amount is important. Projects are prepared in a way to meet the values minimum 30% over than ASHRAE standards asked by LEED. After increasing the fresh air of the workers, heat loss and gain calculations are considered. For this reason, design is made according to the minimum values asked by local standards. First values were seen to be at 15% according to simulation results. Considering these situations, isolations of the construction elements outside the building are made additionally. Considering the comfort of the workers, utilizing the natural light is aimed. Windows with low shading but having high light transparency are chosen.

Figure 4.28.: Birleşim Engineering Factory, Indoor(B2B Media, 2012)

Seminar hall and archive are on the basement floor, lunch hall is on the top floor of the building. Other floors are reserved for the office workers. As only the male workers will be working in the production fields, showers are designed only for them at the first stage. However, after LEED told that there was a possibility that female workers might be employed and they had to consider them and build showers for them as well, showers are spared for the female workers.

Material

Buildings cause a lot of waste and use of material and resource during both the construction and the management stages. Material and Resource category of LEED leads to the sustainable options during growing, mining, production and transportation of the products and materials and it guides sustainable building strategies in this category. In this way, both reduction of the waste is provided and uncontrolled consumption of the natural resources is avoided by means of strategies like re-use, re-gain and recycle.

Recyclable wastes reduce sending the waste created by the users of the building to the waste lands and it encourages the users of the building to recycling. Project consists of a building which operated in two different functions. Within this scope, 5 recycling bins are placed on each floor both in management building and factory building. General recycling waste collection land is designed in a place where collection vehicles can easily reach outside the building and a system is established to collect the recycled wasted that will be applied operation.

Figure 4.29.: Birleşim Engineering Factory, Facede System (B2B Media, 2012)

Reuse of the material reduces the demand for the raw material and it enables to reduce creating waste, not to consume energy and natural resources that will be used for the production of a new material or a product and to use the available material without creating new environmental effects. Within the scope of the project, office furniture of the former management building is maintained to make ready to be used in the new building. In this way, lifecycle of the product is lengthened and one of the most important sustainability strategies is applied.

The aim of using **recycled material** is to reduce the consumption of the natural resources; %29 of the material cost is supplied from recycled materials within the scope of the project.

Local material use encourages the raw material of the material to be used in the building to be mined, processed and manufactured within 800 km. In this way, material suitable for the structure of the region is used and local economy is supported and most importantly carbon emission level that will occur during the transportation of the material will be kept at a minimum level. Within the scope of this project, local material at about 38% of the material cost is used.

Water

Double press reservoirs, waterless urinals, batteries with photocell and low flow are used in Birleşim Engineering building for water efficiency.

Rain water is collected to be used for landscape and toilet reservoir so that mains water use is kept at zero for landscape and reservoir.

Table 4.4.: The Evolution of Birleşim Engineering Factory in Terms of Proposed Aims and Criteria

	BİRLEŞİM ENG.
SITE	
Preparation of user manuals for the building	
Re-use of land or rehabilitated land	*
Sparing fields for recycling of organizational waste	*
Green space maximization	*
Prevention of pollution during construction	*
The calculation of the ecological value of the land	*
ENERGY	
Systematic commissioning (Commissioning)	*
Minimum lighting levels	
Lighting elements of comfort	*
Fresh air levels	*
Thermal elements of comfort	*
Monitoring energy consumption	*
Reducing light pollution	*
Promoting the use of renewable energy out of the field	*
Use of renewable energies in the field	*
Calculations of reducing CO2 emissions	
INDOOR AIR QUALITY	
Acoustic performance	
Use of low volatile organic component materials	*
Daylight applications and anti-glare applications	*
High-frequency lighting	
Prevention of indoor air pollution	*
MATERIAL	
Choice of sustainable materials	*
Choosing recycled materials	*
Re-use of the building skeleton and shell	*
Local supply of materials	*
WATER	
Use of vitrify which enables water-saving	*
Leak sensors	
Use of water-efficient landscaping	*
Monitoring water consumption	*

4.4. Conclusion

Industrial buildings which have heavier environmental load during construction, occupancy and demolishment stages compared to the other structure types due to their great sizes and dense user quantity residing in them have carried an important role in terms of applying the sustainability concept.

In this section, characteristics of industrial buildings, their relation with the environment and industrial buildings that are evaluated with building environmental assessment methods within the scope of sustainable architecture are analyzed. From this point of view, this study aimed to reduce the environmental damages of the industrial buildings in Turkey.

In this context, Siemens Factory, Inci Akü Factory, Schnieder Electric Adh Factory, Gebze and Birleşim Engineering Factory are selected. Evaluations are made in line with the reports, interviews and inspections in place.

Reviews of the industrial structures are compared in Table 4.5. An evaluation in line is not provided for the entire complex of certificates, Factories were observed for certain parts taken. This case take in terms of the partial documents emphasize the importance of prestigous identity and branding. Efficiency can be taken literally for all of the factories to be certified in the future based problems that may arise will eliminate the use.

Table 4.5.: Comparison of Example Results

	SIEMENS FACTORY	INCI AKU FACTORY	SCHNIEDER ADH FACTORY	BİRLEŞİM ENG.
SITE				
Preparation of user manuals for the building		*		
Re-use of land or rehabilitated land	*	*	*	*
Sparing fields for recycling of organizational waste	*	*	*	*
Green space maximization	*		*	*
Prevention of pollution during construction	*	*	*	*
The calculation of the ecological value of the land	*	*	*	*
ENERGY				
Systematic commissioning (Commissioning)	*	*	*	*
Minimum lighting levels		*		
Lighting elements of comfort	*	*	*	*
Fresh air levels	*	*	*	*
Thermal elements of comfort	*	*	*	*
Monitoring energy consumption	*	*	*	*
Reducing light pollution	*	*	*	*
Promoting the use of renewable energy out of the field	*		*	*
Use of renewable energies in the field	*	*	*	*
Calculations of reducing CO2 emissions		*		
INDOOR AIR QUALITY				
Acoustic performance		*		
Use of low volatile organic component materials	*		*	*
Daylight applications and anti-glare applications	*	*	*	*
High-frequency lighting		*		
Prevention of indoor air pollution	*	*	*	*
MATERIAL				
Choice of sustainable materials	*	*	*	*
Choosing recycled materials	*	*	*	*
Re-use of the building skeleton and shell	*	*	*	*
Local supply of materials	*		*	*
WATER				
Use of vitrify which enables water-saving	*	*	*	*
Leak sensors		*		
Use of water-efficient landscaping	*		*	*
Monitoring water consumption	*	*	*	*

CHAPTER 5

CONCLUSION AND SUGGESTIONS

Human beings have always tried to change the environment and ecology since the beginning. However, all these interruptions on the environment have affected the humans and their habitat. The first of all these effects is the global barriers (Erbas, 2001). Global warming, climate changes and similar other global problems are all based on building sector.

When we look in terms of energy efficiency, the sectors that stand out are industry, transportation and building. When we look at the energy consumption as per in sectors, in examined that 30% of the energy and 43% of the total energy consumption are used in the buildings, and buildings take the second place in energy consumption after industry sector is seen (Türkay, M., Yılmaz Özbağcı, Ş., ve Şan Akça B., 2012). When use of materials, lighting and cooling systems that are unproductive and have no effective technology is preferred, not taking necessary precautions and similar reasons show energy efficiency is not considered in the buildings so that the effects on the environment reach to the maximum level. Industrial sector is an important determinant on energy consumption both today and in the future in an increasing trend as a result of developing and advancing growths. Besides, as saving in industry will result in serious income, industry sector has become a target sector in terms of energy efficiency investments.

In this research, sustainable environment and sustainable architecture concepts are handled; climate changes and environmental problems depending on this are considered in the developing and evolving world. In the studies and examinations, evaluations on industrial buildings which have higher environmental loads than the other building types including the construction, using and deconstruction period due to their big sizes and dense number of users residing in them are made. Within this scope, international building environmental assessment methods that are developed to reduce the effects of the industrial buildings on the environment and to provide a better future for the human beings in social and economic terms are internalized to lead the production of environmentally responsive design.

As the sustainability of a building can only be evaluated according to the local environment it is in, countries have developed local green building assessment methods by referring to their own legal documents and market conditions and needs. Today, there are more than thirty local sustainable building assessment systems used by different countries. The ones that are the most developed and accepted were first founded when environmental building assessment subject was discussed in England 80 years ago. The first environmental assessment tool is BREEAM: Building Research Environmental Assessment Method which was released by BRE: Building Research Establishment in England in 1990. In the years following BREEAM, many building environmental assessment methods occurred in different countries as a result of similar studies. BEPAC: Building Environmental Performance Assessment Criteria which was created by Canada Government in 1993, HK-BEAM: Hong Kong Building Environmental Assessment Method which occurred in Hong Kong in 1996, LEED: Leadership in Energy and Environmental Design which was created by American Green Building Council in 1998 are amongst those. CASBEE (Comprehensive Assessment System for Built Environment Efficiency) developed by Japan Sustainable Building Consortium in 2004 and SBTool (Sustainable Building Tool) developed by iiSBE (International Initiative for Sustainable Built Environment) which is a non-profit organization in 1995 followed these.

These building assessment methods that are developed by certain countries must be adaptable to the regions they are developed and they must be applicable at a national level. Performance standards and indicator limits needs to be determined depending on the national conditions in terms of climate, geography, natural resource capacity and economical and social conditions. These methods to be used show differences at national and regional levels in terms of the problems regarding efficient use of land, energy, internal air quality, efficient use of material and water.

These methods are discussed within the scope of researches made on environmental assessment methods. BREEAM, LEED, BEPAC, HK-BEEM, CASBEE and SBTOOL methods are studied, compared and evaluated in detail. As a result of the evaluations, days of release, countries to develop, criteria they consider, buildings they examine, their level of use at a national level for the environmental assessment methods are studied and detected. It is seen that abovementioned methods show similarities to each other at their basis. However, some of these methods are used in all the countries whereas some of them show differences as they are used locally in the country where they are developed.

BREEAM which was released in England in 1990 as one of the building environmental assessment methods preferred all around the world and LEED which was released in the USA in 1998 broadened their limits internationally to serve the entire constructed environment better and they are also preferred in Turkey as they have wide range of use. During the studies made in this dissertation, it has been detected that industrial buildings which have the highest energy consumption in Turkey are certified by LEED and BREEAM.

Industry is developing in Turkey day by day. Economy and social welfare also increases with the development of industry and environmental problems increases in parallel. Within this scope, this dissertation aim to reduce the environmental damages of the industrial buildings in Turkey. It has been understood that it is possible to reduce the mentioned damages to the minimum level by means of environmental assessment methods.

In this study, common aims and criteria are determined by comparing the environmental assessment methods. These aims are evaluated under the titles of use of land, energy, indoor air quality, material and water. SIEMENS FACTORY, SCHNIEDER ELECTRIC ADH FACTORY, INCI AKU FACTORY, BİRLEŞİM ENGINEERING FACTORY which are the industrial buildings certified with LEED and BREEAM certificates are studied under these titles. Evaluations are made in line with the interviews and inspections in place. It has been seen that the aims of the facilities are to produce buildings that can make clean and environmentally responsiveproduction, that is healthy for the workers with its indoor air quality, that has low operation cost with maximum energy saving and that has high performance.

In this dissertation which evaluates the sustainability of the industrial buildings, it has been determined that there is a low amount of industrial buildings which are certified with building environmental assessment methods in Turkey and consciousness of energy efficiency has not been constructed at a sufficient level. In this framework, works regarding the acknowledgement of the industrial facilities about energy efficiency must be processed more effectively. Incentives for the projects of the organization must be continued in industry sector which is the one to make the most progress about energy efficiency; industrial organizations must be encouraged to release projects and put them into life. Energy management activities must continue in an increasing trend. Besides, Energy Efficiency Consultancy companies like GVP, Altensis, Erke Tasarım and Eko Bina must be supported to increase in number. Energy efficiency activities of small and medium scale industrial organizations must be supported as well as big industrial organizations.

In this dissertation, industrial buildings in Turkey are studied and evaluated within the framework of results gathered from the comparison of building environmental assessment methods within sustainable architecture. It is emphasized to minimize the harmful environmental effects of the industrial buildings that consumes the biggest amount in energy sector and to create the consciousness of having a better future for the human beings in terms of social and economic aspects.

In continuation of this thesis as further research topics, according to the importance of industrial sector, a specific building model with building environmental assessment methods for the new industrial buildings, especially in Aegean Region and Aliaga can be proposed. And the creation of this model by examining the proposal is considered to be certified.

BIBLIOGRAPHY

Alagöz Çaputçu, M., 2009. Sanayi yapıları planlama sorunları ve çözüm önerileri, Konya 3. Organize Bölgesinde Üretim Alanında Faaliyet Gösteren Orta Ölçekli Sanayi Yapıları Örneklemeleri, Yüksek Lisans Tezi, Selçuk Üniversitesi, Fen Bilimleri Enstitüsü, s.6

Alptekin E., 2007, Binalarda iç hava kalitesi toz partiküllerinin iç mekan hava kalitesi üzerindeki etkilerinin incelenmesi, Yüksek Lisans Tezi, Gazi Üniversitesi, Fen Bilimleri Enstitüsü

Amstrong World Industries, 2007, LEED PLATINIUM from http://www.armstrong.de/commflreu/de-de/reference-leed-headquarter armstrong.html, May 2014.

Batur, A. ve Batur, S., 1970, Sanayi, Sanayi Toplumu ve Sanayi Yapısının Evrimi Üzerine Düşünceler, Mimarlık Aylık Dergisi, C.VIII, Sayı:80, s.27

Berber, F., 2012, Ekolojik malzemenin tasarımdaki yeri ve ekolojik malzemeyle mimari konut tasarımı, Yüksek Lisans Tezi, Haliç Üniversitesi, Fen Bilimleri Enstitüsü s.36

Birleşim Mühendislik Binası, 2012, Leed Gold Sertifikası, Yeşil Bina Dergisi, B2B Medya, 14, 30-36s.

Boran, D., 2009, LEED, http://v3.arkitera.com/g152-leed.html?year=&aID=2743 MAYIS, 2014

BREEAM, BREEAM New Construction: Industrial, http://www.breeam.org/page.jsp?id=16, May, 2014

BREEAM, What is BREEAM?, http://www.breeam.org/about.jsp?id=66 , May,2014

Canarslan, Ö., 2007**,** Evaluation Indicators for Selection of Sustainable Building Materials, The degree of Master of Science in Building Science, Middele East Technical University, The Graduate School of Natural and Applied Sciences,

CHEP Service Centre, Central Park, 2012, BREEAM VERY GOOD, from http://www.centralparkbristol.co.uk/news/site-progress-april-2012/, May 2014.

Chung, W.Y., 2005, Comparison of two Sustainable Building Assessment Tools Applied to Holmen Project in Stockholm, Master of Science Thesis, KTH Royal Institute of Technology, Stocholm, Sweden

Civan, U., 2006, Akıllı Binaların Çevresel Sürdürülebilirlik Açısından Değerlendirilmesi. Yüksek Lisans Tezi, İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü

COOK, J., 2001, "Ekolojinin Mimarisi", *Domus m Dergisi*, Nisan-Mayıs, S.10, s/52-57

Crawley, D., Aho, I., 1999. Building Environmental Assessment Methods: Application and Development Trends. Building Research and Information, sayı 27 (4/5), s. 300–308.

Çalıkoğlu, E., 2007, "Energy Efficiency in Turkey" (TAIEX Workshop)

Çelik, E., 2009, Yeşil Bina Sertifika Sistemlerinin İncelenmesi Türkiye'de Uygulanabilirliklerinin Değerlendirilmesi. Yüksek Lisans Tezi, İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü

Çelebi, G., 2003, Environmental Discourse and Conceptual Framework For Sustainable Architecture, Gazi University Journal of Science, 16(I): 205-216,

Durmuş Arsan, Z., 2008, Türkiye'de Sürdürülebilir Mimari, Mimarlık Dergisi, Yem Yayınları, 340, http://www.mimarlikdergisi.com/index.cfm?sayfa=mimarlik&DergiSayi=290&RecID=1701 adresinden.

Emre, Ş.B., 2008, Sanayileşme ve Sanayi Yapılarının Yeniden İşlevlendirilmesinin İstanbul' dan örnekler üzerinde Analizi, Yüksek Lisans Tezi, Mimar Sinan Güzel Sanatlar Üniversitesi, Fen Bilimleri Enstitüsü, s.9

Erten, D., 2009, Türkiye İçin Yeşil Bina Sertifikası ve Çözüm Önerileri. Yapı Dergisi Yapıda Ekoloji Eki, Yem Yayınları, 329, İstanbul, 50-55s.

Erten, D. , 2007, LEED Türkiye’de Uygulanabilir mi?, Yapı Dergisi, Yapıda Ekoloji Eki, 11/2007, 20-21s.

Erten, D., Henderson, K. and Kobas, B., 2009, Türkiye İçin Bir Yeşil Bina Sertifikası Oluşturmak için Yol Haritası, Fifth International Conference on Construction in the 21st Century (CITC-V).

Foster + Partners, 1998, McLaren Production Centre, UK, http://www.fosterandpartners.com/projects/mclaren-technology-centre/, 2014, June

Göksal, T. 2003, “Mimaride Sürdürülebilirlik Teknoloji İliskisi: Günes Pili Uygulamaları”, Arredamento Mimarlık Dergisi, S.154, s/76-80

Gönül, H., 2000, Tek Katlı Geniş Açıklıklı Betonarme Prefabrike İskelet Sistemlerle Üretilen ENdüstri Yapıları sorunlarının Analizi ve Diyarbakır Birinci Organize Sanayi Bölgesi Örneği, Yüksek Lisans tezi, Gazi Üniversitesi, Fen Bilimleri Enstitüsü, 1-8s.

Görgün, B., 2012, Enerji Verimli Yeşil Bina Sertifikasyonunda Yol Haritasının Belirlenmesi için LEED ve BREEAM örneklerinin incelenmesi, Yüksek Lisans Tezi, İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü , 5-31s.

HK-BEAM, BEAM Plus New Buildings & Existing Buildings, from http://www.hkgbc.org.hk/eng/BEAMPlus_NBEB.aspx , October, 2014

IAIA Science and Technology Center, 2011, LEED BD+C: New Construction v2 - LEED 2.2, from http://www.usgbc.org/projects/iaia-science-and-technology-center, May 2014.

İlgürel, M.N., 2009, Sanayi yapılarının tasarımında Gürültünün bir ölçüt olarak Değerlendirilmesi için bir Yöntem Geliştirilmesi, Doktora Tezi, Yıldız Teknik Üniversitesi, Fen Bilimleri Enstitüsü, s.1

İnci Akü Factory, Factory Visit and Interviews, October, 2013

Kavaklı, M. and Civan, Z., 1997, Türkiyede Su Kullanımı, Atıksuları Geri Kazanma ve Yeniden Kullanma Uygulamaları", Su ve Çevre Sempozyumu, Istanbul.

Kırılmaz, K., 2010, Analyzing LEED with Comparison to Other Building Assessment Systems: California Academy of Sciences as a Case Study, Master of Design, Graduate Program of Design Studies, Izmir University of Economics, The Graduate School of Social Sciences (55-59).

Kışlalıoğlu, M., Berkes, F. Cevre ve Ekoloji, Remzi Kitapevi, 6.basım İstanbul 1997, s.10

Kibert, C.J., 2007, Sustainable Construction, Green Building Design and Delivery, John Wiley & Sons, Inc. All rights reserved, USA, 65-71p.

Kobaş, B., 2011, Oluşturulmakta olan Türk Yeşil Bina Değerlendirme Sisteminin Malzeme Kategorisi için BREEAM ve LEED örneklerinin İncelenmesi, Yüksek Lisans tezi, İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü,

Krygiel, E. and Bradley, N., 2008, Green BIM: Succesful Sustainable Design with Building Information Modeling, Wiley Publishing, Indiana, 17-23p.

Mclennan, J.F., 2004, The Philosophy of Sustainable Design, Ecotone Publishing, Canada, 97-150p.

Mitsuru, S., 2005, Architecture for a Sustainable Future, Architectural Institute of Japan, Tokyo, Japan, 46-246p.

Kahraman İ., 2013, A Sustainable Building Assessment Model Proposal For New Residential Buildings in Turkey, Doctora Thesies, Dokuz Eylül University, Graduate School of Natural and Applied Sciences, 7-34p.

Keskin, M.T. and Ünlü, H., 2010, Türkiye'de Enerji Verimliliğinin Durumu Ve Yerel Yönetimlerin Rolü (İstanbul: Heinrich Böll Stiftung Derneği, 2010), 34.

LEED, Building Design & Construction, Teknik Değerlendirme ve Uygulama Eğitimi, 2012, May.

Odaman Kaya, H., 2012, Ölçütlere dayalı değerlendirme ve sertifika metodlarından LEED ve BREEAM' in Türkiye Uygulamalarına Yönelik İrdeleme ve Önerileri, Yüksek Lisans Tezi, Dokuz Eylül Üniversitesi, Fen Bilimleri Enstitüsü

Özmehmet, E., 2005, Sürdürülebilir Mimarlık Bağlamında Akdeniz İklim Tipi için bir Bina Modeli Önerisi, Doktora Tezi, Dokuz Eylül Üniversitesi Fen Bilimleri Enstitüsü,

Peuportier, B., Kohler, N., Boonstra, C., Blanc-Sommereux, I., Hamadou, H., Pagani, R., Gobin, C., Kreider, J., 1997, European Methodology for the Evaluation of Environmental Impacts of Buildings, Project REGENER Final Report to European Commission DG 12, Paris, Fransa, January 1997, 48-50

Sev, A., 2009, Sürdürülebilir Mimarlık, Yem Yayınları, İstanbul, 31-56s.

Sev, A. ve Canbay, N., 2009, Dünya Genelinde Uygulanan Yeşil Bina Değerlendirme ve Sertifika Sistemleri, Yapı Dergisi Yapıda Ekoloji Eki, Yem Yayınları, 329, İstanbul, 42-47s.

Schnieder Electrik Adh Factory, Factory Visit and Interviews, 2014, February

Siemens Factory, Factory Visit and Interviews, 2014, February

Somalı, B. ve Ilıcalı E., 2009, Leed ve Breeam Uluslararası Yeşil Bina Değerlendirme Sistemlerinin Değerlendirilmesi, IX. Ulusal Tesisat Mühendisliği Kongresi

Tunççan, A., Endüstri yapılarında enerji verimliliği destekleri, Yenilenebilir Enerji genel Müdürlüğü, Ocak, 2014.

Türkay, M., Yılmaz Özbağcı, Ş., ve Şan Akça B., 2012 Türkiye'nin Enerji Verimliliği Haritası ve Hedefler, Rapor, Koç Üniversitesi, 2012

TEVEM, 2010, Türkiye Enerji Ve Enerji Verimliliği Çalışmaları Raporu., ENVER Enerji Verimliliği Derneği, Iconomy Vezir Consultancy , s.70

Velioğlu, Ü., 1992, Endüstri Yapılarında Mimari Planlama İlkeleri ve Ülkemizdeki Başlıca Örneklerin Bu İlkeler Açısından İrdelenmesi, Yüksek Lisans Tezi, Yıldız Teknik Üniversitesi, Fen Bilimleri Enstitüsü.

Yağcıoğlu, M.H., 2006, An Investigation of the Water Efficiency Credits in International Green Building Assessment Systems and a Roadmap for their Implementations in Turkey, Master Thesis, Boğaziçi Univercity,

Yaman, C., 2010**,** First Green Building In Turkey Certificied AS Leed Gold Energy Efficiency Workshop with KFW & TSKB, September 28th, 2010.

Yenilenebilir Enerji Genel Müdürlüğü, Enerji verimliliği mevzuatı, http://www.eie.gov.tr/verimlilik/v_mevzuat.aspx adresinden, Ocak, 2014.

Yenilenebilir Enerji Genel Müdürlüğü, Enerji verimliliğinde uygulanan destekler, http://www.eie.gov.tr/verimlilik/destekler.aspx adresinden, Ocak, 2014.

Yaman, C., 2009, Siemens Gebze Tesisleri. Yapı Dergisi Yapıda Ekoloji, Eki, sayı 329, Yem Yayınları, 329, İstanbul, 66-69s.

Zeybekoğlu, S., 2002, Erken Cumhuriyet Dönemi Sanayi Komplekslerinin Mekansal Analizi: Nazilli, Kayseri, Bursa ve Eskişehir Örnekleri, Yüksek Lisans Tezi, Yıldız Teknik Üniversitesi, Fen Bilimleri Enstitüsü.

Ulutaş, F., 2013, Sanayi ve Çevre Birlikteliği, http://www.ttgv.org.tr/tr/sanayi-ve-cevre-birlikteligi-i-yeni-firsatlar Haziran, 2014

CURRICULUM VITAE

Kültür District No: 66

ALİAĞA İZMİR

Telefon: 02326161980-308

E-posta: hande.koc87@hotmail.com

Personal Information

Nationality: Türkiye Cumhuriyeti

Date of Birth: 14.06.1987

Place of Birth: İzmir

Work Experiences

2010 - Aliağa Belediyesi (Architect)
2009 KUR-SMS İnşaat(ANKARA) (Traniee)

2008 EB proje/inşaat (Fevzi-Neşe Bozkır) İzmir/Karşıyaka (Traniee)

2007 Rota İnşaat (Turgay Atar İzmir/Aliağa (Traniee)

2006 Kent İnşaat (Ebru Bozdemir) İzmir/Aliağa (Traniee)

Education

2005-2010 Yaşar University Architecture

2010- Yasar University Architecture

Master Programme

Interests

Art, Photography, Architecture,Sport

Languages

English (Upper Intermediate)

Certificates

2011- LEED EDUCATION

2012- LANGUAGE CERTIFICATE IN ENGLAND

2014- JOB SECURITY EDUCATION