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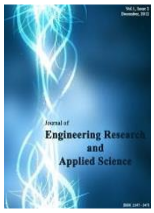

Renewable energy, green building and sustainable water management

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Abstract
Renewable energy is a current issue in the world as well as in Turkey. Turkey has developing policies in the renewable energy field. Although it is a beneficial mean of obtaining energy, there are barriers on renewable energy production. In order to develop renewable energies, those barriers have to be analyzed and suitable implementations should be developed to overcome them. On the other hand, building sector is the largest source of greenhouse gas emissions around the globe. Being green, or sustainable, is one pressing issue coming from both internal and external drivers for construction and engineering companies. Green building has experienced rapid growth in the past several years. To assess how green, or sustainable, the building is, several green rating systems have been developed. Water conservation, efficiency and reuse are becoming increasingly important as the planet faces reduced groundwater and surface water levels, drought and changing climate patterns. To encourage the design and development of sustainable water management in commercial buildings, it is important for regulatory authorities and Councils to incorporate the principles of sustainable water management into development controls and regulatory guidelines to increase the take up of the technologies and practices for new commercial buildings. Support from water utilities is crucial, with a change in mindset from being water suppliers and wastewater managers to complete water service providers.

Keywords: renewable energy, green building, water management, Turkey.

1. Introduction

Energy is a fundamental requirement of life [1]. Especially in the modern world it is the foundation of all economic and social activities [2]. The global energy need is increasing day by day [3]. The energy had been mostly understood as fossil fuels since Industrial Revolution. However, the limited nature and the complexity make fossil fuels based energy consumption unsustainable. As a result of this, humanity rediscovered nature based renewable energy [4].

Renewable energy is a key issue in today‘s world and may continue to play a globally essential role in the future [5]. The trend that started in the last quarter of 20th century seems to continue in a more intense fashion. International organizations are also working on this field to create a common policy for taking advantage of renewable energy in multinational level. Also, currently almost all of the countries are developing policy and trying to determine attainable targets in this field [4-6].

The capacity usage of renewable energy resources is increasing day by day. Since the early periods of this new era, there has been a consequent effort for reaching the targets of implementation policies. However the process in the renewable field is still in an early stage. It is still far beyond the exploitation of all renewable resources. Since, a considerable amount of time passed after the starting point of this new era, the past effort and experiences need to be carefully analyzed [3, 6].

In this study, it is aimed to investigate the developments in renewable energy, green building and sustainable water management fields. In recently, renewable energy sources such as wind, solar, biomass and hydropower is very attractive for domestic and clean energy sources. On the other hand, building sector is the largest source of greenhouse gas emissions around the global with the water management for great buildings.

2. Renewable energy

In Turkey, electricity is mostly produced in thermal power plants by using coal, lignite, natural gas and

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fuel oil. The production of electricity from renewables except hydropower is small. As for nuclear power, it is new and very limited, but Russia and Turkey signed a $20 billion agreement in May 2010 for the construction of a four-reactor Nuclear power plant near the coastal city of Mersin (Akkuyu). Although there is opposition from environmental organizations to nuclear energy, Turkey wants to launch the nuclear power industry to diversify its energy mix and supply its soaring demand. The Turkish Government encourages domestic and foreign private sectors to carry out the country's power generation projects on a built operate transfer basis. The distribution of electrical energy generation by primary energy sources in Turkey (2017) is given in Table 1 [7, 8].

Table 1. Electricity generation percent by energy sources in Turkey (2017).

Energy source	Percent (%)
Natural gas	30.0%
Hydropower	30.2%
Hard coal and lignite	28%
Wind	7.0%
Oil	1.4%
Geothermal	1.6%
Renewable & waste	1.8%

Primary energy demand in Turkey is expected to reach the value of 218 million tons of oil equivalent (Mtoe) with the increase of 90% by the year 2023. Also, the predictions for the share of coal will be 37%, the share of natural gas will be 23%, the share of oil will be 26%, the share of hydropower will be 4%, the share of nuclear energy will be 4%, and the share of renewable and other energy sources will be 6% in primary energy demand by 2023 [7-9].

Table 2 shows renewable energy potential in Turkey; including energy type, usage purpose, natural capacity, technical and economical values. One of the main energy goals of Turkey is to increase the share of renewable energy sources in the country's energy supply. Due to its geographical location and geological structure, Turkey is rich in renewable energy resources. Effective use of these resources will contribute to not only security of energy supply but also help the formation of new employment areas. While Turkey's installed capacity was 14,365 MW in renewable energy sources in 2004; this value has reached the number of 24,947 MW at the end of 2014. The electricity generation from renewable sources was 40 billion kWh in 2002, with an increase of 90% this number reached to 75.3 billion kWh in 2014 [7, 8].

Table 2. Turkey's annual renewable energy potential.

Energy sources	Installed capacity (MW)	Electricity generation (GWh)	Heat (10^3x toe)	Potential
Hydropower	23 641	40 396	-	160 TWh/year
Wind	3 946	8 964	-	48 000 MW
Solar	42	-	840	1500 kWh/m^2-yr
Biomass	290	1 186	unknown	20 million toe
Geothermal	405	2 250	5.0	31 500 MW_{th} 2 000 MW_{elc}

Toe: tons of oil equivalent

The installed capacity of new commissioning power plants based on renewable energy sources in 2014 has been around 3,030 MW. The power plants that sharing this value can be listed as follows [7, 8]:

- 468.3 MW of wind,
- 2,324 MW of hydro power,
- 159.6 MW of geothermal,
- 77.5 MW of landfill gas, biomass and waste heat electricity generation plants.

Turkey's renewable energy potential can be seen as a great opportunity from an economic, environmental and national security perspective. Turkey's dependency on foreign energy resources for heating and electricity is planning to be lessened because of its high costs for the country. Developing and using domestic alternative energy resources will support security of energy [1, 4].

Renewable energy sources in Turkey are the second largest source after coal in terms of energy production, and an important portion of the renewable energy production is met by biomass [8]. The annual biomass potential of Turkey is around 32 Mtoe. Especially in rural regions of Turkey, the woody biomass is used for heating and cooking [6]. Almost all of biomass energy is consumed in residences mostly for cooking and heating purposes. Wood is the main heating fuel for 6.5 million residences in Turkey. The Paper industry also uses wood wastes to provide 60% of needed energy for their production plants [2, 9].

3. Green building

3.1. Introduction

Green building is a way of enhancing the environment, which benefits human well being, community, environmental health, and life-cycle costs [10]. It belongs to the concept of "sustainable development," which also serves as the driving force. However, instead of simply regarding green building as an assembly of new materials, technologies, and other pieces of environment-friendly innovations, it should be a holistic solution to achieve the concept of sustainable development in the project life cycle including project planning, designing, constructing, and operating. In the past few decades, green building has been through a flourishing development due to a growing market demand for environment-friendly solutions and products. The practices of green building were initiated primarily from the nonprofit sector, federal, state, and municipal building projects [11]. However, the concept of green building is now widespread in the construction industry due to the rising awareness of sustainability [12].

According to Adler et al. [10], green building is often developed under the guideline of a rating system provides guidance on the measurements and can supply recognition and validation of that level of commitment. Rating systems can be divided by the difference of concentration into two groups: one focuses on specific building components and the other that centers on regarding the building as a whole entity. Among the whole-building rating systems, the leadership in energy and environmental design (LEED) green building rating system and the green globes are the most well-known standards [13]. It is obvious that these green building rating systems share many similarities, including water, energy efficiency, and indoor environment quality. However, significant questions relating to how the degree of the differences in the rating criteria among the rating systems influences performance should focus on the major differences. This paper aims to take the first step in assessing the three green building rating systems, mainly focusing on one major difference, which is project management, to identify the role of project management in achieving the green agenda or sustainable construction. Thus, the objectives of this study are [14, 15]:

- To compare the LEED, the Green Globes, and the BCA Green Mark on a general level, mainly focusing on the measurements;
- To highlight the sections in all three rating systems which address the role of project management in obtaining the corresponding rating credits; and
- To identify the sections which are highlighted above and to prepare a package for the construction industry to understand the role of project management in achieving sustainable construction in terms of processes and practices.

3.2. Green building

Green building emerged during the late 19th and early 20th centuries [16]. However, it is until recently that green building has gained widespread development. In the 1980s, under the cover of sustainable development [12] and sustainable design, green building has proven to be successful in contributing toward sustainability. Green building refers to tailoring a building and its placement on the site to the local climate, site conditions, culture, and community to reduce resource consumption, augment resource supply, and enhance the quality and diversity of life [10]. In accordance with the three aspects of sustainable development, which are economic, social, and environmental, green building can benefit human well being, community, environmental health, and life-cycle costs [12]. Green building rating systems are designed to assess and evaluate the performance of either the whole building or a specific division of the building from planning, designing, constructing, and operations. In so far as the assessment and evaluation criteria are concerned, rating systems, guidelines, and standards can be categorized into two groups: those which concentrate on specific building components or areas, and those which identify the building as a whole evaluation entity [10]. As the concentrations of different rating systems vary, the same building can be green credited by one while failed to be credited by another at the same time. The rating process seems to be a more subjective review than it was thought to be [12]. Figure 1 shows the green building concept.

Figure 1. Green building concept [10].

When the first passive house was built almost 40 years ago, a vision became reality. A house that didn't require a conventional heating-in the minds of most people at the time, this simply wasn't possible. Since then, passive houses have demonstrated that not only do they perform effortlessly, but that they also offer maximum living comfort with very low energy costs. In this way, they relieve a significant financial burden on households and make an important contribution to environmental protection. Figure 2 and 3 are show a solar houses in Denmark and Germany, respectively [10].

Figure 2.Solar House in Denmark [10].

Figure 3.Passive House in Germany [10].

Due to different market concentrations and its relative newness, the Green Globes, on the other hand, does not attract as much attention as the LEED does [11]. It originated from a British version, which is the building research establishment assessment method (BREEAM) and was adopted and introduced into the Canadian market as the BREEAM green leaf rating system. This system is known as the origin of the Green Globes. Similar to the LEED, the Green Globes has seven areas of assessment as well as other supplements. A rating certification between one and four Green Globes is issued to the project based on the scores achieved [13].

To reflect the more common practice, the most popularly adopted versions are chosen for comparison, which are the LEED for NC and major renovations version 2.2, the GBI-proposed American National Standard 01-2008P, and the BCA Green Mark for nonresidential building version 3.0. At first sight, it seems that all three rating systems share a lot of common areas in terms of rating categories and allocation of points. As can be seen from Table 3, the allocation of credits/points to different categories is only a few percentages off when comparing these three systems, among which energy takes up the highest weighting. In addition, although LEED 2.2 does not set the minimum credits required to achieve certification, there is a certain amount of prerequisites under each area that must be implemented without being allocated with credits [12-15].

Previous studies carried out by Smith et al. [11] reallocated the assessment areas to form a system based on eight generic “sustainability” categories, including (1) energy use; (2) water use; (3) pollution; (4) indoor air quality and occupant comfort; and (5) other sustainable design. Adopting the same consideration, rating criteria are reallocated accordingly. However, only those related to project management are reorganized, in accordance with the objectives of this study.

4. Sustainable water management

4.1. Introduction

Sustainable water management systems are based on the principle of the water quality cascade. This means that water sources should be matched with end uses in terms of the required water quality as shown in Table 3. The principles of sustainable water management help identify alternative sources of water that can be supplied to meet the water demand in ways that do not require potable water quality. It also puts emphasis on using the most water efficient appliances where possible [14-17].

Table 3. Water quality cascade with end uses.

Source	End use
Scheme water or treated and disinfected rainwater	Drinking, kitchen, showers, basins
Treated and disinfected grey-water	Cleaning, cooling tower make up toilet flushing
Treated and disinfected cooling tower blow-down	Cleaning toilet flushing
Treated and disinfected black water and black water blowdown	Roof garden irrigation

In the residential sector in terms of sustainable water management, it is less advanced than the commercial sector. However, there are some examples, including the Millennium Dome in London, the Olympic Park at Homebush Bay in Sydney and the Water Garden in Santa Monica in California [16]. However, there have been few examples, particularly in Australia, that have considered maximising water conservation through the integration of the whole suite of water conservation measures such as rainwater capture, installation of water efficient fixtures, effluent reuse and evaporation and productive reuse of treated effluent in roof gardens [17].

The commercial sector typically comprises 10-20% of total water demand in an urban water supply system and provides ample opportunities for sustainable water management and potential savings in scheme water [18]. This sector, unlike the industrial sector, is easy to target for water conservation measures, as a significant proportion of its indoor water use is similar to residential water use. Hence, commercial office buildings can make use of the technological advances made in the improved water efficiency of fixtures like toilets, urinals, taps and showerheads and other systems such as cooling towers, reuse systems and rainwater capture and treatment systems [18].

4.2. Alternative supply opportunities

As can be seen from Table 3 and Table 4 over 50% of the total water demand in a commercial office building can be met by substituting potable water with rainwater or treated greywater and blackwater. Rainwater can be harvested from the impervious surfaces of the commercial building premises. The quality of the rainwater from rooftops is higher than from any other paved surfaces. Consequently rainwater collected from rooftops would require less treatment when compared with the rainwater collected from any paved surfaces exposed to people and vehicular traffic. Rainwater used as make-up water for cooling towers could minimize blow-down, as it has lower levels of total dissolved solids compared to scheme water.

Table 4. Breakdown of end use in a typical commercial building.

Indoor (domestic/restrooms)	**32%**
Cooling and heating	48%
Landscaping	17%
Other	3%

Grey-water is collected from indoor sources other than toilets such as showers and hand basins and requires treatment such as screening, oil and grease removal, filtration and disinfection. Black-water is the discharge from the toilet and contains significant nutrient concentrations. The microbial contamination associated with black-water means that it needs to be treated to a very high level, especially with respect to disinfection. The decision about matching alternative sources of water to an appropriate end use takes into consideration two major factors [17, 18]:

- the minimum level of treatment required to ensure that the water from the alternative source is fit for the end use
- the quantity of the water supply from the alternative source.

The most preferred match is where the quantity of the supply from the alternative source is able to meet the demand of the end use with least cost of treatment. Treated grey-water can be utilized for one or more of the following [17-19]:

- Toilet flushing,
- Landscape irrigation and
- Cooling tower make up water

Treated black-water is most suited for sub-surface irrigation of landscape. Combined sewage such as grey-water and black-water can be used for toilet flushing and irrigation purposes. Table 5 shows the percentage of water savings of modeled options compared to a conventional office building.

Table 5. Percentage of water savings of modeled options compared to a conventional office building.

No:	Option	Water saving
1	Business-as-usual	0%
2	Level 1 Efficiency	0>35%
3	Level 2 Efficiency	70%
4	Effluent reuse in toilets	>80%
5	Rainwater supply + effluent reuse in toilets and roof garden	>85%
6	Rainwater supply + composting toilets+ effluent reuse in toilets and roof garden	>85%

5. Conclusions

Allowing for the electricity generation, renewable sources provided 57.8 TWh of electricity, or 27.6% of the total power generation in Turkey. Hydropower accounted for 92% (52.3 TWh) of this total and wind power for 6% (5 TWh). The remaining 3% came from biomass (1.3 TWh) and geothermal energy (1.5 TWh). Hydropower generation varies according to rainfall. The Turkish government is planning to realize the target of electricity production from renewable energy sources as around 30% in the share of energy generation by 2023. In Turkey, energy sectors are the main contributor to Turkey's greenhouse gas emissions, which increasing rapidly. The Turkish government is therefore focusing on clean energy development, such as from domestic renewable resources and introducing incentives and the feed in tariffs in energy production from RES, so it is aimed to increase the share of renewables in the electrical energy mix.

Green building is not a simple fusion of green design, techniques, and materials. It is a holistic solution to achieve the concept of sustainable development in the project life cycle including project planning, designing, constructing, and operating. Although this life-cycle concept is adopted by a majority of the professionals, most concentration has been focused on design and technical-related areas that can be applied in the design and construction stage. Through the comparison of the three rating systems, this research is able to address the importance of project management, in terms of both the practice and the process, which is allocated around 20% of the credits. Finally, green building is not a simple building. It is rather a process with long operational duration that has to be continually improved because green building is still a niche market representing only 2% of the market share in Turkey. This supports the importance of building commissioning and performance documentation. As with the changes and continuous improvements in the green building rating systems, such a scenario is also expected in the physical construction of green building to keep pace with recent development in the former. Project managers should not limit themselves to the current focus of the project management practice but also to both the internal and external processes to achieve the green objective.

The present study have shown that in commercial buildings of typical size and configuration a reduction of 80% or more in scheme water demand and 90% reduction of sewage discharge can be achieved compared to a conventional building through the integration of innovative water efficiency measures, rainfall capture and use, treated effluent reuse and roof gardens. The building can be functionally efficient and at the same time provide enhanced amenity and interpretive and experiential educational opportunities. There is also considerable potential for integrating aspects of energy management with the water management due to the overlap between these issues. This can be important for enhanced benefits and reduced costs. Having these types of systems become reality will require regulatory authorities and Councils to incorporate the above principles into development controls and regulatory guidelines to increase and ensure the take up of the technologies and practices for new commercial buildings. There is also a need to set up demonstration projects that monitor and evaluate the savings and benefits from these buildings.

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