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Green buildings for sustainable energy development

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Abstract
Green buildings are energy efficient, resource efficient and environmentally responsible. Their design, construction and operational practices that consider sustainability will minimize their negative impact on the environment and people, while taking into consideration the financial impacts. To become a sustainable energy leader among emerging economies, Turkey would have to implement a progressive and coherent sustainable energy policy. Although solid energy policy architecture is in place, sustainable energy targets are weak, government support is limited, and bureaucratic hurdles for energy investment still frustrate potential investors. Most importantly, many top policymakers do not seem to be ready to play a productive role in designing a forward-looking, sustainable energy policy for Turkey. Construction sector has a great potential to reduce total energy consumption through sustainable projects. All over the world policy makers have already realized the potential and begun setting some governmental goals. As an energy dependent country, Turkey has also set some energy oriented policies in which sustainability issues in Turkish built environment are also gaining attention. This paper discusses the green buildings for sustainable energy development in Turkey.

Keywords: green building; sustainable energy development;building environment; Turkey.

1. Introduction

Climate change and its disastrous consequences are stimulating the transformation towards a sustainable development, with its increasing economic efficiency, protection and restoration of ecological systems and improvement of human well-being [1]. The maintenance of natural resources is a subject that often appears when sustainable development is considered. In addition, with increasing world population and economic development, the strain on resources is increasing. As economic development and environment are linked, the realization has set in to conserve energy and natural resources. Globally, infrastructure and building construction consumes 60 % of the raw materials extracted from the Earth. From this volume, building accounts for 40 %, in other words 24 % of these global extractions [2, 3].

The increased use of resources that cause pollution and emissions, highlight the need to save and conserve energy for sustainable development. In engineering, sustainable building design is a design ideology, which harbors the notion of sustainable human development [4]. Sustainable development can be defined in various ways. Every individual will approach the issue of sustainability in a different manner depending upon various factors, such as, sustainability goals, background, awareness, and economic conditions [5-7].

Sustainability is providing opportunity of development to the future generation, in terms of resources [8]. One of the key aspects in sustainability is sustainable construction. Sustainable construction practices are such that they are based on ecological principles, with no environmental impacts, have a closed material loop, and have full integration into the landscape after the service life of the structure is over [9]. The concept of green buildings is the measure of our efforts in attaining that idealistic sustainable construction practices. Green Building is the “practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building life-cycle from siting to design, construction, operation, maintenance, renovation, and deconstruction”. This definition has evolved over the years. “Green Buildings” is an ever evolving, dynamic term. Green Building is the status of our efforts in attaining sustainability in construction practices. As technology evolves and new materials are developed, the status of our efforts are also changing [10-13].

As an energy dependent country, Turkey has also set some energy oriented policies in which sustainability issues in Turkish built environment are also gaining

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attention [6]. As a result of the economic development, Turkey witnesses a rampant urbanization of rural areas and also rising expectancy of living conditions so in parallel with all development plans, sustainability issues in construction sector should not be underestimated [6].

In order to be able to move towards our objective of sustainability, we should have a clear definition of what is called as a green and sustainable building, as it is defined by the US. Environmental Protection Agency (EPA) [11], "Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable building" [11].

Since recently most of the developed countries have already begun to implement the sustainability policy in their countries and made new regulations to change the conventionally practiced administrative patterns in construction sector, the number of claims related to sustainability feature of the construction projects has been growing ever since. Construction contracts are playing a critical role in preventing these types of legal risks that can lead to claims. So that consequently, these changes have caused a need for some alterations in industry's contractual practices [6]. With the new demand, organizations publishing standard forms of contracts for construction sector, have begun forming new standard forms of contract specially designed for sustainable projects. These global changes in the industry's contractual practices can also affect the other developing countries in the near future, and Turkey as an energy dependent country will also be a part of this new sustainable trend in the next years.

2. Overview of green building

Green and sustainable building refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort [14-16]. Figures 1-6 are show the green building concept.

Figure 1. Green building concept

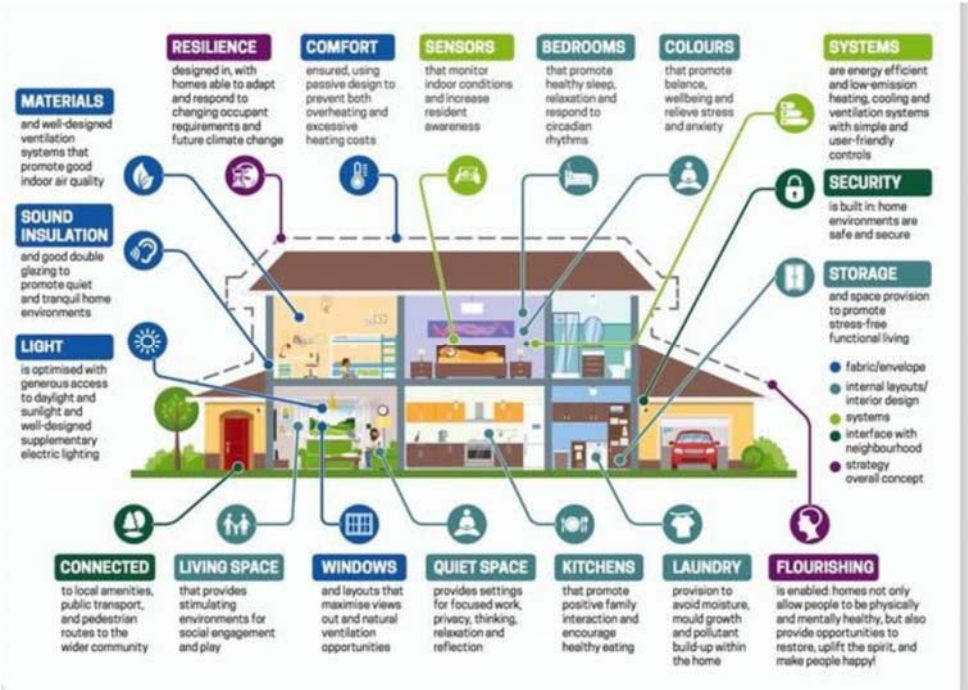

Figure 2. detailed plan for green building concept.

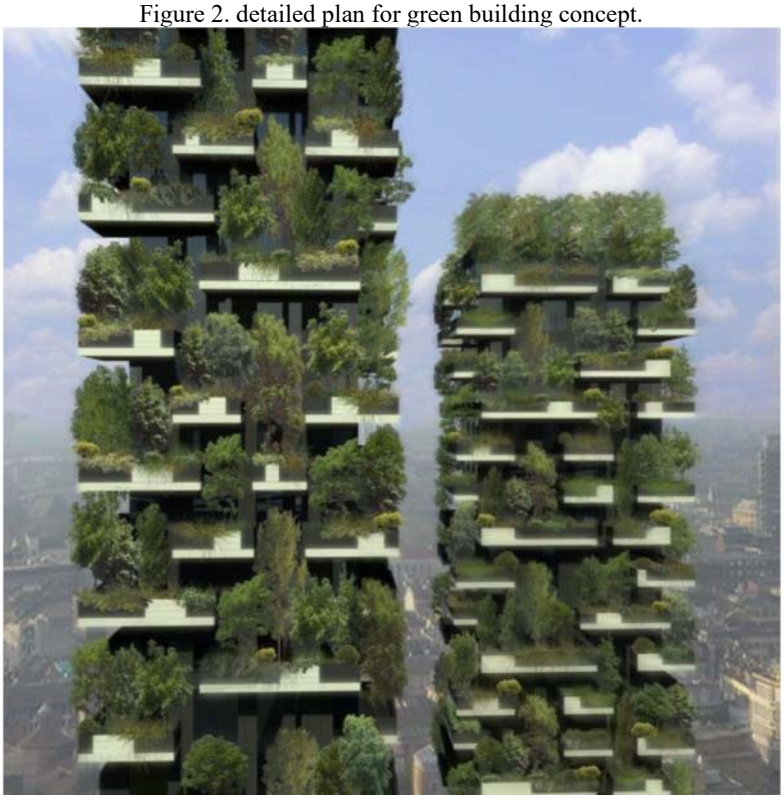

Figure 3. Vertical forests in Milan, Italy – banking on ¨eco¨ as the new fashion
Source: Modern Treehouses: A vertical Forest. 28 February 2013. http://www.spiegel.de/international/europe/

Figure 4. Most Sustainable Office Building, Bussumse Watertoren, The Netherlands
Source: http://www.greendiary.com/sustainable-office-buildings-world.html

Figure 5.Solar House, Denmark
Source: http://www.greendiary.com/best-sustainably-creative-home-designs.html

Figure 6.Passive House, Germany. Source: http://www.cepheus.de/

Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by [15]:

- Efficiently using energy, water, and other resources,
- Protecting occupant health and improving employee productivity,
- Reducing waste, pollution and environmental degradation.

A similar concept is natural building, which is usually on a smaller scale and tends to focus on the use of natural materials are available locally [16]. Other related topics include sustainable design and green architecture. Green building does not specifically address the issue of the retrofitting existing homes. For reducing environmental impact, the green building practices aim to reduce the environmental impact of new buildings [15-19].

The concept of sustainable development can be traced to the fossil energy crisis and the environment pollution concern in the 1970s [3]. The green building movement in Turkey and other developing countries originated from the need and desire for more energy efficient and environmentally friendly construction practices. There are a number of motives to building green, including environmental, economic, and social benefits [2-4]. However, modern sustainability initiatives call for an integrated and synergistic design to both new construction and in the retrofitting of an existing structure. Also known as sustainable design, this approach integrates the building life-cycle with each green practice employed with a design-purpose to create a synergy amongst the practices used [8-10].

Green building brings together a vast array of practices and techniques to reduce and ultimately eliminate the impacts of new buildings on the environment and human health. It often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic techniques and using plants and trees through green roofs, rain gardens, and for reduction of rainwater run-off. Many other techniques, such as using packed gravel or permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water, are used as well [11-13].

The foundation of any construction project is rooted in the concept and design stages. The concept stage, in fact, is one of the major steps in a project life cycle, as it has the largest impact on cost and performance [9-12]. In designing environmentally optimal buildings, the objective is to minimize the total environmental impact associated with all life-cycle stages of the building project. However, building as a process is not as streamlined as an industrial process, and varies from one building to the other, never repeating itself identically. In addition, buildings are much more complex products, composed of a multitude of materials and components each constituting various design variables to be decided at the design stage. A variation of every design variable may affect the environment during all the building's relevant life-cycle stages [7].

Green buildings often include measures to reduce energy use. To increase the efficiency of the building envelope, they may use high-efficiency windows and insulation in walls, ceilings, and floors [12]. Another strategy, passive solar building design, is often implemented in low-energy homes. Designers orient windows and walls and place awnings, porches, and trees to shade windows and roofs during the summer while maximizing solar gain in the winter. In addition, effective window placement (daylighting) can provide more natural light and lessen the need for electric lighting during the day. Solar water heating further reduces energy loads. Reducing water consumption and protecting water quality are key objectives in sustainable building. One critical issue of water consumption is that in many areas, the demands on the supplying aquifer exceed its ability to replenish itself. To the maximum extent feasible, facilities should increase their dependence on water that is collected, used, purified, and reused on-site [13, 14].

The protection and conservation of water throughout the life of a building may be accomplished by designing for dual plumbing that recycles water in toilet flushing [15]. Waste-water may be minimized by utilizing water conserving fixtures such as ultra-low flush toilets and low-flow shower heads. Bidets help eliminate the use of toilet paper, reducing sewer traffic and increasing possibilities of re-using water on-site [16]. Point of use water treatment and heating improves both water quality and energy efficiency while reducing the amount of water in circulation. The use of non-sewage and grey-water for on-site use such as site-irrigation will minimize demands on the local aquifer [17].

Building materials typically considered to be 'green' include (Expanded polystyrene) rapidly renewable plant materials like bamboo (because bamboo grows quickly) and straw, lumber from forests certified to be

sustainably managed, insulated concrete forms, dimension stone, recycled stone, recycled metal, and other products that are non-toxic, reusable, renewable, and/or recyclable. The EPA (Environmental Protection Agency) also suggests using recycled industrial goods, such as coal combustion products, foundry sand, and demolition debris in construction projects [11]. Building materials should be extracted and manufactured locally to the building site to minimize the energy embedded in their transportation. Where possible, building elements should be manufactured off-site and delivered to site, to maximize benefits of off-site manufacture including minimizing waste, maximizing recycling, high quality elements, better energy management, less noise and dust.

The Indoor Environmental Quality (IEQ) category in LEED standards, one of the five environmental categories, was created to provide comfort, well-being, and productivity of occupants. The LEED IEQ category addresses design and construction guidelines especially indoor air quality (IAQ), thermal quality, and lighting quality [12]. Indoor Air Quality seeks to reduce volatile organic compounds, or VOC's, and other air impurities such as microbial contaminants. Buildings rely on a properly designed HVAC system to provide adequate ventilation and air filtration as well as isolate operations (kitchens, dry cleaners, etc.) from other occupancies. During the design and construction process choosing construction materials and interior finish products with zero or low emissions will improve IAQ [16-19].

Green architecture also seeks to reduce waste of energy, water and materials used during construction. For example, in Turkey nearly 40% of the state's waste comes from commercial buildings. During the construction phase, one goal should be to reduce the amount of material going to landfills. Well-designed buildings also help reduce the amount of waste generated by the occupants as well, by providing on-site solutions such as compost bins to reduce matter going to landfills [1, 3, 6, 8].

To reduce the impact on wells or water treatment plants, several options exist. "Grey-water", wastewater from sources such as dishwashing or washing machines, can be used for subsurface irrigation, or if treated, for non-potable purposes, e.g., to flush toilets and wash cars. Rainwater collectors are used for similar purposes [3]. Centralized wastewater treatment systems can be costly and use a lot of energy. An alternative to this process is converting waste and wastewater into fertilizer, which avoids these costs and shows other benefits. By collecting human waste at the source and running it to a semi-centralized biogas plant with other biological waste, liquid fertilizer can be produced. Practices like these provide soil with organic nutrients and create carbon sinks that remove carbon dioxide from the atmosphere, offsetting greenhouse gas emission. Producing artificial fertilizer is also more costly in energy than this process [16-19].

3. Energy for sustainable development in Turkey

3.1. Energy consumption in Turkey

This section investigates the politics of energy procurement and consumption in Turkey within the context of sustainable development. It examines current and projected energy usage patterns against the backdrop of existing energy procurement strategies and their renewable energy alternatives. A key consideration in this regard is that Turkey is an energy importing country: roughly three-quarters of its energy needs in 2017 were met through imports. Given its long-term plans for continued economic growth, even conservative projections that privilege efficiency gains over production increases create a scenario in which the energy needs of Turkey will far outweigh the existing productive capacity. Therefore, the challenge facing Turkey is the creation of energy policies that help realize economic growth, support and shape social development, while ensuring timely and secure supplies with a view to price competitiveness and environmental impact [20, 21].

Until recently, the dominant policy strategy aimed at “energy independence”, a policy discourse built around increased domestic production that found widespread favor across the entire political spectrum. For example, an agreement was signed between Turkey and Russia in 1997 to import 60% of Turkish natural gas requirements should be supplied by the Russia. We concluded that this a tragic strategic mistake that carries the potential to create very serious security problems for sustainable energy development in Turkey. This position is predicated upon a realpolitik view of international energy trade. In other words, energy is seen as a key arena for geostrategic competition, where the gains of one country often translate into losses for others. Moreover, for the proponents of this view, international trade in energy will not produce mutually beneficial results, as the control of energy sources imbues the exporting country with immense strategic power [20-22].

Turkey has made progress in relatively decoupling its strong economic growth from air pollution emissions including CO_2, SO_2 and NOx, energy use, waste generation and water consumption. However, these pressures are increasing as economic and population growth continue. Turkey's energy demand growth is among the highest in the OECD countries. On the other hand, fossil fuels represent 88% of the energy mix, with most of these being imported. Turkey plans to reduce amount of imported fossil fuels and ensure energy security by diversifying imports; increasing domestic coal production, renewable energy sources especially hydropower, wind and solar energy and promoting energy efficiency in industry and household applications [20-22].

Turkey's total final consumption was 145.3 million tons of oil-equivalent (Mtoe) in 2017 as shown in Table 1. Energy demand has continued its growth path and was 35.8% higher in 2014 than ten years earlier. During the global financial and economic crisis in 2008-09, demand contracted by 4.2%, but rebounded strongly by 18% in the three following years will be reach a record high in energy consumption of 273 Mtoe in 2020 (see Table 1).

Table 1. Total energy production and consumption in Turkey (Mtoe)

	Energy Production		**Energy Consumption**	
	2017	2020	2017	2020
Coal and Lignite	14.47	32.36	38.42	107.57
Oil	2.68	0.49	44.28	71.89
Gas	0.29	0.14	44.32	74.51
Hydropower	5.00	10.00	5.00	10.00
Geothermal	7.12	1.71	7.12	1.71
Wood and waste	2.53	4.96	2.53	4.96
Solar & Wind & Other	2.63	2.27	2.64	2.27
Total	35.35	52.23	145.31	273.21

Mtoe: Million tons of oil equivalent

Industry is the largest consuming sector in Turkey, with 47.9 Mtoe in 2017 or 36.1% of Total Final Consumption (TFC). Demand increased by 20.3% over the ten years to 2014, with its share in TFC falling from 40.7%. Growth in industry demand was slower than total TFC owing to a 20.7% plummet in 2008. From 2008 to 2017, demand grew by 36.2%.

The residential sector accounts for 23.3% or 34.1 Mtoe. Residential demand grew by 5.8% from 2004 to 2017, which is the slowest sector-specific rate of growth mainly due to a two-year contraction in demand during 2015-17 (16.1% in total). The share of the residential sector in TFC has fallen from 26.6% in 2004 [20].

Turkey's transport sector represents 24% of TFC or 20.6 Mtoe. Demand grew by 71.4% in total over the period 2004-14, with its share in TFC increasing from 19% in 2004. Demand growth was strong in the first four years after 2003 (8% per year on average), followed by three years of decline from 2008 to 2010 (2.8% per year) and four years of strong growth (9.1% per year) [20].

The strongest growth over ten years (105.4%) has been in the commercial and services sector (including commercial buildings, public services and agriculture). This sector accounted for 17.6% of TFC in 2017, a rise from 11.7% in 2004. Demand grew by 15.7% per annum from 2004 to 2008, had a 10.1% annual decline during 2009-10 and another period of strong growth – 11% in 2014 and 28.3% in 2017 [20].

3.2. Green building market in Turkey

Turkish Green Building Industry is relatively new and is currently evolving. Since most of the industry practitioners believe that the Turkish construction market has a positive inclination towards sustainable projects, it is expected to grow further in the near future. The results obtained by Mohammadi [6] from his thesis are attempted to draw out a connection between respondents' perception and current real world green buildings' situation regarding legal issues and risks to achieve a more realistic perspective towards the future of green building market in Turkey [6].

From Turkish practitioners perspective the main reasons to build green building projects in Turkey is financial benefits and gaining reputation particularly because the market of sustainable buildings are quite new and gaining reputation may have a positive effect on competitiveness of the various construction & design firms. However this process should be more supported by various organization and institutions to

be accepted in extensive ranges and get more widespread [6].

There are many factors of high importance that may affect this issue. Among them social awareness, education, and support of government with various types of incentives are the most effective strategies. The other important strategy which may also have a huge effect is legal enforcement by the government but then again in comparison with incentives it is not so much preferred. Turkish government has already set some regulations to increase sustainable projects, which are considered insufficient from Turkish professionals' point of view, so there is an improvement necessity of these regulations [20-22].

For all these strategies to be practicable government has the most critical role. Government is the main organ which can set up standards, regulations and ordinances and also allocate enough budget in order to increase community awareness, and change the culture in a positive way towards sustainability issues by adding sustainability related subjects in the school curriculum and sponsoring various organizations like professionals chambers to set up informative seminars and educational sessions. And also allocate budget to universities' researches to support sustainable approaches. Among all the others Turkish media can also have a great influence on this matter, by introducing successful green building projects to the society and advertisements or educational programs.

The owner of a project is the one who should make the last decision to build green or not. In order to encourage investors, government should provide financial support or other kinds of incentives, or setting up certain minimum criteria and standards or regulations for issuing permissions for projects. Private sector should be definitely getting governmental support at least in a partial way. Architects also have the important role of informing the owners of sustainability features of the projects, since they are in contact with each other from the early phases of the project, architects have an important effect in decision making process..

4. Conclusions

Sustainability is increasingly becoming a key consideration of building practitioners, policy makers, and industry alike, since the world is moving towards zero-energy construction. When buildings have net zero energy consumption, the effect of embodied energy and greenhouse gas emissions become important. A zero energy house can be built with different materials and construction methods that create different cumulative carbon footprint. Wood products can have very low or negative carbon footprint. Therefore, the utilization of wood, the most important renewable material, in all aspects of human existence appears to be the most effective way to optimize the use of resources and to reduce the environmental impact associated with mankind's activities. Typically, the use of wood products results in lower emissions and thus a lower overall environmental impact. However, to achieve sustainable development, certain criteria within a framework of economic, environmental and social systems must be followed.

Therefore, research, development and innovation related to "green" buildings should focus on LCA analysis in all product stages, from primary processing and use to disposal, and integrate knowledge and experience from various disciplines, engaging scientists from areas like engineering, material science, forestry, environmental science, architecture, marketing, and business. The activities should be oriented towards new product development from renewable materials, and utilization of the whole wood value chain, engineering solutions, and cradle-cradle concept.

From the study, it was concluded that the sustainability can minimize the harmful impact of the conventional buildings on environment, economy and people in using green materials, technologies. "Sustainable" or "green" buildings use key resources like energy, water, and materials more efficiently than conventional (non-sustainable) buildings. Furthermore, sustainable buildings increase natural light, incorporate high-performance systems, rainwater system, and improve air flow for occupants. Sustainable building has many obvious benefits to builders, buyers, and others, but these benefits cannot be achieved without applying proper a sustainable (green) standard like LEED, which is a proper rating system to assist designers and builders in understanding and implementing sustainability in construction industry. Accordingly, if sustainable principles can be used in building projects, then numerous benefits of green buildings may be achieved, as follows:

- *Environmental benefits:* Enhance and protect biodiversity and ecosystems; Improve air and

water quality; Reduce waste streams, and; Conserve and restore natural resources.

- *Economic benefits:* Reduce operating costs; Improve occupant productivity, and; Optimize life-cycle economic performance.

Social benefits: Enhance occupant health and comfort; Improve indoor air quality; Minimize strain on local utility infrastructure, and; Improve overall quality of life.

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