

# Usage Of Renewable Energy Resources In Buildings in The Context Of Sustainability

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**Abstract-** At the present day energy and environment problems occurring because of urbanization, population growth and technology bring the usage of renewable and environment-friendly energy resources in the foreground in local, regional and global scale. Construction sector, which causes environmental pollution by using considerable part of natural resources, uses energy beginning from raw material extraction phase going through construction, usage and demolition phases. Therefore utilisation of renewable energy resources and tackling environmental problems come into the sphere of interest of not only architecture discipline but also but also other disciplines related with architecture; and sensibility increasing by environmental and energy problems obligates to collaborate all disciplines related with construction production. In this context sustainable architecture concept find interest and acceptance more and more by the day. Providing the conservation of resources by using renewable energy resources helps to solve environmental problems. In order to solve environmental problems it is beneficial to define said concepts, determine the criteria for energy use by prompting the use of renewable energy resources in buildings, and approach the subject by interdisciplinary rapprochement. Biological energy, water, solar and wind energy through easily supplied renewable energy sources that do not pollute environment are used in different ways in buildings. Parallel to these developments there are some solar houses in Turkey implemented by universities and related organizations. However, it is required to increase the number such applications, and supply the widespread use of solar energy in buildings. In this proceeding, usage of solar energy in buildings in the context of sustainability and solar houses in Turkey designed for utilising solar energy will be evaluated, and some suggestions will be made about efficient use of solar energy in buildings.

**Keywords-** Sustainable building design, energy efficient building design, renewable energy resources, usage of solar energy in buildings, solar houses

## Sürdürülebilirlik Kapsamında Yapılarda Yenilenebilir Enerji Kaynaklarının Kullanımı

**Özet-** Günümüzde kentleşme, nüfus artışı ve teknolojinin gelişmesi sonucunda ortaya çıkan enerji ve çevre sorunları yerel, bölgesel ve küresel ölçekte yenilenebilir ve çevreyle dost enerji kaynaklarının kullanımını ön plana çıkartmıştır. Doğal kaynakların önemli bir bölümünü kullanarak çevre kirliliğine sebep olan yapı sektörü, hammaddenin çıkarılması aşamasından başlayarak yapım, kullanım ve yıkım aşamalarında da enerji kullanmaktadır. Bu nedenle çevre sorunlarını gidermek ve yenilenebilir enerji kaynaklarından yararlanmak mimarlık disiplininde olduğu kadar yapı ile ilgili diğer disiplinlerin de ilgi alanına girmekte; çevre ve enerji sorunlarına karşı artan duyarlılık yapı üretimi ile ilişkili tüm disiplinleri işbirliği yapmaya zorlamaktadır. Bu kapsamda ortaya çıkan sürdürülebilir mimarlık kavramı gün geçtikçe daha çok ilgi ve kabul görmektedir. Yenilenebilir enerji kaynaklarını kullanarak kaynakların korunumunu sağlamak çevre sorunlarının çözümüne de yardımcı olmaktadır. Çevre sorunlarını gidermek için, söz konusu kavramların tanımlanmasına, yapılarda yenilenebilir enerji kaynaklarının kullanılmasına yönelik çalışmaların desteklenerek enerji kullanımına yönelik ilkelerin belirlenmesine ve konunun disiplinler arası yaklaşımla ele alınmasında yarar görülmektedir. Dünyada çevreyi kirliletmeyen ve kolay elde edilen yenilenebilir enerji kaynaklarından biyolojik enerji, su, güneş ve rüzgâr enerjisi yapılarda farklı şekillerde kullanılmaktadır. Türkiye sahip olduğu güneş enerjisi potansiyeli açısından elverişli konumda olmasına karşın, ülkemizde güneş enerjisinden yeterince yararlanılmamaktadır. Bu kapsamda üniversiteler ve ilgili kuruluşların aracılığıyla gerçekleştirilen sınırlı sayıdaki uygulamaların artırılmasına ve yapılarda güneş enerjisinden yararlanılmasının yaygınlaşmasına gereksinim duyulmaktadır. Bu bildiride Türkiye'nin güneş enerjisi potansiyeli göz önüne alınarak sürdürülebilirlik kapsamında yapılarda güneş enerjisinin kullanımı ve Türkiye'de güneş enerjisinden yararlanmak amacıyla kullanılan yöntemler irdelenecek, yenilenebilir enerji kaynaklarından güneş enerjisinin yapılarda etkin kullanımına yönelik önerilerde bulunulacaktır.

**Anahtar Kelimeler-** Sürdürülebilir yapı tasarımı, yenilenebilir enerji kaynakları, yapılarda güneş enerjisi kullanımı

## 1. INTRODUCTION

Environment is the collection of the physical, chemical, and sociological factors that affect the actions and behaviours of living and non-living substances together with natural, economical and human factors. Buildings, which are the components of the environment and sustain this environmental interaction throughout their lifetime, cause serious environmental problems. Thus; architectural discipline aims for creating healthy and habitable environments where the physical and physico-social requirements of the users are supplied thoroughly. Moreover, architectural discipline intends to protect the natural environment as to be used by the next generations, and responsible for effective and efficient usage of the resources, and decreased usage of non-renewable energy resources [1].

A certain fact today is that urbanization, population growth, and improved technology cause environmental and energy resource related problems. By using a significant part of the natural resources, construction sector distracts the ecological balance and threatens the environmental health conditions for human [2], which affects the human-nature-environment interaction negatively.

Construction activities require the consumption of 50% of the energy resources of earth, and 42% of water sources. In addition, 50% of sera gases that cause global warming, 40% of water pollution, 24% of air pollution, and 50% of CFC and HCFC releases are caused by activities related to construction [3].

90% of the energy consumed in the world and 75% of the energy consumed in Turkey is supplied from fossil sources such as coal, petroleum, and natural gas [4]. The gases released to the atmosphere due to the usage of the fossil resources force the solar lights to be held in the atmosphere longer, which in turn causes the global warming. Drought, flood, and fire situations are thought to be the possible crucial results of the global warming, and these situations severely damage the health and safety of the environment, and threaten the security of entire habitats.

Recently, increase in heating, cooling, and ventilating costs of the buildings, and the environmental problems caused by the fossil resources as mentioned earlier, necessitate and prioritize the usage of renewable and environment-friendly energy resources.

In order to protect the habitats and decrease environmental problems, World Wild Fund for Nature (WWF) has been trying to warn the countries to make interferences that prevent excessive release of carbonic gases. To perform the interferences, countries started to

include the research and usage of renewable and environmental friendly resources, in their energy strategies. Therefore, to prevent the problems caused by the excessive usage of non-renewable resources in the construction sector, sustainability approach is respected to be a crucial context of the architecture discipline.

Sustainability is a key concept that requires careful and efficient usage of the natural resources in order to supply sufficient resources and healthy habitats for the next generations [5]. Thus, architects, the main designers of the artificial environment, are supposed to create designs that provide energy efficiency by the usage of renewable resources.

## 2. PRINCIPLES OF SUSTAINABLE BUILDING DESIGN

“Sustainable Building Design” is a comprehensive concept that considers buildings with respect to ecological, economical and social aspects [6]. It requires decreasing the energy maintenance costs, diseases related to the building, and waste and pollution. Moreover, it necessitates increasing the efficiency and comfort of building materials, endurance and flexibility of the building and its components, and effective and efficient use of energy [7].

The theme of the Sustainable Building Design concept is the design standards that change according to the sustainability aspect, and the environment friendly building materials and construction techniques selected in accordance with these standards. Therefore, the initial objective is to create environment friendly designs that offer the usage of renewable energy sources, and improves the energy efficiency [8].

In the processes of usage and destruction of the buildings, taking out of the raw materials of the building materials, production, construction, usage, destruction, and after-destruction stages, natural resources are used continuously. These resources are transformed and returned to the nature as waste. At this stage, energy transforms into waste side materials, building materials into solid waste, water into waste water, consumer products into waste and renewable materials, wind into air pollution, and rain into underground water [9]. In this context, sustainability is assumed to be a negative and positive feed backed repeatable design principle through the life cycle of the building.

Sustainable building design suggests efficient and effective usage of building through its life cycle, and the usage of renewable and environment friendly construction materials. Moreover, it requires designing healthy and long lifetime buildings which are adjustable to changing

conditions, and necessitates decreasing the health and safety risks related to the building to a minimum level [10–13].

### 3. USAGE OF RENEWABLE MATERIALS IN BUILDINGS

In the historical stages of architectural discipline, renewable energy sources have been utilized in different forms. These forms can be listed as follows; hydraulic, wave, wind, geothermal, biomass, and solar energy. Renewable energy sources help protect the nature by preventing pollution, and by providing the usage of local energy sources. In the construction sector, one of the interferences that will eliminate the excessive usage of fossil sources is the usage of solar energy.

#### 3.1. USAGE OF SOLAR ENERGY

Lately, solar energy has been a preferable energy source due to its local applicability and technological non-complexity. Solar energy is used not only for heating and cooling but also for producing hot water and electricity. Turkey has better solar energy potential compared to European countries, and the most common method to produce solar energy is solar absorbers replaced on the ceilings of the buildings.

Producing hot water by utilizing solar energy can either be held by a decision taken during the design stage or during the utilization of the building. By the help of solar energy, heating and cooling costs of the buildings are decreased significantly and energy preservation is provided.

The activities to preserve energy by using solar energy in buildings can be categorized as passive and active heating-cooling systems. Passive systems are mainly performed by the decisions taken during the planning stage. In these systems, solar lights exposed on the walls, windows, and ceilings of the buildings are absorbed and transferred to the interior parts by at least one of the transferring, transporting, or radiation methods [15].

South openings (windows, greenhouses, and ceiling openings), wall surfaces, winter garden, sun wall / sun ceiling and new wing fitted with glass are basic examples of passive heating systems. In passive systems, various methods are performed in order to collect, store, distribute and control the solar energy [16]. The most preferable method is the *direct return system*, which is mainly aimed to use the stored solar energy to create *sera effect* that will force the building to act as an energy absorber. So as to apply this method efficiently, heat loss should be minimized on the openings where sun light is absorbed and stored. In order to increase the amount of energy stored and transferred naturally to the interior space, and to optimize the heat comfort, interior space should be kept

small, and heat absorber mass space should be kept large [15]. Even though window openings help the storage of heat and improvement of heat preservation during summer, they cause heat loss during winter when sun lights are not directly observed. For that reason, in cold climates, window openings should be kept large on south side, and as small as possible on other sides of the building.

Moreover, for winter nights, night insulation and for summer days sun protection are suggested [16]. In case, south side efficiency cannot be utilized because of neighbour buildings, and topography, solar energy should be stored by ceiling openings to achieve sufficient heat storage. However, the disadvantage of ceiling openings are extreme heating during summer and high heat loss during winter, and the necessity of night insulation.

Another method for passive heating systems is *indirect return systems*. In this system, the heat transferring from the glass surface to the wall by the mediation of a heating mass, which is placed mainly on the glass surface and to the back of the glass surface, is transferred into indoor space by transporting or radiation.

*Direct return system* provides easier interior heat control, and sun wall, water wall, and greenhouse addition are possible methods being used for this system [17]. Furthermore, this system provides construction easiness and does not require any dynamic parts except for insulation. Yet, the time required for the heat mass to get warm is long, and heat transferred to the interior space cannot be controlled in this system, which can be regarded as the possible disadvantages [18].

Active heating system includes addition of mechanical equipment and extra heat storing precautions to utilize solar energy. Moreover, heat distribution is controlled automatically; water-air collectors, highly efficient collectors and photovoltaic panels are used in this system. Solar energy is collected by flat collectors in the active systems that are not used for directly heating the indoor spaces, the collected energy is stored in storage tanks near the building or below the building or on gravelly area, and the indoor spaces are heated by the stored energy by the mediation of hot water dispensed by pump and pipes [19].

Passive and active systems, which are used to obtain heating and cooling from solar energy are environment friendly and by the implementation of energy efficient building materials prevent any possible harm to the environment.

#### 3.2. SOLAR ENERGY POTENTIAL IN TURKEY

Turkey has a higher solar energy potential compared to most of the countries in the world with the help of its geographical position. According to the research

conducted lately, Turkey has average sun absorption duration of 2640 hours per year, and sun radiation power of over 1311 kWh/m<sup>2</sup>. If solar energy potential is utilized efficiently and actively, energy amount achieved is estimated to be approximately 1015 kWh [20]. By the decisions taken during the design and usage stages and the changes performed, the building can be improved in terms of energy saving, using the passive and active heating-cooling systems [21].

In Turkey, the most common usage of the solar energy is supplying heated water. The solar energy potential has the capacity to supply all the hot water requirement during summer season, and photovoltaic pannels that could be placed on houses, office buildings, and factories are estimated to provide 40 milliard kWh electricity on average [22].

Even in the countries that possess much less solar energy potential compared to Turkey, photovoltaic pannels are used widely to produce electricity due to the inexistence of mechanical depreciation, easiness of operations, quick preparedness for service, and long life cycle.

Photovoltaic pannel applications will be providing electricity without any fuel cost, and much less release of CO<sub>2</sub> to the environment, which decreases the environment problems significantly.

#### 4. CONCLUSION

At present day, industrialization and population growth causes environment pollution, and excessive use of energy resources. Sera gas releases due to the use of fossil based fuels results with local and regional climate

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changes, and global warming. Serious environmental problems come at with a result of global warming. Therefore, as all other sectors, building sector starts taking precautions to limit the use of non-renewable resources in order to constraint the environmental problems. With respect to these limiting efforts, buildings designs should force renewable resources so that less energy will be consumed, and environment will not be harmed. Most significantly, solar energy should be utilized efficiently and more widely throughout the world due to its indefinite source and environment friendly properties. In Turkey, even though there is huge potential of solar energy, required investments have not been made in order to utilize the solar energy potential, yet.

Passive heating and cooling systems do not cause an extra financial burden for the building costs. Moreover, passive systems could be implemented in later stages of the building construction. Therefore, implementing passive systems will be an aid for Turkish Economy by their efficiencies and affordable costs.

Even though sustainable building design is a globally respected approach, it is not sufficiently known in Turkey. The main usage of solar energy in Turkey is producing hot water for households, yet only applications that solar energy used for improving energy efficiency is implemented on government buildings or performed for academic researches.

For that reason, in architecture teaching programs, studies that cover sustainability and energy preservation issues such as ecology, energy active building design, physical environment control should be included.

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