
Important Factors in Sustainable Design of Buildings with use of Solar Panels

Nika Baghaei, Halil Zafer Alibaba

Department of Architecture Engineering at Eastern Mediterranean University, North Cyprus

**Corresponding Author*

Email Id: samiyeh.khosravi.99@gmail.com

ABSTRACT

For many years most of the industry in the world has relied on fossil fuels. Fossil fuels are non-renewable resources. That is, it takes thousands of years to re-create them. Therefore, this fuel cannot meet all human needs for a long time and will eventually run out. Therefore, we have to find a suitable alternative to these fuels. Solar energy can be a very good alternative, especially for future generations. Using this energy is no longer a concern. Because if the existing energy sources run out, we will have forever renewable energy like solar. Nor it will have any adverse environmental effects and safety impacts on our health. Installing solar panels on the roof of the house is very effective in reducing the cost of consuming electricity and not only increases the value of the home, but also significantly reduces the carbon dioxide in the air. Solar energy is clean and renewable. In this paper, we examine the impact of the role of solar panels in terms of profitability on household economies and value added on housing prices.

Keywords: *Sustainability, Solar energy, Sustainable Building design.*

INTRODUCTION

Photovoltaic Energy (Solar Energy) is the conversion of sunlight into electricity through a photovoltaic cell, commonly called a solar cell. A solar cell is a device for the direct generation of electricity. These cells are a non-mechanical tool, usually made of silicon alloy. Sunlight is made of photons or particles of solar energy. Solar energy is one of the sources of free, clean and environmentally friendly energy [1]. Due to the energy crisis in recent years, as well as the reduction of pollution and energy savings and the control of energy supply and demand, the replacement of fossil fuels with renewable energies such as solar energy has become increasingly important. The sun, as an endless source of energy, can solve the problems of energy and the environment [2]. Unfortunately, cheap energy and high bank profits both make the cost of solar power in our country seem unprofitable. Although they are cost-effective in the

long run and have a significant impact on reducing air pollution. Photovoltaic systems are used for both general and agricultural applications, as either grid-independent power plants or grid-connected or stationary grid-connected systems in small low-power units to supply the electricity needed for small calculators to large power systems. Each square meter of surface that the sun shines on - in a day without clouds and pollution - receives about 1000 watts of radiation [3]. The average radiation in Iran is about 950 W/m². Commercially available solar panels have an efficiency of about 15 to 17 percent, and given that the entire surface of a solar panel does not contain energy-efficient silicone, each square meter of these panels can have about 100 to 150 watts of energy [4]. It should be noted, however, that this amount of energy is due to the sun's perpendicular exposure to the panel and the angle of the panels should be adjusted in different seasons of the year.

Commercial solar panels are generally above 300 watts. Scientists using nanotechnology have succeeded in making cells that absorb 5% of the sun's radiation. Such production allows us to dramatically increase the efficiency of our concentrated solar power [5]. Unlike traditional solar cells, modern cells produce more energy by concentrating energy, gathering sunlight through mirrors and focusing on heated salts. These heated salts are used to produce steam and thus to generate electricity [6]. New technologies can withstand high temperatures and last for many years in a variety of environments. With this technology, developing countries will be able to build concentrated solar power plants. In addition, while they will no longer need extensive repairs in the short term. The technology is capable of being merged into existing factories and rebuilt by clean energy [7].

Solar Energy and Construction

Today, as the world's population grows, we are witnessing the growth of the industrial sector. Especially the building construction industry. On the one hand, there is an increase in fuel consumption,

which results in uncontrolled production of building environmental pollutants, and on the other hand, lack of compliance with standards and lack of insulation in many buildings has led to increased fuel consumption. Fuel consumption is a result of technical deficiencies in buildings and appliances, and the current situation has worsened fuel consumption [8]. Discussions and studies regarding the use of solar energy in building and due to the large amount of daylight available on buildings, with the proper reception, accumulation and distribution of solar energy can be achieved using minimal heating or cooling energy through Better understanding of the properties of materials led to superior quality in operation [9]. Discussion of studies and studies regarding the use of solar energy in building and due to the large amount of daylight available on buildings, with the proper reception, accumulation and distribution of solar energy can be achieved with minimal heating or cooling energy through better understanding of the properties of materials led to superior quality in operation [10].



Fig. 1: Placing the solar panels on the roofs of the houses.

At present, solar energy is used and used by different systems for different purposes, including the following:

- 1) Use of solar thermal energy for indoor, industrial and power plants.
- 2) Direct conversion of sunlight to electricity by means of photovoltaic equipment, as well as attention to local architecture and local climate.
- 3) Much of the world's raw energy is used in the building industry, for heating in winter and in summer for building cooling.

In fact, energy consumption in buildings, especially in Iran, is very high in terms of lack of proper insulation and seam as well as lack of use of high quality materials or incompatibility with climate and cultural conditions. One of the free and accessible sources of energy in the world is the sun. Using solar energy to heat consumed water

or heating water to heat a building can reduce the cost of hot water for residential homes by about 70% of buildings in each city by about 60% per year. Solar water heaters and solar heating and cooling systems can save a lot of money over the entire life of the building and can also help people conserve natural resources and the environment. There is usually an auxiliary system in the solar system that can be used on days when solar energy may not be sufficient to provide heating. The use of solar systems is a rational investment and from an environmental perspective and a reduction in greenhouse gas emissions is a rational investment. In hot and dry regions, the intensity of the radiation and its timing are very high, so that solar energy in the form of direct radiation, without special interference and capture, is almost annoying for more than 85% days [11-15].

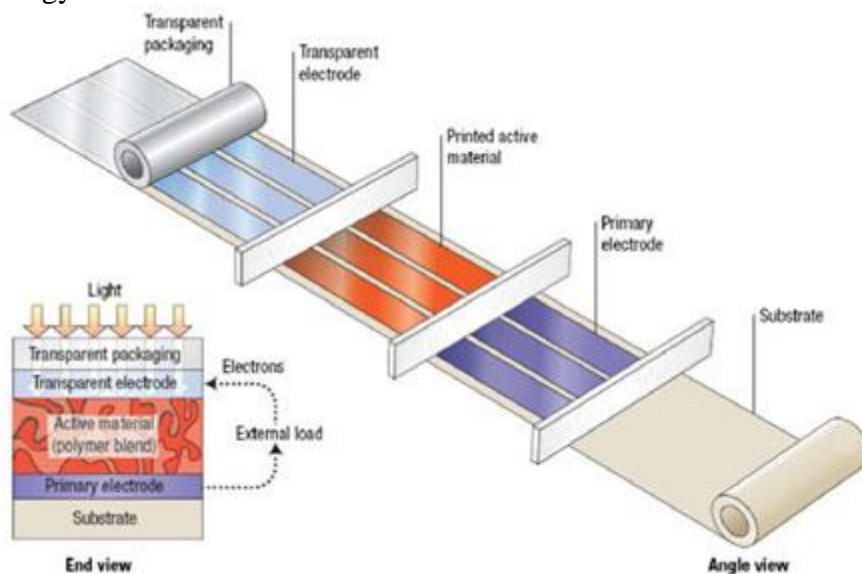


Fig. 2: Different Layers and Substrates of Solar Panels.

Executive Points on Building Design [16-18]

Particular attention should be paid to the design of buildings in hot and dry areas with regard to climate issues and the use of solar energy.

- 1) Preventing unnecessary solar energy from entering the building, given the climatic conditions of these areas,

there is usually no problem heating the building. In a variety of ways, including insulation such as insulation of roofs, thick walls or both layers or dioramas with low openings or brackets, use of double-glazed windows or completely sun-backed windows to ward off heat and prevent the intensity of sunlight.

- 2) In designing the climate against intense radiation, buildings should be designed so that there is no problem with the use of heavy materials to adapt to the climate and nature to cool or keep the building warm and compared to the electrical energy consumed in the building. To achieve comfortable conditions in the long run is very small.
- 3) Making the most of solar energy in receiving, storing, and converting it into less sophisticated devices and tools. Therefore, that the public can use it easily and this will become a culture in economic savings.
- 4) The goal is to reduce energy costs to create conditions in buildings. For example, the shell of a building, i.e. the external surfaces in relation to free space, plays an important role in this.

Methods of using Solar Cells in the Building Industry [19-22]

There are two ways to discuss the use of solar cells:

- 1) Thermal absorption method, i.e. receiving, accumulating and distributing and converting heat to heat for home heating as well as the production of hot or consumable water.
- 2) A photovoltaic method that involves converting solar energy through cells and panels into electrical energy for heating, cooling, and setting up electrical appliances in buildings that are powered by electricity.

In the first method, much of the solar energy received in the building by the reflection of the sun from the horizontal and vertical surfaces around and around the ground and surrounding buildings can be avoided by changing the color to dark. Another way to reduce the intensity of summer heat in dry and humid climates is to move air and wind around the building to cool the walls and clear surfaces in the outer shell of the building to avoid

radiation and also using the canopies on horizontal and vertical over windows and openings to create shadows. The amount of solar energy emitted throughout the year depends on the intensity and duration of the radiation, as well as its duration. Nevertheless, the main purpose is to prepare the environment for the thermal equilibrium of the human body and its environment for human life. In hot and dry areas during the summer, natural conditions are far from comfort. Therefore, ventilation is not suitable both for water balance and for thermal comfort. The clear sky makes the nights very cold, so buildings with thick ceilings and walls are also heavy materials. It is very useful because it keeps indoor air at a relatively constant temperature. The correct way to do this is to open windows at night to allow cooler air to enter the building, and then close them during the day to keep the cooler in the space until late in the day to eliminate the heat of the day [23-29].

CONCLUSION

Solar cells can provide the building energy needed by thermal and photovoltaic methods. Thermal absorption is used to supply heating and hot water consumed through the reception, storage, distribution and conversion of energy into heat. In this method the maximum amount of solar energy is obtained by reflecting light from the surface of the solar cells, but in the photovoltaic method, solar energy is converted into electrical energy and the electricity needed for heating, cooling and electrical appliances is provided. In this paper we review fundamentals of using solar panels in buildings and assess how the using of these panels can affect on the sustainable development of buildings and cities.

REFERENCES

- 1) Reisdorf, R. J., & Morris, B. (2013). U.S. Patent No. 8,511,006.

- Washington, DC: U.S. Patent and Trademark Office.
- 2) Wood, G. S., Denoon, R. O., & Kwok, K. C. (2001). Wind loads on industrial solar panel arrays and supporting roof structure. *Wind & Structures*, 4(6), 481-494.
 - 3) Bilge, H. H. (2014). U.S. Patent No. 8,640,402. Washington, DC: U.S. Patent and Trademark Office.
 - 4) M. Darbandi; "Proposing New Intelligence Algorithm for Suggesting Better Services to Cloud Users based on Kalman Filtering"; Published by *Journal of Computer Sciences and Applications* (ISSN: 2328-7268), Vol. 5, Issue 1, 2017; PP. 11-16; DOI: 10.12691/JCSA-5-1-2; USA.
 - 5) S. Haghgoo, M. Hajiali, A. Khabir, "Prediction and Estimation of Next Demands of Cloud Users based on their Comments in CRM and Previous usages", *International IEEE Conference on Communication, Computing & Internet of Things*; Feb. 2018, Chennai. DOI: 10.1109/IC3IoT.2018.8668119.
 - 6) Benad, J. (2018). Fast Numerical Implementation Of The Mdr Transformations. *Facta Universitatis, series: Mechanical Engineering (FU Mech Eng)*. Vol. 16, No. 2.
 - 7) Janošević, D., Pavlović, J., Jovanović, V., Petrović, G., (2018). A Numerical And Experimental Analysis Of The Dynamic Stability Of Hydraulic Excavators. *Facta Universitatis, series: Mechanical Engineering (FU Mech Eng)*. Vol. 16, No. 2.
 - 8) Radiša, R., Dučić, N., Manasijević, S., Marković, N., Čojbašić, Z. (2017). Casting Improvement Based On Metaheuristic Optimization And Numerical Simulation. *Facta Universitatis, series: Mechanical Engineering (FU Mech Eng)*. Vol. 15, No. 3.
 - 9) G. Prakash, N. Gafar, N. H. Jabarullah, M. Jalali, "A New Design of 2-bit Universal Shift Register Using Rotated Majority Gate Based on Quantum-dot Cellular Automata Technology"; Published by *International Journal of Theoretical Physics*, (ISSN:), PP. 1-19, June 2019. DOI:10.1007/s10773-019-04181-w
 - 10) M. Khorraminia, Z. Lesani, M. Ghasvari, L. Rajabion, A. Hassani, "A Model for Assessing the Impact of Cloud Computing on the Success of Customer Relationship Management Systems"; Under the Process of Publishing by: *Digital Policy, Regulation and Governance* 2019.
 - 11) S. Seyedi, Mehdi Darbandi, N. J. Navimipour; "Designing an efficient fault tolerance D-latch based on quantum-dot cellular automata nanotechnology"; Published by *Optik Journal*, (ISSN: 0030-4026), Vol. 185, PP. 827-837, May 2019. DOI:10.1016/j.ijleo.2019.03.029
 - 12) Ibrahim, A., & Jin, G. L. (2009). Hybrid Photovoltaic Thermal (PV/T) Air and Water Based Solar Collectors Suitable for Building Integrated Applications Adnan Ibrahim, Goh Li Jin, Roonak Daghig, Mohd Huzmin Mohamed Salleh, Mohd Yusof Othman, Mohd Hafidz Ruslan, Sohif Mat and Kamaruzzaman Sopian Solar Energy Research Institute, University Kebangsaan Malaysia, 43600, Bangi, Selangor, Malaysia. *American journal of environmental sciences*, 5(5), 618-624.
 - 13) Cornaro, C., Bartocci, S., Musella, D., Strati, C., Lanuti, A., Mastroianni, S., ... & Brown, T. M. (2015). Comparative analysis of the outdoor performance of a dye solar cell mini-panel for building integrated photovoltaics applications. *Progress in Photovoltaics: Research and Applications*, 23(2), 215-225.
 - 14) Yong, C., Yiping, W., & Li, Z. (2015). Performance analysis on a building-integrated solar heating and cooling

- panel. *Renewable Energy*, 74, 627-632.
- 15) Mimura, T. (2003). U.S. Patent No. 6,545,211. Washington, DC: U.S. Patent and Trademark Office.
- 16) Hossain, M. F. (2016). Solar energy integration into advanced building design for meeting energy demand and environment problem. *International Journal of Energy Research*, 40(9), 1293-1300.
- 17) Chong, W. T., Fazlizan, A., Poh, S. C., Pan, K. C., & Ping, H. W. (2012). Early development of an innovative building integrated wind, solar and rain water harvester for urban high rise application. *Energy and Buildings*, 47, 201-207.
- 18) M. Darbandi; "Proposing New Intelligent System for Suggesting Better Service Providers in Cloud Computing based on Kalman Filtering"; Published by HCTL *International Journal of Technology Innovations and Research*, (ISSN: 2321-1814), Vol. 24, Issue 1, PP. 1-9, Mar. 2017, DOI: 10.5281/Zenodo.1034475.
- 19) Willert, E., Kusche, S., Valentin L. (2017). The Influence Of Viscoelasticity On Velocity-Dependent Restitutions In The Oblique Impact Of Spheres. *Facta Universitatis, series: Mechanical Engineering (FU Mech Eng)*. Vol. 15, No. 2.
- 20) Dimaki, A., Pohrt, R., Popov, V. (2017). Simulation Of Frictional Dissipation Under Biaxial Tangential Loading With The Method Of Dimensionality Reduction. *Facta Universitatis, series: Mechanical Engineering (FU Mech Eng)*. Vol. 15, No.
- 21) Bottger, W. O. J., Schaap, A. B., Hoekstra, K. J., & Schoen, A. J. N. (2000). U.S. Patent No. 6,105,316. Washington, DC: U.S. Patent and Trademark Office.
- 22) White, S. D., Kohlenbach, P., & Bongs, C. (2009). Indoor temperature variations resulting from solar desiccant cooling in a building without thermal backup. *International journal of refrigeration*, 32(4), 695-704.
- 23) Jetter, A., & Schweinfort, W. (2011). Building scenarios with Fuzzy Cognitive Maps: An exploratory study of solar energy. *Futures*, 43(1), 52-66.
- 24) Yin, H. M., Yang, D. J., Kelly, G., & Garant, J. (2013). Design and performance of a novel building integrated PV/thermal system for energy efficiency of buildings. *Solar Energy*, 87, 184-195.
- 25) Bradley Jr, D. (2003). U.S. Patent No. 6,584,737. Washington, DC: U.S. Patent and Trademark Office.
- 26) Pierce-Bjorklund, P. (1990). U.S. Patent No. 4,942,865. Washington, DC: U.S. Patent and Trademark Office.
- 27) Toyomura, Fumitaka, Naoki Manabe, and Nobuyoshi Takehara. "Method and apparatus for testing solar panel, manufacturing method for manufacturing the solar panel, method and apparatus for inspecting solar panel generating system, insulation resistance measuring apparatus, and withstand voltage tester." U.S. Patent 6,753,692, issued June 22, 2004.
- 28) Angrisani, G., Entchev, E., Roselli, C., Sasso, M., Tariello, F., & Yaïci, W. (2016). Dynamic simulation of a solar heating and cooling system for an office building located in Southern Italy. *Applied Thermal Engineering*, 103, 377-390.
- 29) Zanatta, Francesco. "Automatic washing device for continuous surfaces, in particular solar thermal collectors, photovoltaic panels, continuous glazed building walls and similar surfaces." U.S. Patent 9,192,966, issued November 24, 2015.