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Letter

Considering the Opportunities, Tools and Technical Methods to Use Solar Energy Technologies

Mojtaba Jamiati[1,✉]

[1] *Department of Physics, Naragh Branch, Islamic Azad University, Naragh, Iran*

✉ *Corresponding author*: **M. Jamiati**; *E-mail address*: **drmjamiati@gmail.com**, *ORCiD*: **0000-0002-1590-5502**.

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ABSTRACT

Today, energy demand is increasing globally and due to limited resources of fossil fuels for energy production, tendency toward finding alternative renewable resources is being observed. Since solar energy is one of the infinite and full of energy resources, it doesn't lead to any pollution in environment. In this paper, opportunities, tools and technical methods for using renewable energy technologies in design and construction of buildings are addressed. Then, a comprehensive review over renewable energy resources and available technologies which can be used for electrical and thermal energy loads is presented. Moreover, notes and methods for application and implementation of solar renewable technologies such as solar electricity, heating and geothermal and their contribution to energy efficiency of the building in renewable energy projects are described.

KEYWORDS Energy usage, Renewable energy, Solar energy, Energy efficiency.

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INTRODUCTION

Environmental necessities and limitations in fossil fuel resources prompted human to make substantial changes in the type of his energy usage. Demand for renewable energy resources for achieving higher levels of electrical power is one of the most important and fundamental contexts of finding renewable energies. Buildings constitute about 40% of the annual energy usage in the world.[1-7] In 2007, overall energy usage in the world was 495 BTU from which building sector consumed about 198 BTU of the whole energy. According to the report of energy information agency, it is expected that energy usage all around the world increases 1.4% per year until 2035 and approaches 296 BTU.[2, 3] Fossil fuels are one of the energy demands of the world and since buildings consume a considerable portion of the energy, they contribute significantly to the emission of greenhouse gases. Currently, by concentrating on the energy consumption pattern in buildings, usage of fossil fuels and emission of greenhouse gases declined. Reduction of global energy consumption in buildings includes two strategies:

- Reducing the demand for energy through executive actions for energy productivity
- Compensation for remaining energy demands of the building through application of renewable energy resources

Since actions corresponding to energy productivity in buildings are of great significance and priority, all of the opportunities for energy productivity are explored. It must be noted that this research focuses only on opportunities

and issues corresponding to implementation of renewable energy projects in available buildings. National and local policies of both developing as well as developed countries are toward more usage of renewable energy resources. In 2009, 20% of the energy produced in EU was from renewable resources and this has to be increased until 2020.[4] In this way, incentives for installing systems of renewable energies are provided in EU. Using renewable energy resources for meeting building energy demands (Fig. 1) has been a tool for directing toward sustainability in environment and energy resources and considerable increase in energy for electrical and thermal appliances.[5] Renewable energy resources are used for producing applied plans including solar, wind, geothermal and biomass energies. It must be pointed out that before selecting an appropriate renewable energy technology for the project of strengthening of an available building, it is important to consider many factors some of which are in the following points.[6]

- Available and accessible renewable resources for buildings
- Accessible region for positioning the place of renewable energies
- Evaluation of the costs of electrical and thermal energy for purchased buildings
- Present motivations for compensation of installation and startup of renewable energy systems
- Governing local regulations for renewable energy systems
- Reluctance for keeping or change current specifications of the architecture

Information regarding Europe renewable energy resources is accessible through organizations such as global energy network institution. Map of renewable energy resources is a starting point for determining that whether a construction site is located in a region with acceptable energy resources. However, other factors such as cost and renewable energy resources and local incentives for renewable energy equipment are not often economic with installation of renewable energy systems.

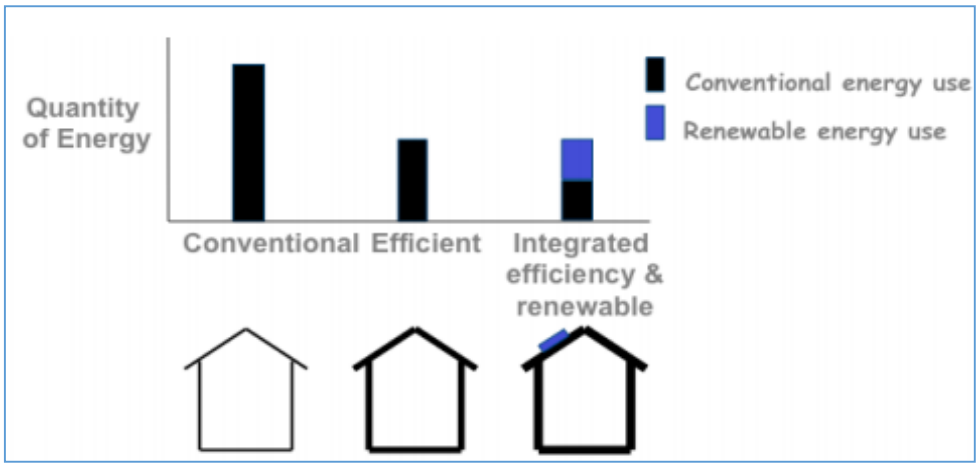

Fig. 1: Schematic representation of combination method of energy productivity and renewable energy consumption in regular buildings.

SYSTEM OF SOLAR ELECTRICITY

Examples of renewable energy technologies, which can be included in a building energy system are summarized in the following notes:

- Solar electricity and photovoltaic systems
- Solar heating including solar hot water (internal water heating and space heating) as well as solar air conditioning and air preheating
- Geothermal heat pump
- Wind turbines
- Biomass systems

SOLAR ELECTRICITY

PV is to convert sunlight into electricity. These systems are constructed in assembled modules in arrays which can be installed within or near buildings. Power inverter converts DC current produced by system into a high quality alternative current. Traditional solar cells are made up of silicon like a flat plate and in general, they are less effective

compared to the most efficient multi-crystal solar cells with the same technology. Solar cells are made up of thin films of silicon or non – silicon amorphous materials such as cadmium telluride. In solar cells, thin film is made of semiconductor materials having only a few microns thickness. In Table 1, a general schematic of the efficiency of the module for every type of solar cell is presented.

Table 1: efficiency of various types of solar electricity modules.

Productivity of modules	Single-crystal	14-19 %
	Multi-crystal	13-17 %
	Thin film	6-11 %

Using photovoltaic products integrated with building can be appropriate for available buildings during retrofit process. Such technologies can enhance the façade of the building as well as its light like lathing and tiling on roofs. Fig. 2 represents an example of the technology integrated with lathing.

Fig. 2: An example of the technology integrated with lathing.

In some cases, BIPV can add to cost and complexity of the project and at the same time, be possible and accessible. Today, most of the PV systems installed in buildings are in the form of flat plates which are normally composed of solar cells and are combination of modules of 40 cells. In a regular house in US, about 10-20 solar panels are used for power production. Many of solar panels are combined with each other and make a system referred to as solar array. For large units of power production and applied industrial programs, hundreds of solar arrays are connected to each other in a PV system in a large scale. Such systems are in general in a single and fixed position. However, in design of structures, solar orientation can be considered seasonally or within structure changing from east to west during the day. Fig. 3 illustrates the components of the PV system.[8, 9]

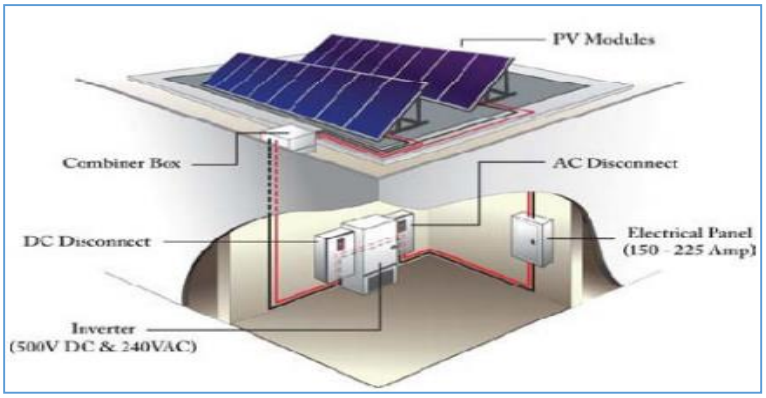

Fig. 3: Components of a PV system.

There are normally three scales of solar equipment: tool, commercial and residential scales.

- Tool level equipment are very large arrays of tools which are located in open lands and supply power for hundreds and thousands of homes and offices.
- Commercial systems are smaller and provide power for one or more buildings or commercial units in urban or regional level.
- PV systems in residential level provide power for a personal home. In this regard, main challenge of PV technology is to ensure the appropriate place for installing solar cells to produce maximum power. In this respect, it is better to position system southward and out of shadow.

- Finding exposed region to install solar cells especially during maximum daily radiation for example, middle part of the day; 9:00-15:00 is of great significance. Presence of shadow reduces the output power of the solar panels. It must be kept in mind that this shadow is made by trees and surrounding buildings.
- Maximizing annual energy production from a fixed PV system with rotation of array and accordance with latitude in which system is located; for example, a system in 40°N must rotate 40 degrees to gain maximum productivity.
- Installation of solar panels fixed in roofs or on the ground or merging with masonries including roofs, windows and canopies; however, making intended slope angle is not always possible since factors such as roof, land or snow load can affect installation of panel in various angles.
- Note that diverse modules of PV are different in productivity. Fewer modules are made up of a cell with high efficiency (like single-crystal) which has relatively the same output power like most of the modules made up of a cell with less efficiency like thin film.

SOLAR HEATING

Solar hot water can be an economic way for producing hot water and air and elimination of both electricity and fossil fuels leading to environmental effects. Systems of solar water heater utilize collector to absorb and transfer heat from sun to the water stored in a tank. Such systems are classified according to temperature. Such classification which depends upon the heat with highest contribution and the type of collector according to available temperature, include low temperature (non-glazed collector), moderate temperature (flat plate collector) and high temperature (evacuated pipe collector).[10] In general, systems of solar hot water have high reliability with respect to maintenance and repair since they have few moving parts. Parts of the system include collector, heat exchanger and water storage tank, pump and control systems.

PREHEATING SYSTEM OF SOLAR AIR CONDITIONING

In the system of solar preheating air condition, collector surface is heated by sunlight and where heat is available, it is in contact with air exposed by fans blowing over hot surface and then, they are directed toward intended points through channels. Fig. 4 illustrates this fact.[11]

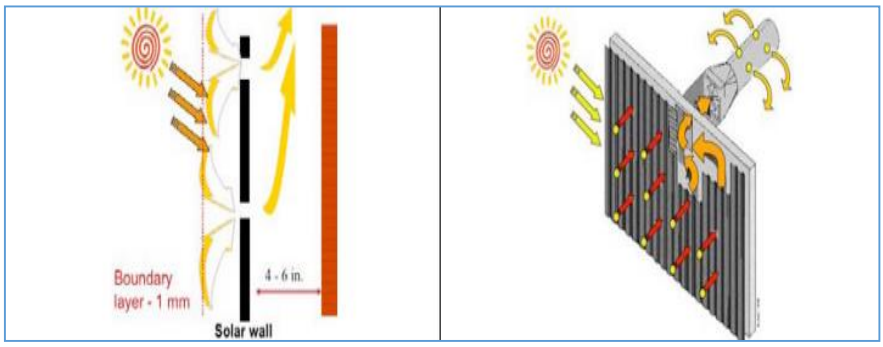

Fig. 4: Performance of collector in solar preheating air conditioning.

Preheating of the solar air conditioning can be added to available buildings in the project of strengthening. Various factors contribute to appropriateness of a solar preheating air conditioning system for a region; including relatively high number of tools for heating, relatively long hot season and sufficient wall surface toward south to locate collector.

GEOTHERMAL

Geothermal technologies use earth center heat. Geothermal resources are: heat stored in shallow lands, hot water and stones a few miles beneath the earth surface and molten stoned in high temperatures called magma in depth of the earth. Nearly in all point with shallow lands or 3m above the ground, relatively constant temperature is used for houses heating and cooling by means of geothermal heat pumps. Deeper and hotter geothermal resources can be used directly for heat or through modern technologies of heating and electricity producing. Applied plans of

building for geothermal technologies include geothermal heat pumps and direct usage of geothermal resource. Since geothermal heat pumps are the most frequently used geothermal energy technology in buildings and geothermal heat pumps act as a medium for heat exchange with the help of constant temperature of the earth, the system of geothermal heat pump includes a heat pump, system of air delivery and heat exchangers, piping system buried in shallow grounds. During winter, heat pump transfers heat from heat exchanger to aerating system of internal space of the building. In summer, the trend inverses and pump transfer hear from internal of the building to heat exchanger and the ground.[12]

CONCLUSION

Studies performed in EU reveal that buildings are responsible for about 45 % of CO_2 produced throughout the world. According to the significant contribution of buildings in emission of greenhouse gases, it is time to reconsider the construction industry to reduce energy usage to reduce greenhouse gases production accordingly. In this way, some renewable energy resources such as energies corresponding to sun and relevant technologies are introduced. It must be noted that maintaining and retrofit of available buildings can reduce energy usage and costs as well as emission of greenhouse gases. One of the other ways of optimization of energy usage is to strengthen available buildings and using renewable solar energy technologies instead of constructing a new building. Many of the available buildings are the first candidate for energy productivity and renewable energy technologies. In fact, old buildings have often the unique characteristics with high energy efficiency; such as appropriate design for utilization of natural light, natural ventilation and storage of thermal energy.

DISCLOSURE STATEMENT

The author(s) did not report any potential conflict of interest.

REFERENCES

1. Houser T. The economics of energy efficiency in buildings. Transport. 2009;1:6.
2. Outlook AE. Energy information administration. Department of Energy. 2010;92010:1-5.
3. Mandil C. 7. World energy outlook. Singapore Energy Conference. 2006:47-52.
4. Union E. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. Official Journal of the European Union. 2009;5:2009.
5. Directive EN. 91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings. Official Journal of the European Communities. 2002;4:L1.
6. GENI. Renewable energy resource maps. Global Energy Network Institute. 2014.
7. Shum KL, Watanabe C. An innovation management approach for renewable energy deployment - the case of solar photovoltaic (PV) technology. Energy Policy. 2009;37:3535-3544.
8. Kandt A, Hotchkiss E, Walker A, Buddenborg J, Lindberg J. Implementing solar PV projects on historic buildings and in historic districts. Contract. 2011;303:275.
9. Observ ER. Photovoltaic barometer. Systemes Solaires. 2014:60-81.
10. Buildings US, Initiative C. Buildings and climate change: status, challenge and opportunities. Paris: United Nations Environment Programme. 2007.
11. Observ ER. Photovoltaic barometer. Systemes Solaires. 2013:53-80.
12. Anderson A, Rezaie B. Geothermal technology: trends and potential role in a sustainable future. Applied Energy. 2019;248:18-34.