New generation of solar panels by combination of optical fiber and solar cell

Armin Ebtekar,

*Bsc of Physics, Physics group, Tehran unit, faculty of Physics, Tehran, Iran*

Supervisor: Omid Rahmani

*Scientific board member, Physics group, Tehran unit, faculty of Physics, Tehran, Iran*

**Abstract**: The sun is the source of life so that the life will die without the sun. The sun has considerable energy (its temperature is millions degrees and its external surface temperature is 4600 degrees).  The amount of energy received by the earth which is 150 million km far from the sun is different in different locations. Its daily amount is measured about 5 kwh/m2 in Tehran. The energy of the sun as an eternal, pure and free energy, is one of the promising sources for the human which is replaced as one of the reliable and economic energy sources with passing away fossil fuels. Nowadays, with regard to the advances of the human life, the need to the energy has been increased, so it is necessary to look for different renewable different resources. The solar energy is one of these resources which has been used since 20 years ago. The sun transmit 1000 Jules per square meter of the earth each second which by gathering it we can supply the required energy for different works. Today, for transforming the solar energy to the electrical one, the solar cells and solar panels and surfaces are used. These solar cells are used by the same traditional way in which the solar panels and surfaces are exposed directly to the sun light. These solar panels and surfaces have several problems.

In this design, we introduce the new generation of solar panels by combination of solar cells with the optical fiber.

**Keywords**: solar energy, the sun, solar panels, optical fiber

# Introduction

It seems that the wonderful development of science and technology in current world has resulted in comfort and welfare of human being, but this development has yielded new problems to people such as pollution of the environment, widely climate changes in the earth on so on. Particularly, we know that oil and its derivatives are of nationally and vitally valuable wealth of each country which the non-optimized implementing of them causes irrecoverable damages. Thus, experts are looking for sources which can gradually be replaced by fossil fuels. Fossil fuels result in infinite environmental pollutions. In the other words, due to burning fossil materials, the toxicant gases spread in the environment and create breathing problems and environmental pollutions, on the other hand, the concentration of these gases in the atmosphere forbids the heat to go away from the around of the earth which yields the increase of the temperature and widely climate changes in the earth. If the increasing of the temperature continues the current trend, it will be impossible to return the previous situation, so the best solution which is proposed by the scientists is to stop this trend of growing the harmful gases (Satba, 2016).

Nowadays, there are several approaches to generate electrical energy, and the generation of electrical energy without injuring the environment is one of the preferences of the human. To achieve this purpose, we must use the renewable energies more and look for the new methods to make better use of these energies. The energy of wind and water, geothermal and solar energies are of the most important renewable energies and among them the solar energy is considerable in each aspect such as quantity and accessibility and it outperform other renewable energies while being non comparable with them (Mohaghegh,،1396).

The recognition of the solar energy and employing it for different aims comes from the prehistoric era perhaps the pottery era. While the solar energy and its advantages were recognized in the last centuries but the highly initial costs of these systems in one hand, and the supply of oil and gas energies on the other hand, has stopped the progresses of these systems. Then, by increasing the oil price in 1973, the industrial and developed countries considered the problem of the generation of energy by the non-fossil fuels more seriously (Thomas Kietzke, 2007). The solar energy is one of the free and pure energies without harmful environmental damages which has been used by the human since long times ago. The power industry and light is considered as one of the basic consuming which possess significant potential in optimizing the energy usage (Han et. al 2003). Today, solar cells and solar panels and surfaces are employed to convert the solar energy to electrical energy. In spite of these progresses in solar cells, they are used by the same initial methods, such that they are placed in solar panels and surfaces and are exposed to the direct radiation of sun light. These panels and surfaces have several problems but we can use the solar cells in different ways, which not only overcome the problems of solar cells, but also improve the effectiveness of them. In this paper by the help of nano-technology and combination of optical fibers and solar cells, we introduce a new generation of solar panels.

# The design

The experts believe that the making use of pure energies such as solar energy instead of the energies resulted from fossil fuels prevent the environmental pollutions and related risks (Driggers, Ronald, 2003). On the other hand, the fossil fuel such as oil, gas and coal will be over eventually and then the human civil which is directly related to the energy faces with a new and huge challenge (renewable energy world magazine, 2009). One of the ways to absorb the solar energy is making use of solar cells or solar panels. The solar panel is called to the surfaces which its area is constructed by numerous solar cells. Each of these solar cells are able to receive the energy of light and convert it to the electrical energy on the other side. This energy is completely pure which does not release any pollution in the surrounding space (Green, 2002).

The sun is a huge source of energy which can be found in several locations of the world and transformed it to the electrical energy with the help of solar cells (Cai et al. 2010). Today the solar cells are divided to two main groups: the cells which work with direct light and the ones which work with indirect light, also the flexible types of solar cells are fabricated. The solar panels have very problems, which the main problem is that in the regions which the strength of the light is low, the efficiency of the solar surfaces decreases. Hence, the installation of solar surfaces in many of regions is not effective, additionally, in winter, which the radiation decreases and smallest decrement in the light intensity results in negative effect in the efficiency. The other problem of these solar panels is that the occupied area and volume is very large. For example, take into account a 39 units apartment, since to provide the electrical energy of each unit we need 5 m2 panel in average, thus to provide the energy of the whole apartment, the required area is 150 m2 and of course it is important that this area and volume should be such that all beams of the sun must radiate to all of this surface and it is apparent that such area and volume is not accessible for everyone. Because of this reason and many other reasons, the installation of solar surfaces is not possible for everyone (Mohaghegh, 1396).

The power and lightening industry as one of the main consumers of energy have a considerable potential to optimize the energy consumption (Maxey et al, 2008). Contemporary, the energy is exploited by different systems and for different aims which include the followings (Green, 2006):

* Making use of energy for household, industrial and power plants consumptions.
* The direct transform of the light from the sun beams to electricity by the help of photovoltaic instruments.

As is mentioned before, in this design, we introduce a new generation of solar panels by the help of nano-technology and the combination of optical fibers and solar cells. This design not only solves the problems of solar surfaces and multiplies its efficiencies, but also, unlike the solar panels, occupies less volume. As is expressed above, one of the problems of solar panels is that by diminishing the light intensity, the efficiency of the solar surfaces decreases but in this apparatus due to the convergence of the “integration” of light beams, the low intensity of the light does not affect so much. Overall, this design and apparatus can to solve the solar panels problem and by overcoming these problems the ability to use the solar energy will be possible for everyone and this increase in solar energy consumption guaranties the health of the environment (Mohaghegh, 1396).

# Literature

## Solar energy

The energy which the earth receives from the sun is 1000 times more than the energy required for the human. The energy consumption in 2050, i. e., 1350 SH will be 50-300% more than the current consumption. However, if only 0.1% of the area of the earth is covered by the solar energy transformers and with just 10% efficiency, it will be enough to supply the energy of the humans (Petela, 2005). The solar energy is one of the most rich, pure and efficient types of energy which exist broadly around the world without any limits. This energy is the result of continues nuclear fusion in the sun. All electromagnetic waves which are emitted by the sun travel the space with light speed (almost 300,000 km/s) and the earth which is as far as 150 million kilometers from the sun can absorb just 1 part of 2000 million parts of the solar energy, and even this very small portion, is the source of energy supply of all atmospheric and biotic evolutions on the globe (J.F. Randall, 2005). It is promising that by having definite advantages relative to the fossil and atomic energies and specially compatibility with environment, the solar energy can overcome the problem of power particularly in the end of the oil and gas resources. Implementing the solar energy will provide fertile future and strong base to help the self-sufficiency and the end of dependency to oil exports for the country. Now it is worthy to mention some advantages of this energy (Golestani, 1391):

Power generation without burning the fuel: the solar energies don’t need fuel and in spite of fossil power plants in which the price of power changes always ad is related to the price of oil, the solar energy does not have any fluctuations and it is possible to keep the price of consumed power at a constant value.

Non pollution of the environment: the solar energies generate the power without polluting the air and generating toxic and harmful materials. While, the fossil power plants will pollute the space around by consuming the oil, gas or coal, also the atomic plants create the nuclear wastes which are very contaminating, dangerous and radioactive and provide huge problems for the residents of the globe.

The possibility of establishing small and local networks: the solar energy can deliver the power to the main network and while it is possible to supply the small and local networks. This is performed without using the high pressure pipes to power transmission and need to high expenses to construct transmission grids.

## Solar cell

The solar cell or photovoltaic cell is a solid state electronic piece which transforms a fraction of the sun’s light energy by the help of photovoltaic effect as a physical and chemical effect to the electricity. The solar cells fabricated by silicon wafers have several applications. Single cells are employed to provide required power for smaller devices such as electronic calculator. The photovoltaic arrays generate renewable and stable electricity which are mainly applicable in the lack of power transmission grid and power distribution systems. For example we can point to the far of access locations such as orbiter satellites, space probes and far communication buildings. In addition, the use of this type of energy is possible in locations which the distribution grid is present. In order to decrease the dependency and pressure on the fossil fuel and avoid other environmental problems and also from economical points of view, it is common to use this type of energy (Green, 2006).

## The types of solar cells

Different classifications are applied in different types of resources. With regard to the technology, the solar cells are divided in 3 classes (زو،2011):

Organic solar cells: the newest group of solar cells comprise small molecules, polymer components and organic/mineral hybrids. Despite the low achieved efficiency and stability problems, these types of solar cells show multiple advantages such as simple processing, flexibility, light weight and low fabrication costs.

Some types of solar cells based on organic materials are as below (استلا،2009):

- Solar cells sensitized by color

- Polymer solar cells

- Solar cells based on liquid crystals

Polymer solar cells: some of the significant properties of solar cells are as: low cost, light weight and simple fabrication. But what highlights its significance is the solubility of the used materials in organic solvents which allows us to provide flexible solar cells.

Hybrid solar cells: a hybrid solar cell is the result of the combination of two organic and mineral semiconductors. In fact, this is a combination of unique properties of mineral semiconductors with conjugate polymers including organic materials or conjugate polymers which are used as donor and electron transmitter that absorb the light. The effective strategy to build hybrid solar cells is to use complexes of nano-particles and semiconductor polymers as bulk inhomogeneous junctions (گینس،2007).

## The design remarks

Generally this apparatus is a specific combination of optical fiber and solar cell. The basic elements of the design are as follow:

* Optical fiber: optical fiber is formed by three parts: 1-core, 2- reflecting layer and 3- protective coating. The main work of optical fiber is simply the information transformation by transforming light. But the optical fiber which is used in this design is different from other optical fibers as below:

1. In the typical optical fibers the diameter of the core is very low but in our used optical fibers in this device, the ratio of core diameter to the thickness of the reflecting layer is larger.
2. The general optical fiber diameter is usually about 1mm but the used optical fiber in this design can be through several centimeters.

* Solar cell: simply its work is the transformation of light energy to electrical energy and is fabricated in different types.
* Converging mirrors: if the light is radiated parallel to the principal axis, the light beams will be convergent in the focus.

# First section

The nano science allows us to place solar cells among the molecules of different materials. For example, this is performed in a particular type of textile in which solar cells are laid down in its texture or one type of paints in which the solar cells are placed between its molecules. With the help of nano-technology we can place solar cells between reflecting layers of optical fiber and even in protective coating of the optical fiber. From the expertise point of view in the nanotechnology, based on the structure of optical fiber and solar cell it is possible to place solar cells between reflecting layer and protective coating layer of optical fiber. This optical fiber in which the solar cells are placed in reflecting layers or protective coating is the main element of the design which we call it principal optical fiber or central optical fiber. The length and diameter of this central optical fiber varies and we calculate it based on the amount of required energy for the location which this device is established there and the light strength of that region and the diameter of optical fiber in this device. The beginning and the end of optical fiber are connected to each other, that is by connecting the beginning and the end of the central fiber we create a close set.

# Second section

In the next step we use converging mirrors. The converging mirrors collect (converge) the light of sun in a point as the focus. We import these converged beams to the central optical (principal) fiber. The transformation of convergent beams in the focus of the mirror to the central optical fiber can be performed by the typical optical fiber.

By importing the light into the central optical fiber, the existed solar cells in the central optical fiber become active and cause to generate electrical energy.

Because the central optical fiber is closed (by connecting the beginning and the end of the central fiber we create a close set) and the entering the converging beams to the central optical fiber, the efficiency of the solar cells existed in central optical fiber is multiple times of the efficiency of solar cells which are placed in typical solar panels.

## The size and the number of the mirrors

We can use the mirrors in two different ways:

* Using one converging big mirror
* Using multiple converging small mirrors

Both two mentioned mirrors are tested and no effect on the efficiency of the device is observed.

The first method: using one converging big mirror:

The size of the mirror is determined by two factors:

1. The length and the diameter of the “principal” central optical fiber;
2. The strength of the sun light in the region wherein the device should be installed.

The converging mirror converges the sun light in a point known as focus, we enter this convergent beam into the optical fiber. This mirror is as an antenna of the satellite dish ind it is tuned such that converges the sun light in the focus and according to the apparent motion of light in the sky.

The second method: - Using multiple converging small mirrors:

In this method both size and the number of the mirrors are determined based on the following factors:

1. The length and the diameter of the “principal” central optical fiber
2. The strength of the sun light in the region wherein the device should be installed.

These mirrors are installed on a plate which are motional that is move with regard to the apparent motion of the sun in the sky, each of these convergent beams are entered the central optical fiber by following periodicities:

**The periodicity of the arrival of converging beams to the optical fiber:**

The beams which are converged by each mirror enter the principal optical fiber according to the following periodicity:

The length of principal optical fiber divided to the number of converging mirrors= the periodicity of entering the convergent beams to the principal optical fiber

# The points of design execution

* If the light intensity is low in a region, we can compensate it by adding the number mirrors or using larger mirrors.
* Due to heat generation in this apparatus, the optical fiber used in this device should be of glass or resilient plastic.
* Instead of using converging mirrors, we can make use of converging or diverging mirrors.
* The important point in fabricating this device is that the material of the core must be different in some parts of the principal optical fiber core “especially the arrival points of the convergent beam to the optical fiber”, in the other words, the material of the core must cause scattering and dispersion of light.
* Instead of using converging lens or mirror we can make use of glassy spheres and globes. These types of optical tools converge the light in each point without regarding to the angle of radiation of light.
* Using glassy spheres or globes is recommended in regions in which the light intensity is moderate or high. These spheres or globes have several advantages, one of the most these advantages is its being static and installed in a constant place which does not need to be installed on a surface to move according to the apparent motion of sun in the sky.

# The positive points of the design

This design occupies a very low space and in fact the problem of space and area of solar panels is solved. This device works in places which the intensity of light is low and being low of the light intensity has not much effect on its efficiency.

The efficiency of solar cells are much more and better than solar cells which are installed on typical solar panels.

This device has other positive points, but one of its most important one of the MCDM is that it can be installed on variety of different electrical equipment. For example, electrical vehicles are not broadly used due to their several problems. One of their problems is their fast discharging and longtime of their charge. Using the glassy sphere or globe, we can install this device on the electric vehicles. By installing this device on electric vehicles, we can generate the total energy required for the vehicle and thus the new generation of electric vehicles is build which don’t need to be charged except emergency cases. Also we can install and use this device in other various electric equipment.

# Design execution for a house

In addition to house, this device can be installed in other places such as offices, halls and schools. In principle we should calculate the required energy for the location and based on the required energy and the light intensity, we can calculate the length and diameter of the optical fiber. The dimensions mentioned below, are calculated on average for a residential house.

* On average we need a central optical fiber with length 53 MCDM and diameter 5.1cm for a house.
* We connect the beginning and the end of optical fiber to each other and create a closed set.
* If we wrap the optical fiber with 53m length and 5.1cm diameter around an axis, it occupies less the 0.5 m3, and on the other hand we can fish this optical fiber on the wall, roof or ceiling of the building “like heating pipes in the ceiling” that by which no space is occupied.

The number of the mirrors are determined based on two factors:

1. The length and the diameter of the optical fiber
2. The amount and intensity if the sun light in the region in which the device should be mounted.

For a principal optical fiber with length 53 m and the diameter 5.1cm and also the moderate climate we can use the following cases:

* Using one large converging mirror: in this situation we need a converging mirror by diameter 90 cm. here one convergent beam is created that we should transmit it to the principal optical fiber with a typical optical fiber.
* Using multiple mirrors by small dimensions: in these conditions, we need other ten converging beams. Here, ten converging beams are created, so we have ten converging beams which we must transmit these ten beams to the principal optical fiber via the typical optical fiber according the following relation:

The periodicity of entering the convergent beams to the principal optical fiber=the length of principal optical fiber divided to the number of converging mirrors

The length of principal optical fiber=53 m

The number of converging mirrors=10

53/10=3.5.

Accordingly, in each 3.5 m, we enter one convergent beam. Here we can use glassy sphere or globe instead of converging mirror. To supply and generate this amount of energy in a moderate weather we need 5 glassy spheres with 15cm radius. According to periodicity formula, per each 10.3 m, one convergent beam enters the principal optical fiber.

# The result of design execution

This design can cause a huge and new evolution in using light to generate electrical energy and this leads to significant increase in using solar energy and on the other hand with regard to the air pollution and global warming which its main reason is using the fossil fuel, this design can decrease our dependency to fossil fuel to its possibly minimum value and this by itself guarantees the health of environment for the futures.