

# Photovoltaic and Fuel Cells application in Remote Areas

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**Abstract** - This paper represents that photovoltaic and fuel cells provide an additional method of acquiring energy, converting sunlight directly into electricity and other form of energy through the use of semiconductors. This paper also tells about modern applications and investigation on incredible solar energy in real World. The Sun is the ultimate source of energy. Here we are focusing on 'Photovoltaic and Fuel Cells application in Remote Areas' This Paper also deals with the various utilities of solar energy and makes life comfortable & nature friendly. Solar energy is an important, clean, cheap and abundantly available renewable energy.

## 1. INTRODUCTION

With the ever increasing demand for energy, the search for alternative energy sources has increased. Solar energy is the radiating light and heat from the sun that is harnessed using devices like Heater, cooker, photovoltaic cell to convert it to other forms of energy such as electrical energy and heat. The sun radiates about  $3.8 \times 10^{26}$  W of power in all the directions. Out of this about  $1.7 \times 10^{17}$  W is received by earth.

**Average solar radiation:** Outside the earth's atmosphere is  $1.35 \text{ kW/m}^2$  varying from  $1.43 \text{ kW/m}^2$  (in January) to  $1.33 \text{ kW/m}^2$  (in July).[6] It varies due to the change in weather day by day. It is received on Earth in cyclic, intermittent and dilute form with very low power density 0 to  $1 \text{ kW/m}^2$ . Diagram related to radiation is shown in figure1 & 2.

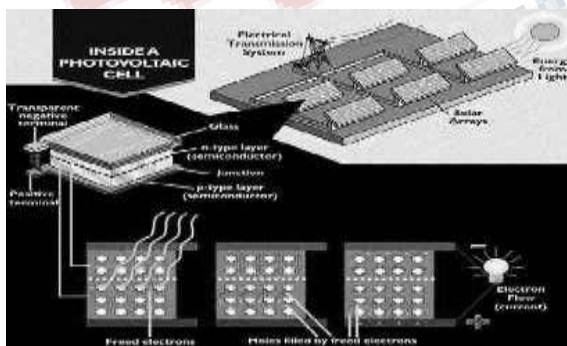


Figure: 1 Solar Panel & Radiation



Figure: 2 Solar Radiations

Energy from the sun in solar energy received at the ground level is affected by atmospheric clarity, degree of latitude, etc. For design purpose, the variation of available solar power, the optimum tilt angle of solar flat plate collectors, the location and orientation of the heliostats should be calculated. Solar energy is the most readily available and free source of energy since prehistoric times. It is estimated that solar energy equivalent to over 15,000 times the world's annual commercial energy consumption reaches the earth every year. Renewable energy sources also called non-conventional energy sources that are continuously replenished by natural processes. For example, solar energy, wind energy, bio-energy - bio-fuels grown sustainably), hydropower etc., are some of the examples of renewable energy sources.

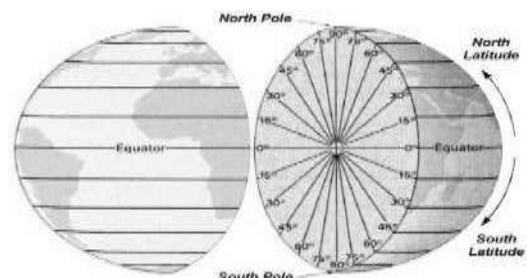


Figure:3 Degree of Latitude

The energy is measured as an hourly or monthly or yearly average and is expressed in terms of kJ/m<sup>2</sup>/day or kJ/m<sup>2</sup>/hour. Solar power is expressed in terms of W/m<sup>2</sup> or kW/m<sup>2</sup>.

**Solar energy constant:** The density of power radiated from the sun (referred to as the “solar energy constant”) at the Outer atmosphere is 1.373kW/m<sup>2</sup>. Part of this energy is absorbed and scattered by the earth’s atmosphere. The final incident sunlight on earth’s surface has a peak density of 1kW/m<sup>2</sup> at noon in the tropics. The technology of photovoltaic’s (PV) is essentially concerned with the conversion of this energy into usable electrical form. The basic element of a PV system is the solar cell. Solar cells can convert the energy of sunlight directly into electricity.

- Low-Grade Heating Devices - up to the temperature of 100°C.
- Medium-Grade Heating Devices -up to the temperature of 100°-300°C
- High-Grade Heating Devices -above temperature of 300°C

## 2. APPLICATIONS OF PHOTOVOLTAIC CELL

### SOLAR WATER HEATER

Solar water heating (SWH) is the conversion of sunlight into heat with the help of semi conductor material for water heating using a solar thermal collectors. A variety of configurations are available at varying cost to provide solutions in different climates and latitudes. SWHs are widely used for residential and some industrial applications. A sun-facing collector heats a working fluid that passes into a storage system for later use.[1]



**Figure: 4 Solar Water Heater (SWH)**

SWH are active (pumped) and passive (convection-driven). They use water only, or both water and a working fluid. They are heated directly or via light-concentrating

mirrors. They operate independently or as hybrids with electric or gas heaters. In large-scale installations, mirrors may concentrate sunlight into a smaller collector.

### SOLAR AIR CONDITIONING

Solar heat energy is also used for cooling purpose in coolers and air conditioning, solar absorption cooling – or solar air conditioning using an absorption chiller – is one of the most efficient and cost effective solutions for commercial air conditioning and space heating[2]. The world’s first air conditioners used thermal energy to provide cooling and this technology is common in the northern east coast USA and is used for refrigeration in campers, RVs and the like. This type of cooling is powered by solar evacuated tube collectors, which collects solar thermal heat from the sun. This energy is then collected and transmitted into a solar absorption chiller by means of a heat transfer fluid (HTF).

This HTF is generally comprised of water and corn or propylene glycol, it is designed for the most efficient heat transfer as well as providing freeze protection in the winter. The HTF then passes into the solar absorption chiller and thus powering it, providing free, solar air conditioning. Absorption chiller air conditioners are not new, they have been commercially used in the U.S. since the early 20th century and are a very widely deployed technology. Absorption chiller AC units are also very popular in Asian countries like Japan, where the high cost of electricity make them very desirable and they constitute up to 40% of all installed commercial air conditioning tonnage.



**Figure: 5 Solar air cooler**

They are simple and dependable, using no harmful CFC (Freon, etc.) and some units actually operate without any moving parts.

When engineered to run on solar energy the absorption chiller AC units provide the lowest cost to operate and the best return on investment of any air

conditioning system in the world. Our solar heating and air conditioning units can be used anywhere that the sun shines; they are low in operating and maintenance costs.[5] They consume little or no electrical energy – essentially the only parts that use electricity are low amp fan motors and small pumps that move the thermal transfer fluid (Glycol, a food-grade antifreeze) from the collectors to the chiller and then back up to the collectors - all of these small electrical loads can run from solar PV panels if desired. Inside the unit is another small pump that circulates the refrigerant. There is no "compressor" to consume power.

### SOLAR-POWERED PUMP

Solar power pumps in wide area of farming for irrigation purpose. A solar-powered water pumping system is composed of a power source consisting of one or more PV (photovoltaic) panels. Solar cells are the building blocks for solar panels. Each solar cell has two or more specially prepared layers of semiconducting material (generally silicon) that produce direct current (DC) electricity when exposed to sunlight. This current then flows to a control box which manages the power generated. Using a program called Maximum Power Point Tracking the control box can regulate the speed of the pump motor so it runs at best efficiency. It also protects the pump motor from over voltage or low power situations. It can also start and stop the pump based on input from sensors and at the same time displaying the systems status.



**Figure:6 Solar water pump**

Whenever the sun shines the current turns the motor and the pump operates. If there is a requirement to run the pump for longer hours eg at night then a battery system must be included. This can store electricity during the day to run the pump later but it does require more solar panels to charge the battery.[8] In early systems the motor was driven by DC current through brushes (brushes needed to be replaced periodically). Today's modern systems use

high efficiency brushless motors which are driven by an alternating current produced by the control box.

A solar-powered pumping system is fairly easy install, especially if you decide that you do not need a battery-coupled solar water pump. In this case the system will only work when the sun is shining and stop when it doesn't. A mounting pole is concreted into the ground and once the concrete has set the solar panels are mounted on it as is the control box.

### SOLAR WATCH

A solar-powered watch or light-powered watch is a watch which is a battery less watch that is powered entirely or partly by a solar cell. Some of the early solar watches of the 1970s had innovative and unique designs to accommodate the array of photovoltaic solar cells needed to power them (Synchronar, Nepro, Sicura and some models by Cristalonic, Alba, Rhythm, Seiko and Citizen). In the 1990s, Citizen started to sell light-powered watches under the Eco-Drive series name. Since their introduction, photovoltaic devices have greatly improved their efficiency and thereby their capacity. Watchmakers have developed their technology such that solar-powered watches are now a major part of their range of watches. Several other watch manufacturers offer similar watches or are developing such technology.



**Figure:7 Solar Watch**

Typically, sunlight and artificial light are absorbed by a solar panel behind the crystal. The dial is either on a layer above or actually on the solar panel. This solar panel converts the light into electrical energy to power the watch.[9] The watch will usually store energy in a rechargeable cell to power itself during the night or when covered such as a wearer's clothing (e.g., sleeve).



Citizen's watches use lithium-ion batteries to store sufficient energy to power the watch for several months/years without light exposure, by allowing the watch to enter a power-saving or hibernation mode during which the seconds hand stops until the watch is re-exposed to light. Not all have a power-save mode, yet will still hold a charge for typically six months, as with uncomplicated (date only) analog versions made by Citizen.

### 3. FUEL CELL APPLICATIONS

#### LIGHT VEHICLES

Fuel cell are used in light vehicles for powering them. A fuel cell vehicle (FCV) or fuel cell electric vehicle (FCEV) is a type of electric vehicle which uses a fuel cell, instead of a battery, or in combination with a battery or super capacitor, to power its on-board electric motor. Fuel cells in vehicles generate electricity to power the motor, generally using oxygen from the air and compressed hydrogen. Most fuel cell vehicles are classified as zero-emissions vehicles that emit only water and heat. As compared with internal combustion vehicles, hydrogen vehicles centralize pollutants at the site of the hydrogen production, where hydrogen is typically derived from reformed natural gas. Transporting and storing hydrogen may also create pollutants.

Fuel cells have been used in various kinds of vehicles including forklifts, especially in indoor applications where their clean emissions are important to air quality, and in space applications. The first commercially produced hydrogen fuel cell automobile, the Hyundai Tucson FCEV, was introduced in 2013, Toyota Mirai followed in 2015 and then Honda entered the market.[2][3] Fuel cells are also being developed and tested in trucks, buses, boats, motorcycles and bicycles, among other kinds of vehicles.



**Figure:8 Light Vehicle**

As of 2017, there was limited hydrogen infrastructure, with 36 hydrogen fueling stations for automobiles publicly available in the U.S., but more hydrogen stations are planned, particularly in California. Some public hydrogen fueling stations exist, and new stations are being planned, in Japan, Europe and elsewhere [10]. Critics doubt whether hydrogen will be efficient or cost-effective for automobiles, as compared with other zero emission technologies.

### 4. FUTURE SCOPE

We can enhance this work in different applications at the village level and develop many others modules of solar and fuel energy with use full applications.

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