# Solar Photovoltaic Technology for Industrial and Domestic Applications

**M. Guna Sekhar[1], K. Upendra[2], Mr. P. Kamalakar[3] and Mr. T. SanjeevaRao[4]**

[1, 2]Final Year B.Tech, Department of Electrical and Electronics Engineering, Malla Reddy Engineering College (A), India
[3, 4]Associate Professor, Department of Electrical and Electronics Engineering, Malla Reddy Engineering College (A), India.
E-Mail: kamaleee209@gmail.com

**Abstract** - Solar energy is clean and available in abundance. Solar technologies use the sun for provision of heat, light and electricity. These are for industrial and domestic applications. With the alarming rate of depletion of depletion of major conventional energy sources like petroleum, coal and natural gas, coupled with environmental caused by the process of harnessing these energy sources, it has become an urgent necessity to invest in renewable energy sources that can power the future sufficiently. The energy potential of the sun is immense. Despite the unlimited resource however, harvesting it presents a challenge because of the limited efficiency of the array cells. The best efficiency of the majority of commercially available solar cells ranges between 10 and 20 percent. This shows that there is still room for improvement. This project seeks to identify a way of improving efficiency of solar panels. Solar tracking is used. The tracking mechanism moves and positions the solar array such that it is positioned for maximum power output. Other ways include identifying sources of losses and finding ways to mitigate them. When it comes to the development of any nation, energy is the main driving factor. There is an enormous quantity of energy that gets extracted, distributed, converted and consumed every single day in the global society. Fossil fuels account for around 85 percent of energy that is produced. Fossil fuel resources are limited and using them is known to cause global warming because of emission of greenhouse gases. There is a growing need for energy from such sources as solar, wind, ocean tidal waves and geothermal for the provision of sustainable and power. Solar panels directly convert radiation from the sun into electrical energy. The panels are mainly manufactured from semiconductor materials, notably silicon.

**Keywords** - Environmental, Fuel Resources, Industrial, Domestic, Solar, Tracking.

## I. INTRODUCTION

Three ways of increasing the efficiency of the solar panels are through increase of cell efficiency, maximizing the power output and the use of a tracking system. Maximum power point tracking (MPPT) is the process of maximizing the power output from the solar panel by keeping its operation on the knee point of P-V characteristics. MPPT technology will only offer maximum power which can be received from stationary arrays of solar panels at any given time. The technology cannot however increase generation of power when the sun is not aligned with the system. Solar tracking is a system that is mechanized to track the position of the sun to increase power output by between 30% and 60% than systems that are stationary. It is a more cost effective solution than the purchase of solar panels. There are various types of trackers that can be used for increase in the amount of energy that can be obtained by solar panels. Dual axis trackers are among the most efficient, though this comes with increased complexity. Dual trackers track sunlight from box axes. They are the best option for places where the position of the sun keeps changing during the year at different seasons. Single axis trackers are a better option for places around the equator where there is no significant change in the apparent position of the sun. The level to which the efficiency is improved will depend on the efficiency of the tracking system and the weather. Very efficient trackers will offer more efficiency because they are able to track the sun with more precision. There will be bigger increase in efficiency in cases where the weather is sunny and thus favourable for the tracking system.

### A. Problem Statement

A solar tracker is used in various systems for the improvement of harnessing of solar radiation. The problem that is posed is the implementation of a system which is capable of enhancing production of power by 30-40%. The control circuit is implemented by the microcontroller. The control circuit then positions the motor that is used to orient the solar panel optimally.

### B. Project Justification

The project was undertaken to ensure the rays of the sun are falling perpendicularly on the solar panel to give it maximum solar energy. This is harnessed into electrical power. Maximum energy is obtained between 1200hrs and 1400hrs, with the peak being around midday. At this time, the sun is directly overhead. At the same time, the least energy will be required to move the panel, something that will further increase efficiency of the system. The project was designed to address the challenge of low power, accurate and economical micro controller based tracking system which is implemented within the allocated time and with the available resources. It is supposed to track the sun's movement in the sky. In order to save

power, it is supposed to sleep during the night by getting back into an horizontal position. There is implementation of an algorithm that solves the motor control that is then written into C- program on Arduino.

A. Performance of Conventional Generation

The electricity generation target of conventional sources for the year 2017-18 has been fixed as 1229.400 Billion Unit (BU). i.e. growth of around 5.97% over actual conventional generation of 1160.141 BU for the previous year. The conventional generation during 2016-17 was 1160.141 BU as compared to 1107.822 BU generated during 2015-16, representing a growth of about 4.72 %.

## II. NON CONVENTIONAL POWER GENERATION

A. Solar Energy

One of the most widely developed renewable energy sources is solar energy. Solar energy applications are constantly increasing in the last few years, and they are considered perhaps the most promising that can significantly contribute to the total electricity generation. There are two main technologies involved in the exploitation of solar energy, which differ in the way that solar radiation is harvested and converted to electricity. These are the solar photovoltaic (PV) and the concentrated solar power (CSP) technology, which are presented in the following sections

B. Solar Photovoltaic Technology

Solar photovoltaic technology (PV) is the most popular technology for capturing solar energy and converting it to electricity. One reason for its popularity is the modular design/size of a PV unit which has no moving parts, permitting it to be installed even on building roofs with generation capacity starting from a few Watts. The basic element of a PV is the solar cell. There are various technologies of such cells, having a large variety of efficiency and cost. The most common solar cells are the crystalline silicon ones, while thin films are also increasing their market share, due to their low cost and sufficient performance. Multijunction solar cells are still at a very early stage of commercialization, due to their extremely high cost and are used only in special applications and in high-concentration PV plants. A number of solar cells form a solar panel with common power output of some hundreds of Watts. A PV plant consists of many such modules arranged in arrays in order to produce the required power, ranging from a few kW up to a few MW. It should be mentioned that PVs produce direct current (DC) electricity and inverters are required to convert it to alternating current (AC), decreasing somewhat their efficiency. The maximum electric efficiency of such plants at real conditions is around 10–15%, considering also their losses at the cables, cells, and their temperature effect. PV cells are also used in concentrating photovoltaic (CPV) units, where lenses or curved mirrors are used in order to increase the direct solar radiation on the PV cell surface. In such units, a solar tracking device is used, which traces the Sun's movement during the day. Such trackers can be also used in flat PVs, which are not very common, because of the increased maintenance and installation costs.

C. Wind Energy

Another very common renewable energy source is wind. With the use of a wind turbine, the kinetic energy of wind is converted to mechanical power and then to electricity. Usually, several wind turbines are installed together and constitute a wind farm. Their capacity ranges from some kilowatts up to some megawatts, while they can be installed either on-shore or off-shore. A common wind farm capacity factor is around 20–30 %, while their installation is advised only in areas with high wind potential. This technology is very mature, since many commercial units are installed every year, and with thousands of GW already installed around the globe. Their cost is steadily declining, although with a slower rate compared to PV, and is currently equal to around 1,000–1,500 €/kW for the large shore units of megawatts-scale. This cost is much higher for the smaller ones, due to the economies of scale and for the off-shore ones, since large infrastructure is required for installing them at deep waters. The LCOE of wind farms takes into consideration the equipment cost, the operating and maintenance cost and the electric energy produced, while it shows a large variety, depending on the size, the location, and the wind potential. Common values are around 0.10 €/kWh or even less for large wind farms, which is highly competitive and has pushed wind farms to a fully commercialization. However, there are still some relevant research activities, mainly dealing with the development of very large wind turbines and very small one.

D. Bioelectricity Generation

Biomass is a renewable energy source and refers to waste and residues from agriculture, forestry and related industries, energy crops, as well as the biodegradable fraction of industrial and municipal waste that can be used as fuel for different scale power production. Its use for electricity production is ''CO2-free'', or, in other words, ''CO2-neutral'', since the amount of the CO2 released during its utilization equals the amount, which has been assimilated from the plant during its growth. The potential of the so-far unexploited biomass for energy power, fuels, and chemicals from biomass is of increasing importance in addressing issues of global warming and sustainability. The total amount of primary bioenergy production in the 27 Members States of the European Union was 100.77 Moe in 2009 and 112.73 Moe in 2010 respectively with a continuous growing market, in order to meet the goals of 2020. The bioelectricity predictions in EU-27 for 2020 are depicted in, where the expected bioelectricity production is shown in each EU country for solid, gaseous and liquid biomass. Biomass can vary in composition and form according to fuel properties, cultivation, and harvesting period. The low energy content of biomass fuel imposes additional techno-economic barriers concerning availability, logistics, and replacement of food crops. The conversion of biomass can be realized with either thermochemical processes

including combustion, gasification, pyrolysis, liquefaction, or biochemical processes, such as anaerobic digestion, fermentation, and enzymes.

## III. TYPES OF POWER GENERATION

Now-a-days, the power is generated by using conventional methods or renewable methods or combining both. Such types of power generation methods are discussed below,

### A. Solar power plant

These plants convert energy from the sun into thermal or electrical energy. It is one of the cleanest and most abundant renewable energy sources. Solar energy plants generally do not require high maintenance and last for about 20-25 years. The International Energy Agency (IEA) projected in 2014 that by 2050 solar PV and solar thermal would contribute about 16 and 11%, respectively, of the worldwide electricity consumption and solar would be the world's largest source of electricity. However, initial costs involved in setting up solar power plants are high. Installation of solar power systems requires a lot of space.

### B. Solar-thermal power plant

Solar thermal is a system of giant mirrors. They are arranged in such a way to concentrate the sun's rays on a very small area to create significant amount of heat. It is used to create steam to power a turbine that creates electricity.

### C. Nuclear power plant

Using a nuclear fission reaction and uranium as fuel, nuclear power plants generate high amount of electricity. As nuclear power plants emit low greenhouse gas emissions, the energy is considered as environmentally friendly. When compared to renewable sources of energy such as solar and wind, the power generation from nuclear power plants is considered to be more reliable

### D. Hydroelectric power plant

Hydroelectricity is produced by harnessing the gravitational force of flowing water. Compared to fossil fuel-powered energy plants, hydroelectric power plants emit lesser amounts of greenhouse gases. However, construction of hydroelectric power plants and dams need huge investments. According to the International Hydropower Association's 2017 Hydropower Status Report, an estimated 31.5 GW of hydropower capacity was put into operation, including pumped storage, bringing the world's cumulative installed capacity to 1,246 GW in 2016. China alone accounted for almost one-third of global hydropower capacity and added around 11.74 GW of new capacity in 2016.

## IV. CONCLUSION

A maximum power generation using solar panel with dual axis tracking has been designed and implemented in Malla Reddy Engineering College Campus for a street lamp. The working model has been tested and mounted for a single LED lamp as a model.Dual trackers are most suitable in regions where there is a change in the position of the sun like India. The dual axis trackers has been designed and tested. The working condition of the dual axis tracker brings satisfactory operation. As a future extension, the same design and implementation can be extended for the entire campus street lights by the selection of suitable inverter, battery and panel rating.

## REFERENCES


[1] A.K. Saxena and V. Dutta, "A versatile microprocessor based controller for solar tracking," in Proc. IEEE, 1990, pp. 1105 – 1109.

[2] A.V.Sudhakara Reddy, M. Ramasekhara Reddy, M. Vijaya Kumar "Stability Improvement During Damping of Low Frequency Oscillations with Fuzzy Logic Controller", International Journal of Engineering Research and Applications (IJERA), Vol.2, No.5, pp.1560-1565, September 2012.

[3] P Prasad, B Bhargava Reddy and A V Sudhakara Reddy "Power Loss Minimization in Distribution System using Network Reconfiguration with Particle Swarm Optimization", International Journal of Engineering Science & Advanced Technology, Vol.5, Iss.3, pp.171-178, May 2015.

[4] S.Bharathi, A.V.Sudhakara Reddy and M.Damodar Reddy, "Optimal Placement of UPFC and SVC using Moth-Flame Optimization Algorithm", International Journal of Soft Computing and Artificial Intelligence, ISSN: 2321-4046, Vol.5, No.1, pp.41-45, May2017.

[5] K.Surekha and A.V.Sudhakara Reddy "A New Control Topology for Smart Power Grids using Bi-directional Synchronous VSC", International Journal of Informative & FuturisticResearch, Vol.2, No.10, PP.3695-3704, June 2015.

[6] B Bhargava Reddy, D Sivakrishna and A V Sudhakara Reddy "Modelling and Analysis of Wind Power Generation Using PID Controller", International Journal For Scientific Research & Development (IJSRD), Vol.1, No.9, pp.2045-2049, November 2013.

[7] A. V. Sudhakara Reddy, Prof. M. Damodar Reddy, "Optimization of network reconfiguration by using particle swarm optimization",2016 IEEE First International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES-2016), July 4th - 6th, 2016.

[8] T.A. Papalias and M.Wong, "Making sense of light sensors," http://www.embedded.com, 2006.

[9] R. Condit and D. W. Jones, "Simple DC motor fundamentals," Texas Instruments. Publication AN907, pp. 1 – 22, 2004.

[10] S. J. Hamilton, "Sun-tracking solar cell array system," University of Queensland Department of Computer Science and Electrical Engineering, Bachelor's Thesis, 1999.

[11] A. V. Sudhakara Reddy, M. Damodar Reddy and N.Vinoda, "Optimal Placement of Dynamic Voltage Restorer in Distribution Systems for Voltage Improvement Using Particle Swarm Optimization", International Journal of Engineering Research and Applications (IJERA), ISSN: 2248-9622, Vol.7, No.3, pp.29-33, March 2017.

[12] D.Raja Reddy, A.Gayathri Reddy "Controlling Power Oscillations in Real and Reactive Power using Symmetrical HYBRID PFC (Power Flow Controller)" i-manager's Journal on Electrical Engineering, Vol. 10, Issue. No. 3, pp. 11-17, January - March 2017.

[13] M. F. Khan and R. L. Ali, "Automatic sun tracking system," 2011.