INTERNATIONAL ADVANCE JOURNAL OF ENGINEERING, SCIENCE AND MANAGEMENT (IAJESM)
July-December 2023, Submitted in December 2023, iajesm2014@gmail.com, ISSN -2393-8048
Multidisciplinary Indexed/Peer Reviewed Journal. SJIF Impact Factor 2023 =6.753

A Study of Semiconductors' Function in Solar Energy

Manu, Ph.D. Research Scholar, Department of Physics, Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu Rajasthan, India)
Dr. Narendra Ram Kishan, Department of Physics, Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu Rajasthan, India

Abstract

The sun produces solar energy, which is sustainable, renewable, and ecologically benign. Hourly, the amount of solar energy that reaches the Earth is sufficient to meet the global annual energy requirement. In the current generation, electricity is needed continuously. Solar energy is utilised throughout various sectors, including industrial, commercial, and residential uses. It can readily harness energy from direct sunlight. Consequently, it is very efficient and environmentally sustainable. This article examined solar energy, along with prospective trends and problems. Additionally, the essay examines societal energy functions, energy production, photovoltaics, concentrated solar power (CSP), solar cell efficiency, fuel generation, and the roles of semiconductors.

Keywords: Solar Energy, Energy Production, Photovoltaic cell, CSPs

Introduction

Solar energy is derived via capturing heat and light from the sun. The energy derived from the Sun is referred to as solar energy. Innovation has provided diverse methods to utilise this abundant resource of interoperability. The energy derived from the Sun is referred to as solar energy. Innovation has provided multiple methods to utilise this abundant resource. It represents an environmentally sustainable invention as it does not emit ozone-depleting pollutants. Solar energy is abundantly available and has been utilised for an extended period as a source of electricity and heat.

Energy Production

Solar energy is generated from sunlight, either directly through photovoltaics or indirectly via concentrated solar power (CSP). In CSP systems, lenses or mirrors and tracking mechanisms are employed to concentrate a vast area of sunlight into a narrow beam. Solar power is projected to become the predominant energy source in the industry over the next 30 years. In the 1980s, solar power plants with a commercial emphasis were established. The Ivanpah Power Plant, with a capacity of 392 megawatts, located in California's Mojave Desert, is regarded as the largest power plant globally.

Photovoltaics

Photovoltaic (PV) technologies, generally referred to as solar panels, produce electricity by utilising devices that capture solar radiation and transform it into electrical energy via semiconducting materials. These devices, referred to as solar cells, are subsequently interconnected to create bigger power-generating units called panels. The transformation of light into electricity using semiconducting materials exhibiting the photovoltaic effect, a phenomenon studied in physics, photochemistry, and electrochemistry, is termed photovoltaics (PV). The photovoltaic effect is utilised commercially for energy generation and as photosensors. Power electronics are employed to regulate the energy system.

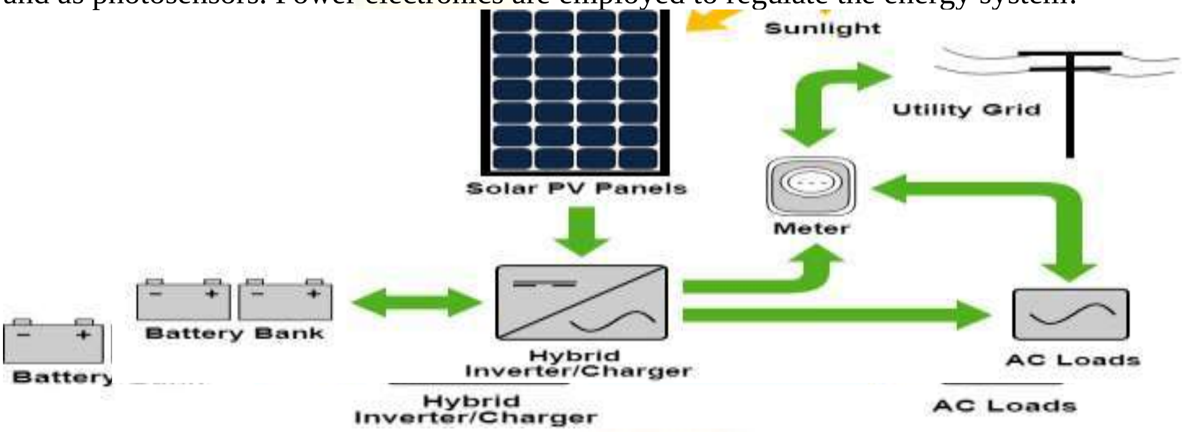

Fig. 1 Solar Energy Based System

INTERNATIONAL ADVANCE JOURNAL OF ENGINEERING, SCIENCE AND MANAGEMENT (IAJESM)
July-December 2023, Submitted in December 2023, iajesm2014@gmail.com, ISSN -2393-8048
Multidisciplinary Indexed/Peer Reviewed Journal. SJIF Impact Factor 2023 =6.753

Semi-Conductor With P-N Junction

The voltage in a solar mobile is produced by the photovoltaic effect. The aggregation of minimally formed partnerships at the p-n junction induces the migration of electrons towards the n side and holes towards the p-type side of the junction. Under rapid switching conditions, there is no price rise as suppliers emit the gadget as luminous flux.

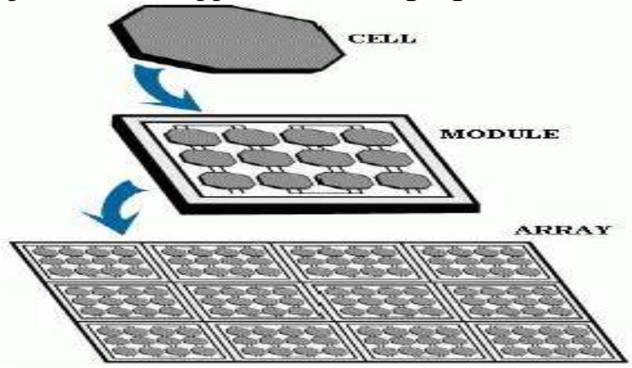

Fig. 2 Solar Pannel

An array can be formed by connecting many modules. In general, the greater a module or array's surface area, the more electricity it produces. Direct-current (dc) electricity is generated by photovoltaic modules and arrays. They can be coupled in both series and parallel electrical configurations to provide any voltage and current combination desired.

Concentrated Solar Power

CSP (concentrated solar power) is a technique for generating electricity using mirrors. Natural sunlight is reflected, concentrated, and focused on a certain point by the mirrors, which is then transformed into heat. The heat is subsequently con- verted to steam, which powers a turbine and generates electricity. Because CSP technology can store the heat produced, the process can be repeated indefinitely. It can thus be utilised on days when there is no sun, as well as before and after dawn and sunset.

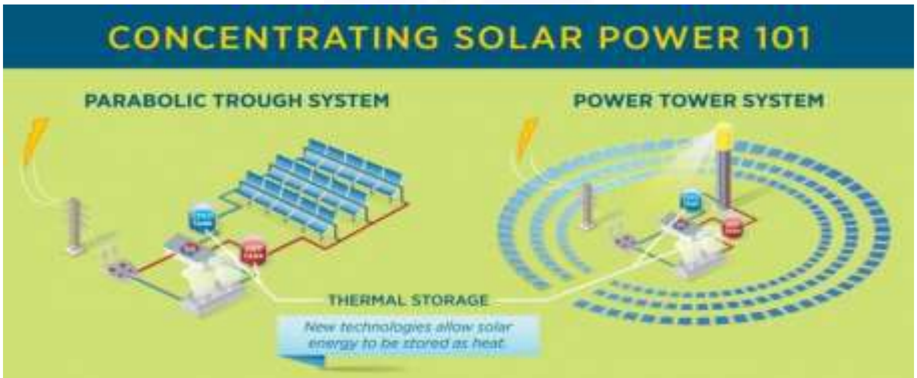

Fig. 3 Concentrating Solar Power

CSP systems operate by focussing solar energy onto a receiver that subsequently transforms it into heat. The heat is converted into steam, which drives a turbine that produces energy. Thermal energy storage systems can be utilised by CSP facilities to retain energy until required, particularly during intervals of diminished sunlight. Concentrated Solar Power (CSP) is a multifaceted renewable energy source due to its ability to store energy.

Hybrid power plants can be established by integrating CSP systems with alternative energy sources. CSP can be combined with thermal power facilities that utilise fuels such as coal, natural gas, and biofuel.

CSP technologies are classified into four groups:

i) Parabolic trough systems:

Solar energy is concentrated via curved, trough-shaped reflectors, which are focused onto a receiver pipe in a parabolic trough system. The pipe normally holds thermal oil, which is heated before being utilised in a steam generator's thermal power block to generate electricity.

INTERNATIONAL ADVANCE JOURNAL OF ENGINEERING, SCIENCE AND MANAGEMENT (IAJESM)
July-December 2023, Submitted in December 2023, iajesm2014@gmail.com, ISSN -2393-8048
Multidisciplinary Indexed/Peer Reviewed Journal. SJIF Impact Factor 2023 =6.753

ii) Power tower systems:

Heliostat mirrors track the sun and focus its energy onto a receiver at the top of a tower in these devices. Inside the receiver, a fluid (typically molten salts) is heated and utilised to generate steam, which drives a turbine generator.

iii) Linear fresnel systems:

There are many collectors arranged in rows. The flat mirrors on the ground reflect the sun onto the receiver pipe above. Fresnel can include storage in a power block or generate steam directly, similar to trough and tower systems.

iv) Parabolic dish systems:

A parabolic-shaped dish serves as a concentrator, reflecting solar energy onto a receiver installed on a structure with a sun-tracking system. A heat engine then generates the accumulated heat. The dish can reach extremely high temperatures, making the technology suitable for use in solar reactors.

Benefits of Using CSP

CSP offers a community a multitude of advantages. These systems produce no pollution during power generation as they utilise solar energy, a renewable resource. CSP systems can store energy in batteries that can be accessed on demand, enabling them to meet local power requirements more consistently, particularly during peak usage times.

CSP systems are economical to operate and generate high-efficiency energy. Engineers have recently identified that certain CSP technologies can be incorporated into fossil fuel power plants, thereby diminishing carbon emissions and enhancing efficiency in the utilisation of both fuel types. Concentrating solar power possesses significant potential to revolutionise the global energy sector, and as the technology advances, its use will increase.

Efficiency of Solar Cells

Efficiency of a system is estimated from its energy of output to its energy of input. This is the ratio of usable electrical energy produced by solar photovoltaic cells to the amount of solar energy incident on the cell under controlled testing conditions. Few experimental solar cells have achieved efficiencies of around 50%, most commercial solar cells have efficiencies of less than 30%. The "band gap energy" is responsible for limiting the efficiency of solar cells, unlike the Carnot efficiency, which limits the thermal efficiency of heat engines.

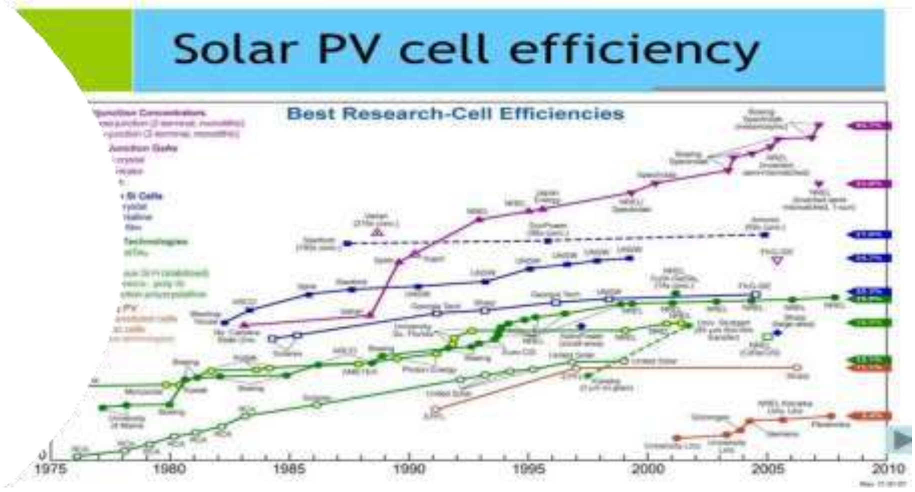

Fig. 4 Solar PV Cell Efficiency

Solar cell's efficiency is determined as the fraction of incident power. It is then converted to electricity and is given by:

$P_{max} = V_{OC} I_{SC} FF$

Where:

Voc = open-circuit voltage; Isc = short-circuit current;

FF = fill factor and

η = efficiency

Role of Semiconductors In Solar Energy

$$\eta = \frac{V_{oc} I_{sc} FF}{P_{in}}$$

P-kind and n-kind silicon are the 2 varieties of semiconductors utilized in sun cells. P-kind silicon is made with the aid of using blending with atoms with one much less electron of their outer electricity degree than silicon, inclusive of boron or gallium. A hole is generated due to the fact boron has one much less electron than is needed to shape bonds with the encircling silicon atoms.

PV cells are made of a lot of semiconductor materials. When a semiconductor is uncovered to light, it absorbs the electricity and transfers it to electrons, which can be negatively charged debris withinside the material. This extended electricity lets in electrons to go with the drift as an electrical present day thru the material. This energy is retrieved through conductive metallic contacts (the grid-like traces on sun cells) and utilised to strength your private home and the relaxation of the elec- trical grid.

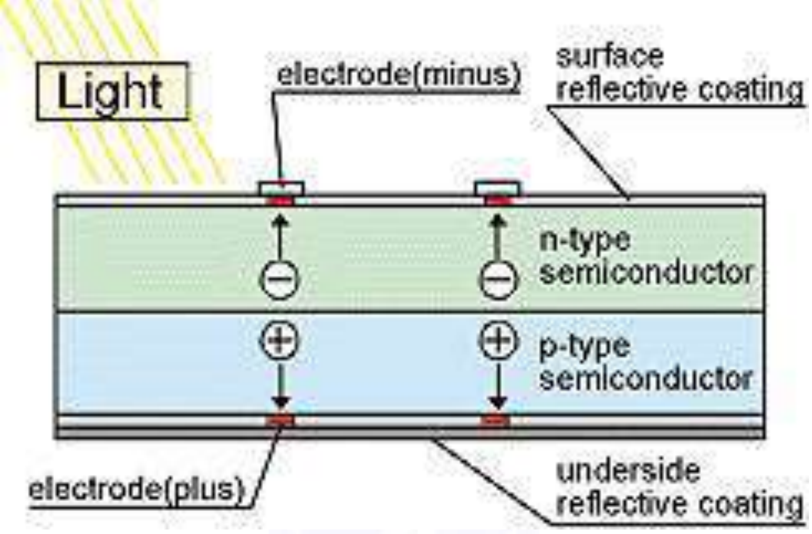

Fig. 5 Semiconductor Based PV Cell

Conclusion

Solar strength is a tremendous supply of without delay useable power and ultimately creates different strength sources: biomass, wind, hydro-power and wave electricity.

Use of sun power is the best renewable means able to in the long run supplanting modern-day worldwide power deliver from non-renewable assets, but on the fee of a land place of as a minimum half of one million km^2.

References

1. M. R. Patel and O. Beik, *Wind and solar power systems: Design, analysis, and operation*, 3rd Edition. Boca Raton, FL: CRC Press, 2021.
2. S. P. Sukhatme and J. K. Nayak, *Solar Energy*. McGraw-Hill Education, 2017.
3. P. Onu and C. Mbohwa, "Advances in solar photovoltaic grid parity," in *2019 7th International Renewable and Sustainable Energy Conference (IRSEC)*, 2019, pp. 1–6.
4. Roadmap for a Renewable Energy Future. [Online]. Available: http://www.irena.org/documentdownloads/publications/irena_remap_2016_edition_report.pdf. [Accessed: 09-Sep-2018].
5. J. Mohtasham, "Review article-renewable energies," *Energy Procedia*, vol. 74, pp. 1289–1297, 2015.
6. T. T. D. Tran and A. D. Smith, "fEvaluation of renewable energy technologies and their potential for technical integration and cost-effective use within the U.S. energy sector," *Renew. Sustain. Energy Rev.*, vol. 80, pp. 1372–1388, 2017.
7. M. A. Islam, M. Hasanuzzaman, N. A. Rahim, A. Nahar, and M. Hosenuzzaman, "Global renewable energy-based electricity generation and smart grid system for energy security," *Scientific WorldJournal*, vol. 2014, p. 197136, 2014.

8. D. N. Nkwetta, M. Smyth, A. Zacharopoulos, and T. Hyde, "Optical evaluation and analysis of an internal low-concentrated evacuated tube heat pipe solar collector for powering solar air-conditioning systems," *Renew. Energy*, vol. 39, no. 1, pp. 65–70, 2012.
9. F. R. Pazheri, M. F. Othman, and N. H. Malik, "A review on global renewable electricity scenario," *Renew. Sustain. Energy Rev.*, vol. 31, pp. 835–845, 2014.
10. S. Abolhosseini, A. Heshmati, and J. Altmann, "A review of renewable energy supply and energy efficiency technologies," *SSRN Elec- tron. J.*, 2014.
11. N. R. Alfonso, J. R. Salazar, J. J. Monserate, and M. M. Sarong, "Potential for photovoltaic cell material by green synthesis of silicon carbide from corn cob through magnesiothermic reduction," *Int. j. energy prod. manag.*, vol. 5, no. 1, pp. 14–23, 2020.
12. H. Heidari, M. Arabi, T. Warziniack, and S.-C. Kao, "Assessing shifts in regional hydroclimatic conditions of U.s. river basins in response to climate change over the 21st century," *Earths Future*, vol. 8, no. 10, 2020.