

# Satellite Solar Power System: A Future Renewable Energy Solution

Chaitali Dhaygude<sup>1</sup>, Bhakti Ganapa<sup>2</sup>

<sup>1</sup> Electrical Engineering Department, Shri Siddheshwar Women's Polytechnic, Solapur

<sup>2</sup> Electrical Engineering Department, Shri Siddheshwar Women's Polytechnic, Solapur

\*\*\*

**Abstract** - The increasing global demand for electricity and the environmental impact of fossil fuels have encouraged the development of renewable energy technologies. One promising concept is the Satellite Solar Power System (SSPS), which collects solar energy in space and transmits it to Earth. Unlike terrestrial solar systems, satellites receive continuous sunlight without atmospheric interference, resulting in higher efficiency and uninterrupted power generation. The captured solar energy is converted into microwave or laser energy and transmitted wirelessly to Earth, where it is received by rectifying antennas and converted into electrical power. This paper explains the concept, components, working principle, advantages, limitations, and future prospects of satellite solar power systems. The study highlights how SSPS can contribute to sustainable energy production and support future global energy requirements.

**Key Words:** Satellite solar power, space-based solar energy, wireless power transmission, rectenna, renewable energy.

## 1. INTRODUCTION

Energy plays a vital role in the development of modern society. Rapid industrial growth and increasing population have led to a significant rise in global energy demand. Conventional energy sources such as coal, oil, and natural gas are limited and contribute to environmental pollution and climate change. Therefore, the development of clean and renewable energy sources has become essential for sustainable development.

Solar energy is one of the most abundant and widely available renewable energy resources. However, ground-based solar power systems have certain limitations. Their performance depends on weather conditions, atmospheric absorption, and the day-night cycle, which reduces the overall efficiency of energy generation.

Satellite Solar Power System (SSPS) is an advanced concept that collects solar energy directly in space using satellites and transmits it to Earth through wireless power transmission. Since satellites operate above the Earth's atmosphere, they receive stronger and more consistent

sunlight compared to solar panels installed on Earth. The concept of space-based solar power was first proposed by Peter Glaser in 1968. Since then, scientists and researchers have explored the potential of using satellites to generate electricity in space and deliver it to Earth. Satellite solar power systems are considered a promising solution for meeting future energy demands while reducing environmental impact.

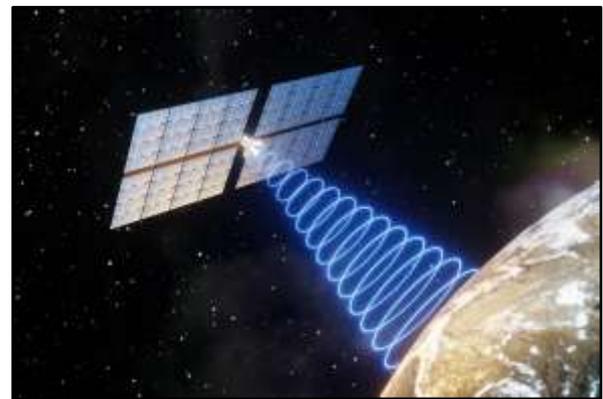


Figure -1

## 2. LITERATURE REVIEW

Several researchers and space agencies have conducted studies on the development of satellite solar power systems. Early research focused on the feasibility of collecting solar energy in space and transmitting it to Earth using wireless power transmission techniques.

Studies conducted by NASA analyzed different designs of solar power satellites, including large photovoltaic arrays and microwave transmission systems. These studies suggested that space-based solar power could provide continuous and reliable energy compared to conventional solar systems.

Research by the Japan Aerospace Exploration Agency focused on microwave power transmission technology and the development of efficient rectenna systems. Their experiments demonstrated that microwave energy could be transmitted over long distances and safely converted into electrical energy on Earth.

Recent research efforts are aimed at improving solar panel efficiency, reducing the cost of launching satellites, and developing lightweight space structures. Researchers

are also exploring advanced wireless transmission methods to increase the efficiency of power transfer from space to Earth. These developments indicate that satellite solar power systems have significant potential to become a sustainable energy source in the future.

### 3. Body of Paper

#### 3.1 Components of Satellite Solar Power System

A satellite solar power system consists of several major components that enable the generation and transmission of energy from space to Earth.

- Solar Panels:

Solar panels installed on satellites capture sunlight and convert it into electrical energy using photovoltaic cells. Since the satellite operates in space, it receives high-intensity solar radiation without atmospheric losses.

- Power Conversion System:

The electrical energy generated by solar panels is converted into microwave or laser energy using specialized converters. This conversion allows wireless transmission of energy over long distances.

- Transmission Antenna:

A large transmitting antenna mounted on the satellite directs the microwave or laser beam toward Earth. The antenna ensures accurate and efficient transmission of energy to the ground station.

- Rectenna:

A rectenna is a receiving antenna located on Earth. It receives microwave energy from the satellite and converts it into electrical energy that can be supplied to the power grid.

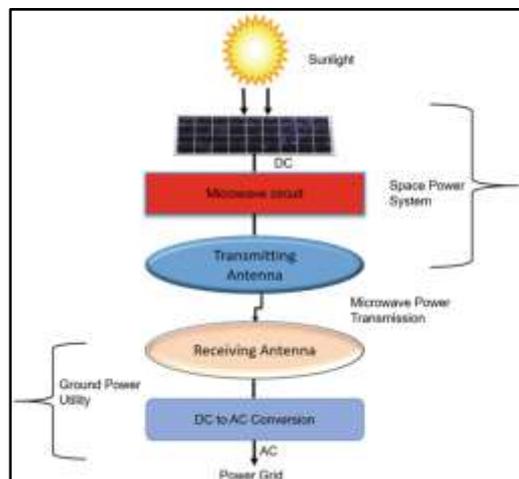


Figure-2

### 3.2 Working Principle

The Satellite Solar Power System works by collecting solar energy in space and transmitting it to Earth. Large photovoltaic solar panels mounted on the satellite capture sunlight continuously because they operate above the Earth's atmosphere. These panels convert solar radiation into electrical energy. The generated electrical power is then converted into microwave or laser energy using a power conversion system. This energy is transmitted wirelessly from the satellite to a receiving station on Earth through a transmitting antenna. A rectifying antenna, known as a rectenna, receives the microwave energy and converts it back into electrical power, which is then supplied to the power grid.

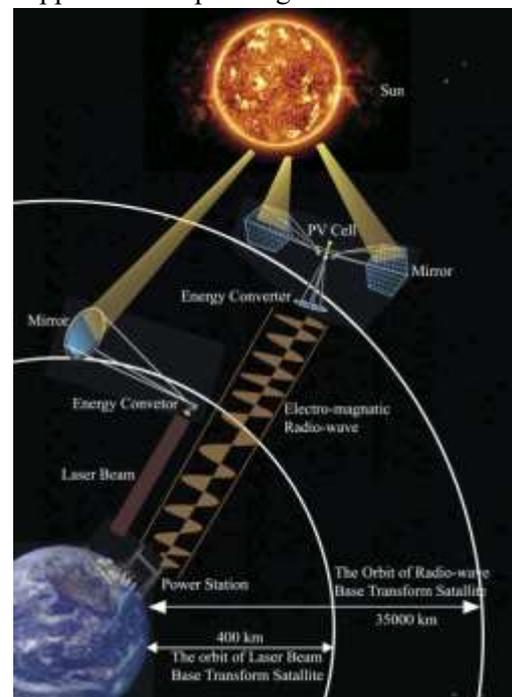


Figure - 3

### 4. FUTURE SCOPE

Satellite Solar Power Systems have significant potential for future energy generation. Continuous advancements in space technology, wireless power transmission, and photovoltaic materials are expected to improve the efficiency and reliability of these systems. Several countries including Japan, the United States, and China are actively researching space-based solar power technologies. Future developments such as reusable launch vehicles, lightweight satellite structures, and advanced microwave transmission systems may significantly reduce the cost of deploying solar power satellites. Satellite solar power systems may also play an important role in providing electricity to remote areas,

supporting smart grid systems, and supplying emergency power during natural disasters.

## 5. CONCLUSIONS

Satellite Solar Power System is an innovative and sustainable technology that can provide continuous and clean electricity by utilizing solar energy in space. Unlike conventional solar power systems, satellite solar power is not affected by atmospheric conditions or the day-night cycle. Although the technology faces challenges such as high initial cost and complex infrastructure, ongoing research and technological advancements may overcome these limitations in the future. Satellite solar power has the potential to become an important renewable energy source for meeting global energy demands.

## 6. ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the Electrical Engineering Department of Shri Siddheshwar Women's Polytechnic, Solapur for providing guidance and support during the preparation of this research paper.

## 7. REFERENCE

1. Peter E. Glaser, "Power from the Sun: Its Future," IEEE Spectrum, Vol. 5, No. 9, pp. 86–93, 1968.
2. John C. Mankins, The Case for Space Solar Power, Virginia Edition Publishing Company, 2014.
3. Mukund R. Patel, Wind and Solar Power Systems: Design, Analysis and Operation, CRC Press, 2006.
4. S. P. Sukhatme and J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill Education, 2008.
5. G. D. Rai, Solar Energy Utilization, Khanna Publishers, New Delhi, 2017.
6. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, Wiley-IEEE Press, 2011.
7. Hassan Bevrani, Renewable Energy Systems: Modeling, Control and Optimization, Springer, 2014.
8. S. Sasaki, "Microwave Power Transmission Technologies for Solar Power Satellites," Research Report, Japan Aerospace Exploration Agency, 2010.