

### Space-Based Solar Power (SBSP)

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#### Abstract

AS we know solar power is one of the main types of renewable energy source, which is going to use in very wide manner in the whole world. But at the earth surface only 5-10% solar radiation are reaching as compare to solar radiation in space. This article is all about on another future technology Space-Based Solar Power. Talking about solar system, it's the best source of power generation because solar energy is present in bulk amount and will long for decades. The power generated using solar energy is alone sufficient to fulfill whole world's power crisis. Space-based solar power deals with the generation of solar energy in space and transmitting it on earth's surface and deriving useful from it. The plus factor with SBSP is that solar energy is available in space; no matter whatever the weather conditions or any other factors. Apart from that the power generated from SBSP can be collected and made useful on any part of earth.

**Keywords:** Solar Power, Solar Panel, Solar cell, Energy, Space.

#### 1. Introduction

Imagine a day when suddenly crisis of power occurs? With ever increasing global population, consumption of energy is on the hike. To fulfill everyone's need, world can't rely on remaining resources. It's the time to switch over a reliable and constant source of energy. In recent researches a new way to utilize solar energy has been discovered, the method is well known by "Space-Based Solar Panel". Again another futuristic word which sounds weird but the best power generation source with a long life span. In that black world, what we humans call it space contains uninterrupted solar energy in form of light and heat. So it makes it easy for solar satellites to get maximum amount of solar energy and is then concentrated towards surface of earth. This new concept can change the upcoming future problems of power consumption and generation. Let's move on our next topic.

#### Necessity

With the speed at which our resources are getting consumed, the time is not far enough when electricity charges are going to be as high as current price of gold. Now ,looking at some of earth's non-conventional sources because conventional sources now or after sometime will going to be just history and will be read in books only. Non-conventional sources of energy are considered best alternatives as they are environment friendly but their power generation is not sufficient to fulfill everyone needs.

#### 2. Reclassification Procedure in India

Let's consider solar energy, scientists have managed to convert energy coming from sun for human needs. The drawbacks which came up with solar energy generation are:

- Sunlight is not present every time. Nights and days are natural phenomena.
- Earth is entirely covered with numerous types of gases which reduce intensity of sunlight reaching on Earth's surface. Thus, generation of energy is reduced.
- Also power generated is not sufficient to fulfill everyone's demand.

What if the solar panels can send out in space so that maximum utilization of solar energy can be done? Scientists gave a thought upon that and came with a solution, 'Space-Based Solar Power'. Now let's jump to brief history of 'Space-Based Solar Power'(SBSP).

## History

The story started in 1941, with a science fiction writer "Isaac Asimov" with a story "Reason" showing a space station which transmits energy from the sun to different planets using the concept of microwave beams. Dr. Peter Glaser gave up an idea of transmitting power over large distances by using microwave from a very large antenna built on a satellite to a much larger one, now known by 'Rectenna' on the ground. He introduced the concept of large power solar satellite system for collection and conversion of sun solar energy into electromagnetic microwave beam to transmit that energy to receiving antenna. Now let's have closer look at concepts and model of Spaced-Based Solar Power.

## Theory

Space-Based Solar Panel (SBSP) is essentially built up of three main components-

- Accumulating Sunlight onto solar cells.
- Wireless power transmission to Earth.
- Receiving power through rectenna.

Before moving to detailed discussion of SBSP concept, let's have a overview of block diagram of SBSP system-

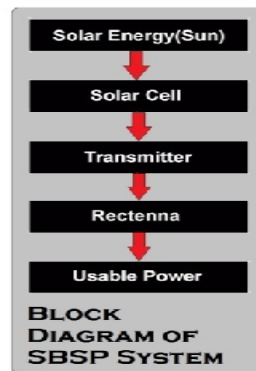


Figure 1: Block diagram of SBSP System

### 3. Solar Energy Conversion

SBSP works on the same principle of solar panels. Primarily solar cells convert solar energy to electrical energy directly. This method is known as photovoltaic conversion (Usually termed as solar cells). This method uses semiconductor (as Silicon Arsenide) cells which convert photons into electrical energy through quantum physics. Using solar has much more benefits and are much less expensive and generally lighter. Also, they don't require much space. They do not require the structural support as required for terrestrial use.



Figure 2: Solar Energy Generation in Space

### 4. D.C to Microwave Power

Now what we draw from solar cells is D.C power which cannot be transmitted directly. To convert the DC power to microwave for the transmission through antenna towards the earth's receiving antenna, microwave oscillators like

Klystrons, Magnetrons can be used. In transmission, an alternating current is generated in the elements by applying a voltage at the antenna terminals, leading elements to emit electromagnetic fields. In order to perform wireless transmission D.C power needs to be converted in microwave power at transmitting end by taking using microwave open magnetron. The Rayleigh criterion states that any radio wave, laser or microwave will get dispersed and become weaker over distance. The larger the transmitter antenna or laser aperture compared to the wavelength of radiation, the tighter the beam and the less it will spread as a function of distance or vice-versa. Microwave power beaming can prove more efficient than lasers, and is less affected by atmospheric conditions which are caused due to dust particles or water vapor losing atmosphere to vaporize the water in contact.

### Transmission

Power transmission through radio waves can be made more directional, allowing faraway distance power beaming, with briefer wavelengths of electromagnetic radiation usually in the microwave range. Concentrating power using microwaves has been proposed for the transmission of energy from orbiting solar power satellites to Earth. The concentrated microwave is extensively diffusive in nature causing the larger area of the receiving antenna as compared to transmission end. Although the use of microwave for transmission is considered attractive, most part of the microwaves receives powerful obstruction due to atmosphere. Wireless Power Transmission (using microwaves) has been proved well. This technology in distant future can prove profitable leading in removal of high tension power lines and reducing the risk of humans getting caught by HT lines during rainy seasons.

### Ground Segment Reception

For the microwave power transmitted from space, a receiver needs to be installed on earth's surface with much larger area than transmitting antenna, often used by term "Rectenna". A single rectenna supplies just a few watts of power, while the total power received is in Giga watts (GW) .That why we need to install a no. of rectenna for large amount of power generation. The word 'Rectenna' is combination of 'rectifying circuit' and 'antenna'. Rectenna is a passive element with a rectifying diode, and is operated without any extra power source. It contains a low-pass filter between the antenna and the rectifying diode to suppress re-radiation of higher harmonies. It also has an output smoothing filter. The antenna receives the microwaves and rectifying circuit converts it into D.C power with conversion efficiency of more than 95% practically proven. The receiver antenna (or rectenna) is most critical part of the Solar Power System (SPS) concept. Rectenna needs a wide area of kilometers for installation. Confused, let's get things more understandable with a simple diagram.

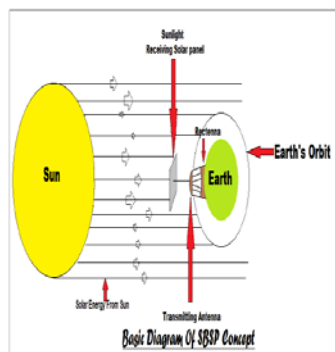


Figure 3: Basic diagram of SBSP concept

### Highlights

The SBSP concept is attractive because space has several major advantages over the Earth's surface for the collection of solar power. There is no air in space, so the collecting surfaces would receive much more intense sunlight, no worry about weather conditions. In geostationary orbit, an SPS would be illuminated for maximum period of the time. The Solar power satellite would be in Earth's shadow only a few days at spring seasons and fall equinoxes and during eclipses; and even then for a maximum of 70-75 minutes late at night when power demands are at their lowest. These characteristics of SBSP would avoid the expense of store of facilities necessary in many Earth-based power generation systems.

## 5. Future Scope

With unstoppable increase in global population, demand for energy is continuously increasing and will continue until global extinction of earth is done. With the remaining fossil-fuel, energy demands can be fulfilled for 3-4 decades only. However space-based solar power could prove better alternative than any other, either conventional or non-conventional source of energy. It has been predicted that by 2030, the world needs 30TW power from renewable energy sources and solar energy alone has the capability of producing around 600TW which is 20times what will be generated at that time. Unlike terrestrial solar and wind power plants, space solar power is available 24\*7 in much larger quantity as compared to Earth's surface. It works regardless of cloud cover, daylight, or wind speed. Apart from that switching to SBSP, it will help to reduce the emission of toxic and harmful gases in atmosphere. Thus reducing the effect of worldwide issue of Global warming. Space Solar power can completely solve our energy problems long term. The sooner we work, the shorter "Long term" will be.

**Fact:** Solar chimneys are passive solar ventilation systems. Shafts connect the interior and exterior of the building. The functioning can be improved by glazing and using thermal mass materials.

## 6. Conclusion

After studying the operation and application of solar energy generation on space we concluded that solar radiation playing a very vital role in Space science. Without using the solar radiation by space equipments, their life will be very short and depends only on the charged battery which is send from the earth surface during launching. So no fuel is required in space to operate the all equipments available in space. The amount and intensity of solar radiation is much high on space as compare to earth surface.

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