SPACE SOLAR POWER

Abstract:

Space solar power is a concept which involves building solar collection stations that would literally tap into nature's fusion reactor, the Sun, and transmit that energy to Earth. The energy thus collected is limitless and pollution less

The space around Earth is filled with intense sunlight, undiffused by atmosphere continuously. It represents an inexhaustible supply of energy that can be converted to electricity using semiconductors - that is without the use of any moving parts.

A small fraction of this energy could supply a large part of the world's future energy requirements for the foreseeable future. In addition, it could do it without the need for any kind of fuel, and without producing any waste product.

All that's needed is large-area collectors - and that means *large*, thousands of square kilometers - and a way to transmit the collected power down to Earth. Several different methods are possible, but the one that has received the most effort so far is the use of microwave beams or wireless power transmission.

Key Words: *Reactor , semiconductors,microwavebeams,wireless*

Conclusion: Non-Conventional Energy tapping is a greater job. This may be achieved in many ways. Among the wind and tidal, Solar is abundant. An attempt to harness solar power a system may be implemented by the concept of Space Solar Power.

Introduction:

Humans are going to need enormous amounts of electric power in coming decades. Within 50 years the world population is expected to double, while economic growth will continue around the world, especially in the poorer countries. But existing energy sources already face serious problems. They're limited; they're polluting; they're dangerous. And so we believe that new large-scale possibilities should be studied further. Thus there is a need to study about solar space power.

Sun: The big fusion reactor

It is presently believed that the bulk of the energy released in the Sun comes from the fusion of protons. The power in the Sun, about 4×10^{26} Watts, is produced by the burning of ~ 4,000 tonnes of material every second

A Limitless Source Of Energy :

The solar energy that reaches the Earth is about 10,000 times total human energy production today and the energy available in near-Earth space is limitless. Research is being done on many different ways of using solar power economically on Earth, and many of these will be successful. Terrestrial solar energy is going to become a colossal business. However, sunlight is diffuse and not available continuously at the Earth's surface. So one additional possibility is to collect solar energy 24 hours per day in space, and transmit it as microwave beams to receivers on Earth.

Main Requirements:

The main requirements for a proposed space solar power system are mainly

1. Solar Power Satellite (sps)
2. Microwavebeams or wireless power transmission
3. Rectenna

Space solar power systems utilize well-known physical principles -- namely, the conversion of sunlight to electricity by means of photovoltaic cells, Giant structures consisting of row after row of photovoltaic (PV) arrays could be placed either in a geostationary Earth orbit or on the Moon. A complete system would collect solar energy in space, convert it to microwaves, and transmit the microwave radiation to Earth where it would be captured by a ground antenna and transformed to usable electricity.

Photovoltaic arrays in a geostationary Earth orbit (at an altitude of 22,300 miles) would receive, on average, eight times as much sunlight as they would on Earth's surface. Such arrays would be unaffected by cloud cover, atmospheric dust or by the Earth's day-night cycle.

The above described is a solar power satellite which stores the solar energy. . The advantage to placing the solar collectors in space is the unobstructed view of the Sun, unaffected by the day/night cycle, weather, or seasons.

Then comes the principle of microwave power transmission

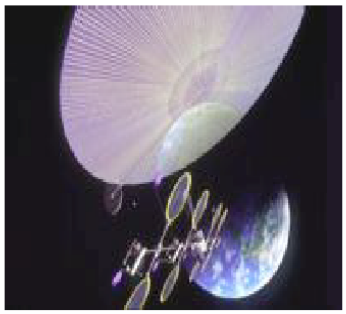
Microwave power transmission (**MPT**) is the use of microwaves to transmit power through outer space or the atmosphere without the need for wires.

Most proposed MPT systems now usually include a phased array microwave transmitter. While these have lower efficiency levels they have the advantage of being electrically steered using no moving parts, and are easier to scale to the necessary levels that a practical MPT system requires**.** The microwave radiation is then beamed down to the earth and is collected by an antenna called a **rectenna.**

A **rectenna** is a rectifying antenna, a special type of antenna that is used to directly convert microwave energy into DC electricity. Its elements are usually arranged in a mesh pattern, giving it a distinct appearance from most antenna.

How Does This Work:

Concept Of Solar Power Satellite (Sps)



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The SPS essentially consists of three parts:

1. a huge solar collector, typically made up of solar cells
2. a microwave antenna on the satellite, aimed at Earth
3. an antenna occupying a large area on Earth to collect the power

The solar power satellite fits into an asteroidal and lunar materials utilization scenario very well -- it is composed of materials most abundant in asteroids near Earth and/or from the Moon, and it is made up of a small variety of simple parts mass produced in large quantity. The industry required in space to produce SPS components is relatively modest. Some design studies claim that more than 99% of an SPS can be made from asteroidal and/or lunar material.

The SPS structure could be made from asteroidal nickel-iron steel or steel-reinforced lunarcrete or astercrete using cheap glass-ceramics or fiberglass composites. The waveguides could be made of glass ceramics. The vacuum tubes to generate the beam could be largely steel in terms of weight, with the small electrodes perhaps imported from Earth depending on the level of effort we put into processing the different kinds of asteroidal materials

The Solar Power Satellite (SPS) concept would place solar power plants in orbit above Earth, where they would convert sunlight to electricity and beam the power to ground-based receiving stations. The ground-based stations would be connected to today's regular electrical power lines that run to our homes, offices and factories here on Earth.

The satellites would be placed in so-called "geostationary" or "Earth synchronous" orbit, a 24-hour orbit which is thus synchronized with Earth's rotation, so that satellites placed there will stay stationary overhead from each' receiving antenna. Geostationary orbit is very high, 36,000 km (22,500 miles) above the surface of the Earth. It is far above the range of the Space Shuttle, which has a maximum range of about 1000 km (600 miles) above Earth's surface.

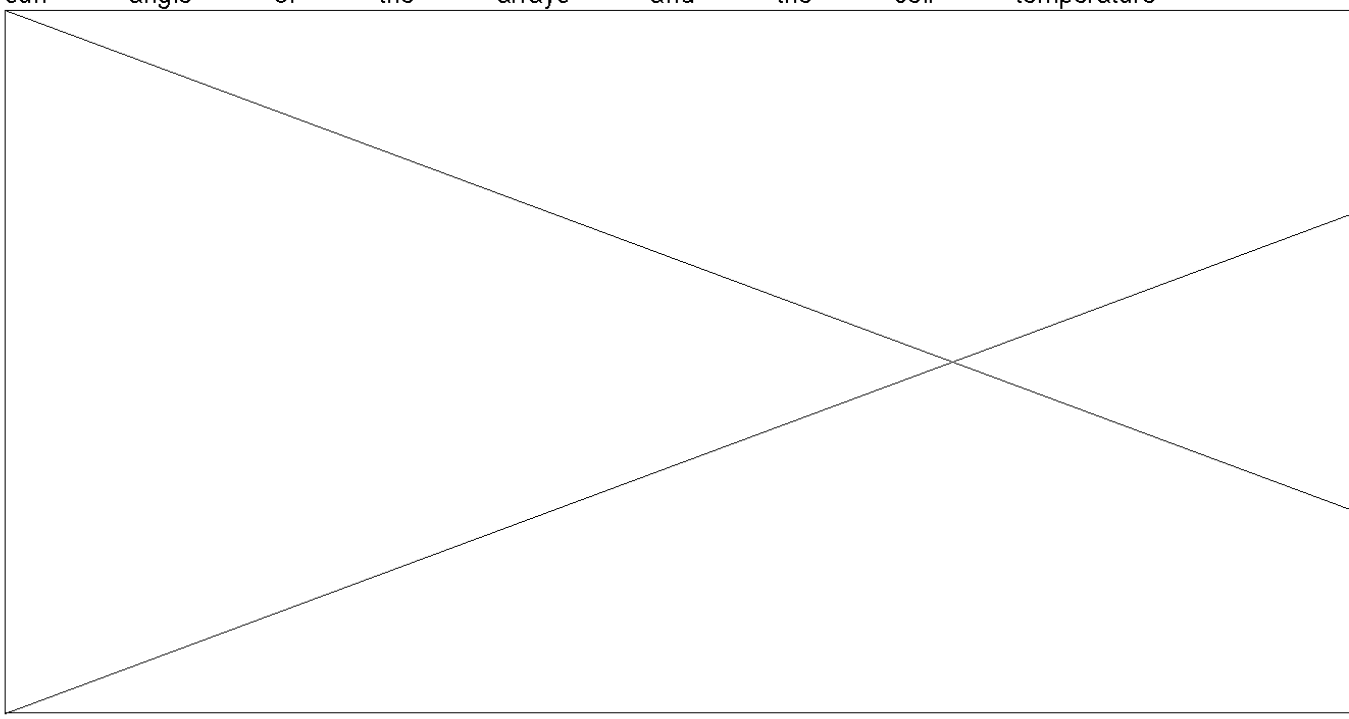
The SPS concept arose because space has several major advantages over earth for the collection of solar power. There is no air in space, so the satellites would receive somewhat more intense sunlight, unaffected by weather. In a geo synchronous orbit an SPS would be illuminated over 99% of the time. The SPS would be in Earth's shadow on only a few days at the spring and even then for a maximum of an hour and a half late at night when power demands are at their lowest. This allows expensive storage facilities necessary to earth-based system to be avoided

The solar cells produce electricity from sunlight with no moving parts. The only moving part on the satellite is the transmitter antenna(s) which slowly tracks the ground-based rectenna(s) while the solar cell array keeps facing the sun. Each transmitter antenna is connected to the solar cell array by two rotary joints with slip rings. The transmitter on the SPS is an array of radio tubes (klystrons), waveguides, and heat radiators. They convert the electricity from the SPS solar cell power plant into a radio or microwave beam

The SPS would be in Earth's shadow on only a few days at the spring and fall equinoxes; and even then for a maximum of an hour and a half late at night when power demands are at their lowest.

The transmitter on the SPS is an array of radio tubes (klystrons), waveguides, and heat radiators. They convert the electricity from the SPS solar cell power plant into a radio or microwave beam. A space solar array must be extremely reliable in the adverse conditions of space environment. Since it is very expensive to lift every kilogram of weight into the orbit, the space array should also have a

high power-to-weight ratio Power generation of SPS changes with the local time, depending on the sun angle of the arrays and the cell temperature



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Microwave Power Transmission (Mpt):

Solar-generated, DC power would be converted to microwaves and transmitted through space as electronically steerable microwave beams. Called "wireless power transmission" (WPT)), these beams would be captured by receivers (covering several square miles) in remote areas on Earth and converted back into DC power for terrestrial electrical grids. According to the SunSat Energy Council, a non profit organization affiliated with the United Nations, the beam would be so low in density that it wouldn't even feel warm if you happened to walk through it.

In 1990s, Japan research flew a small airplane powered by microwaves beamed up from the ground. Indeed, because the island nation has no energy resources of its own, Japanese officials have announced plans to have their first solar power satellite in operation by the year 2040.

Microwave power transmission (**MPT**) is the use of micro waves to transmit power through outer space or the atmosphere without the need for wires. Following world war, 2 which saw the development of high-power microwave emitters known as magnetrons, the idea of using microwaves to transmit power was researched

Most proposed MPT systems now usually include a phased array microwave transmitter. While these have lower efficiency levels they have the advantage of being electrically steered using no moving parts, and are easier to scale to the necessary levels that a practical MPT system requires

Microwaves are electromagnetic waves with wave lengths longer than those of terahertz (THz) wavelengths, but relatively short for radio waves. Microwaves have wavelengths approximately in the range of 30 cm (frequency = 1 GHz) to 1 mm (300 GHz). However, the boundaries between far infrared light, terahertz radiation, microwaves, and ultra-high-frequency radio waves are fairly arbitrary and are used variously between different fields of study.

The term microwave generally refers to "alternating current signals with frequencies between 300 MHz (3 Ã— 10^8 Hz) and 300 GHz (3 Ã— 10^{11} Hz)." This range of wavelengths has led many to question the naming convention used for microwaves. Above 300 GHz, the absorption of

electromagnetic radiation by Earth's atmosphere is so great that it is effectively opaque, until the atmosphere becomes transparent again in the so-called infrared and optical window frequency ranges.

Microwaves can be generated by a variety of means, generally divided into two categories: solid state devices and vacuum-tube based devices. Solid state microwave devices are based on semiconductors such as silicon or gallium arsenide, and include field-effect transistors (FETs), bipolar junction transistors (BJTs), Gunn diodes.Microwaves can be generated and processed using integrated circuits, which are often called MMIC (Monolithic Microwave Integrated Circuits). They are usually manufactured using gallium arsenide (GaAs) wafers, though silicon germanium (SiGe) and heavy-dope silicon are increasingly used

These microwaves are sent to the earth and are again collected by the rectenna.

The main uses of micro waves in solar space power are

1. MPT is the most commonly proposed method for transferring energy to the surface of the Earth from solar power satellites or other in-orbit power sources.
2. MPT is occasionally proposed for the power source in beamed energy orbital space ships. Although lasers are more commonly proposed, their low efficiently in light generation and reception has led some designers to opt for a microwave based systems. Although microwave are more easily scaled to high powers and suffer from less atmospheric distortion, the engineering hurdles in building a man capable craft to reach orbit involving the beaming of megawatts of power have prevented the realization of such plans.
3. With large solar arrays that would beam power down to the Earth's surface via microwaves. With technology developing scientists are now trying out Lasers for the transmission of energy from space **Lasers** are also under consideration for beaming the energy from space. Using lasers would eliminate most of the problems associated with microwave but under a current treaty with Russia, the U.S. is prohibited from beaming high-power lasers from outer space

Safety Of The Microwave Transmission:

The most controversial aspect of the space solar power station scheme comes from concern for the safety of people and animals which happen to find themselves underneath the microwave transmission. Ninety five percent of the energy of the microwave transmission would be absorbed by the rectenna, the remainder of which is well below what is considered safe for living beings. People in airplanes flying through a microwave transmission would be protected by the metal skin of the aircraft. Experiments in exposing animals to microwaves have shown no harm over several generations. Research is still ongoing

Rectenna:

. A rectenna is a rectifying antenna, a special type of antenna that is used to directly convert microwave energy into DC electricity. Its elements are usually arranged in a mesh pattern, giving it a distinct appearance from most antennae

The ground-based rectenna consists of an array of antennas and standard electronics to convert the energy into regular AC electricity which can then be supplied into today's power lines

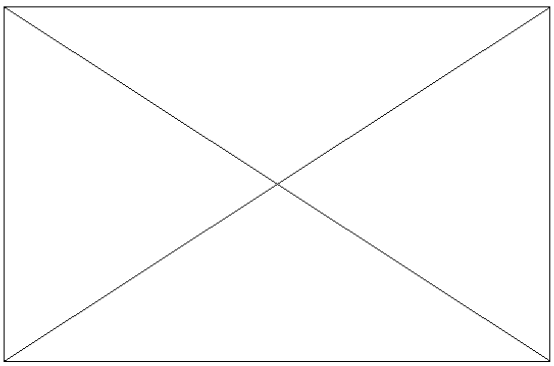
In the design of the ground segment the major issues include selecting a rectenna site and deciding the size of the rectenna; selecting the most appropriate designs for the microwave reception sub-system and the rectenna structure; calculating the actual amount of energy that will be received; estimating the most attractive 24-hour pattern of electricity supply for potential users in the neighboring district; calculating the appropriate size for the electricity storage system and the amount of electric energy that will be available for use; planning the electricity distribution network and its operation; and estimating the overall cost of the ground segment. In the mechanical design of the rectenna, practical engineering problems such as birds nesting on the rectenna, cattle

rubbing against the support structure, or heavy rain causing electrical short-circuits are also important.

Selection Of A Rectenna Site:-

Solar energy in space near the Earth has an intensity of about 1.4 kW per square meter. Near the equator on Earth it's about 1 kW/sqm at mid-day, and at higher latitudes it's typically about 500 W/sqm. So to collect large amounts of energy you need large areas of solar cells. For example, a million kW, one Gigawatt (GW), which is enough for about 1 million people at the rich countries' level of consumption, would need about 1 square kilometer of desert near the equator at mid-day if the efficiency was 100%.Hence it is important to construct a rectenna in a place which is near to the equator

Mini-Rectenna Corner :



14 cm x 14 cm mini-rectenna

This photograph shows a "mini-rectenna" made in the Space Energy Engineering Laboratory at ISAS. This comprises two 12.5 cm dipoles connected to a suitable diode, and a 1.8 mW LED. When held in front of the closed door of an operating microwave oven, the LED lights up - demonstrating wireless power transmission. That is, the small amount of microwave power leaking through the door is absorbed by the dipoles, rectified by the diode and the DC current drives the LED. This is an excellent, simple way of demonstrating WPT, and of explaining the concept of SPS. It is also very cheap to make! The diode costs 20 yen, the LED costs 100 yen, and the rest is just wire and plastic. Note that this design uses a reflecting panel made of ordinary wire mesh behind the dipoles, which increases the proportion of microwaves that are absorbed.

This is how a rectenna works and efforts are in for the study and installation of the rectenna in the countries that are close to equator. But once the work on solar space power clicks then it is a great achievement for the field of science

Advantages Of Space Solar Power:

1. Space solar power does not require fuel for it to operate, unlike virtually every other form of energy production, including oil, coal, natural gas, and even nuclear and fusion
2. Space solar power does not create air or water pollution nor does it create radioactive byproducts. Once the cost of building a space solar power station is completed, the only expense is maintenance which can be amortized over a long life cycle, lasting two or even more decades.
3. There exists some economic analysis that suggests that space solar power would be competitive with other, more conventional forms of energy, even leaving out the intangible

pollution and health costs associated with, for example, oil and coal. Space solar power can be one of the solutions to meeting civilization's energy needs in the future.

4. Unlike earth, in space there are no winters and no cloudy days, sunlight is available for 24 hours a day.
5. Earth solar power plants can be set up only in deserts, whereas using SSP this energy can be transmitted to any point on earth. Production of SPS does not require any kind of fuel and does not create any waste products like CO_2, thus does not add to global warming.

Disadvantages:

1. Over the years a lot of money has been spent on the study for generation of power from space. Over 40 million dollars (1995$) was spent in 4 years reviewing the SPS concept Compared to solar power collected at the Earth's surface, SPS faces the extra costs of space transportation and microwave power transmission.
2. Living and working in space can be Hazardous to health. for the reference system proposed it was estimated that it would take 600 workers, working full time and need 30 years to construct a SPS in GEO
3. The effects of microwaves on humans are not well known, but it is clear that the background from 60 rectenna fields (each producing 5 GWe) will exceed the background by a factor of ~ 100. While probably not a health hazard, the fact that the radiation exceeds the background for a "captive" population means that we almost assured of public protest and delays in implementing this technology