

Beaming Solar Power Down from Space: Not Crazy?

by DR. SEAN WHITE

The earth can get in the way of PV production; this is what we know in layperson terms as nighttime. Terrestrial solar arrays peak out with about 1,000W/square meter at noon on a sunny day. In space, we get about 1,366W/square meter 24 hours per day at our address, which is about 93 million miles from the sun, give or take a few million miles, because of our elliptical orbit (we are closest to the sun the first week of January every year).

1,366W per square meter x 24 hours = 33kWh/square meter per day in space

With 90% conversion efficiency:
33kWh/square meter x 0.9 derating x 365 days =
10,800kWh/kWp/yr

That 10,800kWh/kWp/yr is what a geostationary satellite is getting right now (except for a short time around equinox when the earth is between the sun and the geostationary orbit). The 33kWh per day in space vs. five on earth is six to seven times more energy per kW. Space based solar power is also based on the most efficient PV, which is a thin film technology called gallium arsenide. This is what goes on the satellites and is primarily made by a Boeing subsidiary Spectrolab. www.spectrolab.com Want Boeing solar for your house? You can't afford it unless you are one of those people driving your 787 Dreamliner to the ASES conference in Denver October 9-12, 2017.

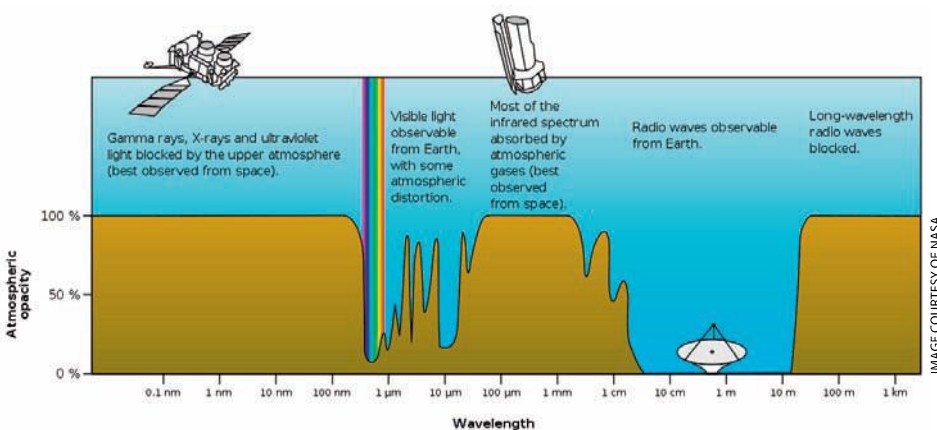
Solaren plans on reflecting 20 to 50 suns with Mylar like reflectors onto the space PV, which in effect brings 10,000kWh/kWp/yr without reflectors, up to 200,000 to 500,000kWh/kWp/yr!

A typical solar system produces 1500kWh/kWp/year. This means that for each kW of PV, we can expect to get 1500kWh per year. Gary Spornak, CEO at Solaren, who has worked at Boeing and Hughes and has a long career in the space industry, believes we can improve on those numbers. Here is what I learned in a recent interview with Gary.

SPSP (Space Based Solar Power) is baseload power. That means, like a nuclear power plant, it gives a solid stream of power constantly. It does not go on or off with the seasons, weather or loads. Unlike a nuclear power plant, we can turn it off quick, and compared to nuclear has no toxic byproducts and it is safe to be around.

Speaking of safety, the topic always comes up, "Can Space Based Solar Power (SBSP) be used as a death ray?" Spornak says the beam is too diffuse to be dangerous. If we wanted him to build a death ray, he would have used a laser. According to Spornak, his solar technology is much safer than earth bound concentrating solar plants, which are known to be a hazard to things flying near the collectors. An airplane or a bird can fly over these collectors on earth and not have any problems.

Will this technology compete with the terrestrial solar industry, as would terrestrial fusion power? Solaren's SBSP will need terrestrial solar racks to keep the microwave radio frequency (RF) collectors facing the satellites. This can mean Big Business for experienced solar installers. There will be a different type of earthbound microwave receiving solar panel tilted towards the geostationary space array and the installation





will be very similar to a traditional solar plant on the ground: tilted rows, inter-row spacing, trigonometry calculations and panel wiring to an inverter.

Inverter companies will also have Big Business with SBSP. Dc power will come out at similar voltages to strings of PV and be connected to MW scale inverter banks, just like we use on our world's largest solar farms.

SBSP can be good for the terrestrial solar industry. More inverters will be shipped, more racking systems will need to be installed, power will be made at night and on cloudy days. Besides PV prices coming down, the ability to send power to where it is needed, will happen without wires. Rather than being competitive with terrestrial solar, it can be complimentary.

What about efficiency and losses in one of these space plants? Spirnak says that transmissivity is well over 99.9% efficient. Transmissivity is the ability of electromagnetic radiation to pass through something, like the sky, a raindrop or a cloud. They will tune the electromagnetic wavelength to pass through Earth's atmosphere. Spirnak told me that he was talking with NASA about sending power to the moon and since they have no atmosphere on the moon, they can send the electromagnetic radiation at a shorter wavelength. On earth they want the wavelength to be bigger than a raindrop, so it can pass through weather.

Sending SBSP to the moon is the alternative to a lunar nuclear power plant. On the moon, the days and nights are 2 weeks each and lunar base will really need nighttime power. Perhaps

we can also have a big mirror out there to shine on the moon for a night-light.

Spirnak claims that his company can make energy that is competitive with the price of natural gas produced electricity.

Here is the pathway for the energy through the system:

- Capture the solar energy with Mylar like reflectors and concentrating about 20 to 50 times the sun's energy onto solar cells.
- Send power via solid-state amplifiers and antennae via reflectors to Earth. The efficiency of this technology has increased from about 30% 10 to 12 years ago to 95% today. This is like tube technology. The frequency will be about 5 to 10 GHz.

On the Earth, we have diode receivers. It looks like a solar farm with panels of diodes to capture the RF energy and convert it to dc electricity. From a satellite they look like oval arrays, because of how it will be a target for a satellite solar array over the equator.

From our microwave receiving solar panels to our inverters, we will have wires going to inverters, off to transformers and the distribution grid. These wires will send power 24/7, unlike our typical daylight solar farms.

This technology is eligible for the solar 30% Investment Tax Credit.

Solaren had a PPA signed by PG&E in 2009 and it was set back by the Great Reces-

sion. They have been held back by financing and not technology according to Spirnak. He insists that SBSP is cost effective and competitive. They are hoping for another PPA contract with PG&E for the early 2020s.

Currently Solaren is going through a private stock offering and has patents in all of the space faring nations of the world.

Solaren is headquartered in Manhattan Beach CA, which is walking distance from SpaceX in Hawthorne. I asked Spirnak if this was a coincidence. He remained neutral on which rocket ship company would send up his solar farm.



Dr. Sean White teaches solar courses around the world on a regular basis and has written three books published by Routledge on solar PV. He was the 2014 IREC Clean Energy Trainer of the Year and is a NABCEP Certified PV Installation Professional.