(Brief Preview) of Space Solar Power for the Global Electric Power Utility Market

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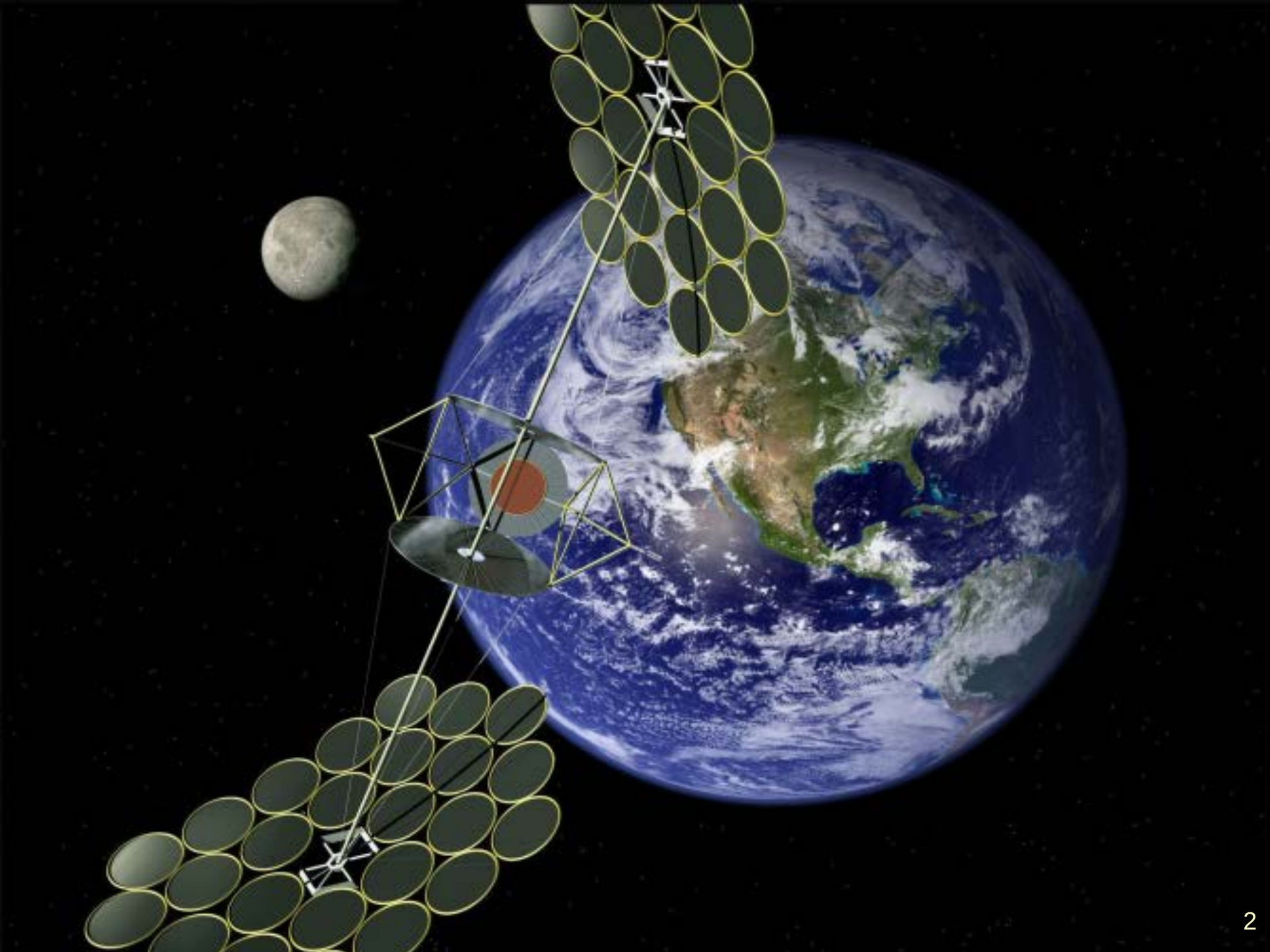


Ground solar (or wind) to SSP conversion ratio

A PV panel at GSO will collect about 9.6 times as much power per square meter per year as an average location in the continental US and require less maintenance. To store the sun or wind, to make it 24/7 like the grid, how long do we need to store it?

To store power to compensate for <u>just one day</u>, suppose we have a 1 MW ground PV or wind power unit that over some days stores 24 MWH into our CAES. When it has been thus loaded, we can then get about 6.48 MWH generated by the CAES when we want it, since the best existing CAES is about 27% efficient operationally.

Can ground solar (or wind) run our grid?(cont.)

It may take 4 days of sun to get 24 MWH. We need 14.8 of avg. sunny days to store our 24 MWh to cover a sunless 24 hour day. That is for just one 24 hour day.

(***Note*** **-** CAES uses natural gas to make most efficient use of the cold compressed air to generate the power, but PV or wind cannot provide gas so it still depends on a fossil fuel.)

Approximately 50% of space solar's PV output will get to the grid, so that 9.6 factor is reduced to 4.8 ;

Attempting to make terrestrial PV or wind "dispatchable" using the best available storage technology, we have shown by comparison that SSP provides **71 times** (= 14.8 x 4.8) **more dispatchable baseload energy.**

(This assumes that we can perfectly predict the weather and the cost of CAES storage equipment is zero, since we don't know how long storage may be required.)

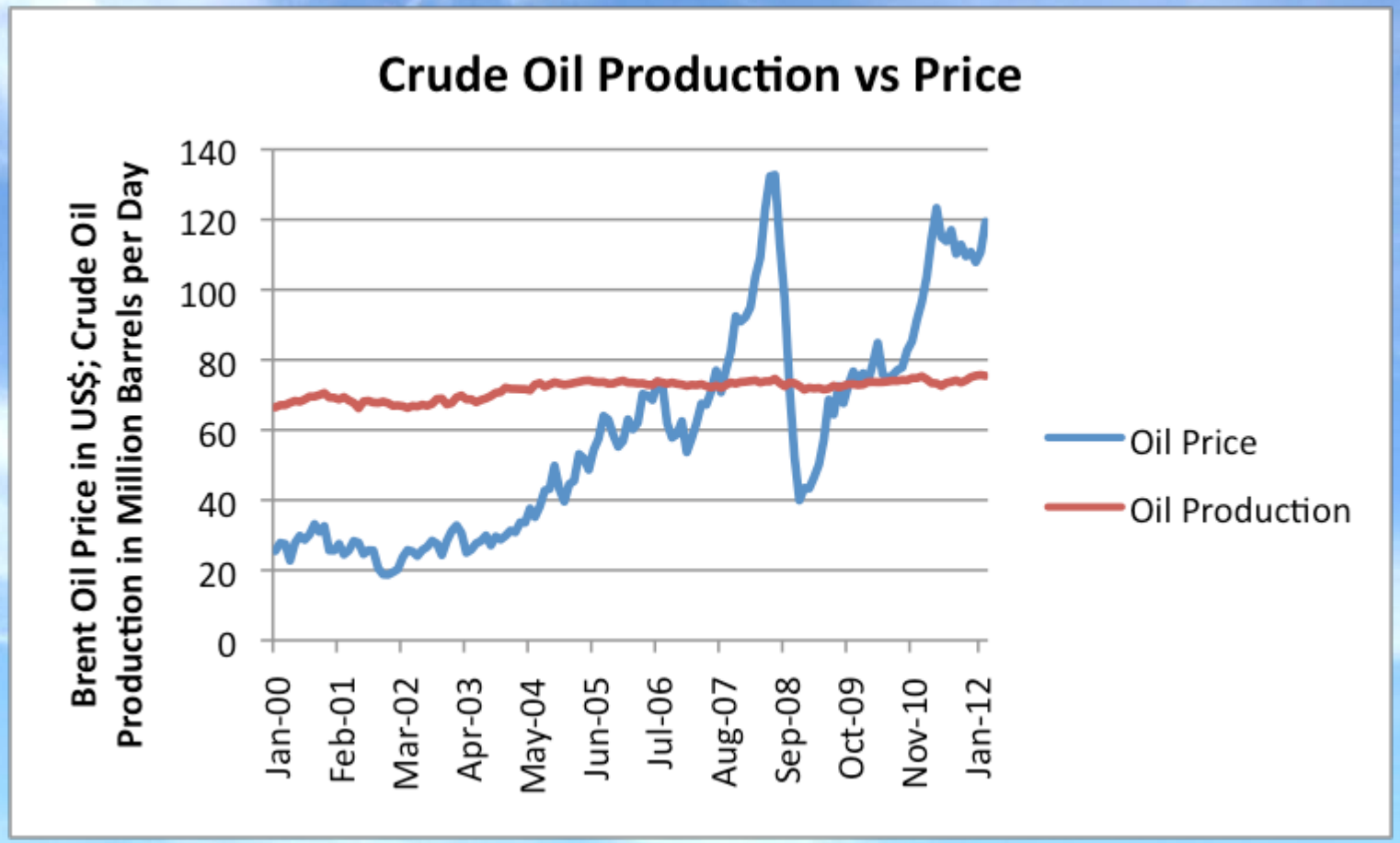
June IEEE Proceedings was completely devoted to Wireless (Microwave) Power Transmission.

Among the great articles was Paul Jaffe's (NRL) and James McSpadden's (Raytheon) excellent overview, "Energy Conversion and Transmission Modules for Space Solar Power" there.

Georgia Tech Space Solar Power Group (GT SSPG)

A Georgia Tech School of Electrical & Computer Engineering Senior Design Team

The GT Space Solar Power Group (SSPG) is a Georgia Tech-affiliated Electrical Engineering design team conducting research on harvesting solar energy and wirelessly transmitting power. The end goal is the development of a small scale prototype that will serve as an educational tool to academia and power companies.



Crude oil production vs Brent oil spot price, in US $ - EIA data.

Space Solar Power + The Electric Power Market — Tapping The Source

By Darel Preble, Executive Director, Space Solar Power Institute

The general public and the electric power utility industry are unfamiliar with Space Solar Power and advanced aerospace capabilities. The aerospace industry is, likewise, unfamiliar with electric power's operational demands, regulatory restraints and critical issues.

Our global and U.S. economy is dependent on stable and reasonable energy prices, especially oil, which directly affect commodities costs.

James Hamilton has shown that 10 out 11 post-World War II recessions were associated with oil price spikes. He has also shown that oil price changes in the 2005-2008 period were sufficient to lead to the Great Recession (Brookings Paper)**…**

(Oct. 2013 article SatMagazine http://www.satmagazine.com/index.php?number=414881136#)

A New Alternative - Space Solar Power (SSP)

1. **Should be dispatchable, or “baseload”.**

   SSP would be available (in full sun) 99.3% of the year at GeoSynchronous Orbit(GEO). The satellites would be in the Earth’s shadow for up to 72 minutes at local midnight during the period ±22 days of the spring and fall equinox..

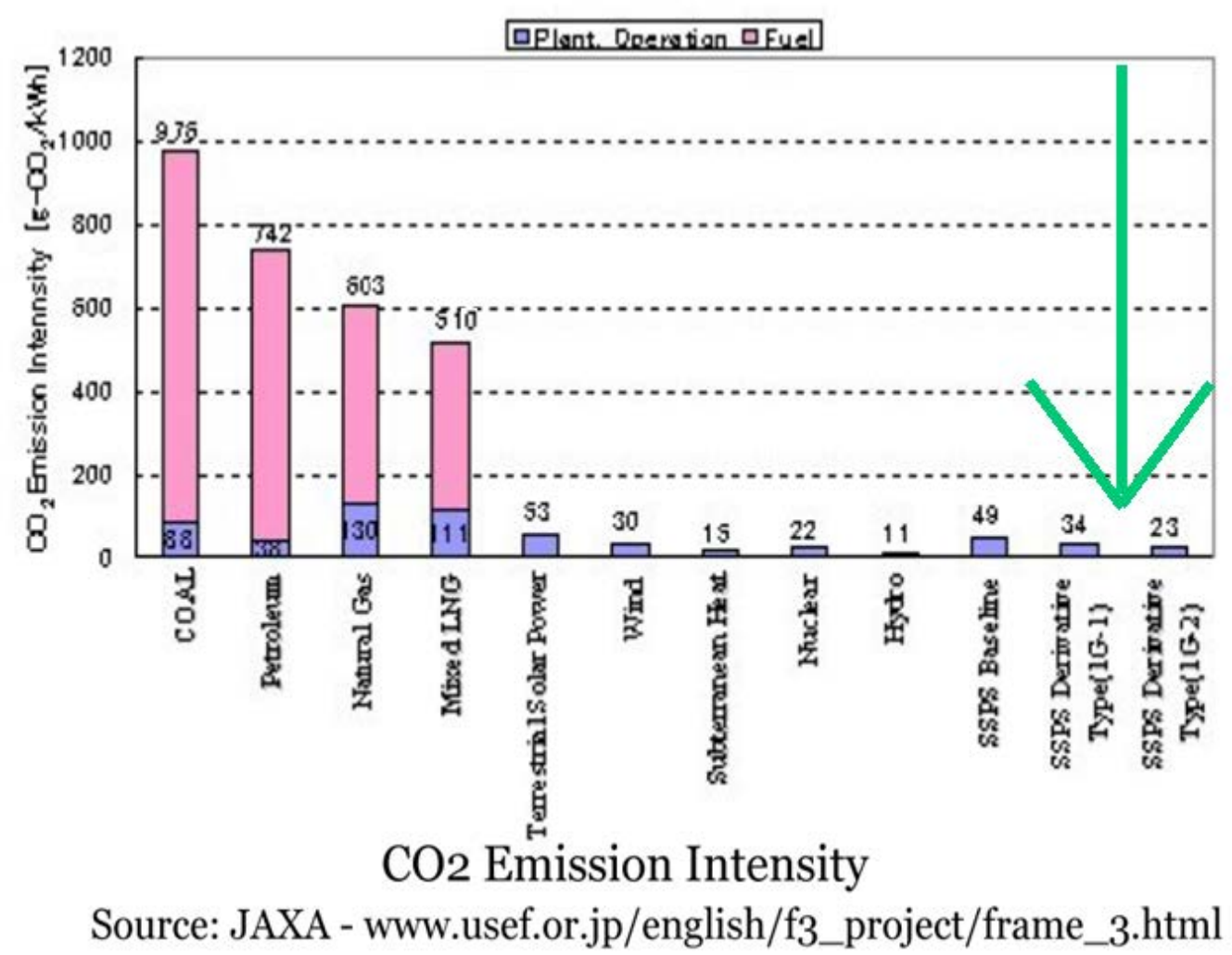
A New Alternative - Space Solar Power (SSP)

2. **Zero fuel costs; like hydro, for example, but easy to dispatch than hydro.**

   SSPs burn no fuel in operation except a tiny amount of station keeping fuel – probably electric ion or plasma drive since electric power is readily available at GEO.

A New Alternative - Space Solar Power (SSP)

3. Low CO_2 emission intensity:

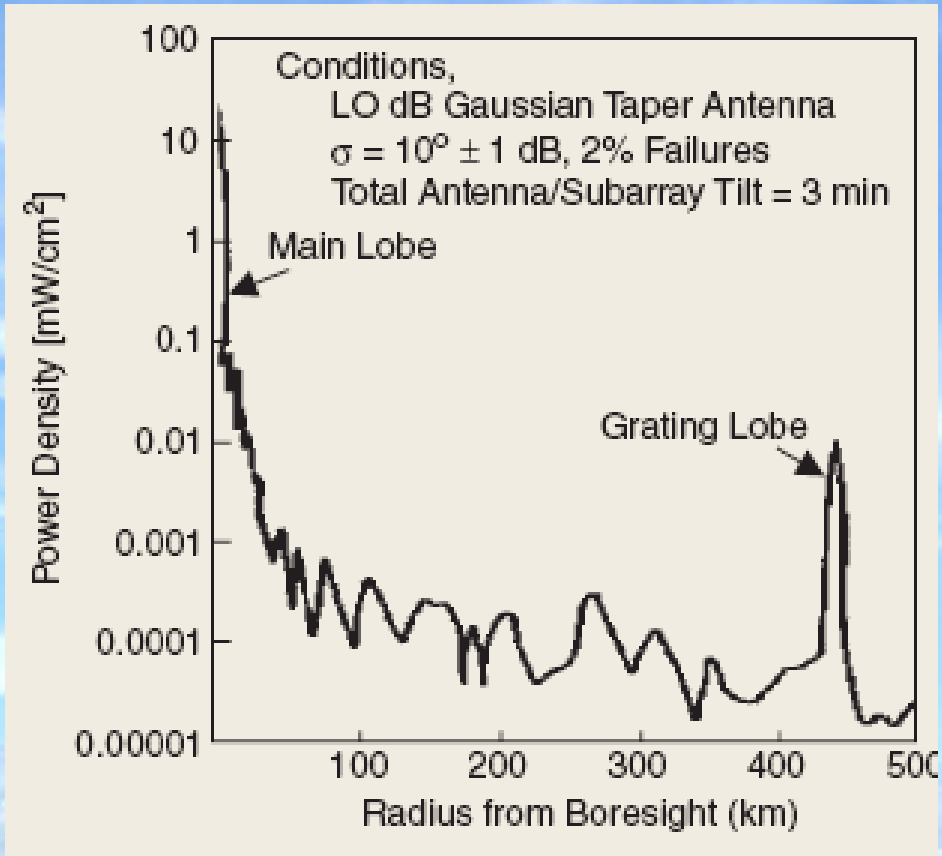


CO2 Emission Intensity

Source: JAXA - www.usef.or.jp/english/f3_project/frame_3.html

A New Alternative - Space Solar Power (SSP)

7. **Environmentally safe -** SSP ground receiver (rectenna) has benign power levels, within all regulatory limits.



Predicted ground-level microwave power density for a full-power GEO SPS as a function of distance - Credit: J. M. Osepchuk, IEEE Microwave, "How Safe Are Microwaves and Solar Power from Space", *IEEE Microwave magazine*, vol. 3, issue 4. page 58-64, Dec. 2002.

A New Alternative - Space Solar Power (SSP)

Boeing's Subsonic Ultra Green Aircraft Research (SUGAR Volt) **Hybrid Electric Aircraft** concept (~2030) would:

- reduce fuel burned by 70% compared to current aircraft.
- have a shorter takeoff and better wings
- turbojets that could be battery powered during most of the flight.

How to proceed?

A public/private Congressionally chartered corporation has all the requisite advantages.

Comsat Corp., chartered in 1962, opened space for communication satellites - when we knew little about space, rockets or space communications. Communication satellites are now a $250+ Billion industry per year.

The “Sunsat Act” would accomplish the same task, creating a space solar power corporation and industry of much greater size.

Today @ 4:45 Koji Tanaka, Associate Professor, Department of Spacecraft Engineering, The Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency(JAXA), Kanagawa, Japan, will talk about Japan's design and plans to launch the world's first SSP demonstration satellite.

His research interests include space power systems and the interactions between high-power systems and space environments. An SPS working group in ISAS/JAXA has been conducting SPS studies including a conceptual study of the huge SPS satellite in orbit, energy transmission by microwave, the interaction with space plasma and a small demonstration satellite.