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Assembly of Space Based Solar Power Satellite using Space Robotics

International Space Solar Power Student Competition

Sejal Jain
Prathmesh Barapatre

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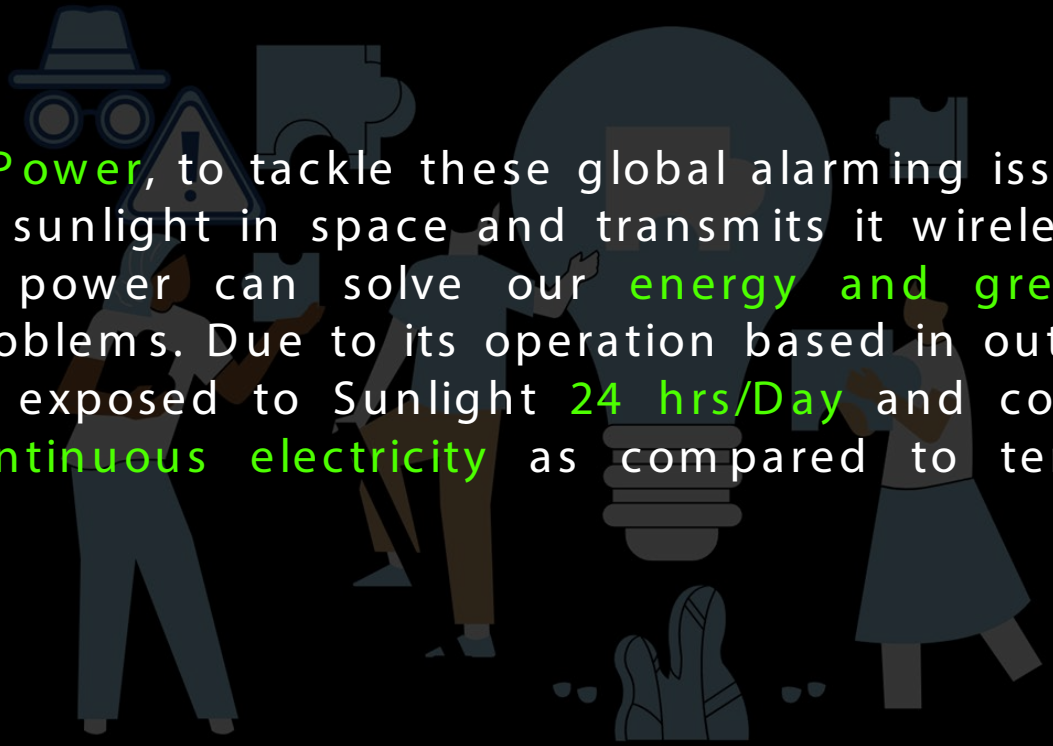
Problem

The most significant percentage of toxic water pollution comes from coal-fired power plants. According to OECD, the total energy supply by non-renewable sources is 7.2EJ (Exajoules, equivalent to 2 E+15 Wh). In a report made by Statista Coal power generation worldwide grew to approximately 10,042 terawatt hours in 2021. Coal and fuel oil combustion emit fly ash particles into the atmosphere, which contribute to air pollution problems and global climate change.

Solution

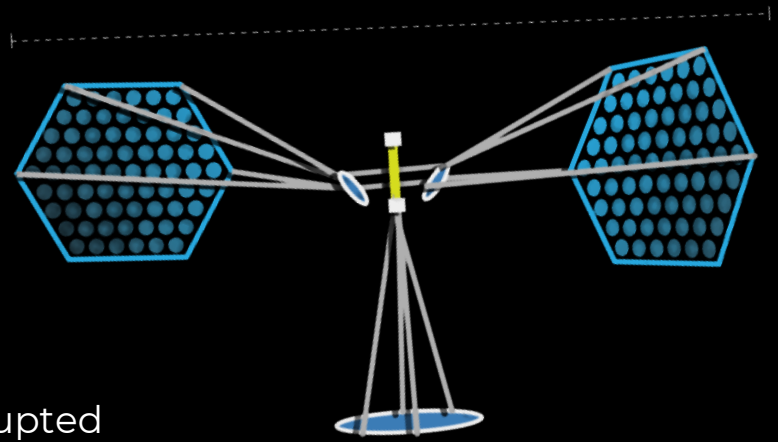


Space Solar Power, to tackle these global alarming issue. It gathers energy from sunlight in space and transmits it wirelessly to Earth. Space solar power can solve our energy and greenhouse gas emissions problems. Due to its operation based in outer-space it is continuously exposed to Sunlight 24 hrs/Day and could therefore generate continuous electricity as compared to terrestrial solar panels.

Solar Power Satellite

Captured solar energy is transmitted to satellite power station and further converted to microwave signals using magnetron / klystron

4 such Ga-As solar panels are deployed in B-roll / Horus patterns round the satellite

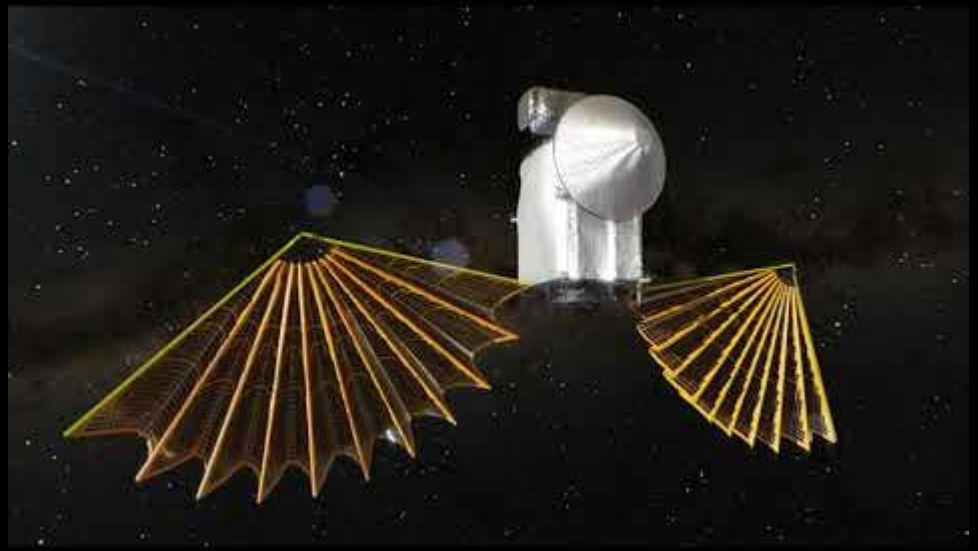


Uninterrupted Microwave energy is beamed to Earth station and received by rect-antennas

Solar Panel Deployment Process

B-roll Deployment

Credits - The Verge



Horus Deployment

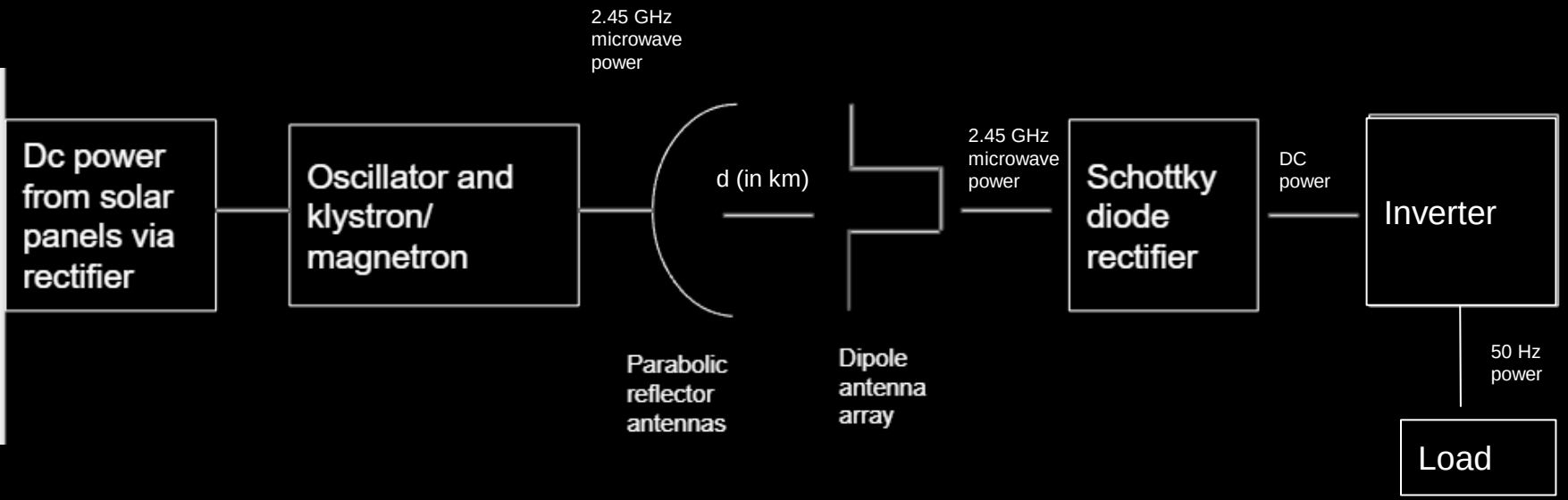
Credits -NASA LUCY Mission

Microwave signal generation

Key components in microwave wireless power transmission system are :

- **Transmitter - Includes a DC-RF converter and transmitting antenna**
- **Beam control**
- **Rect-antenna**

Microwave transmitter



Operation Block Diagram of Space Solar Power

DC-RF converter

Magnetron

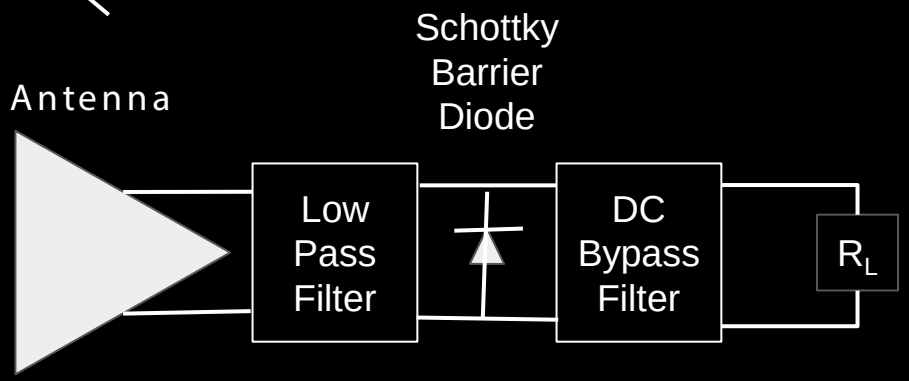
- EM radiation in microwave range is generated when electrons are forced to move in circular path under the influence of permanent magnet
- Higher efficiency and low spectral noise achieved
- The output microwave power signals are radiated by parabolic dish antennas

Klystron

- Operates at higher power and higher temperatures
- Can be used to amplify the power signal if needed
- The output power signals are radiated using slotted waveguide antennas

Ground Station

- **Rectenna receives microwave beams and converts them to DC power.**
- **Array of dipole antennas are arranged to obtain high efficiencies.**
- **If we use 2.45 GHz microwave WPT, the number of antenna elements per square metre is in the order of 100**



Laser VS Microwave Solar Satellite

Laser based SPS

- Troublesome in transmitting power through dense clouds and rains
- Requires constellation of satellites to create a substantial impact
- Blinding and weaponization could raise safety concerns with laser based solar satellites.

Microwave based SPS

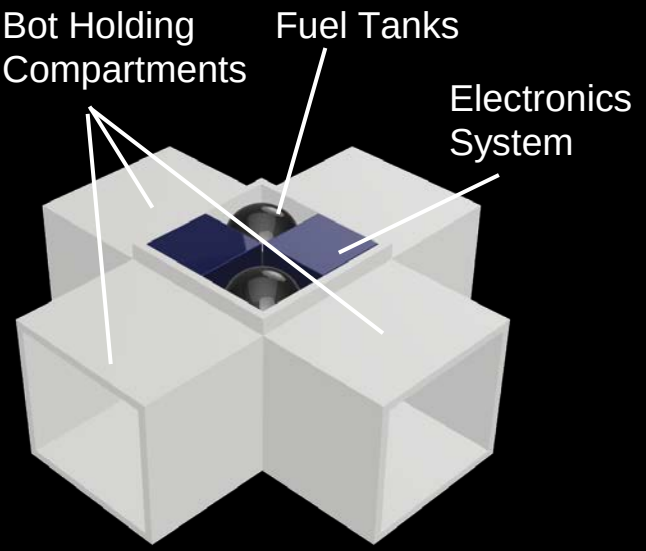
- Uninterrupted power transmission through atmospheric conditions
- Provides almost 1GW of energy to the ground receiver, enough to power a large area
- Much safer and efficient to be deployed into orbit.

Space Robotics - Outstation

Robotics outstation

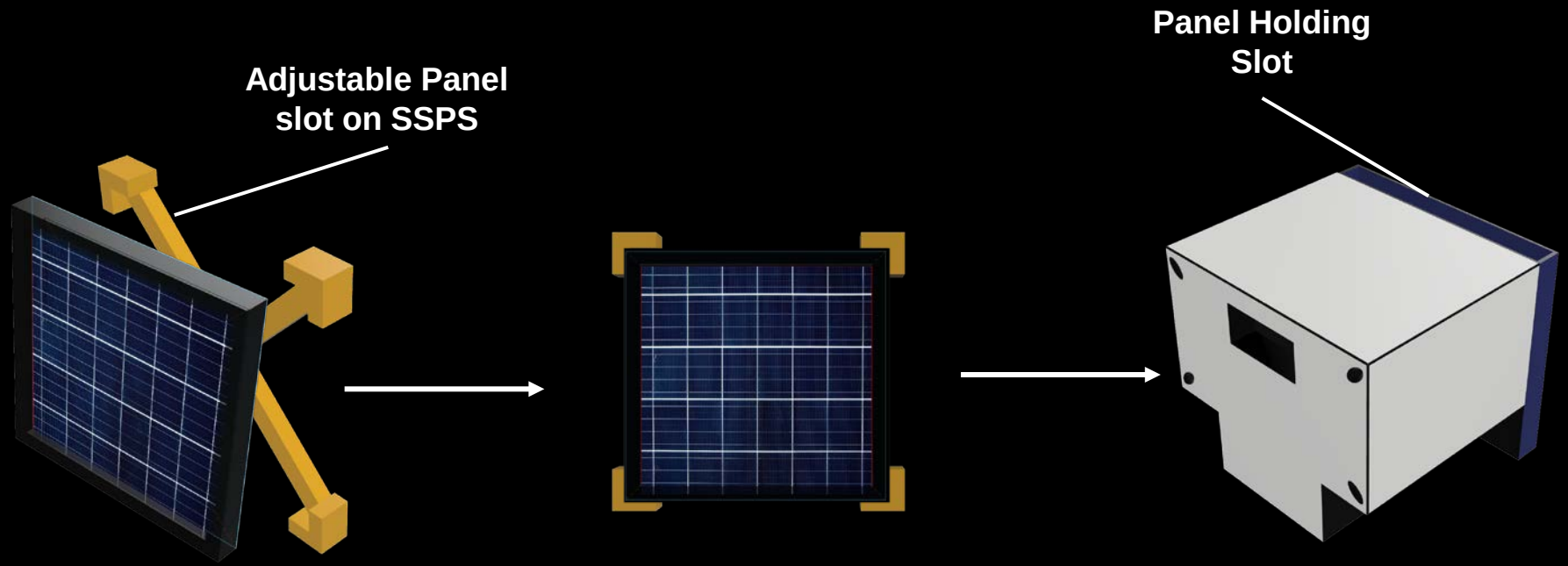
- Consisting of Welding and Grabbing Bots
- This station will have capability to hold Four bots at a time with Recharging and Refueling sources for RCS thrusters.

RCS Thrusters - To control Roll, Yaw, Pitch and Altitude of the station



Outstation - CAD Model

Modular Panels

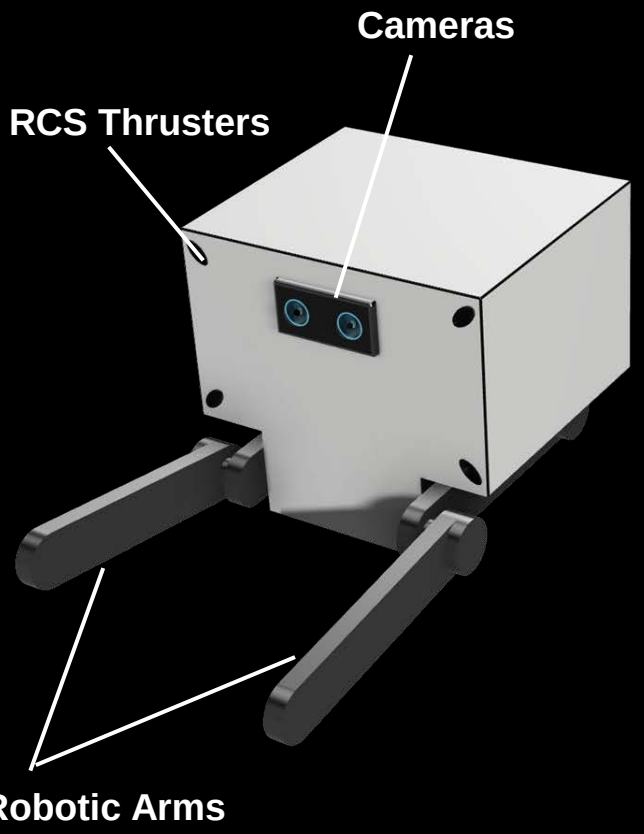


Replacement of Panels done with bots

Bots - Welding and Maintenance

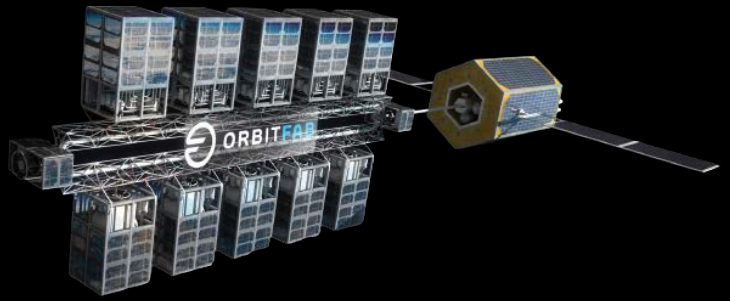
- Welding Bot - Will be used to repair in terms of short damages made due to Space debris or Wear and Tear of the SSPS

- Maintenance Bot - They will be used for routine checkup and predictive maintenance of the SSPS



Inorbit - Refueling

Robotic Outstation
CAD Model



Refueling Outpost by OrbitFab
Credits - OrbitFAB

Team

Prathmesh Barapatre
BE-Mechatronics Engineering
Diploma-Mechanical Engineering

Sejal Jain
BE- Electronics and
Communication Engineering