Energy for Earth from Space: Architecture for a CubeSat Space Solar Power Constellation

Dr. Thomas Sinn,
CEO Deployables Cubed GmbH
Our Vision
To power humanity for worlds to come, and be the conduit for a cleaner tomorrow.

Our Mission
To develop innovative technologies that are pushing the boundaries while only physics is the limit.

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Supported by:
$48,000,000,000,000

The International Energy Agency (IEA) estimates a $48 trillion investment needed to meet global demand of energy by 2035.
Is there an Issue to solve?

Power to Everyone
In the darkest moments

For a greener Future
While strengthening E-Mobility

To go Further
For exploring the great outdoors
WHY NOW?
Because of NEW SPACE

- New Space means **business** in space.
- Higher risk acceptable for **faster development**.
- Significant decrease in launch costs opening **new markets** especially for **new space companies**.
How to do it?

Constellation of Space Power Satellites with Nano satellites

Low Earth Orbit (only 300-500 km between satellite and target)

Global Coverage (similar to internet from space)
**What are the Challenges of Space Solar Power (SSP)?**

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Solution</th>
</tr>
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<tbody>
<tr>
<td>High Cost</td>
<td>Significant decrease in launch costs expected, especially in LEO (500$/kg by 2030) economic megaconstellation due to COTS satellites.</td>
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<tr>
<td>Competitiveness</td>
<td>Unlikely to replace terrestrial renewable energy (0.15$/kWh). But attractive for remote applications like search and rescue/disaster relief, e-mobility, outdoor activities (&lt;500$/kWh).</td>
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<tr>
<td>Efficiency</td>
<td>Solar cells efficiency of up to 32%, microwave transmission efficiency of 54%. SSP efficiency only limited by legal transmission limits. High SSP efficiency of 100W/m² compared to terrestrial photovoltaic of 25W/m².</td>
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<tr>
<td>Danger to People and Animals</td>
<td>1985 experiments (at 250W/m² @ 2.45GHz) with 2x IEEE and 5x ICNIRP standard for human exposure showed no danger for birds.</td>
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<tr>
<td>Power Transmission Regulations</td>
<td>100W/m² are currently allowed within existing safety standards.</td>
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<tr>
<td>Atmospheric Interference</td>
<td>Frequencies of 2.45 GHz and 5.8GHz have minimum atmospheric attenuation.</td>
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<tr>
<td>Misuse as Weapon</td>
<td>Not possible, as power density is within existing safety standards (&lt;100W/m²).</td>
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<tr>
<td>Microwave Frequency Spectrum</td>
<td>Frequency allocation is needed and power beaming not yet in a Telecommunication Union.</td>
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<td>Availability</td>
<td>Constant coverage, independent of weather and seasons due to LEO constellation.</td>
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<tr>
<td>Resource</td>
<td>Hourly solar energy hitting Earth (1.2x10¹⁴ kWh) &gt; energy humanity needs annually (1.1x10¹⁴ kWh).</td>
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</table>
What is needed to make this vision a reality?

All technologies are already existing (in space + terrestrial applications)

To do:
Mature terrestrial technologies and combine them

Our focus is on key technology: deployable solar / transmission arrays

Our Key Technologies:
- Large Deployable Solar Arrays
- Deployable Power Transmission Array

Deployable: Umbrella Analogue
- SECOND: Deployable (subsystem)
- FIRST: Switch / Actuator (component)

Nanosatellite Bus (already available)

Groundstation Network (already available)
The D3 Timeline

DAY 0
The Component

Phase 2
The Sub-System

Phase 3
The System

End State
The Constellation
Component: Actuators (D3PP & D3RN)

- Novel Actuation Principle
- Pin Puller (D3PP) as well as Release Nut (D3RN), available in various sizes.
- Patenting Pending (filed in 02/2020)
- First two actuators (nD3PP) delivered to customers in US & New Zealand in 01/2020 and 02/2020
- Full Space Qualification by 06/2020
- Full Market Entry in 08/2020
USPs of Actuators (D3PP & D3RN)

- Smaller (then anything available in Europe)
- Cheaper (then any available worldwide)
- Export-regulation free (no EAR/ITAR like US products)
Subsystem: Deployables (D3DB & D3DA)

- Deployable Array is needed to collect required power in space
- Breadboarding currently ongoing with deployable boom (D3DB) forming deployable array (D3DA)
- Q4 2020: Space Qualification
- Q3 2021: Tech demo in space
- Q3 2022: Market Entry
USPs of Deployables

- Commercial Off The Shelf (COTS) Product
- Short Lead Time (ready within days and not months/years)
- Cheaper (focus on NewSpace/Nanosat customer)
- Excellent Customer Service
Thank you!

Do you have any questions?

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