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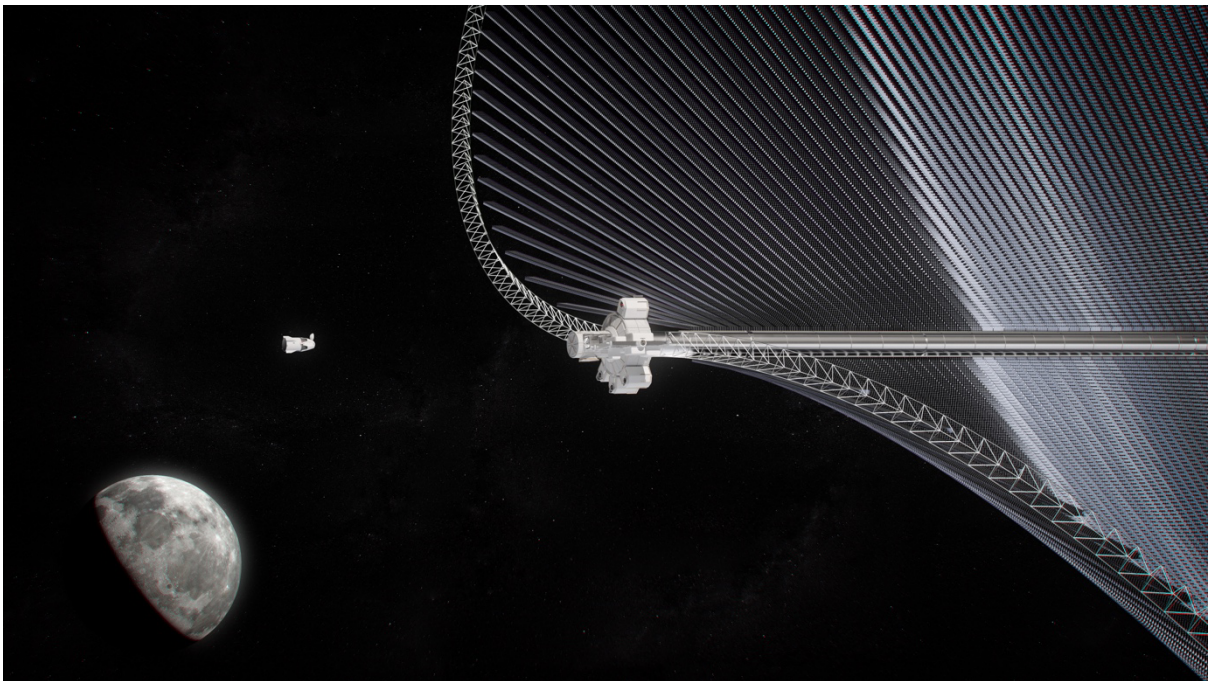
ESA funded study finds Solar Power Satellite production on the Moon could eventually ease dependency on fossil fuels on Earth.



Greater Earth Lunar Power Station

The Swiss company Astrostrom GmbH has been investigating the feasibility of a "Greater Earth Lunar Power Station" (GE⊕-LPS) manufactured on the Moon and assembled at the Earth-Moon Lagrange Point 1 to provide power from lunar orbit to operations on the surface of the Moon. Once the initial station is in operation, the production facilities on the lunar surface could be then used to produce additional Solar Power Satellites (SPS) to be shipped into Earth orbits to deliver clean baseload solar energy to Earth. This 'Space Energy Option' would contribute to a massive reduction of the use of fossil fuels for energy production on the way towards meeting international climate and energy targets.

The study was selected from the European Space Agency's (ESA) open call "Clean Energy from Space" [1] which sought novel ideas related to Space-Based Solar Power (SBSP) systems. During the study, ESA announced the SOLARIS programme [2] to explore the feasibility and potential of SBSP to provide clean energy to Earth, for which funding was approved by the ESA Council at the Ministerial Level in November 2022. Astrostrom was asked by ESA to produce a promotional video introducing the SOLARIS initiative that was shown during this meeting [3]. Now ESA has since announced the first results of the study [4].

The GE⊕-LPS is a crewed facility in lunar orbit that will be constructed primarily from lunar materials. Shown to be both feasible and scalable, manufacturing future SPS components from lunar materials and transporting these to geostationary orbit (GEO), would be a means to avoid the need to launch hundreds or thousands of massive SPSs from the surface of the Earth in order to supply environmentally benign, baseload electricity to Earth. The GE⊕-LPS is a concept that advances lunar development with the ultimate aim to address the terrestrial energy and climate crises.

The construction of GE⊕-LPS with lunar materials requires developing facilities on the Moon for automated mining and manufacturing processes. The materials required for GE⊕-LPS include cast basalt

and basalt fibre for the structural elements. Silicon, ilmenite and especially pyrite are considered for semiconductors and photovoltaics, whereas metals such as iron and aluminium will serve for the electrical connections. The establishment of industrial-scale, robotic beneficiation and processing plants will provide access to several other materials, which may become valuable to other users in the cislunar region. In addition to small amounts of Helium-3, a vast amount of oxygen will be produced as a by-product which can be used in life support systems and as rocket propellant, thereby creating additional business cases for new cislunar enterprises.

Taking inspiration from the butterfly, GE⊕-LPS features a V-shaped solar panels with integrated antennas, deployed in a helix configuration extending more than a square kilometre end-to-end. The initial design would yield 23 megawatts of continuous electrical power for lunar surface operations. Later designs are targeted to reach gigawatt scale power levels. The solar panels would be manufactured from an iron pyrite monograin-layer solar cells produced on the Moon. Astrostrom's approach to realizing SBSP could reduce the amount of mass for a SPS launched from Earth by 80% or more as well as reducing costs and the related CO_2 emissions. The 'butterfly' – a living symbol of metamorphosis – can be seen as signalling humanity's transformation from the fossil fuel age into the space energy age.

Dr. Sanjay Vijendran, overseeing ESA's SOLARIS program explains:

"Launching large numbers of gigawatt-scale solar power satellites into orbit from the surface of the Earth would run into the problem of a lack of launch capacity as well as potentially significant atmospheric pollution. But once a concept like GE⊕-LPS has proven the component manufacturing processes and assembly concept of a solar power satellite in lunar orbit, it can then be scaled up to produce further solar power satellites from lunar resources to serve Earth. This would also create many other benefits in addition to providing sufficient clean energy for Earth, including the development of a cislunar transportation system, mining, processing, and manufacturing facilities on the Moon and in orbit resulting in a two-planet economy and the birth of a spacefaring civilisation."

The Astrostrom study also outlined a business case based on the energy market and the demand for clean energy on Earth. BloombergNEF and other organizations have estimated that the European energy transition will be a 5 trillion Euro or more investment opportunity [5]. Based on the study, just 2% of the cost of the European energy transition – *€ 99 billion or less* – would be necessary to install the infrastructure needed to begin manufacturing SPS components on the Moon. It proposes a multi-national stakeholder organisation called the 'Greater Earth Energy Organisation' for this purpose. Recent developments including lowered launch costs, automation, robotics, and material technology have made the start of a lunar economy a viable investment opportunity.

Note: Greater Earth is a new perception of our planet based on Earth's true cosmic dimensions as defined by the laws of physics and celestial mechanics, and includes the Moon within Earth's gravitational field. ⊕ is the Greek astronomical symbol for planet Earth and GE⊕ is the logo of Greater Earth.

The international study team consisted of:
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Dr. Patrick Collins, Japan – SBSP, Space Tourism and Economics Expert
https://www.spacefuture.com
Dmitrijis Gasperovics, Latvia – Visualizer and Animator

References:

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2. ESA Solaris:
   https://www.esa.int/Enabling_Support/Space_Engineering_Technology/SOLARIS

3. ESA Solaris video on YouTube.
   https://www.youtube.com/watch?v=8ScTbb-43A4

4. ESA: Lunar Solar Power Satellite
   https://www.esa.int/ESA_Multimedia/Images/2023/07/Lunar_solar_power_satellite

5. BloombergNEF: Europe's Path to Clean Energy, (2022) A $5.3 Trillion Investment Opportunity. (Published: April 13, 2022)
   https://about.bnef.com/blog/europes-path-to-clean-energy-a-5-3-trillion-investment-opportunity/

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Hi-Res images are available and Zoom interviews are possible.

The Executive Summary (34 pages) and Final Report (269 pages) can be downloaded from the Astrostrom website.

Videos of the study are also posted on the website.