

# SPACE-BASED SOLAR POWER – SCIENCE & TECHNOLOGY

A recent study estimated that Space-Based Solar Power (SBSP) could meet up to 80% of Europe's renewable energy needs by 2050.

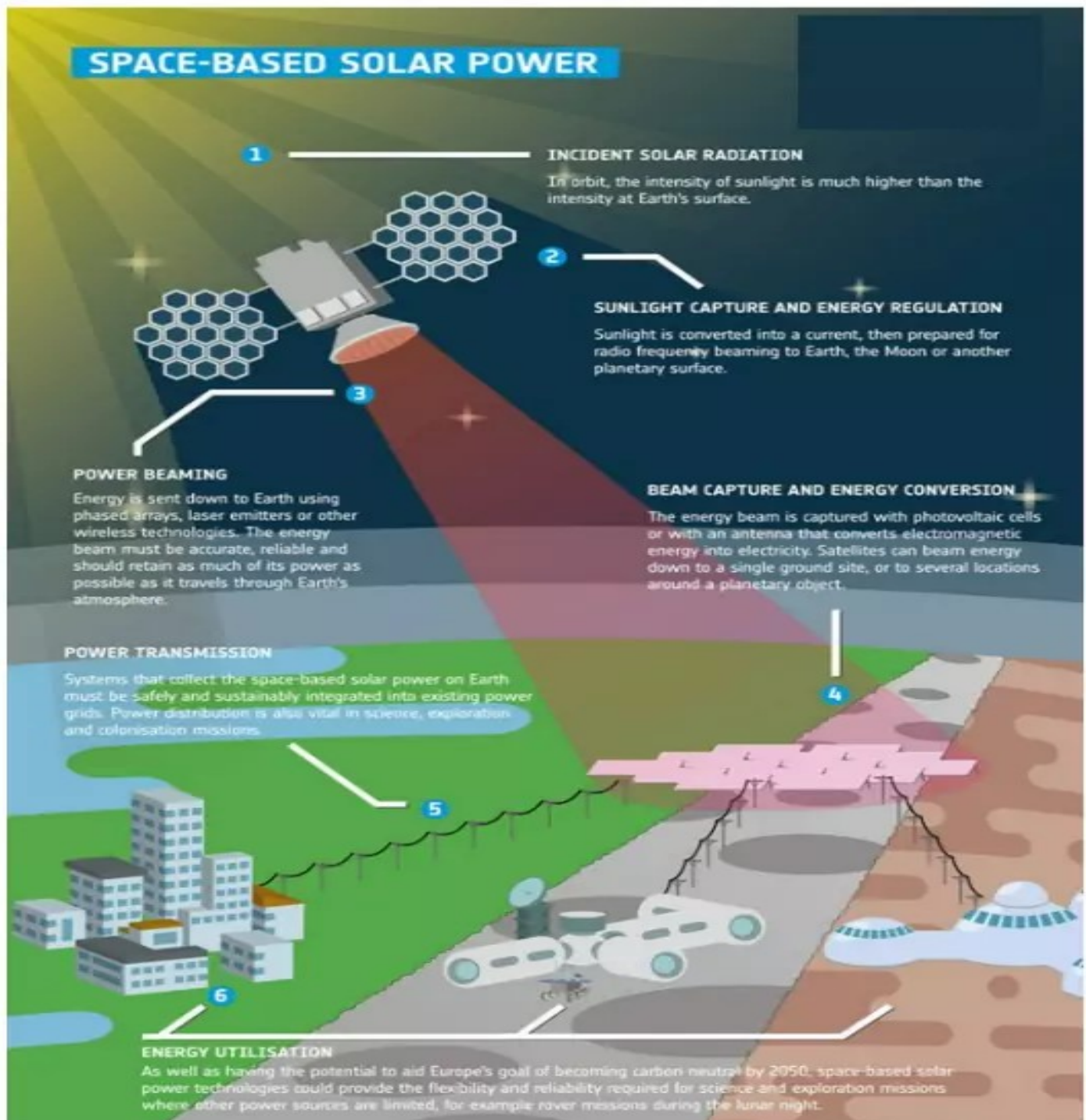
## SBSP

### Concept of SBSP

**Fundamental Idea** – SBSP proposes the launch of large satellites equipped with massive solar panels into geostationary orbit, where sunlight can be harvested without interruption.

**Energy Transmission** – The collected solar energy is converted into microwave beams (or in some models, laser beams), which are then transmitted to large receiving stations on Earth.

**Conversion for Use** – On Earth, these beams are captured by rectennas (rectifying antennas) and subsequently converted into usable electricity for distribution through the grid.



## Feasibility and Supporting Studies

**NASA's Models Studied** – King's College London conducted simulations on two NASA-proposed SBSP designs:

1. **Heliostat Swarm Design** – Uses a network of reflectors that continuously redirect sunlight to a central satellite for collection, ensuring round-the-clock solar harvesting.
2. **Planar Array Design** – Relies on very large, flat solar panel arrays that are intermittently oriented but allow scalability for larger power collection systems.

**Key Findings** – The simulations revealed that both designs can deliver near-continuous power to Earth, thereby overcoming the intermittency challenges faced by terrestrial solar power plants.

### Potential Advantages of SBSP

**Continuous Power Supply** – Unlike ground-based solar, SBSP is not affected by day-night cycles, seasonal variation, or cloud cover, enabling uninterrupted power generation.

**Higher Efficiency Levels** – In space, solar radiation is 40–50% more intense than on Earth's surface due to the absence of atmospheric filtering, leading to higher conversion efficiency.

**Zero-Carbon and Dispatchable Energy** – SBSP can act as a clean, carbon-free energy source that is dispatchable on demand, thereby complementing variable renewables like wind and terrestrial solar.

**Grid Stability Role** – By ensuring continuous energy delivery, SBSP could serve as a balancing mechanism in future renewable-heavy electricity grids, reducing dependence on fossil-fuel based backup systems.

### Challenges to SBSP

**Scale and Infrastructure Requirements** – A single SBSP satellite could span over 1 kilometre in diameter, while its Earth-based receiving rectenna might be 10 times larger, demanding unprecedented levels of construction and materials.

**Launch Logistics** – Realizing one SBSP system may require hundreds of rocket launches, in stark contrast to the ~40 launches needed to assemble the International Space Station (ISS).

**Economic Viability** – Although launch costs are decreasing due to reusable rockets, the overall deployment, assembly, and maintenance expenses remain prohibitively high.

**Operational Risks** – Practical challenges include orbital congestion, transmission losses, interruptions in beaming, and variability in signal intensity—all of which have yet to be adequately addressed in existing models.

**Security and Space Debris Concerns** – Large-scale orbital infrastructure may face risks from space debris collisions, cyber sabotage, or even weaponization of energy beaming technology, raising global security issues.

### Relevance for India

**Net-Zero Alignment** – India's commitment to achieving net-zero emissions by 2070 makes SBSP a promising long-term option to diversify its clean energy mix.

**ISRO's Role** – With ISRO's proven track record of low-cost launches and satellite deployment, India could reduce the otherwise high capital burden of SBSP projects.

**Global Solar Leadership** – As a founding leader of the International Solar Alliance (ISA), India can leverage its diplomatic and technical influence to shape international cooperation on SBSP.

**Strategic Collaborations** – Joint ventures with UK, Japan, EU, and other space-active nations already exploring SBSP could help India fast-track feasibility studies, develop indigenous technology, and reduce costs through shared expertise.

## Conclusion

**Current Status** – SBSP is still at an experimental and conceptual stage, facing enormous technological, financial, and logistical barriers before practical deployment.

**Future Potential** – If developed successfully, it could emerge as a game-changing source of clean, continuous, and globally distributable energy.

**India's Position** – Given India's space technology strength and renewable energy ambitions, SBSP represents a strategic frontier technology that could significantly contribute to its long-term sustainable energy security and climate goals.

Source: <https://indianexpress.com/article/explained/explained-sci-tech/could-we-soon-have-space-based-solar-panels-not-really-10211527/>

