mPower TECHNOLOGY

FUELING SPACE: POWER CHALLENGES FOR A GROWING ECONOMY

AN MPOWER TECHNOLOGY WHITE PAPER

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THE SPACE POWER LANDSCAPE

The commercialization of space is poised to be one of the most transformative yet challenging arenas for innovation this decade. Terrestrial industries – telecommunications, defense, and now artificial intelligence (AI) and data centers – are rapidly pushing into the frontier of space. And, in order to flourish, these space missions will require immense power.

Similar to batteries for electric vehicles here on Earth, power in space is critical enabling infrastructure—nothing happens without it. Typically, power in space is provided by solar arrays, but these have historically been incredibly expensive and represent a significant portion of a satellite's cost. With launch costs dropping rapidly, Space 2.0 missions are growing in scale and scope. In order for these large-scale missions to be economically viable, the solar solutions powering these missions need to be reliable and cost effective - while operating in the most extreme conditions imaginable.

Building solar arrays and operating them in space cost-effectively is no easy feat. Solar arrays must provide reliable power under punishing conditions—dramatic temperature swings on each 90-minute orbit around the earth, intense radiation bombardment, and decades-long mission lifespans. All of the rapidly growing Space 2.0 applications (e.g. LEO constellations, lunar, AI and power beaming) require solar power solutions with three key attributes: 1) scalability, 2) cost-effectiveness, and 3) reliable performance in extreme environments.

THE SATELLITE BOOM: SCALING POWER FOR LEO NETWORKS

Low-Earth orbit (LEO) constellations for applications such as telecommunications, defense, and Earth observation are here and now and present the largest need for space power today. Companies like Starlink and OneWeb are leading the charge with massive telecommunications satellite constellations, driving other players such as Telesat Lightspeed, Globalstar/Apple, AST & Science, IRIS^2 and Lynk Global to move aggressively. All these programs require cost-effective, scalable, and high-performance space power to make their constellation networks economically viable.

The global LEO satellite market is projected to grow from $16.17 billion in 2024 to $34.33 billion by 2030, at a compound annual growth rate (CAGR) of 13.28%. (Source: Satellite Markets)

LUNAR AMBITIONS REQUIRE EARTH'S GREATEST POWER INNOVATIONS

The lunar economy represents the next great phase of space commercialization. Everything planned for the Moon—mining, manufacturing, or permanent habitats—will require massive amounts of power. NASA's Project Artemis reflects the growing urgency of lunar exploration, spurred by competition with China and other nations. In addition, commercial companies, such as SpaceX are developing lunar landers and services to support exploration and resource utilization. The Moon has also become a key focus for scientific research, with efforts to study its water ice, geology, and potential as a base for deeper space exploration. As lunar missions advance, power solutions will need to scale alongside these ambitions, offering low-cost, high-performance systems capable of sustaining operations in one of the harshest environments imaginable. Mining and in-situ resource utilization (ISRU) will be pivotal, but none of it happens without robust power solutions.

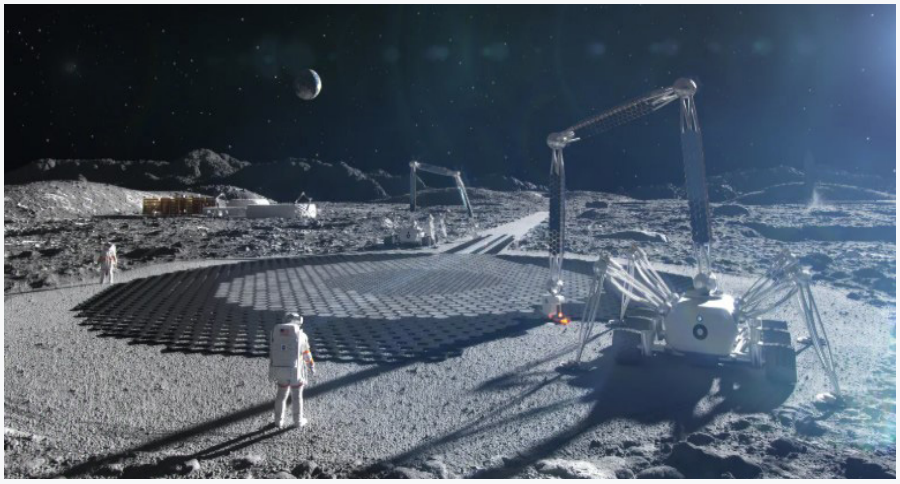


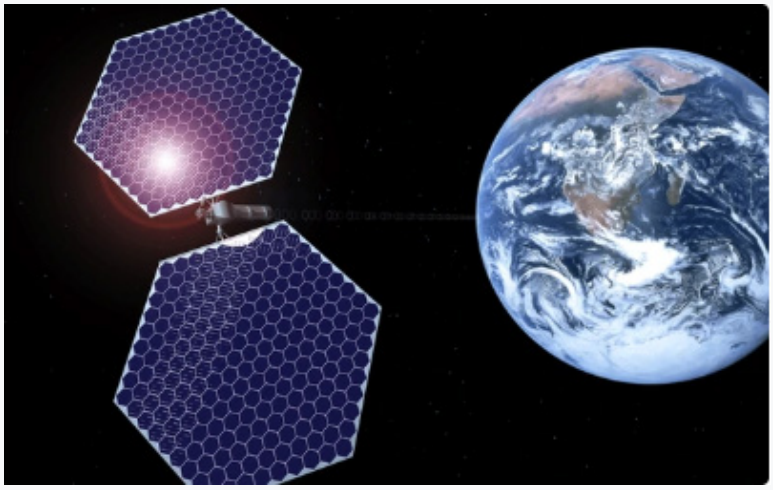
Image: NASA

AI IN SPACE: POWER DEMANDS MEET INNOVATION GAPS

AI-powered data processing has become critical for defense and commercial missions, supporting real-time decision making, image analysis, and autonomous systems. Data centers in space, powered by AI, will require enormous amounts of power. AI is enhancing humanity's ability to commercialize space, uncovering new insights and more ambitious missions. Innovative new power systems that are scalable and economical will be critical to advancing AI in space, ensuring that intelligence, not power limitations, drives the next wave of innovation.

BEAMING ENERGY ACROSS SPACE: THE FUTURE OF POWER DISTRIBUTION

Space-based solar power (SBSP) beaming represents an exciting leap in energy innovation, enabling wireless energy transfer from orbital stations to Earth or other spacecraft. This technology offers the potential to reshape how energy is distributed in space and could play a pivotal role in reducing reliance on Earth-based resources. Technological advancements have been demonstrated with organizations such as the U.S. Naval Research Laboratory, which successfully beamed over a kilowatt of power between two ground antennas, approximately a kilometer apart. While still in its early stages, power beaming is emblematic of the challenges facing the future of space power: scaling the technology to meet demand, lowering costs, and ensuring reliability under extreme conditions.



CONCLUSION

Industry-wide collaboration on power isn't optional — it's the future of space commercialization

To make this future a reality, we must align our efforts and prioritize strategic investments in the technologies and systems that will power the next era of space exploration and commercialization.

This means investing in and supporting photovoltaic (PV) manufacturing ventures in the U.S. to ensure a reliable domestic supply of this strategic energy asset. It also requires closely monitoring new, higher-efficiency terrestrial silicon technologies, such as perovskite-on-silicon, for their potential use in space applications. Finally, we also need to rethink solar design and embrace efficiency tradeoffs — oversizing arrays to ensure end-of-life performance — made possible by the decreasing cost of launch. Together, these steps will be crucial to turning our ambitions, and the significant reliance they have on space power, into reality.

The vision for 2025 is clear: we need to build the foundation for a space economy that supports life and enterprise far beyond Earth's orbit. The future of space power isn't just about solving technical challenges — it's about taking concrete steps today to ensure the next wave of space exploration and commercialization can thrive.

To learn more about mPower Technology and its solar innovations, visit **mpowertech.com**.