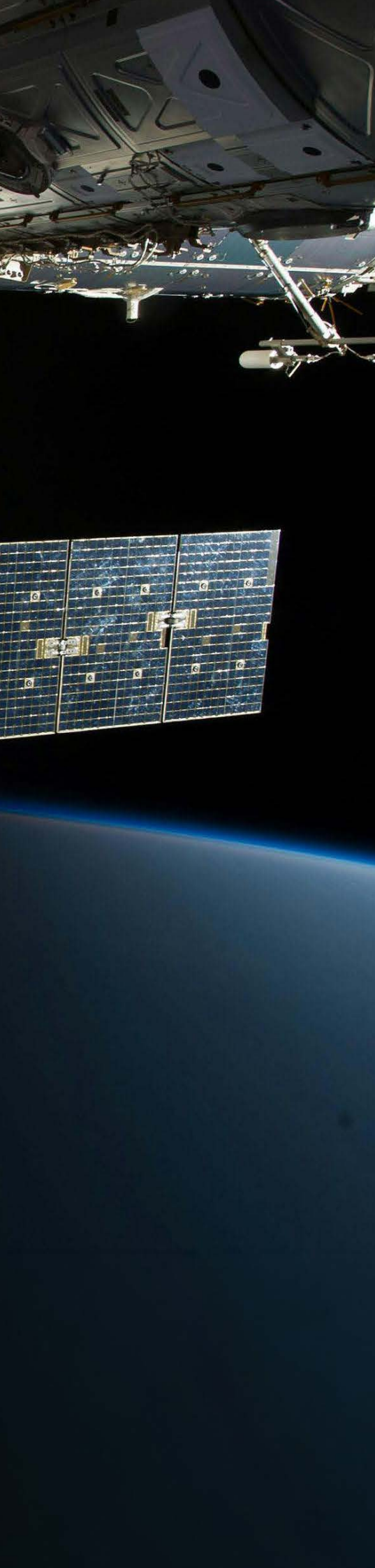


Solar panels in space: the future of renewable energy

In the first study of its kind, researchers at King's College London have discovered that space-based solar power (SBSP) could cut Europe's renewable energy requirements by up to 80 per cent. Here Mike Torbitt, Managing Director of resistor manufacturer Cressall, discusses what this means for the future of renewable energy, and the role resistor technology will play in making these developments possible.



From analysing NASA designs, researchers at King's found that SBSP had the potential to reduce energy battery storage needs by over two thirds.

The feasibility of solar panels in space is still yet to be determined; there are significant technical and cost limitations to overcome first. However, it is hoped that it could become possible by 2050. If successful, it would be a giant leap towards international net zero efforts.

NASA's concepts, involving satellites in geostationary orbit, would allow for a continuous harvesting of sunlight that could then be beamed to Europe as microwaves. The result would be dispatchable, zero carbon power that is unaffected by varying weather conditions.

The advantages are clear, but the challenge, of course, is navigating the technical complexities and initial investment required to complete such an ambitious project.

As highlighted by NASA, SBSP would likely exceed anything built in space before in terms of scale, other than maybe very large satellite constellations with huge combined mass and area. So, it is by no means a given that the current concepts are achievable.

And one small but crucial element of the electronic design that needs to be reliable is the resistor technology.

Requirements for resistor technology in solar power

Resistors are vital for controlling the flow of current to make sure each electronic component receives the right level of voltage. By dissipating excess energy, they can prevent systems from overloading and overheating.

For land-based solar panels, resistors are also used for braking to ensure panels that move or tilt towards the sun stop when required.

While there will be overlaps in resistor functions in land- and space-based solar panels, SBSP will require advanced resistor technology that is both reliable and durable in space.

A major challenge will be during the launch, when resistors need to regulate electronic systems while withstanding extreme vibrations and thrust.

Resistor technology will also be needed for the testing of SBSP designs through load banks. These allow engineers to test how electronic systems will handle different conditions, to ensure faults are identified and resolved before the launch. For such projects, thorough testing is essential.

Lessons from terrestrial solar technology

While space-based solar power represents a future frontier, many of the technical and system-level challenges it aims to address are already visible in today's terrestrial renewable infrastructure. In the UK, rising electrification,

driven by electric vehicles, heat pumps and industrial decarbonisation, is placing increasing pressure on the electricity grid.

Demand is expected to grow significantly over the coming decades, with renewable generation required to scale rapidly in order to meet national decarbonisation targets. The UK Government expects annual electricity demand to at least double by 2050, driven by electrification across heat, transport and industry. However current installed capacity remains well below projected needs, creating a widening gap between ambition and delivery.

This imbalance highlights a broader reality for renewable energy systems. Progress is not determined solely by technological readiness but by the ability to scale infrastructure in a coordinated and reliable way. Even where solar technology is available and economically viable, its deployment depends on grid connections, system integration and long-term operational stability.

These constraints help explain why space-based solar power is increasingly being explored as a complementary approach rather than a direct replacement for terrestrial renewables.

In ground-based solar photovoltaic systems, these challenges are addressed through a combination of electrical and mechanical support systems designed to optimise performance and ensure stability. Solar tracking systems, for example, are widely used in large-scale installations to increase energy yield by maintaining optimal alignment with the sun throughout the day.

While these systems can improve output by up to 35%, they also introduce additional electrical complexity, particularly when managing motor deceleration and positional control.

As panels adjust their orientation, excess electrical energy must be safely managed. Dynamic braking resistors (DBRs) are used to dissipate this energy, ensuring controlled stopping and preventing overshoot that would otherwise reduce system efficiency. In parallel, during installation, maintenance and decommissioning, photovoltaic systems require controlled discharge pathways. Even when disconnected from the grid, solar arrays continue to generate electricity under sunlight, meaning load bank or dummy load resistors are essential for safely dissipating excess power and protecting engineers working on high voltage systems.

As renewable capacity continues to expand, the importance of these supporting electrical systems becomes more pronounced. The principles of energy dissipation, load balancing and system protection that underpin terrestrial solar infrastructure also provide a useful reference point when considering space-based systems. However, in SBSP architectures, these requirements are significantly more demanding due to the

extreme operating environment where reliability is not just a performance factor, but a fundamental necessity for mission survival.

Scaling solar infrastructure

Alongside these technical considerations, the scalability of solar energy is also constrained by real-world deployment challenges. In the UK, large volumes of renewable capacity remain in planning pipelines, yet only a fraction of this translates into operational generation each year.

Delays in approvals, grid connection constraints, and the time required to construct and commission large-scale solar farms all contribute to a slower rate of expansion than is required to meet long-term targets. That complexity is reflected in the connections pipeline itself: NESO reports 'a GB connections queue of over 738 GW, compared with an estimated 200 to 225 GW of clean generation capacity needed by 2030.'

This gap between planned and operational capacity reflects a wider challenge regarding renewable deployment. Even when technology is ready, turning it into a fully integrated national infrastructure is a complex and time-intensive process.

Electrical protection and control technologies, including resistor-based systems used in load management and braking applications, therefore play a crucial role not only in optimising performance, but also in enabling safe commissioning and operation at scale. As renewable systems expand in size and complexity, these supporting technologies become increasingly central to ensuring stability across the wider energy network.

These constraints help explain why alternative generation models such as space-based solar power are being explored alongside continued terrestrial expansion.

Rather than replacing ground-based solar, SBSP is increasingly viewed as a complementary technology that could help address some of the physical and logistical limitations associated with large-scale land deployment, while still relying on the same underlying principles of electrical stability and system control.

Taken together, these deployment and scaling challenges highlight a key point. Even as renewable capacity grows, its effectiveness depends heavily on the reliability of the electrical systems that manage energy flow and ensure operational stability. As these systems are pushed closer to their limits, the engineering demands placed on core components increase significantly.

This becomes particularly important when considering how similar principles would apply in space-based solar power systems where operational failure is not an option and maintenance is impossible.

Navigating the cost of SBSP

Alongside the technical complexities, cost is another factor that has held back developments in SBSP. The potential savings are huge once solar panels are successfully implemented in space, but the design, development and launch of the spacecraft will involve significant costs.

As the weight of spacecraft impacts the launch costs, all components, including resistors, will need to be as small and lightweight as possible. This needs to be achieved while ensuring all power demands are met, which is no easy feat for such a complex project.

Operating in space raises the stakes for any application, and so there will be a pressure to keep all electronic faults to a minimum to avoid project failure. Again, this is why load bank testing is so important in the development process.



Mike Torbitt

By reducing the need for land-based renewables in the continent, space-based technology has the potential to reshape the energy landscape once fully implemented. In fact, researchers at King's predict that SBSP could lead to savings of up to 15% of costs in Europe, equivalent to €35.9 billion per year.

SBSP has the potential to play a significant role in supporting Europe's net zero ambitions by enabling large scale, continuous renewable generation. Beyond its system level impact, the engineering challenges involved in developing and deploying such technology are likely to drive wider innovation in satellite design, power systems and high reliability electronics. Within that context, resistor technology remains a key enabling component, particularly where precision control and system protection are critical.

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