SPACE ENERGY INITIATIVE WHITEPAPER
JULY 2026

The case for Space Based Solar Power

Space Energy Initiative

SPACE ENERGY INITIATIVE
HELPING NATIONS ACHIEVE ENERGY SECURITY
WITH RELIABLE, AFFORDABLE, SCALABLE ENERGY FROM SPACE

"We may someday measure the size of our economy not in pounds but in megawatts. The sunlight striking the Earth in a single hour carries more energy than humanity uses in an entire year, and the countries that learn to harvest that abundance from space will lead the century ahead."

The world's energy debate has always been a debate about trade-offs. Firm sources such as nuclear and hydro deliver reliable, round-the-clock power but cannot scale freely or be exported, and carry their own environmental costs. Variable sources such as wind and solar are clean but generate only when the weather allows and impose heavy balancing costs on the grid. No existing technology is good at everything at once and the entire architecture of a modern power system, with its storage, gas back-up, curtailment payments and overbuilding, exists to compensate for that fact. The UK feels this acutely: it now has the highest industrial electricity prices in the developed world, an existential pressure on its ambition to be a competitive home for AI and advanced manufacturing.

Space-based solar power (SBSP) is the first technology that escapes this trade-off. The seven characteristics of an ideal energy source are reliability, affordability, sustainability, sovereignty, scalability, exportability and grid value, and measured against these it is the only source that scores strongly on all of them at once. It captures uninterrupted sunlight in orbit and beams it to receivers sited near where demand actually is, delivering continuous, dispatchable, low-carbon power that can be redirected between markets electronically rather than down fixed and costly interconnector cables. Space Solar's analysis points to a levelised cost of around £30/MWh at scale at today's launch costs, below every firm source and well below the true system cost of every variable source, falling towards £10/MWh as launch costs drop. Imperial College London has found that each GigaWatt of SBSP could save the UK energy system around £1–2bn a year.

Crucially, SBSP requires no scientific breakthroughs: every subsystem has already been demonstrated, so the task ahead is engineering and scaling rather than discovery.

How This Paper Is Structured

This paper sets out, in five sections, why space-based solar power deserves to be at the heart of the UK's energy strategy and what is needed to secure it.

It begins with Why New Energy Technologies Need Bold Innovation, framing energy as the engine of every leap in human prosperity and arguing that the AI era will be defined by the countries that solve the power question first. From there, The Seven Tests of an Ideal Energy Source introduces the framework — seven characteristics any genuinely good energy source must meet — and shows how today's firm and variable sources each fail on different tests. Space Based Solar Power then explains how a solar power satellite works and why this architecture, uniquely, can meet all seven tests at once.

The final two sections look forward. SBSP delivers strategic advantage for the UK sets out its strategic importance in reducing the very high cost of UK energy, and its pivotal role in the UK's energy security, national security, economic competitiveness, and technological leadership. What Needs to Happen Next identifies the four enablers — public funding, international collaboration, regulatory certainty, and public engagement — without which the opportunity will be lost. The Conclusion frames the choice facing government: support SBSP now and reap the benefits, or buy it from someone else later.

A short annex sets out the scoring rationale behind the seven-tests comparison for readers who want to go deeper.

A global race to capture this opportunity is already under way across the United States, Europe and Asia. The UK holds a genuine and rare lead through Space Solar's patented CASSIOPeiA architecture, but that lead is fragile: without near-term public funding to de-risk a first demonstrator, the UK will cede the ground and the supply chain, high-value jobs and energy sovereignty that come with it, just as it did with the jet engine, the computer and graphene. This paper sets out why SBSP is uniquely valuable, why the moment to act is now, and what government, investors and industry must do to secure it. The choice is stark: support it now and reap the benefits, or buy it from someone else later.

£1–2bn

saved per year in system costs

for every 2 GW of SBSP installed

Imperial College London analysis

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Why New Energy Technologies Need Bold Innovation

Photo by NASA on Unsplash.

Access to energy has underwritten every leap in human prosperity. Coal fired the steam engines of the first industrial revolution and made the UK an economic power; oil and gas built the modern economy. The countries that commanded energy commanded the century. We may someday measure the size of our economy not in pounds but in megawatts. Whoever controls the power controls our future. The artificial intelligence and data revolution will require energy on an unprecedented scale. Every nation that intends to compete in it must first answer a simple question: where will the power come from?

The world's energy landscape is changing faster than it can adapt. The World Economic Forum recognises that SBSP could play a critical role in our future energy system, responding to rising energy demand fuelled by population growth, electrification, big data, and AI. Even as renewable capacity expands, intermittency and land constraints pose major barriers. A resilient, decarbonised energy future will require not just scaling existing renewables but unlocking fundamentally new, 24/7 clean-energy sources.

GW per year per unit of critical minerals

A useful way to compare emerging energy technologies is to look at how much power they can deliver each year for a given quantity of critical-mineral input — the gigawatts of capacity produced each year per tonne of critical minerals consumed. This metric matters because the global energy transition is already placing severe pressure on critical-mineral supply chains: the WTO has highlighted that trade in energy-related critical minerals has grown more than seven-fold over the past two decades, and the International Energy Agency projects that demand for transition minerals could rise three- to six-fold by 2050, with battery storage alone driving a thirty-three-fold increase by 2040. A single GW of baseload battery capacity requires on the order of 19 GWh of cells, consuming the entire annual output of a tier-one mine, simply pushing the environmental burden upstream into the supply chain.

The reason this is a problem rather than just a logistics challenge is that mining these minerals at the scale required carries serious consequences, including habitat destruction, water depletion, tailings pollution, hazardous working conditions, and a heavy environmental footprint concentrated in a small number of host countries, around half of them on or near indigenous land. Solving the climate problem by displacing fossil-fuel emissions only to create a new mineral-extraction problem upstream is not real sustainability; it is the same burden in a different place.

It is precisely on this measure that SBSP stands out. A solar power satellite is engineered for minimum mass, uses no fuel, and delivers up to ten times more energy per unit of installed capacity than wind or solar at the surface (because there are no nights, no weather and no seasons in space). Compared on a like-for-like basis of firm, dispatchable power delivered to the grid, SBSP requires orders of magnitude less critical mineral input per unit of energy than an equivalent renewables system of wind, solar and battery storage. The reason is structural: wind, solar and batteries are very low in energy density, and thus in any firmed renewable system comprising wind and solar there is a huge critical mineral burden compounded by the need for battery storage and the generation overbuild needed to cover intermittency. Operating in near-continuous sunlight, SBSP delivers baseload power directly and removes most of that storage and overbuild.

No other firm, low-carbon technology comes close. For governments thinking seriously about the full environmental cost of the energy transition, this is one of the most consequential arguments for SBSP, and one of the least understood.

The Seven Tests of an Ideal Energy Source

Every debate about energy generation is really a debate about trade-offs. We have learned to accept that no single source can do everything: that firm, always-on power comes at the cost of flexibility or environmental impact, and that clean, scalable power comes at the cost of reliability. The storage, the gas back-up, the curtailment payments and the overbuilding that fill a modern grid all exist to paper over the fact that no individual source is good at everything at once.

It is worth being precise about what "good at everything" would actually mean. A genuinely ideal source would meet seven tests: it would be

- **Reliable 24/7,** available continuously regardless of weather, season or time of day;
- **Affordable** on the true, all-in cost of delivered electricity rather than headline generation cost alone;
- **Sustainable,** with near-zero emissions, much lower land use, orders of magnitude less critical mineral use and no hazardous waste;
- **Sovereign,** reduced dependence on imported fuel, foreign supply chains or transit states;
- **Scalable,** able to scale rapidly to meet rising global demand without hard geographic or material limits;
- **Exportable,** capable of serving more than one market without dedicated fixed infrastructure between each; and
- **High grid value,** dispatchable and supportive of grid balancing rather than imposing balancing and back-up costs on the system.

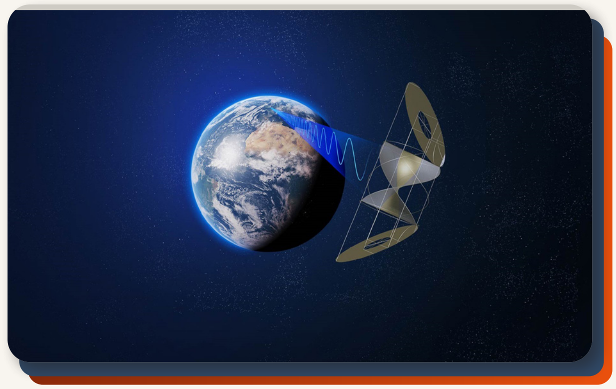
Measured against these seven tests, today's sources fall into two camps, each with a characteristic shape of strength and weakness. Firm sources such as nuclear, geothermal and hydro score well on reliability and grid value, because they deliver steady, controllable power. But they fail elsewhere. Nuclear faces challenges of waste disposal, very high new-build and decommissioning costs, slow pace of build, public acceptance in some jurisdictions, and depends on a concentrated global enrichment fuel supply chain. SMRs may offer improvements in cost and scalability, though that remains uncertain; geothermal and hydro are hostage to geology and geography, with most viable sites already developed; and none of them can be exported beyond a fixed cable to an immediate neighbour.

Variable sources (wind and solar) invert the picture. They are sustainable (though noting the comments on critical minerals use above) and increasingly scalable. But they produce only when the resource permits, cannot be scheduled, and impose substantial balancing, reserve and curtailment costs on the grid — costs the headline figures conveniently exclude. The price of wind and solar is rising, not falling. In the most recent Contracts for Difference auction (AR7, 2026), UK offshore wind cleared at around £91/MWh and solar at around £65/MWh (2024 prices), with offshore wind up 11% on the previous round. On top of that, the UK spent roughly £1.5 billion in 2025 on wind curtailment and the gas generation needed to replace it, a figure NESO forecasts could reach £4–8 billion a year by 2030 as more wind connects faster than the grid can carry it.

Space-Based Solar Power: The Ultimate Energy Source

Space-based solar power (SBSP) captures sunlight using large solar arrays stationed in orbit, typically geosynchronous orbit at 36,000 km, where panels receive uninterrupted, unfiltered solar radiation 24 hours a day. This energy is converted into microwaves and transmitted to Earth, where lightweight ground receivers (rectennas) convert it back into electricity and feed it into the grid.

Unlike terrestrial solar, SBSP is unaffected by weather, atmospheric filtering, nighttime or seasonal variation. This continuous availability makes it capable of providing baseload and dispatchable renewable energy, a function no existing low-carbon technology can provide at scale.

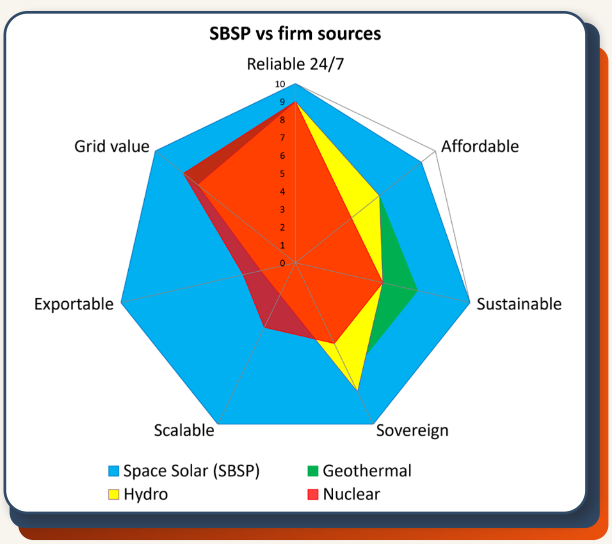


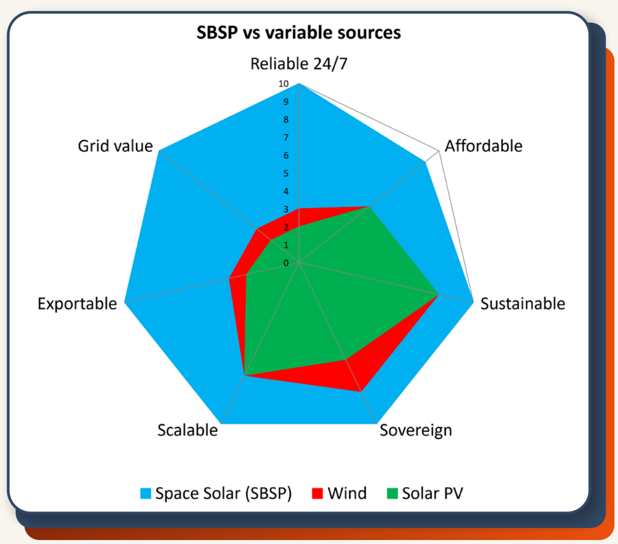
Design for UK-based Space Solar's CASSIOPeiA solar power satellite. Photo by Space Solar.

The Source That Passes All Seven Tests

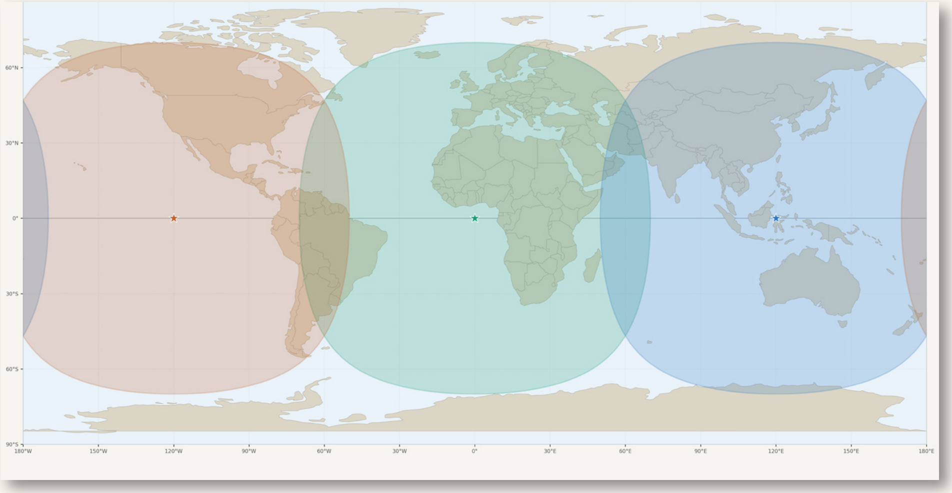
The comparison charts below tell the story at a glance. Against firm sources, SBSP matches their reliability while extending far beyond them on exportability, scalability and sustainability. Against variable sources, SBSP matches their sustainability and scalability while delivering the round-the-clock reliability and positive grid value they fundamentally cannot. In both comparisons, SBSP is the shape that fills the chart.

SBSP compared with firm sources and variable sources across the seven characteristics. Scores reflect Space Solar's assessment against publicly available characteristics; full rationale provided in Annex.





Key Advantages In Detail



Three satellites in geosynchronous orbit give complete global coverage, delivering power to any receiver with no cables or transit states.

Exportability

A satellite in geosynchronous orbit can see roughly a third of the Earth's surface. From a position above the prime meridian it can reach east as far as Tashkent and west as far as Rio, and its power beam can be steered electronically to any receiver within that footprint instantaneously, with no fixed cables, no transit states and no bilateral infrastructure agreements. One asset can serve multiple markets in turn, selling to wherever demand and price are highest as the world's clocks turn.

Grid value

Because the beam can be directed to a receiver sited near where demand actually is, SBSP reduces transmission losses rather than adding to them, and it can be dispatched to support the grid, including balancing the very wind and solar that struggle on their own. It is the rare source that creates positive system value instead of imposing system cost. This matters more than it first appears. Transmission and distribution — meaning the pylons and cables that move power around the country — account for roughly half the total cost of the energy system. Because a rectenna can be sited close to where demand is, SBSP delivers three distinct benefits at once: it reduces that transmission cost; it reduces the need for new pylons and cables; and, being fully dispatchable, it provides the essential grid-balancing service that keeps supply and demand matched at all times. The result is not only cheaper power but a more resilient grid.

The scale of these costs is easily underestimated. Building grid to reach distant generation is strikingly expensive. The 600MW Shetland HVDC subsea link cost around £660 million — more than £1.1 million per megawatt of capacity — and analysis for the energy regulator has estimated that better aligning the location of supply and demand through locational pricing could save consumers around £55 billion by 2050. SBSP attacks the same problem from the supply side: by placing firm generation next to demand, it avoids much of that cost rather than socialising it across bills.

Sovereignty

Once a satellite is in orbit, the energy it delivers needs no imported fuel and crosses no foreign territory. The receiving country owns the receiver, and the beam can be switched between suppliers if geopolitical circumstances change. For a UK-built satellite, that means UK-built energy sovereignty.

The single point on which SBSP does not score full marks is affordability, and that caveat is deliberate. Space Solar's analysis points to a levelised cost of £10–£30/MWh at scale, which would be well below every firm source and the true system cost of every variable one, but it has not yet been demonstrated commercially. We score it honestly. The trajectory is convincing; the proof point is the prize that early investment and government support would unlock.

£10–£30/MWh at scale

Target Levelised Cost of Energy (LCOE) — well below every firm source and the true system cost of every variable source.

Breakthroughs Accelerating Interest

SBSP has always been technically viable; what has changed is the economics. The same advances now drawing the world's largest technology companies towards power generation and infrastructure in space — chiefly a step-change in launch capacity and cost — are precisely what bring SBSP within commercial reach.

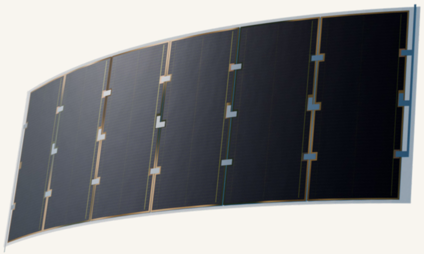
1 Dramatically Reduced Launch Costs

Perhaps the single greatest catalyst for SBSP is the reduction in launch costs and the increased capacity. Today's reusable heavy-lift vehicles have reduced costs to $2,000/kg, reaching the threshold needed to make small-scale SBSP financially plausible. Analysts believe Space X's Starship can reduce costs to $100–150/kg, dramatically cheaper and making large-scale SBSP economically attractive. Indeed, with vehicles capable of delivering 100-ton plus payloads per flight, launch is no longer the barrier it once was. Critically, Space Solar's CASSIOPeiA architecture has an economic and performance advantage that makes it competitive even at today's launch costs.

Fully reusable launch is bringing costs down by two orders of magnitude. Photo by SpaceX on Unsplash.

2 Ultra-Light Materials and High-Efficiency Solar Cells

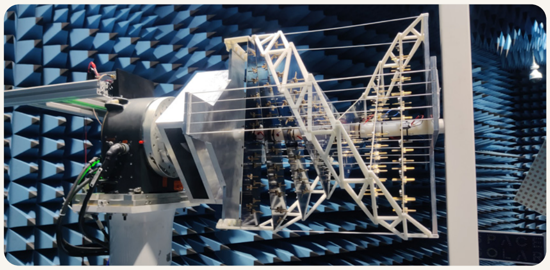
Recent technical advancements are strengthening the case for SBSP. High-efficiency GaAs/InP cells in orbit already capture sunlight at over 30% efficiency — far surpassing terrestrial panels limited to around 22%. Startups such as Arinna are developing ultrathin photovoltaics made from new semiconducting materials like transition metal dichalcogenides (TMDs). These atomically thin layers enable flexible, radiation-resistant solar cells that outperform silicon and rare-earth-based legacy panels. In the UK, the University of Cambridge is developing ultra-thin photovoltaics that are naturally radiation-hard, a particularly valuable property in the orbital environment.



Today's photovoltaics already have the specific power to make space-based solar power's economics work. Photo by American Pwoer Association on Unsplash.

3 Wireless Power Transmission

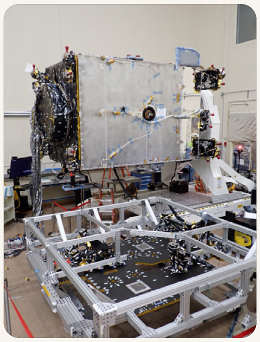
Demonstrations such as Caltech's Space Solar Power Demonstrator (SSPD-1) have transmitted power in space with its MAPLE experiment demonstrating stable pointing accuracy below one microradian. Overview Energy have proven they can transmit electricity from a moving aircraft to a solar array on the ground at 5km. In Japan a planned test will demonstrate energy beaming from space under the OHISAMA project at 450km. At ground level, rectennas convert the RF beam into DC electricity at typically 90% efficiency, occupying only around 40% of the land area of a solar farm of equivalent annual output.



Power beaming has moved from laboratory to field test — the physics is proven. Photo by Space Solar.

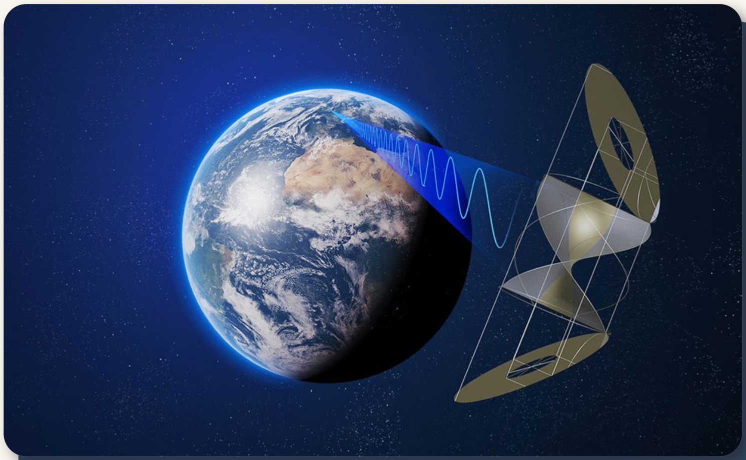
4 Autonomous In-Orbit Construction

Large-scale SBSP requires kilometre-scale solar arrays — not possible to assemble manually in space. SBSP is, however, particularly well-suited to robotic assembly. The hyper-modular architecture of a solar power satellite comprising thousands of near-identical units creates a highly structured, predictable environment in which robots can work efficiently. Space Solar has built and tested a prototype of its structural truss-assembly robot. In-Space Assembly and Manufacturing (ISAM) is a rapidly advancing field, and the same robotic capabilities that will build large telescopes and orbital platforms are directly applicable to assembling SBSP at scale.



Robots, not astronauts, will build the kilometre-scale structures this technology needs. Photo of OSAM-1 by NASA

A Surge in Global Activity



The race for the next energy source is already under the way around the world. Photo by Space Solar showing its CASSIOPieA design.

Around the world, governments, research institutions, and commercial players are investing in SBSP demonstrations and early deployment. Without support the UK will miss out on the growth opportunity and spillover benefits of developing SBSP that have been valued at over £56bn for Europe. Current activity includes:

United States

The conviction of the major hyperscalers that their AI-driven energy demand will outstrip what terrestrial grids can supply is now translating into commercial commitments for power from space. Overview Energy recently agreed to sell Meta 1GW of energy from their SBSP technology concept, demonstrating demand from industry. In the military sector the US Air Force are investigating the potential of SBSP to support activities in the Indo-Pacific with remote power.

Europe

TerraSpark, a Luxembourg startup founded in 2025, is building radio-frequency wireless transmission technology, and aims to demonstrate power beaming from space to Earth before the end of the decade.

Asia

While China's plans to develop a solar array at geostationary orbit have been talked about for some time, the latest updates indicate that it will also provide support to a variety of military activities. In Japan, SBSP has been a part of its space policy since 2009 and it is targeting its first orbital power beaming demonstrator launch in late 2026, building on decades of research into microwave transmission for SBSP systems.

UK

The UK has been at the forefront of recent SBSP developments. The Space Energy Initiative, founded in 2020, brings together the energy and space sectors advocating for SBSP. Space Solar is leading the development of their CASSIOPeiA design, successfully testing a proof-of-concept modular robotic assembly approach in 2025 following on from their 360-degree wireless transmission prototype test in 2024. They are now working at pace to develop the technology towards demonstration of a MW scale pilot plant in orbit by 2030.

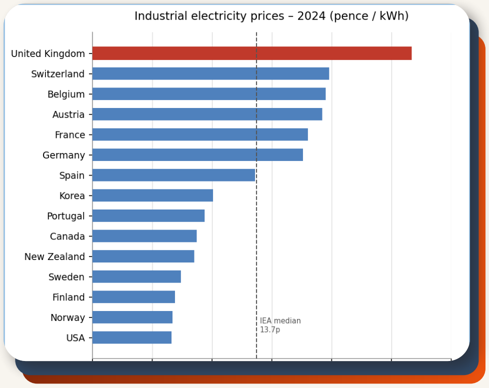
These global efforts mark a shift from speculative research to practical, mission-driven development. The same push is driving the emergence of orbital data centres (ODCs), which several of the hyperscalers are now actively exploring. As that investment scales the underlying capabilities of cheaper launch and reliable power in space, the economics of SBSP improve in parallel.

SBSP Delivers Strategic Advantage for the UK

Development of SBSP is not only about energy generation — it intersects with national security, economic competitiveness, and technological leadership.

1. Energy Security

The UK has a particular reason to care. It has the highest industrial electricity prices in the developed world: DESNZ's latest international comparison shows the UK paying more than any other International Energy Agency country reporting data, at around 27 pence per kWh in 2024, close to double the IEA median and several times the level in the United States, Canada or Korea. The pressure is now so acute that in April 2026 the government launched the British Industrial Competitiveness Scheme, cutting eligible manufacturers' bills by up to a quarter from 2027. But schemes like this do not lower the cost of generating power; they lift certain policy levies off some firms' bills and move the burden onto the Exchequer and the rest of the energy system. The underlying price and the competitive disadvantage remains, and most of the economy still pays it in full. The durable answer is not a standing subsidy but a new source of firm, low-cost, clean power: not a luxury, but a strategic necessity.



The UK has the highest industrial energy prices, a direct brake on advanced manufacturing. Industrial electricity prices, 2024. Source: DESNZ international industrial energy price comparisons (IEA basis, including taxes and levies).

This reframes what success in energy policy should mean. A growing body of analysis argues that the UK's organising goal should shift from simply adding clean capacity to delivering cheaper, abundant power, judging every decision by whether it lowers the total cost of the system rather than by gigawatts contracted. SBSP is not a "clean power" technology that adds to system cost in pursuit of a decarbonisation target; it is a "cheaper power" technology that reduces it — firm, dispatchable, sited near demand, and competitive on the all-in cost that consumers actually pay.

SBSP bolsters the world's energy security; it is a unique low-carbon energy technology like nothing else currently under development or deployment. Large scale systems could deliver power at £30/MWh with today's launch cost and much lower as costs fall. Even at this price SBSP is significantly cheaper than other baseload generation technologies and most renewable technologies but offers several distinct advantages that will reduce the final cost of electricity to the consumer:

No requirement for costly energy storage at scale

No requirement for gas fired back-up systems

No need to pay generation to turn off

No need to build additional transmission infrastructure

Due to SBSP's ability to beam power to the locations that require it, when it is required it can overcome many of the challenges associated with fixed renewables. For example, in the UK if the wind output is low overnight due to the weather conditions our electricity will need to come from a combination of gas, nuclear and energy storage sources. SBSP however, could beam electricity to a rectenna near London overnight, keeping the price of electricity lower for the whole country.

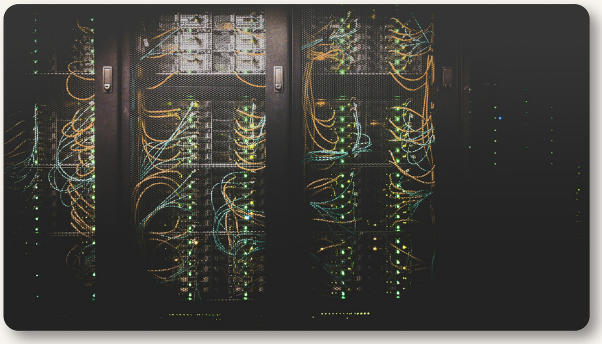
As SBSP can provide power to multiple locations it can access the existing transmission infrastructure without need for more costly cables once the rectenna site is built. In addition, as electricity demand changes around the world at different times of day there is no need to pay it to turn off when it's not required — it simply moves the beam to the next location with a demand for electricity.

Studies by Imperial College showed that every 2GW of SBSP installed into the UK energy system, saves over £1–2bn per year in energy system costs due to the ability to export, to reduce overbuilding of wind and solar and with the ability to switch between grid congestion points.

Strategic Advantage: AI Era, Resilience and Space Economy

2. Powering the AI Era: Affordable, Abundant, Clean

The defining challenge of the coming decades is to meet a steep rise in electricity demand, driven above all by the AI and data-centre boom, with power that is at once affordable, abundant and clean. Most technologies force a choice between those three; as noted in the sections above, SBSP does not. 99.9% of the energy in the solar system is in the sun, making it the long-term energy source for humanity. With baseload capability and enormous theoretical capacity, SBSP can complement terrestrial renewables, reduce reliance on fossil fuels, and accelerate progress toward net-zero targets. With global demand for electricity rising 15% in the last two years due to the rapid building of data centres supporting AI the need for clean baseload generation like SBSP is also increasing rapidly. Critically, SBSP can be scaled on the timescale the AI build-out actually demands: a first operational system this decade and rapid scaling thereafter, rather than the 2040s-and-beyond horizons of new nuclear or fusion.



AI's appetite for power is growing faster than the grid that feeds it. Photo by Taylor Vick on Unsplash.

There is a further, self-reinforcing reason why affordability matters so much. Electrification of transport, heat and industry is the primary route to decarbonisation, but it only happens if electricity is cheap enough that households and businesses choose to switch. When power stays expensive, demand stays weak, and the fixed costs of the system are spread across a smaller base, pushing unit prices higher still — a vicious circle that stalls the very electrification net zero depends on. No country has electrified at scale on high power prices. By adding firm, low-cost supply, SBSP helps break that circle: cheaper power encourages electrification, which broadens the base, which lowers unit costs further.

3. Energy Resilience

SBSP also offers a path toward global energy resilience, delivering clean electricity to remote, underserved, or disaster-affected regions without dependence on terrestrial infrastructure. Because rectenna sites can be quickly constructed and are geographically flexible, SBSP could enhance resilience against weather, conflict, or supply-chain disruptions.

Wind droughts and overcast skies mean weather-dependent renewables need expensive backup. Photo by Juan Pablo on Unsplash.

4. Strategic Advantage in the Space Economy

As launch capabilities expand and orbital manufacturing matures, SBSP becomes a cornerstone of a broader space-industrial ecosystem. Power becomes the next big bottleneck in space, and the companies and countries that master SBSP infrastructure could gain first-mover advantage in space construction, lunar power, and extraterrestrial resource utilisation. For the UK several opportunities stand out for the supply chain in high-efficiency solar cells, specialised electronics, microwave components, structural composites and assembly robotics.

> **"Power becomes the next big bottleneck in space, and the companies and countries that master SBSP infrastructure could gain first-mover advantage in space construction, lunar power, and extraterrestrial resource utilisation."**

What Needs to Happen Next

To support continued progress in SBSP and other frontier energy technologies, four strategic enablers stand out:

1. **Mission-Driven Public Funding**

   Like early offshore wind or semiconductor manufacturing, SBSP requires initial public-sector investment to de-risk early deployment, validate technologies, and build shared infrastructure. A targeted UK fund with public funding requiring private investment alongside it would de-risk the initial demonstrator programme while creating a UK based space energy supply chain.

2. **International Collaboration**

   Because SBSP systems cross borders and international standards for frequency allocation, beam safety, and environmental impact will be required. Collaborative frameworks reduce duplication and increase interoperability.

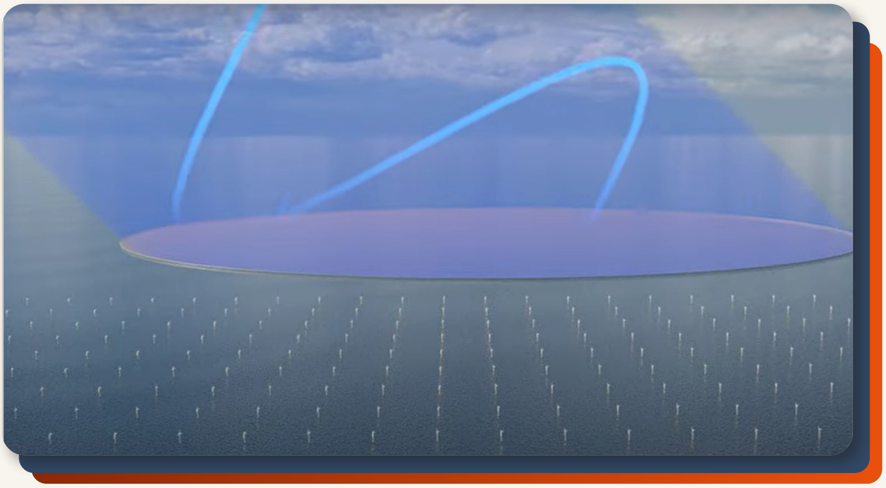
3. **Regulatory Certainty**

   Regulators must build policies that govern wireless power transmission, orbital sustainability, and environmental safeguards. Clear rules reduce risk, encourage investment, and ensure public trust.

4. **Public Engagement and Education**

   As with any emerging technology, public perception matters. Clear communication on safety, environmental benefit, and economic value is essential to building support.

One instinctive concern is worth dispelling directly. The phrase "power beamed from space" can conjure the image of a weapon; the reality is the opposite of dramatic. The transmission uses low-intensity radio waves, not a concentrated beam: at the centre of the receiving site the energy density is a small fraction of the intensity of midday sunlight, and it falls away to harmless levels at the edge. The system relies on a pilot signal sent up from the receiver to lock on, and simply disperses harmlessly if that signal is lost. Birds, aircraft and people can pass through it safely.



The rectenna is a low impact transparent mesh, less than 10% of the area of a wind farm, allowing for better use of the land.

A Transformational Opportunity for the UK

Now	2027–28	2029–30	2032–35	2040s+
Ground validation complete	Orbital wireless power demo	Mw-scale pilot plant in orbit	Commercial demo 100MW+	Grid-scale GW-scale deployment

Innovation in new energy technologies determines not only how we power our societies but how we shape our future. SBSP is no longer a distant dream — it is an emerging reality built on scientific breakthroughs, entrepreneurial ambition, and global collaboration. It has the potential to support our energy system in the near term and long into the future when today's renewables will be decommissioned.

By supporting SBSP innovation now — with funding, policy, research, and industrial partnerships — we unlock the potential for continuous, clean, globally accessible power that transcends the constraints of land, weather and time. In doing so, we prepare the world for an energy-secure future and help ensure that pioneering technologies become practical solutions.

The transition to a sustainable and resilient energy system will not be achieved through incremental improvement alone. It requires bold leaps. Space-based solar power is one of them — and with the right support, it could become one of the defining energy technologies of the 21st century. If we do not support it, we will be buying it from someone else.

This is not a hypothetical risk; it is a recurring pattern in British innovation. The jet engine was invented by Frank Whittle in the 1930s, yet it was the United States that turned it into a dominant commercial aerospace industry. The modern computer traces its origins to Alan Turing and the Colossus machines at Bletchley Park, but the industry that followed was built in California. Graphene was isolated at the University of Manchester in 2004, winning a Nobel Prize. Yet of more than 7,500 graphene patents filed worldwide, the UK accounts for only a few dozen. Britain has repeatedly led the world in invention and then watched others capture the value. Space-based solar power is a chance to break that pattern rather than repeat it.

This time, the UK enters not as a latecomer but from real manufacturing strength. SBSP demands a vast build-out of high-performance components, and Britain already leads in the underlying technologies: high-efficiency photovoltaics, compound semiconductors, carbon composites, precision robotics, power electronics, and space propulsion. Fully realised, it is one of the largest re-industrialisation opportunities open to the UK, anchoring high-skilled manufacturing jobs and supply chains across the country rather than seeing the value captured elsewhere

“Britain has repeatedly led the world in invention and then watched others capture the value. Having developed a market leading design of solar power satellite, the UK now has the chance to break that pattern rather than repeat it.”

About the SEI

We recognise the challenges of Net Zero, and the need for new baseload energy technologies to complement our intermittent renewables. The SEI will lead the development of Space Based Solar Power for the UK, offering large scale, safe, and secure energy day and night, through all seasons and weather. Through a structured and collaborative programme of design, research and technology demonstration, the SEI will promote integration and innovation between Space, Energy, Digital, and Manufacturing ecosystems.

Annex: Scoring Rationale

Each source is scored 1–10 against each characteristic (1–3 fails, 4–6 partially meets, 7–9 strongly meets, 10 fully meets with no caveats). Scores reflect a typical Northern European context, where the variability of wind and solar is most pronounced.

How the Sources Compare Across the Seven Tests

Sources: UK strike prices from DESNZ Contracts for Difference Allocation Round 7 results, 2026 (offshore wind ~£91/MWh, solar ~£65/MWh, 2024 prices); nuclear new-build benchmarked to Hinkley Point C; wind curtailment cost from NESO / Octopus Energy data, 2025. SBSP scoring reflects Space Solar's assessment of the CASSIOPeiA architecture against publicly available characteristics.

Source	Reliable	Affordable	Sustainable	Sovereign	Scalable	Exportable	Grid Value
SBSP	**10**	**9**	**10**	**10**	**10**	**10**	**10**
Nuclear	9	4	5	5	4	3	8
Geothermal	9	6	7	7	2	1	8
Hydro	9	6	5	8	2	2	7
Wind	3	5	8	8	7	4	3
Solar PV	2	5	8	6	7	3	2

Key findings from the scoring:

SBSP is the only source to score 9 or 10 in every category — the only technology that escapes the fundamental trade-off between firm power and scalability.

Nuclear scores well on reliability and grid value but poorly on affordability and scalability; current new-build costs exceed £110/MWh.

Wind and solar are sustainable and scalable but score 2–3 on reliability and grid value, requiring expensive storage and back-up to firm their output.

SBSP's one current limitation — affordability — is addressable through scale-up and falls within a known engineering and investment pathway.

Annex: Scoring Rationale (continued)

Reliable 24/7

Space Solar (SBSP) — 10/10

Continuous orbital geometry. No weather, no seasons, no night. The only interruption is brief eclipse periods around the equinoxes (up to ~72 minutes per day). Crucially, these are short, infrequent and entirely predictable — readily covered by modest local battery storage — and so are categorically different from the prolonged, unpredictable intermittency of wind and solar.

Nuclear — 9/10

~85–92% capacity factor in practice. Unplanned outages and refuelling shutdowns are real — France lost ~50% of its fleet simultaneously in 2022 due to stress corrosion inspections. High but not 100%.

Geothermal — 9/10

Continuous baseload, not weather-dependent. Slight deduction: reservoir output can decline as heat is extracted faster than natural recharge.

Hydro — 9/10

High capacity factor on managed reservoirs. Deduction: drought risk (increasingly significant with climate change). Run-of-river is more variable.

Wind — 3/10

Intermittent — produces when wind blows. Capacity factor typically 25–45%. Cannot be scheduled. Grid must carry backup capacity for periods of low wind across an entire region simultaneously.

Solar PV — 2/10

Intermittent and diurnal — zero output at night, reduced in winter/cloudy conditions. Capacity factor typically 10–25% in Northern Europe. Worst resource at peak demand (winter evenings).

Affordable

Space Solar (SBSP) — 9/10

Target levelised cost of £10–30/MWh at scale (depending on launch cost). No grid balancing cost imposed. Receivers sited near demand centres reduce transmission cost. Score 9 not 10: not yet demonstrated commercially.

Nuclear — 4/10

Hinkley Point C carries a contracted CfD strike price of £110/MWh in current prices. Sizewell C reached final investment decision in July 2025 at a projected capital cost of around £38bn (2024 prices). High capital, long lead times and persistent cost overruns.

Geothermal — 6/10

IRENA 2024 global weighted average around $60 USD/MWh. Competitive where geology is favourable. High upfront drilling cost.

Hydro — 6/10

IRENA 2024 global weighted average around 57 USD/MWh. Low operating cost once built. New large hydro expensive and geographically constrained.

Wind — 5/10

UK AR7 offshore wind strike price around £91/MWh (2024 prices), up 11% year-on-year. Raw global LCOE looks lower, but firming wind to be despatchable adds substantial system cost.

Solar PV — 5/10

UK AR7 solar strike price around £65/MWh (2024 prices). Same firming cost issue as wind. Solar plus storage for 24/7 reliability pushes system cost far above the SBSP target.

Sustainable

Space Solar (SBSP) — 10/10

Near-zero operational emissions, no fuel extraction or processing, and no waste. Land use is modest: a receiver (rectenna) requires roughly 40% of the land of an equivalent solar farm for the same annual energy output, and the site can be co-used. A peer-reviewed LCA of the CASSIOPeiA design estimates a lifecycle footprint of around 24 gCO_2e/kWh.

Nuclear — 5/10

Long-lived radioactive waste (10,000+ year containment). Uranium mining impacts. Low-probability, high-consequence accident risk. Near-zero operational emissions balance against genuine sustainability concerns.

Geothermal — 7/10

Does not heat the atmosphere. Real concerns: H_2S and CO_2 releases at flash steam plants; water use; subsidence; induced seismicity at EGS sites.

Hydro — 5/10

Reservoir methane can be significant — some tropical reservoirs are net GHG emitters. Habitat destruction, fish migration disruption, altered sediment flows.

Annex: Scoring Rationale (continued)

Sustainable (continued)

Wind — 8/10

Near-zero operational emissions. Land co-use possible. Deductions: visual and noise impact, bird/bat mortality, blade disposal challenge, mineral intensity.

Solar PV — 8/10

Near-zero operational emissions. Concerns: land use at utility scale, cadmium/lead in some panel types, end-of-life recycling not yet at scale, manufacturing energy intensity.

Sovereign

Space Solar (SBSP) — 10/10

Once in orbit: fully sovereign. No fuel imports, no transit states, no foreign infrastructure dependency. Receiving country owns the rectenna. Beam can be switched between suppliers if relations change.

Nuclear — 5/10

Uranium supply concentrated in a handful of countries; enrichment dominated by Russia and a few others. Fuel dependency is a real sovereignty risk.

Geothermal — 7/10

Domestic resource where geology permits. No fuel imports. Sovereign for the geologically lucky, unavailable for most countries.

Hydro — 8/10

Domestic resource where geography permits. No fuel imports. Shared river basins occasionally create diplomatic complexity.

Wind — 8/10

Predominantly domestic resource. Some turbine manufacturing supply chain concentration but components are multi-sourced.

Solar PV — 6/10

Panel manufacturing around 80% China. A supply chain shock could strand new deployment. Structural dependency remains despite diversification efforts.

Scalable

Space Solar (SBSP) — 10/10

Orbital resource effectively unlimited. Hyper-modular in-space assembly architecture scales continuously. No geographic constraint. Launch cost reduction unlocks economics progressively.

Nuclear — 4/10

Constrained by construction lead time, limited global supply chain for specialised components, public acceptance and regulatory timeline.

Geothermal — 2/10

Hard geology constraint. Conventional geothermal limited to volcanically active zones. Cannot meet global demand.

Hydro — 2/10

Hard geography constraint. Most suitable large sites in developed countries already used.

Wind — 7/10

Large global resource; offshore expands available area. Constraints at full scale: land/sea competition, grid connection costs, mineral supply chains.

Solar PV — 7/10

Enormous global resource. Constraints: land use at terawatt scale, manufacturing supply chains, storage required for reliability.

Annex: Scoring Rationale (continued)

Exportable

Space Solar (SBSP) — 10/10
Beam steerable in software to any rectenna within the satellite footprint (~40% of Earth's surface from a single GEO satellite). No cables, no transit states, no bilateral infrastructure agreements. One asset can serve multiple markets by time-sharing the beam.

Nuclear — 3/10
Uranium fuel is exportable; the electricity is not — the plant is immovable. Adjacent countries can interconnect via grid but range is limited.

Geothermal — 1/10
Effectively unexportable. The resource is the location.

Hydro — 2/10
Can export via HVDC to immediate neighbours only. Fixed geography, fixed corridors.

Wind — 4/10
Can export via subsea interconnectors, more flexibly than hydro/geo. But each corridor is fixed and expensive.

Solar PV — 3/10
HVDC export proposed (e.g. Xlinks Morocco-UK, around £24bn for a single 3.6 GW corridor). One market, one route.

Grid value

Space Solar (SBSP) — 10/10
Fully despatchable: beam can be steered to any rectenna. Receivers sited near demand centres reduce transmission losses and infrastructure cost. Can provide active grid balancing alongside variable renewables.

Nuclear — 8/10
Firm baseload — imposes no balancing cost. Despatchable within limits (ramping is slow). Does not require backup capacity.

Geothermal — 8/10
Firm, continuous, despatchable. Can ramp to support balancing. Fixed location limits ability to target demand centres.

Hydro — 7/10
Highly despatchable — especially pumped hydro, which can respond in seconds. Deduction: geography fixes location relative to demand.

Wind — 3/10
Intermittent — imposes balancing costs, reserve requirements and curtailment costs on the grid. At high penetration requires significant backup or storage.

Solar PV — 2/10
Intermittent and diurnal. Peak output at midday, not at peak demand (winter evenings). Imposes the largest balancing costs of any source at high penetration.

Notes

1. https://www.weforum.org/stories/2025/10/space-based-solar-power-energy-transition/
2. Tailings are the slurry of finely ground rock, water and residual processing chemicals left once the target mineral has been separated from the ore. Stored behind dams, they can contaminate groundwater and rivers through heavy-metal leaching and acid mine drainage, and carry the risk of catastrophic dam failure, as at Brumadinho, Brazil, in January 2019, which killed 272 people. For the risks and the resulting management standards, see the Global Industry Standard on Tailings Management, launched in August 2020 by the International Council on Mining and Metals, the UN Environment Programme and the Principles for Responsible Investment (globaltailingsreview.org). On the scale of mining waste implied by the energy transition more broadly, see IEA, The Role of Critical Minerals in Clean Energy Transitions (2021).
3. https://assets.publishing.service.gov.uk/media/61517f12d3bf7f71919a7f8f/space-based-solar-power-derisking-pathway-to-net-zero.pdf, p12
4. SSEN Transmission, World-leading Transmission project energised – first in Europe, 28 August 2024 (project value stated as £660 million for the 600MW Shetland HVDC Link, energised summer 2024). Available at: https://www.ssen-transmission.co.uk/news/news--views/2024/8/world-leading-transmission-project-energised--first-in-europe/
5. National Energy System Operator (NESO), Summer Outlook 2026, published 14 April 2026. NESO forecasts secure supplies but warns of more frequent periods of excess renewable generation, expanding its Demand Flexibility Service to incentivise consumption during sunny periods and reduce reliance on curtailment.
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