Agrivoltaic solar installation

Solar surge heralds a bright future

Exploring insights on some of the key emerging technologies and trends that are evolving to shape the industry.

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Around 560 GWdc of solar PV installations were projected for 2024, up about a third from 2023[1] and the five leading solar markets either kept pace or increased PV installation capacity in the first half of 2024, with China installing more than 100 GWdc and India installing more solar in the first half of 2024 than it did for the whole of 2023.

This surge of growth, coupled with increasing demand, continues to drive innovation, and we're seeing many exciting technological advancements come to fruition that are worth exploring in more detail.

Perovskite solar cells, which are known for their potential to achieve high efficiencies and be manufactured at a lower cost than traditional silicon cells, are reaching commercial readiness. Some companies are now integrating perovskite layers with silicon in tandem solar cells, boosting efficiencies beyond 30%, which is higher than typical silicon cells.

Perovskites are lighter and more flexible, allowing for innovative uses, such as in portable solar products, building materials and vehicles.

Building-integrated photovoltaics (BIPV) means solar technology can be integrated directly into building materials, such as windows, walls and rooftops, making solar power generation part of the building design. Transparent and semi-transparent solar panels for windows and facades are becoming more efficient, enabling buildings to generate energy without installing traditional solar panels on rooftops alone. Added to this, the efficiency and affordability of solar roofing tiles, which integrate seamlessly with building aesthetics, are improving and will appeal to those interested in more discreet solar energy installations.

We all know about floating wind farms, however, floating solar farms, which can be installed on reservoirs, lakes and other bodies of water, are expanding rapidly. This approach will be particularly useful for land-scarce countries and will also help to reduce evaporation from water bodies while simultaneously generating energy.

Some developers are now starting to deploy offshore floating solar farms. This has really exciting potential to revolutionise access to electricity, for example in Indonesia, a nation of more than 10,000 islands, where more than 1 million people have no access to the electricity grid[2]. It will also be a critical development in densely populated coastal regions, such as the Netherlands, where space on land is limited and greatly needed for housing, recreation, industry, roads and agriculture. Moving solar energy installations to bodies of water not only relieves spatial pressures on land but in most cases, will not even be visible from the shore which is a huge plus point for concerns around visual impact.

Furthermore, offshore solar can also be paired with wind farms to optimise energy generation in areas with high wind and sun exposure.

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Combining solar with agriculture is nothing new, but the latest adjustable and/or semi-transparent solar panels are enhancing light management, optimising conditions for both crop growth and energy production. This dual-use model is particularly appealing in areas where land is shared for food production and energy generation. Indeed, some studies are showing that certain crops can benefit from the shade provided by solar panels, improving land productivity and quality while generating additional income for farmers.

Increasingly, we are seeing solar and battery energy storage hybrid systems being consented and moving to build. Battery technology advancements combined with decreasing costs, have made solar plus storage systems more accessible and efficient, providing a reliable power source during night hours and low-sun days. Hybrid systems that combine solar with other renewables, like wind or hydropower, provide more consistent and reliable energy output. Then pairing this with energy storage means systems can serve as microgrids for off-grid or remote areas, providing resilience for communities during outages and natural disasters.

The idea of community solar is furthering access to shared systems through new financing and incentive structures to support equitable solar power access.

Developments in the areas of artificial intelligence and the Internet of Things (IoT) technology are being used to monitor and optimise solar panel performance, predict maintenance needs and increase overall efficiency. For example, AI-driven systems and smart inverters enable solar installations to respond to grid conditions, such as shifting solar output based on demand, stabilising the grid and improving energy flow.

There is also research into other grid stabilising solutions including thermal storage of utility-scale power and new advanced material technology and cooling techniques to push for better efficiency that will also support the viability of large-scale power generation.

As the industry matures and older installations reach the end of their lifecycles, recycling programs are expanding and manufacturers are developing panels with recyclable materials that will enable more efficient recycling of components like silicon, glass and metals. The newer solar panels use less energy-intensive production methods and some are developed with eco-friendly materials, making solar power more sustainable from production to disposal.

To summarise, 2024 was an exciting year for solar. It's no longer limited to the traditional rooftop or ground-mounted installations. Innovations like agrivoltaics, floating solar farms, transparent BIPV and materials development are expanding accessibility and the breadth of applications, enhanced storage solutions and AI-driven efficiency are driving versatility, resilience and long-term sustainable options that underpin the central role solar plays in the global energy landscape.

Floating solar installation

Solar window technology in commercial setting

Case study: solar capacity assessment for proposed floating solar

Project overview

Natural Power was commissioned to conduct a solar photovoltaic (PV) capacity assessment and energy yield assessment (EYA) for a proposed floating PV system. The project, located in a lake in England, will be connected in a behind-the-meter configuration, supplying power to two industrial off-takers.

Scope of work

The primary objectives included assessing suitable system sizing for the floating PV installation and conducting an energy yield analysis using industry-standard methodologies. The study involved modeling a 1 MWp floating PV array in PVsyst to produce an hourly generation time series and analysing the viability of different solar farm capacities in relation to the off-takers' energy consumption.

Technical approach

The proposed system design comprises monofacial, monocrystalline silicon modules mounted on fixed-tilt floaters with string inverters for direct-to-alternating current conversion. A base case of 1 MWdc was used to obtain a generation profile over a period that was concurrent with the available off-taker energy consumption data. The hourly time series was then scaled to be representative of different DC capacities at a high level and compared with the consumption data.

Five different solar farm capacities were analysed, considering their ability to meet the off-takers' annual consumption and the percentage of energy curtailment.

The study highlighted that for capacities exceeding 5 MWp, the increase in curtailment outweighed the benefits of higher energy supply to the off-takers.

Key findings and recommendations

Optimal system sizing: the analysis indicated that larger solar capacities resulted in diminishing returns due to increased curtailment. Financial considerations such as export tariffs, seasonal variability in energy pricing and potential future changes in demand should be factored into the final capacity selection.

Battery energy storage system (BESS) feasibility: a BESS was recommended to store excess solar generation for use during high-consumption periods, particularly in the mornings and evenings when solar generation is low, but demand remains high.

Environmental and design considerations: a detailed layout design should be completed to refine capacity estimations. Additionally, an avian survey assessing local bird populations and migration patterns is recommended to inform soiling potential and cleaning strategies.

Advanced energy yield assessment (EYA): as the project advances, a site-specific EYA incorporating local shading objects, cable routes and electrical losses was advised.

Natural Power's assessment provided key insights into optimising the floating PV system's size and performance. The recommendations, including consideration of BESS and further site-specific analysis, will help the client refine the project design and maximise its operational efficiency.

About Natural Power

With solar power being the largest renewable energy sector in the world, Natural Power has built a specialist team of solar energy experts that can look at the potential and development of new solar sites and deliver solar projects. It offers support and advice on the successful development of solar and energy storage projects, from early-stage feasibility analysis to repowering and the optimisation of existing asset performance.

Natural Power is an independent consultancy and service provider that supports a global client base in the effective delivery of a wide range of renewable projects including onshore wind, solar, renewable heat, energy storage and offshore technologies. It has a global reach, employing more than 500 staff across 14 international offices.

Its experience extends across all phases of the project lifecycle from initial feasibility, through construction to operations and throughout all stages of the transaction cycle.

www.naturalpower.com/uk/expertise/sector/solar

www.linkedin.com/company/natural-power

References

[1] www.nrel.gov/docs/fy24osti/91209.pdf

[2] www.bbc.co.uk/news/business-63728020