Solar solutions for a sustainable maritime sector

As one of the world's most challenging sectors to abate, shipping must transform the way it powers its fleets if it is to meet international climate goals. Joep Groot, COO at MarineSolar Energy Solutions[1], explains how solar technology can help.

Over the past decade, maritime stakeholders have made significant strides in improving vessel efficiency, from optimising hull design to refining engine performance and adopting energy-saving technologies. However, despite these gains, overall emissions have continued to rise. A growing global fleet and increasing trade volumes have outpaced the benefits of efficiency alone, which means that the industry needs to consider a different approach.

This is increasingly reflected in the regulatory landscape. The EU has taken a leading role by introducing measures such as the EU Emissions Trading System (EU ETS), which places a price on carbon emissions from shipping, and FuelEU Maritime, which sets limits on the carbon intensity of the energy used onboard vessels. Together, these policies are designed to accelerate the sector's transition beyond incremental efficiency gains toward lower carbon energy solutions.

Other governments, including the UK, as well as international bodies such as the International Maritime Organization (IMO), are moving in a similar direction, developing their own proposals and frameworks as part of the wider push toward achieving net-zero emissions in maritime by 2050.

As a result, shipowners and managers are increasingly being pushed to consider alternative energy pathways. While options such as biofuels, hydrogen, ammonia, methanol and battery-based systems are gaining attention as potential routes to compliance and long-term decarbonisation, they also introduce a significant challenge: cost. Most alternative fuels and energy systems introduce higher operating expenses, adding financial complexity to the already capital intensive maritime sector.

Free green fuel

One often overlooked category in the search for alternative fuels is energy that is freely available from nature; both wind and solar are abundant and renewable sources that can help reduce reliance on fuel-based power onboard vessels.

Wind Assisted Ship Propulsion (WASP) technologies are already gaining traction across the maritime sector, helping vessels capture natural wind energy to supplement propulsion and improve efficiency. Yet, despite offering similar advantages, solar has received far less attention.

Solar power represents a highly accessible and practical way to reduce a vessel's overall energy demand. While it is not intended to replace main propulsion, it can supply clean electricity to a wide range of onboard systems, including navigation, accommodation, cargo handling and engine room operations, as well as WASP systems. By generating power directly onboard, solar reduces the load on auxiliary engines and generators, displacing energy that would otherwise be produced through fuel consumption.

While the concept of harnessing solar energy at sea may appear straightforward, its successful implementation depends on solutions specifically engineered for the harsh maritime environment. Vessels operate in extreme conditions, with constant motion, salt exposure and strict safety and performance requirements.

In recent years, advances in materials science and engineering have yielded robust, efficient, and cost-effective solar technologies specifically designed for maritime applications. For example, MarineSolar has developed a modular solar system that can transform the vast unused surfaces of ships into active energy assets.

By harvesting solar energy, this system generates three-phase AC electricity that feeds directly into the vessel's power grid. In effect, it provides ships with a source of free green fuel, delivering renewable electricity at minimal operational expense after installation.

Designed to withstand the harsh marine environment, the system converts sunlight into electricity with high efficiency. Unlike other energy sources that rely on complex production and conversion chains, this power generation process is inherently efficient. It captures up to 25% of solar energy and delivers as much as 80% to 90% of that to the ship's electrical system.

In contrast, e-fuels such as hydrogen or ammonia must first be produced using renewable power, stored, transported, and then reconverted to electricity, losing significant energy at each stage. Even conventional diesel generators operate at efficiencies below 50%. The result is that direct solar generation offers one of the most efficient pathways for decarbonisation.

While some clean technologies are designed to replace conventional systems entirely, solar serves as a complementary solution that enhances efficiency and carbon performance. It fits perfectly alongside other green energy solutions like e-fuels and wind-assisted propulsion, as well as energy-saving devices like air-lubrication, hybrid battery propulsion and ultrasonic systems.

Additionally, it is compatible with both existing diesel-powered ships and new vessels designed for alternative fuels such as ammonia or hydrogen, making it a powerful addition to any decarbonisation strategy.

The technology supporting solar for maritime applications is still relatively young, and ongoing advances in efficiency and materials mean that its performance will continue to improve over time. Recognising this, modern systems such as MarineSolar's are designed to be easily upgradeable, allowing vessels to incorporate new, higher-efficiency panels and components as they become available.

This future-proof approach ensures that ships can continuously benefit from technological progress without requiring a complete system replacement, maximising both the environmental and financial return on their solar investment. Additionally, older materials can be responsibly recycled or repurposed, supporting a circular economy and reducing the environmental impact of system upgrades.

Measurable, verifiable impact

Another important advantage of solar solutions is the ability to measure their impact with a high degree of accuracy. As regulatory reporting requirements continue to expand, shipowners and managers are under increasing pressure to demonstrate not only their emissions reductions, but also how those reductions are achieved.

Unlike most other emerging technologies, including WASP, where performance improvements may rely on modelling or estimated savings, solar systems generate clear, verifiable data on energy production and associated emissions reductions.

This is crucial considering that emissions monitoring and reporting requirements have increased significantly in recent years, and that further obligations are expected as new frameworks are introduced.

As these requirements expand, so too will the administrative burden on shipowners and managers. They therefore need simple, reliable reporting tools that can automatically capture and verify operational data, allowing it to be seamlessly integrated into existing compliance and reporting systems.

Accurate and validated data also has value beyond regulatory compliance. It can support commercial transparency between shipowners and charterers, for example, by enabling verified reporting of energy use and associated emissions reductions. In some cases, data may also be used to support mechanisms such as Scope 3 insetting, helping shipping organisations demonstrate progress against their wider decarbonisation commitments.

Operational visibility is equally important. Test rigs fitted with intelligent automation tools autonomously collect and securely transmit data every 30 minutes. Once processed, the data can be visualised through dashboards, allowing users to securely access and monitor energy production, battery performance, and environmental conditions through intuitive maps and graphs.

Solar generation is also highly predictable. Output can be forecast based on the vessel's operational schedule and weather predictions, enabling more accurate planning for energy demand, voyage optimisation, and fuel consumption.

In addition, this continuous monitoring can highlight maintenance needs in real time, such as identifying broken or dirty panels, ensuring the solar system operates at peak efficiency and prolonging its service life.

Powering the path to net zero

The transition to cleaner shipping will not be achieved through a single technology or fuel, but through a portfolio of complementary solutions. As vessels move toward alternative fuels and greater electrification, onboard solar power generation will play a critical supporting role in providing emission-free energy, reducing overall emissions and contributing to competitive operating costs.

Joep Groot

Solar technology also brings a unique economic advantage. Once installed, these systems have negligible operational expenses and long service lifetimes, unlike fuels that must be continuously purchased or replenished. This makes solar both a sustainable and a financially prudent choice.

Moreover, by contributing to a vessel's energy efficiency and lowering its net carbon output, it directly supports compliance with the FuelEU Maritime and the IMO's anticipated NZF regulations, reducing costs for emission allowances while helping operators improve their carbon-intensity indicator (CII) scores.

Ultimately, solar technology is one piece of the decarbonisation puzzle. It is an alternative zero-carbon energy source that complements other low-carbon technologies and devices, lowers operating costs, and strengthens the industry's collective path to net zero.

The decarbonisation of shipping demands both innovation and realism. Efficiency improvements will remain essential, but the future lies in harnessing cleaner, smarter, and more integrated energy systems. Solar is not a distant prospect or an experimental technology. It is deployable today, on existing fleets, without waiting for new fuel infrastructure to mature.

For shipowners, managers and charterers, solar delivers immediate energy savings, lowers operational emissions and reduces operating costs, making it one of the most pragmatic investments available.

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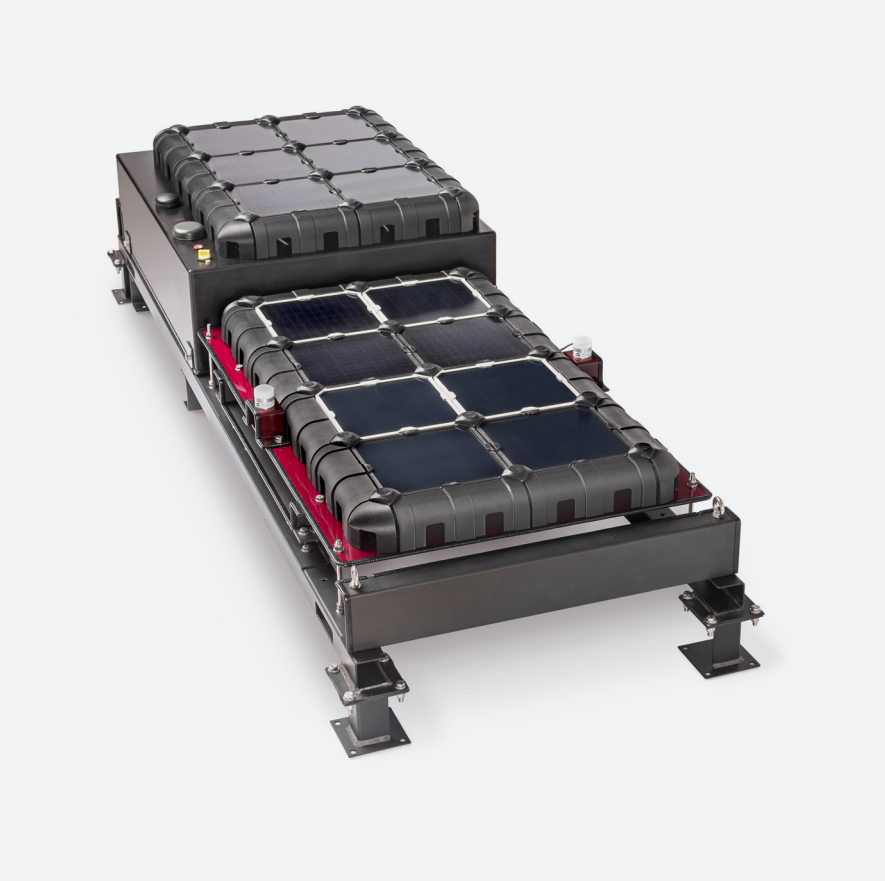

Reference

[1] MarineSolar Energy Solutions is the trading name of Grafmarine.