Cool ideas for a bright future

Words: Bob Long, Executive Chairman at Organic Heat Exchangers and a Fellow of the Institute of Refrigeration

As industries seek more sustainable and cost-effective solutions, the integration of cold thermal energy storage with solar photovoltaic systems offers a promising opportunity. By storing excess solar energy as cold, businesses can optimise cooling efficiency, reduce electricity costs and support decarbonisation efforts.

The integration of cold thermal energy storage (CTES) with solar photovoltaic (PV) systems presents a transformative opportunity for industries with high cooling demands.

By storing excess solar energy as cold; for example as ice, chilled water, or phase change materials; businesses can shift cooling loads to off-peak hours, reduce electricity costs and enhance their solar utilisation. Ultimately, this approach minimises reliance on fossil-fuel-based cooling systems, supporting decarbonisation efforts and sustainability goals.

Key industrial applications include food processing and cold storage, where refrigeration systems can operate more efficiently; pharmaceutical and chemical industries, which require stable cooling for temperature-sensitive processes; data centres, where cooling demand is continuous; and large industrial HVAC systems, which benefit from optimised air conditioning.

Various technologies enable CTES integration, such as phase change materials (PCMs), chilled water storage, ice-based storage and thermal batteries. However, challenges remain, including high capital investment, space constraints and system integration complexities. Advances in high-density thermal storage materials, AI-driven energy management and policy incentives are expected to drive adoption further.

This article explores the potential, applications, technologies and future developments of integrating CTES with solar PV, offering insights into how industries can harness this synergy for cost savings and energy efficiency.

How does cold thermal energy storage work?

CTES involves storing cooling capacity in the form of ice, PCMs, or chilled water, during periods of low energy demand such as at night when electricity rates are lower. This stored cooling energy can then be used to offset peak cooling loads during the day, reducing the strain on active cooling systems, cutting overall electricity consumption and flattening the power load curve.

EnergiVault technology, which was developed by Organic Heat Exchanger (O-Hx), takes this concept to the next level. Unlike traditional ice-based storage which can be bulky and inefficient, EnergiVault uses advanced PCMs that allow for greater energy density and power transfer. This makes it a more compact, scalable and highly effective solution for modern cooling challenges, such as data centres.

The cold thermal energy storage technology provides an innovative solution for integrating solar PV systems into industrial applications, addressing energy intermittency and ensuring efficient, round-the-clock energy usage. By combining advanced thermal storage systems with renewable energy sources and chilled water systems, it unlocks the potential for industries to achieve higher energy efficiency, cost savings and sustainability.

Conventionally, lithium-ion batteries are installed to soak up excess generation, however, where facilities have centralised chillers supporting air conditioning or process cooling, EnergiVault offers a much more cost-effective solution, in addition to enabling chiller optimisation, peak cooling capacity and backup cooling resilience.

The benefits

Energy capture and storage

Solar PV systems often produce excess energy during peak sunlight hours. EnergiVault captures this surplus energy and stores it as cold thermal energy in a highly insulated, efficient cold storage medium. This enables the use of solar energy during dull or dark periods, such as evenings or cloudy days, effectively mitigating the intermittency issues associated with solar power and doing so more cost-effectively than lithium-ion batteries.

On-demand energy supply

The stored thermal energy is used directly for industrial processes that require cooling, refrigeration, or low-temperature operations, supporting existing chilled water circuits. This flexibility ensures that energy is available precisely when needed, reducing reliance on grid electricity and fossil fuels.

The application of EnergiVault highlights where storing cold thermal energy delivers major benefits over an electrical battery plus chiller. It provides seamless cooling support, no high inrush currents to start up chillers, no oversizing battery inverters for direct chillers, but low power input and high cooling power output.

Peak shaving and load balancing

The technology enables industries to draw on stored energy during peak demand periods when grid electricity is more expensive, or chillers lack capacity such as in high summer ambient temperatures. By levelling energy consumption and avoiding costly demand spikes, businesses can flatten their demand curve, alleviating capacity constraints whilst achieving significant cost savings and demand response value.

Efficiency and environmental impact

EnergiVault is designed to operate with minimal energy losses, ensuring high system turnaround efficiency. By leveraging the abundant and renewable energy generated by solar PV, the system helps industries reduce their carbon footprint. Additionally, the technology supports the global transition to net zero energy systems by enabling greater adoption of renewable energy in sectors traditionally reliant on non-renewable sources.

Industrial applications

Refrigeration and cold storage

For industries like food processing, pharmaceuticals and data centres, where temperature control is critical, EnergiVault seamlessly integrates with solar PV and centralised chillers to maintain stable cooling, even during power outages or off-peak solar production hours.

Manufacturing processes

Many industrial processes require consistent energy inputs, which solar PV alone cannot provide due to its variability. EnergiVault bridges this gap by ensuring a continuous cold energy supply, boosting chiller and operational efficiency.

Energy intensive operations

Industries with high energy demands during daylight hours can use solar PV for real-time operations and store excess energy for chilled water applications during off-hours, optimising energy usage and reducing overall costs.

A scalable solution for the future

As well as its responsiveness, one of the stand out features of EnergiVault is its scalability. Whether deployed in small-scale single facility sites or large hyperscale developments, the system can be customised to fit different cooling requirements. The modular design enables easy integration into existing infrastructure, making it a practical upgrade for both new build and legacy projects.

Integrating the cold thermal energy storage technology with solar PV installations is a revolutionary approach for industrial energy management where cooling is a major part of the load. By maximising renewable energy usage, providing reliable energy storage and delivering cost savings, the solution addresses key challenges in the transition to sustainable industrial operations. With its adaptability across various industries, it empowers businesses to achieve energy resilience and align with global sustainability goals.

The increasing deployment of CTES presents a major opportunity for the solar industry, enhancing both the viability and attractiveness of PV systems. By enabling the storage of surplus solar energy as cold, CTES maximises self-consumption, reduces grid dependency and improves the economic case for industrial PV adoption. This will drive greater demand for larger solar installations, expanding the market.

Furthermore, CTES helps stabilise the grid by addressing the intermittency of solar power, ensuring energy flexibility and power quality for industrial users. As industries with high cooling needs, such as food processing, pharmaceuticals and data centres, increasingly adopt CTES, the solar sector can diversify revenue streams and enter new industrial cooling markets.

Additionally, it strengthens the business case for solar-plus-storage projects, reducing energy costs and shortening payback periods. This improves financing prospects and attracts further investment into solar energy infrastructure. With growing regulatory support for decarbonisation and clean energy policies, the solar industry is well-positioned to benefit from incentives that promote integrated solar and thermal storage solutions.

By capitalising on CTES adoption, the solar industry can accelerate growth, enhance grid integration and play a crucial role in industrial energy sustainability.

About the author

Bob Long

Bob is a distinguished refrigeration engineer with more than 45 years of experience in refrigeration and thermal energy management.

Bob has established himself as an expert in refrigeration engineering, particularly in the development of innovative solutions in ice technology and industrial heat pumps.

He is a Fellow of the Institute of Refrigeration, which is a testament to his expertise and contribution to the industry.

About O-Hx

Organic Heat Exchangers is revolutionising the approach to AI-driven industrial cooling, providing global access to cool energy storage. It provides dynamic cooling technology for industrial refrigeration through its trademarked EnergiVault technology.

The team is comprised of industry-leading engineering and refrigeration experts, including founder and Executive Chairman Bob Long, Fellow of the Institute of Refrigeration; Geoff Barker, Product Director, Fellow of the Institution of Mechanical Engineers and a Chartered Engineer; Dr David Kane, Software Director; and David Grundy, Finance and Commercial Director.

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