Cool power tech energising the renewables mix

Words: Geoff Barker, Product Director at Organic Heat Exchangers

In tandem with continual progress to increase the share of renewables in the energy mix, the demand from refrigeration, air-conditioning, and heat pumps will surge dramatically during the next few decades. Global cold demand accounts for approximately 20% of total electricity consumption and is currently increasing at a rate of approximately 13% per year.

This growth of intermittent renewable energy sources is driving the need for efficient and cost-effective energy storage technologies, where the use of CTES is often overlooked. It is estimated that there are more than two million installations of central chilled water plants around the world, with greater than 400 kW of cooling demand. These installations, for the most part, don't have any thermal energy storage and therefore no flexibility. Many of these installations are now adding solar PV or sourcing renewable power, and by adding dynamic CTES to the microgrid, major energy, carbon and resilience benefits can be accrued.

CTES enables many different facilities, such as data centres, drug manufacturers, food producers and commercial buildings, for example, to efficiently store cooling capacity during off-peak hours when prices are low, reducing their peak electricity demand. This load shifting not only reduces energy bills but also helps optimise on-site renewable generation and engages with utilities demand response programmes, where high electrical demand chillers can be replaced by CTES for periods of several hours, helping to balance the grid more effectively.

Vitally, CTES also enhances resilience by providing peak capacity when chillers are at their limits, then continue with backup cooling capacity during power outages or grid disruptions. This is particularly important for hospitals, data centres, and other industries where cooling is mission-critical for operations.

As the global digital economy expands, so too does the need for effective cooling solutions for data centres. These facilities require massive amounts of cooling to operate efficiently, and CTES can help these facilities maintain optimal temperatures while also lowering energy consumption and reducing environmental impact.

Our thermal energy storage experts at Organic Heat Exchangers, are already starting to revolutionise this approach in global industrial cooling applications with EnergiVault®, a cold thermal energy storage battery and charger system that provides dynamic cooling power.

EnergiVault CTES is an enabler of renewable energy generation, particularly behind the meter, where on-site generation combined with dynamic CTES can deliver flexibility in centralised chilled water systems that were previously unavailable.

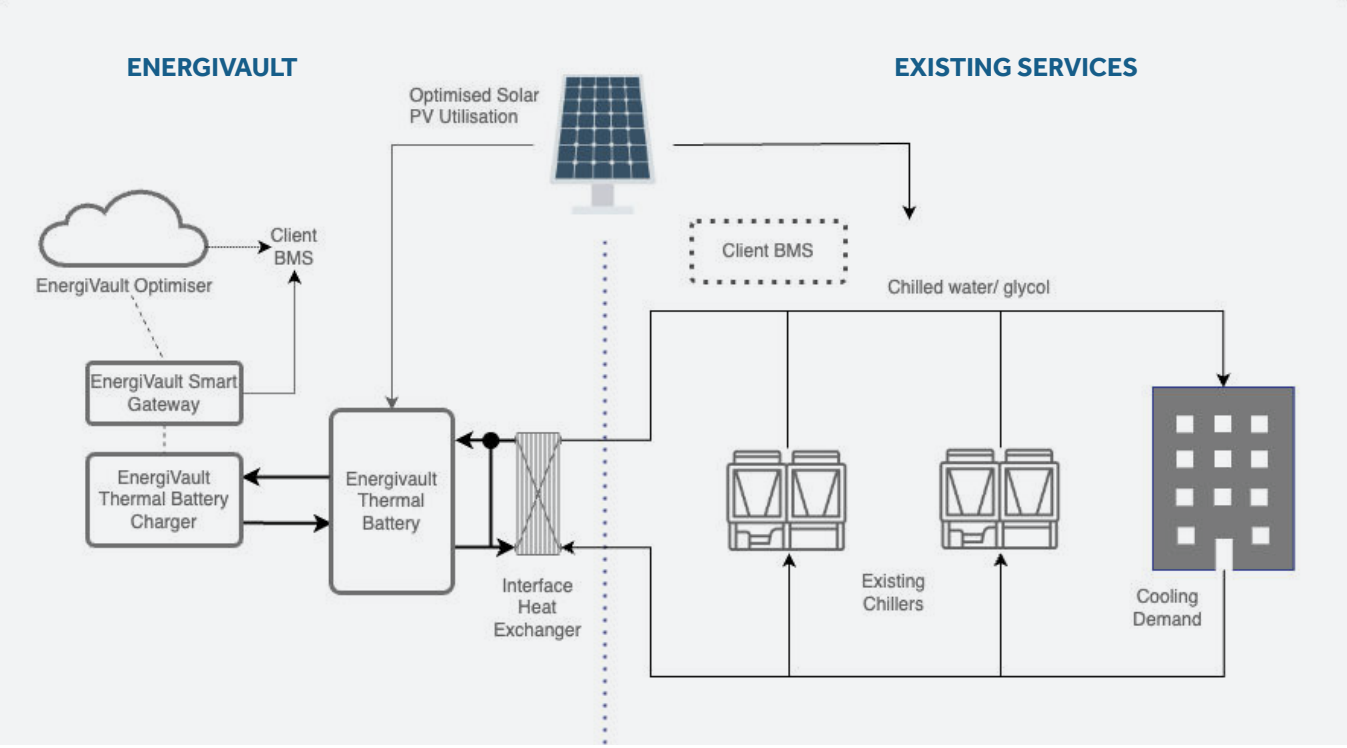
By combining EnergiVault with chillers and solar PV, the system delivers both energy and CO_2 savings. By adding flexibility, it can flatten chiller load curves, optimise and maximise the use of onsite renewable energy generation and reduce chilled water electrical demand during high grid carbon intensity periods of the day and coincidentally high-cost periods too. This microgrid type of installation with renewable PPA agreements greatly enhances the energy service providers' value offering savings to the end user, and during a lifetime of 20 years, will deliver enhanced PPA rates and utilisation.

EnergiVault is different from other CTES approaches such as chilled water and solid ice storage. It is a hybrid of chiller water and solid ice, having the energy density of solid ice and the dynamic response of chilled water, without their limitations. Chilled water storage volumes are more than eight times that of EnergiVault and solid ice systems are not suitable for flexibility applications where discharge rates are below three hours.

These challenges have triggered a rapidly growing interest in dynamic cold thermal energy storage (CTES). The combination of intermittent renewable power generation and increased cooling demand requires energy storage to achieve greater flexibility. The use of highly dynamic CTES offers solutions that electrical batteries and chillers simply cannot provide.

The global CTES market is forecast to expand by more than 14% to 2028, and it is expected that by the middle of the next century, the energy consumption of cold demand will exceed that of heat demand. Against the backdrop of climate change and global population increases, the cold supply chain is facing a massive challenge.

With rapid urbanisation, industrial growth, and increasing climatic temperatures, the global demand for cooling, including air conditioning, refrigeration and cold energy storage, is rising. Particularly in warmer regions, energy-intensive cooling systems are becoming more widespread.



It stores latent heat in freezing tiny water particles and this characteristic allows high-efficiency charging of the thermal battery, compared to equivalent solid ice storage systems, and ultra-high discharge cooling for peak and transient cooling demand management.

This first-of-its-kind, AI-driven technology has been developed to enhance operational resilience, reduce energy costs and lower carbon emissions for facilities that use water chillers to deliver their cooling requirements.

EnergiVault's thermal energy storage system comprises a thermal battery charger (refrigeration module) and thermal battery (energy storage) with dynamically controlled cooling delivery. This system uses a combination of predictive analytics, machine learning and AI to optimise the operation of the energy assets such as chillers and on-site renewable energy generation. By combining cooling demands, weather and energy price data with system efficiencies and capacities, the EnergiVault platform optimises the charging and discharging of the thermal store to maximise the energy, carbon and resiliency benefits.

The world's first commercial-scale installation of EnergiVault has now been operational at Quotient Sciences, a drug development and pharmaceutical manufacturer in Alnwick, Northumberland for 18 months.

This particular site was selected due to several key characteristics: two x 240 kW chillers supporting temperatures of 5 to 15°C; annual electricity consumption on refrigeration of ~250 MWh; pinch points arising from chiller cycling, high weather temperatures resulting in operating risk to production due to loss of cooling capacity; as well as a change in tariff structure mid-test. EnergiVault has successfully delivered chiller optimisation, peak demand support and uninterruptible cooling for the site.

Dynamic CTES can create different benefits throughout the seasons. For example, chillers can struggle to meet summertime demand as their capacity reduces in high ambient temperatures, or inefficiently short cycles during low winter demand required for de-humidification or process cooling. EnergiVault supports summer peak by augmenting chiller capacity to maintain water temperatures in the peak of the day and can avoid chiller short cycling entirely during low demand.

Although the demonstration site does not yet have solar PV, an exploratory exercise carried out with the microgrid partner demonstrated higher returns for both the microgrid/solar PV supplier and the client, when the EnergiVault CTES was combined with on-site renewable generation.

In summary, the rising demand for renewable energy, global cooling needs, cost-efficiency, and decarbonisation goals are key drivers behind the growing adoption of cold thermal energy storage.

Alongside international decarbonisation targets and addressing the challenges of climate change, EnergiVault technology is sector-agnostic and has been engineered to support the global market.

About the company

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 company was founded by Bob Long, a distinguished refrigeration engineer and Fellow of the Institute of Refrigeration, and the wider team includes Geoff Barker, Product Director, Fellow IMechE, who has spent more than 30 years developing cooling, thermal storage, and onsite power generation technologies and businesses; and Dr David Kane, Software Director, an accomplished chartered engineer with a doctorate in optimisation and control of energy generation and storage systems.

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Organic Heat Exchangers is being supported by the specialist environmental incubator and accelerator 350 PPM.

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