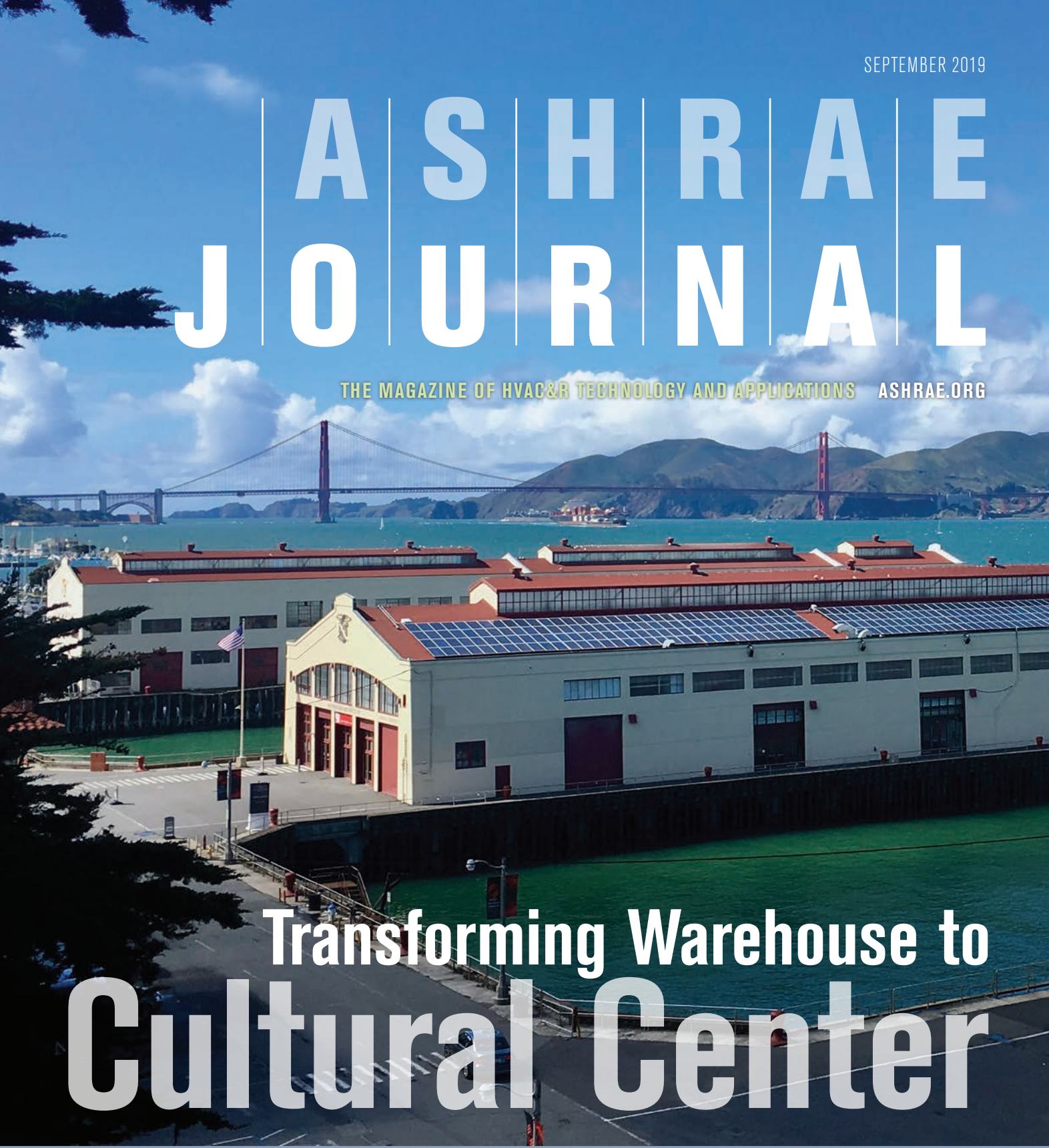
SEPTEMBER 2019

ASHRAE JOURNAL

THE MAGAZINE OF HVAC&R TECHNOLOGY AND APPLICATIONS ASHRAE.ORG



Transforming Warehouse to Cultural Center

Selecting and Specifying Pipe Flow Meters | Pressure Sustaining Valves

Celebrating 125 Years of HVAC&R | Indoor Air Quality Guide

Achieving Resiliency in The Cold Chain: Strategies To Maintain Food Safety

BY MARY KATE MCGOWAN, ASSOCIATE EDITOR, NEWS

Ensuring food security during natural disasters, loss-of-power events or refrigeration equipment malfunctions calls for more than hoarding milk and bread. Whether grocery stores and the broader supply chain for cold products lose power momentarily, for hours during demand response events enforced by the local utility, or for days after a hurricane tears through town, maintaining stable temperatures to keep food safe is vital for everyday life and during emergencies.

Thermal energy storage in the low-temperature cold chain provides both temperature stability to protect food from temperature fluctuations during daily operations and during a catastrophic loss of power. There are multiple strategies to achieve resilience in the cold chain and different viewpoints of what works best.

Damon Vance, marketing director at Viking Cold Solutions, said TES improves resiliency and supports the cold chain in several key areas:

- Improving refrigeration system efficiency while minimizing temperature fluctuations during normal daily operations;
- Minimizing the risk to the food from temperature fluctuations while enabling power management of the facility; and
- Extending the protection for products during events such as equipment failure or power outages caused by hurricanes, wildfires or other extreme events.

"Resiliency in the cold chain refers to a facility's ability to withstand and recover from several factors, and thermal energy storage can help improve resiliency for all of them," Vance said.

Thermal storage is a broad umbrella for a lot of different technologies, and applications range from supplying air-conditioning to refrigeration to pre-cooling to heating to power generation.

"Each solution/end application has a lot of nuances, so I think it's important to consult with folks that have worked in the end-user application that you're looking into," said John Lerch, vice president of sales and marketing for Axiom Exergy.

Resiliency in cold chain application is critical. Refrigeration systems operate 24-hours-a-day seven-days-a-week. Situations that call for adapting operation strategies can happen at any time and vary in predictability and length of time.

Thermal storage systems inherently provide some resiliency protection, and the systems can add features to increase their resiliency protection, said Lerch. Thermal systems can play three major roles

in resiliency: backup cooling during power outages, supplemental cooling during equipment failures and supplemental cooling during heat waves and high ambient temperatures.

Strategies

Using backup cooling during power outages is a strategy. Thermal storage can maintain temperature stability when the grid fluctuates when coupled with a small generator or electrochemical battery, which powers pumps and fans. This can save money by preventing food spoilage and buying enough time to get refrigerated truck or backup generator on site for longer duration outages, said Lerch.

Thermal storage can provide cooling services if a compressor, condenser or another piece of equipment fails or underperforms. During heat waves, thermal storage can supplement the cooling capacity, he said. This redundancy provides a level of resilience.

Another strategy is connecting thermal storage to a small, on-site generate or a small lithium ion battery to power case fans. If the power goes out on-site, this can provide cooling to the cases and the walk-in freezers for an extended period.

When frozen food experiences temperature changes, micro-thawing and micro-freezing create larger ice crystals that degrade cell structure and reduce food quality and shelf life, Vance said.

Thermal energy storage systems provide a key element of resiliency for long-term duration power outages and normal daily business operations, which can also affect temperature, food quality and product shelf life, said Vance. He said TES systems use latent heat to absorb 50%-85% of the heat infiltration, consolidate the heat near the top of the room directly in the refrigeration airflow and shift more compressor runtime to nighttime hours. The result is systems with thermal energy storage use an average of 25% less energy while improving temperature stability.

"When all of this is understood, engineers and facility operators can use TES for disaster back-up, temperature stability during normal daily operations and for broader energy reduction strategies," Vance said.

> The integration of intelligent controls and phase change materials (PCM) for thermal energy storage applications has advanced to the point that any refrigeration project should consider TES for resiliency, risk reduction, operational improvements and energy savings.

Design Considerations

Some TES systems for low-temperature, frozen applications can be designed into new facilities or added as a retrofit to existing facilities, said Vance. He said most design firms consider the heat loads, product turn, refrigeration capacity, airflow circulation, humidity and envelope insulation when designing a facility's refrigeration system.

"When adding a TES system, designers should also consider the installation requirements (the system footprint, racking measurements, mechanical interface with the refrigeration system, control system integration), the local utility fee structure (demand charges, time-of-use fees, efficiency or demand incentives available) and required life-time maintenance of the TES system," he said.

TES systems can provide additional benefits such as improved temperature stability, energy use reduction, component-level energy use measurements and temperature data for increased visibility and actionable

information for the facility operator.

"The integration of intelligent controls and phase change materials (PCM) for thermal energy storage applications has advanced to the point that any refrigeration project should consider TES for resiliency, risk reduction, operational improvements and energy savings," Vance said.

Grid Operations

Thermal storage systems can also help customers with load shifting and demand-response revenue benefits.

The utility grid is changing. Operators are challenged with dealing with utility grid shut-offs, extreme weather events and other obstacles that make managing the grid difficult. With higher demand charges, customer utility bills are increasing, and refrigeration is a big energy consumer. Using an energy storage asset at facilities can help customers save on their utility bill, and thermal storage systems can take advantage of demand response or grid service revenue at the same time to help the operators, according to Lerch.

Collin Coker, vice president of sales and marketing for Viking Cold Solutions, said that generation on the utility grid is no longer centralized due to the increased use of renewable energy sources such as wind and solar and the growth of distributed energy storage.

Solar power provides a growing percentage of the load during the day and the utility grid is now experiencing spikes when the sun goes down. The utilities must also manage for fluctuating wind energy. These changes make it difficult to balance supply and demand on the grid, so utilities are providing incentives for energy storage systems, including thermal energy storage, that help level out demand across the grid.

Regardless of how cold storage facilities are powered, thermal energy storage systems can help avoid high demand periods on the grid and improve resiliency for the site while also protecting food quality and shelf life.

"The load is changing, and thermal energy storage can help both grid operators and cold storage facility owners tackle some of their greatest challenges at the same time," Coker said. ■