# Research team's energy-saving solution for frozen-food storage could mean big cost savings

October 2 2018, by Joe Kullman

The thermal-energy system being tested in a Bashas' ice cream freezer employs "ice packs" of phase-change materials that can transform repeatedly from liquid to solid and back to liquid again. The materials are encased in plastic and placed on the racks of shelving throughout the storage facility. Credit: Salt River Project

Sometimes something sweet requires serious smarts.

Kristen Parrish's work focuses on integrating energy-efficiency methods into the design, construction and operational processes of buildings.

Robert Wang's expertise in thermal science includes the applications of thermoelectricity, thermal-energy storage and phase-change materials and processes.

Together they are a formidable force in the quest for … well-preserved, quality ice cream.

Their know-how is especially valuable if you have very large facilities filled with vast quantities of food that must be kept frozen under precise technical specifications to maintain its optimal attributes as an edible.

Parrish and Wang, associate professors in Arizona State University's Ira A. Fulton Schools of Engineering, are working on just such a project with Arizona's Salt River Project water and power utility and Viking Cold Solutions, the leading thermal-energy storage provider to the low-temperature cold-storage market.

The companies and the ASU researchers are experimenting with Viking Cold Solutions' novel thermal-energy storage and cooling technology in the 10,400-square-foot ice cream freezer in the Bashas' Family of Stores grocery chain's 800,000-square-foot distribution center in Chandler, Arizona.

The ice cream freezer uses a good portion of the total power required to operate the entire facility, which hums constantly with the running of refrigeration equipment and electrical systems.

"Annually, the facility requires the equivalent amount of energy needed to power almost 1,000 homes for a year," said Chico Hunter, SRP's research and development manager.

That includes providing the energy to keep the ice cream storage space at a constant minus-18 degrees Fahrenheit.

Parrish and Wang, along with Nexant, an industrial energy consulting and services company, are monitoring and measuring the performance of the system, which offers the advantage of a low-tech chemical and mechanical cooling technique.

The thermal-energy system utilizes proprietary, food-safe phase-change material formulas composed of deionized water and inorganic salts held in individually sealed plastic cells. The cell modules are designed to be installed above the storage racks in the ice cream freezer.

As phase-change material transitions from liquid to solid and from solid to liquid, the system absorbs or releases large amounts of energy while maintaining a stable temperature.

"It's sort of like the ice packs you put in your lunchbox," Parrish said. "They store the cold. The idea is to get enough cold stored in them that you can run the refrigeration compressors in the freezer for a lot less time during peak hours and still maintain the same cold temperatures throughout the storage space."

"Keeping a space cold is essentially a process of removing heat," Wang explained. In this system, as the phase-change material encased in the plastic melts, "it absorbs the surrounding heat and keeps the freezer cold."

An important feature of the method is "it's a passive energy process," Wang said. "No electricity is needed to drive the melting process of the phase-change material."

ASU engineers (from left) Robert Wang and Kristen Parrish discuss energy systems operations inside the 10,400-square-foot ice cream freezer at Bashas' Chandler, Arizona, distribution center with Salt River Project research engineer Alejandra Mendez and senior engineer Catherine O'Brien. Credit: Marco-Alexis Chaira/ASU

The benefit SRP and Bashas' hope to reap from the project is not simply energy efficiency but also significant energy cost savings. The thermal-energy process enables Bashas' to reduce the amount of time it has to run the facility's conventional electrical refrigeration system during more expensive peak-load hours—that's between 2 and 7 p.m. each day when customer demand is highest for SRP and when the cost of power is up to three times as high as during nonpeak hours.

Bashas can now run the electrical refrigeration system mostly during nighttime hours when costs are lower.

"The less expensive and more efficient nighttime refrigeration run time refreezes the phase-change materials, and those ice packs are then able to maintain stable temperatures in the facility to keep the ice cream adequately frozen during much of the daytime peak-load period," said SRP research engineer Alejandra Mendez.

"We have been able to shed about five hours of running conventional refrigeration off the peak-load time and shift it to the nighttime operations," Mendez said.

Such peak-load shifting, especially in large industrial facilities that operate day and night, also saves SRP money in the long run.

"The more power we have to deliver during peak-load times, the more we will have to purchase power elsewhere to meet that demand or eventually have to build more power plants," Mendez said.

"The thermal-energy storage technology also offers the advantage of making the overall system more sustainable and cost-effective," Mendez added. "With a non-mechanical, passive energy-storage technology, you won't need to make expensive upgrades to an existing refrigeration system."

The ultimate goal of the project is to determine whether users' electric bills can be adequately reduced to offset much of the installation costs.

"If that's the case," Hunter said, "we hope to develop a customizable thermal-energy storage system incentive plan to offer to customers who will implement these measures."

ASU engineers Parrish and Wang hope to see positive signs for the system's future capabilities once there is complete data on its performance over this year's hot and humid summer.

The researchers expect to have sufficient data to present the project's results to the American Society of Heating, Refrigerating and Air-Conditioning Engineers at the organization's conference in January.

The phase-change material has already allowed Bashas' to run compressors less often during the hottest hours of the day—the peak-load time when electrical power is most expensive—resulting in lower operating costs, Parrish said. She and the other ASU researchers are in the process of determining the overall energy impacts of the phase-change material.

Parrish, a civil engineer, has successfully teamed with SRP in the past to improve residential energy efficiency by applying her building operations expertise and research.

The ice cream freezer project is giving Wang an opportunity to apply his varied expertise to the energy sector.

The work is also providing a real-world research opportunity for students. Neda Askari, who is pursuing a doctoral degree in civil, environmental and sustainable engineering—with a focus on the latter field—and Prathamesh Vartak, a materials science and engineering doctoral student, are helping to measure the efficiency of the thermal-energy storage system and to model the energy and cost impacts of such systems.

Beyond the value the endeavor may yield for Bashas' and SRP, Parrish and Wang are hoping it leads to blueprints for successfully replicating the system in a variety of other large-scale industrial freezer operations.

Provided by Arizona State University