

DR19.04 Evaluation of Direct Energy Savings and DR Potential from PCM for Cold Storage Applications

Overview

The project is intended to determine the effectiveness of phase change materials (PCM) technology to act as a means for refrigeration facilities to “shift” their energy usage and electrical demand. Thermal storage has been examined in various ways to provide various durations of “shed” for traditional demand response programs, but PCM has not typically been used as a tool for enabling other modes of demand response that may provide longer durations.

This technology utilizes the existing walk-in space for storing frozen food and acts as an element of the thermal storage mass by adding more storage “load” via sealed modules on top of the storage racks. The PCM system combines phase change materials designed for cold storage applications of -10° to 0° F (-23° to 18° C) and modified refrigeration system control logic.

PCM Technology Installed in Warehouse



The project test plan will assess both the value of the PCM as a storage media that provides “shift” and possibly more flexible refrigeration compressor cycling. At least four tests with large walk-in freezers will be selected. The project team will quantify the value of the PCM technology under various demand response scenarios. It will evaluate its success at maintaining stored food temperature limits and document any impacts on energy performance.

Test scenarios will determine minimum and maximum demand reduction for midday, evening, and nighttime periods for each season, and will study when the maximum and minimum demand reductions occur.

The project will confirm the advantages of constant availability of the PCM on the volume of food storage space. For example, how much time can the refrigeration system be off for certain volumes of cold storage? This information will offer information about “hour-ahead” demand response strategies. The project will assess the response that could be expected from various pricing signals to the customer and the distribution system.

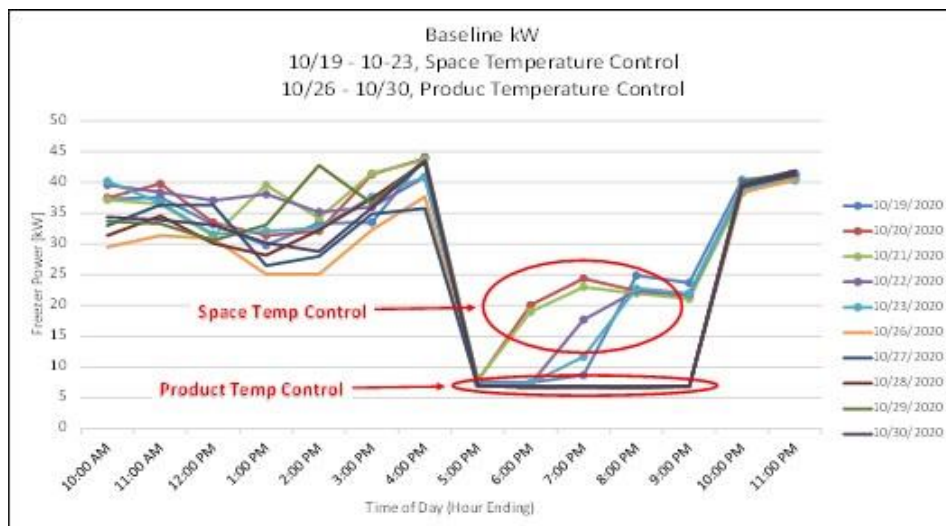
Collaboration

The first test is being overseen by SCE refrigeration engineers at a refrigerated food warehouse in Rancho Cucamonga, California. The PCM will be provided by Viking Cold Storage. D+R International engineers will be installing the monitoring equipment, coordinating the DR scenarios, and reporting on the results.

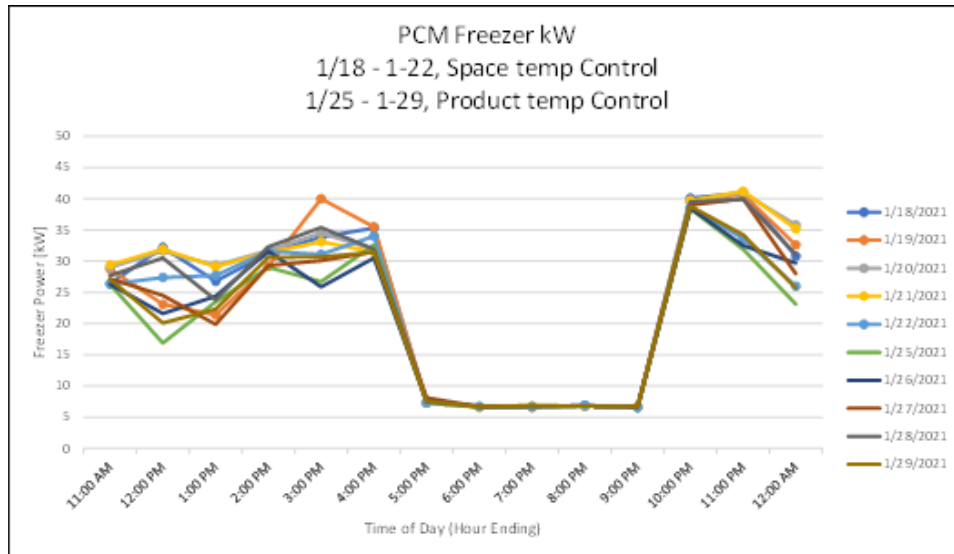
Results/Status

Properly engineered PCMs can manage how energy is consumed in cold storage facilities. PCM is a low-cost method for thermal storage that can help manage everything from door openings to flexible demand response opportunities to reduce or increase electrical demand, and the need to shut off refrigeration systems altogether for an extended period. The DR Portion of the project has been completed. It was found that both the space temperature and product temperature control strategy results demonstrated that the addition of PCM within the freezer allowed the mechanical cooling systems to reduce runtime during demand response events, thereby improving the load shed potential.

Baseline Freezer Demand Graph



PCM Freezer Demand Graph



It can be seen in the graph that the PCM and Controls were able to keep the energy usage down between 4 p.m. to 9 p.m. However, the initial results show that the payback period was going to be 30+ years for the DR portion of this project.

Next Steps

The final energy efficiency measure assessment portion of the project is still underway. SCE will finalize the M&V plan for the EE evaluation and commence testing. The completion of the project and final report is expected in December 2021.