ENGINEERING TOMORROW

Case story | Danfoss Enterprise Services

Danfoss Helps **Transform Supermarkets** into **Smart Stores** for Demand Response

Utilize the "Internet of Things" to monitor equipment performance and generate energy savings.

Like any supermarket chain, Giant Eagle operates in a very competitive marketplace where energy management can be a crucial ingredient to success and profitability. That's why the Pittsburgh, Pennsylvania-based chain carefully manages its stores' critical energy consumers: lighting, refrigeration and HVAC equipment. When Giant Eagle learned its utility -- PJM Interconnection -- offered a demand response program that provided incentives to reduce electric consumption, they talked to Danfoss to see how they could take advantage of the opportunity.

"Three years ago, Giant Eagle wanted to participate in PJM's demand response program," said Dan Donovan, Giant Eagle spokesperson. "The challenge was how to leverage the Danfoss controllers already being used in our stores to control and monitor store equipment. Turned out, it was as simple as tapping the intelligence inside Danfoss system managers so our stores could participate in PJM's demand response and peak-shaving programs."

The ingredients of a successful demand response program

Demand response programs are offered by many utilities nationwide to allow their customers to voluntarily reduce their electricity usage during periods of high power demand. When electricity demand is at its peak, utilities like PJM, one of the nation's largest electric transmission operators, want to avoid buying power from less competitive utilities or firing up inefficient generating equipment. This creates a smart business opportunity for the utility, and is why PJM rewards customers like Giant Eagle who can cut electricity consumption when there are balancing problems in the grid.

Utility customers like Giant Eagle benefit by receiving compensation from PJM when its supermarkets reduce electric consumption during a demand response event.

"One of the things we can do during a demand response event is reduce sales floor lighting levels," said Donovan. "We can also let the temperature drift to the upper acceptable range in the stores' air conditioning. The only thing customers notice is some overhead sales lights being turned off. We have experimented to find a balance between maximizing the benefit of the practice without impacting the shopping experience of our customers."

Giant Eagle developed these setpoints internally, then worked with a curtailment service provider (CSP) to enroll the stores in the demand response program. Giant Eagle devised a plan to handle power reduction notifications from PJM, and also to get more out of the program through peak shaving.

"There are not a lot of emergency events in our region where the utility demands power curtailment," notes Donovan. "So, in 2016, we switched strategies to maximize the program. In addition to responding to demand response events, we arranged to shed electric consumption on what are known as 'peak days.' That helps us lower our capacity charge the following year."

In the complex world of electricity pricing, retail consumers like Giant Eagle generally pay electricity rates based on monthly electricity consumption and demand. In addition to these charges, commercial customers pay peak-demand charges, also known as capacity charges, to defray the cost of supplying electricity to meet the highest levels of grid demand.

AK-SC 255
System Controller

"The capacity charges for Giant Eagle are based on their electric use during the grid's peak hours," explains Terry Joyal, manager of global electronic services at Danfoss. "The five hours of the previous year when the grid's kilowatt usage is the highest determines their peak load contribution (PLC), also known as the capacity tag. Giant Eagle's capacity tag in 2015, for example, influenced up to 25 percent of their electric bill in 2016. That may seem excessive, but an entire utility plant may need to be turned on for just a few hours to meet the load customers demand at peak periods. In effect, the end-user is tagged with their share of extra generating cost they were responsible for.

"Supermarkets want to shrink their PLC as much as possible," emphasizes Joyal. "Curtailing electric usage at peak load – known as 'peak shaving' – will reduce the capacity tag. It's a smart way to manage long-term energy costs, and helps everybody by reducing the strain on the grid."

Working with Danfoss, Giant Eagle benefited from PJM's demand response program in two ways: by turning down power consumption when notified by the CSP during curtailment events and by reducing capacity at peak periods. The agreement worked out with Danfoss defined four tiers of power reductions Giant Eagle was willing to make.

"We worked with Giant Eagle to develop a strategy to offset store HVAC setpoints and shed up to three levels of lighting using our existing AK-SC 255 and AK-SM 880 controllers," explained Steve Renz, Danfoss account manager. "Rather than introduce a solution that would have required the installation of additional equipment, we were able to show Giant Eagle that they could meet their demand response requirements using the existing control platform installed in the store."

In 2016, only the first two tiers of power reductions -- reducing HVAC and overhead sales floor lighting -- were used because they had the most impact cutting power consumption and the least impact on customers.

How demand response works for Giant Eagle

At Giant Eagle, handling a demand response event is coordinated among the CSP, Giant Eagle and Danfoss Enterprise Services.

"Under Giant Eagle's demand response agreement, the CSP sends a notification to Giant Eagle about an event," explains Joyal. "It could be a voluntary or mandatory event depending on the terms of the agreement. The notification gives Giant Eagle the event date, including start and end times. If it's a peak-shaving event, for example, it typically occurs over a two- to four-hour period.

"When the Danfoss team gets an email from Giant Eagle, it includes the desired response tier level of curtailment actions to be taken. The company also gives us the listing of specific stores that will participate in the event. A Danfoss team member then simply initiates the scheduling of the event at the chosen tier level for the selected stores."

To verify the event, the Danfoss software sends a notification indicating whether the program completed successfully. It could also indicate whether a demand response program was overridden, perhaps by a store manager.

Giant Eagle uses a separate energy manager to generate a report of the kWh reduction registered by the electric meters. Together with the data log from the Danfoss system, this information creates a record of the peak-shaving event so Giant Eagle gets credit from the CSP.

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TOMORROW

Danfoss Smart Store: The key to coordinating demand response

To facilitate communications between all parties and devices, Danfoss implements its "Smart Store" approach in Giant Eagles stores.

"The idea behind the 'Smart Store' is to take advantage of the internet of things (IoT), which utilize connected devices to collect and exchange data over the internet," explains Rick Ruth, Danfoss product manager - services. "Danfoss has deep expertise not just in HVACR technology, but also in monitoring equipment, compressors and controllers for grocery stores."

Ruth continued, "Our Smart Store solution is being used in more than 5,000 sites worldwide to give store owners and operators insights into equipment performance and energy savings. By having Danfoss smart connected devices in their stores, Giant Eagle gets more visibility into energy performance -- and a communication path for sending and receiving signals to implement demand response."

To provide demand response services, Danfoss accesses intelligence inside its AK-SC 255 system controller and AK-SM 880 system manager used in Giant Eagle supermarkets. A single device serves as a full store controller that monitors and controls lighting, refrigeration compressors and HVAC equipment.

AK-SM 880
System Manager

At every point, connections are fully encrypted. To enable demand response, the Danfoss system controllers were upgraded to support Ethernet communications. Then, it was a matter of configuring the programming for demand response.

For Giant Eagle, the Danfoss Smart Store infrastructure is handling the demand response capability and providing alarm monitoring services. Using a cloud-based platform, Danfoss alarm monitoring services collect a range of data points from connected devices. This data provides powerful insight into nearly every aspect of the stores' lighting and HVACR equipment to enhance food safety, operations, energy management and usage, benchmarking, and food safety. The advanced alarm monitoring system provides alerts and reports to enhance food safety, detect malfunctioning equipment and reduce costly energy waste. Through the Smart Store web portal, a regional administrator can access operations in a group of stores, and view each store in the system.

All corporate Giant Eagle locations are benefiting from Danfoss alarm monitoring services, and more than 100 stores are using the demand response capability. In total, Danfoss handles everything from equipment issues to providing alerts and notifications to Giant Eagle to a freezer door being left open to technical dispatch, along with peak-shaving and energy-curtailment events.

Danfoss smart-connected technology for the entire store

Danfoss technology for Giant Eagle doesn't stop with high-level system controllers for demand response and alarm monitoring and control. The Danfoss technology portfolio also includes evaporator and rack controllers, actuators and low-level sensors that can signal an open freezer door.

According to Donovan, Giant Eagle has a sharp vision for saving energy. "The demand response solution has worked out really well," he says. "We've had a lot of collaboration between Giant Eagle and Danfoss. Our CSP, mechanical contractors and lighting contractors are all in the loop. It's kind of an online community that is fully aware when we're shaving energy use during peak periods or handling an alarm to make sure equipment is operating properly. This initiative is reducing our energy usage and capacity tags. And, it's helping shrink the carbon footprint of each store to make Giant Eagle a responsible citizen in all the communities we serve."