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# Putting the CHILL on High Energy Bills

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Ice Machine Energy Management

Ice machines can be turned off periodically without compromising foodservice operation

The Directory of Certified Automatic Commercial Ice Machines and Ice Storage Bins provided by the Air-Conditioning, Heating and Refrigeration Institute (AHRI) lists the containing ice harvest rate (i.e., production capacity) and energy and water usage rate data for current models. This database can be used for selecting both water- and energy-efficient models.

Figure 1 shows the energy use for the complete 2012 AHRI data set for air-cooled, cube-type ice-making machines. The graph illustrates how energy use decreases dramatically with increased icemaking capacity. Also, the range in energy consumption can be significant from one model to another.

For example, at a nominal 1,600-lb. capacity, the energy use ranges from a high of 7 kWh/100 lb. to a low of 4 kWh/100 lb., representing a whopping 42 percent reduction. At the other end of the scale, the plot shows an energy use of 6.5 kWh/100 lb. for an average-efficiency, 400-lb machine. If the capacity of the machine was increased to 600 lbs. and the best-in-class machine was selected, an 18 percent reduction in energy use would be realized. Combined with the 50 percent increase in ice-making capacity, this is a huge win-win for the restaurant operator.

FSTC Field Study No. 1

In one field study, the FSTC selected eight local restaurants to show the water and energy saving potential that would be realized by replacing an existing unit with a more water/energy-efficient model. It is significant that all eight machines operated consistently during the PG&E peak period (12 p.m. to 6 p.m.) and were shut off at night (12 a.m. to 6 a.m.).

Of the eight machines, three would be immediate candidates (i.e., with peak duty cycles below 70 percent) for load shifting using a simple time-clock based control. Another three were in the "maybe" category, with average duty cycles below 70 percent but with peak duty cycles as high as 90 percent. These machines may be candidates for a utility demand response program, provided they could be overridden on days when the restaurant experienced a high demand for ice. Two of the eight ice machines were simply undersized, with average duty cycles greater than 80 percent and peak duty cycles of 100 percent.

Figure 2 shows the load profile for two 1,200- lb. capacity ice-making heads with remote condensing installed on a single ice storage bin in a casual dining restaurant. Immediately obvious is the continuous load of 5 kW (2.5 kW per head) throughout the PG&E peak period of noon to 6 p.m. If this load could be shifted and the ice machine locked out during the peak period, the FSTC calculated an annual cost saving of $1,200 (based on the applicable PG&E E-19 rate). The demand reduction and cost-saving potential exhibited by this example became the catalyst for a second field study to confirm load-shifting in a foodservice operation.

FSTC Field Study No. 2

A second field study was undertaken to retrofit an older ice machine with an ENERGY STAR-qualified unit. The test site for this field study had an older model, average-sized ice-cube machine with 380 lb. production capacity and a 310 lb. bin capacity.

After consultation with the equipment supplier and facility owner, the FSTC team was confident that the replacement machine with a 410-lb. production capacity and a 430-lb. bin capacity could operate entirely during non-peak periods. This new machine featured computerized control, which was programmed to lock-out ice production between noon and 6 p.m.

Figure 3 shows the power profile of the old machine in comparison to the power profile of the new machine with load shifting, each highlighting the machine's operating (or non-operating) state over the utility peak period.

The original ice machine exhibited an energy consumption rate of 6.54 kWh/100 lb. of ice, an average cycle power of 1.05 kW, a duty cycle of 64 percent and a water use rate of 28.0 gal/100 lb. of ice. The replacement ice machine operated with an energy consumption rate of 4.34 kWh/100 lb. of ice and an average cycle power of 0.89 kW, representing a 34 percent reduction in energy and a 15 percent reduction in power. The duty cycle was 37 percent, reflecting a 42-percent run-time reduction.

Overall, the increase in efficiency of the new ice machine over that of the existing machine translated to an annual energy and water cost saving of $303 for this small foodservice operation that was not on a time-of-use rate. Combined with load shifting, the new machine effectively reduced the facility's on-peak load by the entire 1.05 kW. When this facility is converted to a mandated time-of-use rate in 2013, the cost savings will increase to $500 per year.

The Future

ice machine with an overlay of the PG&E peak billing period The Future Ice machines represent one of the few pieces of electrical equipment in a restaurant that can be turned off for a period of time within the context of "utility demand response," "time-of-use" or "peak demand" without compromising the foodservice operation.

Thanks to the ice-storage bin, ice machines have the ability to make ice during periods of the day that do not coincide with either the usage of ice or the utility peak. However, the length of time that a given machine can be turned off is a function of its capacity (both ice making and storage) with respect to the demand for ice within the foodservice operation.

This measure of capacity is directly reflected by the duty cycle and load profile of the ice-making machine on a given day. If an existing ice machine has sufficient production and storage capacity to meet the afternoon ice requirement, complete load shifting can be achieved. If there is not enough capacity for sustained load shifting over the entire peak period, then some form of automated demand response may be an option for the critical-peak days.

Retrofitting existing machines with up-sized ENERGY STAR qualified ice machines provides a tremendous opportunity for restaurants to combine energy efficiency with "full-time" demand response and return significant operating cost savings to the bottom line. In the foreseeable future, it is conceivable that ice making in all restaurants will be during non-peak utility periods, and in many cases, during the off-peak, cooler hours of the night.

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