Stupid Energy Tricks: An Ice Storage System

By **Bill Holmes, P.E.** June 10, 2013 12:36:52 pm

I was in the control room at a large state university in Southern California. It was about 10 am and already close to 95 degrees outside. John, the operator, was explaining the ice storage system. A lot of money had been spent to design and install this system – I wasn't told how much but this was a huge cooling plant for a major university campus in the desert. The local electric utility was offering programs to help reduce the demand for electricity during the daytime hours and I am sure they had kicked in a bunch of money as an incentive to build the system.

I had left my hotel near the water in San Diego about an hour before, where it was around 70 degrees. As I drove east just a few miles into the desert, the outside temperature rose more than 25 degrees.

The theory behind the ice storage system is relatively simple. Think of your house. If your local utility charged you five cents a kilowatt-hour (kWh) to run your air conditioner at night and 50 cents between the hours of 8 am and 6 pm, what would you do? Well, you would run that air conditioner all night and cool your house to just above freezing by 8 am. Then you would shut it off and hope the house stayed under 85 or 90 until 6 pm when you could turn the A/C back on again. A bonus would be that you might only need to buy a two-ton air conditioner to run at night when it is cooler outside with no sun instead of the five-ton one you would need to handle the peak at 4 pm.

An ice storage system works essentially the same way. But instead of an air conditioner, which makes cold air, cooling comes from giant compressors or chillers that produce cold water. Most large buildings have chillers for air conditioning. The chillers would run all night, outside of peak hours, and build ice in a giant, insulated tank. In the morning, most if not all of the chillers would be turned off and the campus would be cooled by circulating chilled water from the ice storage tank through the air handling equipment and cooling coils in the buildings. As I remember, the cost of electricity for the university during the night was about 10% of what it was during peak hours in the day.

The tricky thing under this arrangement is the demand charge. At home, most of us pay only for each kWh of electricity we use. In larger buildings on commercial and industrial rates, they also pay for each kWh but those charges may only account for 40% or 50% of their bill. The largest cost each month is the peak demand charge which is determined by the greatest number of kWh used during any one time interval, normally 15 minutes, during the month. The logic behind this is that utility companies have a maximum capacity, a maximum amount of electricity they can generate and transmit to their customers. These days they can usually purchase additional capacity through the grid, but ultimately there is only so much electricity available in an area at one time. To have more would require building more generating plants and transmission lines and then the excess capacity would only be used a few hours a day during peak periods. With costs, permits, environmental concerns, etc. it makes more sense to try to use existing capacity more efficiently.

Oh yes, there is this additional factor called the "ratchet." Under some rate structures, your peak demand each month is compared with the peak for each of previous months, perhaps for a year. There are probably as many different rate structures as there are utility companies. If you have a 1,000 hp chiller there for night usage and someone accidentally (or otherwise) turns it on during the day for as little as 15 minutes, and only once during a billing period, you pay a huge cost. And even if you only turn it on one time, you pay that month and you may pay every month for the following eleven months. And these things do happen. Although that may seem a little unfair, the logic behind it is that, even if you only needed it once, the utility company had to have the capacity to provide it, and that cost them a lot of money.

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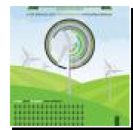

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Author Bio

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Bill Holmes, P.E. founded Holmes Energy LLC www.holmesenergy.com and developed the AutoPilot Monitoring-Based Commissioning (MBCx) System in 1979. He has a B.S. and M.S. in mechanical engineering and has done additional coursework and research for his PhD. He is a former Purdue professor and taught for several years in the Continuing Education in Energy Management Program at the University of Wisconsin.

Bill has produced savings from 20% to, in a few projects, more than 50% from low-cost, no-cost changes in management, operation, maintenance and control alone in all types of facilities including Industrial Plants owned by Fortune 500 Companies.

He is the recipient of a DOE Award for Energy Innovation and was the Indiana Energy

Accidents happen. A serviceman working on the chillers at an RCA plant in Indianapolis, one of our clients, was getting them ready for the summer and turned them all on at once for testing. Including the ratchet charge, it cost RCA an extra $10,000 in peak demand charges. Luckily we had installed our monitoring system and RCA was able to use the data from our system to bill the chiller service company. It showed exactly what had happened and when. At that time there were no automatic controls or alarms to prevent it from happening. Perhaps there should have been but the serviceman was working unsupervised and violated RCA's standard operating procedures. Of course this was just an isolated incident in Indiana, most probably a little backwards when compared with the rest of the Free World. It couldn't happen in a big city in a facility with a sophisticated control system and a highly trained operator who is always on top of everything. Could it?

Back to the university in southern California. I was talking with John, the operator at the ice storage plant on a day when the outdoor temperature was going to be over 100 degrees. Was he ever glad he had this ice storage plant; it was going to save him a fortune! Well, not literally – his check would be the same every payday no matter how much it cost to run the ice storage system. I was looking at the gauges showing every detail of the plant and system and thinking maybe there was something I was missing. I said to him, "Excuse me, I must be missing something. It appears that there is no ice in the ice storage tank." John walked around, looked at all of the same gauges and says, "Damn, you're right. I hadn't noticed."

To keep the campus cool that day, after I left, he would have had to kick on some of the big chillers, driving the demand up by a couple of thousand kW at $31 a kW, costing perhaps $50,000. But maybe that's what he did every day, I have no idea. And there may have been a penalty every month for the following 11 months, I don't know. I wonder if anyone noticed when that bill came in. I wonder if a copy was sent to the engineer who designed the system. Those economic analyses done before the project was approved sure looked great. You spend a million dollars or so on an ice storage system; you save $100,000 a year and pay it off in 10 years. Looked really good on paper.

About then I was wondering if John was a fisherman – if he ever packed a cooler at 5 am with ice and 10 or 12 cold beers with the expectation that they would still drinkable by the end of day, before he got too wasted to notice. Any sober person would immediately notice if all of the ice had melted and the last couple of beers were warm, wouldn't they? As I was driving back to my hotel to pick up my things for my evening flight back to Indiana, I was hoping that the university was paying John really well. I would hate to think he had a night job at the airport doing the preflight inspections on the planes.

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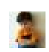

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