What Does a Smart Grid Mean to You and Me?

By Paul Valenta

Lately I have been hearing and reading a great deal regarding the smart grid. What does a smart grid mean to you and me? I know as my children mature and they become more educated or smarter I surrender to the fact that I have to step it up or get smarter to stay even with them. If I don't get involved and understand what they are learning, I cannot guide them.

How does that lesson apply to the smart grid? I think it means that buildings and building systems must now be intelligent to keep up with and support the smart grid. The smart grid will have the ability to generate and move electricity around a grid. In short, the smart grid is a tool to manage supply and demand of different generation types, including renewable energy, and consumption. The smart grid will be able to harvest wind energy at night in the desert and move it to an urban area for consumption. The smart grid will incorporate electricity pricing that reflects its value at the time of consumption. Prices will behave like hotel prices. Room rates are high during the peak season, and lower in the off peak season.

Utilities are gearing up for market based pricing with smart meters and other technology that will give them the ability to move energy around for optimum performance and bill based upon time of consumption. Smart meters are available now to consumers in much of the country. States that have a de-regulated utility industry are providing non deregulated states a glimpse of what rates will look like as the smart grid get closer to a reality. If a consumer has a low energy management ability, they would most likely choose to go on a flat rate. This market based flat rate pricing will consist of a modest monthly demand charge for maximum kilowatt demand and a flat rate for each kilowatt-hour. The flat rate is based upon the customer's electricity consumption profile from the previous year. The history is applied to the upcoming years electricity market based pricing. The market based flat rate is dependent upon not only how much energy is consumed but when that energy is consumed. If a customer has a higher ability to manage consumption there is a real time pricing rate available for customers. Real time pricing, again, consists of a nominal demand charge for maximum kilowatt demand, and an energy charge for every kilowatt-hour consumed but pricing is based upon market conditions. Sometimes the energy charge can be negative other times it could be well over one dollar per kilowatt-hour and anywhere in between.

Because HVAC is the largest contributor to peak demand and electricity for cooling can be easily shifted, energy storage is becoming a more and more popular cooling system choice in commercial applications because these systems can move consumption to different times to take advantage of cheaper pricing. In these designs the building generates its cooling at nighttime when demand and costs are low and stores it for use during high cost high peak times. The challenge for engineers is how do you model electricity costs for a life cycle cost analysis when the market based prices change annually, seasonally, or as in Texas on the ¼ hour?

The answer is to look at historical history. Let's look at the Marginal Clearing Price for Energy (MCPE) real time pricing available in Texas. The MCPE changes every fifteen minutes. This rate was available in 2002 and there is a history of pricing through 2009 and soon 2010. For instance the average price at 4 am in August was 3.3 cents /kWh while the price was 13.5 cents /kWh at 3 pm. Reviewing the six year history of rates and by narrowing down the time period a clear pattern emerges

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which can be used for a life cycle cost analysis. Significant discounts are available for off peak consumption.

Let's look at an 8 story 225,000 sq.ft office in Dallas, Texas. The system will use air cooled chillers and fan powered VAV. Alternate one is a conventional system supplying 42 degree water to air handling units that distribute 55 degree air to the space. The standard flat rate for an office building is $5.60 /kW demand and $0.10 / kWh. Alternate two adds ice storage to the building. This building will have a slightly lower flat rate of $0.085 / kWh because its demand profile is flatter than a conventional cooling system with the same delivery demand charge of $5.60 /kW. Alternate three is the same as two but low temperature air distribution is added to the design lowering the supply air to 45 deg. F. from 55 deg. F. The electricity cost is the same as alternate two. Alternate four is the same as alternate three except the historical real time MCPE pricing data is used along with the delivery demand charge of $5.60 /kW.

Gathering the historical data of the MCPE pricing allows the life cycle cost analysis to move forward in a more conventional manner allowing the analysis to demonstrate the cost savings opportunity available should the real time costs stay in line with historical costs within their consumption periods. In this example the 1st year utility costs is 45% lower using energy storage and low temperature air distribution and the MCPE pricing over a conventional cooling system. Simple paybacks averaged from 3.5 years with the energy storage system to less than one year on the systems using low temperature air.

Now that the system is properly designed to take full advantage of pricing for the smart grid, smart controls can ensure the design goals of energy cost savings are reached. An existing Dallas office building uses the MCPE pricing and thermal energy storage to contain its cooling costs. Below is a graph showing its building demand and electricity pricing for a couple days in May. On the right hand side you can see a price spike of over 30 cents a kWh. The control system knew that would happen and the demand was reduced by shutting off the chiller saving money.

The smart grid will provide a method to reduce demand, use the most efficient assets, incorporate more renewable energy, and keep the grid reliable. Utility incentive programs and laws such the California Energy Storage bill are addressing how to reduce the demand for electricity during peak periods. Designers of buildings and cooling systems must recognize how using and purchasing energy from the smart grid will change their practices accordingly. How much and when electricity is used is changing and building owners must understand that a little more investment in the life cycle cost and design stage can pay big dividends later.

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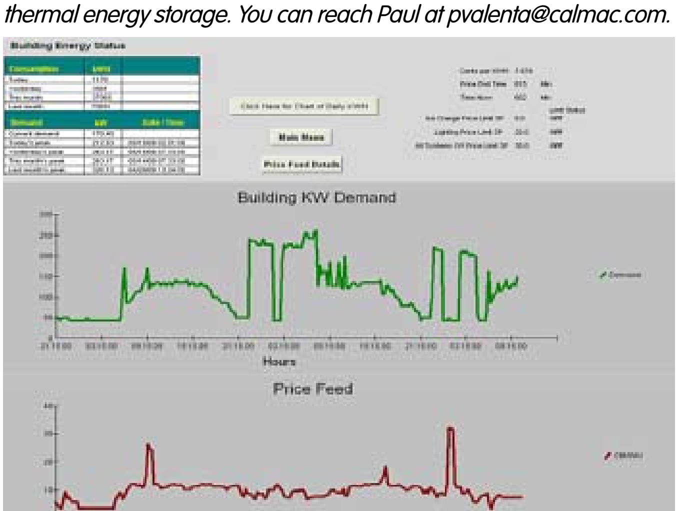

Electricity Consumption (that is on the top in green) vs Electricity Cost (that is on the bottom in red) Consumption vs Cost.