Smart Grid and Building Operators

By Phil Davis

We think of efficiency and conservation as twins, but there is a key difference. Conservation stops at using less of a resource. Efficiency is additive; it means doing more with less. On the grid, efficiency has great leverage. Because of thermal and delivery losses, three units of energy (Btus) must be consumed for every unit of energy used at the plug. This makes energy efficiency a big deal for emissions reductions and other environmental impacts.

Then, there are subsidiary impacts. Creating electricity requires water, lots of water; roughly 40% of all water consumed. If we generate less electricity, we have more water for agriculture, drinking and recreation. Then comes the aftermath of generation: smokestack emissions, nuclear waste disposal, maintenance costs and so forth.

Buildings can improve windows, insulation, lighting and HVAC efficiency, but there is much more to efficiency. More sophisticated elements include continuous analysis to keep major systems in tune as well as delivering building services only where and when needed, using outside air when appropriate, and ensuring that changes in occupancy types and numbers are mirrored in the programming of building management systems. These are elements of a strong efficiency program, but still fall short. The total answer reaches outside the building.

Real efficiency is total systems efficiency; it is coordination from utility control rooms to customer systems.

Demand Response

Demand response programs are becoming fairly common. Still, of the 40,000 or so buildings nationally that are listed as large commercial by the Energy Information Administration, only about 10% participate to any meaningful degree. The idea is simple: curtail energy use in response to a signal from the grid. Program participants are paid in various ways ranging from bill credit to rather large checks written for major participation.

Execution is not always so simple. What to curtail? How long? How to verify? Tenant comfort? Safety? All of these topics are covered extensively in industry literature. It's sufficient to acknowledge they exist.

The real value of demand response is that it creates knowledgeable energy consumers. Typical DR practitioners understand the concepts of demand curves, grid congestion, energy planning and much more. The result is total management versus piecemeal management.

Since building managers are in control of how and whether they respond to external DR events, they also have the ability to create internal DR events. Properly configured energy management systems allow staff to monitor peaks

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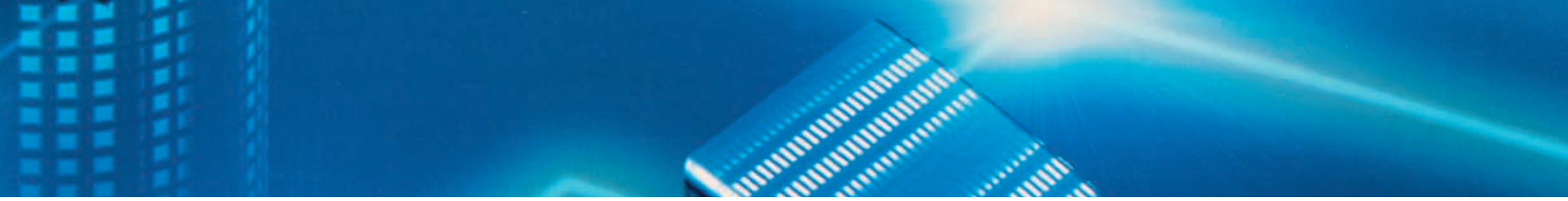

and to curtail loads rather than set new peaks. Commonly, this capability saves more money than that generated by participating in formal programs. It's a great example of how better knowledge of how the electric grid works can produce significant improvements to the bottom line. We've only begun to tap this potential.

Changes in Rate Structures

There was a time when utilities, like any retailer, encouraged increasing use of their product. Rate structures frequently offered tiered discounts as usage increased. Today, the opposite is more likely. Depending on location and vendor, large energy users may pay a flat rate, a demand charge, a tiered rate, a time of use rate, or combinations of those. There are thousands of rate structures across the U.S. Their purpose ranges from encouraging conservation to local economic development. Some rates have nothing to do with electricity consumed.

This is changing rapidly influenced by renewable energy, emission controls, electric vehicles, grid constraints, and a host of other new realities.

Consider the mix: generators conclude that retrofitting coal plants to meet new emissions standards is too expensive, so they close the plants. Nuclear safeguards and permitting are too expensive, so large numbers of future plants are dropped. As current plants require maintenance, they are closed. The remaining generators charge more, knowing there aren't many alternatives.

Natural gas generators have replaced most of the closed plants, aided by the relative ease of construction and the incredibly low price of gas. The problem is that gas pipeline planners never expected the current situation, so there are limits to the amount of gas the pipelines can deliver. As power plants require more, the cost of delivery rises causing cheap gas to become expensive.

After the cost of generating, there is the cost of delivering those electrons. At peak loads, delivery is constrained so costs shoot way up. The concept is that increased revenue will fund investments in infrastructure. Unfortunately, no one wants that infrastructure in their back yard, so it isn't being built.

These things are a reality now. Customers don't see price volatility because traditional rate structures mask it. Ideally, the rates charged will somehow approximate the averages of the volatile price the utilities actually experience, and there are large and expensive staffs to make sure of it as long as they guess right. When they guess wrong, the result can be anything from a blackout to financial instability. Navigating these waters is only more difficult as the physical intermittency of renewable energy enters the mix.

In response, the trends are toward increased customer exposure to true real time pricing. This may encompass a fixed range from *x* to 10*x*, or it may mean paying true energy prices plus delivery charges. Today, average energy costs, including delivery, range from 7 cents to 20 cents per kWh (higher in Hawaii). At the wholesale level historic highs have reached 100 *dollars* per kWh *exclusive* of delivery. That's an extreme, but it serves as a warning to pay attention to energy and to have a plan to manage it. Fortunately, a number of trends on the customer side can answer the challenge.

Emerging Trends in the Smart Grid

Permanent is becoming only a bit longer than temporary in today's utility world. The industry faces rapidly shifting social norms coupled with an infrastructure that takes decades to plan, permit and build. The nuclear "renaissance," only five years old, now consists of mostly cancelled projects.

The real renaissance is in gas-fired generation, but the pipeline infrastructure isn't there to handle this new demand. The result? Generation prices are increasing even as fuel prices drop. Utilities are responding by trading some of their engineering culture for sophisticated risk managers and more robust forecasting tools.

Smart customers will do the same. The most attractive Class A space will have little value without the electricity to power it. A number of emerging trends on the customer side will help prevent this outcome.

First, demand response is becoming much more sophisticated, and being matched with new customer side capabilities. This recognizes that the most reliable energy is steady-state energy. Customers who can shave peaks and fill valleys in their energy demand profiles will see rewards in lower overall costs of that energy. Preconditioning of air has been done for years, but now it is being coupled with more sophisticated building models.

Rather than following a blind assumption that a 4 a.m. HVAC start will avoid afternoon demand, newer systems are able to use real-time electric meter data and couple that with weather forecasts, 24-hour energy price curves, outside air use, scheduled DR events or forecasted demand peaks to create a rolling 24-hour schedule of HVAC settings that are always optimized for external and internal conditions. This may not avoid setting new peaks altogether, but there will be solid reasons for setting new ones.

Second, microgrids are a major trend. Microgrids are nothing more than the application of smart grid technology and business practices to a specifically defined area where all demand is related in some way. This might be as small as a single building, or as large as a military base, health care community or college campus. In some instances, utilities will develop and operate microgrids as a defense against major storms or other threats.

These microgrids will have some form of local generation, energy storage or other technique for isolating and surviving major grid outages, but they also will interact with utility control rooms thousands of time daily.

Issue of Control

Does this mean utilities will control energy activity within the customer premise? It does not, nor do they want the liability. All it means is better and more automated communications between supplier and consumer. Much like today's demand response events, grid operators will signal grid conditions that may include real time energy prices based on those conditions. The customer will have a standards-based gateway as a firewall between internal and external communications. It will be the customer's choice how—or even whether—to respond to those signals. This allows sophisticated and efficient facility management, but also it could penalize those that fail to prepare.

In 2007, federal legislation designated that the National Institute of Standards and Technology (NIST) develop energy standards that would allow for "plug and play" grid interactivity as well as provide the tools required to manage in a more demanding environment.

NIST responded with the formation of the Smart Grid Interoperability Panel (SGIP.org), a large and international group of subject matter experts, standards bodies, industry and utility trade groups and others to create the new ecosystem

ASHRAE, together with ANSI, SAE, OASIS and many more are working together to create a Catalog of Standards. This effort led directly to the OpenADR protocols for building to grid communications, and many others that will be pivotal to a secure, reliable and efficient energy future. Among these are protocols for electric vehicles, appliances, energy price communications and so forth.

Our energy future holds great promise for a new era of growth and prosperity. To achieve this, it is vital that a large and wide range of stakeholders participate in this important process. ■

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