Distributed Generation and Energy Management: Reducing Energy Costs

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ABSTRACT

We are entering a new energy era in the United States, one that is forcing—or will force—end-users to become much more energy-minded, efficient and more mindful of energy costs and uses. In other words, they will need to become fairly sophisticated energy managers, or be willing to outsource their energy purchasing needs. There are a number of drivers to suggest that this scenario will, indeed, play out. Such drivers include:

- The Federal Energy Regulatory Commission (FERC) mega-Notice of Proposed Rulemaking (NOPR RM01-12-000) issued in July, 2002 states that the FERC is placing equal weight on all potential electric transmission solutions, including distributed generation.

- A formal or informal national energy policy that reflects the threat of energy shortfalls within two decades. This strategy will equally focus on conservation, efficiency improvements and alternative energy as well as domestic production;

- Lack of investments in grid infrastructure (and subsequent events such as the August blackout);

- The popularity of existing demand response programs;

- Volatile energy prices resulting in rising prices over time in some energy markets;

- Market rules that require much more sophistication in order to benefit from deregulation, including nominations and compliance penalties;
- Automated meter reading (AMR) growth;
- Rapid adoption of internet-connected devices;
- Energy service companies' continued growth; and,
- An emerging liability issue.

While the status of the FERC mega-NOPR is unclear, the demand response aspect will likely gain acceptance in other forums. Together, these drivers have the potential to help shape and deliver the long-awaited distributed generation (DG) market[1]. Of course, the current "hybrid" model of regulation—stuck somewhere between open and closed markets—and other barriers (emissions, interconnect, etc.) will continue to be the determining factors in the short-term. But, the overall trend suggests that DG will, indeed, finally emerge as a resource accepted by all parties—regulators, utilities and end-users.

Notice that the majority of drivers are demand side focused, and not supply oriented!

The strategy of the future is one of risk management. This is a dramatically different business model from the one that is now in place because it could lead to fewer operating hours (peaking vs. base load), thus increasing paybacks. But, it could also lead to much wider acceptance of DG as one more solution to manage customers' energy bills. The enabling technologies for this transformation include new generations of controls and energy management systems that will seamlessly bring DG and load management together.

Winning products will include low-cost, hassle-free, plug and play and clean DG/CHP; retrofit emissions controls; and sophisticated, reliable, affordable controls.

RISK SHIFTING TO END-USERS

In virtually every area of business, owners and operators have the ability to take considerable actions to control costs. That is, all except actions to curb energy consumption—without taking drastic actions resulting in significant changes to operations, schedules, labor costs, etc.

In most cases, energy costs are not commercial and industrial (C&I) end-users' largest expense. However, as volatile fuel prices are passed through to the end-users, they have had few alternatives other than to pay them. As seen in the recent past, big price swings can wipe out any projected savings that end-users may think is due them via interruptible or other discounted rates. However, simple controls and communications abilities that are currently available may provide a true load management ability that provides a real benefit to all parties, including the utility.

According to the Energy Information Administration (EIA), there are over 2.2 million demand-metered buildings; about 11 million commercial accounts; and over 527,000 industrial accounts in the U.S. Some 496,000 buildings have metered demands exceeding 50 kW. This represents a mass market that has so far eluded DG. In some situations existing buildings will have gas or diesel standby generators. Building owners could tie these existing gensets in to an energy management system and provide better load control and reduce energy expenses—perhaps even participate in demand response programs.

Considering that less than 1/3rd of the industrial market has been involved in any load management exercises in the past, and fewer commercial end-users, the market potential appears to be enormous (see Table 1). Older energy management systems have been relatively successful in managing energy, but their market penetration never reached more than a 10% share of the industrial market, according to the EIA.

It remains true that the cheapest, cleanest energy is that which is not produced. Reducing demand requirements can solve multiple problems, and make the country much more energy efficient.

Today's energy management systems can measure and manage loads, point out efficiency improvements, communicate with the market and/or the ESP, among other things. (Some can even provide predictive analytic tools, such as failure analysis.) These systems can include DG assets that can shave peaks, fill valleys, or provide base load operations when the price of power, or utility tariff, indicates that it is cheaper to produce power than to purchase it from the grid.

The smaller commercial and industrial (C&I) customer segment (under 1 MW) is typically the most neglected and inefficient power consumers (excluding residential) any utility serves. The biggest energy

Table 1. U.S. Establishments Participating in Energy Management Activity, 1998 (Manufacturing Only)

	Not Participating	*Participating*	
		Number	*Percentage*
Participating in one or more of the following types of activities	151,365	75,448	33.3
Energy Audits	202,475	24,338	10.7
Electricity Load Control	205,891	20,922	9.2
Special Rate Schedule	206,500	20,313	9.0
Standby Generation Program	220,531	6,282	2.8
Equipment Rebates	221,952	4,861	2.1
Power Factor Correction or Improvement	207,272	19,541	8.6
US EPA Energy Star Program	224,937	1,876	0.8
US EPA Green Lights Program	224,663	2,150	1.0
US DOE Motor Challenge Program	225,533	1,280	0.6
Full-time Energy Manager	**224,568**	**2,245**	**1.0**

Source: EIA
Note: Rates included time-of-use, interruptible rates.

consumers for the majority of these customers will be lighting, and heating, ventilation and air conditioning (HVAC). Energy management systems reconfigured with simple controls to manage these usages can provide a beneficial service to this underserved market.

NEW BUYING RULES

Many states are considering market rules that bill end-users based on their load factors. Load factors express how well or poorly a given electric load is being utilized, and can be graphically illustrated by developing a load profile, which graphs a building's electrical demand in kW and/or kWh over time. The higher the load factor, the more efficient the facility becomes. High load factor customers will obtain better pricing as a result of their more consistent use of electricity. These customers are easiest to serve because energy service providers know with relative certainty that the customer will actually use the power they purchase on their behalf, thus reducing volatility. In other words, these customers have predictable behavior.

But, most customers have poor load factors. The EIA tracks energy usage throughout the United States. According to 1995 data (the last year records were updated), the agency kept demand records for ten categories for commercial accounts. The records indicate that the median load factor in most of these categories ranged from 21.4% to 38.9% (see Figure 1).

If customers are billed on load factors, proper energy management techniques may be able to increase a customer's load factor to the point he could be moved to a lower cost power range. Perhaps the customer needs nothing more than a simple management system to enable him to reach a lower-priced energy tier. Or, perhaps with the use of DG, he can reach an even lower-priced tier.

In Texas, for instance, most C&I customers must nominate usage prior to consumption (much like many industrial natural gas users do today). If the end-user's actual consumption falls outside a bandwidth (usually +/–10%), compliance penalties will be assessed.

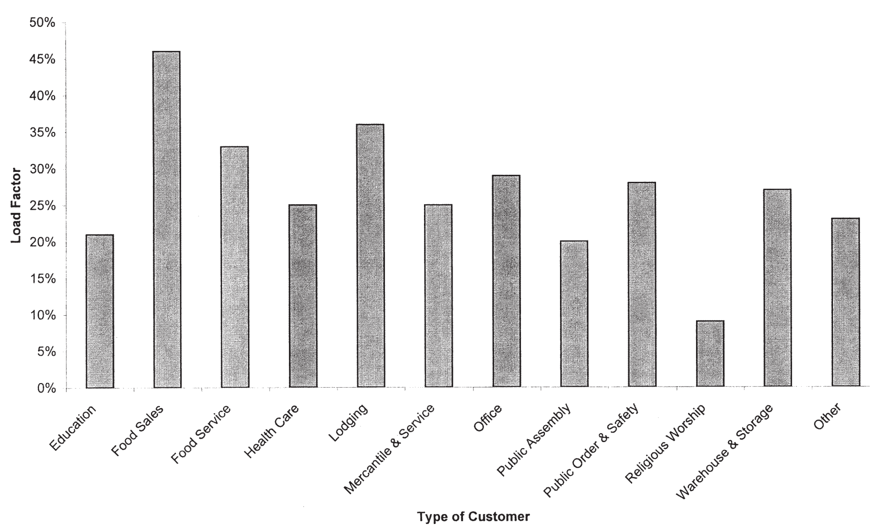

Figure 1. Median Load Factor for Commercial Buildings, 1998.

ACTIONS REQUIRING BEHAVIORAL CHANGES RARELY WORK

In an assessment of existing demand response programs, Lawrence Berkeley National Laboratory (LBNL) found that almost 70 percent of the customers participating in load response programs relied on manual approaches to respond to curtailment events, rather than an automated response. That is, customers responding to curtailment orders manually had to control systems. The study also found that enabling technologies such as a web-based control system have a positive effect on load curtailment compliance.[2]

By automating the response to a demand reduction order, or to just manage energy consumption, the likelihood of a positive impact rises exponentially. To accomplish this, energy management systems must enable end-users to communicate (both ways in most cases) with the market; measure, monitor and manage loads (including DG).

Many utilities understand that load management is the likely result of conservation and efficiency programs. One can reason that one of the primary reasons for the growth in automated meter reading (AMR) stems from the utility drive to become more efficient. But, AMR can also be the gateway towards implementing automated demand side management programs.

AN EXAMPLE

An example of the role an automated energy system can play follows: The building examined (see Figure 2) has a maximum connected load of 100 kW; its daily and annual peak day load profile is illustrated. The shaded range represents the bandwidth, or range of power consumed, where no penalties would be applied (the +/– 10% tolerance range). The average annual load factor is 18%. Peak day usage is also illustrated, and shows that on the highest usage day (in August caused by air conditioning load) the building reached a maximum demand of 93 kW. The volatility of the load suggests that the building's chiller is frequently cycling. The load factor indicates that the building will fall into the third tier, or most expensive, rate category. In this case, the customer has installed an IDR meter.

When the usage is outside the bandwidth, financial penalties will

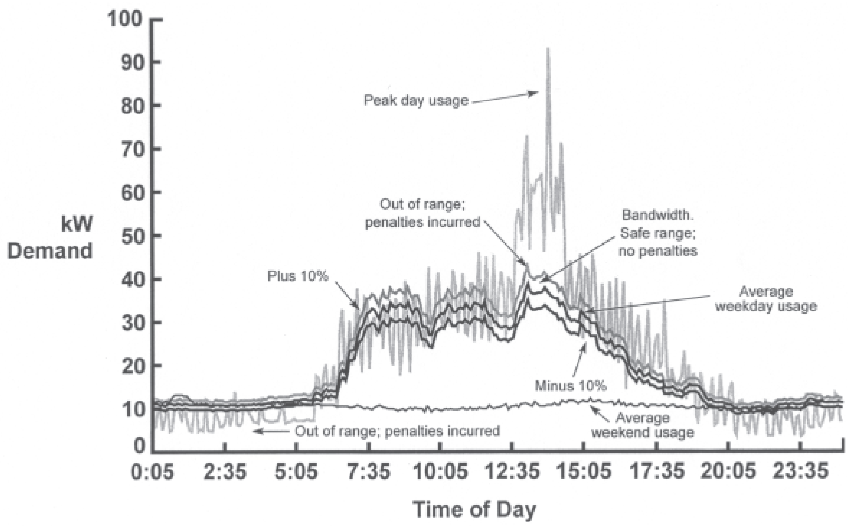

Figure 2. Typical Load Profile (100 kW Maximum Load; No Controls). Source: Cambridge Energy Research Associates

be incurred. In this example, the customer will nominate power usage based on the building's past history, which means that this building's energy usage would be out of compliance a significant part of the average day. The customer could elect to have a swing percentage greater than +/–10%, but will pay a premium for this ability.

Using a new generation of automated energy management system the chiller could be more closely monitored and controlled, thus reducing the number of cycles, increasing the life of the chiller, and providing better control of the electric load factor. Additionally, the system could provide direct control over other equipment whose load could be shed if necessary; point out efficiency improvements that could be made; monitor the market for the best rates; and even predict equipment problems and alert the proper personnel prior to actual problems.

If this customer connected to a 50-kW natural gas generator, the building's owner could program the generator to turn on whenever the building's demand reaches a set threshold, say, 7.5% higher than the average demand throughout the day (see Figure 3). This would enable the owner to avoid financial penalties for exceeding his nominated electric usage amount (but would not provide protection for being below the bandwidth). It could perhaps also increase the load factor to the point where the customer does meet the requirements for the next lowest-price tier.

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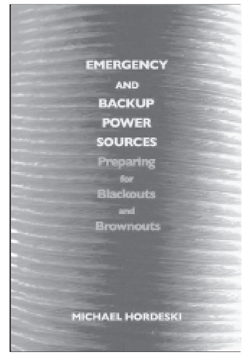

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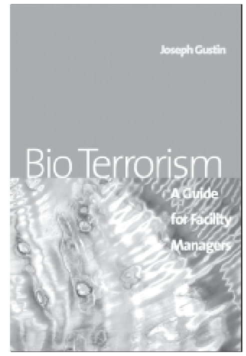

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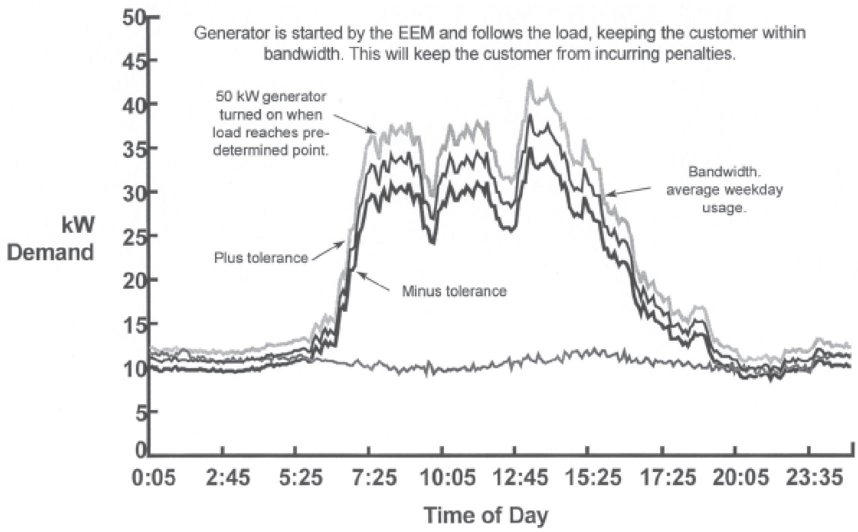

Figure 3. Same Building with Load Management System and Use of Backup Generation for Peak Shaving. Source: Cambridge Energy Research Associates

DEMAND RESPONSE AND DG

A 2001 study by New York State Energy Research and Development Authority (NYSERDA) found that customer participation in demand response programs was more effective if the customer had backup generation. Participants with backup generation tended to set aside, or promise to curtail, more power when called upon than those without backup. These customers also tended to meet their performance goals, and in some cases, significantly outperformed their targets. Customers without backup generation tended to fall short of their curtailment goals.[3]

One of the key determinants of success for demand response programs was the threat of fines for non-compliance. In California, for instance, when load-shedding programs were introduced and implemented many times in 2000 (23 curtailments) and early 2001, customer fatigue was commonplace and non-compliance became a problem. The study found that participating customers who did not meet their stated goals were much more likely to meet them when facing fines. The motivating factor for end-users to participate in load shedding programs was to save money, both by less energy consumed at critical times, and by accepting ISO or utility payments for the right to curtail.[4]

The LBNL study found that the most common load reduction strategies used fell into three categories: backup generation only; load reduction; and load reduction and backup generation. The most common load reduction strategies were reduced lighting (by manually turning off banks of lighting), and reduced cooling (by manually resetting thermostats).[5]

Back-up generators represent a significant investment by end-users, and thousands of backup generators are already in existence at key points along utility systems and could quickly be called upon to help provide relief during peak-usage times or during blackouts. The overwhelming majority are diesel-fired, but low-cost technologies are being developed to clean emissions to the level that will allow them to run in non-emergency situations. Liability issues are emerging that will further highlight the importance of back-up generation. With the proper controls, the existing base of engines can become an important resource for more than just the owner/operator.

Another study found that further opportunities for efficiency and conservation exist at smaller C&I customers. Specifically, it found:

- Commissioning of existing commercial buildings (that is, energy efficiency upgrades) could result in some 60 billion kWh savings, and could lead to a reduction of 20,000 MW of peak generating capacity;

- High-efficiency air-conditioning systems could reduce peak demand by an average of 20 percent if they installed the most efficient systems available. (However, most people choose systems based on price, not efficiency.)

- Efficient commercial-lighting systems could be cut by 30-50 percent through a combination of improved technology, automated controls, and better lighting design.[6]

CONCLUSION

End-users, who adopt load management programs, stand to gain real cost savings. The Environmental Protection Agency (EPA) recently released a list of 729 buildings that it identified as Energy Star buildings. By definition, Energy Star buildings are 40 percent more efficient than the average buildings of similar size. Of these 729 buildings, 620 (or 85%) had energy management control systems. The EPA reported that Energy Star buildings cost on average, $0.86 per square foot less per year to operate than those buildings without such control systems.[7]

Smart energy management is a concept whose time has come. And, DG proponents can play an important role in the country's future energy strategy.

Endnotes

1 For the sake of this article, distributed generation is categorized to include all forms of distributed or dispersed, power generation equipment under 20 MW in total capacity. This, of course, includes all prime movers such as engines, turbines, fuel cells, etc. But, it also includes small-scale combined heat and power plants.
2 LBNL. Do Enabling Technologies Affect Customer Performance in Price-Responsive Load Programs? LBNL. August 2002.
3 Impact of Enabling Technologies on Customer Load Curtailment Performance: Summer 2001 Results from NYSERDA's PON 585 and 577 Programs and NYISO's Emergency Demand Response Program. LBNL. February, 2002.
4 Ibid.
5 Ibid.
6 Steven Nadel, Fred Gordon, Chris Neme. Using Targeted Energy Efficiency Programs to Reduce Peak Electrical Demand and Address Electric System Reliability Problems. American Council for an Energy-Efficient Economy, November 2000.
7 See Energy Star program results at www.energystar.gov.

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Mr. Ritchie Priddy is the business development director for Attainment Technologies, LLC. Ritchie Priddy came to PMSI and Attainment Technologies from Cambridge Energy Research Associates (CERA), where he was associate director, distributed energy advisory service. With over 17 years of experience in the energy arena, Mr. Priddy has held positions in electric and natural gas utilities, as well as a gas pipeline company. He has been involved with distributed generation since 1995 and designed an award-winning DG program for Atmos Energy. He has written numerous articles and publications on DG and has consulted with manufacturers, vendors, energy companies and utilities throughout the United States, Canada, and Europe. Mr. Priddy holds an MBA from Wayland Baptist University, Texas, and a MA from Texas Tech University. He can be contacted at rdpriddy@aol.com.