End-user Electric Demand Management Should be a National Policy Objective

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ABSTRACT

An effective national energy policy must include a broad array of approaches to meeting the nation's energy needs. The more energy arrows in the quiver, so to speak, the better we may meet the challenge. As it has evolved over the past 25 years, our energy policy has reflected mounting awareness that we must address both the need to increase energy supply and the need to curb the growth in energy demand. Yet the application of attention and resources to these complementary efforts has been uneven. Energy supply issues are often at the forefront of political discourse and public awareness, and supply-side initiatives tend to generate the lion's share of funding. As to the various techniques of demand-side management (DSM), however, the pronouncements of policymakers have not always kept pace with technological advancements that stand to vastly improve the effectiveness of such techniques. Time-of-use energy pricing, in particular, could become a far more potent DSM tool as a result of innovations in metering technology. Despite the past relative neglect of such matters, there are encouraging signs in proposed federal legislation and ongoing federal and state regulatory initiatives that DSM in general, and time-of-use energy metering and pricing in particular, may finally have their day.

ENHANCING SUPPLY AND CURBING DEMAND— MEANS TO THE SAME END

A widespread popular belief holds that enhancement of supply should be the primary vehicle for satisfying our national appetite for electric energy. This belief is embodied in priorities of the current administration, such as encouraging research into the feasibility of new supply technologies, promoting the construction of new power generation and transmission facilities, fostering renewed exploration, and easing environmental restrictions. While governmental incentives have, at times, stimulated successful supply-oriented research and development projects, the ultimate benefits of these initiatives may be uncertain, long-term, and costly. Developing supply, whether this means finding and extracting hydrocarbons or siting and constructing new generation and transmission facilities, is expensive, controversial, and can require years to implement. For example, while there is a current government initiative to develop low-pollution coal-fired generation technology to address concerns regarding the air quality consequences of using America's most abundant fuel, such development is, as yet, only at an early stage.

Supply-side initiatives also often run afoul of incompatible priorities grounded on public concern over environmental degradation. There is not only significant public resistance to building large new power projects, but even sentiment favoring closure of some existing plants. For example, nuclear power, although a proven source of electric energy with an excellent domestic safety record, is so controversial due to public health and safety concerns that development is at a virtual standstill and existing plants often face hostile scrutiny. Even supply technologies thought to be relatively benign face significant obstacles. Hydroelectric power, long touted as a "renewable" resource, now faces strong opposition because of perceived harms to riverine ecosystems. Small urban combined cycle gas turbines, which have low pollution levels and do not require new transmission lines, are nevertheless resisted simply because of their likely proximity to populated areas (not in my back yard).

Given these problems with supply-side solutions, it is of critical national importance to focus upon developing and implementing DSM alternatives. Regrettably, while initiatives that enhance supply and those that curb demand ought to be viewed as working in tandem toward a common goal, the tendency to politicize the respective efforts has impeded constructive and balanced consideration of their merits. Such biases should be "checked at the door" in any examination of the benefits of alternatives, including DSM alternatives, so that the benefits may be weighed objectively.

DSM is often associated with reducing the amount of energy that is consumed. However, when energy is used can be as important, or even more important, than how much is used. As explained below, our widespread failure to effectively manage our energy end-usage has resulted in patterns of use that entail greater energy costs and a far larger investment in supply than would otherwise be necessary.

ENERGY USE MUST BE SHAPED AS WELL AS MODERATED

Electric power must be managed with an eye toward its nature. Because it is impractical to store electricity in large quantities, there must always be sufficient operating power plants (on-line or available upon prompt call up) to meet peak demand. During non-peak times of the day (and year), more efficient baseload power plants are dispatched by electric utilities and are the successful bidders in markets conducted by state or regional independent system operators (ISOs). As peak periods build, increasingly expensive, less efficient, and (often) more polluting plants are required to satisfy the increasing demand.

Peak power is significantly more expensive to produce than non-peak power. In regulated markets, the cost of producing power is passed on to customers through utility tariffs that typically include fuel adjustment clauses. In unregulated markets, ISOs predominantly establish the price of power purchased through non-bilateral contract transactions. ISOs typically operate in such a manner that the "market clearing price" of the highest bid accepted by the ISO is used to determine the price of all power sold in any given time period. In practical terms, that means that if bids for a peak hour in a particular ISO market[1] include a bid from a hydroelectric plant at $20 per MWh and a bid from an older gas or oil-fired turbine unit at $80 per MWh, the wholesale price of power sold during that hour will be $80 per MWh.

An important economic reality for end users is that even a relatively small reduction in demand can result in significant reductions in the cost of wholesale (and ultimately retail) electricity. For example, it has been calculated that in certain ISO markets such as the New York ISO, a one percent reduction in demand during peak periods may result in as much as a ten percent reduction in the wholesale cost of electric power.

The lesson from these market attributes is clear: even in regions with adequate electric supply, the higher the peak demand, the more expensive and inefficient are the plants required to meet that demand. The corollary to this lesson is that the higher the peak demand, the more plants have to be built and the more energy has to be extracted or imported to operate those plants. Peak demands for electricity also impose strains on our electric transmission system and can require the upgrading of existing facilities and construction of new facilities. High peak demand can also lead to brownouts, load shedding, or even blackouts.

For these reasons, in order to achieve efficient and low-cost generation of electricity, it is necessary not only to reduce overall demand, but to levelize the daily demand "curve" for electric usage as well. Unfortunately, most end users purchase power at the same price regardless of the time of day, and have meters that calculate only cumulative energy consumption for the day (or longer period). Those end users have no specific way of knowing how their demand varies throughout the day and no price signal[2] motivation to move "elastic" demand to other lower-priced "valley" periods of the day or otherwise reduce or curtail usage.

Being aware of and acting to "flatten" these peaks of energy usage are of critical importance. When electricity is priced depending on the time when it is used, the informed customer is incentivized to spread electric demand more evenly over the course of the day and thereby avoid the added expense and other problems occasioned by high electricity demand peaks. The ability of end users to take advantage of time-of-use pricing by regulating their own use temporally—in effect, to "shape" their own load curves—has been greatly enhanced in recent years through the continued development and deployment of the advanced interval meter (or "smart" meter), which measures both the amount of electricity used and the time when it is used. End users that are equipped with accurate information about their patterns of use are more likely to respond intelligently to the economic consequences of those patterns by minimizing unnecessary use during expensive peak periods.

TIME-OF-USE PRICING AND METERING—THE FEDERAL RESPONSE

To what extent has national energy policy fostered time-of-use pricing and supporting technology? Arguably, the effort has been half-hearted, notwithstanding an auspicious start many years ago. Section 111 of the Public Utility Regulatory Policies Act of 1978 (PURPA)[3] contains a number of federal ratemaking standards, and requires each state regulatory authority and nonregulated electric utility to consider each standard and make a determination concerning whether or not it is appropriate to implement the standard. Among the standards to be considered, as set forth in subsection (d), is "time-of-day rates":

> The rates charged by any electric utility for providing electric service to each class of electric consumers shall be on a time-of-day basis which reflects the costs of providing service to such class of electric consumers at different times of the day unless such rates are not cost-effective with respect to such class…

Unfortunately, while consideration of this standard, among others, was required, actual implementation of the standard was discretionary. The result is that now, 25 years later, time-of-use pricing is still far from universal.[4]

The National Energy Conservation Policy Act (NECPA),[5] which was enacted contemporaneously with PURPA, calls for DSM measures that are more typical of what has been implemented in the intervening years. NECPA addresses, among other things, energy management in federal buildings, but omits the time-of-use concept. In NECPA, energy management is viewed solely in terms of incremental long-term energy reductions brought about through changes to existing buildings or the design of new buildings.[6] Changes to existing buildings might include, for example, the installation of energy conservation measures such as retrofit fluorescent lamps. Effectively, NECPA conceives of energy management as the achievement of simple reductions in energy usage through retrofits of low efficiency equipment with energy-efficient devices, or changes to building characteristics that bring about such reduced usage.

This approach is typical of federal energy management initiatives and of many state and utility DSM programs.[7] Such an approach offers many benefits but is limited inasmuch as it fails to take into account the aforementioned unique characteristics of electricity and the role that time-of-use pricing and smart metering can play in dampening costly and inefficient peak demands.

For this reason, it is encouraging to see that the proposed "Energy Policy Act of 2003" (EPA), published as a discussion draft on February 28, 2003, by Congressman Joe Barton (R-TX), would attempt to give added impetus to time-of-use pricing and smart metering. Section 7061 of the proposed EPA would amend Section 111(d) of PURPA to require state regulatory authorities to consider, within one year of enactment of EPA, whether each electric utility shall, at the request of an electric consumer: (1) "provide electric service under a real-time rate schedule, under which the rate charged by the electric utility varies by the hour (or smaller time interval) according to changes in the electric utility's wholesale power cost… [to] enable the electric consumer to manage energy use and cost through real-time metering and communications technology"; and (2) "provide electric service under a time-of-use rate schedule which enables the electric consumer to manage energy use and cost through time-of-use metering and technology."[8]

Congressman Barton's proposed EPA would also amend NECPA. Section 1003 of EPA would add to the pertinent section of NECPA (i.e., 42 USC §8353) a requirement for the installation of advanced interval meters:

> Each agency shall use, to the maximum extent practicable, advanced meters or advanced metering devices that provide data at least daily and that measure at least hourly consumption of electricity in the Federal buildings of the agency. Such data shall be incorporated into existing Federal energy tracking systems and made available to Federal facility energy managers.

This measure is to be accomplished by October 1, 2010, in the interest of "efficient use of energy and reduction in the cost of electricity used in such buildings."

This proposed legislation, while encouraging, does not necessarily herald widespread adoption of time-of-use pricing and smart metering technology in the near term, for a number of reasons. At this writing, the legislation has been published only as a discussion draft—while it has been aired in Congressional subcommittee hearings, it is not yet a bill pending before Congress and, in pertinent part, may never be. Even if it is presented as a bill, the key provisions may not survive to enactment. Further, the proposed amendments to NECPA do not call for implementation of the new metering technology in federal buildings until 2010, seven years in the future. The proposed amendments to PURPA, once again, require state regulatory authorities to consider and make a determination on real-time and time-of-use rates to facilitate the use of real-time and time-of-use metering, but do not mandate the adoption of such rates, thus reflecting continued deference to state jurisdiction and prerogatives.

Given the uncertainty of federal initiatives and the deference that may be afforded to the states on key ratemaking matters, it is apparent that effective implementation of a national energy policy that recognizes the importance of DSM in general, and time-of-use pricing and metering in particular, will require the substantial cooperation of the states. The need for such cooperation is evidenced in the pending Federal Energy Regulatory Commission (FERC) rulemaking on standard market design (SMD), which seeks to make demand response as important as generation in wholesale electric markets—for example, through locational marginal pricing and demand bidding. Comments on the rulemaking to date have made clear that many of the states intend to vigorously assert their prerogatives in ratemaking, including rate design, matters.

Indeed, the states may have to take the lead in DSM matters. To what extent have the states themselves perceived the benefits of time-of-use pricing and metering and acted on that perception? As might be expected, the answer to this question varies widely from state to state. New York provides a case study of a state that has been forced by circumstances to take these matters seriously.

DSM IN NEW YORK—A CASE STUDY

In New York State, the "downstate" New York City region faces increasing electric supply shortages, electricity transmission congestion, and rising energy prices during peak periods. Given the reliance of the northeast on imported oil and natural gas, these problems may well become more widespread.

To meet these challenges, New York State has implemented incentive programs and promulgated regulations to encourage end users in the state to turn to technology to conserve energy and realize lower prices. New York State is actively encouraging the use of advanced meters, other load management devices, and participation in load management programs. As explained above, among the significant aspects of smart metering is that it enables end users to take advantage of timing differences in the market price of electricity.

Commercial and Industrial Voluntary Demand Curtailment

Recognizing that expected enhancements to supply and transmission facilities may not occur, or may occur years after expected, the New York Independent System Operator (NYISO) is looking to persuade end users to curtail usage in high demand situations. NYISO, with the approval of the FERC, is encouraging users to voluntarily curtail demand in response to NYISO's signals during periods of high demand. For example, NYISO has implemented emergency demand response programs (EDRPs), which make payments available to end users for curtailing usage at times of peak demand.

Essentially, NYISO perceives that curtailing usage is equivalent to providing additional generation. This is not a new concept. Utility DSM projects over the past two decades have "purchased" demand or energy reductions from customers and energy services companies. For example, the New Jersey Bureau of Public Utilities approved "standard offer" DSM programs provided by Public Service Electric & Gas Company that treated electric demand/energy reductions in much the same manner as the incremental production of capacity and energy. These programs required the installation of energy conservation measures, such as replacing incandescent lamps with fluorescent lamps, that result in continuous passive reductions in demand and energy use. NYISO curtailment differs in that it entails taking action to cease use of electric energy or to provide replacement energy (i.e., a facility generating its own electricity) in response to notification of an emergency or high-demand situation.

Curtailment is viewed by NYISO as essential to the proper functioning of electricity markets with respect to reliability and price. As to reliability, the laws of physics dictate that a significant load imbalance may cause a system-wide inability to function, necessitating load shedding to prevent an involuntary power outage. As to price, it is essential to have a sufficient number of sellers and buyers to have a liquid market. Too much demand is the equivalent of having too many buyers. Reducing the number of "buyers" helps to restore equilibrium and liquidity to the market. Once there is a liquid market, the market participants can arrive at a "market-clearing price" that reflects the interests of all market participants fairly.

NYISO's EDRPs are open to customers ranging from light commercial to heavy industrial and, accordingly, the participants have varied widely, from cement factories to cheese producers. Options under the EDRPs generally include: (i) voluntary load reduction measured against a statistically set load baseline, (ii) competition within NYISO's day-ahead bidding program, under which participants offer their load reductions into the market and compete against generator offers, and (iii) contractual commitments to either reduce load or serve it by on-site generation.

The New York State Public Service Commission (NYPSC) has supported demand response programs and has encouraged their operation by requiring utilities to establish appropriate tariffs, including real-time pricing rate structures based upon NYISO's day-ahead market for those customers who participate in the NYISO programs.

Metering

It is also noteworthy that the NYPSC has sought to open utility service to competition. NYPSC policy calls for the installation, testing, and reading of meters, along with data handling, to be opened to competitive providers, including the incumbent utilities. This policy also allows for meter ownership by competitive providers, utilities, and non-residential end users meeting specified demand criteria. The NYPSC has also encouraged electric distribution utilities to facilitate efforts by customers to utilize advanced, remote metering.

Incentives

Nationally, we have a history of reacting to crises rather than anticipating and planning for such contingencies. Perhaps that is because it is difficult to achieve a political consensus until voters feel threatened by events. This tendency may be analogized to not fixing the roof until it rains. New York State is facing a crisis and, therefore, besides addressing supply-side development, is also providing financial incentives to end users to adopt effective load management and working on a host of other energy efficiency and conservation initiatives.

On the incentive side, the New York State Energy Research and Development Authority (NYSERDA) is encouraging the installation of advanced meters and other energy management devices by commercial, industrial, and institutional customers to permanently reduce load or enable them to participate in NYISO's demand response programs. For example, a NYSERDA Program Opportunity Notice provides incentives for the installation of interval meters by customers participating in NYISO load reduction programs, transmission owner load response programs, or similar programs offered by load-serving entities such as electric utilities. Another example is that NYSERDA will provide incentives for incurrence of the installation costs related to advanced interval meters and other elements of energy management systems for multi-family residential apartment buildings.

Real-time or Other Time-Sensitive Pricing

Advanced interval meters are necessary to take full advantage of purchasing electric energy on a time-sensitive basis. Time-of-use pricing has a long history, but has not been generally available in bilateral contracts following deregulation. Widespread time-sensitive pricing is essential to encourage non-residential and residential end users to manage demand.

Notwithstanding NYISO encouragement, it can be difficult to find suppliers offering time-sensitive rates. As of this writing, the authors are aware of at least one non-utility supplier that is planning to offer real time-price (RTP) power. Utilities may also offer RTP tariffs. For example, Consolidated Edison Company of New York, Inc.'s (Con Edison's) voluntary RTP rate is applicable to several service classifications such as commercial, industrial, and multi-family dwellings. Although the demand rate under that tariff can be higher than Con Edison's retail access demand rate (because the RTP rate is under Con Edison's full service tariff), there remain significant potential savings to those end users able to move usage to off-peak periods. Prior to taking service under any RTP rate, end users should analyze their specific demand curves to determine whether there is sufficient elasticity of demand to justify purchasing at the RTP rate. The installation of advanced interval meters is essential to any comprehensive analysis of a facility's usage patterns. While Con Edison and other utilities can provide standardized load curves, only an interval meter will enable an individual end user to determine its own usage characteristics to conduct a meaningful analysis.

There are several potential benefits to load management—reduced demand charges, lower energy costs, and possible receipt of curtailment payments. A variety of end users can benefit from load management. Non-residential customers such as commercial users, hospitals, and school districts have installed advanced interval metering and building management systems (BMSs) that serve diverse functions. For example, school districts have made such installations as a feature of projects that also involved the installation of energy conservation measures and cogeneration. The installation of a BMS affords the facility owner or occupant knowledge essential to the control of its energy usage. Apartment buildings that have submetered under NYPSC regulations by installing a master meter and individual apartment meters can also benefit from advanced metering and load management.

There are several "cutting-edge" projects in New York City cooperative apartment buildings designed to demonstrate the benefits of programs centered around advanced metering, curtailment, and time-sensitive rates. The lessons learned from these projects should be broadly applicable to residential and non-residential electricity end users alike. These projects are being conducted by Energy Investment Systems, Inc., a New York City based company that has developed an innovative energy management program for cooperative apartment buildings.[9] NYSERDA is providing incentives for these projects.

The implementation of a rate structure within any building having multiple users, whether commercial or residential, raises challenges. These challenges can have technological, practical, and regulatory aspects. In particular, consideration must be given to state and local regulations relating to the sale of electricity. For example, the apartment building project referenced above is planning to switch to RTP rates and implement an internal rate structure to reflect RTP rates. In establishing an internal rate, the building will have to consider the application of the NYPSC's submetering regulation, which imposes a cap on internal rates that prevents charges applied to submetered residents from exceeding a utility's residential tariff rate for direct-metered utility service. Such problems can be resolved, however, and the effort is amply justified by the benefits of time-of-use metering and rates.

CONCLUSIONS

In summary, the federal government should encourage demand-side management measures, including advanced interval metering and time-of-use pricing. Such measures can provide important benefits to end users and our nation, and should figure prominently in our national energy policy.

References

1. Typical ISO markets include both day-ahead markets and spot markets. ISOs also handle a significant amount of power sold under bilateral contracts.
2. The dangers of having insufficient price signals to end users were vividly illustrated in California. When drought reduced the supply of electric energy in the northwest and natural gas prices increased, prohibitions against long-term utility purchase contracts and a certain amount of admitted market manipulation significantly increased the cost of electric energy to the utilities. However, the utilities were obligated by prior arrangements to charge customers artificially low prices that did not reflect the high prices the utilities paid for power. As a result, customers did not reduce their demand for electricity and experienced shortages. One can view such a problem as being a result of insufficient supply, i.e., with sufficient supply; the price of wholesale electricity would have been more stable. Inadequate supply was also exacerbated by the fact that California has resisted the construction of new power plants and the use of back-up generators for environmental reasons. A more fundamental reason for the shortages, however, is that California's deregulation, in violation of fundamental economic principles, did not require customers to pay prices that reflected the cost of purchased power. This unquestionably resulted in greater overall usage, including during peak periods, than if the end-use customers had been required to pay "full freight" based rates. Ideally, if the customers had had "smart" meters and been charged time-of-use rates, a presumed, resulting significant diminution of peak demand might well have alleviated the situation. Thus far the governmental focus has appeared to be predominantly upon an aspect of the supply issue (i.e., the extent to which there was market manipulation—for example, see the "Final Report on Price Manipulation in Western Markets" in Docket No. PA 02-02-000 issued by FERC on March 26, 2003) rather than giving equal emphasis to an evaluation of how providing economic signals and incentives to consumers to reduce consumption during peak periods could have resulted in reduced demand and more stable markets. In creating and operating markets, it is vital to consider the value of the carrot as well as the stick.
3. 16 USC §2621.
4. There have been instances of electric utilities adopting time-of-use rates with the encouragement of state agencies, but such rates are the exception rather than the rule.
5. 42 USC §8201.
6. See 42 USC §8353.
7. A number of utilities, with state agency encouragement, have provided significant incentives for electric customers to install energy conservation measures.
8. Section 7061 of the proposed EPA would also amend Section 115 of PURPA (16 USC §2625) to provide that, in a state that permits third-party marketers to sell electric energy to retail electric consumers, the electric consumer shall be entitled to receive the same real-time (or time-of-use) metering and communication service as a direct retail electric consumer of the electric utility.
9. Energy Investment Systems, Inc. is implementing a model in these buildings based upon information derived from several years of participation in NYSERDA-sup-

ported programs. One of EIS' projects includes: (i) advanced interval meters and equipment that can measure usage in time intervals and can read meters automatically; (ii) telephonic interconnects with Con Edison; (iii) automatic curtailment control devices (with overrides to meet resident approval); (iv) individual apartment display devices that provide energy-related information; (v) the purchase of electric power at the RTP rate or other time-sensitive arrangement and (vi) the development of an internal time-sensitive apartment rate schedule that mirrors the RTP rate categories and thereby reflects peak demand periods.

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