THE RIGHT PRICE

Dynamic pricing can provide benefits to customers and utilities alike.

BY LISA V. WOOD

THE PRICE OF ELECTRICITY IS SUBJECT TO the market forces of supply and demand. However, since electricity cannot be stored in large quantities, it has to be generated on demand. To serve demand that varies over time, different generation units with varying efficiencies and fuel sources are used to provide electricity at different times of the day and year. But adequate generation capacity must be maintained at all times to serve periods of peak demand.

For instance, certain generation units, typically gas combustion turbines, only operate during the one percent of the hours in a year when the demand for electricity is highest. Due to their relatively high fuel costs, it makes economic sense to dispatch these expensive units only during peak demand hours—typically during summer heat waves. These units are kept idle for the rest of the year at a cost of billions of dollars nationwide.

It is well known that the real cost of serving customers is variable and much higher during peak demand hours than in other hours of the year.

123rf


Kwh

Southern California Edison's substation peaker unit in Downey, CA. It runs at high generation costs—demand response programs help keep running time down.

Despite these characteristics of electricity, the vast majority of today's retail tariffs—especially to mass market customers such as residential and small commercial customers—typically do not account for the time-varying nature of demand and therefore mask the real cost to serve customers. Since prices do not signal the true scarcity value of electricity, customers typically have no incentive to reduce usage during peak periods because they are not charged directly for the high cost of electricity during these hours. Dynamic pricing programs overcome this problem by providing price signals during high-cost hours of the year that give customers incentives to lower their bills by curtailing peak usage and shifting it to less expensive off-peak hours.

Dynamic Pricing Programs

The purest form of dynamic pricing is *real-time pricing* (RTP) where customers pay electricity prices that are linked to the wholesale cost of electricity on an hourly (or sub-hourly) basis. Prices are provided on a day-ahead or hour-ahead basis and may apply to either a customer's entire load or a portion. Typically, RTP is offered only to the largest customers—usually above one megawatt (MW) of demand. By posting prices that reflect the cost of producing electricity during each hour of the day, RTP programs provide accurate price signals to customers, giving them the incentive to reduce consumption during the most expensive hours. More than 70 utilities have offered RTP in either pilot or permanent programs, primarily to their largest customers. Georgia Power, for example, has operated a successful and perhaps the most well known RTP program for about 20 years with its largest customers. In New York, utilities are required to offer hourly rates to their largest customers, and other states also are starting to consider this for large customers. However, for mass market customers, few utilities offer full-scale dynamic pricing programs. Although mass market customers individually represent small loads, as a group they represent about one-third of all electricity consumed in the nation. As of November 2009, shareholder-owned utilities in 14 states and the District of Columbia offer dynamic pricing programs to residential customers—primarily on a pilot basis at this point. (See Figure 1.)

Although RTP may be ideal from a price signal perspective, for smaller mass market customers (such as residential and small commercial) it may not be the best dynamic pricing option. For most mass market customers, other dynamic rate structures that approximate the real-time price may provide more opportunities for customers to reduce their electricity bills. *Critical peak pricing* (CPP), for example, attempts to convey the true cost of power generation to electricity customers by pricing the critical peak, peak, and off-peak periods differently, since the cost of electricity is more expensive during the peak hours than the off-peak hours, and significantly more expensive for a small number of critical hours during the year linked to system conditions. This rate is particularly effective when high wholesale prices are limited to about 100 hours of the year as they are for many utilities nationwide. Under CPP, the utility is responsible for "calling" critical events, determining when the critical rate will be in effect, and letting customers know ahead of time. Customers are typically notified the day before a critical event. In addition, the hours during which an event can be called (such as between 2 p.m. and 7 p.m.) and the number of events that can be called (usually around 12 to 15 per summer) are determined in advance. However, there is some uncertainty surrounding the exact days when these critical prices will go into effect since they depend on actual wholesale market prices and market conditions.

Another alternative to RTP is a *peak time rebate* (PTR) program, which mirrors a CPP rate. However, instead of paying higher rates during the critical peak hours, PTR participants receive a cash rebate for each kilowatt-hour (KWH) that they reduce below their baseline

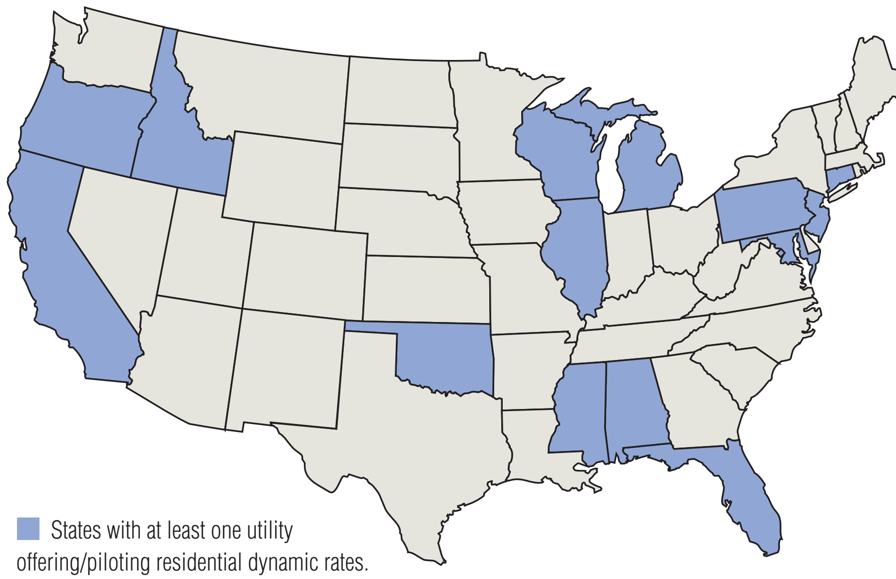
Lisa Wood is executive director of the Institute for Electric Efficiency.

Courtesy: Southern California Edison

FIGURE 1

RESIDENTIAL DYNAMIC PRICING PILOTS AND PROGRAMS BY STATE

(Shareholder-owned utilities only, November 2009)



States with at least one utility offering/piloting residential dynamic rates.

Source: Institute for Electric Efficiency

usage during the event. If customers don't respond to the PTR rates, one advantage of PTR is that their bills remain exactly the same as they would be under their existing rate. Such a concept may provide a politically feasible way to transition from flat rate structures to other flexible rate options such as CPP or RTP. Still, PTR does pose some complications, primarily the computation of a baseline profile of what each participating customer "would have consumed" in the absence of the PTR. This is not an easy task and is subject to error. Another challenge that needs to be addressed is who pays for the rebates for those customers who shift load during critical peak hours. At this time, customers who do not participate in a PTR program typically pay for the rebates that participating customers receive.

More traditional *time-of-use* (TOU) rate structures, which have been in existence for more than 30 years, reflect the higher cost of supply during peak periods and lower cost during off-peak periods, but are not dynamic in that they don't respond to actual wholesale market prices. For example, a peak period might be defined as the period from noon to 6 p.m. on weekdays, with the remaining hours defined as off peak. Under such a structure, there is no uncertainty as to what the rates would be and when they would occur. In other words, these rates are independent of system conditions and not dispatchable by the utility, as are RTP, CPP, and PTR rates. Still, TOU rates do help lower peak loads and reduce the need for peaking capacity.

> ALTHOUGH MASS MARKET CUSTOMERS INDIVIDUALLY REPRESENT SMALL LOADS, AS A GROUP THEY REPRESENT ABOUT ONE-THIRD OF ALL ELECTRICITY CONSUMED IN THE NATION.

As we move from flat rates to more flexible rate options such as CPP and RTP, wholesale price signals are passed on to customers. Each rate carries a different hedging premium—inversely related to the customer's exposure to wholesale market prices. Utilities purchase hedging contracts or make other arrangements to limit their exposure to wholesale price swings and pass the cost of these arrangements on to customers. The hedging premium (estimated to be about 15 percent) is highest for customers on flat rates where the utility suppresses all price volatility to customers, maximizing its hedging obligations. As rates become more dynamic, this hedging premium decreases eventually to zero. Under RTP, customers pay no hedging premium and assume all of the price risk.

As more and more mass market customers are offered dynamic pricing retail rate options, some adjustments will need to be made in deregulated states where independent system operators (ISOs) such as PJM are recognizing the growth in retail dynamic pricing and are starting to discuss how they will incorporate retail price responsive demand into the wholesale market. To date, according to PJM research, demand response (DR) at the wholesale level has been treated as a supply-side resource and bid into the supply side of the market rather than as a demand-side resource that affects the ISO's overall system demand curve.

Automated Metering Infrastructure

A prerequisite for the implementation of dynamic pricing programs is automated metering infrastructure (AMI), which allows for two-way communication between the utility and the customer. Dynamic pricing is only feasible if customer usage can be metered in increments of time required by the specified pricing mechanism and communicated from the customer to the utility. AMI is not required to notify the customers of the event days and hours because this can be achieved through conventional communication methods such as telephone calls, text messages, and emails. However, AMI enables more effective communication from utility to customer through enabling technologies such as energy orbs (which change colors to signal price changes) and programmable communicating thermostats (which can automatically adjust to a price signal). By enabling communication from the utility to the consumer and from the consumer to the utility, such technologies make it easier for customers to respond to price changes, and, in some cases, allow the customer (or the utility) to automate customer response.

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> ADDITIONAL INVESTMENTS IN TRANSMISSION AND DISTRIBUTION INFRASTRUCTURE CAN BE AVOIDED IF ENERGY AND CAPACITY REQUIREMENTS CAN BE LOWERED.

Many utilities are now filing AMI business cases with their regulatory commissions because expenditures on such meters must typically pass a benefit-cost test to be approved. Much of the cost of AMI is justified through operational benefits such as remote meter reading, faster outage detection, lower maintenance costs, and remote on/off service switching. But, in many cases, utilities rely on the DR benefits of dynamic pricing to achieve positive cost-benefit ratios and justify the AMI investment. In more than 30 states across the country, utility-wide AMI deployment to mass market customers is either underway, planned, or proposed. Many more meters will be deployed as a result of the Department of Energy's smart grid investment grants to utilities, and over the next five years, at least half of the mass market customers in the United States will have AMI or some type of smart meter in their home or business.

Dynamic Pricing Provides Benefits

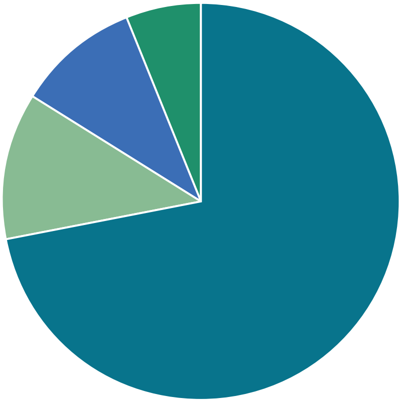
Dynamic pricing programs yield some overall usage conservation but are mostly implemented for the purpose of load-shifting to reduce peak demand. As a result, the major benefit for a utility from a dynamic pricing program is the reduced peak capacity requirement. By lowering system peak demand, the utility can lower its power generation costs by avoiding the cost of building new peaking generation, the need to purchase fuel, and the need to procure expensive peak energy. Moreover, ad-

Pepco Holding's senior vice president of asset management and planning, William Gausman, holds the key to dynamic pricing.

FIGURE 2

DISTRIBUTION OF UTILITY BENEFITS UNDER CRITICAL PEAK PRICING FOR A TYPICAL UTILITY

- Capacity cost savings – **72%**
- Transmission cost savings – **12%**
- Distribution cost savings – **10%**
- Energy cost savings – **6%**



Source: Faruqui and Wood (2008)

ditional investments in transmission and distribution infrastructure can be avoided if energy and capacity requirements can be lowered. (See Figure 2.)

In addition to the utility benefits, dynamic prices also help to relieve congestion by incenting DR from customers and reducing the likelihood that the utility will interrupt service to relieve congestion when the electric grid is under stress. With the implementation of dynamic prices, the system operator obtains another tool or resource to maintain the stable and uninterrupted working of the grid.

Customers also derive benefits from dynamic pricing. Because DR as a resource is cheaper than the alternative—building peaking power plants—and existing generation resources can be used more effectively, the cost to serve a customer on a dynamic price is lower than the cost to serve a customer on a fixed rate. As a result, dynamic prices will, in the long run, lower rates compared to what they would otherwise be without DR. In this way, every benefit that accrues to the utility ultimately flows to customers, even those that do not participate in dynamic pricing programs.

By shifting their load from high-priced to low-priced hours of the day, the major short-term benefit for customers in dynamic pricing programs is a reduction in their monthly electricity bill. Customers with flatter-than-average load shapes, even if they do not shift their load, also will experience monthly bill decreases.

Heat wave. Dynamic pricing can ease congestion when the grid is under stress, helping dispatchers maintain service.

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ISOs also benefit from dynamic prices by using them to better manage the system's constraints. As the system peak decreases, the average variable cost of the unit that sets the marginal price of power is likely to be lower, which in turn suggests that the wholesale market clears at a lower price. When PJM reached a new all-time peak during an August 2006 heat wave, it used DR to produce price reductions that yielded a $230-million reduction in energy payments.

Counter Arguments

Dynamic pricing programs are still in their infancy, in part due to concerns that customers won't respond effectively to dynamic rates, or because policy makers think that mass market customers may be better off under existing fixed rate structures. Policy makers and consumer advocates also express concern that some groups of customers—such as low income—may be adversely or disproportionately affected. These are all fair concerns but the landscape is starting to change.

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Another argument against dynamic pricing is that the industry can achieve all of the demand response it needs via direct load control (DLC), which provides significant DR benefits, can reduce the need for peaking plants, and is often used for reliability purposes. To date, utilities have used DLC primarily as a reliability resource rather than an economic resource; however, DLC is being increasingly repurposed as an economic resource operated in conjunction with price-responsive demand as utilities consider using DLC as a hedge against price volatility.

A Sampling of Dynamic Pricing Initiatives

Utilities around the country are starting to offer dynamic prices to residential customers. With the recent influx of Department of Energy (DOE) smart grid funds accelerating smart meter deployment, the industry can expect even more smart pricing pilot projects over the next few years.

Baltimore Gas & Electric (BGE) was awarded Smart Grid Investment Grant funds to deploy 1.1 million smart meters and a residential Smart Meter Pricing program that will include a peak time rebate (PTR) for residential customers. In 2008-2009, BGE conducted a dynamic rate pilot with 1,000 residential customers over two consecutive summers that included dynamic peak pricing and two different peak time rebates. The Maryland Public Service Commission is currently holding hearings on the residential Smart Meter Pricing program.

Commonwealth Edison's recently approved advanced metering infrastructure (AMI) Assessment & Customer Applications Plan will include pilots for several rates and enabling technologies for residential customers, including a critical peak pricing (CPP) rate, a PTR rate, a day-ahead real-time pricing (RTP) rate, an increasing block rate (IBR), and a time-of-use (TOU) rate. In addition to this large-scale pilot, ComEd has been running a real-time pricing program with its residential customers since 2007 that currently includes about 8,000 customers.

Courtesy: Blueline Innovations

Pending regulatory approval, DTE Energy plans to deploy dynamic pricing pilots in the summer of 2010 as part of its SmartCurrents program, which includes advanced metering technology. DTE's Smart Home program would provide different pricing levels to incent off-peak electrical usage, web-based customer energy usage presentation, and customer outage notification. In addition, certain "smart" appliances could communicate directly with DTE to provide optimum energy savings. As a result of recent DOE funding, DTE will have the opportunity to offer Smart Home technology with in-home displays and high-tech thermostats to 5,000 customers.

Gulf Power's CPP program, Residential Service Variable Pricing, has been in effect since 2000. The tariff consists of four pricing periods which are dependent upon the time of day and season. The low, medium, and high price periods are established based on the cost to produce electricity during each period. Critical periods, called one day prior during winter and by noon of the same day in summer, may not exceed one percent of the total annual hours. With approximately 9,000 customers enrolled in the program, Gulf Power plans to grow the program to approximately 45,000 customers within 7 years.

PG&E currently operates a SmartRate program, which includes a CPP program (60 cents per kilowatt-hour for peak times on SmartDays, applicable May-October). The program is open to customers with installed smart meters and offers bill protection through a participant's first summer. A recent California Public Utilities Commission decision requires PG&E to make dynamic rates available to all customers. As an initial step, PG&E is required to offer optional TOU and CPP rates in 2010 and optional RTP rates in 2011 to its small and medium customers, including residential customers.

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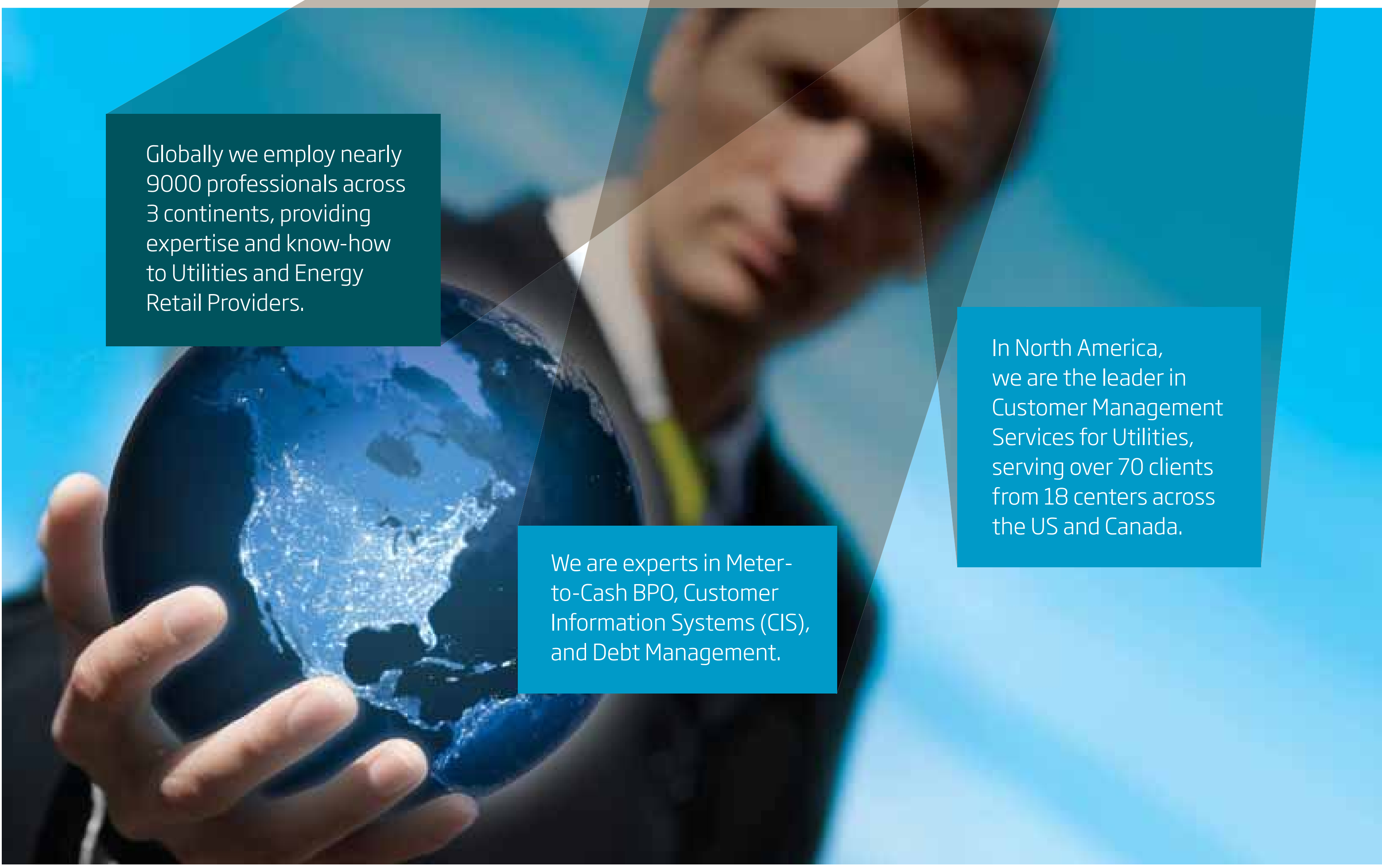

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The combination of DLC and price-responsive demand has two important attributes that DLC alone lacks: an opportunity for the customer to determine his own price threshold (rather than the utility controlling the response) and an opportunity to get rid of the risk (or hedging) premium embedded in average-cost-based rates. DLC customers still pay the hedge premium embedded in average-cost-based rates, which is a major disadvantage. Rather than responding to a price signal, DLC customers receive a rebate or a small monthly credit that is typically unrelated to the value of the actual load that is shifted when an event occurs (i.e., unrelated to wholesale market conditions).

The deployment of AMI is costly, and although it is relatively straightforward to understand the related operational benefits, the potential benefits of price-induced demand response, and why we need those benefits in addition to direct load control, is becoming more clear especially as the industry considers the costs of building new peaking plants. In fact, in the past few years, three states have implemented peak load reduction goals and it is expected that several others will do so shortly.

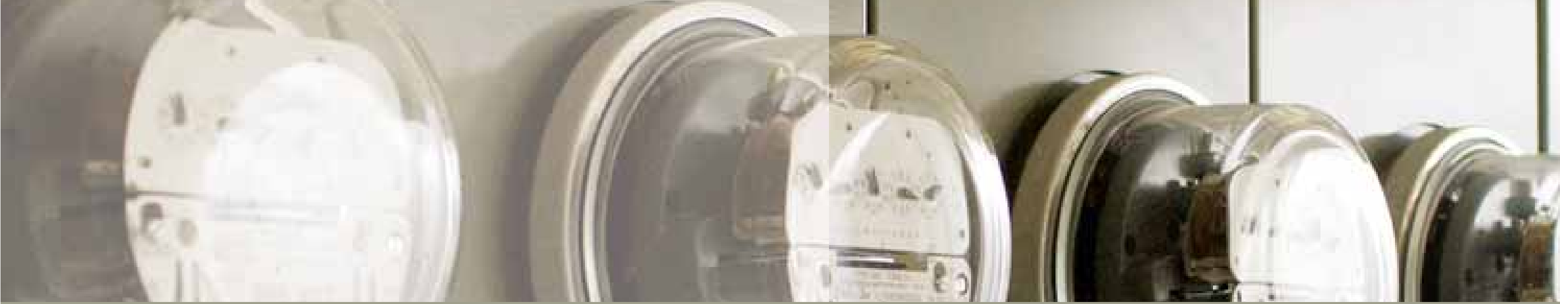
Making the Transition

Moving the majority of mass market customers from current flat rates will be difficult, but the benefits of dynamic pricing will only be realized if customers are offered these rates and take advantage of them. Today more than ever, customers are interested in managing their energy use and saving money and energy—trying new rate options is one way to do this. Several utilities have documented experience with largely successful dynamic pricing pilots—customers have saved money and have been highly satisfied. In addition, the pilots show that enabling technologies such as smart thermostats and air conditioning switches (which automate customer response to the price signal) consistently increase customer response by 50 percent to 100 percent. (See the report, "Moving Toward Utility-Scale Deployment of Dynamic Pricing in Mass Markets," www.edisonfoundation.net/IEE.)

Customers continue to be interested in managing energy use. But moving from flat rates to dynamic ones will be difficult.

Transitioning customers to dynamic rates will require education and a transition period. As the movement away from flat rates starts to occur, the pilot results offer the following guidelines for working with customers:

Create customer buy-in. Customers need to be educated about why rates are changing. They have to be shown how dynamic prices can lower energy costs for society, help them lower their monthly utility bill and manage their energy use, prevent another energy



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Offer dynamic pricing tools. At the simplest level, customers should be told how much of their utility bill comes from various end-uses such as lighting, laundry, and air conditioning, and what actions will have the largest impact on their bill. At the next level, customers could be given real-time in-home displays which disaggregate their power consumption and tell them how much they are paying by the hour. Finally, they could be provided enabling technologies such as energy orbs, programmable communicating thermostats, and home area networks to manage their energy use.

Provide bill protection and bill comparisons for a period of time. This would ensure that the customer's utility bill would be no higher under the dynamic pricing rate than what it would have been on the existing rate. However, the bill could decrease as a result of the dynamic pricing rate, and customers would simply pay the lower of the two amounts. In later years, bill comparisons could be phased out.

Offer customers choices. Dynamic rates may not be appropriate for some customers, while fixed rates may not be appropriate for other customers. Customers should have the option of migrating to different types of time-varying rates or between time-varying and fixed rates. The bottom line is that customers need to be able to choose appropriate rate options, and the industry should enable those choices.

The benefits of dynamic pricing are well established and increasingly within reach as AMI, in-home displays, and other smart-grid technologies are deployed throughout the country. What stands in the way of progress is inertia, misplaced concern about price volatility, and a fear of change.

The transition to dynamic pricing for mass market customers will not occur without the collaboration of regulatory commissions, consumer advocates, electric utilities, and customers. In some states, these collaborations and determined pushes toward dynamic pricing are already occurring. Recent research in behavioral economics also suggests ways to nudge customers toward new behaviors that will benefit them and benefit society. The transition to dynamic pricing in the electric power sector is important and necessary. Without it, our nation will continue to experience the well-known inefficiencies of uniform, static, and fixed pricing for mass market customers and will continue to build peaking plants that run only 100 hours of the year—one percent of the time. In an era of rising costs and scarce resources, our industry must do better. ◆