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Dynamic Pricing for Retail Electric Utility Service in Washington State

- ► Key Concepts
- ► Business Case Development
  - ►► Estimating Benefits
  - ►► Estimating Costs
- ► Systems Approach

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Introduction

Dynamic pricing is a class of rates for retail electric utility service that can be changed more frequently than traditional, more static forms of rate structures. The general theoretical basis for dynamic pricing is that by sending price signals to consumers that reflect fluctuations in costs on a more timely and accurate basis, it can potentially improve overall economic efficiency and reliability in the production and consumption of electricity.

During the last three decades, the concept of dynamic pricing has been widely studied, tested and on a relatively limited basis, implemented by the electric utility industry. To date, the electric utility industry's actual experience with dynamic pricing has not largely captured its theoretical promise. This has partly been due to implementation barriers, including limited capabilities and high costs of the technologies needed for dynamic pricing. In addition, the actual, specific benefits from dynamic pricing have often not been clearly defined, agreed upon or measured. As a result, many previous efforts to use dynamic pricing for retail electric rates have not been successful.

Recently, a variety of forces have emerged and may be converging to improve the future prospects for eventual implementation of dynamic pricing, potentially including by investor-owned utilities in Washington State. For example, advances in technologies are improving capabilities and may reduce the costs to implement dynamic pricing. Second, it has become apparent that dynamic pricing could produce additional new benefits (e.g., facilitation of vehicle electrification and integration of intermittent generation from renewable resources such as wind power) that were not achievable in the past.

Business case analysis can be a highly useful tool for utilities to plan, design and implement dynamic pricing. The business case analysis should be developed using inputs that reflect the actual situation of the utility and its retail customers. Alternative forms of dynamic pricing should be identified, and each alternative should be evaluated in terms of its benefits, costs and risks. If a particular approach to dynamic pricing is proposed for implementation, it must be shown to produce positive net benefits and be superior to other available alternatives. The results of the business case analysis should also be used to guide and monitor program implementation, and to measure and verify actual results.

While dynamic pricing can produce benefits in the form of reduced operating costs for the delivery functions of utilities, the largest share of potential benefits are widely assumed to come from reductions in power supply costs. However, the power supply-related benefits are often represented in abstract terms, founded upon the broad, simplistic economic theory that directly exposing retail electric customers to market prices for power supply will automatically produce large (but not well-quantified) benefits. Rather than accepting such claims on faith, greater effort can and should be made to quantify the potential power supply benefits of dynamic pricing.

In Washington State, investor-owned utilities have a public service obligation to plan, acquire and manage an integrated portfolio of power resources to serve their customers. In this context, it makes sense to view dynamic pricing as an additional, demand-side form of power resource that the utility can employ (e.g., through price-induced shifts or reductions in customer demands) to help manage its overall resource portfolio. Evaluating the impacts of dynamic pricing on costs and risks for the utility's electric resource portfolio better reflects the actual situation of investor-owned utilities in Washington State. It also allows the power supply benefits of dynamic pricing to be quantified more rigorously.

Further, treating dynamic pricing as a demand-side resource can help to avoid the risk that simply and fully exposing retail customers to commodity market prices for electricity may lead to increased volatility in market prices.

A large share of the costs to implement dynamic pricing are incurred by the delivery (e.g., metering) and customer service (billing) functional departments within utility companies. Meanwhile, much of the potential benefit from dynamic pricing involves power resources (e.g., reduced need for peak generating capacity). Therefore, it is important for dynamic pricing programs to be designed and implemented in a way that efficiently and effectively captures the power resource benefits. This requires good cooperation across the utility organization, with a focus on maximizing the overall net benefits from dynamic pricing.

Report Organization

This report provides an overview of dynamic pricing for retail electric utility service, with emphasis on considerations related to investor-owned utilities in Washington State. The report is organized in two sections. The first section summarizes key concepts for dynamic pricing. The second section provides recommendations about utility development of the business case for dynamic pricing, including estimating benefits and costs. The third section describes how a systems approach can be used to address dynamic pricing within the broader context of its interconnectedness with other issues and increasing complexity of the electric utility system.

Section One: Key Concepts

What is Dynamic Pricing?

Summary

Dynamic pricing is an alternative type of rate for retail electric utility service that can be changed (raised and lowered) more frequently than traditional, static rates.

Discussion

Traditional retail electric rates are basically static or flat, reflecting an average of the varying costs that the utility incurs at different times. In contrast, dynamic pricing is an alternative that allows utility rates to be adjusted more frequently, based on fluctuations in costs. Depending on the specific type of dynamic pricing that is used, adjustments in the rates may be pre-determined, based on projections of variations in costs during certain time periods. Or the rate adjustments may be based on changes in actual costs when such changes occur.

Does Dynamic Pricing Make Sense or Not Make Sense in All Cases?

Summary

Because the circumstances of each utility and its customers vary, it is not possible to draw broad, general conclusions that dynamic pricing is or is not preferable to traditional, static rates.

Discussion

Dynamic pricing offers potential benefits that are clearly attractive relative to traditional, more static forms of retail electric rates. These benefits are identified below. However, implementing dynamic pricing also involves various costs and risks, which are discussed below as well. Consequently, the question of whether dynamic pricing is appropriate becomes a matter of evaluating benefits and costs. If the benefits exceed the costs, then dynamic pricing may be justified.

Further, the types and magnitudes of benefits and costs of dynamic pricing can vary significantly from utility to utility. Examples of factors that affect benefits and costs for a particular utility include:

- Characteristics of the utility's retail electric customers (e.g., consumption patterns due to the local climate, customer responses to pricing signals)
- Characteristics of the electric resources that are used to serve the utility's customers (e.g., the mix of power generation technologies varies between regions and among individual utilities)
- The utility's current and future capabilities to implement dynamic pricing (e.g., if the utility has already implemented advanced metering capabilities that support dynamic pricing, new costs for that part of the implementation would be avoided)

In other words, the potential for dynamic pricing depends on the specific situation of each utility and its customers. In order to draw definitive conclusions about the desirability of dynamic pricing, the utility must evaluate the benefits and costs that are relevant for it.

As also discussed below, future development of the Smart Grid is expected to provide enhanced capabilities that can facilitate implementation of dynamic pricing. Thus, the prospects for dynamic pricing are likely to improve over time.

What are the Primary Purposes for Dynamic Pricing?

Summary

The most commonly-stated objectives for dynamic pricing are to promote increased overall economic efficiency and reliability in the provision and consumption of electricity.

Discussion

Under traditional retail electric rates, changing conditions can cause the actual costs of providing electric service to differ from the amount of revenue being collected at a given point in time. At certain times or under various circumstances, the utility's actual costs can be significantly higher (or lower) than a static retail electric rate.

Two examples of this can be at times when extreme cold winter temperatures in the Pacific Northwest cause electric heating loads to dramatically increase, or when extreme hot summer temperatures in California cause air conditioning loads to dramatically increase. In such circumstances, power supplies in the Western U.S. can become constrained, causing market prices for power and the incremental costs of meeting the higher loads to go up.

In such circumstances, the power supply constraints, and thus the increase in prices and costs, could be mitigated if customers shift or reduce their consumption of electricity. However, consumers who receive retail electric service under a static rate do not have an economic incentive to do so, and in many cases may not be aware of the need. To address this lack of information and incentives under static rates, dynamic pricing is used to send a price pricing signal that creates an incentive for retail electric customers to reduce or shift their consumption and thereby help relieve the power supply constraint.

Is There More Than One Type of Dynamic Pricing?

Summary

Several forms of dynamic pricing have been developed and used by the electric utility industry. Examples of dynamic pricing include real-time pricing, time-of-use rates, critical peak pricing, interruptible rates and seasonal rates.

Discussion

Following are descriptions of several types of dynamic pricing:

Real-Time Pricing – Under real-time pricing, or "RTP", retail rates are varied on an hourly or other short-term basis, typically tied to variations in commodity market prices for wholesale power supplies. Real-time pricing is the most complex form of dynamic rates and is therefore the most difficult and costly to implement. For example, it requires frequent, ongoing transmittal of prices to consumers, and advanced meters to measure the quantity of electricity each customer consumes during every pricing interval (e.g., hour). Implementation also requires the availability of a robust commodity market for power supplies, with prices that are reliable indicators not subject to manipulation or other distortions. Communications, data management and customer billing requirements are greater as well.

Time-of-Use Rates – Time-of-use, or "TOU", rates are similar to real-time pricing, but change less frequently and on a more predictable basis. Time-of-use retail electric rates are typically varied on a specified schedule, with a rate that is predetermined for each time period. For example, time-of-use rates are normally set at a higher level during the daytime and set at a lower level during the night time. Rather than market prices for power, time-of-use rates are instead set using estimates of how the utility's costs vary during each pricing interval.

Critical Peak Pricing – Critical peak pricing, or "CPP" is an approach that adjusts retail electric rates on an occasional basis, typically as a temporary response to events or conditions such as extreme high peak loads (e.g., hot weather events in the summer, cold weather events in the winter). Critical peak pricing rates may be set at predetermined levels, or they may be adjusted to reflect prevailing costs or actual market prices during the pricing event. Because critical peak pricing is only triggered in limited circumstances, implementation may be somewhat less complex and costly than real-time pricing or time-of-use rates.

Peak Time Rebates – Like critical peak pricing, peak time rebates provide price signals intended to inform and motivate customers to shift or reduce their consumption of electricity during peak periods. However, rather than raising the customer's rate during the peak period to create a disincentive for consumption at that time, peak time rebates provide a positive incentive. The positive incentive is in the form of a rebate that is provided to "pay" customers for shifting or reducing their consumption during the peak period.

Interruptible Rates – Under interruptible rates, participating customers agree to allow the utility to curtail a portion or all of their electric consumption under certain predefined conditions. In return, the customer typically receives a discounted retail electric rate for allowing their load to be curtailable. However, only certain types of customers are able and willing to allow their consumption of electricity to be curtailed. As a result, most interruptible rate programs have focused on certain types of industrial customers. For these customers, implementation of interruptible rates can be relatively simple and less costly.

Seasonal Rates – Seasonal rates can be considered to be a subset of time-of-use rates, where the rate charged to the customer is set at different levels during different parts of the year.

It may be possible to combine more than one type of dynamic pricing. For example, time-of-use rates could be used in normal circumstances, and critical peak pricing could be triggered during specific events such as periods of extreme peak loads.

Are Dynamic Pricing and Customer Demand Response Related?

Summary

Dynamic pricing and customer demand response are overlapping approaches that both change the consumption of electricity for the purpose of helping to relieve constraints on the power system.

Discussion

Customer demand response can be defined as a group of mechanisms designed to change the consumption of electricity as and when needed to relieve temporary or intermittent constraints on the power system. Customer demand response programs are voluntary, with participation by customers who have loads that can be curtailed or shifted.

There are two basic types of customer demand response. Under the first type, pricing signals are used to elicit shifts or reductions in consumption by retail electric customers. Under the second type, the utility or system operator exercises direct control of the participating customers' loads, where the maximum frequency and duration of such direct load control events is mutually agreed upon in advance.

Specific triggers for customer demand response include periods of abnormally high market prices for power supplies, or events that could affect reliable operation of the power system (e.g., unplanned outages of generating plants or regional transmission facilities).

Certain forms of customer demand response, particularly those that use pricing signals, can be similar, if not identical, to specific types of dynamic pricing.

While customer demand response has tended to focus somewhat more on the goal of protecting system reliability, dynamic pricing has tended to focus somewhat more on the goal of promoting economic efficiency.

Because the direct load control forms of demand response can be operated by the utility, some utilities appear to consider them to be more dependable than dynamic pricing. In other words, one point of view is that if the utility has the ability to directly control a customer's electric load, this provides a greater degree of assurance that the load can actually be curtailed when needed – including in extreme circumstances. However, another point of view, backed by recent pilot studies, holds that electric customers adjust their consumption in response to dynamic pricing in a predictable and reliable fashion.

What Kinds of Benefits Could Dynamic Pricing Provide?

Summary

Dynamic pricing offers a number of potential benefits, including improving the economic and reliable provision of retail electric service, promoting efficient consumption of electricity and investment in conservation, and facilitating vehicle electrification.

Discussion

In theory, dynamic pricing could provide a number of potential benefits: Examples include the following:

- By enabling timely reductions or shifts in the use of electricity by consumers, activate an additional, demand-side form of power resource that can in turn improve the efficient and reliable provision of electricity. Specific types of opportunities include:
  - incrementally reduce the overall need for generating resources, particularly peaking power plants that are rarely used
  - reduce the frequency and severity of power supply constraints and the resulting spikes in market prices for wholesale power
  - help integrate renewable resources, including by enabling customer loads to respond to fluctuations in generation from wind power
  - reduce overall emissions and other negative environmental impacts
  - assist in reliable operation of the bulk power system
  - assist in reliable operation of local distribution systems
  - support more efficient operation and reduced costs for local distribution facilities
- By helping customers better understand how and when the cost of the electricity that they use varies, promote efficient consumption and enable more informed choices about investments in energy efficiency.
- Facilitate vehicle electrification by allowing electric rates to fall at times when costs are lower (e.g., during overnight hours), thereby reducing consumers' costs to recharge vehicle batteries.

Not all types of dynamic pricing provide the capability to realize the full range of benefits listed above. For example, most forms of time-of-use rates would not assist in responding to fluctuations in output from wind power. This is because, unlike other forms of dynamic pricing (e.g., real-time pricing), time-of-use rates do not have the ability to respond to variations in wind generation. In particular, while time-of-use rates vary depending on the time of day, the time-of-use rate for each part of the day is fixed and does not change based on fluctuations in the actual level of wind power generation within that part of the day, or from one day to the next.

Can Dynamic Pricing for Vehicle Electrification Enable Other Benefits?

Summary

In addition to facilitating vehicle electrification, dynamic pricing could enable the batteries of grid-connected electric vehicles to be used to help balance power system loads and resources, including potential use of the batteries as a standby source of capacity and as a sink for excess generation.

Discussion

One of the justifications for dynamic pricing is that it could provide lower off-peak rates that cut the costs to recharge vehicle batteries at night. Facilitating vehicle electrification in this way could open the door for significant energy, economic and environmental benefits in the transportation sector.

Further, the use of dynamic pricing for electric vehicles can also create opportunities to provide significant benefits to the power system itself. Specifically, dynamic pricing may enable vehicle batteries to become useful as a dual-faceted, demand-side resource that could be used to help balance overall loads and resources on the power system.

For example, at times when wind generation suddenly increases and causes the power system to have excess power, the surplus could be used to charge grid-connected vehicle batteries, thereby helping to stabilize the power system. Conversely, at times when wind generation unexpectedly decreases or when non-vehicle loads are high, causing supply constraints on the power system, power could be drawn from grid-connected vehicle batteries, again helping to stabilize the system.

If and when substantial numbers of electric vehicles are adopted by consumers, the potential impacts of vehicle-to-grid ("V2G") uses could become quite large. To illustrate, a single passenger vehicle with a Class 2 in-home charging system could use or supply over five kilowatts of power. This means that 20,000 grid-connected passenger vehicles could potentially provide more than 100 megawatts of quick-response, short-term load or power supply.

How is Dynamic Pricing Related to the Smart Grid?

Summary

Development of the Smart Grid is expected to occur over a period of time and will provide new capabilities, including advanced metering, two-way communications, data management and advanced system controls that could become highly useful for implementing dynamic pricing.

Discussion

Smart Grid is a set of complementary technologies designed to modernize the power grid. Grid modernization is identified as a priority in national energy policy and is being supported by federal funding. Digital technologies will be key components of the Smart Grid, including:

- advanced metering infrastructure
- more intelligent automated devices that enhance operation and control of the power system.
- two-way, real-time communications systems
- systems for collecting, storing and accessing huge volumes of data

Full implementation of the Smart Grid will likely be a long-term process, where new components and advanced functionalities will be progressively added over a number of years.

There are several important linkages between the Smart Grid and dynamic pricing:

- Smart Grid is intended to achieve a number of the same objectives that are typically identified for dynamic pricing, including improved system reliability and more efficient provision and use of electricity.
- Smart Grid will provide a number of the capabilities (e.g., transmission of real-time pricing signals, recording and collection of hourly consumption data) that would be required to implement certain types of dynamic pricing.
- Investments in Smart Grid can reduce (or share) the costs of implementing dynamic pricing.
- The timing for actual implementation of the Smart Grid will affect the timing for when certain more advanced forms of dynamic pricing can be implemented (e.g., real-time pricing).

It should also be noted that a number of reports advocating development of the Smart Grid include broad, unsubstantiated statements that a significant portion of the benefits from the Smart Grid will come from its facilitation of dynamic pricing.

Further, it is foreseeable that as the Smart Grid is implemented, there may be increasing pressure (e.g., from the Federal government) to put new capabilities for dynamic pricing to use. However, exercising ‘neat’ or ‘cool’ technological capabilities simply because they are available, or on the basis of simplistic, abstract economic theories, could lead to disastrous consequences if those capabilities are not appropriately applied in an approach to dynamic pricing that is superior to more traditional forms of retail electric rates.

Therefore, given the important role that the Smart Grid is likely to play with respect to facilitating potential future implementation of dynamic pricing, it is important that utilities plan and develop their Smart Grid capabilities to be consistent with clear policies and objectives for dynamic pricing. This should include identifying whether and how dynamic pricing could become cost-effective in the context of the Smart Grid, and which forms of Smart Grid-supported dynamic pricing can best achieve overall goals. In addition, a “no regrets” approach should be taken to ensure that each utility’s design and implementation of the Smart Grid does not foreclose future opportunities to support preferred forms of dynamic pricing.

How Long Has Dynamic Pricing Been in Use?

Summary

Dynamic pricing for retail electric utility service has received attention since the late 1970s; since then, numerous pilot programs have been conducted, as well as more limited permanent deployments.

Discussion

The concept of dynamic pricing by retail electric utilities has been in existence for more than three decades. Initial efforts to develop dynamic pricing programs began in the late 1970s and early 1980s in response to dramatic increases in oil prices and rising electric rates. Federal and State initiatives to deregulate electricity in the late 1990s, along with the Enron debacle and Western energy crisis of the early 2000s stimulated a second phase of widespread interest in dynamic pricing. Then in the late 2000s, promotion of the Smart Grid and maturation of bulk power markets in certain regions stimulated another wave of interest that is continuing today.

A large number of utilities in over half of the States in the U.S. have conducted pilot programs to test opportunities for dynamic pricing and to evaluate the potential for deploying full-scale programs. But to date, a relatively small proportion of utilities have elected to implement ongoing dynamic pricing programs. However, a large number of new pilot programs have recently gotten underway or are being planned. It remains to be seen to what extent and when these pilots may result in many more utilities implementing new dynamic pricing programs.

Georgia Power has the largest and one of the nation’s longest-running dynamic pricing programs. The utility began pilot-testing a real-time pricing program in 1992 and then in 1994 offered the program to all of its commercial and industrial customers with loads greater than 250 kilowatts. Today, Georgia Power offers an array of dynamic pricing programs, including real-time pricing and time-of-use rates. One or more forms of dynamic pricing are offered to all of the utility’s customer sectors, including residential, commercial and industrial. In 2005, the commercial and industrial real-time pricing program alone had 1,600 customer participants, representing over 5,000 megawatts of qualifying load. The utility estimates that roughly 17 percent of the load (900 megawatts) could be avoided in emergency conditions. Real-time prices for some customers are based on day-ahead power supply prices; and others are based on hourly power supply prices.

A number of other utility programs have been implemented, including a real-time pricing program that Niagara Mohawk (now National Grid) began offering to its large customers in the late 1990s. Today, National Grid offers a variety of dynamic pricing programs. New dynamic pricing programs are also being actively pursued in California, including by investor-owned utilities and publicly-owned utilities.

Has Dynamic Pricing Been Implemented in the Pacific Northwest?

Summary

Various forms of dynamic pricing programs have been implemented by several utilities in the region; in addition, numerous pilot projects are being planned, implemented or have recently been completed.

Discussion

The largest example of dynamic pricing in the Pacific Northwest to date has been Puget Sound Energy's Personal Energy Management, a time-of-use rates program that was implemented for 300,000 of PSE's residential and small commercial customers beginning in May 2001. The program was discontinued in late 2002. One of the main reasons for ending the program was that many customers found that even when they shifted their loads, their monthly electric bills were higher than they would have been under the utility's traditional rate design.

Examples of dynamic pricing programs that are currently in effect for utilities in the Pacific Northwest include:

- Portland General Electric offers optional time-of-use rates for its residential and small business customers.
- The City of Port Angeles offers optional time-of-use rates to its residential, commercial and industrial customer classes.
- Klickitat PUD offers optional time-of-use rates to its irrigation customers.
- Chelan County PUD and Grant County PUD both offer their large customers rates that vary during each day's on-peak and off-peak market periods, based on market price indices for wholesale power supplies.
- Clark County PUD offers creative optional off-peak demand rates that provide a discounted demand charge to commercial customers with loads above 30 kilowatts and to industrial customers with loads above 1.5 megawatts. The discounted demand charge applies to the portion of the customer's peak demand that a) occurs during off-peak hours and b) is in excess of the customer's peak demand that occurs during peak hours.

For most of the optional dynamic pricing programs listed above, only a subset of the utilities' customers have elected to participate in dynamic pricing, while the majority of customers remain on the utilities' traditional rate schedules. However, for customers who have chosen to participate in the optional dynamic pricing programs, the overall level of satisfaction is generally good.

Consistent with the current national trend, a significant number of dynamic pricing pilots have recently been completed, are currently underway or a being planned in the Pacific Northwest. Examples include:

- During 2006-2007, Pacific Northwest National Labs conducted the Olympic Peninsula Project, a field demonstration in Washington and Oregon that involved residential electric water heaters and thermostats, commercial building space conditioning, several distributed generation units and a municipal water supply pump. The project used real-time two-way communications to send price signals to customers and to observe resulting impacts on electricity consumption.
- In the summers of 2005 and 2006, Idaho Power conducted a pilot program for residential time-of-use rates along with critical peak pricing in the Emmett area of Idaho.
- In 2009, Portland General Electric proposed to conduct a residential critical peak pricing pilot project (current status is described in further detail on page 22 below).
- The Bonneville Power Administration is currently planning to conduct over 20 demand response pilot projects in collaboration with various utilities and other entities during the next several years. One or more of these pilot projects is anticipated to test dynamic pricing, including super peak time-of-use pricing for retail electric customers.

Why Has Dynamic Pricing Met With Limited Success So Far?

Summary

Many previous dynamic pricing programs were discontinued after it was discovered that the actual benefits produced did not exceed the actual costs incurred; however, in some cases and to some extent this may have been the result of greater-than-anticipated costs and technical difficulties to implement, and/or faulty program design.

Discussion

To date, a relatively small number of dynamic pricing programs have been successful. In some cases, pilot programs revealed shortcomings that led to decisions not to launch a large-scale program implementation. In other cases, major programs were launched, encountered unforeseen difficulties and were then discontinued.

Over time, a number of dynamic pricing programs have been shelved as a result of one or more of the following causes:

- actual costs of implementing the program were higher than expected
- key technologies (e.g., metering and communications systems) did not perform as expected or did not work together (i.e., interoperability issues)
- other technical difficulties were encountered such as unexpected complexities to modify the utility's existing information systems (e.g., update billing systems to handle dramatically larger volumes of data)
- actual power supply costs did not vary across large enough ranges to create significant savings from shifting or reduction of consumer loads
- price signals sent to consumers did not accurately reflect relevant power supply costs, were not timely, or did not elicit the desired level of load shifting or reduction
- consumers who participated in the program were unable to realize a net reduction in their bills compared to traditional rates

In other words, in actual practice the benefits that have been realized from dynamic pricing programs have often not been large enough to overcome the costs of implementing them.

However, where the actual costs incurred have exceeded the actual benefits realized, this did not in all cases mean that dynamic pricing was infeasible or that it could not have been cost-effective. Instead, in certain instances costs may have been higher than necessary due to overconfidence in new technologies that were not fully mature, or due to inadequate planning and execution of implementation. In other instances, benefits were not fully realized because the type of dynamic pricing program chosen did not fit the utility's and/or its customers' circumstances.

How Could Choosing Different Forms of Dynamic Pricing Affect Cost-Effectiveness?

Summary

If a particular form of dynamic pricing is chosen that is not well-suited to the specific circumstances of a utility and its retail electric customers, it could turn out to not be cost-effective, even when an alternative, better-suited form of dynamic pricing is available and could be cost-effectively implemented.

Discussion

For example, consider the hypothetical situation of a vertically-integrated utility that has adequate, cost-effective electric resources to serve the typical energy needs of its retail customers. Further assume that the utility does not have sufficient long-term capacity to meet the rise in its customers' peak loads that occurs during periods of extreme hot or cold temperatures.

Then suppose that the utility chooses and implements a time-of-use rates program composed of a slightly higher rate during the daytime hours of each day and a slightly lower rate during the nighttime hours of each day.

Implementing such a time-of-use rates program would likely require the utility to incur significant additional metering, communications, data handling, billing, marketing, and customer service costs.

Further, if the differential between the daytime rate and the nighttime rate is not very large (e.g., if it reflects the utility's costs to serve loads under normal temperature conditions), the potential savings that consumers could realize by shifting their consumption of electricity into the nighttime hours may be quite small in terms of dollars per month. As a result, the time-of-use rates may not elicit a significant change in consumer behavior.

Meanwhile on the power supply side, the utility's actual costs to produce or acquire the additional power supplies to meet its customers' higher loads during extreme temperature events could be quite high, significantly above its costs to serve loads during normal temperatures. If dynamic pricing could be used to reliably produce shifts or reductions in customer loads during periods of extreme temperatures, the utility's need for peaking resources and thus its overall costs could be reduced.

But the small differential in the utility's time-of-use rates would not create a strong incentive for many customers to significantly shift or reduce their loads. Further, the static form of the time-of-use rates would not provide a timely signal or an added incentive for customers to shift or reduce their consumption during extreme temperature events, at the time when it would be most valuable.

In this example, time-of-use pricing would not be a good fit for the situation, and if it is implemented the benefits are less likely to exceed the costs.

However, a critical peak pricing form of dynamic pricing would likely be a better fit for this situation. The costs for a critical peak pricing program may not be higher than for the time-of-use rates program. Further, the potential benefits from a critical peak pricing program could be much larger, including more-timely and larger reductions in peak loads during extreme temperature events that in turn reduce the utility's need and costs for peaking capacity. Thus, if properly implemented, a critical peak pricing program could potentially turn out to be a cost-effective approach for the utility.

In other words, the utility in this example has an electric resource portfolio that is not energy-constrained but is capacity-constrained at certain times (i.e., when extreme temperatures drive customer loads upward). Using a form of dynamic pricing that is static and based on average costs does not address the utility's or its customers' circumstances and would not likely be a cost-effective solution. However, using a form of dynamic pricing that is more responsive to intermittent conditions and has the ability to produce larger short-term shifts or reductions in consumption by consumers, is a better fit for the situation and offers better prospects for success.

An important conclusion that can be drawn from the example above is that to be cost-effective and successful, the form of dynamic pricing that is chosen must be appropriately-matched to the particular circumstances of the utility, its electric resource portfolio and its retail customers.

Does Dynamic Pricing Raise Regulatory Policy Issues?

Summary

Consideration of dynamic pricing involves a number of regulatory policy issues including allocation of risks, costs and benefits; impacts on certain customers; utility responsibilities for power supply portfolio management; and disposition of excess revenues.

Discussion

Several of the topics discussed above involve important policy issues. Additional policy issues include the following:

- Allocation of responsibility between the utility and its customers for technological and financial risks, including project cost overruns, delays and failures of new technologies to meet performance expectations.
- Other fairness and equity issues, including allocation of costs and benefits among customers with different electricity consumption profiles.
- Avoidance of negative impacts on low income, elderly and other customers who have limited abilities or are unable to shift or reduce consumption of electricity in response to dynamic pricing.
- For utilities that manage a power supply portfolio on behalf of their retail electric customers, ensuring that the utility continues to plan, acquire and manage its resource portfolio to meet actual customer loads reliably and cost-effectively.
- Disposition of excess revenues that are collected above and beyond the utility's actual power supply costs (e.g., for periods when the utility charges its customers a real-time price that reflects incremental costs that exceed its average cost of power during that period).
- Depending on the form of dynamic pricing that is used, the utility's incentives to manage supply and price risks in their power supply portfolios could be reduced (e.g., by failing to acquire sufficient capacity to meet peak loads and instead relying on "the market" to fill shortfalls). In turn, this could create increased market price volatility and expose retail consumers to unstable and potentially extreme high price events. This risk is often overlooked in discussions of dynamic pricing. A solution would be to view dynamic pricing as a complement to other resources, rather than as a substitute or replacement for the utility's obligations to plan, acquire and manage resources.

Are Certain Considerations Unique to Washington Utilities?

Summary

Utilities in Washington State face several issues that are different from typical circumstances for utilities in other regions.

Discussion

Utilities in Washington State face several issues that differ from typical circumstances in other regions of the country, including the following:

- In many regions where coal-fired generation or other forms of thermal generation make up a large share of the fleet of power plants, there is adequate power supply to meet energy needs, but the power supply system's ability to meet peak loads is constrained. In contrast, the situation in the Pacific Northwest has historically been the reverse – the large share of hydroelectric generation has made the region more energy-constrained and less capacity-constrained. (However, recent additions of natural gas-fired generating facilities in the Northwest has changed this somewhat. Further, hydroelectric generation makes up a smaller share of the resource portfolios for several investor-owned utilities when compared to most of the region's publically-owned utilities, making those utilities more capacity-constrained.)
- For most utilities in Washington State, peak loads occur during the winter. However, spot market prices tend to be the highest during the summer months, when hot weather drives up loads in California. As a result, there is a mismatch in the timing of when dynamic pricing could be most valuable for load-serving utilities in Washington State (i.e., in the winter when peaking capacity is needed to serve Washington utilities' retail customers), and when spot market prices for power supply are highest (i.e., in the summer).

Why Has There Been a Recent Resurgence of Interest in Dynamic Pricing?

Summary

Much of the impetus for increased focus on dynamic pricing is coming from national energy policy initiatives, including promotion of the Smart Grid and its potential to facilitate the implementation of dynamic pricing.

Discussion

At the broadest level, much of the heightened interest in dynamic pricing is the result of increased attention being paid to energy issues as a matter of national policy. This includes federal funding support for the Smart Grid, including advanced metering infrastructure and other capabilities that it will create that could be used to implement more advanced forms of dynamic pricing.

Several specific forces (some of which are contained in the federal energy policy framework) are also more directly driving growing emphasis on dynamic pricing, including:

- Interest in enabling consumers to become more actively involved in using energy efficiently
- Growing momentum toward vehicle electrification, and support for lower electric rates to recharge vehicles during off-peak hours when power supply costs are low
- Development of advanced home automation technologies that would make it easier and more convenient for consumers to adjust their consumption in response to dynamic pricing signals
- Motivations to utilize new capabilities that the Smart Grid will provide, and to rely on dynamic pricing to realize benefits that help justify a significant share of the costs for the Smart Grid
- Development of new retail electric service offerings in deregulated States where consumers have the ability to choose their power supplier

Have Recent Dynamic Pricing Efforts Encountered Any Difficulties?

Summary

During the last year, several utility dynamic pricing projects have run into significant difficulties; however, the underlying causes do not appear to indicate fatal flaws with the concept of dynamic pricing.

Discussion

Several recent utility efforts to conduct pilot projects or to implement large-scale programs have encountered significant problems. Examples include the following:

- Public Service of Colorado – With great fanfare, the subsidiary of Xcel Energy initiated a "SmartGridCity" project in Boulder, Colorado in 2008. The pilot comprises 23,000 retail electric customers and is intended to test a variety of advanced technologies, along with time-of-use rates, critical-peak pricing and peak time rebate options. Costs were initially estimated at $15.3 million, but have grown to nearly $45 million, largely due to higher-than-expected costs to provide fiber communications to customers. Concerns have also been expressed that the project may not deliver all of the capabilities that were initially included. It has also been reported that a cost-benefit analysis was not prepared as part of the project planning and design.

- Portland General Electric – In September 2009, the Oregon Public Utilities Commission approved PGE's proposal to conduct a critical peak pricing program for several thousand of its residential customers. (Note that this program is distinct from PGE's existing time-of-use rates described on page 14 above.) The pilot was scheduled to begin operation in October 2010. However, on September 21, 2010, PGE requested and received approval from the OPUC to temporarily withdraw the pilot due to underestimated complexities and delays in modifying its information systems (e.g., meter data, customer enrollment, billing, customer service). PGE is currently working on an updated implementation plan that is expected to delay the start of the critical peak pilot by one to two years.

- Pacific Gas & Electric – PG&E's large-scale program to install smart meters for its retail electric customers has encountered a number of technical and customer service problems, drawing significant criticism from consumers and regulators. The smart meters are being installed to enable implementation of Peak Day Pricing for all customer classes, including residential, commercial, industrial and agricultural. In early 2010, after a number of residential customers saw their bills rise significantly, questions were raised about accuracy of the new meters. An independent audit found that the meters are working properly. However, the report also pointed out problems with PG&E's customer services, including customers receiving multiple bills and not being able to obtain answers to questions from PG&E's customer service group.

- Baltimore Gas & Electric – On June 21, 2010, the Maryland Public Service Commission denied a Proposal by Baltimore Gas and Electric for a Smart Grid Initiative (including automated metering, two-way communications and mandatory time-of-use rates), on the grounds that the business case for it was "untenable". The

Order stated that "The Proposal asks BGE's ratepayers to take significant financial and technological risks and adapt to categorical changes in rate design, all in exchange for savings that are largely indirect, highly contingent and a long way off." The utility's plans for customer education were also found to be inadequate. BGE then modified and resubmitted its Proposal, and on August 13, 2010 the Maryland PSC approved it with additional conditions. As modified, the Proposal includes system-wide implementation of automated meters, two-way communications between the utility and its customers, and voluntary time-of-use rates along with peak time rebates. Customer education is identified as a critically important activity, to be completed *before* any changes take effect. The PSC also directed "BGE and the parties to develop, and submit for our approval, a comprehensive set of installation, performance, benefits and budgetary metrics that will allow us and the public to gain a full understanding of whether, and to what extent this Initiative is being deployed and is working as planned." Installation of the automated meters is scheduled to be completed in 2014.

It should be noted that the four recent cases described above do not demonstrate that dynamic pricing is not cost-effective or that it cannot be successfully implemented. Instead, they illustrate the importance of:

- advance planning that reflects the actual situation and realistic opportunities for the utility and its customers
- development of a program design that is complete, practical and achievable
- capable execution, including strong project management and good communications

Section Two: Developing the Business Case for Dynamic Pricing

Business Case Analysis

Dynamic pricing represents a fundamental change in the service and commercial relationship between a utility and its retail electric customers. While the potential benefits can be substantial, the costs and risks are also significant. To be successful, a dynamic pricing program must produce benefits that exceed its costs.

Therefore, it is vitally important that dynamic pricing programs be carefully planned, designed and implemented to ensure that net benefits are actually realized.

One of the key lessons learned (in some cases the hard way) is that before launching a dynamic pricing effort, the utility should prepare a rigorous and robust business case. The business case should identify and evaluate a range of alternative approaches, including the benefits, costs and risks associated with each alternative.

Rather than relying on broad or generic assumptions, sufficient effort must be put into gathering inputs to the business case that accurately reflect the situation of the utility and its customers.

If dynamic pricing is found to be cost-effective, the business case analysis should identify the preferred form of dynamic pricing, and demonstrate why it is superior to other available approaches.

Once a particular form of dynamic pricing is chosen and receives regulatory approval, the business case results should then be used to guide, monitor and report on implementation activities and to evaluate whether operation of the selected approach is proving to be successful. This can help to control costs and timeliness of implementation activities, and to measure and verify actual impacts of the dynamic pricing program.

The following sections identify the benefits and costs to be estimated.

Estimating Benefits

Types of Benefits to Be Included

Dynamic pricing can produce a variety of benefits. To the extent possible, the business case analysis should include estimates of the value of the benefits that will be created in the following categories:

- Reductions in power supply costs as a result of changes in customer consumption patterns
- Integration of renewable generating resources
- Reduction of emissions and other negative environmental impacts
- Improved reliability of the bulk power system (generation and transmission)
- Improved reliability of local distribution systems
- More efficient operation and reduced costs for local distribution facilities
- Increased investment in energy efficiency triggered by dynamic pricing
- Facilitation of vehicle electrification

Focus on Estimating Reductions in Power Supply Costs

The largest share of potential benefits from dynamic pricing are widely recognized to come from reductions in power supply costs that result from customers modifying their consumption of electricity in response to price signals. In recent studies, benefits in the form of reduced power supply costs frequently represent as much as 80 percent of the total potential benefits of dynamic pricing.

Many studies and business case analyses of dynamic pricing estimate a dollar value of the power cost reductions by multiplying two component parts:

- The estimated change in the **quantity** of electricity that is consumed under dynamic pricing relative to traditional rates – for example, the quantity of load reduction or load shifting that is expected to occur during peak periods.
- The estimated **unit value** (e.g., market price in dollars per megawatt-hour) during the periods that dynamic pricing is used to induce customers to reduce or shift their consumption.

Because the results of this calculation represent the majority of the estimated benefits of dynamic pricing, it is important for the business case analysis to develop reliable estimates of each component.

Regarding the first component, it has become well-recognized that the consumption patterns of retail electric customers can vary significantly from region to region and from utility to utility. Thus it is a becoming a more general practice for each utility to conduct extensive market research in order to develop sound estimates of the quantity of load reduction or load shifting that can be expected by the utility's customers. This market research should be encouraged, supported and used.

However, estimates of the second component can be based on rough approximations or use approaches that do not adequately reflect the actual situation. For example, some studies and business case analyses use either a forecast of spot market prices for power supply, or actual spot market prices observed over a limited period of time. Economic theory considers these prices to be representative of short-run marginal costs. Other studies and business case analyses use the capital and fuel costs of a new single-cycle natural gas-fired combustion turbine to represent the cost of adding peaking generating resources to serve peak loads. Economic theory considers these costs to be representative of long-run marginal costs.

Neither of these approaches necessarily provides an accurate and reliable indication of the power cost savings that are actually realized from dynamic pricing. Reasons for this include:

- As noted earlier, spot market prices in Western power supply markets typically are highest in the summer, while the need for dynamic pricing to meet the peak loads of most Washington utilities occurs in the winter.
- Any forecast of spot market prices for power supply is highly speculative and uncertain.
- Small samples of actual spot market prices for power supply provide at best a very limited snapshot and do not reflect the potential range or distribution of market prices.
- Pilot programs conducted during limited periods of time and under unconstrained system conditions do not necessarily represent the actual behavior of retail electric consumers over time or in extreme circumstances.
- The effects of introducing significant quantities of price-responsive demand into commodity power supply markets on prices in those markets have not been extensively studied and are not well-understood.
- Extended, inconclusive debates have been conducted over the relative merits of using short-run marginal costs versus long-run marginal costs as a basis for pricing electricity service to consumers.
- Using resources such as a new single-cycle natural gas-fired combustion turbine to represent the cost of meeting peak loads does not necessarily represent the type of incremental resource that the utility would actually need to meet peak loads.

Further, and perhaps most importantly for Washington State, it is not clear that either approach represents a valid indicator for valuing the power costs that a utility actually avoids when its retail customers modify their consumption in response to dynamic pricing.

The key to understanding this issue is that investor-owned utilities in Washington State have a fundamental public service obligation to plan, acquire and manage a portfolio of electric resources that is sufficient to serve the needs of its customers reliably and cost-effectively. Unless this public service obligation is overturned, the value of load reductions or shifting from dynamic pricing depends on the resulting changes in the configuration and operation of the utility's overall portfolio of electric resources.

Thus, a more sound approach for estimating the power supply-related benefits of dynamic pricing is to incorporate it into an analysis of the utility's portfolio of electric resources. This will allow the net impacts of customer load shifting and reductions on power supply costs to be more directly and accurately estimated.

Using portfolio analysis to estimate power supply benefits can also facilitate the evaluation of alternative forms of dynamic pricing. For example, a portfolio analysis could be conducted to estimate and compare the benefits and costs of several alternatives such as:

- Time-of-use rates.
- Critical peak pricing
- Time-of-use rates combined with critical peak pricing.
- Time-of-use rates combined with peak-time rebates.
- Real-time pricing.

Inputs to the portfolio-based evaluation of each alternative would include estimates of the costs for the particular form of dynamic pricing being evaluated, as well as estimates of the impacts on customer consumption under each alternative. Total costs for the utility's electric resource portfolio would then be estimated and compared. All else equal, the alternative that produces the lowest total cost for the utility's portfolio would be identified as the preferred form of dynamic pricing.

This resource portfolio analysis approach effectively recognizes the load shifting and load reductions from dynamic pricing as an additional demand-side resource. This has the advantage of fully integrating the demand-side resource into the utility's combined portfolio of electric resources, thereby promoting achievement of the overall objective of minimizing overall costs.

To a certain extent, the portfolio analysis approach has already been implemented in the Pacific Northwest. For example, PacifiCorp has included demand response resources in the portfolio analyses for its recent integrated resource plans. The Northwest Power and Conservation Council also used a portfolio-based approach to evaluate demand response as a resource in its 6th Northwest Power Plan. Extending this approach to the evaluation of dynamic pricing is recommended.

Estimating Costs

Types of Costs to Be Included

While most of the potential benefits of dynamic pricing are related to power supply, the costs to implement dynamic pricing mainly involve non-power supply functions by electric utilities. Further, dynamic pricing involves greater complexity and costs than traditional, more static forms of rates.

The business case analysis should include thoroughly-vetted, realistic estimates of the costs that will be incurred in each of the following categories:

- Advanced Metering
- Two-Way Communications
- Data Storage and Management Systems
- Customer Billing Systems
- Marketing and Customer Education
- Customer Service

Need for Realistic Planning to Address Increased Complexity

One of the more important lessons learned from various dynamic pricing programs has been the importance for up-front planning to clearly identify, understand and address the extent and degree of challenges involved in modifying existing utility infrastructure and systems to add new capabilities that are needed to implement dynamic pricing. Examples of such real-world challenges that must be addressed include:

- Dramatically increased volumes of data that must be gathered, communicated, stored and manipulated. For example, consider the conversion of a single customer from traditional, static rates to real-time pricing. Under traditional rates, the customer's meter may have been read once per month. Under real-time pricing, an advanced meter would automatically measure and record the customer's consumption as often as 744 times per month (24 hours per day x 31 days per month). Further, calculation of the customer's monthly bill would require the application of as many as 744 hourly prices to each hour's metered consumption. This represents a huge increase in data gathering, communication and management.
- The need for, and complexities of, integrating multiple systems that previously operated on more of a stand-alone basis.
- Technological risks, including failures of new technologies to deliver promised levels of performance, and interoperability issues where new systems must integrate seamlessly but do not.
- Risks of significant project delays and potentially large cost overruns due to the factors listed above, or due to other unforeseen problems.

- Increased consequences of breakdowns or other technical difficulties during system operations. For example, consider the impact of a several-week-long outage in a key dynamic pricing system, while the system is needed to deliver results on an ongoing hourly basis.

Systems Approach

As noted above, although dynamic pricing has been seen as potentially beneficial for more than three decades, the electric utility industry's actual experiences with dynamic pricing have been at best mixed. In some cases, the available benefits of dynamic pricing have been outweighed by the costs required to implement it. In other instances, the form of dynamic pricing that was chosen did not fit the circumstances of the utility and its retail electric customers. And in yet other situations, the realities of implementation turned out to be more expensive or provided less real-world functionality than was expected. Clearly, these past experiences provide a number of useful 'lessons-learned' that should not be overlooked in any future consideration of dynamic pricing, including in business case analyses.

However, it also appears that some if not many of the specific problems encountered to date have actually been symptomatic of a broader, more fundamental challenge for dynamic pricing. In brief, the broader issue is that retail rates are one part of a larger electric utility system that is changing in ways that are increasing its complexity and interconnectedness.

As described earlier in this report, dynamic pricing has significant (but not always well-recognized) interactions with a variety of other topics and issues, including:

- Economic Efficiency
- Energy Efficiency
- Power Supply Portfolio Planning and Management
- Smart Grid
- Vehicle Electrification
- Environmental Impacts
- Retail Electric Services

Given both the importance and inherent interconnectedness among these topics, there is a significant risk that continued attempts to address dynamic pricing primarily within a single-issue perspective will produce faulty designs and cause implementation problems, all leading to further failures. In particular, treating dynamic pricing as an incremental 'adjustment' that leaves the existing system basically unchanged may continue to produce the apparent (but not necessarily accurate), self-fulfilling result that any move away from traditional, static forms of retail electric rates will not be cost effective. But if alternative forms of pricing for retail electric rates are addressed from a broader perspective, it may be possible to achieve better results.

Therefore, a more promising approach would be to address dynamic pricing using comprehensive, systems-oriented methods that recognize the growing interconnectedness of the electric utility system and that explicitly deal with its complexities.

The need for an alternative to the single-issue focus and the advantages of systems-oriented methods can be illustrated by comparing some of the identifying features of each.

Single-Issue Focus

Treating dynamic pricing on a limited, primarily single-issue basis, is characterized by:

- Utility-centric thinking, including:
  - A relative lack of interest in, or understanding of the potential for behavioral responses by customers to positively impact utility system operations (this appears to be based in part on utilities' greater familiarity with centralized, top-down physical control of the system)
  - Comparative lack of emphasis by utilities on market research and development of new services that consider or address changing customer needs, preferences and capabilities
  - Basic retention of the uniform, one-size-fits-all approach to utility services
  - Emphasis on strengthening and preserving the utility system's traditional functionalities, (e.g., a tendency to use new technologies to perform system operational functions faster and more reliably – ahead of seeking opportunities to change how the system operates or support new types of services to customers)
- Organizational silos within utilities and incentive mechanisms that can lead to narrow optimization within one functional area while foregoing opportunities to achieve better overall outcomes for the whole system (e.g., consider a utility's distribution group that chooses to support one form of dynamic pricing that is less expensive to implement and thus improves its own cost metrics, while neglecting to consider greater overall benefits that are available from another form of dynamic pricing that costs more for the distribution group to implement but produces an even larger reduction in power supply costs)
- Fundamental confusion and conceptual inconsistencies surrounding: a) services provided to customers; b) costs to provide the services; and c) rates or pricing for the services
- Emphasis on making incremental changes sequentially to one component of the system at a time (e.g., proposals for dynamic pricing that either make unsubstantiated claims of benefits or do not adequately address key interconnected topics that will be impacted by implementation of dynamic pricing, thus leading to negative, unintended consequences)

Systems Approach

In contrast, a systems approach would address dynamic pricing within a broader, more comprehensive framework. In this context, key characteristics of the systems approach would include:

- An emphasis on designing the utility system as a whole, by:

    - Treating dynamic pricing as one of several major components, with each playing an important role within the integrated system
    - Explicitly recognizing linkages and interactions among key topics
    - Addressing recurring issues that have been difficult to resolve on a stand-alone basis
    - Seeking integrated solutions that maximize the net benefits of the overall system, rather than individual parts
    - Considering alternative forms of services that could be provided to customers and how the utility system could be configured to provide such services, along with estimating the costs that would be incurred and what types of rates could be offered for each service
- Greater utility efforts on market research to better understand customer needs and interests in alternate forms of retail electric services and pricing
- Recognition of variations among customers and among their uses of electricity (e.g., are residential lighting and vehicle recharging and fundamentally different uses of electricity?)
- Consideration of a wider range of utility services with characteristics that are matched to different customers' needs and capabilities
- Formal recognition of increasing complexity of the system, including consideration of an expanded range of technologies and approaches that may be available to help manage complexities
- Explicit recognition and analysis of interactions with the other major topics that dynamic pricing would impact and be impacted by (e.g., designing the Smart Grid to facilitate beneficial forms of retail electric rates ←→ evaluating alternate forms of retail electric rates in light of variations in the costs to implement different Smart Grid capabilities)

<u>Conclusion</u>

In closing, this section of the report provides some rough initial thoughts about the potential for applying a systems approach to consideration of dynamic pricing. Clearly, such an approach would be a more ambitious undertaking than addressing dynamic pricing as a discrete topic. However, given the increasing complexity of the electric utility system and expanding interconnectedness of various issues, the value and importance of a using a systems approach can be expected to grow.