Chapter 3

The Ethics of Dynamic Pricing

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Chapter Outline

INTRODUCTION

The smart grid has the potential for bringing an immense amount of innovation to the consumption and production of electricity. On the consumption side, it can enable efficient use of energy that can lower societal costs. A key enabler of efficiency is the accurate, cost-based pricing of electricity. In this chapter, we focus on dynamic pricing, which conveys the time-varying nature of electricity costs to consumers.

While the idea of time-variable pricing has been widely practiced in many markets for large commercial and industrial customers, its application to residential and small commercial and industrial customers is in the nascent stage. Since the latter group of customers typically have lower load factors than the system average, the ability to modify their load profiles through dynamic pricing can provide substantial benefits to customers, utilities, and society as a whole. However, two conditions have to be met before dynamic pricing can be successfully implemented in this market segment.

- First, the appropriate type of metering and communication technology—called advanced metering infrastructure or AMI—has to be in place. This is further discussed in Chapter 11 by King and Strapp.
- Second, concerns about the equity of dynamic pricing have to be resolved. It is this second condition, which forms the focus of this chapter and also Chapter 4 by Felder.

Concerns about equity issues have always been associated with changes to the status quo when it comes to any form of energy policy. Nowhere is this more evident than in the pricing of electricity. Under prevailing rates, virtually all small customers typically pay the same flat rate per unit of electricity consumed regardless of the quantity or time-of-use. But since load profiles vary by customer, the cost of serving customers varies. It is more expensive to serve those customers who use relatively more energy in the peak period, and relatively less in the off-peak period, than those who use relatively less electricity in the peak period. In other words, the peakier-than-average customers are subsidizing the less peakier-than-average customers, often without knowing it.

Over a period of time, for a utility with a million customers, the amount of the subsidy can run into the hundreds of millions of dollars. Thus, any attempt to introduce more cost-reflective price schemes, such as dynamic pricing, would result in the elimination of these cross-subsidies. The beneficiaries will be delighted but those who are no longer subsidized will be upset. The latter will find a way to their local regulators and file a complaint. It is the nature of the regulatory process that the complainers who show up get a seat at the table while those who benefit but never show up don't. In the United States, and in fact around the world, in places as far afield as Australia and Britain, opponents of dynamic pricing have filed complaints that the practice is unethical and should not be rolled out. This chapter argues the contrary position—that flat-rate pricing is unethical and it should be pulled back.

The chapter is organized as follows. The section "Background" provides some key definitions, section "The Distributional Effects of Dynamic Pricing" introduces the distributional effects of dynamic pricing, section "The Barriers to Dynamic Pricing" discusses the barriers to dynamic pricing, section "The Unfairness of Flat Rate Pricing" discusses the unfairness of flat rate pricing, section "Dynamic Pricing in Other Industries" discusses dynamic pricing in other industries, section "Overcoming the Barriers to Dynamic Pricing" discusses ways of overcoming the barriers to dynamic pricing, section "The Effect of Dynamic Pricing on Low-Income Consumers" discusses the impact of dynamic pricing on low-income customers, section "Accommodating Potential Objections" reviews potential objections to dynamic pricing, and section "Conclusions" provides the conclusions of the chapter.

BACKGROUND

Dynamic pricing is a form of time-of-use (TOU) pricing where prices during the peak period on a limited number of days can vary to reflect market conditions on a day-ahead or day-of basis. One popular variant of dynamic pricing is critical-peak pricing (CPP) in which prices during the top 40–150 hours of the year rise to previously specified levels designed to recover the full capacity and energy cost of power plants that run primarily during those hours. During all other hours of the year, prices are lower than existing rates by an amount sufficient to leave the bill unchanged for a customer whose load shape mirrors that of the rate class.

An example of CPP is provided in Figure 3.1. Other examples are shown for TOU pricing in Figure 3.2 and real-time pricing (RTP) in Figure 3.3. Combinations of dynamic pricing designs can also be envisaged.

Dynamic pricing has garnered much interest in the country during the past decade since it has the potential for lowering customer energy costs by mitigating the need to install expensive peaking capacity. As can be seen by reviewing load duration curves for various markets around the country, the top 1% of the hours of the year can account for 8–12% of annual system peak demand. In some cases, they may account for as much as 14–18%.

Several studies have been published on the benefits of dynamic pricing. A recent example is the one that was conducted by the New York Independent System Operator [2]. The study, conceived as a *gedanken* or thought experiment, quantified the benefits that would flow from universal deployment of

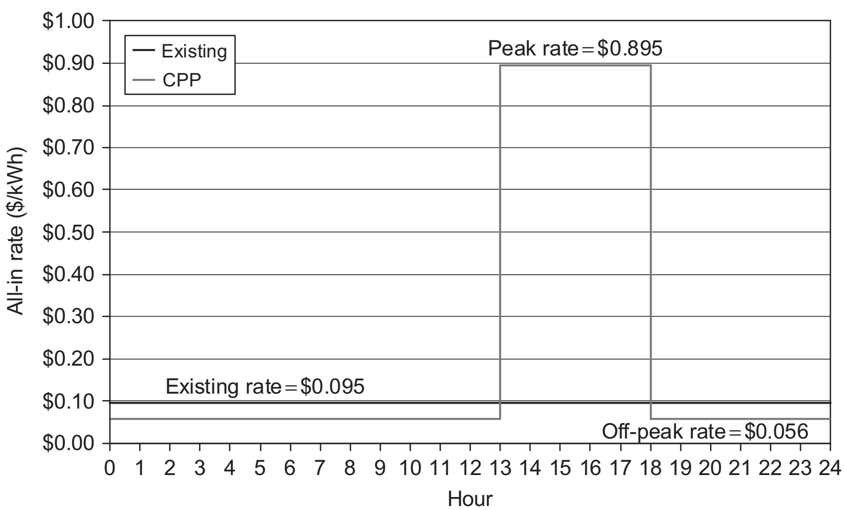

FIGURE 3.1 Illustration of a CPP rate.

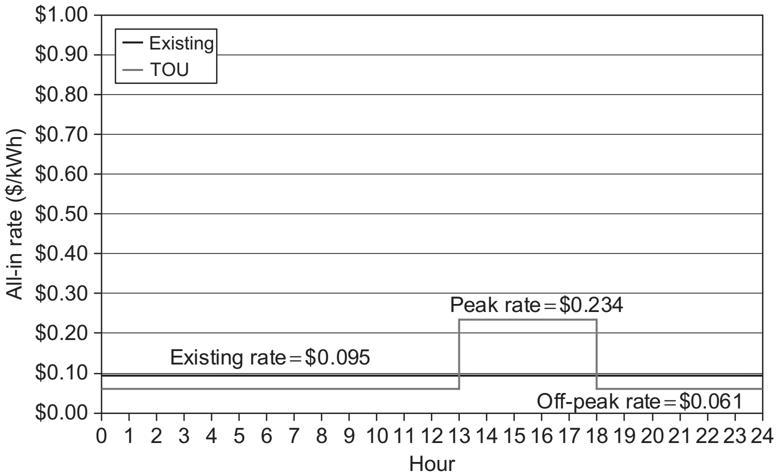

FIGURE 3.2 Illustration of a TOU rate.

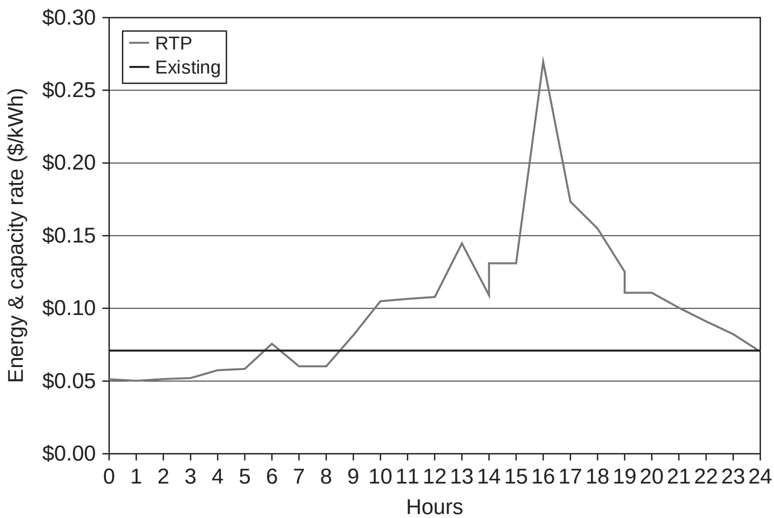

FIGURE 3.3 Illustration of an RTP rate.

real-time pricing in New York State. It used a single year to simulate the benefits [3]. The study found the following benefits:

- *Demand Reduction*: Dynamic pricing would result in system peak demand reductions in the 10–14% range, from a projected value of 34,000 megawatts (MW). The reductions would range from 13–16% in New York City and 11–14% reduction in Long Island.

- *Cost Reduction:* Total resource costs would decrease by \$143–509 million per year, or 3–6%. Market-based customer costs would decrease by \$171–579 million per year, or 2–5 %.
- *Economic Efficiency Gain:* Dynamic pricing would improve societal welfare by \$141–403 million per year.

Another study by the Demand Response Research Center informed California's decision to deploy advanced metering infrastructure (AMI), a prerequisite for dynamic pricing, to all customers served by the state's investor-owned utilities [4]. The California Public Utilities Commission (CPUC) has ruled that dynamic pricing will become the default rate for all non-residential customers once AMI has been rolled out to them and has suggested that it be extended to residential customers once legal restrictions dating back to the energy crisis on residential tariffs have expired [5].

At the national level, the Federal Energy Regulatory Commission (FERC) filed a staff report with the U.S. Congress in June 2009 that quantified the potential impact of dynamic pricing on a state-by-state level [6]. Several deployment scenarios were presented, ranging from a continuation of current trends to one that included universal deployment. Earlier work has shown that even a 5% drop in demand during critical peak hours can be worth \$35 billion [7].

DISTRIBUTIONAL EFFECTS OF DYNAMIC PRICING

For the benefits of dynamic pricing to be realized, not all customers need to respond. In fact, as commonly developed under revenue-neutrality principles, half of the customers whose load factors are better than average will see an immediate reduction in their bills *before* they make any adjustment to their pattern of electricity consumption [8].

To illustrate this point, Figure 3.4 shows the load profiles of three prototypical customers, one whose profile coincides with the class, one whose load profile is peakier than the class average profile, and one whose profile is flatter than the class average.

Figure 3.5 presents the share of peak load in daily load for a representative set of customers who are ordered by their peak shares. The three prototypical customers from Figure 3.4 appear as points along a continuum.

Now a prototypical CPP rate is applied to all these customers. The changes in bills brought about by this change in rate design are displayed in Figure 3.6. The cross-subsidies that were inherent in flat rates are removed, and this causes bills to rise for some customers and to fall for others. Since these distributional impacts may vary across utilities, the results are displayed across three utilities in Figure 3.7. Interestingly, there is not much variation across the utilities.

The distributional impacts would also be expected to vary across rate designs, as shown in Figure 3.8.

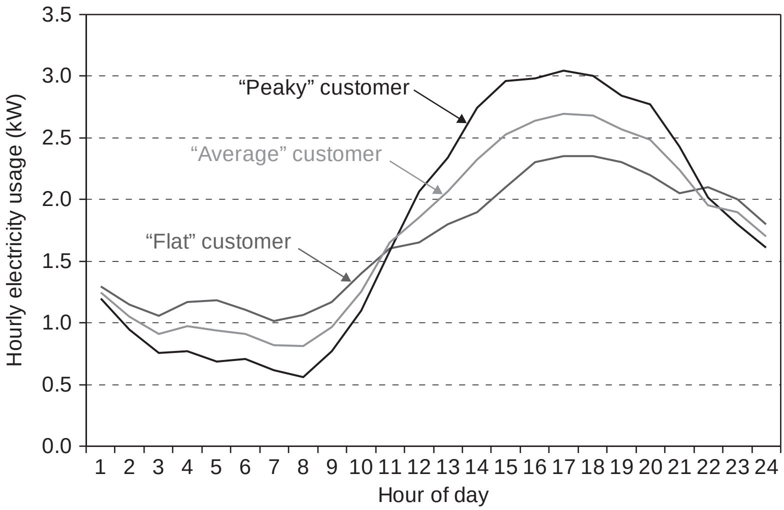

FIGURE 3.4 Average, peaky, and flat usage profiles.

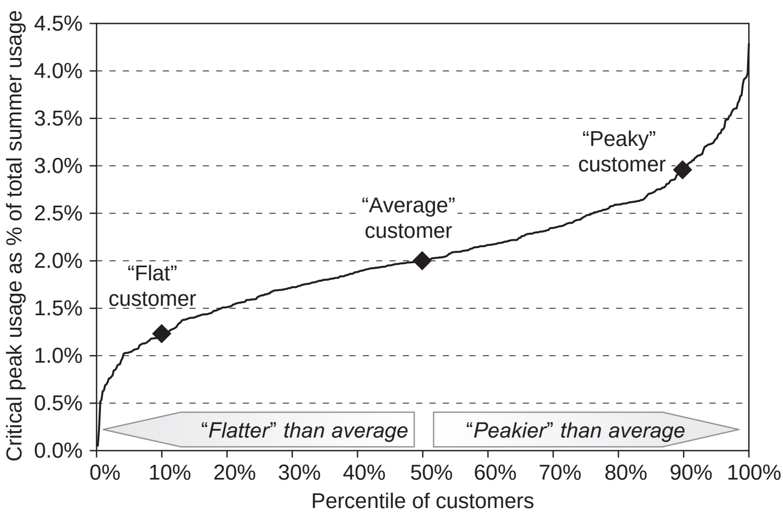

FIGURE 3.5 Distribution of residential customer usage profiles.

So what can be done to offset the adverse impact of moving customers to dynamic pricing rates? Customers who don't see an immediate reduction can lower their bills by reducing their usage during the expensive peak period hours by curtailing some of that use or by shifting some of it to lower-priced hours. As shown later in this chapter, about two-thirds to three-quarters of the customers are likely to see lower bills as a result of dynamic pricing.

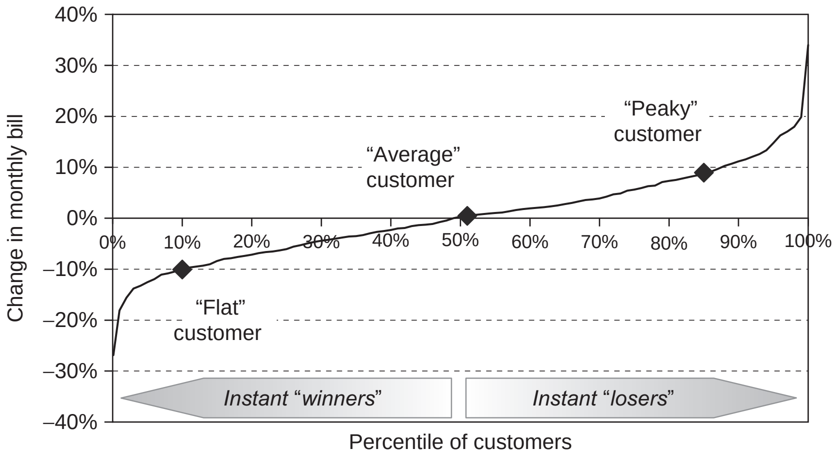

FIGURE 3.6 Distribution of dynamic pricing bill impacts (residential critical-peak pricing).

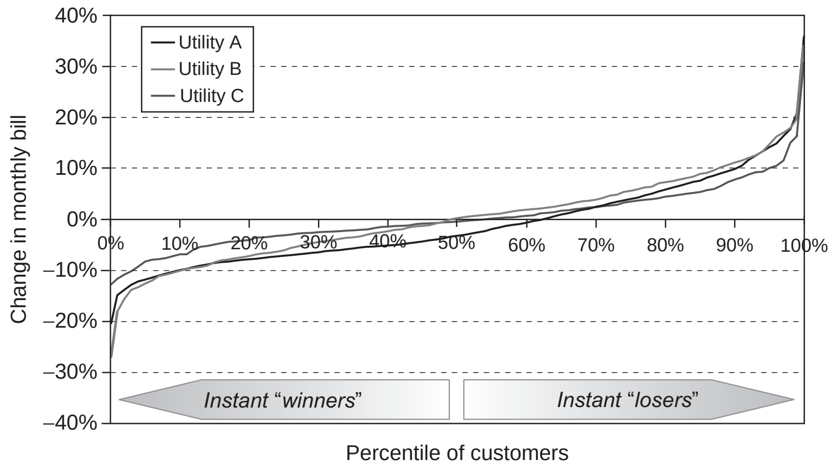

FIGURE 3.7 Comparison of dynamic pricing bill impacts across utilities.

It is important to clear up an important misconception. Under dynamic pricing, customers do *not* have to pull the plug on major end-uses, live in the dark, or eliminate all peak usage in order to benefit. They simply have to reduce peak usage by some discretionary amount that does not compromise their life style, threaten their well-being, or endanger their health. Clearly, the more they reduce, the more they will save. But the choice is up to them.

Over the past several years, 18 pilots have been carried out in North America, Europe, and Australia to assess the magnitude of demand response associated

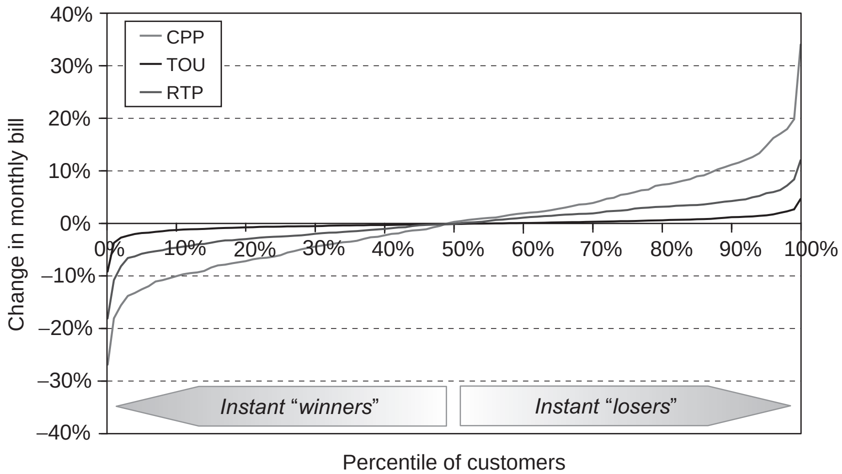

FIGURE 3.8 Comparison of dynamic pricing bill impacts across rate designs.

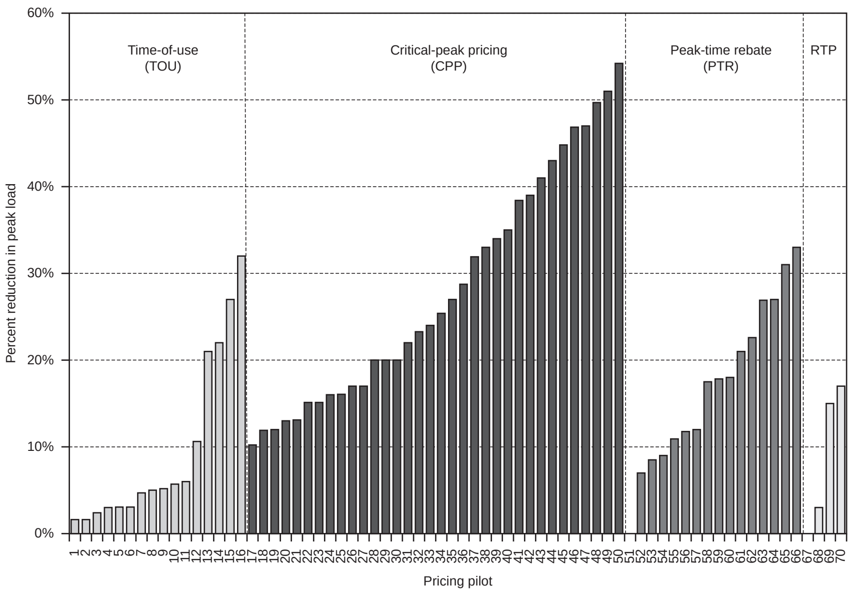

FIGURE 3.9 Customer response in recent pricing pilots.

with dynamic pricing. In just about every case, consumers on average have shown the ability to lower peak usage. Some respond a lot, some respond marginally, and some do no respond at all. The evidence from the 70 most recent tests is presented in Figure 3.9 [9].

Barriers to Dynamic Pricing

Despite the promise of substantial economic gains, the deployment of dynamic pricing has been remarkably tepid, in large measure because of misplaced but recurring concerns about the inequity of dynamic pricing. Approximately 5% of the customers are on AMI today, but less than a tenth of that number is estimated to be on dynamic pricing. The software firm eMeter recently announced that the United States has crossed the 20 million milestone and will add another 50 million smart meters by 2015.[1] If current AMI deployment trends continue, a significant percentage of U.S. customers would have smart meters. However, it is an open question about how many customers would be moved to dynamic pricing in the coming years.

From certain quarters, most notably consumer advocates such as The Utility Reform Network (TURN) in California, concerns have been voiced that dynamic pricing inflicts harm on low-income consumers, seniors and people with disabilities who stay at home a lot, people with medical conditions that require special electrical equipment, people with young children, and small businesses. It is stated that these consumers are unable to curtail peak period usage, in part because they have very little load to begin with.

The underlying premise is that dynamic pricing is unfair. This concern is not confined to the United States. It has shown up recently in the state of Victoria, Australia, where the state government has ordered a review of the smart meter roll out policy after the state's Auditor-General warned that electricity consumers would be worse off [10]. The Essential Services Commission has been asked to conduct a review "to ensure vulnerable Victorians are not disadvantaged." Victoria plans to roll out smart meters to 2.4 million homes and small businesses over the next four years.

The review was triggered by a finding by the state's auditor-general that consumers would have be paying an extra $150 annually under the new metering system. Another study by the University of Melbourne estimated that bills for low-income earners would rise by 30%, or $300 a year.

At the time of this writing, Victoria's Energy and Resources Minister was considering imposing a moratorium on new tariffs until the investigation was completed. The government will establish a consumer working group to consider the impacts of smart meters and help customers access competitive rates. It will also provide $50,000 to the Consumer Utilities Advocacy Centre (CUAC) for a communications campaign to help customers change their usage patterns to maximize the benefits of the new system.

Such concerns are not new. In 1971, Professor William Vickrey of Columbia University wrote a groundbreaking paper on "responsive pricing," his term for what would later be called dynamic pricing [11]. Vickrey, who went on to earn

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[1]Statement by Chris King of eMeter dated 17 May 2011 and at http://www.emeter.com/smart-grid-watch/2011/us-20-million-smart-meters-now-installed/

the 1996 Nobel Prize in Economic Science, opined, "The main difficulty with responsive pricing is likely to be not just mechanical or economic but political." He felt that people shared the medieval notion of a just price as an ethical norm, and that prices that varied according to the circumstances of the moment were intrinsically evil:

The free market has often enough been condemned as a snare and a delusion, but if indeed prices have to perform their function in the context of modern industrial society, it may be not because the free market will not work, but because it has not been effectively tried.

In 1987, building on many years of work on homeostatic control, Professor Fred Schweppe of MIT co-authored a book that laid out the theory and practice of spot pricing or real-time pricing, the ultimate form of dynamic pricing [12]. Schweppe et al. believed that given the overwhelming efficiency benefits that would flow from dynamic pricing, it was inevitable that deployment of this optimal rate design would soon follow. But it did not.

In 2001, reviewing the slow progress toward dynamic pricing in restructured markets, Eric Hirst of the Oak Ridge National Laboratory lamented, "The greatest barriers are legislative and regulatory, deriving from state efforts to protect retail customers from the vagaries of competitive markets" [13].

It had never been easy to change tariffs in the electricity industry and the problem was not confined to the United States. Back in 1938, the author of a leading British text on costs and tariffs lamented [14]:

There has never been any lack of interest in the subject of electricity tariffs. Like all charges upon the consumer, they are an unfailing source of annoyance to those who pay, and of argument in those who levy them. In fact, so great is the heat aroused whenever they are discussed at institutions or in the technical press, that it has been suggested there should be a "close season" for tariff discussions. Nor does this interest exaggerate their importance. There is general agreement that appropriate tariffs are essential to any rapid development of electricity supply, and there is complete disagreement as to what constitutes an appropriate tariff.

The present tariff position in [Great Britain] is little short of chaos. Even the terminology has not been standardized, and the tariffs themselves appear to be the unbridled whim of the particular undertaking. To quote only one example—taking a single load group (industrial power) and a single type of tariff (the block rate), and considering only the larger undertakings (one quarter of the whole), there were found to be 102 different tariffs! At this rate, the block-rate tariffs alone would muster about 400 different specimens. Kipling might well have said of electricity:

There are nine-and-sixty ways in which the user pays and every single one of them is right.

But change is in the air. In an interview that he gave in December 2008, the former president of the National Association of Regulatory Utility Commissioners (NARUC), Commissioner Fred Butler of New Jersey noted that fundamental changes were coming for energy delivery and pricing. He said that for more than a century "most people have paid for their electricity at the same rate every day of every year, every hour of every day."

"That's going to have to change," Butler noted. "If you're going to have a smart grid, that allows you to measure and have two-way communication between the end-use premises, the utility company, the RTO, and other entities, rates will have to change to be more time-of-use rates or critical peak period rates." With rate changes coming, he added, "We have a massive education campaign that's needed to explain to people why this is happening and why they can adapt their usage of electricity the way they've adapted their telephone usage," waiting for "free nights and weekends" to make calls, Butler says.

While acknowledging that both the FERC-NARUC smart grid collaborative and individual states are working on that massive education campaign and developing programs to effect time-of-use rate changes, "you can only go so fast" to avoid consumer backlash. The process has already begun today in some places, while in other areas the time-of-use changes will take several years. Ultimately, however, Butler concluded, "Pricing five years from now will be very, very different than it is today." As of this writing, very little change had occurred in the industry's pricing practices.

Unfairness of Flat Rate Pricing

The opponents of dynamic pricing, such as Barbara Alexander, use the unfairness argument to present their case [15]. But the presumption of unfairness in dynamic pricing rests on an assumption of fairness in today's tariffs. A flat rate that charges the same price around the clock essentially creates a cross-subsidy between consumers who have flatter-than-average load profiles and those who have peakier-than-average load profiles. This cross-subsidy is invisible to most consumers but over a period of time, it can run into the billions of dollars. An example will suffice to make this point.

Let us divide electricity customers into three groups based on their load profiles: Average Users, whose hourly load profile corresponds to the class peak; Peaky Users, whose load profile has greater than average concentration in the peak period; and Flat Users, whose load profile has less than average concentration in the peak period. Let's set the peak period from noon to 6 PM. Average Users consume electricity in proportion to the ratio of peak to off-peak hours so 25% of their consumption occurs during the peak hours. Peaky Users consume 40% during peak hours and Flat Users 10%. Let us also assume that the population is equally divided between the three types of users and that there are a total of 10 million customers in the population of interest. Finally, let us set each customer's average monthly consumption at 500 kWh.

Now we can calculate the total cost of electricity for each of the consumption profiles under two different rates: a flat rate and a TOU rate. A similar approach can be used to estimate costs under dynamic pricing rates, such as CPP.

The flat rate is assumed to be 10 cents/kWh and applies around the clock. The marginal cost of electricity during the peak period is 20 cents/kWh and 6.7 cents/kWh during the off-peak period, and these costs are used to establish the peak and off-peak TOU rates. Table 3.1 summarizes the characteristics of the customer population.

Given these assumptions, we can calculate the total costs incurred by each consumption profile over a 10-year period for both the flat and TOU rates. This is done by multiplying each customer's peak and off-peak consumption by the corresponding rate and summing over both the number of months in the period (120) and the number of customers belonging to each consumption profile (3.3 million). A discount rate of 4% is used to yield a present value. Finally, by subtracting the total costs incurred under the flat rate from the total costs incurred under the TOU rate, we can estimate the cross-subsidy that results from flat rates.

As shown in Table 3.2, while average users do not experience any benefit or loss under the flat rate, flat users are paying $3.92 billion above what they would have paid under a TOU rate and peaky users are benefiting from this subsidy.

TABLE 3.1 Customer Population Characteristics

Consumption Profile	Monthly Consumption (kWh per Customer)			Weight Average Rates (cents/kWh)	
	Peak	Off-Peak	Total	Flat	TOU
Flat	50 (10%)	450 (90%)	500 (100%)	10.00	8.00
Average	125 (25%)	375 (75%)	500 (100%)	10.00	10.00
Peaky	200 (40%)	300 (60%)	500 (100%)	10.00	12.00

TABLE 3.2 Cross-Subsidy Over a 10-Year Period from the Flat Rate

Consumption Profile	Monthly Electricity Cost ($)		Monthly Benefit/ Loss from Flat Rate Cost ($)	Total Benefit/Loss ($ Billions)
	Flat	TOU		
Flat	50.00	40.00	(10.00)	(3.92)
Average	50.00	50.00	0.00	0.00
Peaky	50.00	60.00	10.00	3.92

DYNAMIC PRICING IN OTHER INDUSTRIES

The concept of time-varying rates, while it may be portrayed as being foreign to electricity consumers, is one that those very consumers encounter daily in a variety of applications. Just take the case of a driver looking for a parking space in the downtown of any major metropolitan area. In most cases, the driver expects to pay a sizable parking fee during working hours on weekdays. But he or she knows that parking will be free during evenings and nights on weekdays and typically also free on weekends. In some of the newer parking meters, which have digital technology embedded in them, parking rates vary based on the number of vacant spaces, which will often vary dynamically.

The driver may also find that he or she also has to pay congestion pricing rates in congested areas such as central London in Britain. Another example comes from the San Francisco Bay Area where the Bay Area Toll Authority (BATA) has unanimously approved congestion pricing on the San Francisco-Oakland Bay Bridge [16]. This went into effect in July 2010. Tolls for cars increased from $4 regardless of time to $6 during weekday commute hours, dropping to $4 during off-peak hours on weekdays. On weekends, the auto toll on this bridge became $5. Officials expect the congestion pricing plan to ease commute-period congestion as drivers divert some of their discretionary driving to off-peak hours.

Travelers are likely to encounter dynamic pricing every time they book their flights, hotels, and rental cars. In each of these industries, the fixed costs are very high, and the only way to survive in business is to manage revenues, and therefore yields, by pricing differentially based on demand conditions [17].

Certain cell phone plans also embody time-varying rates. Prices for produce vary seasonally as do movie tickets and sometimes theater prices. The latest industry to introduce dynamic pricing is the sporting industry. This season, the San Francisco Giants plan to introduce dynamic pricing to their fans [18]. This will allow the Giants to offer more price options to patrons since the goal is to have more fans enjoy Giants baseball. Roughly three-quarters of tickets are currently selling for less than they cost last year. Of course, it will cost more to attend popular games. Dynamic pricing will take into account a variety of factors other than seat location. These will include weather, starting pitcher, opponent team, the number of seats already sold, promotion or giveaway day, performance of team, likelihood of making playoffs, day of week, and time of day.

Another team that uses dynamic pricing is the Buffalo Sabres hockey team. For the 41 home games that will be played during the current season, the team will continue with its practice of variable pricing. In this system, each game is designated by a different classification that reflects the capabilities of the opposing team, time of the year, day of the week, rivalries, and games against all-star players [19].

OVERCOMING THE BARRIERS TO DYNAMIC PRICING

Among economists, there are two schools of thoughts when it comes to dynamic pricing. The purist school of thought argues that rates should reflect time-variation in costs, regardless of whether customers respond or not. The pragmatic school of thought argues that rates should reflect time-variation in costs if the societal benefits from so doing exceed the societal costs. Typically, the societal benefits are associated with avoided capacity and energy costs, and the societal costs are associated with implementing AMI.

The challenge is that while net societal benefits might be positive, individual consumer benefits may be positive or negative. A conservative approach associated with the work of Vilfredo Pareto argues that dynamic pricing should only be pursued if at least one consumer is better off and no one is worse off. A more aggressive approach in public policy associated with the work of Hicks and Kaldor would suggest that dynamic pricing is worth pursuing if the gains to the winners exceed the losses to the losers. In other words, if the winners can compensate the losers, go ahead and pursue the policy. Of course, this compensation would not actually be paid because if it were paid, the Hicks-Kaldor solution would collapse to the Pareto solution. Clearly, the Hicks-Kaldor approach would yield much larger societal gains than the Pareto approach.

But that is where the equity argument kicks in and the push back begins. So what can be done to offset the adverse impacts of dynamic pricing? Figure 3.10 shows that by providing an incentive for demand response, dynamic pricing would increase the number of winners from 50% to 75%.

Further gains can be obtained by removing the hedging premium embodied in flat rates [20]. A conservative estimate of the size of the hedging premium is 5%. Once this credit is applied, the share of winners goes up to 92% (Figure 3.11).

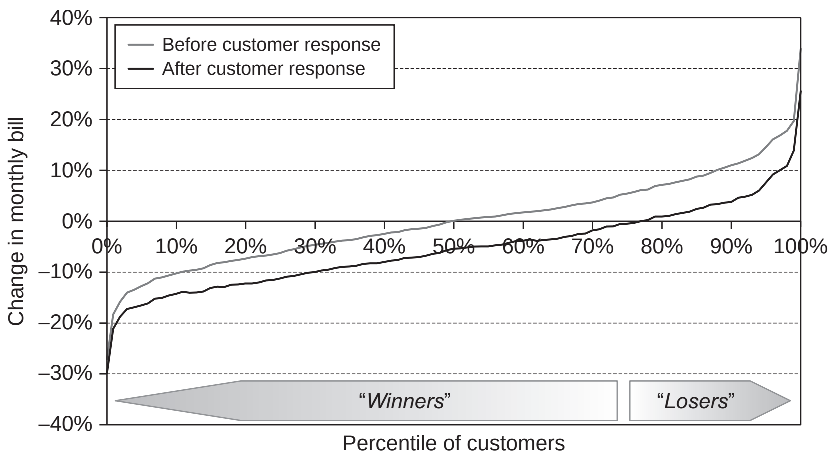


FIGURE 3.10 Distribution of dynamic pricing bill impacts (after customer response).

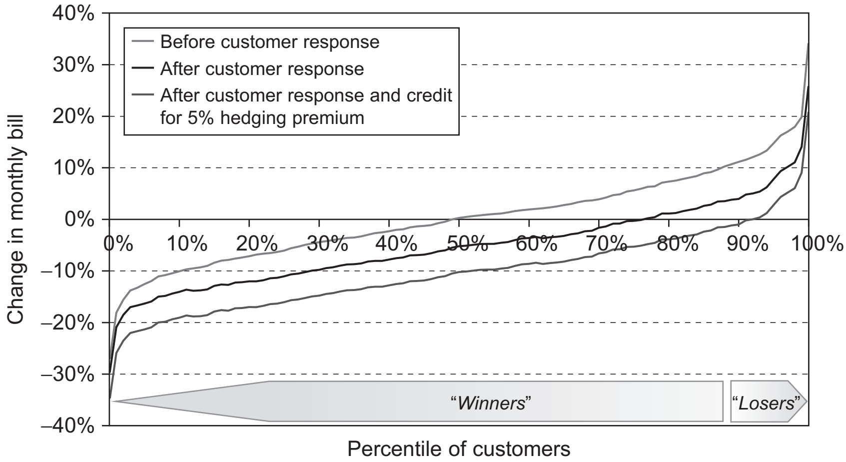


FIGURE 3.11 Distribution of dynamic pricing bill impacts (after customer response and credit for hedging premium).

The Effect of Dynamic Pricing on Low-Income Consumers

How does dynamic pricing affect low-income consumers? More than any other issue, this one crystallizes opposition to dynamic pricing in regulatory proceedings. The contention is that low-income consumers don't use much energy to begin with and therefore are in no position to lower usage during peak period hours. It is also asserted that they lack the know-how and wherewithal with which to curtail peak period usage. Being strapped for cash, they may feel compelled to avoid higher peak period prices and, by reducing energy for essential usage, may cause themselves significant physical harm.

Is this factually correct? There is no documented instance of low-income customers harming themselves through dynamic pricing. In addition, intuition suggests that low-income consumers are likely to have flatter than average load shapes because many of them lack central air conditioning. Thus, one might expect them to come out ahead with dynamic pricing. What are the facts?

New data have recently become available from a large urban utility that shed light on the subject. An analysis of low income customers at this utility is shown in Figures 3.12 and 3.13, which show percentage changes in bills and nominal changes in bills, respectively Figure 3.12 shows that about 80% of low-income customers would gain from dynamic pricing. With a modest amount of demand response, 92% of low-income customers would gain from dynamic pricing.

Then there is the question of whether low income customers are likely to respond to dynamic pricing. The most recent evidence on this topic comes from the experiment with dynamic pricing that was carried out during the summer of 2008 in Washington, D.C. One unique feature of the PowerCentsDC

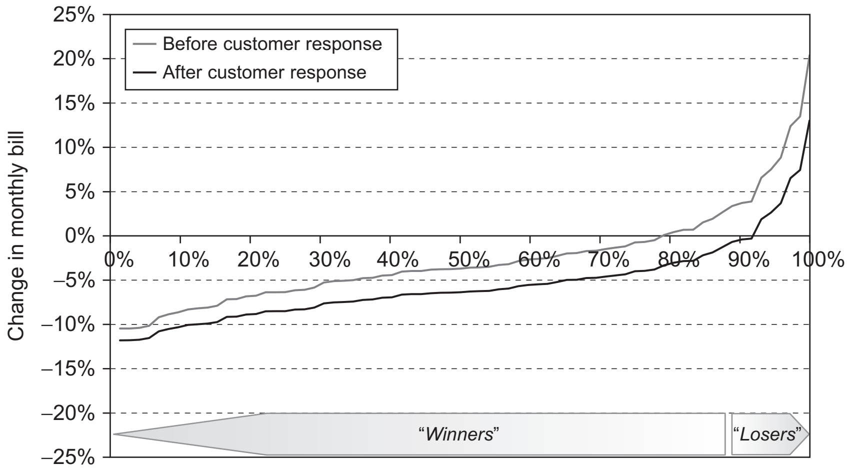


FIGURE 3.12 Bill impacts for low-income customers (expressed as % of monthly bill).

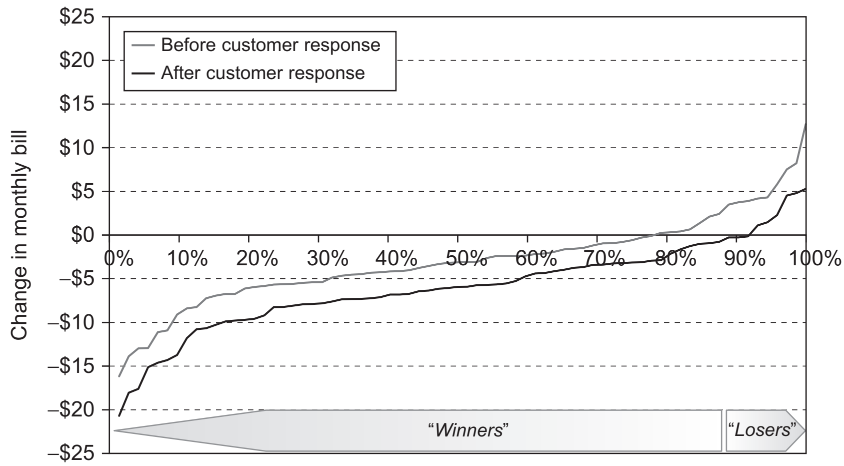


FIGURE 3.13 Bill impacts for low-income customers (expressed as dollars per month).

program is that it actively recruited a group of limited-income customers to understand their responsiveness to dynamic pricing. Of the 857 residential customers in the pilot, 118 were low-income customers. The lead researcher on the project, Frank Wolak of Stanford University, found that the magnitude of demand response, expressed as a percent of their peak load, exhibited by low-income customers to a critical peak pricing rebate program was almost twice as large as that exhibited by non-low-income customers [21].

ACCOMMODATING POTENTIAL OBJECTIONS

Given the potential benefits of dynamic pricing, what practical policies might be contemplated to offset the adverse impact on those customers who might be adversely affected? Several options are available [22].

- Creating customer buy-in. Customers need to be educated on why a century-old practice of ratemaking is being changed. They have to be shown how dynamic pricing can lower energy costs for society as a whole, help them lower their monthly utility bills, prevent blackouts and brownouts, improve system reliability, and lead to a cleaner environment.
- Offering tools. These should allow customers to get the most out of dynamic pricing. At the simplest level, they should be equipped with information on 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 response on their bill. At the next level, they could be provided real-time in-home displays that disaggregate their power consumption and tell them how much they are paying by the hour. Finally, they could be provided enabling technologies such as programmable communicating thermostats. Similar examples can be constructed for commercial and industrial customers.
- Designing two-part rates. The first part would allow them to buy a predetermined amount of power at a known rate (analogous to a forward contract), and the second part would give them access to dynamic pricing and allow them to manage their energy costs by modifying the timing of their consumption. They could be allowed to pick their predetermined amount, or it could be based on consumption during a "baseline" period.
- Peak-time rebates. The consumer pays the standard rate but has the opportunity to earn rebates during critical peak periods by reducing consumption relative to an administratively determined baseline.
- Demand subscription service. Each consumer *may* contract for a different "baseline" of demand at a known price and pay for variations in demand from that baseline at real-time prices. A key element of the demand subscription service is that each customer has a choice. For example, the preferred baseline may be zero for a consumer with a flat consumption profile and higher for a consumer with a peaky consumption profile [23].
- Providing bill protection. This would ensure that their utility bill would be no higher than what it would have been on the otherwise applicable tariff but would not preclude it from being lower based on the dynamic pricing tariff. Customers would simply pay the lower of the two amounts. In later years, the bill protection could be phased out. For example, in year one, their bill would be fully protected and would be no higher than it would have been otherwise; in year two, it would be no higher than 5%; in year three, no higher than 10%; in year four, no higher than 15%, and in year five, no higher than 20%. In the sixth year and beyond, there would be no bill protection. Or full bill protection could continue to be offered for a fee.

- Giving customers on dynamic pricing a credit for the hedging premium they no longer need once they move from flat rate pricing to dynamic pricing. Existing fixed price rates are very costly for suppliers to service since they transfer all price and volume risk from the customers to the suppliers. In addition, the supplier takes all the volume risk. In order to stay in business, the supplier has to hedge against the price and volume risk embodied in such open-ended fixed price contracts. It does so by estimating the magnitude of the risk and charging customers for it through an insurance premium. The risk depends on the volatility of wholesale prices, the volatility of customer loads, and the correlation between the two. Theoretical simulations and empirical work suggest that this risk premium ranges between 5 and 30% of the cost of a fixed rate, being higher when the existing rate is fixed and time-invariant and being smaller when the existing rate is time-varying or partly dynamic. For example, a flat and fixed and non-time varying rate may bear a premium of 30% when compared to a real-time pricing rate or a premium on 10% when compared to a critical peak pricing rate.
- Giving customers a choice of rate designs. Dynamic pricing rates, even with all the items mentioned above, may still be too risky for some customers. Thus, they should have the option of migrating to other time-varying rates, perhaps with varying lengths of the peak period and with varying numbers of pricing periods. If the CPP rate (combined with a TOU rate) becomes the default rate, risk-averse customers should have the opportunity to migrate to a fixed time-of-use rate, and risk-taking customers should have the opportunity to migrate to a one-part or two-part real-time pricing rate.

CONCLUSIONS

As a matter of principle, ethical pricing should be cost based and not create subsidies between customers. Flat rate pricing, which has been in place for the past century, creates an enormous subsidy between customers with varying load shapes. It is unethical and needs to be replaced by dynamic pricing. Not only will this be more ethical, it will also improve the economics of the power system and lower costs for all customers.

However, as with any significant change in rate design, it has to be phased in gradually. Several methods for making this gradual change have been discussed in this chapter.

APPENDIX: QUANTIFYING THE HEDGING COST PREMIUM

In defining the benefits of price response, recent analysts have suggested that those who engage in such behaviors realize savings from paying a lower hedge premium. In other words, they get rid of the middlemen (the utility or competitive retailer) and buy directly from the factory, paying wholesale market spot prices or utility RTP prices for their energy consumption. This raises an intriguing question; how large are risk premiums, and are they identical under competitively determined retail prices and regulated rates? However, it's not apparent that the concept of a risk premium as an element of price produced by a regulated, vertically integrated utility is an oxymoron. Traditional rate making bundles costs associated with investment recovery and cost associated with the difference between rates and dispatch costs that might be construed as risk premiums.

Centralized wholesale markets produce transparent spot market prices that provide insight into the risk premiums that competitive retailers build into their prices. If utilities use these prices to establish marginal-cost rates, then price response will improve resource efficiency, and the notion of a risk premium savings is moot.

Traditional Cost of Service

Under conventional embedded cost ratemaking, there is no explicit risk premium added to the energy rate. Overall, the rate includes a provision for the recovery of fixed costs at a rate of return (ROR) that reflects the market's perspective on the enterprise risks a utility undertakes, which largely are associated with generation investments. That ROR premium is folded into the revenue requirement, which is then allocated to classes based on relative load levels and patterns and then incorporated into a bundled rate. There is no way to isolate the risk element; it is inextricably bundled into the rate. Thus, one does not think of traditional rates as having risk premiums. But, implicitly they do, and that is revealed by examining how prices are set in competitive markets.

Competitive Market Pricing

Competitive retailers set prices based on their cost of supply and what customers are willing to pay, the latter determined in part by what their competitors charge. Some competitive retailers are selling generation owned by the same company, while others have to acquire energy to serve their customers' requirements. The integrated generation/retail entity must explicitly consider which is more profitable: to commit capacity to serving customers under fixed retail rates or to sell energy in the wholesale spot market. The specialized retailer faces generation prices that already have taken that opportunity cost into account. So, retail prices implicitly or explicitly embody spot market price expectations, and that includes a provision for risks.

It follows then that in setting prices, a retailer first considers the cost of serving its retail load obligation through spot market transactions. If retail prices are linked directly to wholesale prices, which change every hour, then the retailer passes the cost it incurs in supplying its retail customers directly to the consumer, and there is little or no risk. This works only to the extent that customers are willing to pay prices that change hourly. What about if customers who want to pay a uniform price that changes only periodically (for example every few months or once a year) or to buy from a time-of-use schedule? To accommodate these pricing plans, the retailer must define the risks inherent in committing to serving load under fixed prices. Those risks include the following:

Load risk due to episodic variations in customers' load shapes and levels, due to weather, economic circumstances, and changes in individual customer circumstances (e.g., the need to increase or decrease business or plant output, accommodating a house full of relatives for a week in the summer).

Market load risk—retailers that contract with a utility to serve its default service customers face scale and load shape risk from customers switching to and from utility default service. A larger or different load pattern can result in marginal supply costs that are above the pre-set rate.

Price risk—if the load is being served at a fixed rate through purchases from the spot market, then there is explicit risk associated with the inherent volatility of spot market prices. If the load obligation is being supplied from owned generation assets, then the then the opportunity cost of lost spot market sales defines the price risk. Finally, if the retailer is buying supply from a generation supplier, then that opportunity cost is already incorporated in what it pays.

These risks have to be covered in rates for the retailer to ensure an acceptable return on investment. Consequently, customers who buy power other than at wholesale terms (streaming hourly prices) are paying a risk premium. The higher the degree of temporal aggregation used to price usage, the higher the premium. TOU rates have a higher premium than RTP, and a uniform, fixed rate has a hedging premium that is even higher.

Traders in many commodity markets devise risk premiums from the mean and variance of expected spot market prices, using financial models that rely on predictable market characteristics to determine relative risk. But, is that how competitive electricity retailers set their prices? If that were the case, then the risk premiums in retail prices could be revealed by employing those analytical techniques, in effect reverse-engineering retailers' posted prices. Making the risk premium explicit would aid customers in making usage decision. They could compare the risk premium with buying at spot market prices, first assuming no price response and then factoring in price response behaviors, (and their costs) and deciding which course to take.

Competitive retailers are understandably unwilling to reveal the risk premiums that they add in creating their retail price offerings. Conventional financial models may be employed, but electricity prices do not conform to some of the assumptions these models require, which means that they may not produce consistent and therefore reliable results. The level of hedging premiums therefore remains the subject of speculation.

Comparing the posted prices of competitive retailer products with the cost of paying spot prices for that load is one avenue for establishing risk premiums, albeit a somewhat flawed one. Such a comparison uses already known spot market prices and retail prices that were based on the retailer's price expectations. However, it is at least a rudimentary indicator of implied risk premiums. Applying that reasoning to competitive markets in the Northeast yields implied premiums of 15–40% for a fully hedged service. The difference among retailers' rates for equivalent service reflects their forward market view (each's expectations of prices), along with other transactional considerations, like the cost of operating a retail business (acquiring and servicing customers).

Auctions and RFPs for default service provide another hedge cost indicator. The results of the auction for default service in Illinois caused some to conclude that the implied risk premium was 20–40%. Recent studies of price response by ISO-NE utilized risk premiums that are graduated in the degree of risk of the pricing plan; RTP has the lowest (3–5%), TOU even higher (8%), and the uniform rate had the highest (15%). Under these risk premiums, the analysis concluded that the majority of benefits of price response redound to those that adopt that behavior.

Estimating the Hedging Cost Premium in Flat Electricity Rates

How can the hedging cost premium be quantified? In one approach, the hedging premium is considered to be exponentially proportional to the volatility of loads, the volatility of spot prices, and the correlation between loads and spot prices. This can be represented as follows:

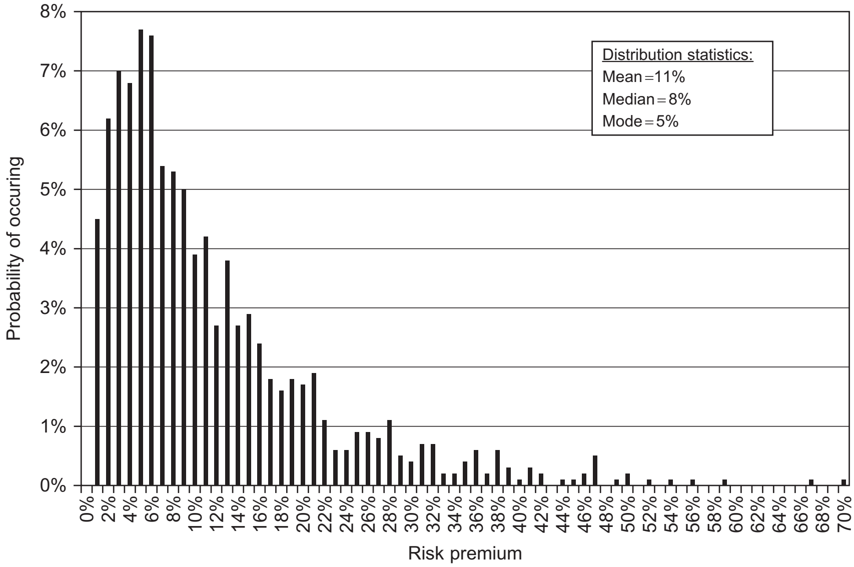
$$\pi = \exp(\sigma_{\mathrm{L}} \cdot \sigma_{\mathrm{P}} \cdot \rho_{\mathrm{L,P}})$$

where:

π = Risk Premium
σ_{L} = Load Volatility
σ_{P} = Spot Price Volatility
$\rho_{\mathrm{L,P}}$ = Correlation Between Load and Spot Price

For example, if price volatility was assumed to be 0.6, load volatility was 0.2, and the correlation between load and the spot price was 0.4, the resulting estimate of the hedging premium would be 5%. In other words, on average, customers are paying 5% more than they would if they were simply exposed to spot prices.

With an assumption about the distribution of these three variables, a Monte Carlo simulation can be used to approximate a distribution around this premium. Assuming that the variables are all triangularly distributed with a minimum of 0 and a maximum of 1, a Monte Carlo simulation of 1,000 iterations produces the hedging premium distribution shown in the following figure.



Simulated Distribution of Hedging Cost Premium

The mean, median, and mode of the premium are 11%, 8%, and 5%, respectively. The standard deviation is 10%.

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