The Brattle Group

Managing the Benefits and Costs of Dynamic Pricing in Australia

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ACRONYMS

AEMC	Australian Energy Market Commission
AMI	Advanced Metering Infrastructure
CBL	Consumer Baseline
CPP	Critical Peak Pricing
CPUC	California Public Utilities Commission
PTR	Peak-Time Rebates
RTP	Real-Time Prices
TOU	Time-of-Use
VLR	Voluntary Load Reduction
VPP	Variable Peak Pricing

SECTION 1: INTRODUCTION

In this paper we discuss ways of managing the benefits and costs of dynamic pricing in Australia. Specifically, we discuss four different types of time-varying electricity prices: Real-Time Prices (RTP), Time-of-Use rates (TOU), Critical Peak Pricing (CPP) and Peak-Time Rebates (PTR).

RTP requires setting prices on a short-term basis to reflect current market conditions, either on a day-ahead basis or an hour-ahead basis. TOU rates divide the day into several pre-determined price periods, each with a pre-determined price. Prices may also vary seasonally across the year. CPP increases electricity prices during the hours that fall into critical peak pricing events called by the utility or retailer and decreases them during all other hours of the year. PTR does not change the price of electricity during any time period but offers customers a rebate on electricity conserved during the hours of the critical peak pricing period.

We evaluate each pricing scheme on five criteria: economic efficiency, equity, bill risk, revenue risk and risk to vulnerable customers. Economic efficiency in this context means that electricity prices reflect the marginal costs of production. Since consumers will only buy a product when its value to them exceeds the price, pricing at marginal cost will ensure that electricity is only consumed when its value to the consumer is greater than its cost of production. Economic efficiency ensures that scarce capital and fuel resources are used in such a way to meet consumer wants that the gains to society are maximized.

Equity is realized when no consumer subsidizes another consumer. If all consumers pay a flat rate, then those consumers who use most of their electricity during the least expensive times of day are subsidizing those who use it mostly at the most expensive time of day. In other words, flat rates create inequities among consumers.

Revenue stability is a measure of the risk that the retailer faces in moving away from the current rate structure. Theoretically, all pricing schemes can be implemented to be revenue neutral, in the absence of consumer price response. It is much more difficult to ensure revenue neutrality once consumer response does occur.

Similarly, bill risk measures the risk that customers face, of large increases in their electricity bills, when moving to a new electricity pricing structure. While pricing schemes can be designed to be bill neutral for the average consumer, in actuality some customers will pay less and others more. This can be addressed by instituting a unique type of two-part rate, as discussed later in this paper.

Finally the risk to vulnerable consumers is the bill risk faced by those customers that have some form of bill support under the current pricing scheme. In Australia, over 30 percent of the population aged 15 and over is eligible for electricity subsidies. These individuals are a good proxy for vulnerable consumers, although there may still be other vulnerable consumers who do not meet the various eligibility criteria. This diverse group includes senior citizens, unemployed youth, low income families, and the chronically ill among others.

The rest of the paper proceeds as follows: In Section 2 we describe each pricing policy and use the decision criteria to evaluate its pros and cons. In Section 3 we compile a scoring matrix for all the basic policies using the decision criteria. In Section 4 we give a detailed discussion of several policies that reduce the bill risk that consumers face under dynamic pricing. In Section 5 we consider additional adaptions to the CBL, our bill risk mitigation strategy of choice. In Section 6 we consider the long run effects of customers opting out of different dynamic rate schemes.

Unless specifically noted, we have assumed that all new dynamic rates will be set as the default rate for both new and existing customers, with customers able to opt-out of these rates once they are implemented. This is in contrast to an opt-in scenario, where the current rate is set as the default and customers can choose to opt-in to the new rate.[1] Theoretically if preferences over rate structures are strong and the costs of changing rate structure are low, both options should produce the same end result. However, a large body of empirical work has shown that customers have an irrational attachment to the default, regardless of what it actually is.[2] More details on Default Bias are provided in the corresponding information box below.

Since opt-out is likely to be far more effective at moving large numbers of consumers to a dynamic rate, we focused on this as our default policy for the rest of our paper.[3] It should be noted that while opt-out can be far more effective in encouraging participation, it may adversely affect vulnerable consumers who do not have the capacity or awareness to easily opt-out. Additionally, we have abstracted away from all the price transmission mechanisms between the network and the retailers and have focused solely only the final retail price that consumers face. Using network tariffs to create

[1] One can also imagine hybrids such as existing customers are opt-in and new customers are op-out.

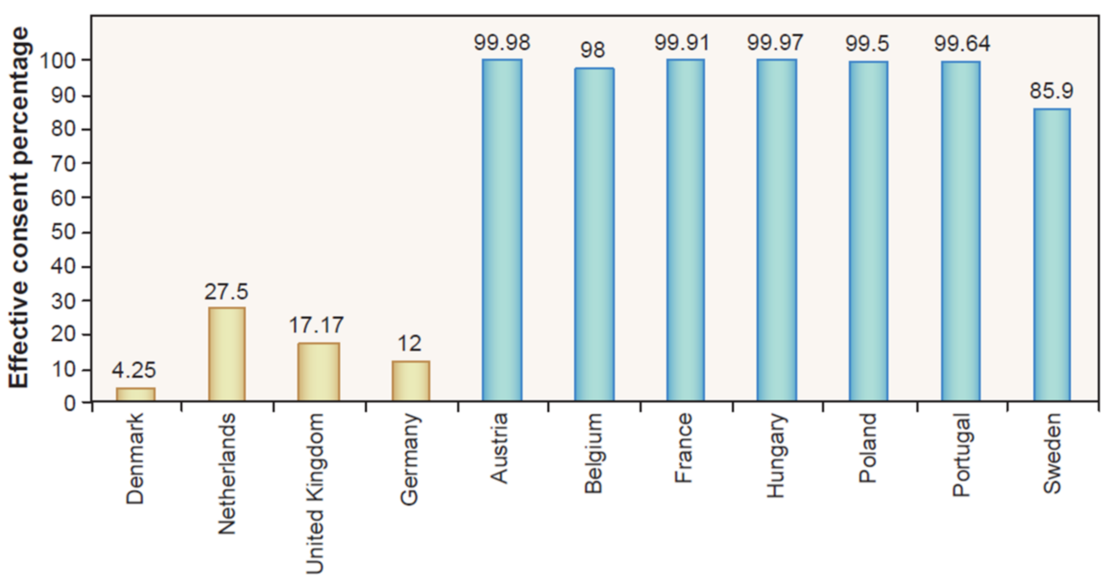
[2] See for example Cass Sunstein and Richard Thaler's book on choice architecture, "Nudge".

[3] For example, existing RTP programs at Ameren and ComEd have suffered from extremely low customer participation despite significant bill savings and high customer satisfaction among participants.

Default Bias

Default Bias (also known as Status Quo Bias) means that consumers have an irrational preference for the current status quo. This attachment may be because consumers fear losses from the new program more than they value the gains, because consumers intend to switch to the new program, but procrastinate indefinitely on doing so, or because they take the default as being an implicit recommendation by the retailer/authority.[1] An example of Default Bias is beautifully illustrated in Figure 2, which shows how opt-in verse opt-out organ donation rates affect organ donation rates. It is hard to imagine that the consent rates for organ donations is more than 8 times higher in Austria than Germany because of large cultural differences that effect preferences.

Figure 1:
Organ Donor Rates by Country



Effective consent rates, by country. Explicit consent (opt-in, gold) and presumed consent (opt-out, blue).

Source: Johnson & Goldstein, 2003

a retail price offering that reflects the dynamic pricing structures that we use in our analysis is a complex issue that merits further study.[4] In U.S. markets, this issue is moot since network charges typically only comprise a small component of the total customer bill. However due to unique geographical and institutional features of the Australian electricity sector, network tariffs form a far more substantial part of the customer bill.

Finally, all dynamic pricing rates require additional metering infrastructure to be installed. Such deployment requires time and money and also offers several societal benefits not discussed in this

[4] This analysis would require further conversations with the network providers. In North America we have not yet seen any dynamic component to network charges.

report. We proceed under the assumption that adequate metering technology will be installed to allow for all of our dynamic pricing policies. With the exception of TOU, these policies all require an Advanced Metering Infrastructure (AMI). However, recent deployments of TOU rates in North America have for the most part been done using AMI. AMI has been used exclusively in recent deployments which have implemented TOU on an opt-out basis.

SECTION 2: DYNAMIC PRICING POLICIES

In this section we layout and evaluate the basic dynamic pricing options. These polices can be grouped together to form new pricing options or augmented to achieve certain goals. In Section 4 we discuss strategies for augmenting these policies to minimize bill risk.

REAL-TIME PRICING

Participants in RTP programs pay for energy at a rate that is linked to the hourly market price for electricity. Depending on customer class, participants are made aware of hourly prices on either a day-ahead or hour-ahead basis. For the most part, the application of RTP is limited to the largest customers (*e.g.*, those above one megawatt of load) in the U.S.. However, there are two utilities that offer RTP to residential customers and both are located in the state of Illinois: Ameren-Illinois and Commonwealth Edison.[5] These programs post prices that most accurately reflect the cost of producing electricity during each hour of the day, and thus provide the best price signals to customers, giving them the incentive to reduce consumption at the most expensive times.

In order to cover fixed costs, retailers sometimes augment the short-run costs with an "adder" to cover long-run costs, or use a two-part price that has a fixed and a variable price component. Two-part RTP preserves the price signal, but can be more complex for consumers to understand. However, since a relatively large part of their energy bill is invariant to their actual usage, the price signal is muted compared to one-part RTP.

Advantages: The main advantage of RTP rates is that they provide the most granularity in conveying accurate hourly price signals to customers. By providing a dynamic price signal that reflects underlying costs, these rates are economically efficient and equitable. Moreover, by passing on the actual costs of electricity provision to customers, revenue risk is reduced for retailers.

Disadvantages: Generally, without automating technologies it is difficult for customers to respond to prices on an hourly basis – response tends to happen at a less granular level.[6] This combined with load inflexibility or a lack of consumer attention leads to increased bill risk for consumers.

Vulnerable Consumers: RTP will benefit some vulnerable consumers while harming others. Vulnerable consumers who have a flatter load curve such as low income consumers, unemployed

5 See, for example, Star, Isaacson, Haeg, Kotewa, 2010.

6 For example, see Navigant Consulting, 2011.

consumers and consumers on medical devices, may benefit from a RTP structure that is designed to be bill neutral for the average customer. There is evidence that more than three-quarters of low-income consumers are overpaying under flat rates and if allowance is made for their likely response to dynamic pricing rates, one would expect more than 80-90% of low income consumers to benefit from such rates.[7] However, some vulnerable customers, such as the frail and ill, may not be able to shift load during peak periods (for example reducing cooling on a hot day).

TIME OF USE

A TOU rate divides the day into time periods and provides a schedule of rates for each period. For example, a peak period might be defined as the period from 2 pm to 6 pm on weekdays and Saturdays, with the remaining hours being off-peak. The price would be higher during the peak period and lower during the off-peak, mirroring the average variation in the cost of supply. In some cases, TOU rates may have a shoulder (or mid-peak) period, or even two peak periods (such as a morning peak from 8 am to 10 am, and an afternoon peak from 2 pm to 6 pm). Additionally, the prices might vary by season. With a TOU rate, there is certainty as to what the rates will be and when they will occur.

Advantages: TOU rates are more economically efficient and equitable than flat rates since they encourage permanent load shifting away from peak hours. They have a simple design that is predictable and easy for customers to understand (*e.g.*, it is analogous to the pricing of cell phone minutes). Since TOU rates do not reflect varying cost conditions, bill risk is more moderate than in the case of RTP. TOU rates also could be used to encourage adoption of plug-in electric vehicles, solar photovoltaic systems, and distributed energy storage technologies by providing lower rates during the optimal time of charging (off-peak) and higher rates during the time of discharge or selling back to the grid. In fact, many utilities are offering specific TOU rates for electric vehicle owners.

Disadvantages: TOU rates are not dynamic in that they are not dispatched based on the changes in actual wholesale market prices or in reliability-related conditions. This means that their value decreases as day-to-day usage volatility increases. They are therefore less economically efficient and equitable than RTP and also less useful for addressing specific events on the grid and integrating variable renewable energy resources. TOU rates don't provide as large a peak load reduction as dynamic rate designs due to the price signal being averaged over a large number of peak hours instead of being averaged over a relatively limited number of very high-priced hours.

[7] Faruqui *et al.*, 2010.

Vulnerable Consumers: Much like RTP the bill risk that vulnerable consumers face will depend on their ability to shift load from peak to off-peak periods. However, since rates do not fluctuate with generation costs, customers will face less bill risk with TOU than with RTP.

In Ontario, Canada, 4 million residential customers face TOU rates as their default option. There is no bill protection, but customers have the option of switching to other rates. More details on this program can be found in Section 6.

CRITICAL PEAK PRICING

Under a CPP rate, participating customers pay higher rates during "critical peak events." In return, the participants receive a discount on the standard tariff price during the other hours of the season or year to keep the utility's total annual revenue constant. Customers are typically notified one day in advance of a critical peak event, where these are generally called on the few days when wholesale prices are the highest or when the power grid is severely stressed (*i.e.*, typically up to 15 days per year during the season(s) of the system peak).

***Advantages*:** The CPP rate is simple for customers to understand. It provides a strong price signal, improving economic efficiency over flat rates. Bill risk is somewhat limited, since it exposes customers to higher prices during only a very limited number of hours. Revenue risk is reduced since utilities can pass on some of their highest marginal costs to consumers.

Disadvantages: Political acceptance of the rate is sometimes limited due to the relatively high critical peak price and the bill risk that this places on consumers. Some utilities have expressed concern over revenue stability, since they are pushing a larger share of their fixed costs into a higher price that occurs during relatively few hours of the year.

Vulnerable Consumers: Much like other dynamic rates, the bill risk that vulnerable consumers face will depend on their ability to shift load from peak to off-peak periods. However, since exposure to higher rates is limited to a few hours a year, customers will face less bill risk with CPP than with RTP.

PG&E has rolled out a voluntary residential CPP program in California over the last four years. Participation is growing and as of this writing, it is at 60,000 customers or just over one percent of the total population of 5 million customers.

PEAK TIME REBATE

Under a PTR rate, participating customers are paid for load reductions (estimated relative to a forecast of what the customer otherwise would have consumed) during critical peak events. In the PTR there is no rate discount during non-event hours, but customers face no additional bill risk. If customers

Calculating the PTR Baseline

PTR requires that utilities/retailers calculate how much electricity the consumer would have used, had a critical peak pricing event not been called. Calculating this baseline is inherently difficult and the costs of inaccuracy are large. If the baseline is set too high, customers receive no benefit from peak-load reduction and the PTR may fail. If the baseline is set too high, the utility/retailer will land up paying customers who did not conserve or shift load. Several different approaches to calculating the baseline have been developed, a subset of which are listed below:

- **ComEd's Voluntary Load Reduction (VLR):** Takes hourly averages of the 5 non-holiday weekdays preceding an event.
- **ComEd's VLR with Load Normalization:** Calculates the hourly averages for the 2 hours preceding the event on both the 5 days preceding the event and on the event day. Scales the basic VLR by the difference between these two estimates.
- **California Public Utilities Commission (CPUC):** Takes hourly averages of the 10 non-holiday weekdays preceding an event and multiplies these by 120% to account for weather.
- **Baltimore Gas & Electric:** Compiles average peak THI (temperature-humidity index) and peak kWh values for each of the ten non-event, non-holiday weekdays preceding an event day. Selects the three days with the highest average peak kWh values and omits any days not within 10% of the THI for the event day. If all three days are outside the 10% THI threshold, the day with the highest average peak kWh is selected. Once the baseline days are identified, an average 24-hour load profile for each customer is calculated.
- **Pepco DC:** Identifies the three highest load non-event non-holiday weekdays within the 30 day window preceding the event. A baseline is then calculated by averaging the hourly loads on the three identified days.

The variation across these different calculations illustrates the complexity and potential for error in calculating a baseline for PTR.

do not wish to participate, they simply pay the existing rate.

Advantages: While all forms of time-varying rates are designed to provide customers with the opportunity to save on their electric bill, the PTR provides a level of bill protection that is not embedded in other dynamic rates. Because it provides a rebate during critical events but does not increase the rate during other hours, a customer's bill can only decrease under the PTR in the short run. As a result, the PTR rate is often more acceptable to regulators and policy makers. The concept is also generally easy for customers to understand. It provides a significant incentive to reduce peak demand and is thus more economically efficient than the flat rate.

Disadvantages: PTR requires the calculation of each customer's baseline usage, which is necessary for determining individual rebate payments. This process is inherently inaccurate and leads to added revenue risk for the retailer who may land up paying customers who did not actively change their electricity consumption. One study estimated that as much as 40 percent of a utility's total rebate payment would be simply due to the inaccuracies associated with estimating individual customer baselines.[8] In other cases, it may result in underpayment to customers who made significant changes. Since the PTR applies only to changes from each individual's own baseline, it does not improve equity over the

standard flat rate. While in the short-run a PTR is a "no lose" proposition for all participants, in the long run it is possible that rates will need to increase to cover the cost of the rebate payments. The magnitude of that rate increase will depend on the accuracy of the baseline estimation method. Additional information on how utilities calculate the PTR baseline in practice can be found in the corresponding information box above.

Further, while a PTR provides an incentive for reducing demand during the peak period, it does not convey the true time-varying cost of providing electricity and does not provide the price signal necessary to encourage adoption of plug-in electric vehicles or rooftop solar systems. There are also concerns about the potential for customers to artificially inflate their baseline energy usage in order to receive a higher rebate payment.

PTR programs are currently being rolled out by Baltimore Gas & Electric, Pepco, San Diego Gas & Electric, and Southern California Edison. All of these programs are on an opt-out basis since customers face no risks, only rewards from the PTR rate.

RATE COMBINATIONS

The rate options described above can also be offered in combination to take advantage of the relative advantages of each. One common combination is CPP and TOU. The TOU component of the rate reflects the average daily variation in peak and off-peak energy prices. The CPP component during a small percentage of hours each year reflects the cost of capacity during the seasonal system peak. Together, these rates can facilitate greater energy awareness among customers and provide a greater opportunity for bill savings through a more heavily discounted off-peak rate. However, the added complexity of a combination rate design means that additional customer education is necessary for the rate to be effective.

Seasonal differentiation can also be effectively integrated into TOU or dynamic rates. In regions that are distinctly summer-peaking, for example, it may be desirable to offer higher peak period prices only during summer months. This concentrates the events during the window of time when they are most beneficial to the system. A discount could then be provided and spread over the remaining hours of the year, or instead constrained to the summer season in order to provide a greater incentive for load shifting.

[8] Williamson & Marrin, 2008.

Similarly, the CPP can be combined with RTP, so that the critical peak price varies with the RTP. This is called Variable Peak Pricing (VPP).

One example of combining policies is Oklahoma Gas & Electric, who have combined VPP with TOU. This ensures that there is a market based rate during the few "super-peak" events that occur during the year, while for the rest of the year, customers are incentivized to shift to off-peak periods in an easily understood and predictable way. Participation in this program is voluntary.[9]

[9] Mass rollout has just begun after a two year pilot. OG&E aims to have a 20% participation rate after 3 years. Customers are incentivized to join with a free smart thermostat valued at $300.

SECTION 3: SCORING MATRIX

Table 1 shows how each policy performs according to our decision criteria. In the table, "+ +" represents a "very good" score, "+" is "good", "o" is "average", "-" is "poor" and "- -" is "very poor".

Rankings within each criterion are subjective and are based on our expert opinions. These scores are based on a best-practice implementation scenario and will change depending on how well a specific rate design is structured.

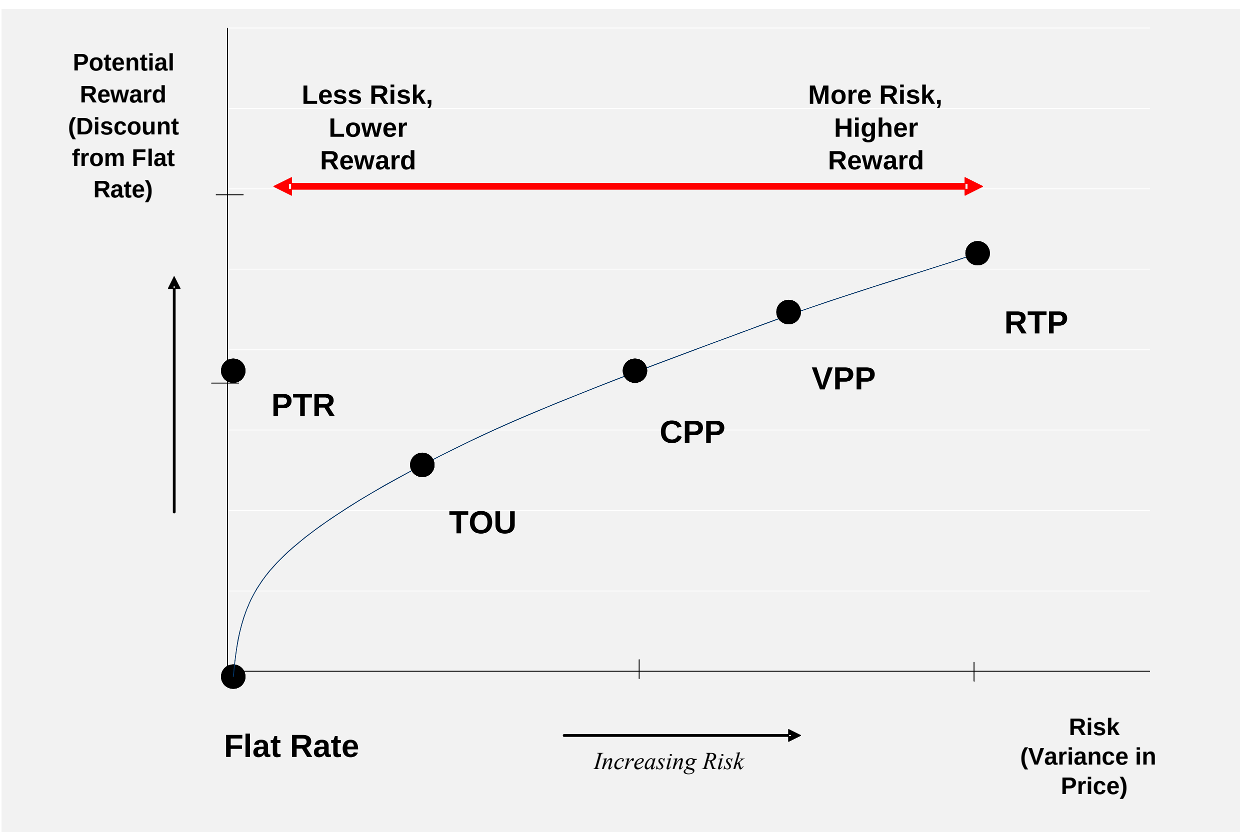
Table 1:
Scoring Matrix Based on Decision Criterion

Policy	Economic Efficiency	Equity	Bill Stability (Risk to Vulnerable Consumers)	Revenue Stability
Flat Rate	--	--	++	-
PTR	+	-	++	--
CPP	+	0	0	+
TOU	+	+	0	0
One-Part RTP	++	++	--	+
Two-Part RTP	++	++	-	++

SECTION 4: MINIMIZING BILL RISK UNDER DYNAMIC PRICING

Under flat rates the retailer faces the risk that peak sage and prices could exceed their forecasts, leading to financial losses. RTP, CPP and TOU rates all shift financial risk from the retailer to the consumer. However, because consumers ultimately control when and how they use electricity, this additional financial risk also allows for greater rewards as users shift their electricity usage to the cheapest periods. By contrast, PTR offers no additional risks to consumers, only potential rewards. These rewards are paid for by the retailer, who faces increased financial risk due to errors in estimating the correct usage baseline. The risk reward trade-off that consumers face is illustrated in Figure 2.

Figure 2:
Conceptual Representation of the Risk-Reward Tradeoff in Time-varying Rates.



In this section, we evaluate strategies for reducing the bill risk that consumers face under RTP, CPP and TOU.

CONSUMER BASELINE (CBL)

The basic idea behind the CBL approach is that only incremental or detrimental electricity usage, measured to a baseline, is exposed to the new dynamic price. The definition of which electricity usage is incremental or detrimental energy depends on how the baseline is defined. The most common baseline is historical hourly load data since this ensures that customer's bills remain unchanged if their usage remains unchanged. However, any baseline is theoretically possible. For the rest of this discussion we will refer to CBL in conjunction with RTP for ease of exposition. However the lessons learnt are just as applicable to CPP and TOU, which are special cases of RTP.

Advantages: CBL eliminates much of the bill risk that consumers are exposed to under RTP. If a customer maintains the same usage as her historic baseline, then her electricity bills will remain unchanged from the flat rate. However, since any changes from this CBL are charged at the market price, the customer now has an incentive to shift consumption from expensive peak periods to cheaper off-peak periods. This can reduce customer bills and increase economic efficiency. There is minimal revenue risk for utilities, since all new marginal electricity usage is at the real-time price.

Disadvantages: Since all customers pay their own individual access fee based on past energy usage and prices, previous patterns of cross-subsidization are still preserved making it less equitable than other RTP schemes. The concept of having a CBL that varies by person may be difficult for consumers to understand, and they may not be certain of what the marginal rate that they face is. There may be some administrative costs in setting up and running the CBL. The CBL concept has only been applied to large industrial and commercial customers. Calculating the baseline for consumers may be more difficult since they have greater variability over their loads. In addition the CBL may be difficult to implement for new customers who have no usage baseline. Initially, they could be given the class average profile as their baseline.

PRICE CEILINGS AND PRICE FLOORS

Imposing price ceilings and price floors (a maximum and minimum price, respectively), will limit some of the exposure that consumers have to bill risk imposed by extreme short-term prices. This is not necessary for TOU rates, which manages this type of extreme price risk by aggregating all extreme events into a long term average price for the time period.

Advantages: Price ceilings and floors can reduce bill risk from extreme prices and if used together, can be revenue neutral for retailers.

Disadvantages: By capping prices, price ceilings and floors distort the price signal and limit its effectiveness as a signaling device, reducing economic efficiency. Likewise, since peak users are not paying the full cost of their usage, equity is reduced.

PARTICIPATION THRESHOLD

The aim of a participation threshold would be to protect the amount of electricity that consumers need to meet basic needs. Dynamic prices would only kick in once this threshold had been met.

Advantages: This would ensure a minimum amount of energy security and reduce the exposure to dynamic prices.

Disadvantages: Low income consumers who can benefit disproportionately from dynamic pricing[10] will automatically be excluded. Vulnerable consumers in Australia are a diverse group that may include large electricity users who would not be protected under the threshold.

BILL PROTECTION

Bill protection would ensure that final electricity bills do not exceed a certain percentage above their baseline level (adjusted for differences in electricity use).

Advantages: limits the bill risk that customers face.

[10] Faruqui *et al.*, 2010.

Disadvantages: Reduces economic efficiency by distorting the price signal at the bill protection threshold. Bill protection is not revenue neutral and decreases revenue stability for retailers. Ultimately these extra costs will be passed on to all consumers, reducing equity.

EDUCATION

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, improve system reliability, prevent an energy crisis, and lead to a cleaner environment**.**

ENABLING DEVICES

Energy management tools should be offered to customers to help them to understand and manage their electricity usage. At the simplest level, such tools should provide information on how much of the customer's utility bill comes from various end-uses such as lighting, laundry, and air conditioning, and what actions will have the largest effect on their bill. At the next level, real-time in-home displays would disaggregate the customer's power consumption and explain how much they are paying by the hour. Finally, these tools would include enabling technologies such as programmable communicating thermostats. Devices that automate conservation during peak periods can help insulate vulnerable consumers who are not able to shift load by themselves. More generally, prioritizing and subsidizing vulnerable consumers in the deployment of enabling devices will help them mitigate bill risk.

A COMBINED STRATEGY

Risk mitigation strategies can be combined. Education and enabling devices should be a key component of any risk mitigation strategy. We favor the CBL approach as it limits the exposure that customers have to dynamic prices without dulling the price signal. The cost of this is equity since prior cross-subsidization patterns are maintained by the CBL. Another favorable attribute of the CBL is that it will preserve the flat rate at its historic level for any customers who wish to opt-out. This is discussed in Section 6. In Section 5 we discuss some ideas on how to implement the CBL.

TRANSITION PATH

Consumer gains under any dynamic pricing rate will come from a combination of conservation and load shifting. Both activities may entail costly and time consuming investments that are difficult to make in the short-term. These investments (for example a smart thermostat) will help mitigate bill risk by reducing usage at peak periods. To allow consumers time to make these investments in small incremental steps, dynamic prices can be phased in over a number of years. This will allow retailers to concurrently roll out demand side management programs targeted at vulnerable consumers. If necessary, vulnerable consumers can also be placed on a slower transition path.

SECTION 5: IMPLEMENTING AND ADAPTING THE CBL

Implementing a CBL will require that an advanced metering infrastructure is installed and running for at least one year before any dynamic rates are put in place. This time period is needed to create the CBL itself. Regardless of whether a CBL is implemented, such a baseline is recommended so as to facilitate the later measurement and verification of lad-shifting resulting from the dynamic pricing program.

The CBL concept has thus far only been applied to large industrial and commercial customers. We identify several strategies to make it more viable for residential customers:

TEMPERATURE ADJUSTMENTS

The biggest bill risks that residential customers face under CBL are events that disproportionately increase usage beyond the CBL in peak periods. Similarly for the retailer, events that disproportionately reduce demand below the CBL in peak periods will increase revenue risk. The most likely risk event in the Australian setting is temperature shocks. If a day is moderate in the CBL, but extremely hot in the present period, customers will be exposed to a large amount of electricity usage at peak prices. This is the idea behind RTP, since it will motivate consumers to conserve on electricity when it is most expensive to provide. However, vulnerable consumers, such as the frail and elderly may find it difficult to conserve during these periods, and as a result will face increased electricity bills. To alleviate this financial strain, but still maintain the price signal, the CBL can be scaled up by a temperature factor that takes account of cooling (or heating) needs. To maintain revenue neutrality for the retailer, the CBL would also have to be scaled down on days that are more moderate than the CBL.

NEW CUSTOMERS

New customers do not have any historic load data to use as a CBL. One approach would be to calculate average load shape data based on some basic consumer inputs. This approach has been implemented for commercial and industrial customers by both Georgia Power & Progress Energy. An alternative policy would be to use the phased transition and place a weight of zero on real-time prices for the first year.

VARIABLE CBL

The CBL can be scaled up or down to limit or increase exposure to the dynamic price. Customers can choose the level of risk that they wish to bear. Since the CBL preserves historic cross-subsidization, customers will need to pay a premium to reduce the CBL in order to maintain revenue neutrality.

Implementation of CBL in the U.S.

So far implementation of the CBL concept has been limited to RTP rates for large industrial and commercial customers. This historical focus on large nonresidential customers reflects both the technological constraints of CBL calculation and historical circumstances in the US market. In the early to mid-1990s, as the movement towards retail market restructuring gained momentum, utilities became increasingly concerned about unregulated, retail suppliers luring away large customers with market-based rates (LBNL, 2004). RTP rates were thus introduced to large industrials to pre-emptively encourage customer retention. CBL was bundled with RTP since it offered utilities more revenue stability than previous RTP programs (LBNL, 2004). The proliferation of new RTP programs began to subside in the latter half of the 1990s, as utilities focused their attention more directly on restructuring-related issues (LBNL, 2004).

Current experience with CBL is very limited. Of the twenty programs that we found in the US, 19 were pilots with limited enrollment. In fact, only 5 programs ever had more than 50 customers. For the most part CBL rates expired with the pilots or continue only as legacy rates.

Only one program, Georgia Power, successfully made the transition from an experimental to permanent CBL rate. At 1600 customers, Georgia Power's CBL implementation exceeds that all of the other programs combined. They offer a large variety of products that allow customers to choose their own risk levels. These "Price Protection Products" include the ability to buy or sell CBL, a price cap, contract for differences, and a price collar. These products do not offer blanket coverage, but rather are for specific time periods. This illustrates how retailers can move away from the historic CBL and allow customers a variety of products that allow them manage their own risk.

In terms of calculating the CBL, the most common metric was to use one year of hourly load data as the baseline. British Columbia Hydro and Power Company used a daily peak and off peak period as the baseline instead of hourly periods. About half of the programs allowed for the CBL to be adjusted over time. The approaches undertaken by these programs were very different. Florida Power & Lighting made the CBL a rolling average of past and current electricity usage, with the rolling average and each additional year's electricity usage weighted at 50% each. Otter Tail Power Company also used a rolling average, but allowed the customer to determine each year's weighting. Ameren and South Carolina Electric & Gas both adjusted the CBL if current load varied too much from the CBL. All of these adjustment approaches limit customer's exposure to real-time prices, reducing the bill risk, but also eroding the gains of load shifting.

Another way that firms protected customers was to offer a weighted average of the flat and RTP rate. These weighted average prices have been offered both as predefined bundles with different weights (*e.g.* Aquila and Kansas Power & Lighting) or at the customer's discretion (*e.g.* Dominion).

SECTION 6: THE LONG-RUN EFFECTS OF OPT-OUTS

The effect of customers opting out of dynamic rates depends on the load profile of those customers. Under the current flat tariff rate regime, customers whose load shape is relatively flat are cross-subsidizing other more "peaky" customers. Since they will no longer be cross-subsidizing their "peakier" counterparts, these 'flatter' customers will be better off under TOU, RTP and CPP (without CBL), even without shifting any load. Thus these customers are likely to choose to continue with the new dynamic rate regime. However customers with peakier than average load shapes (who are not willing or able to shift load), may face higher bills and choose to return to the flat rate. This asymmetric selection into the flat rate by peaky customers will drive up the cost of providing the flat rate, since there is no longer cross-subsidization. In the long-run, the retailer will therefore need to raise the flat rate to maintain revenue neutrality. If vulnerable consumers are in this group, then they will face rising prices under the flat rate.

An example of this can be seen in Ontario, Canada, where 4 million customers were placed on a default TOU rate. These customers had the option to opt-out by switching to other retailers who offered flat rates. Anecdotal evidence shows that the new flat rate that was offered to these consumers was higher than the old flat rate would have been in the absence of the TOU rate. About 10 percent of customers elected to opt-out and go back to a flat rate.

This eventual increase in flat rates comes about because of selective opting-out. If opting-out is essentially random (at least in terms of load profile), then the flat rate will remain unchanged. This is the case under dynamic rates with a CBL. Since the CBL ensures bill neutrality under historic base load conditions, there is no self-selection into or out of the new rate based on historic usage behavior. This means that customers who opt-out of the rate can cross-subsidize each other as they did before dynamic rates were instituted.

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