GALVIN ELECTRICITY INITIATIVE

Perfecting Power for a Secure, Sustainable Energy Future

Maximizing Consumer Value Through Dynamic Pricing: A Suggested Approach for Regulators

Summary

Regulators and electricity providers have developed and now offer numerous pricing structures to optimize their provision of electricity to consumers. This brief intends to provide a broader set of criteria for evaluating the effectiveness of proposed dynamic pricing structures. The Galvin Electricity Initiative suggests that **market-based pricing,** can be deployed to maximize conservation, consumer cost savings and permanent demand response. **Event-based pricing,** on the other hand, can effectively reduce demand in response to supply constraints and events. Furthermore, market-based pricing creates a more elastic price-response market where consumer action is valued continuously throughout the year. Understanding these distinctions, along with establishing specific pricing program goals, can help regulators achieve desired outcomes in electricity delivery.

Background

In response to consumer demand, communities across the country have committed to reducing the CO_2 emissions associated with electricity use through conservation and by procuring lower carbon-generating sources. Meanwhile, regulators have sought to design and pilot pricing and load control structures that reduce peak load when the system is constrained, typically only a few hours a year. Furthermore, independent system operators (ISOs) in restructured markets are creating a wide variety of market- and event-based pricing structures to encourage consumer participation in electricity markets.

In 2007, the Brattle Group published a comprehensive evaluation of the many utility-designed dynamic pricing pilots that have been tested over the past decade[1]. This report revealed that the utility pilots have largely focused on direct load control. A year later, in 2008, a Synapse report on the New Jersey critical peak pricing structure (CPP) — a structure in which a utility calls for voluntary reduction in electricity use — revealed that customer annual savings were estimated at about $10 to $50 per year[2]. Typically, a CPP occurs eight to 12 times each summer for four to five hours of load reduction per consumer, totaling about 50 hours per customer annually.

The reports confirm that customer response to CPP — and the rebates offered as incentives — effectively reduce demand for that event. However, they do little to reduce consumer annual costs or daily demand, nor do CPPs appear to maximize annual conservation. Furthermore, neither study provides information on which pricing structures do affect these typical consumer goals.

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The Many Faces of Dynamic Pricing

To better understand how pricing structures affect change in electricity consumption, it is important to recognize that most dynamic pricing structures generally fall into two performance categories. **Event-based pricing** structures apply some type of price signal or load control device for a limited number of hours throughout the year to mitigate a supply constraint or other event such as a brownout. With **market-based pricing**, pricing information is provided to customers continuously (e.g., on an hourly, daily or real-time basis). These pricing structures provide a financial incentive for consumers to reduce demand or shift demand to off-peak periods continuously, thereby creating opportunities for greater savings and investment in conservation technology.

According to the Brattle study, most of the utility pilots performed so far have focused on event-based pricing and have demonstrated dramatic reductions in demand for acute time periods or supply events. These pilots, however, provide limited information regarding the impact of market-based pricing.

Both the event-based and market-based categories include a number of different pricing structures that are used by consumers, regulators and system operators as alternatives to flat pricing. These pricing structures are summarized below.

Event-based pricing structures:

- **Demand-response payments** — In demand-response programs, the regulator or system operator compensates consumers for reducing their load when called upon. It is typically up to the consumer to determine how the loads are reduced during a demand-response event.
- **Critical peak prices** — Critical peak prices are special consumer charges that apply during supply or distribution constraint events. Critical peak pricing by itself encourages consumers to reduce peak loads during an event, but as was mentioned earlier, does not necessarily encourage conservation, ongoing peak load reduction or CO_2 reduction.
- **Direct load control** — Under this program, consumers are compensated for allowing key loads, such as a central HVAC system, to be temporarily turned off or controlled by the utility when supply or distribution is constrained.
- **Rebate for reduction** — Under this type of program, the consumer is given a rebate for reducing electricity demand during a supply or distribution constraint event.

Market-based pricing structures:

- **Time-of-use (TOU)** — This structure charges different prices for on- and off-peak hours and may include seasonal price changes. This pricing structure provides greater financial incentive for investment or action that reduces peak load or shifts peak load to off-peak periods.
- **Tiered pricing** — Tiered or multi-tiered prices are similar to TOU prices except that the pricing structure is more complex, with different prices offered throughout the day. With tiered pricing, consumers are charged more during the hours of the day that the grid is typically most constrained. Tiered pricing can provide super-peak prices that provide greater financial incentive for solar photovoltaics, storage and other technology that can reduce usage for a few hours each day.

- **Real-time pricing** — Real-time pricing changes each hour based on market conditions, supply and demand. Real-time prices tend to be significantly lower than flat prices during off-peak periods. However, real-time prices can be significantly higher than flat prices during peak periods. Entire campus electric systems, such as Princeton University's, operate in real-time pricing markets and take advantage of lower-cost off-peak prices while switching to gas-fired generation and cooling when prices rise.
- **Day-ahead pricing** — Day-ahead pricing is similar to real-time pricing except that hourly prices are settled one day ahead, thus giving consumers advance notification of the next day's hourly prices. Day-ahead pricing creates a new market in which consumers can sell fixed-price contracts in return for demand reduction the next day. Day-ahead prices are not as volatile as real-time prices.
- **Increasing block pricing** — In this type of pricing structure, the more electricity a consumer uses, the more the consumer pays per kWh. This system is intended to promote conservation by penalizing large electricity users, but it does not necessarily reduce peak loads.
- **Third Party-Supplied Flat Rate** — Surprisingly, a flat rate supplied by a third party is a dynamic price signal. Competitive retail suppliers determine the flat-rate price charged to customers based on the actual annual usage load profile. Third-party suppliers charge customers who have a great deal of on-peak power usage (e.g., weekday usage) and very little off-peak usage (e.g., weekends and nights) higher flat rates. This provides a financial incentive for frequent on-peak users to invest in technology to flatten their load profile. Consumers who make changes to permanently lower their peak demand can obtain lower-cost flat rates when they rebid their contract or switch suppliers. Utility-supplied flat rates are the same for every customer within a customer class regardless of load profile, thereby subsidizing customers with on-peak load profiles and eliminating the economic incentive to act or invest to reduce peak-time usage.

To optimize the benefits of various pricing structures, regulators should first determine the outcomes that they are trying to achieve for their constituents. For example:

- **Conservation** — the total annual reduction in electricity usage resulting from implementing a new pricing structure, measured in MWh.
- **Consumer cost reduction** — the total reduction in annual electric bills resulting from the new pricing structure. This can result from reduced usage, shifting usage from higher cost periods to lower cost periods and selling services to the grid.
- **CO_2 reduction** — the extent to which the pricing structure helps reduce greenhouse gases associated with electricity production.
- **Permanent demand reduction** — the extent to which the pricing structure eliminates peak loads, measured in terms of system asset utilization and demand factor.
- **Temporary demand management** — the extent to which the pricing structure effectively reduces demand during a utility or independent system operator supply constraint or event.

- **Load shifting** — the extent to which the pricing structure provides incentives for consumers to move loads from on-peak periods to off-peak periods (e.g., when integrating plug-in hybrid vehicles or electric automobiles).
- **Price responsiveness** – the extent to which a pricing structure values consumer action when prices rise, measured in terms of reduced price volatility and peak electricity prices.

TABLE 1: **Efficacy of Various Rate Structures in Achieving Select Outcomes**

	EVENT-BASED RATES					MARKET-BASED RATES				
DESIRED OUTCOME	**Flat Price**	**DR Payment**	**CPP**	**Direct Load Control**	**Rebate for Reduction**	**TOU Pricing**	**Tiered Pricing**	**Real-Time**	**Day-Ahead**	**Increasing Block**
Conservation	low	low	low	low	low	high	high	med	med	med
Consumer cost reduction	low	low	low	low	low	low	med	high	med	low
CO_2 reduction	low	low	low	low	low	med	high	med	med	low
Permanent demand reduction	low	low	low	low	low	med	high	med	med	low
Temporary demand reduction	low	high	high	high	med	low	low	low	low	low
Load shifting (e.g. PHEV)	low	low	low	low	low	high	high	high	high	low
Price responsiveness	low	med	low	low	med	med	high	high	high	low

Source: Galvin Electricity Initiative

Based on data from the Brattle and Synapse reports, the Galvin Electricity Initiative has developed Table 1 to provide regulators with a tool for evaluating the effectiveness of various types of event- and market-based pricing. The Initiative ranked each pricing approach based on experience; however, further research is needed to complete this assessment.

This approach can be utilized to assess the overall impacts of various pricing structures. Market-based pricing may prove to be more effective for motivating consumer investment in conservation. Event-based pricing, on the other hand, appears to be most effective in reducing demand to mitigate grid supply constraints and events, such as heat waves or loss of a large generator. As such, a combination of market- and event-based pricing structures may be most effective.

Suggestions for Smart Grid Pilots

The preliminary assessment in Table 1 indicates that market-based pricing may be a critical component of smart grid programs if conservation is a primary goal. However, more data is needed to determine specific impacts of market-based pricing on both consumers and utilities. This data could be effectively obtained through pilot programs. But in order to be successful in shedding light on this issue, pilot programs should consider including the following:

- Consumer access to secure, wireless, near-real-time usage data directly from the meter;
- Consumer choice regarding their post-meter device selection;
- Consumer access to ancillary service payments (e.g., direct load control, demand response, capacity, day-ahead markets, etc.); and
- Sufficient time for market response (multiple years). In response to these new pricing structures, entrepreneurs will produce and continuously improve upon new products and tools, lowering costs and improving performance (conservation and savings). Many devices deployed in the first year of pilot programs could be rendered obsolete by the year's end.

Conclusion

The Galvin Electricity Initiative encourages regulators to identify desired outcomes for new smart grid dynamic pricing structures and pilot programs — such as conservation, consumer cost savings and permanent demand response. With outcomes in mind, regulators can design and pilot dynamic pricing structures to achieve them. The Initiative recommends categorizing new dynamic pricing structures as either market- or event-based and evaluating accordingly based on their relative benefits.

References

[1]Faruqui, A. *Zen and the Art of Dynamic Pricing*, Brattle Group, December 1, 2009.

[2]Hornby, R. et al. *Advanced Metering Infrastructure – Implications for Residential Customers in New Jersey*, Synapse En. Econ, Inc., July 2008.