Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design

A RESOURCE OF THE NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

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The Leadership Group of the National Action Plan for Energy Efficiency is committed to taking action to increase investment in cost-effective energy efficiency. *Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design* was developed under the guidance of and with input from the Leadership Group. The document does not necessarily represent a consensus view and does not represent an endorsement by the organizations of Leadership Group members.

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List of Abbreviations and Acronyms

CO_2	carbon dioxide
CPP	critical peak price
FERC	Federal Energy Regulatory Commission
kW	kilowatt
kWh	kilowatt-hour
MW	megawatt
SFV	straight fixed-variable
TOU	time of use

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Executive Summary

This brief,* Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design*, summarizes the issues and approaches involved in motivating customers to reduce the total energy they consume through energy prices and rate design. The scope of this brief is limited to how the multi-objective ratemaking process can address customer incentives to reduce total energy consumption, which also contributes to reductions in peak demand.[1] This brief is provided as part of a comprehensive suite of papers and tools to assist organizations in meeting the National Action Plan for Energy Efficiency goal to achieve all cost-effective energy efficiency by 2025.

Improving energy efficiency in our homes, businesses, schools, governments, and industries—which consume more than 70 percent of the natural gas and electricity used in the country—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security, air pollution, and global climate change. Despite these benefits and proven approaches, energy efficiency remains critically underutilized in the nation's energy portfolio. Regulators can address this problem in part by removing one of the persistent barriers to energy efficiency by creating effective customer incentives for energy efficiency through electric and natural gas rates.

Prices, Rates, and Energy Efficiency

Customers respond to increases in energy prices by (1) changing energy usage behavior, (2) investing in energy-using technologies and practices, or (3) making no change to their energy usage. Customers see energy prices through their rates, which are typically embedded in a "tariff," a document approved by a regulatory commission (for investor-owned utilities) or by a utility's leadership (for publicly owned utilities). Rates differ across customer classes and are offered in various forms, consisting of charges they must pay regardless of how much energy is consumed[2] and charges they can avoid by using less energy. Both rates and prices affect the total energy bill paid by customers. Some states are considering how to encourage all types of customers to become more energy-efficient as one of the many objectives of rate design.[3]

Key Findings

States may consider rate design changes due to a number of drivers, including rising energy prices and utility investments in advanced meter infrastructure, as well as new energy efficiency policies. This brief explains how retail electricity and natural gas rate design affects customers' energy use behavior and investment choices. The key findings include:

Overarching Findings

- Ratemaking is a complex process that serves multiple policy and business goals. Encouraging energy efficiency is one of those goals, but it must be balanced with equity and other considerations.

- Utility tariffs and the prices they convey can motivate energy efficiency, but high rates and prices alone are not likely to overcome the well-documented barriers to cost-effective energy efficiency.

- Utilities and regulators should continue to examine rate and pricing approaches that encourage customer energy efficiency, while recognizing their limitations and pursuing non-price approaches as well.

- Price transparency and the ability for customers to understand their rates and energy usage are important elements of providing customer incentives through rate design.

Specific Findings

- Shifting costs from volumetric to fixed charges, through rate designs such as straight fixed-variable, does not encourage customer energy efficiency.[4]

- Some rate designs, such as declining block rates and bill adders, send price signals that mask the true cost of incremental units of energy and thus can encourage more rather than less energy consumption.

- Rate designs that encourage energy usage should be examined. Alternatives such as inclining block rates offer greater customer incentives for energy efficiency.

- New time-differentiated rate options referred to as "dynamic pricing" have delivered energy use reductions under specific, short-term conditions, although their long-term impacts on total customer energy use remain uncertain.

- Enabling technologies and programs, such as energy information to customers and grid-connected measures, have been shown to increase customer savings.

As states proceed with rate and pricing policy changes, additional information would be useful to inform considerations of using rate design to encourage energy efficiency, including:

- Additional and more consistent data on emerging rate and pricing options, including their effect on total energy consumption and the persistence of savings over the long term.

- Assessing the limits of rates to achieve desired energy efficiency levels, maintain political acceptance, and meet other ratemaking objectives.

- More reliable methods for projecting the longer-term impacts of rate and pricing designs on load forecasts, so as to better incorporate their effects into resource plans.

Achieving All Cost-effective Energy Efficiency—A Vision for 2025

This brief has been developed to help parties pursue the key policy recommendations of the National Action Plan for Energy Efficiency and its Vision for 2025 implementation goals. It directly supports Vision Implementation Goal Seven, which encourages utilities and ratemaking bodies to align customer pricing and incentives to encourage investment in energy efficiency. The Action Plan has identified this as an area of minimal progress (National Action Plan for Energy Efficiency, 2008a, Chapter 2); significant state progress is needed in order to achieve the Action Plan Vision to achieve all cost-effective energy efficiency by 2025.

This brief necessarily focuses somewhat narrowly on the effects that rate design and pricing may have on customer energy efficiency behavior and investment. It therefore does not address the many other considerations involved in ratemaking, nor does it encompass the numerous

non-price policies and programs that states and utilities can pursue to encourage customer energy efficiency. Many of these issues are addressed in other Action Plan documents.

Within this context, state public utility commissions, publicly owned utility boards, and all energy utility companies are encouraged to consider how the rates and pricing they provide to customers can be part of a comprehensive solution to energy efficiency. All parties, including policy-makers, utilities, and stakeholders, are encouraged to consider the role of rates and pricing within a comprehensive suite of policies and programs to remove persistent barriers to energy efficiency. For information on the full suite of policy and programmatic options to remove barriers to energy efficiency, see the Vision for 2025 and the various other Action Plan papers and guides available at www.epa.gov/eeactionplan.

Notes

1 Discussion of rate design options commonly designed to incent customer reductions during limited days and hours of peak demand is limited in this brief, addressing only the incentives these rates and pricing provide to customers to reduce total consumption throughout the year. Further, the brief does not encompass additional issues in the multi-objective ratemaking process, such as utility cost recovery and inter-class customer equity.

2 These charges are often referred to as customer charges, which recover costs that do not vary with kilowatt-hour (kWh) usage (e.g., transmission and distribution assets, billing and customer care services).

3 As of December 31, 2007, seven states have examined and modified electricity rates considering the impact on customer incentives to pursue energy efficiency. Two states have done the same for natural gas rates. See National Action Plan for Energy Efficiency (2008a).

4 While fixed charges are being considered to reflect utility costs, the focus of this brief is customer incentives for efficiency. For more information on ratemaking considerations to incent utility investment in energy efficiency, see the Action Plan's utility incentives guide (National Action Plan for Energy Efficiency, 2007).

Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design

This brief examines utility rates and pricing policies to encourage customers to pursue energy efficiency. The need for this brief stems from the Action Plan's Vision for 2025, which observed that minimal progress has been made in examining and modifying rates considering the impact on customer incentives to pursue efficiency.[5]

This brief is designed to discuss the key concepts and issues surrounding rate design and the incentives/disincentives they provide for customer energy efficiency, in terms of both behavior changes and investment in efficient technologies. The brief reviews existing common rate design approaches and summarizes selected case studies of rate design approaches for their impact on energy efficiency. The brief also highlights the typical steps a state would need to take to implement new rate designs and identify areas where additional information is needed to understand the contributions rate design can make to achieving all cost-effective energy efficiency.

After reading this brief, parties are encouraged to turn to one of the many references provided in the brief for additional information and detailed guidance on implementing changes in rate design. Changing rates is a state-specific process, supported by localized analysis of how the rates can encourage customers to save energy. During these and other processes, states may also explore options to incentivize customer energy efficiency through programs and financing mechanisms.[6] Some utilities are also considering the effectiveness of information delivery and related technologies that communicate usage and price levels to customers to affect their behavior and investment decisions. These options are not covered in this brief, but a separate Action Plan guidance document (National Action Plan for Energy Efficiency, 2008c) is available on the options and benefits of providing commercial customers with standardized electronic billing data.

This brief also does not address issues related to ratemaking such as decoupling of sales and revenues, or incentives to shareholders for utility investments in efficiency resources; these are addressed in other Action Plan documents (see National Action Plan for Energy Efficiency, 2006 and 2007a).

What Are Customer Incentives for Energy Efficiency Through Rates?

In this brief, the term "energy efficiency incentive" is used to refer to any effect that a change in utility rates or pricing may have to encourage or motivate customers to reduce the total amount of energy they consume, without compromising the service they receive. This energy efficiency can be due to an investment in energy-efficient technologies and practices and/or a change in customer behavior. The terms "motivate," "encourage," and "incent" may be used interchangeably.

Effective rate designs can incent customers to pursue more efficient technologies or practices by providing clearer and more timely energy use and price information and by reducing the perceived payback period of the investment from the customers' perspectives. The payback period needed to incent more efficiency varies greatly by customer and customer type. Providing a short payback period with a high degree of certainty to customers can help remove

one of the key financial barriers to energy-efficient investments. Factors such as split incentives, lack of information, and transaction cost barriers will also affect a customer's decision to invest in energy efficiency. These barriers and the potential solutions to address them are well known, and they are discussed by the Action Plan in its reports, its Vision for 2025, and its work with commercial customers under the Sector Collaborative on Energy Efficiency.[7] Policy-makers, utilities, and stakeholders are considering changes in utility rates as part of a comprehensive policy framework to motivate customers to use energy more efficiently.

Utility Rates and Energy Prices—Key Concepts

"Electricity and natural gas rates," "ratemaking," and "rate design" are terms used to refer to the regulated process of setting prices for energy delivered to customers. To elaborate:

- A **rate** is typically embedded in a **"tariff,"** a legal document approved by a regulatory commission, which defines the prices to be paid for defined classes of customers under defined terms of service.

- **Prices** are defined more narrowly, as the amount charged for a specific unit of energy under defined conditions.

- A rate may thus contain multiple prices: for example, a time of use (TOU) rate may contain two prices, one for peak periods and one for off-peak periods.

- Prices are based either on the costs incurred to provide the service or on market prices, depending on whether electricity rates are administered pursuant to cost of service regulation or set in competitive markets. In a restructured state with competitive energy service, a regulated distribution utility may have a rate tariff that applies to its distribution service, while an unregulated retail electric or gas provider may charge a separate price for the energy it sells to the consumer. Regardless of regulatory structure, all customers pay rates with various prices embedded in or associated with those rates.

As discussed in the Action Plan report (National Action Plan for Energy Efficiency, 2006), utility ratemaking has evolved to achieve multiple policy goals such as providing universal energy service, recovering utility costs, ensuring that energy is affordable, incenting energy efficiency, and encouraging economic development. The process of designing new rates and changing existing rates is a state-specific, time-consuming process that can often be highly contentious. In this process, regulators balance the increasingly complex linkage between utility system costs and customer rates and prices. Today's utilities incur a complex array of fixed and variable costs, and they use more sophisticated methods to manage these costs. Utility or retail provider rates include:

- Costs of energy acquisition (which include a mix of capital and variable costs of self-production and purchases under spot and long-term contracts).

- Fixed and variable energy delivery costs.

- Other fixed cost components (such as customer service, administration and management, and more).

- Some utilities use techniques to manage price risk, while others have retail rate structures that allow supply prices to flow through to customers, such as fuel adjustment clauses.

Lastly, electricity and natural gas embody different supply, distribution, and consumption characteristics that have led to different rate treatments. Most notably, natural gas usage is typically more uniform throughout the day, and gas utilities have greater flexibility to purchase and store gas supply before distributing to customers. By contrast, electricity use varies significantly throughout the day while the electricity supply cannot be stored in quantities needed to even out these daily changes in demand and, therefore, must largely be delivered as it is generated. Also, electricity transmission and distribution systems are typically subject to more congestion and other constraints, which change the cost of electricity across time and location. Natural gas networks can also be subject to congestion and constraints, but historically these effects have been less pronounced than in power grids.

Due to these differences, electric rate design has become more complex, more variable, and more subject to experimentation than natural gas ratemaking. While many of the principles in this brief are also relevant to natural gas rates and prices, most of the discussion focuses on electricity-specific issues. This is not to suggest that natural gas rates and prices cannot be used to provide customer energy efficiency incentives; it means only that the range of considerations in the gas utility industry is somewhat narrower.

The Economics of Energy Prices and Customer Incentives

For the purpose of this brief, "price response" means the change in customer energy consumption as the price of energy supply changes. From a policy-maker's viewpoint, it is important to understand the economic theory behind price response, which is the concept of price elasticity. Price elasticity is based on the concept that consumption of a good or service is elastic, or changeable, and that consumption tends to change inversely to changes in price—higher prices cause consumption to drop, and vice versa.

While the general theory of price elasticity is well established, applying it to specific ratemaking/pricing policies requires real-world experience and effective measurement methods that policy-makers can use. To bring theory into effective practice, investigation and debate continues on the magnitude of elasticity effects, the differences between short-term and long-term elasticity, and related issues.

Measuring elasticity involves different methods, depending on the framework of analysis. Long-term, economy-wide analyses typically examine elasticity over periods as long as 10 to 30 years. Short-term elasticity effects are estimated more narrowly, sometimes just for a period of hours or less when a particular price signal is in effect. Electricity rates that change by time of day and load management programs[8] can create short-term elasticity effects, though estimating sustained effects on energy usage over a multi-year basis is more difficult.

For example, a long-term price elasticity may be expressed in terms of "-0.15," which means that for every 10 percent increase in electricity prices in such timeframes, usage would be expected to fall by 1.5 percent. Short-term elasticities are often measured as hourly peak demand or energy use reductions, and are not consistently measured as changes in annual energy use. In programs that encourage short-term price response, initial hourly demand reductions can decline over subsequent hours or days, making longer-term usage impacts especially difficult to predict.

Price response, whether short-term or long-term, also varies by customer class and end-use. Smaller customers, such as residences and small businesses, are typically seen as less price-responsive overall than larger commercial and industrial customers, although providing residential customers with enabling technologies and programs can narrow this gap (see Sachs, 2007). Such differences can be attributed to several factors, including:

- Ability to prioritize energy cost control and invest in the personnel, monitoring capabilities, and load management capabilities needed to make significant price-responsive changes in energy use.

- Varying degrees of price transparency—customers' ability to see and understand price and rate information, in a timeframe and format that enables them to make price-response decisions. Customers need to get usage and cost information that allows them to connect their energy use decisions with the resulting cost impacts.

- Availability of technical options to manage energy use, such as substituting the type of energy used, shifting operating hours, or changing processes to respond to price signals.[9]

- Inelasticity when energy is used to provide an essential service.

- Additional persistent market barriers to energy efficiency across customer types.

This discussion suggests that for ratemaking purposes, it may be most useful to estimate price elasticity by customer type and location.[10] Localized analysis can determine the magnitude of price signals associated with local utility system costs: in some regions, on-peak energy is much more expensive compared with off-peak energy than in other areas. Customer end-uses and their relative importance also vary geographically; for example, customers in some climates may show different tolerances for comfort effects associated with changing air conditioning settings than customers in other climates.

Other, non-energy elasticity effects can affect net changes in energy consumption. For example, income elasticity tends to increase energy demand in economies with rising incomes; e.g., a household may buy a larger home or purchase more energy-using devices when its income increases, increasing net energy use. Also, cross-elasticity tends to deflect energy price effects onto other goods; e.g., a household whose utility bills rise may elect to reduce other expenditures, such as dining out, rather than reducing energy use.

As part of implementing rate designs to encourage customer energy efficiency, policy-makers, utilities, and states may also consider options to increase transparency, or visibility, of prices such as billing statement enhancements and providing electronic usage and cost data to customers (National Action Plan for Energy Efficiency, 2008c). Unlike other energy products such as gasoline, which are typically quite transparent to customers at the time of purchase, utility prices are typically embedded in billing statements that (1) are not seen until after energy is consumed and (2) may not lend themselves to simple understanding of prices. As discussed above, large energy-intensive customers typically are more price-responsive, in part because they have assigned staff or specialist consultants to interpret their utility bills, and may invest in their own metering, data reporting, and other methods to make energy cost information both transparent and linked to operational behavior and capital investment decisions.

Utility Rate Design and Pricing Options

Rate design is a multi-objective process in which policy-makers seek to balance goals for utility cost recovery, equity among customers, economic efficiency, and other considerations along with energy efficiency. In recent decades, many different energy rate and pricing options have been offered to customers to meet different policy goals and address the regulatory, business, and technical issues of the time.[11] This section reviews the main pricing options in use today. These options are organized in three categories:

- Fixed rates
- Variable rates
- Emerging approaches to blend fixed rates and variable pricing

The section discusses the rate options and their link to energy efficiency incentives. A high-level summary of key issues to consider for the rate options when incentivizing customer rates for energy efficiency is provided in Table 1. This table, in a necessarily oversimplified fashion, provides a qualitative assessment of rate options with respect to the following five variables:

- **Customer types**—indicates which customer types are typically appropriate for each rate option.

- **Customer incentive for overall energy savings**—indicates the degree to which the option encourages customers to reduce overall energy use over the entire year or during limited hours, days, or months.

- **Customer incentive for peak demand savings**—indicates the extent to which the option encourages customers to reduce peak demand during limited hours, irrespective of total energy use.

- **Financial risk to utility**—indicates the extent to which the option tends to place more risk on the utility; for example, TOU rates are judged lower-risk than flat rates, because rates are more closely linked to utility costs, and so the risk of failing to recover costs is reduced.

- **Financial risk to customer**—indicates the extent to which customers take on relatively more risk; for example, customers' risk is assessed as relatively lower with flat rates than with TOU rates, in that their total bill is less likely to vary based on when they use energy.

Table 1 builds on Chapter 5 of the Action Plan report (National Action Plan for Energy Efficiency, 2006, p. 5-9), which contains a more detailed discussion of ratemaking options to support customer energy efficiency actions, including references to utility tariff examples in Table 5-2. *Aligning Utility Incentives With Investment in Energy Efficiency* (National Action Plan for Energy Efficiency, 2007a) provides greater discussion on utility financial risk.

Table 1. Overview of Customer Incentives for Energy Efficiency From Various Rate and Pricing Options

Rate/Price Type	Description	Customer Types*	Customer Incentive for Overall Energy Savings**	Customer Incentive for Peak Demand Savings**	Financial Risk to Utility**	Financial Risk to Customer **
Fixed Rate Options						
Flat rates	▪ Customer charge for direct service costs. ▪ Other fixed and variable costs allocated on an average basis, per kWh consumed.	A	M	L	M	L
Inclining block rates	▪ Basic customer charge. ▪ Fixed volumetric rate for first usage block. ▪ Higher fixed volumetric rate for subsequent “tail” block(s).	A	H	M	M	M
Seasonal rates	▪ Fixed volumetric rates, but with seasonal increase.	A	M	M	M	M
TOU rates	▪ Basic customer charge. ▪ Volumetric charges that vary by time of day (typically with two or three periods, e.g. peak/off-peak or peak/mid/off-peak).	A	M	H	L	M
Declining block rates	▪ Basic customer charge. ▪ Fixed volumetric rate for first usage block. ▪ Lower fixed volumetric rate for subsequent “tail” block(s).	A	L	L	M	L
Bill adders/ surcharges	▪ Recover various costs such as franchise fees, universal service charges. ▪ Some fee structures use fixed charges, some use volumetric. ▪ Absolute amounts typically small.	A	L	L	L	M

Rate/Price Type	Description	Customer Types*	Customer Incentive for Overall Energy Savings**	Customer Incentive for Peak Demand Savings**	Financial Risk to Utility**	Financial Risk to Customer **
Demand charges	▪ Separate billing charge for peak demand, separate from customer or energy charges. ▪ May include ”ratchet” feature, where peak demand charges carry over for up to a year.	C I	M	H	L	M
Straight fixed-variable (SFV) rates	▪ Customer charge recovers all fixed costs. ▪ Volumetric charge covers only variable costs.	A	L	L	L	M
Flat/fixed-bill rates	▪ Billing charges are fixed over a 12-month or longer period. ▪ In budget billing, charges are adjusted in the following year. ▪ In flat bill contracts, no automatic adjustment.	R C	L	L	M	L
Variable Rate/Dynamic Pricing Options						
Critical peak pricing	▪ Basic customer charge. ▪ Basic fixed volumetric rate. ▪ Critical peak price (CPP)—substantially higher rate for usage during CPP periods. ▪ CPP periods not preset, but infrequent.	R C	M	H	L	H
Peak time rebate	▪ Offers a rebate for reduced usage during CPP times, rather than a higher price. ▪ Requires baseline and savings calculation.	R C	M	H	L	L
Variable peak pricing	▪ A variant of TOU pricing, in which on-peak prices vary, typically daily. ▪ Requires interval metering.	C I	M	H	L	H

Rate/Price Type	Description	Customer Types*	Customer Incentive for Overall Energy Savings**	Customer Incentive for Peak Demand Savings**	Financial Risk to Utility**	Financial Risk to Customer **
Real-time pricing	▪ Beyond basic fixed customer charges, prices vary hourly, typically based on wholesale power market prices.	C I	M	H	L	H
Blended Fixed and Variable Rate Options						
	▪ Mainly unregulated price offerings. ▪ Generation price only—customer can choose a mix of fixed and variable prices.	A	M	M	L	M

Source: National Action Plan for Energy Efficiency analysis.

* A = all; R = residential; C = commercial; I = industrial

** H = high; M = moderate; L = low. Note that "low" can include cases where there is no effect or a negative effect.

Fixed Rates

Within the fixed-rate category, the rate options that tend to provide customer incentives for energy efficiency are:

- **Flat rates.** Flat rates are constant rates that do not vary by TOU, though they are also volumetric, in that they are based on the volume of energy consumed. They are designed to produce revenue for the utility to cover its fixed and variable costs of service and its allowed rate of return. While flat rates are neutral in the sense that they charge the same for each unit of energy consumed, they do not convey the signal that the cost of electricity supply varies by TOU. They do convey that customer bills will be in proportion to consumption, and thus signal to customers that controlling consumption can control costs.

- **Inclining block rates.** By making incremental consumption beyond a minimum block more expensive (a "block" is simply a defined amount of usage, for example 1,000 kilowatt-hours [kWh]), customers get price signals that should encourage them to moderate additional usage. The effectiveness of this incentive depends, however, on customers understanding this price signal through billing statements or other sources, and in knowing when they have exceeded their initial block of consumption and are thus in higher-price territory. These transparency issues can limit the effectiveness of this incentive; utilities can and often do provide information to help customers understand these issues.

- **Seasonal or TOU rates.** These rate types signal to customers that energy consumption can become more expensive depending on when it is used. Customers might then, for example, invest in products, such as high-efficiency air conditioners, that use less energy in higher-priced seasons, or higher-cost times of day, and might modify their behavior to shift usage like dishwashing or clothes drying to lower-cost hours. While such incentives are somewhat indirect and may have limited transparency without specific customer information on when or in what devices to reduce usage, they nonetheless encourage customers to reduce usage at least at certain times.

Other fixed-rate options, however, tend to discourage customer energy efficiency:

- **Declining block rates.** Because they offer lower prices for consumption beyond the basic block of consumption, declining block rates encourage customers to increase rather than decrease energy consumption and convey the message that using more power is good, and that the utility can always provide more power at cheaper costs.

- **Bill adders.** Many states include various charges, such as specific-purpose surcharges, franchise fees, or other charges, on utility bills in addition to base tariff charges. If such charges appear on the customer bill as fixed costs, they may be efficient ways to recover fixed costs, but they do not encourage customers to reduce energy use because they cannot be avoided through energy efficiency.[12] If the charge is volumetric, but shown as a separate line item without a total volumetric charge, it can reduce price transparency and inhibit customers' understanding of the full price and how much they can save, and thus can indirectly reduce incentives to cut consumption.

- **Straight fixed-variable (SFV) rates.** This approach places all utility fixed costs in a fixed charge and all variable costs in a variable charge. Because it tends to shift costs out of

volumetric charges, it tends to reduce customers' efficiency incentive, because the marginal price of additional consumption is reduced. While SFV rates are being considered to better reflect the utility's costs behind the rate, these rates do not encourage customers to change energy usage behavior or invest in efficient technologies. Such customer disincentives persist even when SFV rates are applied to individual components of the bill, such as charges for distribution service.

- **Flat/fixed-bill pricing.** Many utilities offer a "budget billing" option, which levelizes billing payments over 12 months. This reduces efficiency incentives in the short run, because customers do not see any bill impacts from consumption changes until the following year. However, there is an annual adjustment, which may provide a longer-term efficiency incentive. Some companies offer a fixed annual bill without an automatic annual adjustment. This approach can produce both short and long-term disincentives for customers to become more energy-efficient, in that the customer's actions may have little effect on their bill.

Variable Rates/Dynamic Pricing

Variable rates and dynamic pricing are under active development and are being implemented in some states, with substantial pilot program activity and associated research and evaluation. Table 1 summarizes the four main options in this category. Due to the differences in physical characteristics and system economics between electricity and natural gas service providers, no evidence was found of these kinds of rates being pursued for natural gas service. Hence this brief discusses only electric rates in this category.

In simple terms, variable rates and dynamic pricing are designed to reflect the actual cost of electricity during specific hours of the day and year, to change customers' hourly load shapes with reductions in peak demand or shifts of peak usage to other hours of the day. Energy efficiency is typically a secondary effect of such pricing approaches, although measured short-term energy usage reductions have been documented.[13] Because the specifics of these pricing plans vary substantially, it is difficult to make generic assessments of their effectiveness as customer energy efficiency incentives. The incentive effect can depend heavily on implementation details, including customers' capabilities to see and respond to price signals, the effectiveness of control technologies, and whether customers are given effective education on their price response options. Rates intended to reduce peak usage often build a large price differential between on-peak and off-peak energy, so that the high on-peak cost strongly dissuades on-peak use.

For example, a residential customer who participates in a dynamic pricing program may have pre-agreed to an automated adjustment in their thermostat set point during critical peak periods. Assuming that the customer simply reduces energy use during the critical peak period, and does not over-consume energy in a recovery period, there will be a net reduction in daily energy use. However, this behavioral effect is likely to be limited, because the customer may not be willing to accept more than minimal comfort losses lasting only a few hours on a limited number of days. In addition, usage in some cases could simply be shifted to off-peak periods, resulting in no overall savings or in some cases a small increase in use. However, if the critical peak price level were high enough and sustained over a period of time, it might create a "tipping point" effect that would encourage the customer to invest in a more efficient air conditioner in the longer term. This would allow the customer to save energy through the entire cooling season without sacrificing as much comfort on peak days, and would thus create both short-

term behavioral and long-term investment changes that over time can help transform energy use markets and change customer demand for more energy-efficient products and services.

As a commercial sector example, a large customer may combine dynamic pricing with a sophisticated energy management system and technologies to reduce peak, such as thermal storage optimized with chiller plant design and operation, dimmable lighting systems linked to daylighting controls, and a building automation system programmed to respond to price signals using advanced controls that adapt building systems operation to price signals. In this example, the rate gave the customer the incentive to reduce energy and peak demand, but may also have encouraged the customer to examine and act on other efficiency opportunities.[14,15]

Emerging Approaches to Blend Fixed Rates and Variable Pricing

In competitive retail energy markets, some electricity providers offer blends of fixed and variable prices. Typically, this kind of offering provides a portion of a customer's consumption at an agreed fixed rate and prices the remaining amount at a variable set linked to market prices. In some cases, customers can select different amounts of fixed-price energy, and these blended offers may also vary in terms of pricing details by time of day or seasonally. Such offerings are typically provided by unregulated power marketers rather than regulated utilities, and they are most commonly marketed to larger customers, who are seen as better able to use the risk management value such price offerings may promise.

The effectiveness of blended price offerings as energy efficiency incentives depends greatly on the specific design of the offering. If a customer elects a plan in which the great majority of consumption is priced at fixed rates, it would tend to create a longer-term incentive, in that most of the customer's energy bill will not vary in the short term. But if there is a substantial difference between the fixed price and the variable price, this could create a strong short-term behavioral focus on avoiding high energy bills when variable prices are in effect. If the majority of the customer's bill is driven by variable rates, this would tend to shift the focus more strongly to short-term load management to control energy costs.

Current State Examples—Rate Design to Incent Energy Efficiency

States are making minimal progress in encouraging utilities and ratemaking bodies to align customer pricing and incentives to encourage investment in energy efficiency (National Action Plan for Energy Efficiency, 2008a, Chapter 2). Those states that have advanced activities within this space are listed in Table 2.

A recent national summary of utility pricing data is also available from the Federal Energy Regulatory Commission's (FERC's) 2008 report on demand response (FERC, 2008). Table 3 summarizes the relevant information from that report; it is limited to time-based pricing, but still indicates some of the trends emerging in the utility pricing arena.

Key observations from this recent pricing and ratemaking experience include:

- In the fixed-rate category, in addition to the general trend toward overall rate increases in many jurisdictions, a trend is emerging away from declining block rates toward inclining block rates. Five states have eliminated declining block rates.

- In the variable rate category, an increasing number of jurisdictions are experimenting with several varieties of dynamic pricing and rate-setting. The reported peak demand

and energy savings results from the selected programs in Appendix C range from peak reductions of 3.7 to 41 percent and short-term energy savings of 3.3 to 7.6 percent.[16]

- The trends in time-based or dynamic pricing show an overall 9 percent growth in total offerings from 2006 to 2008. TOU rates remain the majority of total time-based pricing offerings, though their share dropped between 2006 and 2008.
- Most of the dynamic rate results are from pilot efforts lasting less than a full year. This limits the ability to project longer-term price response effects from these initiatives, especially effects on customers' longer-term energy efficiency investments.

Table 2. Summary of State Actions on Electricity and Natural Gas Rates

	States That Have Taken Electricity Rate Action	States That Have Taken Natural Gas Rate Action
Impact on energy efficiency a consideration when designing retail rates?	AZ, CA, IA, ME, NY, OR, WI	IA, NY
Declining block/fixed-variable rates eliminated?	CA, ID, OR, VT, WI	
Time-sensitive rates in place?	AL, CA, CT, DC, DE, GA, IA, ID, IL, KY, MD, MI, MN, MO, ND, NM, NV, NY, OK, SD, TX, VT, WI, WY	IL, NM
Usage-sensitive rates in place?	CA, DC, DE, MD, OR, VT	

Source: Supporting data used in National Action Plan for Energy Efficiency (2008a).

Note: Table 2 reflects state actions through December 31, 2007, as compiled in support of the Action Plan's Vision measuring progress efforts. See Appendix D of the Vision 2025 report (National Action Plan for Energy Efficiency, 2008a) for more information on this methodology.

Table 3. Total U.S. Time-Based Rate Offerings

Rate/Price Type	Number of Offerings Reported in 2006 FERC Survey	Number of Offerings Reported in 2008 FERC Survey
TOU rates	366	315
Real-time pricing	60	100
Critical peak pricing	36	88
Total	462	503

Source: FERC (2008)

Note: The 2008 survey was sent to 3,407 entities across the United States, representing investor-owned utilities, municipal utilities, rural electric cooperatives, power marketers, state and federal agencies, and demand response providers. Respondents include all entities covered by EIA Form 861 reporting requirements, plus regional transmission organizations/independent system operators and curtailment service providers. A total of 2,094 entities responded to at least part of the survey; the entities reported in this table thus represent about 24 percent of respondents.

Implementing New Pricing and Rates

Change is never easy, and changing utility rates is typically a contentious process. Rate changes viewed as excessive, arbitrary, or unfair by some parties can lead to legal and political action with potentially major repercussions. In such environments, customers, utilities, and policy-makers can benefit from ratemaking and related processes that emphasize proactive outreach, communication, and stakeholder participation.

Based on a review of current practices in utility ratemaking, policy-makers and utilities may want to consider three key principles to guide future activity on changing rates to increase energy efficiency incentives to customers:

1. **Incremental vs. radical changes can be effective.** Energy efficiency incentives can be provided to customers without requiring rates and prices that are very complex or radically different from current practices. For example, shifting from declining block rates to inclining block rates can provide energy efficiency incentives to customers, as or before a state or utility considers more complex dynamic pricing designs.[17]

2. **Implementation processes should keep focus on rate design goals while addressing other issues.** Because ratemaking is a public and somewhat judicial process, many of the key details of rate design can be distorted in the process. It is thus important to understand the analytical issues and their implications, as well as the participants and their interests, before entering the potentially long and difficult process of implementing new rate/pricing plans.

3. **Communicate actively with key stakeholders.** If there is a policy purpose that suggests new rate designs, outreach should be undertaken with key stakeholders before any ratemaking proceedings begin, to communicate the basis and the importance for these changes. During the ratemaking process, opportunities for stakeholder involvement should be considered, beyond those available through current adjudicatory proceedings. Once decisions are made, further communication efforts are needed to educate customers and sustain support for the decisions.

Several other contextual issues are driving changes to rates and pricing to encourage energy usage changes and efficiency investments, including:

- **Rising supply energy prices.** Some states are facing large rate increases due to higher energy supply prices, especially as rate caps that were put in place during restructuring and deregulation are removed. In areas of price increases, there is more pressure to provide consumers with options to become more energy-efficient, which includes but is not limited to pricing.

- **New efficiency policies.** Many states have enacted new energy efficiency policies and aggressive energy savings goals on electric and natural gas utilities. Utilities are considering rate changes as part of a larger suite of approaches to deliver and encourage energy efficiency.

- **Smart grid technologies.** Proposals for advanced metering and other “smart grid” technology applications are being considered, in part for their ability to offer new rate design and pricing possibilities and customer response options. Because many smart

grid proposals claim to offer energy efficiency benefits, it is also important to understand the claims made.

- **Transparency.** Beyond changing rates or pricing, utility billing and customer information delivery affect customers' response to energy prices. As noted above, lack of transparency can limit some customers' ability to understand and respond to the price signals their bills contain. Today's information technologies can allow bills to include more granular information and can also create parallel options for utilities and customers to interact on pricing and energy usage. Further, several utilities and larger customers are working to automate customer information into energy management systems and building benchmarking tools (National Action Plan for Energy Efficiency, 2008c).

Additional factors that should be considered in designing rates that effectively increase customer incentives to change usage behavior and invest in energy efficiency include:

- **Cost allocation.** When rate changes shift costs among times of day, seasons of the year, or customer types, equity issues can arise. Much discussion has been devoted to the issue of identifying "winners and losers" in a given rate or pricing scheme. This requires analytical effort to determine how cost allocation changes affect different customers, and policy decisions on balancing equity concerns with other policy goals. Further, existing unintended and hidden subsidies can be removed so customers currently paying disproportionately more can see bill reductions; this can be an important part of the balancing act involved in ratemaking.

- **Customer protection.** Concerns have been raised about some kinds of rate/pricing approaches, based on the perceived disadvantaging of customers who are unable to respond to the proposed new plan, resulting in net energy bill increases. If new rates are to be mandatory, they should be designed to minimize such disadvantages. One way to address this concern is to create "opt-in" or "opt-out" conditions that give customers degrees of choice. The "opt-out" approach tends to create wider participation. This may lead to explicit subsidies in some cases.

- **Market targeting.** Following the classic "80/20 rule," some rate or pricing designs can achieve the majority of the desired price response effect by targeting a small segment of customers. Effective voluntary marketing of such plans to the segments that can best realize their benefits can help maximize the effectiveness of the plan while managing concerns about customer equity. For example, residential and small commercial customers with high summer monthly consumption can be targeted for marketing of peak pricing programs.

- **Funding priorities.** In some situations, competition may arise between energy efficiency and demand response or load management programs. It is thus important to understand the full range of benefits and costs from each type of customer program, so that policy-makers can allocate resources appropriately.

- **Scale-up.** Most recent pricing/rate innovations have been implemented as pilot programs. Scaling up to cover entire rate classes or broad customer segments raises new challenges, recognizing that challenges are bigger for some options than others. Stakeholders must be engaged to understand issues involving costs, benefits, and equity. This can entail a substantial public participation/communication process if rate changes are large or sweeping.

Processes for Implementing New Rates and Pricing Plans

Rate cases are the most common processes for instituting new rate and pricing offerings. Sometimes, a revenue-neutral rate design proceeding changes the rates that specific customers pay. Depending on state rules, either utility commissions or utilities can initiate such proceedings. In states with competitive retail markets, unregulated power marketers can also offer new pricing plans, typically without extensive (or any) regulatory review, while the default service provider remains governed by the regulator for its rate and rate design. In the context of reviewing new options from an energy efficiency standpoint, the following elements of such a proceeding can be important:

- **Documenting expected customer response and net impacts.** Proponents should be able to estimate with quantitative analysis how the proposed rate or pricing plan will affect customer peak demand and net energy consumption. Demand and energy impacts should be calculated on both short-term and long-term bases. Data sources and assumptions for customer response should be transparent. Stakeholders should be able to review the data, assumptions, and analyses behind these estimates.

- **Documenting benefits and costs.** Proponents should be able to detail projected costs and benefits on both short-term and long-term bases. Stakeholders should be able to review the data, assumptions, and analyses behind these estimates. Costs should include customer education and complementary programs that will be required in order to achieve customer response assumptions.

- **Balancing customer equity and stakeholder interests.** Deciding which customers are covered, be it by mandatory or voluntary rate/pricing plans, is an important part of the process. Some rate/pricing approaches may be appropriate for mandatory application, but only for some customer types. Voluntary eligibility is more a marketing question of where the plan would be most effective and best accepted. For any broad-based change in rates or pricing to be sustainable, though, customers and other stakeholders need to understand and ultimately accept the rationale for the new approach.

- **Staging.** Many jurisdictions have begun their efforts with pilot projects to test impacts, benefits, costs, customer acceptance, and other issues. Scaling up in steps, rather than all at once, may be desirable to ensure long-term success.

While these issues generally apply to all rate innovations, more complex rate and pricing designs may entail greater challenges in documenting customer response, net impacts, and net benefits, and in resolving customer equity issues.

Needs Identification

While this brief summarizes a substantial body of research and market experience, it also has identified several needs for more data and research, covering such topics as:

- **Persistence of energy savings.** Most pilot impact data are relatively short-term, particularly with dynamic rates. To be useful for resource planning purposes, policy-makers will need longer-term, reliable estimates of the expected effects of pricing and rate plans on energy usage forecasts.

- **Understanding changes in benefits at scale and over time.** If significant peak demand reductions occur on a large scale under dynamic pricing, they may begin to reduce the price differential between time periods. They may also modify overall average prices. These effects could reduce and ultimately negate the nearer-term energy and demand price signals they initially contain. Addressing this issue requires better understanding of the total scale of demand, energy, and price effects, beyond their marginal, short-term effects.

- **Developing the best approaches to incorporate dynamic pricing into resource planning.** Because the key benefit of many variable rates and dynamic pricing plans is to reshape load curves and utility costs, policy-makers may need more sophisticated tools for understanding the effects of such pricing and ratemaking approaches on longer-term energy and demand forecasts, which are fundamental to determining future resource needs. While these pricing approaches can reduce risk and costs in the near term, understanding their longer term effects on total energy use can be more complex, and better tools may be needed to fully incorporate these approaches in formal resource plans.

- **Developing new approaches to evaluating energy savings from behavioral changes.** Proven approaches exist for evaluation, measurement, and verification of administered energy efficiency programs (National Action Plan for Energy Efficiency, 2007b). More work is needed, not only to understand the effects rate design could have on customer behavior and the investment choices they make, but also to inform decisions to modify program approaches that maximize energy savings through rate design changes.

Notes

[5] The Vision (National Action Plan for Energy Efficiency, 2008a) found less than 20 percent progress under Goal Seven, step 21.

[6] A future Action Plan brief will be developed on this topic.

[7] See the Action Plan's Vision for 2025 (National Action Plan for Energy Efficiency, 2008a), as well as an upcoming Action Plan paper on energy efficiency and carbon dioxide emissions and the Action Plan Sector Collaborative resources at <http://www.epa.gov/cleanenergy/energy-programs/napee/collaborative.html>.

[8] "Load management" traditionally refers to "direct load control" or "active load management" programs that control customer devices via utility-installed control technologies; in these programs, rate designs are typically not directly affected, through incentives may be offered for participation. More recent demand response and dynamic pricing programs tend to encourage customers to change behavior or operational settings of devices (e.g., changing air conditioning thermostat settings or appliance start times) with greater customer choice, in response to utility price signals.

[9] Note that the California pilot results showed that the persistence of residential customer response is enhanced through enabling technology. Residential customers who were given remotely controlled thermostats, for example, showed greater average load reductions and also were more likely to sustain such reductions over successive days (George et al., 2006).

[10] See Faruqui and Wood (2008). For example, the New Jersey Board of Public Utilities is having Jersey Central Power & Light Co. amend its summer rate pilot program to account for customer differences in ability to reduce usage at certain times.

[11] See Appendix B for more background on the history of utility ratemaking.

[12] If costs are fixed in nature, the utility still incurs them even if customers reduce their total consumption.

[13] For example, see findings by the Center for Neighborhood Technologies, Chicago, Illinois.

[14] For more guidance on larger-customer energy and demand control options, see the Sector Collaborative report (National Action Plan for Energy Efficiency, 2008b), Chapter 3.

[15] Advanced ratemaking practices such as dynamic rates still must recover the underlying costs of acquiring and delivering electricity, as well as infrastructure and fixed and variable costs. Over time, one would expect well-designed rates to change these underlying fixed and variable cost elements, and one would expect those changes to be passed through in future rates.

[16] See summary results for selected dynamic pricing pilots in Appendix C.

[17] It should be noted, however, that the analytical effort needed to develop robust numbers for new rate designs may be substantial, even if the price signal and rate structure provided to the customer is relatively simple.

Appendix A: National Action Plan for Energy Efficiency Leadership Group

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Appendix B: A Brief History of Pricing and Ratemaking Practices

Pricing and ratemaking has evolved substantially in the century-plus history of energy utilities in the United States. Some of the first power generation ventures were hydroelectric facilities, such as the Niagara Falls project in New York. Their initial customers, typically industrial facilities, were charged a flat amount based on the amount of capacity they required. Because the hydroelectric facilities' costs were almost all capital costs, this provided a simple rationale for flat capacity payments. As thermal power generation evolved to provide the bulk of power supply, as grids evolved into universal service networks, and as utility commissions emerged to set pricing and ratemaking policies, the practices involved in setting customer utility rates grew more complex.

It is also worth recalling that for most of the 20th century, expanding the electricity grid was associated with public policy goals of providing universal service at affordable rates. Economies of scale predominated in most electricity markets in this era, such that adding customers, load, and power supply capacity to the grid tended to reduce average costs. In this environment, ratemaking remained a relatively straightforward process of calculating utilities' fixed and variable costs into rate tariffs on an averaged basis. Because rate cases most often resulted in reduced average rates, there was little perceived need to examine costs and rates more closely.

One of the few departures from pure average-cost ratemaking was the practice of declining block rates. These typically included:

- A fixed customer charge, designed to recover the direct costs associated with serving an individual customer in that rate class.

- A rate assigned to the first block of energy consumed for the billing period (e.g., 500 kWh).

- A lower rate assigned to additional energy consumed above the first block.

This practice was based on the assessment that marginal additional consumption imposed lower marginal costs on the utility, as most of its fixed costs would be recovered through fixed customer charges, plus the initial block of energy consumption. Because it was also true in most cases that adding generation to the grid would tend to reduce average costs, the potential load growth that declining block rates might stimulate was generally seen to be a public good. In an era of declining energy and capital costs, with few perceived limits on grid capacity or natural resources, and with little accounting for environmental impacts, this straightforward system of pricing and ratemaking worked well for decades.

Since 1970, at least three important shifts occurred to disrupt traditional ratemaking practices:

- Capital costs stopped declining for many power supply and grid technologies. Maturation of the U.S. grid, flattening economies of scale, and natural resource constraints began to drive power plant and other system costs higher, resulting in rate increases and the phenomenon popularized as "rate shock."

- Energy costs stopped falling in many markets with spikes in global oil prices. Coupled with rising capital costs, higher energy prices exacerbated the rate shocks that began in the 1970s.

- Environmental laws and regulations came into energy markets, adding new compliance costs for utilities and shifting the earlier perception that additional energy consumption was beneficial.

Energy and environmental legislation of the 1970s reflected these trends. The Public Utility Regulatory Policies Act of 1978 and subsequent amendments called for states to examine a number of standards or practices for ratemaking, among other things:

1. **Cost of service.** Rates charged by any electric utility for providing electric service to each class of electric consumers shall be designed, to the maximum extent practicable, to reflect the costs of providing electric service to such class, as determined under section 2625 (a) of this title.

2. **Declining block rates.** The energy component of a rate, or the amount attributable to the energy component in a rate, charged by any electric utility for providing electric service during any period to any class of electric consumers may not decrease as kilowatt-hour consumption by such class increases during such period except to the extent that such utility demonstrates that the costs to such utility of providing electric service to such class, which costs are attributable to such energy component, decrease as such consumption increases during such period.

3. **Time-of-day rates.** The rates charged by any electric utility for providing electric service to each class of electric consumers shall be on a time-of-day basis which reflects the costs of providing electric service to such class of electric consumers at different times of the day unless such rates are not cost-effective with respect to such class, as determined under section 2625 (b) of this title.

4. **Seasonal rates.** The rates charged by an electric utility for providing electric service to each class of electric consumers shall be on a seasonal basis which reflects the costs of providing service to such class of consumers at different seasons of the year to the extent that such costs vary seasonally for such utility.

5. **Interruptible rates.** Each electric utility shall offer each industrial and commercial electric consumer an interruptible rate which reflects the cost of providing interruptible service to the class of which such consumer is a member.

6. **Load management techniques.** Each electric utility shall offer to its electric consumers such load management techniques as the State regulatory authority (or the non-regulated electric utility) has determined will—

a. be practicable and cost-effective, as determined under section 2625 (c) of this title,

b. be reliable, and

c. provide useful energy or capacity management advantages to the electric utility.

These policy developments spurred a wave of studies and experiments in pricing and ratemaking; the late 1970s and early 1980s were studded with groundbreaking work in ratemaking and related analysis, and several states instituted ratemaking changes accordingly.

Energy market conditions stabilized to a large extent later in the 1980s, and the wave of ratemaking experimentation subsided somewhat accordingly. Energy prices moderated, system capacity was adequate in most areas, and the urgency for further action became somewhat muted, though industry researchers, utility commissions, and advocates continued to work on many of these issues.

In the current decade, the urgency for action on utility pricing and ratemaking has risen once more. The growth in peak electricity demand has created the risk of capacity shortages in many regions (North American Electric Reliability Corporation, 2008). This is driving a new round of capacity construction proposals; however, rising energy prices and capital costs promise to make new builds more expensive, raising new rate shock concerns. Additionally, the emergence of climate change as a public policy issue, and specifically the designation of carbon dioxide (CO_2) as a pollutant covered under the Clean Air Act, has created the likelihood that U.S. CO_2 emissions will soon be regulated, raising energy prices and adding new risks for CO_2-emitting energy facilities. Because energy efficiency is viewed as a cornerstone of the policy solution to today's energy and climate challenges, utilities and their regulators are looking for new ways to encourage customer energy efficiency.

As this new era of carbon constraints and higher energy and capacity costs unfolds, the utility industry is a much more complex business than it was in the last century. Restructuring and deregulation of electricity and natural gas markets in wholesale and many state retail markets has added new layers of complexity to calculating and managing utility system costs and risks. At the same time, technologies have advanced to enable substantial new capabilities in managing grid operations and customer price response, in a wave known generically as the "smart grid."

These factors have converged to increase both the urgency and the complexity of pricing and ratemaking in the utility sector. This brief seeks to highlight the electricity pricing options that utilities and policy-makers can best use to help customers become more energy-efficient, both in near-term behavioral changes and in long-term technology investments. In the broadest sense, customer awareness of rising energy prices and the need to reduce carbon "footprints" provides a general set of signals to use energy more carefully. However, because of the issues raised earlier in this section, differences in price response between customer types and end-use markets call for a more focused assessment of the specific techniques most likely to produce desired reductions in peak demand, energy consumption, and CO_2 emissions.

Appendix C: Summary of Recent Dynamic Pricing Programs

Table C-1 summarizes five well-documented dynamic pricing experiments. (The table begins on page C-2.)

Table C-1. Summary of Recent Dynamic Pricing Programs

Program	Rate/ Price Type	Location	Customer Type/Load Size	Participants	Customer Incentive	Duration	Peak Demand Reductions	Energy Savings
California Statewide Pricing Pilot	CPP	Southern California Edison Service Area	Commercial/ industrial <20 kW	59 in 2004: 57 in 2005; about 33% accepted thermostats	Free installation of smart thermostat that automatically adjusts air conditioning setting in CPP periods	4 months x 2 years: June–October 2004 and 2005	<20 kW: Peak-period energy use fell 4.83%; with thermostats, savings rose to 13%	Savings calculated for peak hours only, not monthly or annual
			Commercial/ industrial 20–200 kW	83 in 2004: 76 in 2005; about 60% accepted thermostats			20–200 kW: Peak-period energy use fell 6.75%; with thermostats, savings rose to 9.57%	
Gulf Power Company—Energy Select	Price-responsive load management with CPP	Gulf Power Company service territory—northwest Florida	Residential	8,500	None—customers pay $4.95/month to participate in the program for the opportunity to save on their electric bill by purchasing electricity at prices lower than the standard rate 87% of the time	March 2000 to present	Summer peak reduction of 1.73 kW/home or 14.7 MW to date Winter peak reduction of 3 kW/home or 25.5 MW to date	Savings calculated for peak hours only, not monthly or annual
Ontario Energy Board/ Hydro One	Regulated Price Plan TOU rates	Hydro One service area	Residential, farm, small business under 50 kW	500	Real-time in-home display monitors for half the participants	5 months: May–September 2007	Peak load reductions averaged 3.7% With displays, impact averaged 5.5%	Annual energy savings averaged 3.3%; with displays, savings averaged 7.6%

Program	Rate/ Price Type	Location	Customer Type/Load Size	Participants	Customer Incentive	Duration	Peak Demand Reductions	Energy Savings
Ontario Energy Board—Smart Price Pilot	Regulated Price Plan TOU; TOU with CPP; TOU with critical peak rebate	Hydro Ottawa's service territory	Residential TOU scheduled to have smart meters installed prior to the start of the pilot	373 participants total: 125 in a critical peak rebate price group, 124 each in TOU-only and CPP groups	CPP participants: off-peak rate cut to 3.1 cents per kWh to offset critical peak price TOU with rebate participants: refund of 30 cents per kWh below baseline usage +$75 at end of pilot	7 months: August 2006–February 2007	Peak load reductions were: 5.7% for TOU-only participants, 25.4% for CPP participants	6.0% average annual conservation effect across all customers
Community Energy Cooperative—Energy Smart Pricing Plan	Hourly pricing pilot program; air conditioning cycling added as an option	Chicago	Residential	750 in 2003, rising to 1,100 in 2006	Cooperative provided outreach, education, information materials, high price alerts	2003–2006	Peak reductions up to 25% in first hour; greatest reductions through air conditioning cycling Peak reductions declined after first hour and over successive high-price days	Summer-month energy usage reduced 3–4%; no annual net usage impact reported

Sources: California Statewide Pilot: George et al. (2006); Gulf Power Company: comments from Ervan Hancock III, Georgia Power Company; Ontario Energy Board: Hydro One (2006); and Community Energy Cooperative: Summit Blue Consulting (2004).

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