CALIFORNIA
ENERGY
COMMISSION

FEASIBILITY OF IMPLEMENTING DYNAMIC PRICING IN CALIFORNIA

REPORT TO THE LEGISLATURE

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Gray Davis, *Governor*

CALIFORNIA ENERGY COMMISSION

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Disclaimer

This report to the Legislature on the Feasibility of Dynamic Pricing in California was prepared to satisfy the legislative requirement of Senate Bill 1976, (SB 1976, Torlakson, Chapter 850, Statutes of 2002) that requires the California Energy Commission, in consultation with the California Public Utilities Commission, to report to the Legislature and the Governor, the feasibility of implementing real-time, critical peak, and other dynamic pricing tariffs for electricity in California.

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Executive Summary

Introduction

In 1998, the utilities began to purchase electricity supplies in a deregulated wholesale market. The unexpected result was the California electricity crisis of 2000-2001, during which unusually volatile wholesale electricity prices and rotating outages led the Federal Energy Regulatory Commission (FERC) to place price caps on wholesale electricity.

In the spring of 2001, the Legislature made $900 million in emergency funding available to the California Energy Commission (Energy Commission), California Public Utilities Commission (CPUC), and the California Department of State and Consumer Affairs (SCA) to implement programs to save energy and reduce peak electric demand. California's electricity market stabilized in the summer of 2001, as these programs were successful in capturing over 5,500 megawatts in peak demand reductions.[1]

To build on successes from the emergency funding measures, the Energy Commission and the CPUC developed *An Action Plan to Develop More Demand Response in California's Electricity Markets* (Energy Commission Publication number 400-02-016F) in the spring of 2002. This document provided the blueprint for joint agency activities to encourage and support the development of permanent peak load reduction and customer demand response capability. In particular, the report called for increased price response capability in California and the implementation of dynamic rates.

In June 2002, the Energy Commission, the CPUC, and the California Consumer Power and Conservation Financing Authority (CPA) implemented a program to investigate, under CPUC Rulemaking 02-06-001, "advanced metering, demand response, and dynamic pricing." To date, Rulemaking 02-06-001 has produced two CPUC decisions: Decision 03-03-036, ordering the utilities to conduct a Statewide Pricing Pilot for small customers (under 200 kilowatts), and Decision 03-06-032, ordering the utilities to offer voluntary critical peak pricing tariffs to large customers (over 200 kilowatts).

In September 2002, the Legislature ordered the Energy Commission to report on the process for implementing dynamic pricing in California, Senate Bill 1976, (SB 1976, Torlakson, Chapter 850, Statutes of 2002). This report satisfies the requirements of SB 1976.

SB 1976 Legislative Requirements

Section 2 of SB 1976 directs the Energy Commission, in consultation with the CPUC, to report to the Legislature and the Governor regarding the feasibility of implementing real-time pricing tariffs for electricity in California.

Below we briefly address the seven legislative requirements set out in Section 2(b) of SB 1976. (More detailed discussion of these issues can be found in the body of the report.)

(1) How wholesale real-time prices would be calculated and made available to customers.

Real-time wholesale prices are expected to be determined and made publicly available by the California Independent System Operator (CA ISO) beginning in spring 2005. In the meantime, the Energy Commission, CPUC and utilities have designed several critical peak pricing tariffs and are currently working together to design specifications for a proxy real-time pricing tariff.

(2) Options for day-ahead and hour-ahead retail prices.

Two options being tested in the residential and small commercial Statewide Pricing Pilot include (1) critical peak prices with 4-hour notice and enabling technologies and (2) 24-hour notice without enabling technologies. The large customer critical peak pricing tariff offers day-ahead notification. The joint agencies are also sponsoring work to develop a real-time tariff with day-ahead notice of hourly prices.

(3) Options for facilitating customer response to real-time and critical peak prices and managing total customer costs, including, but not limited to, interval metering and communication systems, consumer-side of the meter notification, and automatic response equipment.

Beginning in 2001, California has implemented many options for facilitating customer response to real-time or critical peak prices:

- Over 33,000 new advanced meters cover over 20 percent of peak electricity use and allow customers Internet access to real-time energy use information.
- Phone and email notification systems have been developed to warn customers of high prices.
- New automated load control systems facilitate over 150 megawatts of energy use reductions from air conditioning and lighting systems in commercial buildings.
- Emergency peak reduction plans for commercial buildings have been created.

In addition, many existing demand response and automated technologies installed on both large and small customer end uses can be used to respond to dynamic prices.[2] Further facilitation of customer response can be accomplished through

customer education and technology subsidization. Additional options are expected to be assessed by the Energy Commission.

(4) An assessment of the options for a variety of customer classes, including, but not limited to, industrial, commercial, residential, and tenants of a mobile home park, apartment building, or similar residential complex, that receive electricity from a master-meter customer through a sub-metered system.

The Energy Commission and CPUC are currently pilot testing dynamic rates for industrial, commercial and residential customer classes and plan to use this analysis to identify the best metering options for each class. In a future update, the Energy Commission will investigate the feasibility of dynamic pricing in mobile home parks or apartment buildings that receive electricity from a master meter. If the analyses for these customer classes are favorable, these customers will also be provided a choice of dynamic tariffs.

(5) Estimates of potential peak load reductions, including the shifting of peak load demand to off-peak periods.

In July of 2003, the CPUC and Energy Commission adopted a goal of achieving peak savings from dynamic pricing tariffs and programs equivalent to 5 percent of the state's projected peak demand in 2007. Based on the results from pilot programs in other states and preliminary results from this summer's dynamic pricing test in California, we estimate that the peak reduction resulting from the introduction of dynamic pricing to all non-agricultural customer classes could yield peak savings between 5 and 24 percent of California's projected 2013 peak load. However, the agencies have decided it is premature to adjust the 5 percent goal upwards until the pilot tests of critical peak pricing rates are completed and more is understood about how generators might adjust their pricing strategies if the peak savings anticipated from these rates become a market reality. Plans to reduce the uncertainty in this range and integrate these savings with expected peak reductions from the recently adopted demand bidding programs, the CPA's demand response program and pilot real-time pricing tariffs are discussed later in the summary.

(6) Options for incorporating demand responsiveness into the wholesale competitive market and operations of the CA ISO.

California's energy agencies have worked together to develop demand response options that can be directly responsive to the needs of load schedulers at the wholesale level. The CA ISO has three years of experience with demand response products for the energy, non-spin, and replacement reserve markets, including demand bidding programs and the CPA's Demand Reserve Partnership. The CA ISO has been closely following the introduction of dynamic pricing at the retail level and should be able to easily incorporate the impact of dynamic pricing into its markets and operations. A more detailed analysis of these options is expected to be completed over the next year through the Statewide Pricing Pilot and large customer critical peak pricing tariff.

(7) Options for ensuring customer protection under a real-time, critical peak, and other dynamic pricing scenarios, including identifying potentially disadvantaged groups who may be disproportionately vulnerable to the impact of volatile prices and suggestions for effective safeguards for those customers.

Dynamic pricing can more accurately charge customers for their cost of service than do existing fixed rates. As a result, customers subsidized under current rates are most likely to pay more under dynamic pricing. In particular, any customer that uses more energy during peak periods than the average customer, and who cannot or will not shift their usage in response to price signals, is likely to pay more under dynamic pricing. Most customers should not be protected from paying the real cost of purchasing and delivering electricity to their homes. Truly “disadvantaged” customers, i.e., low income and medical necessity customers, could be provided with an explicit subsidy if the dynamic rates actually result in higher bills for them.

A fixed monthly charge for interval meters may increase bills for some low-usage customers. Options to ensure protection of these customers include the following:

- Require that the costs of new interval meters be recovered through volumetric energy rates rather than fixed charges.
- Provide customers below a certain usage level with a credit or subsidy.
- Do not provide interval meters to low-usage customers.

Next Steps

Based on our investigation of dynamic pricing to date, the Energy Commission recommends the following course of action:

1. Complete work on the existing Statewide Pricing Pilot for small customers and evaluate the impacts of critical peak pricing tariffs for large customers.
2. Continue agency collaboration to investigate the costs and benefits of deploying advanced interval metering systems (hereafter called “the business case analysis") and conduct customer education activities.
3. Develop and implement a plan to deploy advanced metering systems if the business case analyses of advanced metering systems prove to be favorable; e.g. if the benefits exceed the costs.

Background

Section 1 of SB 1976 reads as follows:

SECTION 1. The Legislature finds and declares all of the following:

(a) Californians can significantly increase the reliability of the electricity system and reduce the level of wholesale electricity prices by reducing electricity usage at peak times through a variety of measures designed to reduce electricity consumption during those periods.

(b) Dynamic pricing, including real-time pricing, provides incentives to reduce electricity consumption in precisely those hours when supplies are tight and provides lower prices when wholesale prices are low.

(c) The State of California, through Assembly Bill 29x (AB 29x, Kehoe, Chapter 8, Statutes of 2001), has already invested thirty-five million dollars ($35,000,000) in real-time metering systems for customers who consume greater than 200 kilowatts.

(d) Real-time pricing integrates information technology into the energy business, and creates new markets for communications, microelectronic controls, and information.

(e) Electricity consumption for air conditioning purposes during peak demand periods significantly contributes to California's electricity shortage vulnerability during summer periods.

(f) It is the intent of the Legislature to promote energy conservation and demand reduction in the State of California.

Given these legislative declarations, this report investigates the feasibility of implementing dynamic pricing in California by assessing, for a variety of rate, infrastructure and consumer issues:

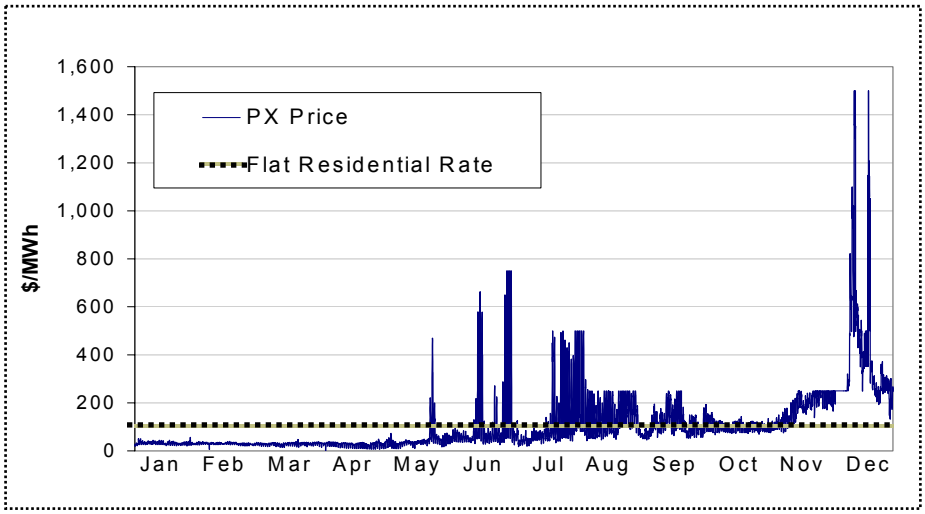
- Requirements for the implementation of dynamic pricing
- California status for each requirement
- Options for satisfying remaining requirements

Dynamic Pricing Rate Issues

California utilities have historically charged fixed average prices for electricity. In the residential sector, customers are served under inverted-tier default rates, which provide incentives to lower total monthly electricity usage by charging higher prices as monthly usage increases. Large commercial and industrial customers are generally served under time-of-use default rates, fixed rates which mimic typical daily cost variations. Neither of these fixed rates is capable of reflecting normal weather-related cost variations or unexpected price spikes.

Dynamic rates better reflect wholesale electricity costs by allowing “dispatchable” prices; i.e., prices that can be initiated on short notice to reflect real-time system or market conditions. **Figure 1** illustrates the divergence between average residential retail rates in the Pacific Gas and Electric (PG&E) service territory and wholesale market prices in 2000. A dynamic rate would be designed to more closely mimic this variation in prices. For example, under a critical peak pricing tariff, a predetermined price would be dispatched each time that some set price level or system indicator was reached. Under a real-time tariff, prices determined just one day or even one hour in advance would be used every hour.

Figure 1: 2000 California Power Exchange Prices vs. PG&E Residential Rate



Below we discuss some of the major policy issues related to dynamic rate design in California.

AB 1x Baseline Rate Limit

Assembly Bill 1x (AB 1x, Keeley, Chapter 4, Statutes of 2002), amended Section 80110 of the California Water Code to cap residential rates for customers with electricity usage at or below 130 percent of the baseline allowance. As written, this amendment may prohibit the CPUC from offering low usage customers the option of dynamic pricing rates, which by definition are not capped, even if the change would provide customers with lower monthly bills or more reliability. To give residential customers the option of choosing some form of dynamic pricing, which could still include some portion of their energy use being charged at the baseline rate, the provisions of this section of the Water Code may need to be modified to allow price variation under certain conditions.

Transparent Electricity Markets Required for Market-based Pricing

Implementation of market-based real-time rates would require public access to wholesale electricity prices. In the absence of a transparent source of wholesale electricity prices in California, the joint agencies have decided to use in the interim, estimates of wholesale electricity costs, such as critical peak pricing tariffs, and other factors as approximations for real-time tariffs. We anticipate that the CA ISO will restore public access to wholesale market prices in the spring of 2005.

Inequities of Average Pricing

Because the cost of delivering energy during peak periods is higher than the average rate, average pricing results in an income transfer from customers who use a lower proportion of their energy during peak periods to those who use a high fraction of their electricity on peak. Even time-of-use rates with demand charges do not accurately differentiate among customers with different costs of service. The Statewide Pricing Pilot and large customer critical peak pricing tariff will allow further investigation of the magnitude of these intra-class subsidies, before seeking to reform the average pricing policies that are likely to be defended by those customers benefiting from them.

Voluntary, Default, or Mandatory Tariffs

Customer inertia is likely to keep customer participation low for most voluntary dynamic rates. One way to overcome this barrier is to offer dynamic pricing as the default rate, with the option to switch to other rates. Evidence from recent studies suggests that default dynamic rates can benefit both customers and the system as a whole, in comparison to flat, voluntary time-of-use or mandatory time-of-use rates.[3]

Dynamic Pricing Infrastructure Issues

If California decides to move forward with dynamic rates, several system infrastructure issues must be resolved before implementation can begin.

Utility systems offering dynamic tariffs require advanced metering systems, which have interval storage and communications abilities. Interval metering is necessary to capture hourly or sub-hourly customer usage that can be matched with either critical peak or real-time prices. Communication capability is necessary to support the dispatch of pricing information and for retrieval of meter data. Utilities would also require enhanced billing and information systems to support the increased data processing needs of dynamic tariffs.

Advanced Meters in California

About 20 percent of peak load in California already runs through advanced meters thanks to AB 29x, which provided $35 million in funding for their installation at customer sites consuming greater than 200 kilowatts. These customers, located in both investor-owned and municipal utility service areas, all have the ability to participate in dynamic tariffs today.

The number of advanced interval meters installed in the small commercial and residential sectors is negligible. Perhaps the largest unresolved question before the energy agencies is whether economies of scale can justify a universal advanced meter and communications deployment in California. The Statewide Pricing Pilot (CPUC Decision 03-03-036) will be vital in making this decision.

Infrastructure Cost Recovery

The utilities must be assured of cost recovery for the advanced metering, communications and billing infrastructure necessary to support dynamic tariffs. The Energy Commission and CPUC are currently investigating different financing mechanisms. One important issue to be decided is whether meters would be paid for through volumetric charges or through a fixed monthly charge. Options will be identified in the utility business case analysis.

Dynamic Pricing Customer Issues

Resolving customer-related issues is critical to the success of dynamic pricing.

Customer Acceptance

Customer acceptance of dynamic rates is a function of three factors: (1) state and utility support for dynamic pricing, (2) customer education about the rate and methods of response, and (3) timely deployment of infrastructure upgrades.

To move forward with dynamic pricing, the state must work with utilities to design fair rates and help customers through the transition to dynamic pricing.

Implementing dynamic pricing tariffs would require educating customers about how dynamic rates more accurately correlate charges with costs. In addition, the vast majority of customers need to be informed of ways to modify their electricity usage patterns to achieve lower bills.

Finally, meters, communications and billing infrastructure must be installed well before the rate goes into affect, so customers can assess their own electricity usage patterns and determine how the new rate would affect their electricity bill.

Thanks to decades of experience with time-of-use rates, the success of the Flex Your Power customer education campaign launched in February 2001, and recent utility efforts to educate customers in the aftermath of the electricity crisis, many

Californians are already aware of daily electricity cost patterns. Customers with the over 33,000 advanced meters used in California are also familiar with their own electricity usage characteristics, and are likely to understand how these usage patterns relate to the daily cost variations they experience under time-of-use pricing.

To date, customer acceptance of default Critical Peak Price rate options in the Statewide Pricing Pilot have exceeded 25 percent, but it is premature to draw conclusions from this result given that the experiment must still run for another year. Nevertheless, this is promising given that analysts believe that achieving just 20 percent participation in each customer class would capture a sufficient level of demand response to create substantial benefits for all customers.

Customer Protection

Some customers would pay more for electricity under dynamic tariffs, while others would pay less relative to their current tariffs. Those most vulnerable to paying higher bills under dynamic pricing tariffs are customers who use a disproportionate amount of their total energy consumption during the on-peak period.

All customers should pay their cost of service, with the possible exception of low-income customers or those who require electricity as a medical necessity. Such customers could be provided explicit subsidies to support their fundamental needs for electric power as is currently provided through “life-line” rates.

Consumer advocates have argued that dynamic rates would harm low-usage customers. According to preliminary Energy Commission analyses, this is not necessarily the case. Using load data from customers using less than 350 kilowatt-hours per month, we analyzed two scenarios, one with a 5 percent shift in usage from on to off-peak, and another with no shift in usage. In both scenarios, the average low-use customer monthly bill was at least $1.00 lower under critical peak pricing than under existing tiered rates.

If meter costs are recovered through a fixed monthly charge that exceeds these rate savings, some low-usage customer bills will increase. Options to mitigate the potential harm to low-use customers are:

- Require that the costs of new interval meters be recovered through volumetric energy rates rather than fixed charges.
- Provide customers below a certain usage level with a credit or subsidy.
- Do not provide interval meters to low-usage customers.

A recent price elasticity analysis of California data from the National Bureau of Economic Research showed that low-income customers have higher price elasticities than the average customer.[4] This suggests that low-income customers would be more likely to shift usage in response to higher prices, and so more likely to benefit from dynamic rates.

Customer Notification, Response and Enabling Technologies

Customer response to dynamic pricing can be enhanced with technologies that receive price signals and automatically control end-uses according to either customer or utility specifications. This is particularly true for short notice events, such as hour-ahead price notification. These are referred to as "enabling technologies."

A concerted effort is being made under the Statewide Pricing Pilot to measure the level of price response that can be expected from small customers, with day-ahead or hour-ahead critical peak price notification, and with or without enabling technologies. Large customers on the critical peak pricing tariff will be given day-ahead notification of all events (increased pricing levels) by email or telephone.

Most existing load control technologies, such as air conditioning load control switches, can be used as is or reconfigured to respond to dynamic pricing. So despite the absence of widespread dynamic pricing tariffs in California, customer load control technologies are fairly common in certain areas, even in the residential sector.

In 2000 and 2001, the Legislature provided emergency funding for a broad array of technologies that could be used to respond to dynamic pricing. Assembly Bill 970 (AB 970, Ducheny, Chapter 329, Statutes of 2000), and Senate Bill 5x (SB 5x, Sher, Chapter 7, Statutes of 2001), provided a combined $50 million for the Energy Commission to oversee the installation of load control tools in commercial and industrial buildings. AB 970 also provided $10 million for 10,000 smart thermostats to control peak demand from residential air conditioning. During the Stage 2 event on July 3, 2001, these technologies combined to deliver over 150 megawatts of peak load reduction to help stabilize California's electricity grid.

Dynamic Pricing Market Issues

The CA ISO has four years experience in developing demand response programs. Since 1998, loads have been able to participate in the CA ISO's energy, non-spin, and replacement reserve markets. In 2000, the CA ISO demand bidding programs enrolled a few hundred megawatts of load reduction bids.

Currently, the CPA's Demand Reserve Partnership is considered part of the demand response program portfolio to be offered by investor-owned utilities. This program provides for direct participation by loads in the CA ISO markets for which they qualify.

Demand response stimulated by dynamic pricing can substitute for additional generation, enabling the CA ISO to balance supply and demand. The CA ISO has been closely following the introduction of dynamic pricing at the retail level and should be able to easily incorporate the impact of these programs into its markets and operations.

Benefits and Costs of Dynamic Pricing

Evidence from outside California indicates that dynamic pricing is cost-effective. Due to a lack of information in California, a full quantitative analysis of the costs and benefits of implementing dynamic pricing is not yet possible. This section summarizes the benefits and costs of dynamic pricing using a qualitative approach.

The Energy Commission, CPUC, and the CPA anticipate releasing a more detailed analysis of the costs and benefits of dynamic pricing at the conclusion of the CPUC's demand response proceeding in late 2004. This analysis will build on the analysis results from the Statewide Pricing Pilot for residential and small commercial customers and a similar analysis of the impact of offering critical peak pricing rates to large commercial and industrial customers.

Dynamic Pricing Benefits

A partial list of the expected benefits of dynamic pricing and related infrastructure requirements are listed below. Some of these benefits related to changes in rate design may not be achievable with the limits currently imposed by the Legislature on rate design and cost allocation.

Customer Benefits

- Dynamic tariffs are expected to reduce electricity prices by encouraging more efficient purchasing behavior and moderating the exercise of market power
- Customers can gain an understanding of their usage patterns with respect to costs, allowing them to make rational decisions to purchase more electricity, generate their own, or invest in energy-efficient equipment
- Dynamic tariffs better reflect the actual cost-of-service, allowing a more equitable distribution of costs across customers and customer classes
- Unlike conventional load control or curtailable/interruptible incentives, dynamic tariffs can be made available to all customers, regardless of overall usage level or appliance ownership

Utility and Regulatory Benefits

- Dynamic tariffs are expected to improve electric system load factors and reduce the costs of producing and delivering electricity
- Regulatory processes can be simplified and regulatory overhead costs lowered through a reduction in the number of customized tariffs and programs
- Dynamic tariffs simultaneously address the goals of both conventional tiered rates (conservation) and load management programs (load reduction or shifting)

Benefits of Advanced Metering and Billing Systems

- System reliability can be improved. Advanced metering systems allow the utility to locate and correct local outage problems more quickly, provide improved trouble-shooting capabilities, and aid planning for maintenance and upgrading. Detailed usage data allows for more efficient local and regional distribution system planning.
- Metering and billing costs can be reduced. An integrated electronic metering and billing system, less complex than that already used by the cellular telephone industry, could reduce the need for the cumbersome data management, processing, and billing systems still used by California utilities. The same equipment and database design can provide both electric and gas utilities with automation efficiencies that would reduce billing costs.
- Customer service can be improved at lower cost. An integrated metering and billing system could allow customers, and customer service representatives, instant access to historical and current usage data. Customer service representatives could more easily identify errors, resolve billing disputes, and help target available programs to the specific usage characteristics of individual customers. Integrated data would allow more useful and frequent energy usage feedback to customers.
- Regulatory costs could be reduced. The need for debates over equitable allocation of costs would be greatly reduced because information about individual customer usage could be factored into the rates from the start.

Table 1 on the following page developed by the Energy Commission illustrates that the advanced metering and communication infrastructure necessary to support dynamic tariffs can also support all other conventional tariff structures. The reverse is not true. Mass implementation of advanced metering systems would create customer choice opportunities, while retaining the current systems acts as a barrier to customer choice. Table 1 also identifies some of the utility and customer value-added applications and services that can be supported with advanced metering infrastructure, regardless of which tariff a customer might select.

Table 1. Meter Compatibility with Tariff Options and Applications

Rate Options	Standard Meter	Time-Of-Use Meter	Advanced Meter w/Communications
Inverted Tier Rates	Yes	Yes	Yes
Time-Of-Use Rates		Yes	Yes
Critical Peak Pricing			Yes
Real-Time Pricing			Yes
Other Dynamic Rates			Yes
Applications/Functions			
Utility Functions			
a. Automated Meter Reading			Yes
b. Outage Detection			Yes
c. Theft Detection			Yes
d. Load Survey			Yes
Customer Functions			
a. Customer Rate Choice		Some	Yes
b. Energy Information			Yes
c. Enhanced Billing			Yes

Source: California Energy Commission, 2003

Expected Peak Load Savings

Evidence from dynamic pricing tariffs in other states indicates that both short and long term demand reductions can be achieved from dynamic pricing. In the short-term (first few months or years on the tariff), customers simply change end-use operation patterns. In the longer-term, experience and automated equipment purchases lead to increased response.

Table 2 on the following page shows the results of our preliminary analysis of expected peak load savings for California. We assume that on-peak prices are 100 percent higher than off-peak prices and that 10 to 40 percent of the customers in each rate class are exposed to the dynamic rate, as given in Appendix Table A1. Elasticities used in the analysis are derived from studies in other states, as given in Appendix Table A2. A more accurate analysis will be conducted after elasticities for California customers are determined in the Statewide Pricing Pilot.

Table 2. Range of Peak Reductions Predicted from Price Response

	Dynamic Rates as Default		Voluntary Switch to Dynamic Rates	
	Low	*High*	*Low*	*High*
Short-Run Demand Response				
Total Megawatts (MW)	-2,200	-11,000	-2,100	-3,800
Percent of Peak Demand in 2013	-4.8%	-24%	-4.7%	-8.4%
Long-Run Demand Response				
Total Megawatts (MW)	-2,100	-6,900	-1,500	-5,200
Percent of Peak Demand in 2013	-4.6%	-15%	-3.4%	-12%

NOTE: All values rounded to two significant digits

DATA SOURCES: **Baseline Forecast of Demand:** California Energy Commission Natural Gas and Electricity Assessment; July 2003. **Customer Choice of Static or Dynamic rates:** California Energy Commission staff determinations based on preliminary results from the California Statewide Pricing Pilot and previous conjoint analysis of customer rate preferences. **Price Elasticities:** King and Chatterjee. *Predicting Demand Response in California*. Public Utility Fortnightly. July 1, 2003.

These preliminary results show that the short-term peak reduction expected during high-priced summer days from the introduction of dynamic pricing rates for all non-agricultural customer classes is between 4.7 and 24 percent of California's estimated peak load by 2013. The residential and small commercial customer share of these estimated peak savings range from roughly 15 to 25 percent with balance coming from medium to large commercial and industrial customers. The long-term peak reduction is estimated to be 3.4 to 15 percent of the projected 2013 peak load. The full magnitude of potential peak demand reduction is unlikely to be accomplished in the first few years after the tariff is introduced, but the overall peak savings found in the table above could be reached over the next decade if the business case analyses show that the deployment of advanced meters to some customers is likely to be cost beneficial.

Dynamic Pricing Costs

There are three main utility costs to implement dynamic pricing tariffs and programs. First, the investment costs to procure an advanced metering and information system is somewhat larger than the costs required by traditional accumulating meters and "shoe leather" networks of meter readers to collect this data. Second, there are new one-time-only and ongoing costs of the communications network that must be developed and maintained to communicate prices to customers. Third, the greater volume of data resulting from hourly or 15-minute interval measurements imposes larger data processing and storage costs on the utility. In addition, consumers themselves may bear some costs.

Cost of Advanced Metering and Information Systems

Advanced metering and information systems consist of three basic components.

- A meter that measures energy usage every 15 minutes or once an hour
- A communications system to retrieve usage data from the customer facility
- A confidential website for each customer, showing the usage data

The cost increment of an advanced meter over a traditional meter is in the tens of dollars and is quickly approaching zero. Telecommunication costs of meter reading can be highly variable, and are dependent upon: (1) the technology used; (2) the density of utility customers in a given geographic area; and (3) regulatory decisions about pricing and conditions of service for regulated telecommunication services. Website posting of usage data has become less costly in recent years and appears to be the wave of the future for all types of consumer billing and transaction data.

Significant economies of scale favor the mass deployment of advanced metering over sporadic installation, with or without widespread use of dynamic tariffs. Mass deployment not only reduces unit incremental costs, it provides an infrastructure that enables a range of beneficial utility and customer choice options that cannot be provided in any other way. Utility experience elsewhere indicates that many advanced metering applications can reduce costs and produce improvements in internal operating efficiencies sufficient to fully recover or substantially offset infrastructure upgrade costs.[5]

Costs of Communicating Prices to Customers

Utilities would incur some costs to develop systems that communicate dynamic prices to customers. These costs would be negligible were the dynamic prices simply posted to a website to which customers had access, as is done for the CA ISO Day-Ahead hourly price. At the other end of the spectrum, communicating a price signal directly to all or a selected number of customers through a dedicated network could be very costly.

Bill Processing Costs

Utility data processing costs would increase with the shift from one usage value per month to 744 hourly values or 2,880 15-minute values per month. Data storage and processing costs would increase and billing software must be upgraded.

Customer Costs

Dynamic pricing customers are likely to incur hardware and ongoing maintenance costs. Controls that respond automatically as prices change using pre-programmed decision rules can help the customer reduce their bills. The costs of such controls range from $50 to $150 per kilowatt for peak load shifted or reduced.

In addition, customers must devote some time and energy to making choices about different pricing options, investigating the hardware systems available to respond to

market prices, and selecting and installing the appropriate hardware. Some periodic attention to pricing patterns and adjustment of control systems may also be appropriate. For some consumers these “overhead” costs are not actual cash out-of-pocket expenses, but for many commercial customers, these activities have real opportunity costs.

The Net Benefits of Dynamic Pricing

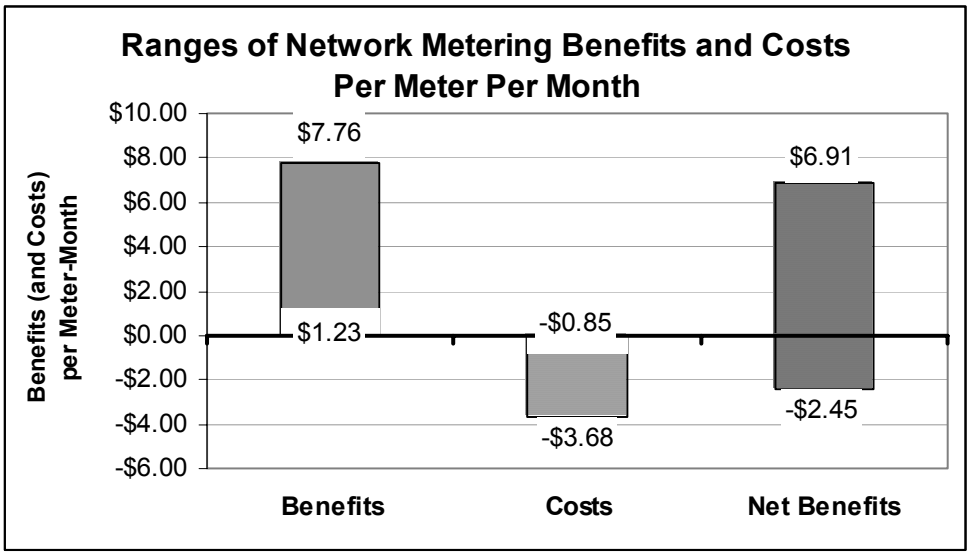
California experience with dynamic pricing is insufficient to determine the net benefits of dynamic pricing at this time. More is known about the advanced metering systems that make dynamic pricing possible.

Figure 2 on the following page shows ranges of the monthly costs and benefits of outsourced advanced metering systems, compiled from several utility business case studies. These results include the benefits of advanced metering systems to field services, administration, customer service, and system operations. They do not include the benefits of price response.

The labels on each of the bars in Figure 2 indicate the highest and lowest values found across all of the studies. Note that the lowest estimate of benefits is within the range of costs, while the highest estimate far exceeds it. According to this study, overall net benefits of advanced metering systems, excluding price response, may be positive or negative. One of the major goals of the Statewide Pricing Pilot is to determine whether the addition of price response benefits makes the net benefits of advanced metering systems unequivocally positive.

The second phase of CPUC R.02-06-001 will investigate the costs and benefits of advanced metering systems including dynamic pricing.

Figure 2: Metering Costs and Benefits, Excluding Price Response



Source: California Energy Commission, 2003

Ongoing Activities Supporting Dynamic Pricing

Several activities are in progress that will either add to the growing body of knowledge about dynamic pricing or help fund the required infrastructure.

Advanced Metering, Demand Response and Dynamic Pricing Investigation

In August 2002, the Energy Commission opened the Demand Response Proceeding Order Instituting Rulemaking (Commission Docket Number: 02-Demand Response-01) shortly after the adoption of CPUC R.02-06-001. Under these rulemakings, the agencies agreed to work together to pursue three main policy goals:

- Achieve more price response from customers by developing new dynamic tariffs and offering customers a choice of tariff forms
- Achieve more demand response savings from customers through well-coordinated programs
- Reduce economic and environmental costs of meeting California's peaks through a combination of pricing and demand response programs

The results of this process to date include the Statewide Pricing Pilot for residential and small commercial customers, and a Critical Peak Pricing tariff for large customers, as described below.

The Statewide Pricing Pilot for Residential and Small Commercial Customers

Decision 03-03-036 ordered the investor-owned utilities to conduct a "Statewide Pricing Pilot" to test critical peak pricing tariffs and supporting control technologies for residential and small commercial customers. This pilot was formulated to gather information on the magnitude of customer price response, the impact of automated controls equipment on household peak demand, the impact of information and feedback on household peak demand, and customer acceptance of and preferences for different types of dynamic rates. The pilot commenced in July 2003 and is scheduled to end in December 2004.

Critical Peak Pricing Tariffs for Large Commercial and Industrial Customers

In Decision 03-06-032, the CPUC authorized the development of new critical peak pricing tariffs for large commercial and industrial customers. Customers were allowed to sign up for these tariffs beginning August 2003. The goals are to recruit up to 1,000 customers in each of the major service territories and to achieve a peak demand reduction capability of up to 330 megawatts by the end of 2003.

The Energy Commission is hopeful that tariffs and programs adopted in CPUC Decision 03-06-032 will result in a significant response in 2003 and will then continue to grow through time. The Energy Commission, CPUC, and CPA have asked the investor-owned utilities to achieve a peak savings goal equivalent to 5 percent of system peak load through the deployment of price response tariffs and programs by 2007. This would be about 2,500 MW on a statewide basis. The CPUC has directed the large investor-owned utilities to achieve this goal using the tariffs and programs adopted in Decision 03-06-032, further efforts for these large customers, and appropriate initiatives that will be developed once the Statewide Pricing Pilot project has been completed and the results have been evaluated.

Public Interest Energy Research

The Energy Commission's Public Interest Research (PIER) Program has initiated a number of program activities for better linking Research, Development, and Demonstration (RD&D) with the development of standards and regulations. For the implementation of dynamic pricing, PIER is undertaking activities to achieve the following:

- Fill information gaps that currently exist around dynamic pricing programs.
- Evaluate appropriate emerging technologies necessary to make dynamic pricing programs more readily feasible.
- Initiate RD&D programs to lower the implementation costs.

These efforts are currently under way.

State-Funded Advanced Meters

In 2001, AB 29x provided $35 million from the state General Fund for the Energy Commission to equip all large customers (greater than 200 kilowatts) with advanced metering systems. The Energy Commission chose automated meter reading systems capable of recording 15 minute interval data. The meters also had the ability to remotely communicate data to the utilities, such that each customer could view daily load data on a secure website. Customer accounts that did not already face time-of-use prices were converted to a time-of-use rate.

Preliminary results from customer interviews indicate that some customers are using the meter data and websites to optimize energy use and plan for efficiency improvements. Utilities reported substantial increases in website access during Stage 2 emergencies in the summers of 2002 and 2003. Several multi-site customers have requested additional meters for their facilities using less than 200 kilowatts.

Load data from 1999-2002 have just recently been provided by one of the three investor-owned utilities. Results of the forthcoming analysis are expected in the fall of 2003. The Energy Commission is currently pursuing acquisition of this data from the other two utilities. Meter data from 2003 will not be available until early 2004.

State-Funded Control Technologies

AB 29x and SB 5x provided substantial funding for the installation of demand response hardware in large commercial buildings, facilitating over 150 megawatts of peak demand reduction. A large residential pilot test of 10,000 smart thermostats was also funded under AB 29x. Customers participating in these hardware demonstrations are knowledgeable, able to participate in dynamic pricing tariffs and programs, and represent a resource the state can use if reserve margins reach dangerously low levels.

Federal Activities

Recent Federal Energy Regulatory Commission (FERC) decisions support:

- Development of demand response as a feature of electricity markets.
- Adoption of tax credits for utility investment in advanced metering systems.

FERC pronouncements about the benefits of demand response have not resulted in specific programs and tariffs, and existing tax incentives extending through 2006 may not cover the meters under consideration in California.

Next Steps

Recommendations

We recommend a three-step process to achieve the goal of providing all customers with a choice of dynamic rates.

1. **Complete Work on the Existing Pilot Test for Small Customers and the Evaluation of Critical Peak Pricing Tariffs for Large Customers.**

   The Energy Commission, CPUC, and the CPA should continue to work together with the investor-owned utilities to complete the statewide pilot test and evaluation of new critical peak pricing rates for large customers, analyze the data, and disseminate the results to key stakeholders, including the Legislature. These results will be critical in helping to resolve the issues discussed earlier in the report and developing the best strategy to deploy these rates to some or all ratepayers.

2. **Continue Collaboration and Conduct Customer Education Activities.**

   The collaboration exhibited in the current proceedings should continue to analyze the costs and benefits of dynamic pricing for those classes of customers that already have advanced metering systems. Phase 2 of the rulemaking should continue to pursue development of the business case for advanced metering and shoring up the states' emergency demand response program and tariffs.

3. **Deploy Advanced Metering Systems if Business Case Analyses are Favorable**

   California's investor owned utilities are expected to complete their analysis of the business case for using advanced meters in 2004. The joint energy agencies will then review these analyses and decide whether and how to deploy the advanced meter systems. These results should be presented to the Legislature along with an offer to help craft legislation that should guide the deployment of metering systems found to be cost beneficial for the customers of investor-owned and municipal utilities. A substantial educational effort targeted at residential and small commercial customers should be designed and undertaken in 2005 if the business case analysis proves favorable.

   During the implementation stage, care should be taken to ensure that all customers have access to new information about their own electricity usage patterns and the prices they pay. This information has already proven to be very valuable for businesses that have installed interval meters over the last three years. Distribution companies should also provide customers with tips on how they can adapt their usage patterns.

APPENDIX: Peak Savings Analysis

Table A1. Rate Choice Assumptions: Fraction of Each Class on Each Rate by the Year 2013

Customer Class	Flat or Inverted Tier	Time of Use	Critical Peak Pricing	Hourly Real-Time Pricing
Residential				
Low case	85%	10%	5%	NA
High case	50%	30%	20%	NA
Small Commercial				
Low case	70%	20%	10%	NA
High case	50%	20%	30%	NA
Medium and Large Commercial				
Low case	30%	30%	30%	10%
High case	10%	30%	20%	40%

Table A2. Range of Price Elasticities by Customer Class

	Short-Run		Long-Run	
	Low	*High*	*Low*	*High*
Residential	-.15	-.4	-.3	-.8
Small Commercial	-.05	-.4	-.2	-.8
Medium & Large Commercial	-.15	-.4	-.3	-.6
Industrial-Critical Peak Pricing	-.1	-.3	-.3	-.5

NOTE: Most of these price elasticities were estimated from customer response to time-of-use rates. Very little information is available on customer response to critical peak prices.

DATA SOURCES: Reiss P.C. and M.W. White. *Household Electricity Demand Revisited*. National Bureau of Economic Research, Working Paper 8687, December 2001; King, C. and Chatterjee. *Predicting Demand Response in California*. Public Utility Fortnightly. July 1, 2003.

Endnotes

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[1] Governor's Conservation Team *, Summer 2001 Conservation Report (California State and Consumer Service Agency: February 2002) * The Governor's team included authors from the California Energy Commission, California Department of Consumer Affairs, California Power Authority, California Public Utility Commission, California State and Consumer Services Agency, and the Department of Water Resources

[2] Case studies of automated control technologies that were installed by customers as part of the California Energy Commission's Peak load reduction program to reduce their peak usage can be found at www.ConsumerEnergyCenter.org/enhancedautomation

[3] Charles River Associates (CRA). *Economic Analysis of Time-of-Use Pricing for Residential Customers*. Ahmad Furuqui and Stephen George, principal authors. December 2001.

[4] Reiss, P. C and M.W. White. "Household Electricity Demand Revisited" (NBER Working Paper 8687, December 2001)

[5] Levy Associates. Advanced Metering Scoping Study. California Energy Commission, Sacramento, CA. August 2001.