BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking on the Commission's Own Motion to Conduct a Comprehensive Examination of Investor Owned Electric Utilities' Residential Rate Structures, the Transition to Time Varying and Dynamic Rates, and Other Statutory Obligations.	RULEMAKING 12-06-013 (FILED JUNE 21, 2012)

RESIDENTIAL RATE DESIGN PROPOSAL OF ENVIRONMENTAL DEFENSE FUND

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Enclosed, please find the Residential Rate Design Proposal of Environmental Defense Fund, filed pursuant to the March 19, 2013 Administrative Law Judge's Ruling Requesting Residential Rate Design Proposals and the May 9, 2013 email from Administrative Law Judge Jeanne McKinney requiring proposal submissions by May 29, 2013.

Respectfully submitted on this May 29, 2013, New York, NY

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Residential Rate Design Proposal

Environmental Defense Fund

Order Instituting Rulemaking on the Commission's Own Motion to Conduct a Comprehensive Examination of Investor Owned Electric Utilities' Residential Rate Structures, the Transition to Time Varying and Dynamic Rates, and Other Statutory Obligations, R. 12-06-013.

May 29, 2013

Our mission

Environmental Defense Fund is dedicated to protecting the environmental rights of all people, including the right to clean air, clean water, healthy food and flourishing ecosystems. Guided by science, we work to create practical solutions that win lasting political, economic and social support because they are nonpartisan, cost-effective and fair.

The complete report is available at www.edf.org

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Executive Summary

California's current tiered residential rate structure was put in place – and has evolved over time – to address California's energy crisis, support low-income ratepayers and promote environmental and other goals. The current rate structure, however, is no longer the best means of accomplishing these, or other state-wide policy goals. With the near universal deployment of smart metering infrastructure, time-variant tariff structures that more closely align with cost causation and marginal cost principles can now be adopted. Rates that provide price signals reflecting the cost of production, which current flat rates cannot, harvest the environmental and economic benefits of California's smart metering investments.

EDF has found, through analyses detailed below, that updating the current structure by phasing in Time-Of-Use Rates (TOU) and a menu of Time-Varying Rates (TVR) and dynamic rate options will result in dramatically lower system costs, more efficient usage of electricity, lowered peak demand, more accurate and effective conservation incentives, and more equitable sharing of energy system costs.[1] Specifically:

- ***TOU Will Dramatically Lower System Costs.*** EDF's analysis estimates that if half of the IOUs' residential customers voluntarily adopt the TOU currently offered by their utility, reductions in peak demand each year would reduce total utility costs by a $113 million (6 percent) in PG&E's service territory, $357 million (15 percent) in SCE's, and $2.6 million (1 percent) in SDG&E's (Table 3, Exhibit A.1).[2] If translated directly into savings for residential electricity customers, rates could be reduced significantly: a roughly 15% rate decrease would be enjoyed by all customers if the SCE program were adopted by half of the residential customers.
- ***TOU Will Avoid Adverse Environmental Impacts.*** TOU will: (1) reduce the need for last-in-the-supply-line peaker plants which tend to be fossil fueled, least efficient, most expensive to operate and among the most polluting resources on the system, (2) reduce the environmental impacts of siting, operating and building power and transmission lines (which would no longer be needed), (3) help to facilitate flexible load management to integrate variable renewable resources, and (4) avoid investments in large scale centralized fossil generation.
- ***TOU Will Attract Clean Energy Investments for Residential Consumers***. TOU will spur innovation in the electricity marketplace, promoting the development of new services and technologies that enable utilities and ratepayers to better manage electricity production

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[1] *See* Comprehensive Examination of Residential Rate Structures, R. 12-06-013 at 5 n.5 (issued June 6, 2012)(OIR, final decision).

[2] The large value and percentage differences amongst the IOUs is an artifact of the significant difference in TOU price ranges in existing programs. EDF estimates that PG&E and SDG&E would save 15% and 13%, respectively, on total marginal costs of half of their customers adopted SCE's TOU rate structure, and total system savings would be $686 million. *See infra* Table 3 & 5, Exhibit A.1.

and consumption through distributed, resilient, clean, low-cost and best-fit energy services and products.

- ***Customers are Signalling Readiness for TOU.*** A recent survey of nearly 5,000 customers by PG&E and So Cal Edison found that 75 percent have tried shifting their energy use already – even though they receive no financial rewards to do so. A sizeable group of customers also said they would be willing to risk higher bills for the chance to realize bill decreases, with over 70 percent of respondents saying they would consider switching. This willingness, strongly suggests that, with appropriate education and incentives, ratepayers (and their service providers) will be well-poised to: (1) take advantage of information from digital electricity meters and automated "set-it-and-forget-it" learning thermostats, (2) to employ best practices, (3) be a part of a cleaner, more efficient energy system while (4) reducing their own energy bills.

Clearly, in the face of these savings and benefits, California's current rate structure leads to higher system costs, inflated consumer bills, negative environmental consequences and hinders innovation and investment in clean energy products and technologies. ***Given the investments that Californians have made to enable TOU, the lost opportunity costs of ignoring the power of TOU are unacceptably high.*** Thus, the Commission should immediately launch universal implementation of default TOU rates, as it is best for consumers and the environment. EDF believes that carefully transitioning to default TOU with a two-phased strategy is the best step forward as summarized below and discussed in more detail in the body of this proposal:

- For Phase I, EDF proposes rates that are time varying simply at first, with peak, off-peak and super off-peak price windows, and with a plan adjusting the timing of peak rates at each general rate case or, perhaps, more frequently.[3]
- Phase II would offer a menu of opt-in options as alternatives to default TOU. The end result of EDF's proposed transition strategy will be to provide customers with choices that will meet their needs. This menu is envisioned to provide all customers other than medical baseline and third-party notification customers with a default marginal cost-based TOU rate.[4] CARE customers who did not opt into TOU during the first phase of the transition would thus be defaulted into TOU rates in this second phase.
- A move to widespread residential class adoption of TOU and more dynamic pricing should be implemented through a rollout schedule that includes consistent, high-quality, customer education and enablement programs. The CPUC should plan now for the collection of data that enables IOUs, the Commission, and other stakeholders to evaluate

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[3] Key attributes of EDF's proposal are listed below in Table EX .1. Notably, EDF supports a design with both a super-off peak rate that is at least 20% below the current tier 1 rate and a small peak rate window (see Exhibit A.2). We suggest a three-hour peak from 4 pm to 7 pm based on our study of service territory historical hourly load for PG&E and SCE (see Exhibit B).

[4] The rationale for not defaulting medical baseline and third-party notification customers is provided in further detail below.

the efficacy of rate structures and to modify policies and programs. The refinement of TOU and, indeed, all rates and associated CPUC and IOU programs should be an ongoing, adaptive process with specific, measurable, time-specified objectives, appropriate metrics to evaluate progress, and a clear game plan for adjustments as we learn together. In this respect, EDF urges that, alongside a set of TVR rates and supporting programs, the Commission adopt robust metrics and associated performance indicators and incentives that accompany the transition to TOU.

Introduction

TOU rate structures provide benefits that the current rate structure cannot. EDF believes that a transition to TOU must, however, be done in a thoughtful manner. As a result, EDF recommends a phase-in to TOU rates that will lead to their widespread adoption and acceptance. This proposal details a proposed TOU rate structure and associated transition period in the following four primary sections:

- Part I provides relevant theory and evidence, which supports the conclusion that a TOU rate structure is preferable to the existing structure; and the current rate structue does not meet California's energy policy goals or the Commission's ratemaking principles;
- Part II provides EDF's proposal for a TOU rate structure;
- Part III lays out an implementation strategy that relies on a two-phased transition, including an adaptive management research plan to monitor progress in transitioning customers to TOU;
- Part IV presents a list of criteria, in addition to the Commission principles, that EDF proposes to use in evaluating rate proposals submitted by stakeholders.

I. Why TOU Rate Structures are Superior to the Existing Tiered Rate Structure: Theory and Evidence

The existing tiered rate structure does not meet California's efficiency, environmental, and consumer objectives. As discussed below, theory and evidence show that a TOU rate is a superior delivery system to meet California's objectives more effectively, efficiently and comprehensively. Compared to the existing tier structure, TOU rates can dramatically reduce system costs, avoid cross-subsidies, improve environmental outcomes, and create new opportunities for ratepayers - including low income ratepayers - to shift electricity use from high- to low-cost times of day.

The theory and evidence presented here uses the analystical frames of (1) economics and behavioral science and (2) CPUC rate design principles. The theory and evidence supports a transition from the current system to TOU (and ultimately, greater use of TVR and dynamic) rate structures.

A. Economic and Behavioral Science Rationale: Theory and Evidence

Meeting peak demand for short time periods is not cost effective because it requires that the electricity system be sized to accommodate ocassional peaks, triggering the use of the least efficient, most expensive generation resources to meet peak load. Both equity and efficiency demand that marginal cost-based pricing be used to address the high marginal costs of peak demand.

While a TOU rate may not be a perfect match for a minority of customers, the many limitations of the current tiered system makes it far less ideal for all customers. The current tiered rate structure is systemically flawed and inequitable: everybody subsidizes high peak energy users, and all customers must incur the high costs of peak load. The current structure does not communicate price signals to customers in a clear or actionable fashion. Furthermore, while current rates are strucured to work with net energy metering (NEM) to inspire investments in self-generation (for the few who can afford it), this approach to NEM is not sustainable at the scale California hopes to achieve to meet state goals. A TOU rate better enables these goals, with theory and evidence indicating that (1) consumers want and are able to act as empowered decision makers, (2) well structured TOU can protect customers and provide system benefits, and (3) system transparency is desirable.

Consumers as Empowered Decision Makers. Californians have consistently seized on opportunities like TOU rates to save money and reduce their environmental footprint. This is amply demonstrated by the success of Commission-authorized energy efficiency and renewable programs, as well as dozens of pilots demonstrating notable consumer response to time- or environmentally-based electricity tariffs. Energy efficiency, renewable, and pricing/education successes are well documented, including rapid absorption of fluorescent light bulb technology, full subscription in solar incentive programs, and substantial responses to FlexAlert and 20/20 programs geared towards obtaining quick reductions in electricity use when needed to avoid outages.

A recent survey of nearly 5,000 customers by PG&E and So Cal Edison found that 75 percent have tried shifting their energy use already – even though they receive no financial rewards to do so. A sizeable group of customers also said they would be willing to risk higher bills for the chance to realize bill decreases, with over 70 percent of respondents saying they would consider switching.[5] This willingness, combined with thoughtful policies – such as bill protection that prohibits bill shocks for up to one year after a customer changes rate plans, and the ability to opt-out required by S.B. 695[6] – strongly suggests that, with appropriate education and incentives, ratepayers (and their service providers) will be able to take advantage of information from digital electricity meters and automated "set-it-and-forget-it" learning thermostats, to employ best practices, and to be a part of a cleaner, more efficient energy system while reducing their own energy bills.

It is important to acknowledge the limited extent to which customers understand and (are able to) respond to the existing tiered rate structure. Evidence suggests that ratepayers do not have a sophisticated understanding of current tiered tariff structures, and almost certainly do not know when their cumulative use in a given month triggers the implementation of the next pricing tier.[7] Likewise, research indicates that customers do not conserve more in response to tiered pricing, but are currently responding mostly to their total monthly bill. From this perspective, energy users' connection with tiered tariffs is essentially inert and motivated, if at all, by a general understanding that the less a household uses, the less it pays – not by the tiered system.[8]

Conversely, there is ample evidence that ratepayers respond well – through both conservation and shifting time of day – when their bills change in understandable and actionable ways, particularly when paired with education and attractive, accessible, technology.[9] At the same time, experience validates the common sense understanding that energy users don't like unpleasant bill surprises, but will change their behavior, or adopt new technology, if presented

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[5] Hiner & Partners, Pac. Gas & Elec., S. Cal. Edison , & San Diego Gas & Elec., *RROIR Customer Survey Key Findings* 11, 43 (April 16, 2013).
[6] Cal. Pub. Util. Code § 745 (West 2013).
[7] *See* Koichiro Ito, *Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing No. WP210*, *in Energy Institute at Haas Working Paper Series* 27 (revised October 31, 2012), http://ei.haas.berkeley.edu/pdf/working_papers/WP210.pdf.
[8] *Id.*
[9] This technology could include but is not limited to: advanced automatic load control devices, colorful signals that remind ratepayers to shift their load to take advantage of lower cost periods, and devices and practices that will not be fully developed until the right pricing structures are in place, such as precooling on peak demand afternoons paired with intensive weatherization and rooftop PV generation, and financing mechanisms that front load benefits for customers and remove the need for them to dynamically respond (e.g., set it and forget it).

with the right incentives, or reasons, to do so. For some customer segments – such as renters – TOU could actually increase their ability to reduce electricity expenditures, since TOU rates offer an additional powerful mechanism (e.g., shifting) to achieve those goals.

Structuring TOU to Protect Customers and Create System Benefits. By structuring rates in a way that better reflects underlying costs, households are able to save money by shifting their consumption to lower-priced, less polluting times. That, in turn, acts to flatten load, and significantly reduce overall service costs for everyone. Additional EDF analysis (Exhibit A.2) indicates that if the TOU on-peak period is just two hours – which would be sufficient to clip the most expensive demand, particularly related to having to plan capacity for infrequently occurring weather-related spikes – peak prices would have to be quite high to cause adverse bill impacts. For example, given an off-peak price of $0.15/kWh, a two hour peak window would have to reflect charges in excess of 40 cents, compared to $0.32/kWh for the four hour peak window, to maintain the same bill as under existing tiered rates, *assuming energy users do nothing to change their demand at all.*[10]

Currently, existing voluntary on-peak TOU are $0.35/kWh for PG&E, which could likely be accommodated without significant bill impacts for most ratepayers, within a three hour peak window. They are $0.51 for SCE, which would require some shifting in order to result in no bill impacts, or actual savings, if adopted widely. Off-peak rates are $0.15/kWh for PG&E – matching the example above – and $.09 per kWh for SCE, which, along with the high peak rates for that utility, gives customers a strong incentive to shift their load off-peak.

Under TOU, the more shifting a customer engages in, the lower their bill. However, under a smaller peak window or shallower ratios of peak to off-peak prices, shifting has less of an impact on monthly energy bills. As the peak period is extended, being able to shift away from peak time usage results in greater decreases in energy bills. For example, if the peak price is twice as expensive as the off-peak price (i.e., ratio equals two), under a four hour peak window, 30% shifting results in almost twice as much bill reduction (relative to no shifting behavior) as under a two hour peak window.

Unfortunately, the ability of a household to shift between time periods decreases as the peak window increases: large shifting behavior is less likely under a four hour peak window than under a two hour peak window. In the end, the amount of shifting that would occur under a TOU schedule depends on the ability of the household to change their behavior. The IOUs can significantly influence shifting behavior by increasing education and helping individuals adopt set-it-and-forget-it technologies to help shift consumption across hours.

[10] 15 cents is illustrative; the result of this analysis holds for different off-peak prices.

Quite significant system benefits can be derived from TOU (see Exhibit A.1) without creating any bill impacts on average residential customers, depending on how the rate is structured in terms of price and period lengths. In fact, the large majority of customers are likely to be structural winners if widely adopted TOU reflect shallower peak-off-peak differentials than is currently offered by SCE, along the lines of PG&E's voluntary rate.

System Transparency is Desirable. Economic theory indicates that consumers need transparent information about products and services – particularly about prices – to make good purchasing decisions.[11] While electricity in California is provided predominately through investor-owned utilities, ratepayers face the same need for clear information related to energy use as they do for any other purchase, such as how one plan their meal purchases at the grocery store. Given the social and environmental consequences of energy production, pricing that reflects economic, social, and environmental costs is especially important to enable consumers to make fully informed choices.[12]

For prices to be most effective in enabling good purchasing decisions they must be seen easily. Information must be salient in terms of the cost per kWh at a given point in time and place, and how much is being used. Transparent electricity pricing requires that, to the extent possible, consumers know the cost of each kWh unit of electricity they use.[13]

Since the underlying cost of delivering electricity varies significantly by time and place, economically optimal rates - those that make the system most cost-effective - would reflect similar variation. However, given the challenges - political, analytical, and technological - of reaching that goal at this time, at minimum the Commission should set kWh prices that differ by time of day and season.

B. Commission Rate Design Principles

The CPUC has defined a set of principles for judging proposed tariffs in this proceeding. These principles support TOU rather than tiered rates. Each of these principles is discussed in turn below.

1. **Low-income and medical baseline customers should have access to enough electricity to ensure basic needs (such as health and comfort) are met at an affordable cost.**

S.B. 695 requires medical baseline customers and third-party notification customers remain on a non-TOU rate. However, for medical baseline and low-income customers that opt-in to a TOU

[11] Andreu Mas-Colell, Michael D. Whinston & Jerry Green. *Microeconomic Theory* 20 (1995).
[12] T. H. Tietenberg, *Environmental and Natural Resource Econoimc* 67 (5th ed. 1999).
[13] W. Nicholson, *Microeconomic Theory: Basic Principles and Extensions* 245 (7th ed. 1998).

rate will enjoy more affordable electricity service than the current rates for several reasons. The information required to optimally respond to electricity costs is lower under TOU rates because they are much simpler to understand than tiers. Even if the consumer does not know the relative prices at different times of day, only knowing that it is more expensive to utilize appliances at certain points of the day provides more information than a tiered rate structure. It also does not require the use and understanding of smart meter data by customers. As a TOU price signal is much clearer and expressed numerically, even those who are less informed or are non-English language speakers are able to make more efficient and optimal decisions. More transparent information leads to better decision making, and a greater amount of conservation. These benefits hold true for all other customers, including low-income customers.

TOU provide three different methods for ratepayers to reduce their monthly electricity bill while tiered rates essentially provide two. Under tiered rates, individuals can either (a) reduce their consumption or (b) invest in more efficient appliances, the latter of which requires access to capital or credit. TOU rates similarly present these incentives to conserve or invest in efficiency, but also provide an extra method to reduce electricity bills by (c) shifting electricity use to less expensive times. With little added information, all households can shift between peak and off-peak times under TOU rates, consequently reducing their monthly bill.[14]

TOU comes with additional legal protection. S.B. 695 requires at least one year of bill protection, during which time consumers will be able to see how their actions impact their electricity costs while shielding them from higher electricity bills. At the same time that some consumers will be able to benefit from TOU immediately by seeing their conservation actions result in a lower electric bill, other customers will have to contribute to achieve CPUC-ordained IOU “revenue sufficiency”. The long term implications provide further support, as the need for revenue will decline, thereby saving all customers their share of the avoided system costs.[15]

Some stakeholders have expressed concern that certain classes of customers, such as medical baseline and third-party notification customers – those most in need of stable electricity costs, rather than responsive energy costs – will not benefit from TOU rates. While all customers would share in the system-wide savings associated reducing peaks (see Exhibit A.1), TOU may not be appropriate for these customers. Indeed, these customers (medical baseline and third-party notification customers) are not legally allowed under S.B. 695 to be defaulted into TOU.[16]

In regards to low-income households, providing an extra path to reduce electricity bills under TOU prices by shifting from peak to off-peak times may be a particularly important asset, as

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[14] P. Fox-Penner, *Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities* 43 (2010); Herter Energy Res. Solutions,*SMUD's Residential Summer Solution* 4-5(Feb. 2012).
[15] This latter benefit cannot be depicted in the IOUs bill calculators developed for the RROIR.
[16] S.B. No. 695, ch. 337, sec. 6, § 745(d)(2), 2009 Cal. Legis. Serv. (West)(codified at Cal. Pub. Util. Code § 745(d)(2)).

these households have less ability to invest in clean energy improvements (such as installation of solar panels or weatherization) due to split incentives and/or diminished access to credit or capital. In fact, low-income households would have the opportunity to financially benefit more than rich households by switching between expensive and cheaper times, given the larger impact that each dollar saved has on household budget.[17] It is important to note that this will not require turning off air conditioning on hot days – but rather using programmable thermostats to precool the house – and avoiding unnecessary electricity use during peak times.

Lastly, in regards to CARE, the program subsidy currently applies through the tiered sytem. The fact that the subsidy is deployed in this way currently does not, however, make tiers a superior delivery mechanism. Rather, an equally significant discount could be applied under any rate design, including TOU. In the long term – as TOU become the norm and it meets metrics for customer participation – it would thus make sense for CARE customers to default into a TOU with similar subsidy, education, and enabling technologies. Acting otherwise would prevent this class of customers from enjoying the TOU benefits discussed above.

2. Rates should be based on marginal cost

TOU pricing reflects marginal costs much better than tiered pricing. There is extensive, unequivocal evidence demonstrating that electricity service costs vary over the course of the day, week, and season. Most recently, California's IOUs noted this cost variation as part of routine General Rate Case inquiry.[18] In a graphical example, PG&E noted how costs vary with a graphic in their proposal for time-dependent valuation to calculate the value of distributed energy resources.[19]

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[17] Stephen Morris, Nancy Devlin, & David Parkin, *Economic Analysis in Health Care* 153 (2007).
[18] *See infra* Exhibit A.1.
[19] Pac. Gas & Elec., *Time Dependent Valuation (TDV) Economics Methodology* 8 fig. 1 (2002), http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/tdv/TDV_ECON_METHOD_EXTRACT.PDF.

Extract of March 18, 2002 Report

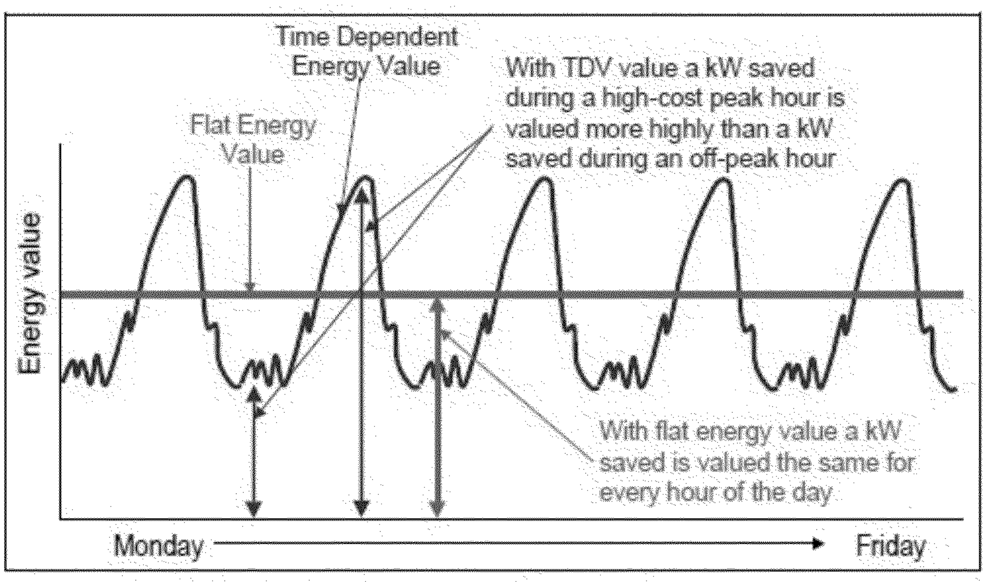

Figure 1 - TDV Costing Compared to Flat Costing – summer weekday

Fully marginal cost-based prices - those that would make the system most efficient and cost-effective - would vary in both time and place. In contrast, the tier structure is the inverse of actual marginal costs. Under tiered pricing, consumers pay more once they have surpassed a certain tier; households that consume large amounts of electricity face a higher cost per KWh than those who consume lesser amounts. This structure is the opposite of how marginal costs operate under a natural monopoly, where marginal costs tend to decrease with each additional increment of consumption.[20]

It is cheaper for the utility to sell a MWh to one big customer than to sell a kWh to each of a thousand small customers, as the marginal cost of supply decreases with consumption. The efficient rate would thus be *decreasing* block tariffs rather than increasing. An increasing tiered rate, as used in California in the recent decade, is grossly inefficient since it implies very large cross-subsidies from big to small consumers.

[20] Nicholson, *supra* note 12, at 569.

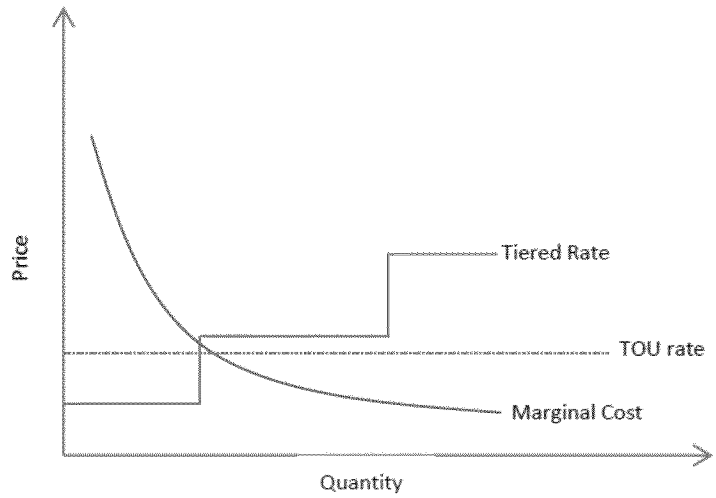

Figure 1: Rate Structures and Marginal Costs

Figure 1 demonstrates how increasing tiered rates go in the opposite direction of marginal costs, while a TOU rate more closely aligns to marginal costs.[21]

Even though tiered rates were designed in reverse of marginal cost principles to encourage conservation, doing so has resulted in unintended problems. Under tiered rates, equal prices across peak and off-peak times, coupled with preference for peak time electricity, induces households to consume more electricity at peak times, when production costs, and concomitant environmental impacts, are highest. In contrast, with TOU rates, consumers face different prices throughout the day and year, which reflect the increased marginal cost of production at that particular time of day or season.[22]

TOU rates, which are closer to marginal cost-based pricing than tiered rates, better satisfies economic efficiency for both consumers and producers, while meeting conservation and consumer goals. On the consumer side, TOU rates provide energy users with information about the costs of electricity service during particular time periods, enabling them to respond by shifting consumption to a less expensive time of day. For example, running the dishwasher at night rather than in the afternoon might require modest behavioral changes and inexpensive timers in return for a lower utility bill.

By better aligning with underlying marginal costs, TOU pricing would also provide a stronger signal to induce development and adoption of cost-effective distributed generation (DG), storage,

[21] T. Sterner & J. Coria, *Policy Instruments for Environmental and Natural Resource Management* 381 (2nd ed. 2012).

[22] Note that TOU pricing implies that all consumers face the same cost at a particular time of day and hence is flat in Figure 1 (although TOU of course does imply that there are steps in the tariff depending on the time of day or location of service). *See* Mas-Colell, Whinston & Green, *supra* note 10, at 12.

and other clean consumer strategies. It would also better align their adoption with the needs of the system, maximizing overall benefit and cost-savings. For example, under TOU pricing homeowners have the incentive to maximize total economic yield by turning their solar panels to the west, which would capture more sunlight at times when the value of a marginal KWh is anticipated to be highest. TOU rates increase economic efficiency by aligning both consumption and DG production with underlying utility costs of services. TOU results in a flatter load throughout the day (given consumer shifting from expensive times to less expensive times), leading to lower production costs at peak hours. On the producer side, TOU allows electricity prices to better reflect underlying costs. Economic efficiency for utilities requires that production occur at the lowest possible per-unit cost, and TOU allows more production to occur when load – and production costs – are lowest.[23]

Critically, creating a flat load through price response is substantially more efficient than meeting high peak demand through increased investments in generation; being able to avoid building new power plants helps keep producer costs low.[24] This cost savings - in addition to the associated environmental benefits - are why California's Energy Action Plan II identified demand response as one of the key first steps in addressing increasing energy needs so as to avoid increasing capacity through power plant expansion (CPUC 2005). Similarly, as discussed below, we will need to be mindful of how production costs will change, potentially dramatically, over the next decade.

The reason for this cost savings is simple: investor-owned utilities (IOU) size the grid to ensure that electricity is available when demand peaks; not just to meet demands that rise daily as people return home from work and school, but to supply demand during extremes that only occur for a handful of hours during particularly inclement weather. Unlike tiered structures, TOU reflects the fact that significant costs are incurred to meet peak demand. Under TOU tariffs prices are higher when demand – and thus the cost to provide electricity – is highest, and lowest when demand and concomitant cost is lowest. High system costs often coincide with adverse environmental impacts, as last-in-the-supply-line peaker plants tend to be the most expensive and most polluting.

In 2005, Charles River Associates (CRA) published what is likely still the most comprehensive analysis of how California ratepayers would respond to time-variant electricity prices, including TOU. The study, "Impact Evaluation of the California Statewide Pricing Pilot," was funded by the CPUC, and vetted through an extensive stakeholder process that included experts from the California Energy Commission and various advocacy groups representing consumers and the environment. The CRA study estimated specific "elasticities" for residential ratepayers,

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[23] *See* Mas-Colell, Whinston & Green, *supra* note 10, at 150.
[24] Fox-Penner, *supra* note 13, at 45.

reflecting how much households would shift or reduce their electricity use in the face of different prices.

EDF combined these elasticities with the most recently available estimates of IOU's marginal costs of service – how much it costs the utilities to provide an additional amount of electricity – to examine the likely consequences on utility systems of large-scale adoption of TOU by the residential class. EDF's analysis is based on half of all residential ratepayers in each of the IOU's service territories voluntarily adopting the TOU currently offered by their utility.

The cost savings are substantial: the results show considerable system-wide cost savings would be triggered by just half the residential class utilizing TOU. Even under conservative assumptions, which look only at short-term behavioral impacts without long-term investments that could significantly improve energy efficiency and management, each year reductions in peak demand would reduce costs by an average of $113 million (6.2 percent of total revenue requirement) in PG&E's service territory, $357 million ($15 percent) in SCE's, and $2.6 million (0.7 percent) in SDG&E's.[25] The difference in savings level is principally related to the spread between peak and off-peak rates; SCE's TOU reflect significant price differentials, while SDG&E has a very small price range.

These hundreds of millions of dollars annually represent money otherwise spent to build and operate expensive and polluting peak power plants and an oversized distribution system – money that could be translated into savings for consumers or invested in energy efficiency improvements. These represent absolute savings – not costs shifted between ratepayers. Were these savings to be maximized to their higher ranges - $800 million annually - they would equal the level of how much is spent to fund the entire CARE subsidy each year.[26]

This rationale dovetails with cost-causation principles. Marginal costs increase sharply to meet peak electricity demand as large loads require greater resources for production and electricity plants that can easily increase output on demand are more expensive.[27] Avoided marginal generation costs are absent in TOU in the near term, but over the long term, TOU can help to avoid "fixed" costs associated with repaying generation and T&D investments. Indeed, there are several values to consider from avoiding electricity demand, with previous study already accomplished on valuation studies for grid related values.[28]

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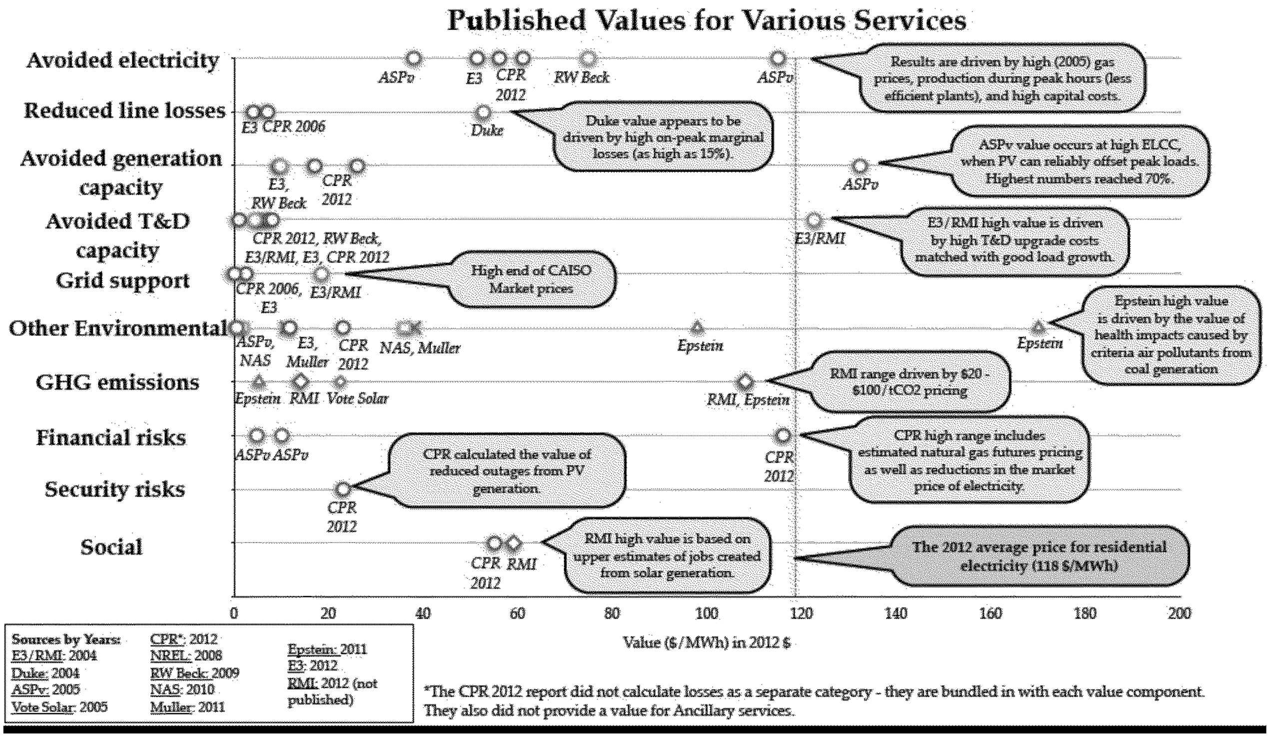
[25] *See infra* Table 3.
[26] *See infra* Table 5.
[27] Fox-Penner, *supra* note 13, at 31.
[28] *See* Travis Bradford & Anne Hoskins, *Valuing Distributed Energy: Economic and Regulatory Challenges, in Princeton Roundtable* (April 26, 2013).



3. Rates should encourage conservation and energy efficiency/ Rates should encourage reduction of both coincident and non-coincident peak demand

TOU rates encourage reduction of both peak and off-peak demand more than tiered rates because TOU pricing causes more costly electricity to be priced higher than less costly electricity. This difference across times changes consumer behavior, defined as the elasticity of substitution.[29] The substitution effect implies that since the consumer faces a cheaper electricity price off-peak, he/she will substitute peak demand to off-peak times. This behavior carried out by many consumers at once helps to flatten the system-wide coincident peak load. To the extent that there is a "rebound effect" – ratepayers simply using more electricity during off-peak times are a result of shifting behavior – it is likely low,[30] and would produce consumer benefits from increased consumption that would have otherwise been unavailable from the high tiered prices.[31]

Conversely, tiered rates may seem as if they were designed to encourage conservation by penalizing high electricity consumption. However, under these rates consumers essentially face one implicit price at the end of the month. This acts to limit the price information consumers

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[29] Nicholson, *supra* note 12, at 133.
[30] Kenneth Gillingham, Matthew J. Kotchen, David S. Rapson & Gernot Wagner, *Energy policy: The rebound effect is overplayed*, *in* 493 *Nature* at 475-76 (2013).
[31] Nicholson, *supra* note 12, at 152.

have available for rational choices about their energy use. Without clear price signals, consumers do not have enough information to effectively reduce consumption overall or to consume at low cost times.

Under TOU pricing, off-peak rates could potentially be lower than tier 1 rates while still allowing for conservation. Some consumption at high prices will be unavoidable, or isn't worth avoiding; this will result in conservation due to income elasticity of demand. EDF considers the tradoff between the peak and off-peak price ratios, and the time-span of the peak price window in Exhibit B. EDF finds that long peak periods should be avoided.

4. Rates should be stable and understandable and provide customer choice.

As discussed above, tiered rates are neither understandable nor actionable. Energy users need to know when their consumption has triggered the next tranche of pricing to effectively respond to tiered rates, and they can't go back in time to reduce their earlier consumption. With TOU rates, the price signal is clear, easy to understand, memorize, and act on: electricity is more expensive during peak times. This type of pricing is common in the marketplace, for example, with many cell phone plans. TOU rates also generate opportunities for consumers to save money with smart appliances that turn off during expensive times, or air conditioner thermostats that automatically pre-cool during less costly periods, creating more options for ratepayers to reduce their electricity expenditures.[32]

Evidence from numerous pilots strongly supports the theory that customers can and will respond to TOU in ways that lower their bills. We have already mentioned encouraging findings from SMUD as detailed in Exhibit C.2. Cost savings "always" resonate with customers.[33] Messages that customers could save by switching to TOU received low response rates before 2008, but have since obtained much higher responses, with 87% of customers conserving due to cost of electricity, and 18% conserving for environmental reasons.[34]

In Arizona, TOU rates have been very successful. More than half of residential customers have voluntary chosen it in the Arizona Public Service (APS) and Salt River Project (SRP) service territories. TOU was promoted during AMI deployment with simple messages focused around saving money. As well, there were no significant issues during AMI deployment. To aid in

[32] Fox-Penner, *supra* note 13, at 42.
[33] Smart Grid Consumer Collaborative, *Excellence in Consumer Engagement* 16 (October 24, 2011), http://smartgridcc.org/wp-content/uploads/2011/10/SGCC-Excellence-in-Consumer-Engagement.pdf.
[34] *Id.*

adoption, pricing plan options are presented clearly on websites and by customer service reps on same level as standard rate option during customer signup.[35]

Perhaps the most convenient time to enroll customers in Smart Grid programs is when they sign up for electric service. For example, APS and SRP have used these opportunities to drive enrollment in their pricing programs, helping them achieve leading participation rates of 50% and 22%, respectively. APS presents all pricing plans as equal and helps customers identify which rates would best suit them, rather than leading with their basic service plan and promoting other plans only as alternatives to this lead offer. Given APS's high customer turnover (~50% annually), this acquisition strategy has been instrumental in achieving high enrollment, with the majority of program participants enrolling during the electricity sign-up process. APS' success suggests that customers are not inherently opposed to pricing programs and can be enrolled in large numbers.[36]

5. **Rates should generally avoid cross-subsidies, unless the cross-subsidies appropriately support explicit state policy goals.**

Tiered rates create two different types of cross-subsidies. The first is a cross-subsidy between the tiers. As marginal costs do not increase with quantity, energy users at the upper tiers are paying an extra fee, essentially subsidizing lower tier energy use.[37] While there is a clear state policy to subsidize CARE customers, which should be maintained under any rate structure, this is not the most effective way to structure rates.

Figure 2 demonstrates how high-tier energy users subsidize the energy consumption for low-tier energy users; the amount of the cross subsidy is highlighted in red and yellow. TOU rates present all other ratepayers with the same rate regardless of usage, which decreases this implicit subsidy by the amount under the curve highlighted with black stripes.

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[35] *Id.* at 20.
[36] *Id.* at 25.
[37] Sterner & Coria, *supra* note 20, at 381.

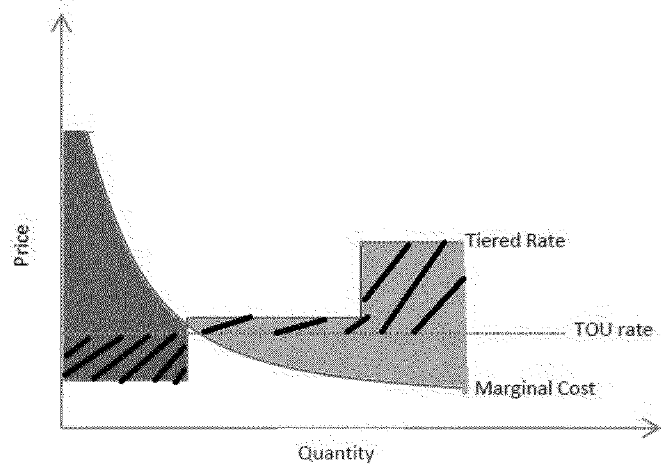

Figure 2: Cross Subsidies under Different Pricing Schemes

The second cross-subsidy is between the coast and the Central Valley. The current tiered structure, along with Net Energy Metering (NEM), creates an incentive for solar investments along the coast - where there is less sunlight and lower energy demand - for two reasons. First, these consumers face smaller lower tiers than the individuals in the Central Valley. Second, towards the end of the month, NEM pays homeowners top tier rates for energy generated throughout the day regardless of the impact on production costs. These trends, and other perverse consequences of tiers, are detailed and mapped in Exhibit C.1.

By signaling to the market when energy is needed, TOU better aligns incentives with electricity production needs. They would increase the payback for a Central Valley home to install solar panels; DG would help reduce the need to pay for peak prices while also incentivizing solar generation at times when production costs are high. TOU would also incentivize coastal households to generate more electricity when prices are highest.

If TOU rates are overlaid on tiered structure (i.e. a higher fee is charged for utilization at peak times), the inherent cross-subsidy still exists, so it is important for the Commission to create a long-term plan to remove all tiered rates if it wishes to eliminate these cross-subsidies.

6. **Incentives should be explicit and transparent; Rates should encourage economically efficient decision making.**

Economically efficient decision making occurs when consumers are (a) presented with underlying service costs, as revealed in energy prices, (b) encouraged and enabled to make their own decisions about how to manage their resulting electricity use. Simply put, if ratepayers know how much a unit of electricity costs, then they can optimize the quantity to purchase given their budget constraints.[38]

With tiered rates, the price of electricity may change throughout the month based on prior use. Even with knowledge of the price of electricity and usage, it is hard to respond to these dramatically increasing rates – once a customer has reached the tipping point from one tier to another, she cannot go back. With TOU, the customer has clear price signals which do not vary with use, but instead vary daily and seasonally; this is an understandable pricing scheme that empowers ratepayers to make optimal decisions, such as running equipment more intensely when power is cheap and orienting solar cells towards the west to produce more power when it is most valuable.

One of the key benefits of TOU - due to the flexibility of how it can be structured - is that it can respond to the needs of the evolving system, such as integrating distributed generation and the ability of diverse customers to comfortably shift load. As previously discussed, TOU structures can vary based on the difference in price between peak and off-peak hours, and the length of the peak period each day. For example, demand currently peaks at around 5 pm on weekdays, though that could change as new pricing tariffs are adopted, energy efficiency and management measures are implemented, and additional renewables are placed on the grid.[39]

TOU can support larger quantities of rootfop solar PV. Increasing PV penetration will also begin to move the net load – system load minus solar minus wind generation – to later in the day, resulting in a drop in the solar's capacity value**Error! Bookmark not defined.**. Under the existing rate structure, the price paid and the incentive to build DG resources will continue to exist even as system PV penetration increases and the marginal value of the incremental PV generation decreases. Under tiered tariffs, as PV penetration increases over time, DG systems will continue to be compensated at the differential between the upper tier energy prices, regardless of PV's marginal value to the system, providing high financial compensation long after their incremental value to the system has begun to decline. While this will encourage the growth of PV installations, which aids in helping California reach its DG goals, the manner in which the NEM installations are compensated will not reflect their marginal value to the system.

In contrast, under TOU pricing the energy being produced by PV systems will be compensated at a rate which reflects the value to the system during the respective TOU peak pricing periods. The differential between on- and off- peak TOU prices creates a financial compensation mechanism to PV owners similar to tiered prices. Under current conditions of low PV penetration, the marginal system value of PV is still quite high. TOU pricing levels and periods

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[38] Mas-Colell, Whinston & Green, *supra* note 10, at 50.
[39] *See infra* Exhibit 2.

could be adjusted to provide a similar compensation to PV owners.[40] As PV penetration increases, and the net load begins to shift to later hours, the TOU peak pricing periods and the TOU prices themselves can be adjusted to reflect the shifting time dependent value of energy.

TOU pricing may also have a positive effect on the size of the NEM cap. There has been much recent debate on the appropriate size of the NEM cap; that is, the amount of DG to be allowed on the system under the NEM tariff. The current NEM cap was recently set to be 5% of non-coincident peak demand.[41] Under a tiered pricing structure, there is essentially no natural equilibrium for DG penetration, since the financial compensation for NEM systems continues to exist independent of the marginal value of PV to the system. However, under a TOU, prices and price windows can evolve. Such a natural pricing evolution will provide a natural equilibrium point for any NEM cap.

As California moves towards higher renewable penetration levels, including the addition of 12 GW of DG and the potential retirement of more than 12 GW of once-through cooled conventional generation units, studies by the CAISO are showing a need for flexible capacity resources to manage net load, where net load is defined as system load minus wind minus solar generation.[42] Increasing the capability of load to respond to pricing signals, either through quasi static TOU or through more dynamic pricing will reduce the burden placed on the system operator to manage net load, and will reduce the financial and environmental costs of these potentially expensive flexible capacity resources.[43] Tiered structures, in contrast, do not help the system operator to reliably meet the evolving needs of net load.

TOU will also promote the development of helpful technologies or third party services that enable customers to seamlessly participate in and take advantage of TOU. For example, a whole class of business opportunities may arise for third parties to provide services that will enable individual customers to to automate how individual devices and their household as a whole take advantage of such rate changes. As well, third party consultants may be able to sell services or technologies to enable retail participation in demand response programs, or to provide economic justification for energy efficiency measures, storage or DG systems. With the proper TOU

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[40] In fact one study has evaluated the impact of all residential NEM customers moving to TOU service under current IOU residential TOU and found a small positive system impact relative to IBP when the current 5% NEM cap is reached, This indicates that the current TOU provides a somewhat smaller financial compensation to NEM customers than IBP. *See infra* reference 3.

[41] Cal. Pub. Util. Code § 2827(c)(1) (West 2013).

[42] Cal. Indep. Sys. Operator, *Market and Infrastructure Policy Straw Proposal* 3, 7 (Dec. 13, 2012), http://www.caiso.com/Documents/StrawProposal%E2%80%93FlexibleResourceAdequacyCriteriaMustOfferObligation.pdf

[43] Currently there is no market for flexible capacity resources, but the CAISO is proposing modification to the CPUC RA process that would create a new type of capacity obligation for Load Serving Entities. Under the current Joint Party Proposal, the only resources able to satisfy the flexible capacity obligation would be conventional thermal units capable of continuously ramping over a 3 hour period.

pricing structure, technologies and service providers can arise that will enable the seamless participation of customers in the transition to a more flexible and responsive load base.

7. **Transitions to new rate structures should emphasize customer education and outreach that enhances customer understanding and acceptance of new rates, and minimizes and appropriately considers the bill impacts associated with such transitions.**

Over the past decade, much work has been done in California and elsewhere to help transition different customer classes to new metering technologies and associated rates. Mistakes – learning opportunities – have been made, particularly related to rolling-out Smartmeters with inadequate educational and outreach support, and too rigid and too late responses to ratepayers' adverse reactions. There will always be complaints associated with new utility offerings, even if those can directly benefit the protesting customers. However, to ensure an overall successful transition to time-variant rates, the Commission should direct the IOUs to follow a best practices approach to associated education and outreach,[44] including:

- *Communicate with consumers early and often, through multiple means and channels*. Thoughtful, consistent, diversely-conveyed messages about the new rates and their benefits should be launched well in advance of their implementation, and continue through the transition period.

- *Adopt integrated approaches using multiple tactics*. Every Commission-funded, utility-sponsored ratepayer "touch" should include mention of the new rate opportunities and support services, with the web of tactics carefully mapped to ensure that overlapping strategies complement one another.

- *Segment the market, implementing tailored approaches for particular customer groups.* The IOUs should continue to build on the significant progress they've made in segmenting the residential class into synergistic groups – by income, race, ethnicity, use patterns, and location, among other variables – and harness those segments as part of effective education strategies.

- *Shape tactics to local contexts.* The IOUs should restructure their marketing and outreach efforts as needed so that they are nested alongside their distribution planning boundaries and defining community characteristics. This approach would also provide a platform to experiment with area-based rates and programs.

- *Demonstrate tangible and immediate benefits rather than "general awareness" messaging*. Highlighting ratepayers – particularly early adopters – who have achieved

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[44] *See* Foresight Bright, *Smart Grid Consumer Education Program Support* (April 2013).

significant bill savings as a result of TOU structures is preferable to round messages about potential cost savings from the rates.

- *Strive for consistent messaging, to ensure accuracy of information, repetition of key concepts, and cohesion across the multiple messengers*. The messenger can and should change; the underlying message shouldn't. The IOUs should foster an ability to monitor communication efforts by diverse parties where they meet the customer, to maintain quality.

- *An emphasis on customer service and satisfaction is critical.* The communication effort should not be one-way. Messengers and customers should be encouraged to provide early feedback on tariffs and associated programs, so that real and perceived issues can be effectively addressed.

In addition to adhering to best practices, EDF proposes a number of features be adopted alongside TOU rates to ensure that customers fully understand and take advantage of the new structures. These include:

- *Offer the rates on an opt-out basis*. Available evidence suggests that many ratepayers will be "structural winners" under TOU rates, and the vast majority will be better-off with TOU in combination with enabling devices or modified energy use behavior. However, to safeguard against untoward bill increases EDF supports customers' ability to choose an alternative rate, be provided with shadow bills, and, for a period, be protected with bill protection.

- *Establish actionable metrics*. As discussed in this proposal, EDF recommends that the Commission adopt metrics that measure TOU penetration levels, bill impacts, and associated outcomes, combined with embedded regulatory processes which enable decision makers and stakeholders clear opportunities to enhance what's working, and eliminate what's not.

- *Implement pilots*. EDF believes that a transition period is important not only to provide time to educate ratepayers on new TOU structures, but also to offer the Commission ample opportunity to continue to "learn by doing." This will be enhanced not only through tracking mechanisms, but by conducting a diverse array of pilots that evaluate different time-variant rate structues, including those which reflect differences in area costs, more dynamic tariffs, and ones which emphasize "set-it-and-forget-it" technologies.

- *Careful with CARE*. Particular attention should be paid to CARE customers. The Commission should consider targetting existing energy management programs to areas with the highest demand (e.g., the Central Valley), requiring that enabling devices be bundled with TOU rates for CARE customers (e.g., TOU adoption triggers eligibility for advanced thermostats), and experiementing with third-party programs that seek to guarantee lower bills through effective energy efficiency and management interventions.

II. EDF Rates Proposal

Based on the evidence presented above, EDF supports default TOU as preferable to a tiered structure. Within the scope of this proceeding, EDF believes, however, that carefully transition to default TOU is the best step forward to reaching those goals laid out by the CPUC and California legislature. As such, EDF proposes a phased transition to residential rates that are time varying simply at first, with peak, off-peak and super off-peak tranches.

The rate proposed herein is a two-phase transition strategy, ultimately leading to default TOU. The transition strategy is summarized in Ex. 1, below. Phase I begins a transition from tiered to default TOU, Phage II begins with full transition to default TOU. Full transition and implmentation would lead to an end state of unbundled rate, service, and product offerings that have default TOU as the backstop and a menu of dynamic opt-in rates and products (such as storage and power quality management services for rooftop PV owners). As detailed below, the transition strategy treats certain customer classes differently. These differences are based upon concerns for particular customers, most notably CARE customers. Additionally and as noted above, current law prohibits medical baseline and third-party notification customers from being defaulted into TOU. The rationale for these differences is discussed more fully below.

In sum, EDF's proposal is structured to (1) provide the full proposal, inclusive of transition strategy in Ex. 1, (2) provide detailed information regarding phase I of the transition strategy, and (3) provide examination of the final, phase II portion of the transition strategy.

A. Full Proposal, with Transition Strategy

Table EX.1. EDF CA Residential Rates Proposal Timeline

Phase	**I**	**II**
Timeline	1 to 3 years	3 to 6 years
Non-CARE Customer Rate Policy	Opt-out TOU with short menu of other pricing options	Opt-out TOU with expanded Menu with dynamic and area-based options
TOU rate structure	<u>Time periods:</u> Peak: 4 pm - 7 pm Off Peak: 4 am - 4pm; 7 pm - midnight Super Off Peak: Midnight - 4 am <u>Design goals:</u> 1.Super off-peak set at >20% below Tier I level, and minimize peak price window. 2. Non-TOU rate is internally revenue neutral	<u>Time periods:</u> Time periods and number of periods revisited at GRCs. <u>Design goals:</u> 1. Add locational price to attract distributed generation investments where they best fit existing grid resources. 2. Adapt to new DG, EE, EV, DR or other policies
CARE Customer Rate Policy	Opt-In or Opt-out TOU depending on magnitude of peak time energy use	If metrics are met, Opt-out TOU with expanded/revised menu and extra assistance if indicated by metrics
Customer Transition Plan	• Strong CARE discount through directly off bill. • Bill protection with limitors & shadow billing. • Pilot rates and engagement/enablement strategies including device installation. • Enhance education and outreach • Deliver enabling devices • Establish measurable metrics and milestones to assess TOU performance (i.e., conservation, shifting) by consumer segment	• Metrics based on consumer participation and satisfaction and bill impacts trigger move from Phase I to II for customer segments. • Refine and implement capacity building through enablement, and education/outreach strategies based on TOU performance assessment in Phase I. • If appropriate, update TOU default policy for Non-CARE & CARE customers. • New measures to enhance competition amongst service providers to enhance service to broader and deep swath of customers.

Note: Medical baseline and third party notification customers are not included in this transition strategy. EDF envisions such customers remaining on a default non-TOU rate, with the same opt-in choices available as for all customers.

B. Phase I Transition Strategy

1. Default customers (with opt-out) to marginal cost-based TOU rates that are recalibrated with each general rate case, or sooner as deemed appropriate by CPUC.

The Commission should launch universal implementation of TOU rates because it is best for consumers and environment. Immediate adoption of a default (with opt-out) TOU rate will create progress towards the goal of rates that more closely adhere to underlying marginal costs, and transparently signal to ratepayers that the timing and magnitude of their consumption (or production) matters.

EDF proposes a simple peak/off peak/super off peak price structure for a Phase I rate, with a plan adjusting the timing of peak rates at each general rate case. Seasonal adjustments aimed at month-to-month bill stability should be considered but not allowed to mute both the message that electricity service costs vary throughout the year and the message that service costs vary during each day.[45]

This first phase will create a number of beneficial changes in how rates are understood and utilised. Customers will have the opportunity to demonstrating engagement and understanding. and The markektplace will develop products and services that TOU ought to attract. Ultimately, a more dynamic time-variant structure will develop, shaped by customer grid flexibility and need.

As the grid absorbs increasing amounts of dispersed and variable generation and demand-side assets with different production profiles, TOU will need to evolve as load and cost patterns shift over time. Energy users will learn to respond to rates by adopting new technologies and practices.

In addition, TOU specified by time (and, as appropriate, location) can provide incentives (i.e., price signals) for adoption of cost-effective distributed energy resources (and in locations of greatest system value). To support DG investments, grandfather net energy metering with static TOU for a time period long enough to ensure a specified return on investment.

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[45] Recalibrating TOU periods to reflect changing load and cost patterns over time will help ensure that key state and rate design goals are achieved as grid conditions evolve. This should be done regularly, perhaps at each GRC, perhaps more frequently. Consumers are accustomed to price changes in virtually all commodities markets, to price seasonality, and to a selecting from a menu of options.

2. Transition Strategy - CARE customers

CARE customers should receive assistance before being switched to TOU without bill protection. There is evidence to indicate that CARE customers are (a) less able to shift demand, and (b) more likely to be price responsive. These countervailing forces lead to opposite conclusions, and are best rectified through assistance with education, enabling technologies, and new strategies to make weatherization and other efficiency upgrades. The suite of assistance and incentives might include education, options to purchase green power at specified prices, energy efficiency initiatives, and preprogrammed set-it-and-forget-it enabling technology that is free or financed via regular payments affixed to their energy bills. More details are provided in Exhibit C.

Ultimately, however, CARE customers may be among the most responsive customer segment, enjoying significant bill reduction benefits. Recent RROIR Customer Survey Key Findings support EDF's view that CARE customers will support and benefit from TOU without fixed charges.[46] For these reasons, EDF supports transitioning CARE customers to default TOU as quickly as possible while ensuring adequate protection – proposed here in phase II.

3. Transition Strategy - Third Party Notification and Medical Baseline Consumers

Third Party notification and medical baseline customers are not placed into a default TOU rate in phase I (nor phase II) of EDF's proposal. As these customers are least able to respond TOU (as discussed earlier), they are the one customer segment least likely to be able to access the associated TOU benefits. EDF thus does not propose changing current law. However, these customers should be able to opt into the full menu of options provided to consumers.

4. Revisit and dramatically expand customer saliency programs to train consumers to be load flexible and to invest in EE, DR and DG.

To transition to pricing that revolves around time-variation, the CPUC should determine what additional support customers may need and how it will be financed, notably in terms of education and enabling technology, to avoid energy bill shocks when defaulted into a TOU rate. For certain customer segments, opt-in programs or pilot rates may be merited to evaluate the efficacy of educational strategies or other program design elements. The CPUC should consider a concurrent rulemaking on customer education/enabling and financing for it during Phase I. As well, a robust research plan for informing adaptive management decisions should be developed during the first phase, and executed for the second phase begins.

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[46] *See* Hiner & Partners, Pac. Gas & Elec., S. Cal. Edison , & San Diego Gas & Elec., *supra* note 5.

C. Phase II Default TOU with a Menu of Options

The end result of EDF's proposed transition strategy will be to provide customers with a menu of choices. This menu of choices is envisioned to provide customers with a default marginal cost-based TOU rate.[47] CARE customers would thus be defaulted into and able to enjoy in the benefits afforded by TOU rates in this phase. The implementaiton of Phase II, as suggested below, provides a window into a new pricing world shaped and made possible by the steps taken in Phase I (to be evaluated and proven by data collection and metrics).

Phase II would offer a menu of opt-in options as alternatives to default TOU. Performance-Based Incentives for IOUs based on their menu of such dynamic and unbundled rates would align utility and customer incentives. Offering customers a menu of rate options, including real-time dynamic pricing with area-adjusted distribution and transmission pricing, critical peak pricing and/or demand response, is a viable means to pursue state goals while meeting the diverse needs of customers. It would also incentivize the IOUs by, first, making them whole, and, second, providing performance based incentives.

With a menu of options based on marginal costs, all residential customers will be exposed to rates that make true costs (and benefits) more salient. Close adherence to time-based marginal costs will achieve all of the Commissions' principals better than the current tiered rates. For example, an electric vehicle owner may desire a super-off peak rate for nighttime charging, a homeowner with rooftop solar may seek a rate that strongly signals sunny-time energy use, and a master-metered multiunit building may be willing to accept payments to cede control of large quantities of load shedding via AutoDR. Over time, as the cost of enabling technology falls, EDF anticipates that increasing numbers of residential ratepayers will opt into some form of dynamic rate.

III. EDF Proposal Implementation

EDF's proposal is fundamentally based on the belief that a TOU rate structure is economically, socially, and politically preferable to a tiered rate structure. These arguments have been discussed in greater detail earlier, laid out in Section I of this proposal. This section builds on the prior two sections by detailing how a TOU rate structure can be implemented in California. To this end, the manner in which the EDF proposal transition strategy should be implemented is first discussed. Second, the proposal implementation, in regards to CARE customers particularly, is examined. Third, the implementation of the proposed menu of options is provided.

[47] Exempting, as previously discussed, medical baseline and third-party notification customers.

A. Transition Implementation

As discussed above in Section I, a transition to TOU provides economic, consumer, and environmental benefits in ways that tiered rates cannot. To fully realize these benefits, EDF suggests the following considerations in designing a transition to TOU structures:

- *Start light while making a commitment*: In order to give consumers time to transition to TOU, the Commission may want to consider bill protection beyond what was required in S.B. 695, a set time period during which the tiers are collapsed, or both. These transitional steps should be taken with a clear commitment to move to TOU in a specified timeframe so as to minimize regulatory uncertainty. Given the time needed to develop, market, and implement enabling strategies, as well as the associated costs, the Commission's progress towards TOU should be steady and firm. This will require clear metrics and goals, strict adherence to their pursuit, and adaptive management.
- *Allow for Opt-Out with at least one non-TOU option*: Provide a viable rate alternative, based on marginal cost of service, for customers who opt-out of TOU rates that encourage smart energy use and conservation. The non-TOU rate option should be internally revenue neutral to avoid cross subsidies being paid by customers who do not select the option.
- *Educate, inform, and enable*: Design utility consumer education, outreach, and enablement plans based on successful programs, pilots and marketing research from across the country, while ensuring that customers have access to enabling technologies. Additionally, once the Commission makes a commitment to new rate structures, the clean technology entrepreneurs and energy service providers will respond with new products and services to help ratepayers get even more from new pricing structures.
- *Learn and adapt; Establish clear metrics*: Smart Grid metrics already require reporting of customers on TOU, Home Area Network (HAN) penetration, use of utility web-based portals, authorizations to share information with third parties, smart meter related consumer complaints, consumers enrolled in electric vehicle tariffs, and various aspects of consumer-owned distributed generation.[48] These metrics could be used and expanded (e.g., to include consumer education, access to enabling devices) – in combination with information from the CAISO about load flexibility resource needs – to inform specific aspects of the TOU policy and refine it over time.

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[48] Adopting Metrics to Measure the Smart Grid Deployments, R. 08-12-009 (E-Filing Cal. P.U.C. Mar. 20 2012)(proposed decision of Comm'r Peevey), http://docs.cpuc.ca.gov/PublishedDocs/EFILE/PD/162118.PDF.

B. CARE Specific Implementation

In addition to developing transition strategies to maximize benefit for all consumers, the Commission may find that CARE customers may benefit from additional specific protections for reasons noted above.

These customers should be allowed to benefit from TOU, as these rates can represent significant opportunities for low-income ratepayers to be substantially better-off than under existing tier-based structures. Critically, with sufficient penetration, TOU will make the system less costly to operate, leading to overall bill reductions even for consumers who do not participate actively. In addition, our expert's work with families located near power plants – who tend to be lower-income – informs our understanding that TOU can be a tool to reduce polluting air emissions in their community by relieving pressures on these highly polluting "peaker" generation resources. This motivation may be reflected in adoption levels for PG&E's SmartRate tariff, in which CARE customers have significantly higher enrollment than non-CARE customers.[49]

In this respect, the Commission should examine strategies that shield ratepayers from adverse bill consequences and provide pathways to secure the benefits they rates offer. Additional dimensions that should be considered include a more shallow TOU structure than the one generally used (less of a cost difference at different hours) and/or structuring these cost differences as rebates. Focus should also be given to:

- *Appropriate education and outreach*: Targeted outreach that meets the needs of non-English, disabled, and other consumers.
- *Access to Enabling Technologies*: Ensure customers have access to enabling devices, such as thermostats, before enrollment in TOU rates.
- *Air Conditioning:* AC is the single most important driver of success under TOU rates – and a well-designed approach is critical to maintaining the well-being of consumers. Strategies might include saturating certain regions and household types with enabling devices capable, or a geographically-structured CARE program that takes into consideration the A/C needs of the Central Valley, perhaps with financing for more efficient air conditioners.
- *Access to Energy Improvement Programs:* Because of the financial barriers some customers face, there is an untapped reservoir of energy and cost savings in households, including plug load dominated by older, inefficient, devices. These households could benefit from increased financing of energy improvements by leveraging existing energy

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[49] 2012 Rate Design Window Application of Pac. Gas & Elec., A. 12-02-020 App. A Vol. 1 at 46 (E-Filing Cal. P.U.C. Feb. 29, 2012)(application of Pac. Gas & Elec.), https://www.pge.com/regulation/RateDesignWindow2012/Testimony/PGE/2012/RateDesignWindow2012_Test_PGE_20120229_230078.pdf.

efficiency and appliance replacement programs and supporting' access to distributed generation options through programs like those envisioned in Senate Bill 43 that uses virtual net metering to make local solar PV investment viable for electricity customers who don't own their homes and thus aren't able to install rooftop PV.[50]

C. Unbundling Rates to Provide Customers with a Menu of Options and Utilities with New Business Models, Metrics, and Performance Incentives

In California and elsewhere, utilities are being asked to push hard on demand response and efficiency before new generation investments will be approved by PUCs. Furthermore, utilities are expected to embrace their competition, one rooftop at a time, while paying a market price for greenhouse gas pollution and helping customers to deliver "negawatts".

When asking utilities to embrace uncertain futures and to accept new risks, the upside opportunities need to be salient, significant and within reach. EDF believes new utility opportunities must be structured to flourish while new demand-side clean energy begins to dominate. Eventually, consumers can become prosumers, selectively buying, selling, storing, enhancing, and generating electricity in response to dynamic energy prices and weather conditions, and utilities can develop lucrative new services models to meet the needs of prosumers, traditional consumers, new customers, such as drivers and future generations.

To get to this desired end state, an unbundling of rates will be needed, and PUCs will need to set the stage for new utility businesses that leverage new smart grid and communications technologies. EDF believes that several principles should be maintained: (a) establish level playing fields for competition amongst incumbents and new industry entrants, (b) transition aggressively but voluntarily to dynamic, time-variant, location-adjusted retail electricity rates and true cost unbundled pricing of services and products on both sides of the meter, and (c) establish performance-based incentives linked to social and environmental goals in ways that inspire utilities to reduce generation inefficiencies, costs, risks, and emissions while supporting self-generation, storage and vehicle charging.

There should be a dovetailing of performance based incentives and unbundling rates. That is, as the customer view of utility service becomes more complex and diverse than simply keeping the lights on, so too must utility compensation structures. This is important for two reasons: utilities must be able to recover costs and the energy marketplace will function best when market participant incentives are aligned. Current structures of incenting utilities to deliver demand-side resources, such as decoupling revenues from sale of electricity, theoretically renders the utility indifferent but in practice provides insufficient incentive. In fact, the current approach to utility

[50] S.B. No. 43, sec. 5, § 2831, 2013-2014 Reg. Sess. (as amended by Cal. Senate May 24, 2013).

compensation for energy efficiency still incentivises investments in rate-based infrastructure. Instead, demand response and other demand-side resoruces should be seen as means to avoid these investments, and thus IOUs should get compensated for delivering them.

It is possible to build more robust incentives into utility compensation that hinge on developing customer and/or environmental benefits. Iit is increasingly important to isolate and price more than just energy on the grid. For example, load flexibility will be increasingly important to integrate large quantities of variable energy resources. Similarly, rooftop solar PV investments can be signaled to provide other services, or avoid utility-side costs, if those services can be isolated and priced. With smart metering infrastructure in place, it is now possible to begin to gather the data needed to unbundle rates in pursuit of more precising pricing.

As stated by the Commission in the OIR, any transition to time variant and dynamic pricing should ultimately address over-arching policy, such as cutting greenhouse gas emissions and supporting modernization of the electric grid.[51] In addition, a move towards TOU and dynamic pricing should develop a rollout schedule for the IOUs and include consistent customer education programs. EDF agrees and emphasizes the need for California's transition to time variant rates to be grounded in data. Further, that data must be used to validate the policies made in this OIR and guide the transition going forward. In addition, EDF believes that the data should be used to drive a transition that incentivizes success for the consumer experience and the overarching policy objectives.

EDF urges the commission to ensure that robust metrics and associated performance indicators and incentives are developed to accompany the transition to dynamic rates. EDF, looks forward to continuing to work with stakeholders to develop meaningful measures that will promote a state of the art transition. Some of this work is already being done in the Smart Grid proceedings, which is being coordinated with this proceeding.

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[51] Notably, EDF's proposal has a positive impact on the safety of electric patrons, employees, and the public, because it reduces the system's reliance on polluting fossil fuel power plants. Customer responses to TOU rates will facilitate increased reliability by enabling reliance on renewable energy resources. Though predictably variable, renewable resources are more reliable than conventional centralized fossil fuel or nuclear generation.

IV. Proposal for Ongoing Evaluation of Time-Variant Rates and Programs

As stated by the Commission in the OIR, the transition to TOU should serve to address over-arching policy goals, such as reducing greenhouse gas emissions and supporting electric grid modernization. A move to widespread residential class adoption of TOU and dynamic pricing should be implemented through a thoughtful rollout schedule, which includes consistent, high-quality, customer education and enablement programs. The CPUC should plan now for the collection of data that enables IOUs, the Commission, and other stakeholders to evaluate the efficacy of rate structures and to modify policies and programs. The refinement of TOU and, indeed, all rates and associated CPUC and IOU programs should be an ongoing, adaptive process with specific, measurable, time-specified objectives, appropriate metrics to evaluate progress, and a clear game plan for adjustments as we learn together.

In this respect, EDF urges that, alongside a set of time-variant rates and supporting programs, the Commission adopt robust metrics and associated performance indicators and incentives that accompany the transition to TOU. These metrics should be carefully tracked and used in ongoing ratemaking proceedings (e.g., General Rate Cases or Rate Window Designs), potentially nested in new proposals that continually improve upon the policies, programs, and tariffs recommended in this proceeding. These metrics might also be tied to IOU performance based compensation.

EDF believes that wider adoption of TOU should be seen as part of the evolution of a grid that becomes more customer-centric, matching with the system's increasing need for more flexibility. Establishing ongoing tracking metrics and associated evaluations, matched with emerging supply-side needs, is essential to achieving that goal. Thoughtful tracking, evaluation and adaptation will be necessary to satisfy stakeholders that particularly vulnerable customer classes, such as CARE customers, are receiving the education and enablement needed for bill reductions in a switch from tiers to TOU, or, perhaps, are being prevented appropriately from using TOU.

TOU rates and other options need to adapt to changing load shapes, resource costs, system needs, and customer responses. Likewise, climate change is demanding new resiliency and adaptability from our economic and environmental eco-systems. Residential ratepayers should be invited to play a beneficial role in rebalancing the grid and reducing its associated environmental impacts, and be encouraged to adopt beneficial adaptive behaviors that are prompted by ongoing grid needs.

The Commission should view TOU as part of an ogoing conversation with electricity customers. Tariffs, education efforts, energy management services, and third party providers should be as enlivened to help manage the system akin to supply side participants, and thus must be allowed to join in the conversation with the customer through secure sharing of customer energy use data and clearer pricing, such as privided with TOU.

A. Proposed Metrics and Evaluation Tools

Metrics have already been developed as part of the Smart Grid proceeding, coordination with which is supposed to occur in this proceeding. For example, a February 12, 2012 Commission staff report included smart grid goals, as well as a list of candidate metrics, including EDF's metric designed to evaluate smart grid's impact on the system's environmental footprint.

In this proceeding EDF recommends that the Commission adopt the following metrics and evaluation approaches to help track, among other things, the environmental benefits of time variant rates:

- Changes in load shapes and bills, along with underlying household characteristics;
- Changes in generation mix emissions intensity; and
- Changes in the quality and level of services and technologies that aid in conservation and shifting.

These metrics should provide the analytical basis to develop new rate options for customers that go beyond the tariffs adopted in this proceeding, and provide cost-based options for ratepayers who choose to opt-out of TOU tariffs. Ultimately, a menu of rates, including those reflecting flat unit prices and dynamic rates, should be offered that match underlying system costs.

B. Ongoing Research Should be Conducted to Evaluate TOU Impacts on Energy Use, Investments, and Bills

Widespread adoption of TOU tariffs would likely have significant, beneficial, impacts on the behavior of electricity customers, as described in the theoretical section of our proposal. These impacts could include:

1) Compared to existing tiered structures, ratepayers can better understand TOU pricing schemes, and so can respond to its conservation and load shifting incentives more effectively;
2) Enhanced responses to prices can prompt investments in more efficient appliances, advanced thermostats, and plug load management devices, leading to decreased energy use, especially during peak periods;
3) Higher prices during peak times can induce substitution away from the more expensive times and towards off-peak periods;
4) NEM customers may improve their peak time solar generation by facing their panels West given the economic incentive to do so.

While implementation of time-variant rate structures will almost certainly produce benefits to ratepayers, the IOUs, and society-at-large, the tariffs adopted in this proceeding merit careful monitoring and examination. Like the rates themselves, Commission policy, and IOU management, should become more dynamic, responding to new needs as the grid and ratepayers evolve.

For example, some households will better adapt to new TOU tariffs than others, given different characteristics, such as income, location, appliance mix, access to information, and other factors. Understanding which households benefit from TOU, and identifying ways to maximize savings across different types of households, is essential to achieve the full welfare benefits of energy pricing, and to be able to adaptively manage rates as electricity users and the system evolves. Likewise, EDF anticipates that new rate structures may be regularly introduced over the next decade, as the grid struggles towards a new equilibrium, creating the need for constant evaluation, feedback loops, and adaptive management.

In this context, EDF proposes that ongoing tracking mechanisms and associated analyses be conducted and presented in relevant proceedings to help the IOUs and Commission evaluate the impacts of TOU pricing on energy use, conservation and load management investments, and customer bills. Under this approach, energy consumption data would be gathered from a sample of households, and matched with a census of household characteristics. This information can be used to document changes in customer segment and marketplace behavior, enabling policymakers and utilities to continually hone their efforts to develop effective rate structures, financing programs, and targeted distributed energy resources initiatives.

Different household characteristics and outcomes of interest are listed in Table 1. For example, the extent to which CARE and non-CARE customers shift their electricity use between peak and off-peak times should be examined; changes in appliance turnover rates and adoption rates of advanced thermostats and plug load controls should be tracked; as should adoption rates for solar arrays in different climate zones.

Table 1: Household Characteristics and Outcomes of Interest

Household Characteristics	Outcomes of Interest
Demographics (income, race, location, etc.)	Investments in energy efficiency, appliances, solar, weatherization
Opt-in vs. Default TOU	Shifting in household energy consumption from peak to off-peak
Appliance Efficiency prior to TOU implementation	Conservation (change in electricity consumption before and after implementation)
CARE vs. non-CARE	Bill Impacts (Change in bill before and implementation)
High vs. Low Energy Users	Gradual transition from high to low energy use
Peaky vs. Flat Load Energy Users	Shifting from peak to off peak for flatter diurnal usage patterns
(Prior) PV users	Recover sunk costs
(Future) PV users	Obtain attractive return on investment
Electric Vehicle Owners	Super off peak charging, obtain value out of demand response, storage and ancillary services

Estimating how the likelihood of opting into a tariff changes based on household characteristics could provide insights into where to focus educational programs that help households effectively manage rate changes. Furthermore, as bill impacts will likely depend on intensity of energy consumption, impacts on high and low energy users, as well as peaky or flat energy consumers, should be captured.

In addition, NEM participants – households with solar panels – and electric vehicle owners may be affected in different ways than those without these technologies. The relationship between TOU and PV adoption rates should be tracked and examined, as should the impact of TOU on households who have already invested in solar arrays.

Research and data tracking should both inform the utilities and the Commission of the outcomes associated with TOU adoption, and measure the impacts of specific interventions, such as cloud-based Internet thermostats, direct load control on pool pumps, and educational programs. Identifying interventions that help control bill impacts and improve conservation and energy shifting will result in greater future cost reductions, by eliminating costly programs or interventions that do not help achieve desired outcomes while promoting those that do, leading to more flexible loads and lower marginal costs.

C. Emissions should be Tracked

As part of its efforts to ensure that California's smart grid technology is being deployed in a timely and cost-effective manner, the Commisison has ordered workshops to develop environmental and other metrics to track AMI deployment. On February 12, 2012, staff submitted a report on smart grid goals to the Commission. In that report staff submitted, as part of its list of candidate metrics, EDF's metric designed to evaluate smart grid's impact on the environmental footprint of the grid. EDF presents this metric here, and requests that it be used to help track, among other metrics, the environmental benefits of dynamic rates. In addition, EDF proposes that performance based mechanisms, like those recommended by the Commission and utilized in other jurisdictions, be applied for here. It may be appropriate to conduct additional pilots to test strategies, enabling technologies and associated rewards to the utility.

As detailed in Staff Report on Smart Grid Goals, emissions associated with the grid should be monitored. This could be done by measuring generation mix emissions intensity (GMEI), a weighted average of emissions from the various resource types on the grid. The GMEI can be used to make real-time GMEI information available to environmentally conscious customers, as reflected in such websites as www.realtimecarbon.org.

Anticipated future changes in generation mix emissions can already be calculated. The utilities' Smart Grid Deployment Plans contain estimated benefits in terms of avoided pollutant emissions, increased renewable generation, avoided load from efficiency and demand response and increased distributed energy resources. These forecasted benefits translate into reduced generation mix emissions, and long term procurement planning indicates what resources each utility anticipates using, and to what degree, to meet peak demand. The expected accomplishments of smart grid ought to be reflected in these long terms plans, again suggesting that adequate information is in the public domain to develop plausible generation mix performance expectations through year 2020.

The CAISO routinely provides real time information about total demand on the California grid and total generation from renewable resources by resource type.[13] This is a useful start, but greater precision is both possible and necessary to ascribe generation mix emissions intensities to individual utility service territories. Notably, the CAISO relies on utilities to report rooftop solar and other forms of distributed generation, and is currently developing a data request procedure to routinely receive this information.

Ultimately, a generation mix emissions benchmark should be linked to financial incentives focused on a long term goal of making the generation mix cleaner at all hours of the year by diversifying generation and making load more flexible.

D. Emergence of Innovative Services and Technologies Should be Monitored

Although EDF does not recommend specific quantitative measures, the IOUs and Commission should be regularly informed of the emergence of new services and technologies that help residential ratepayers manage their energy use, along with their associated costs and benefits. In the best of circumstances a thriving marketplace in this realm should be nurtured, linked with effective rate structures.

Legal Implementation

Dynamic rates, TVR, and TOU implementation is state policy encased in California law. S.B. 17 laid the foundation for California's investment in a cleaner and smarter electric system, including smart meters and other AMI.[52] S.B. 695, allowing the implementation of dynamic rates, TVR, and TOU, "turns on" the power of smart meters to deliver the promise of a smart system. Together, S.B. 17 and S.B. 695 created a pact with California ratepayers to invest in and then implement grid modernization, thus protecting and ensuring the ratepayer investment in AMI. The legislature also intended the investments to be cost beneficial and protect consumers, including vulnerable consumers. The Commission currently has the authority to implement EDF's rate proposal, which recommends the universal adoption of TOU. In order for EDF's full vision of a pure TOU, TVR, and dynamic rates system in the absence of tiers to be achieved, however, 739.9, implemented after the California energy crisis, may need Commission interpretation, change, or expiration.

California's Pact With Ratepayers

In S.B. 17, the legislature expressed that modernizing California's electrical transmission and distribution system is State policy and ordered electric corporations to develop smart grid deployment plans. The legislature then expressed what it expected grid modernization to achieve, or deliver. These deliverables include dynamic rates, TVR, and TOU. Specifically, grid modernization is to deliver the "increased use of cost-effective digital information and control technology to improve reliability, security, and efficiency of the electric grid."[53] S.B. 17 also requires "dynamic optimization of grid operations and resources," "deployment of cost-

[52] Cal. Pub. Util. Code § 8360 (West 2013); Cal. Pub. Util. Code § 8366 (West 2013) (S.B. 17).
[53] Cal. Pub. Util. Code § 8360(1) (West 2013).

effective smart technologies, including real time, automated, interactive technologies," and a method to "provide consumers with timely information and control options" as deliverables.

Grid investments were intended to be cost effective, environmentally friendly, and forward thinking. S.B. 17 states that AMI must use existing grid assets more efficiently, meet stringent cost versus benefits assessments, and reduce negative environmental impacts.[54] Further, the legislature understood that the path to smart and clean power would not necessarily come easily or without challeges. Therefore, the legislature, in S.B. 17, specified that investment in grid modernization required the identification and lowering of barriers to adoption of smart grid technologies, practices, and services.

The Promise of TOU, TVR, and Dynamic Rates that Benefit and Protect Consumers

TOU, TVR, and dynanic rates meet these policy goals in a way that the current, tiered rate structure necessarily cannot. S.B. 695 thus provides for TOU, TVR, and dynamic rate implementation. The legislature, acknowledging that transitions can be challenging, placed conditions on new rate implementation designed to protect customers. These conditions include the requirement that the CPUC only adopt a default time-variant rate after January 1, 2013. The law likewise contemplates default real-time pricing after January 1, 2020. Any default time-variant rate must additionally meet four requirements. First, customers must have the option to opt-out of a time-variant rate. Second, medical baseline customers and third-party notification customers cannot be defaulted into time-variant or real-time rates. Third, customers must receive one year of 'interval usage data' from an advanced meter and customer education before they may be defaulted into a time-variant rate. Fourth, customers must receive one year of bill protection (the cost of electricity cannot exceed the amount that would have been payable under the prior rate structure) after being defaulted onto a time-variant rate.[55] These bright line rules and restrictions provide the only express limits to the universe of options the CPUC may consider in instituting a new rate design, reflective of the broad policy goals stated above.

We believe that California law currently empowers the CPUC to transition California residents to TOU as proposed by EDF. However, because TOU is - by design - structured differently from the current tiered rate system, TOU poses challenges to the existing, outdated, and inequitable rate system. Designed to lower overall bills and system costs, TOU includes price signals that fluctuate - flat rates do not. This fluctuation, however, is precisely what California's smart grid investment was designed to deliver.

Delivering the Promise of California's Investment

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[54] Cal. Pub. Util. Code § 8366 (West 2013).
[55] Cal. Pub. Util. Code § 745(d) (West 2013).

EDF's analysis estimates that TOU will bring savings at an order of magnatide that would allow California's grid investments to pay for themselves in the near term – all while improving the environment. California cannot afford to lose these benefits, and barriers to attaining them, including those entrenched in the current and outdated rate structure, should be eliminated as required by S.B. 17. This can be done, as EDF describes above, while protecting and benefitting consumers. It should, moreover, be noted that this protection and benefit to consumers is not a symptom of or particular design feature in a TOU rate. Rather, because TOU at its core serves as an updated and more efficient rate design than the current stucture, consumers consequently and necessarily benefit.

As stated above, the commission currently has the authority to implement TOU and realize the associated benefits as proposed by EDF. A fully developed and "pure" TOU rate design, as ultimately imagined by EDF, however, cannot be optimized in conjunction with the current 5 tiered system. EDF's optimal rate horizon would implement a menu of TOU, TVR, and dynamic rate options that exist absent a tiered system. 739.9 establishes that, in a tiered structure, the CPUC is limited in raising rates beyond a certain threshold for customers with electricity usage up to 130 percent of baseline quantities.[56] It is likely that such a fully developed and dynamic system, with collapsed tiers or no tiers at all, would require a statutory changes, including changes to 739.9.

Conclusion

EDF thanks the Commission for examining the opportunities for residential ratemaking in California. The Commission has long set electricity rates to express the multiple values Californian's hold: rates that are not only good for our pocketbooks but for environmental and economic prosperity. We believe that now is the time for the Commission to take the next step in designing residential rates that reflect and drive the values held by Californians – the people who make up the "ratepayers" in this proceeding.

TOU rates improve the environmental value proposition for electricity by helping to facilitate flexible load management to integrate variable renewable resources, reducing the need for large scale, polluting centralized fossil generation – especially peaker power plants. These last-in-the-supply-line peaker plants tend to be fossil fueled, least efficient, most expensive to operate and among the most polluting resources on the system. By reducing the need to size the system to meet anticipated peak demand, TOU will further reduce environmental impacts associated with the siting of power plants and transmission lines. Additionally, TOU rates will increase value of clean energy resources, including self-generation with solar photovoltaics.

[56] Cal. Pub. Util. Code §§ 739.9 (West 2013).

In California, the smart meters which are now in place represent billions of dollars' worth of infrastructure investment that the Commission can maximize for all of the values ratepayers hold dear – not only environmental but financial as well. Using the elasticity findings of the CPUC's Statewide Pricing Pilot and marginal costs reported in the three CA IOUs most recent general rate cases, EDF estimates that TOU rates could reduce system costs in the range of half a billion dollars each year (Exhibit A.1). These avoided total system costs combine with the long-term goals Californians have for our environment and for equitable access to affordable, reliable electricity.

In comparison with a tiered system, TOU offers customers more ways to save: by conserving and by shifting away from a short peak time periods on weekdays. For this reason – with appropriate education and enabling technologies where necessary – evidence from around the country and California demonstrates consumers, and future generations, will be bettered with TOU rates today. For this reason, EDF recommends that most customers immediately have opt-out TOU rates, with CARE customers have the ability to opt into these rates. EDF ultimately recommends a vision inclusive of default TOU for all customers in the near future. EDF supports the provision of additional enabling capacities to any households in need of help in managing their energy use and staying comfortable.

To ensure that a transition to TOU rates is as deliberate, and measurably equitable as possible, we recommend a research strategy as part of a transition. EDF anticipates that the detailed mechanics which tiers are collapsed, adjusted, and eliminated – will be the focus of many stakeholder rate proposals. As EDF recommends that most customers have opt-out TOU rates as soon as possible, we acknowledge that some elements of the tiered system – as discussed by many other parties – will need to remain in place for the near term.

EDF believes that the transition – paired with a clear plan to move towards a purer TVR system that learns from itself at each stage and that ultimately provides customers with a diverse menu of choices that meet their varied needs – will meet the goals outlined in this proceeding, as well as the desire of Californians for a cleaner energy system that reduces their bills.

EDF looks forward to continuing to work with the Commission, the parties in this proceeding, and other interested stakeholders to develop a rate structure that meets the environmental and consumer goals outlined herein and developed throughout California's history of dedicated, thoughtful, and effective energy policy.

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Exhibits with Supporting Evidence

Exhibits A.1 & A.2

A. Exhibit A.1: Utility Marginal Cost Savings from TOU

Prepared for Environmental Defense Fund by M.Cubed and Aspen Environmental Group

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Purpose

This exhibit estimates the changes in residential usage and peak load, utility costs and marginal utility benefits that will occur if residential customers are transferred from tiered (which are essentially flat) to time-of-use rates, either as "opt-in" or "opt-out." As is, the model applies to the summer period for each of the three large investor-owned utilities.

Inputs and Assumptions

Elasticity

The analysis relies on short-term elasticity estimates for TOU during the summer period from Charles River Associates' (CRA) 2005 report titled "Impact Evaluation of the California Statewide Pricing Pilot."[57] The study focused on the implementation of "critical peak period" pricing, but customers were placed on baseline TOU schedules, and elasticities measured.

CRA's estimates include the elasticity of substitution and the daily own-price elasticity. The former measures the percentage change in the ratio of peak to off-peak usage for a one percent change in the ratio of peak to off-peak rates, while the latter is equal to the percentage change in peak use resulting from a one percent change in the peak electricity rate.

CRA estimates weekday elasticity for inner summer 2003, inner summer 2004 and outer summer 2003/2004, where inner summer refers to July through September and outer summer includes October 2003 and May and June of 2004. CRA provided standard errors for each estimate, and we computed high and low estimates for each period by adjusting the reported values up and down by one standard deviation. We computed the average high, mid and low elasticities across the three periods for each and applied that to our analysis.

It is important to note that the elasticity estimates from Statewide Pricing Pilot study are short run elasticities. These estimates are conservative in that they are only short-term and do not

[57] Charles River Assocs., *Impact Evaluation of the California Statewide Pricing Pilot* 99 (Mar. 16, 2005), http://www.smartgrid.gov/sites/default/files/doc/files/Impact_Evaluation_California_Statewide_Pricing_Pilot_200501.pdf.

account for further reductions. Generally, price elasticity of demand is greater in the long run because customers have more time to alter their behavior or to install new energy-saving appliances in response to price adjustment. Additionally, a recent study out of the Energy Institute at Haas determined that the price elasticity of demand is 13 percentage points higher for residential customers who are fully informed about real-time energy usage than for uninformed customers.[58] We expanded our range of price elasticities to include elasticities with information benefits by increasing the low, mid and high estimates from CRA by 13 percentage points each.

Table 1. TOU Elasticity Estimates for the Summer Period

	Own Price Elasticity of Demand	Elasticity of Substitution
High	-0.152	-0.065
Mid	-0.129	-0.054
Low	-0.105	-0.042
High w/Information Benefits	-0.287	-0.065
Mid w/Information Benefits	-0.259	-0.054
low w/Information Benefits	-0.236	-0.042

Rates

We used summer rate data from the utilities' tariff schedules as the basis for the TOU. Though the utilities rates are tiered, the analysis uses average rates for the residential class as that recent studies have shown that customers view tiered and average flat rates as indistinguishable.[59] Only PG&E provided an estimate of average rates for its non-TOU residential rates, E-1, EM, ES, ESR and ET, but they did not provide the weights used to compute the average. We estimated weights and applied those to the tiered rates to estimate average TOU and non-TOU for the three utilities. We used the average peak-TOU as the default for our analysis but computed the off-peak TOU for each utility such that the average TOU daily price is equal to the average non-TOU (i.e., tiered) residential rate. Table 2 includes the average non-TOU and TOU peak rates as well as the computed off-peak rate for each utility as well as the ratio of peak to off-peak rates.

Table 2. Average Non-TOU and TOU Rate

	PG&E	SCE	SDG&E
Flat Rate ($/kWh)	0.190	0.182	0.192
TOU Off-Peak Rate ($/kWh) [computed]	0.151	0.0926	0.1863

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[58] Katrina Jessoe & David Rapson, *Knowledge is (Less) Power: experimental Evidence from Residential energy Use No. WP-046R, in Energy and Environmental Economics Working Paper Series* (April 2013), http://www.uce3.berkeley.edu/WP_046.pdf.
[59] *See* Ito, *supra* note 6.

TOU Peak Rate ($/kWh) [from tariff]	0.345	0.506	0.216
Ratio of Peak to Off-Peak Rates for Non-TOU	1	1	1
Ratio of Peak to Off-Peak Rates for TOU	2.287	5.464	1.159

Each utility has vastly different TOU rate structures, as evidenced by the different ratio of peak to off-peak rates for each utility. We used the three ratios to create a range of rate structures in which the ratio is equal across the three utilities. This leaves us with a PG&E rate structure where the ratio for each of the utilities is set to 2.287, an SCE structure where each utility's ratio is 5.464 and an SDG&E structure with a ratio of 1.159 for each utility. In all cases, it is the ratio and not the specific rates that are not identical across utilities, and the daily TOU rate is still set equal to the average non-TOU rate.

Utility Marginal Costs, Peak Load and Usage

The marginal cost, residential peak load and residential usage assumptions come from the utilities' most recent filed General Rate Case (GRC) workpapers. We used marginal costs for generation energy, peak capacity and transmission and distribution investments, adjusted to the residential class per the workpapers. Values for SDG&E come from SDG&E's 2012 GRC Phase 2 (A.11-10-002) Workpapers – Chapter 3 (SAXE), values for PG&E are from its 2011 GRC Phase 2 (A.10-03-014) workpapers and the SCE assumptions are from its 2012 GRC marginal cost and MCCR workpapers (A.11-06-007). The model uses summer usage for E-1, Domestic and DR rate groups for PG&E, SCE and SDG&E, respectively, and peak load values for E-1, Domestic and Residential rate groups for PG&E, SCE and SDG&E, respectively.

TOU Penetration

We constructed a range of TOU penetrations, i.e. the proportion of residential non-TOU customers who move to TOU. We chose 50 percent as a mid-case and default value and 80 percent and 20 percent as the outer bounds, where the low end represents on opt-in TOU system and the high end is a result of an opt-out TOU system. The rationale, here, is that program participation rates are typically higher when people are automatically enrolled in the program and must actively opt-out to abstain from the program than when they only become part of the program by opting-in. The greater proportion for organ donors in Spain, an opt-out nation, than in the U.S.A., where donors must opt-in, is a testament to this.

Methodology

The model is comprised of elasticity and revenue sub-models. The former works in two steps to determine how moving some proportion of existing residential non-TOU customers to a TOU rate structure will change peak use, total use and peak load for the combined group of non-TOU and new TOU residential customers. In the first step, deals with shifting peak use to off-peak periods. We used the average and estimated TOU to compute the ratio of peak to off-peak rates under the TOU system and compared it to the existing ratio of peak to off-peak rates under the non-TOU system, which is equal to one. The percentage change in the use ratio is then equal to the elasticity of substitution multiplied by the percentage change in the rate ratio. We use this change to compute the use ratio rate and, in turn, the proportion of peak and off-peak use for the customers who moved to TOU. The model applies these proportions to the daily use for TOU customers to estimate the peak and off-peak use for the new TOU customers.

The second phase computes the price effect, i.e. how peak use changes in response to changes in peak period rates. The model computes the change in peak use as the percentage change in average peak TOU multiplied by the percentage change in peak rates. The computed change is applied to the peak use value determined in phase I to produce an estimate for peak use after the price effect.

Up until this point, the changes have applied only to the subset of residential customers who moved from a residential to TOU customers. We then compute the results as they apply to the combined group of customers who remained on the non-TOU rate and customers who moved to the TOU schedule. Additionally, we assume that peak load changes in the same manner as peak usage. We multiply the initial peak load for the residential class by the percentage change in peak usage to determine the peak load after a proportion of residential non-TOU customers are moved to TOU.

The revenue sub-model estimates the change in total costs, comprised of capacity, generation and distribution costs, as well as change in utility marginal benefits for PG&E E-1, SCE Domestic and SDG&E DR rate groups when some portion of the group is moved to a TOU rate. To determine the change, the model first computes each cost component for the residential class before TOU are introduced and after some proportion of the residential class has moved to TOU. Generation energy costs are determined by multiplying the marginal generation energy costs ($/KWh) for the summer period by summer usage. Generation capacity costs are the product of marginal generation capacity costs and peak load, and, similarly, distribution costs are estimated by multiplying the marginal distribution costs by peak load.

Results

We first estimated the results using the default assumptions, that is, with both elasticities set at their mid values, the proportion of TOU customers equal to 50%, and current TOU rate structures specific to each utility. Tables 3 and 4 show the results for the default input selections using a 50 percent participation rate. SDG&E experiences very small changes in total use, peak load and total cost compared to the SCE and PG&E. The marginal benefit for each utility is similar to the average residential rate, ranging between $0.147 (SDG&E) and $0.227 (SCE) per kWh.

Table 3. Marginal Benefit and Change in Total Use, Peak Load and Total Cost

	Units	PG&E	SCE	SDG&E
Change in Total Use	KWh	(107,402,296)	(211,549,335)	(4,508,209)
Change in Peak Load	MW	(617)	(1,572)	(18)
Change in Total Cost	$	$112,704,512	$357,367,617	$2,592,294
Marginal Benefit	$/MWh	$183	$227	$147

Table 4. Marginal Benefit and Percentage Change in Total Use, Peak Load and Total Cost

	PG&E	SCE	SDG&E
Change in Total Use	-1.0%	-2.0%	-0.2%
Change in Peak Load	-7.7%	-19.1%	-1.2%
Change in Total Cost	-6.2%	-15.%	-0.7%

Model Sensitivities

Table 5 shows the results for different elasticities, rate structures and TOU penetrations, so that we can see how these inputs impact the results. The table reflects an "all else equal" analysis where the model varies only the highlighted input as the other two inputs are held constant at their default values. For example, the first portion of the table presents results for the range elasticities while holding rate structure and TOU penetration to their default values. This allows you to isolate the impacts of each of the three inputs on the results.

Rate structure is responsible for nearly all the variation in results across the utilities. SDG&E's default peak TOU is only 12.7 percent higher than its flat rate. SCE and PG&E's TOU peak rates are 178 percent and 81.5 percent higher than their flat rates, respectively. Thus, the latter two utilities experience greater decreases in peak use than SDG&E, which leads to greater changes in costs. When the utilities have identical rate structures, the reported percentage changes in costs, peak and usage are nearly identical for each utility.

The marginal benefit does not change significantly as the elasticities, rate structure and TOU penetration vary. This is to be expected because the underlying marginal cost estimates do not change. As is expected, increased TOU penetrations and elasticities lead to greater changes in costs, peak and usage.

Total Costs are equal to the sum of generation capacity, energy and distribution marginal costs reported in the GRC workpapers. Using SCE's rate structure with a 50 percent penetration rate, those costs fall between 12.9 percent (for SDG&E) to 15.5 percent (for PG&E). Residential peak load could fall 19 to 21 percent. In SCE, with an 80 percent participation rate consistent with opt-out, those costs fall 24 percent; peak load falls by 2,515 MWs or more than the entire output from SONGS.

Table 5: Marginal Benefit, Change in Total Use, Change in Peak Load and Change in Total Cost For Varying Inputs

		PG&E	SCE	SDG&E	PG&E	SCE	SDG&E
Elasticity of Substitution and Own Price Elasticity							
Change in Total Use	**Elasticity Selection**		KWh			%	
	Low	(89,318,061)	(183,182,760)	(3,707,885)	-0.8%	-1.7%	-0.1%
	Mid	(107,402,296)	(211,549,335)	(4,508,209)	-1.0%	-2.0%	-0.1%
	High	(124,991,704)	(235,486,441)	(5,306,114)	-1.2%	-2.2%	-0.2%
	Low w/Information Benefits	(199,204,635)	(408,549,563)	(8,269,636)	-1.9%	-3.8%	-0.3%
	Mid w/Information Benefits	(215,917,570)	(425,290,892)	(9,063,136)	-2.0%	-4.0%	-0.3%
	High w/Information Benefits	(232,127,451)	(437,331,961)	(9,854,211)	-2.2%	-4.1%	-0.3%
Change in Peak Load	**Elasticity Selection**		MW			%	
	Low	(503)	(1,291)	(14)	-6.3%	-15.7%	-0.9%
	Mid	(617)	(1,572)	(18)	-7.7%	-19.1%	-1.2%
	High	(729)	(1,841)	(21)	-9.2%	-22.4%	-1.4%
	Low w/Information Benefits	(906)	(2,097)	(27)	-11.4%	-25.5%	-1.8%
	Mid w/Information Benefits	(1,015)	(2,336)	(30)	-12.7%	-28.4%	-2.0%
	High w/Information Benefits	(1,122)	(2,563)	(33)	-14.1%	-31.2%	-2.2%
Change in Total Cost	**Elasticity Selection**		$			%	
	Low	$ 91,960,781	$ 294,009,297	$ 2,107,713	-5.0%	-12.3%	-0.6%
	Mid	$ 112,704,512	$ 357,367,617	$ 2,592,294	-6.2%	-15.0%	-0.7%
	High	$ 133,159,376	$ 417,919,106	$ 3,075,967	-7.3%	-17.5%	-0.9%
	Low w/Information Benefits	$ 167,240,483	$ 483,621,460	$ 4,003,223	*-9.1%*	*-20.3%*	*-1.1%*
	Mid w/Information Benefits	$ 187,044,781	$ 537,198,890	$ 4,484,968	*-10.2%*	*-22.5%*	*-1.3%*
	High w/Information Benefits	$ 206,554,576	$ 587,741,659	$ 4,965,804	-11.3%	-24.6%	-1.4%
Marginal Benefit	**Elasticity Selection**		$/MWh				
	Low	$ 183	$ 228	$ 147			
	Mid	$ 183	$ 227	$ 147			
	High	$ 183	$ 227	$ 147			
	Low w/Information Benefits	$ 185	$ 231	$ 150			
	Mid w/Information Benefits	$ 184	$ 230	$ 149			
	High w/Information Benefits	$ 184	$ 229	$ 149			
Proportion of Customers Moved to TOU Proportion							
Change in Total Use	**Selection**		KWh			%	
	20%	(42,960,919)	(84,619,734)	(1,803,284)	-0.4%	-0.8%	-0.1%
	50%	(107,402,296)	(211,549,335)	(4,508,209)	-1.0%	-2.0%	-0.1%
	80%	(171,843,674)	(338,478,937)	(7,213,135)	-1.6%	-3.2%	-0.2%
Change in Peak Load	**Proportion Selection**		MW			%	
	20%	(247)	(629)	(7)	-3.1%	-7.6%	-0.5%
	50%	(617)	(1,572)	(18)	-7.7%	-19.1%	-1.2%
	80%	(987)	(2,515)	(28)	-12.4%	-30.6%	-1.9%
Change in Total Cost	**Proportion Selection**		$			%	
	20%	$ 45,081,805	$ 142,947,047	$ 1,036,918	-2.5%	-6.0%	-0.3%
	50%	$ 112,704,512	$ 357,367,617	$ 2,592,294	-6.2%	-15.0%	-0.7%
	80%	$ 180,327,219	$ 571,788,187	$ 4,147,670	-9.9%	-24.0%	-1.2%
Marginal Benefit	**Proportion Selection**		$/MWh				
	20%	$ 183	$ 227	$ 147			
	50%	$ 183	$ 227	$ 147			
	80%	$ 183	$ 227	$ 147			
Utility TOU Rate Structure							
Change in Total Use	**TOU Structure**		KWh			%	
	Current Structure	(107,402,296)	(211,549,335)	(4,508,209)	-1.0%	-2.0%	-0.1%
	PG&E's Structure	(107,402,296)	(110,457,088)	(28,905,527)	-1.0%	-1.0%	-0.9%
	SCE's Structure	(208,888,532)	(211,549,335)	(57,845,248)	-1.9%	-2.0%	-1.9%
	SDG&E's Structure	(17,091,814)	(17,767,232)	(4,508,209)	-0.2%	-0.2%	-0.1%
Change in Peak Load	**TOU Structure**		MW			%	
	Current Structure	(617)	(1,572)	(18)	-7.7%	-19.1%	-1.2%
	PG&E's Structure	(617)	(621)	(122)	-7.7%	-7.6%	-8.1%
	SCE's Structure	(1,567)	(1,572)	(313)	-19.7%	-19.1%	-20.7%
	SDG&E's Structure	(90)	(91)	(18)	-1.1%	-1.1%	-1.2%
Change in Total Cost	**TOU Structure**		$			%	
	Current Structure	$ 112,704,512	$ 357,367,617	$ 2,592,294	-6.2%	-15.0%	-0.7%
	PG&E's Structure	$ 112,704,512	$ 142,727,038	$ 17,881,072	-6.2%	-6.0%	-5.1%
	SCE's Structure	$ 283,769,098	$ 357,367,617	$ 45,046,607	-15.5%	-15.0%	-12.9%
	SDG&E's Structure	$ 16,498,050	$ 21,036,647	$ 2,592,294	-0.9%	-0.9%	-0.7%
Marginal Benefit	**TOU Structure**		$/MWh				
	Current Structure	$ 183	$ 227	$ 147			
	PG&E's Structure	$ 183	$ 230	$ 146			
	SCE's Structure	$ 181	$ 227	$ 144			
	SDG&E's Structure	$ 183	$ 231	$ 147			

B. Exhibit A.2: Tradeoffs: Bill Calculator Sensitivity Analysis

In this exhibit, EDF examines the tradeoffs between the peak-off-peak price differences, length of peak price time window, and peakyness of customers in designing TOU rates. We seek to understand the exent of load shifting (i.e., peak to off-peak substitution patterns) that may be needed to avoid any increases in monthly bills in a switch from current tiers to TOU.

1. Limitations of IOU Bill Calculators

Before offering findings, first a note about the IOU provided bill calculators. EDF investigated and exercised all three bill calculators to inform this Exhibit. IOU staff were very responsive in answering questions and clarifying operational steps within the calculators. For several reasons, EDF determined that an analysis with a simpler, generic, bill calculator would be best to elucidate the questions of interest. These reasons included:

- Inability to see individual customer load profiles with the IOU bill calculators (as well as EDF's lack of access to heterogeneous micro data on electricity usage rather than aggregated utilization data), so EDF created an average customer's load profile based on hourly system-load data provided from SCE and total electricity tier usage by PG&E;
- Confusing responses within the IOU bill calculators, specifically with respect to comparing model-derived peak and off-peak prices against tiered rate prices. EDF found the average rates from the bill calculator to be illogically high and much higher than tiered rates also provided from the calculator. It was thus unclear how the bill impacts would be respresented since there appeared to be a bias that implied all TOU bills would be increased.

Along with other parties, EDF has noted that the bill calculators aren't capable of analyzing the complete set of questions that will need to be examined. In this respect, EDF needs the capacity to develop the following analyses:

(1) *What affect will alternative rate structures have on customer demand? EDF can estimate the bill impacts and revenue requirement consequences resulting from a plausible range of customer changes in demand in response to changes in prices (i.e., elasticities).* Consumer price responsiveness will occur when understandable and transparent price structures and when viable "substitutes" (e.g., conservation, load shifting) are made salient to consumers (and their 3rd party service providers). Instead of assuming that consumer price responsiveness is inelastic, or has a limited elasticity that does not vary with differing rate structures, we should instead be designing rate structure and educational programs to *find* the sweet spot where consumers are likely to respond to appropriate and rational price structures. In comparing rate proposals, application of appropriate elasticities to estimate changes in demand prompted by different tariff structures will create a more realistic understanding of the consequences of specific designs, potentially demonstrating a number of benefits, including (peak) load and concomitant emission reductions. Short and long-term elasticity assumptions can be

obtained from California Energy Commission studies, as well as research by Koichiro Ito (UC Berkeley Energy Institute), Ahmad Faruqi (Brattle Group), and summaries of research from Chuck Goldman (LBNL), amongst others.[60] Other stakeholders are concerned about what values should be used for elasticities in the bill calculators. EDF has commented that the key question is: **what elasticities are required to best meet the goals of rate design?** This Exhibit endeavors to answer that question. This then would identify the level and location of DER and other environmentally beneficial subsidies that might need to be offered. Currently the calculators solve for rate(s) while holding fixed both revenue requirement and elasticity.

(2) What are the long term implications of different rate structures on the load forecasts used in distribution planning and on the procurement of new generation resources? EDF can estimate the long term marginal cost benefits of demand (and load factor) forecasts associated with each rate design alternative. The resulting changes to demand forecasts can be used to examine revenue requirements over several general rate case cycles. The IOUs have recently developed distribution system forecast models, which can be employed to estimate avoided distribution costs from consumption changes. EDF examines this question in Exhibit A.1.

(3) What are the long term revenue requirement implications of different rate structures, both in terms of stranded assets and future new investments? EDF can estimate the long term marginal cost benefits of demand (and load factor) forecasts associated with each rate design alternative. EDF can estimate impacts on revenue requirements, and feed that back into other analyses. Similar to the elasticity analyses, changes in revenue requirements need to be traced to fully understand the (beneficial) implications of different rate designs.

(4) What are the tradeoffs between energy bill consequences and incentives for private investment in DER? EDF can estimate changes to the level and location of DER adoption. Of keen concern is whether changes to baseline subsidies and rate design could increase adoption of photovoltaic and other distributed generation, as well as demand-response and efficiency measures, and shift it from the coasts to inland areas.[61] Analyses developed by the California Independent System Operator (e.g., *Final Report for Assessment of Visibility and Control Options for Distributed Energy Resources*, June 21, 2013) may be useful for this purpose, as could examinations of existing relationships between adoption rates, subsidies, and tariffs.

(5) *What are the environmental impacts of rate design alternatives? EDF can compare emission changes for each rate proposal.* EDF's primary goal in the proceeding is Commission adoption of rate designs that serve to lower grid-related emissions and to support the ongoing development of a greener grid ecosystem that includes infrastructure,

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[60] These include examinations of average and tiered rate elasticities.

[61] Solar subsidies associated with tiered rates could also be examined.

regulated and merchant firms, customers and regulators. These tradeoffs cannot be examined in the IOU provided bill calculators.

Though TOU pricing can have positive impacts on conservation and load factor by presenting clearer price signals and inducing shifting behavior from peak to off-peak times, there may be varying impacts on the household energy bill depending on several factors. These factors include the peak time window (e.g., 3 hours), the price levels, the ratio of peak price to off peak price, and the shifting behavior that the household exhibits (i.e., the ability to shift electricity consumption from expensive times to cheaper times of day). The utility defines the first three of these and can help to influence the latter through implementing efficiency and shifting programs that help reduce consumption and smooth it throughout the day.

The size of the peak window could have a large impact on the household energy bill. Specifically, as the peak window grows, the ability of the household to respond to the difference in prices will decrease. For example, if the peak window runs from 4pm to 9pm it is more difficult for the household to avoid cooking dinner during peak times. If the peak window instead ended at 7pm, then the household could utilize the oven starting at 7 pm and face a lower bill than with a larger peak window. Therefore, as the length of the peak window expands, the household will have to increase its shifting behavior, although it will become increasingly more difficult to avoid peak times.

Furthermore, there exists a trade-off between peak window sizes and prices. Consider an average customer who currently utilizes approximately 30% of energy between 3 and 8pm and 18% of energy between 4 and 6pm. If the peak window is 3-8pm, then this customer will need to pay a higher price on 30% of the energy he utilizes; if the peak window is between 4 and 6, then the customer will only face high prices for 18% of his energy consumption. This implies that there is a tradeoff between peak window sizes and prices, given the revenue neutrality condition required by the utility: smaller peak windows require higher peak prices. This can be seen in Figure 1, where the average customer faces either a 4 hour or a 2 hour window.

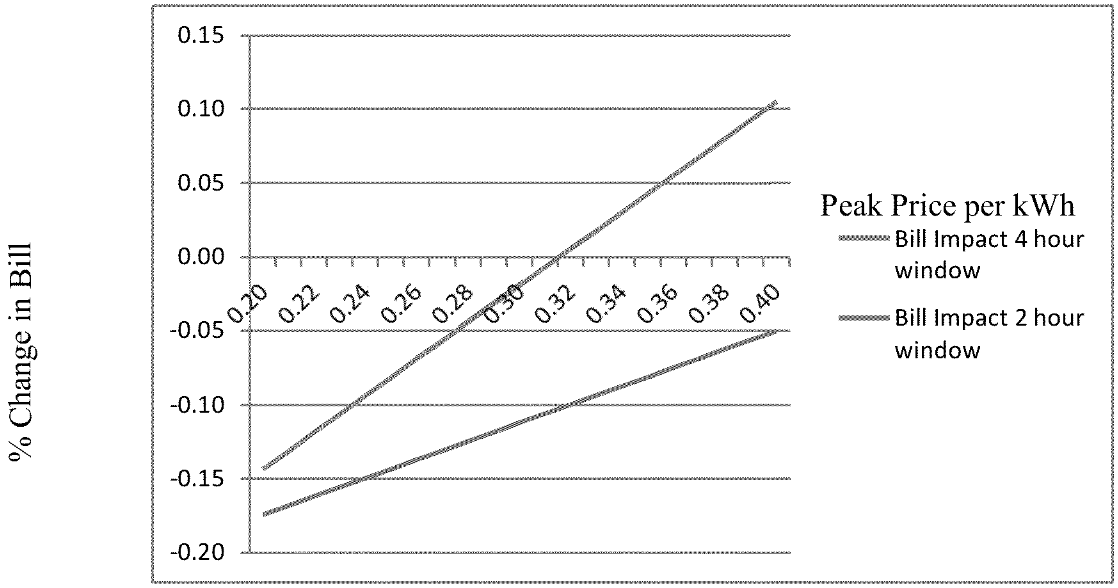


Figure 3: 2 and 4 Hour Peak Windows (15 cents off-peak price)

Given an off-peak price of $.15/kW h, this figure demonst rates that higher peak prices ha ve a much larger impact on b ills when the p eak window is larg er. In f act, the 2 hour p eak window must charge over 40 cents f or the peak per iod compared to $0.32/kWh f or the 4 hour peak window in orde r to mainta in the same bill as unde r tiered rates (g iven a $0.15/kWh off-pe ak price.)[62]

The analy sis above cons iders the bill for an avera ge customer under tiered rates (using data on tier usage, hourly load and pri ces during the summ er), and compa res it to a TOU structure, given no chan ge in ov erall demand. Fur thermore, this initial analy sis p resented in Figures 1a and 1b assumes that the individual does not exh ibit shifting behavior betw een peak and off-peak times, which is highly unlikely given the difference in pri ces between peak and off-peak times. Factoring in shifting behavior, the bill impacts vary depending on the peak window size. That is, the l arger the peak window, the more s hifting has to occur in order to mainta in bill ne utrality between the current tier scheme and the proposed TOU pricing scheme . Fur thermore, the electric utility can set the off-peak price rela tively low when the peak price is high in order to incentivize shif ting behavior: the greater the diff erence betw een p eak and off-peak times, the stronger the price signal is. Figure 1 a ssumes that the off-peak price is set at $0.15/kW h regardless of the peak price, although havin g the off-peak price drop as the peak price increases will help to induce more shifting behavior at lower peak prices.

We therefore analyze the bill impacts for an average non-CARE customer g iven a varyin g off-peak price, where the peak price increases in relation to the off-peak price (i.e., the off-peak price

[62] 15 cents is merely an example; the result of this analysis holds for different off-peak prices.

decreases as the peak price increases). Figure 2 demonstrates the bill impacts for an average customer given a decreasing off-peak price, rather than a constant $.15/kWh off-peak price, for both a 2 hour and a 4 hour peak window. [63] The horizontal axis demonstrates the ratio between peak and off peak prices given starting values of $.20/kWh for both the peak and off-peak price (the ratio begins at 1 and ends at 3, where the peak price is $0.40/kWh and the off-peak price is $0.13/kWh). The vertical axis shows the bill impact (percent change in bill) relative to current tiered structure and prices.

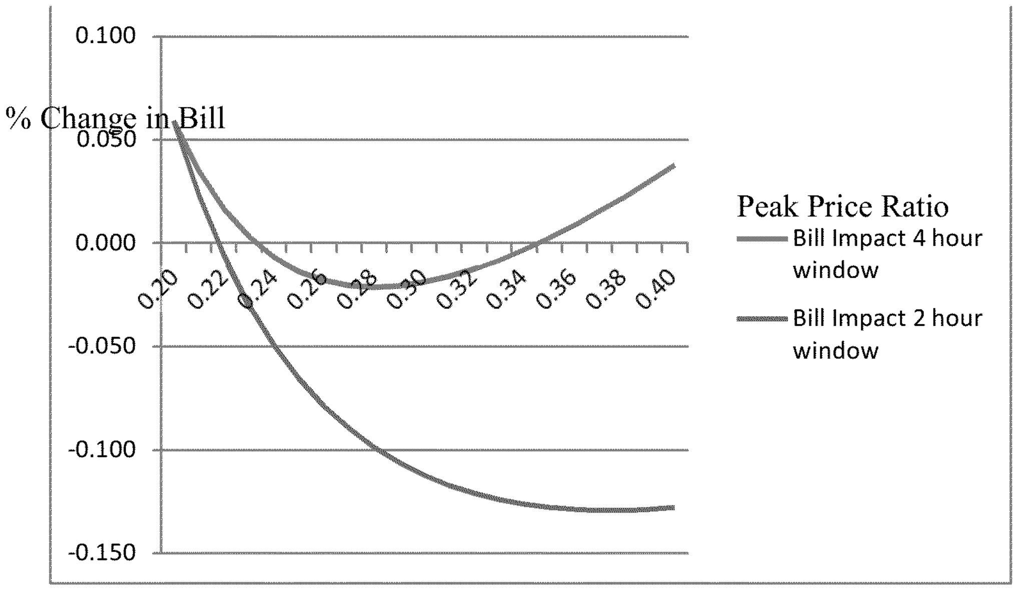


Figure 2: 2 and 4 Hour Peak Window (varying off-peak price)

Figure 2 demonstrates that under a larger peak window, the impact of the high priced energy is more important in the bill than the low priced energy; under a 4 hour peak window, once the peak price becomes more than 1.8 times larger than the off-peak price, the bill impact begins to rise. However, under a smaller peak window, the impact of a high peak price stabilizes given an increasingly lower off-peak price. This implies that, all else being equal, larger peak windows will need to have a smaller ratio between peak and off-peak prices in order to minimize the bill impacts for the average customer.

Missing from this analysis is the customer's shifting behavior between expensive and inexpensive times of day. Of course, the more shifting that occurs, the lower the bill impact will be. Thus it is important to understand how these impacts vary given the level of shifting and peak window size. Figures 3a and 3b demonstrate how shifting behavior affects the bill outcomes under different ratios of prices and peak time windows. A 5% shift, for example, implies that 5% of the peak energy usage is transferred to off-peak times.

[63] This graph also assumes no shifting behavior (i.e., the hourly load does not change under TOU).

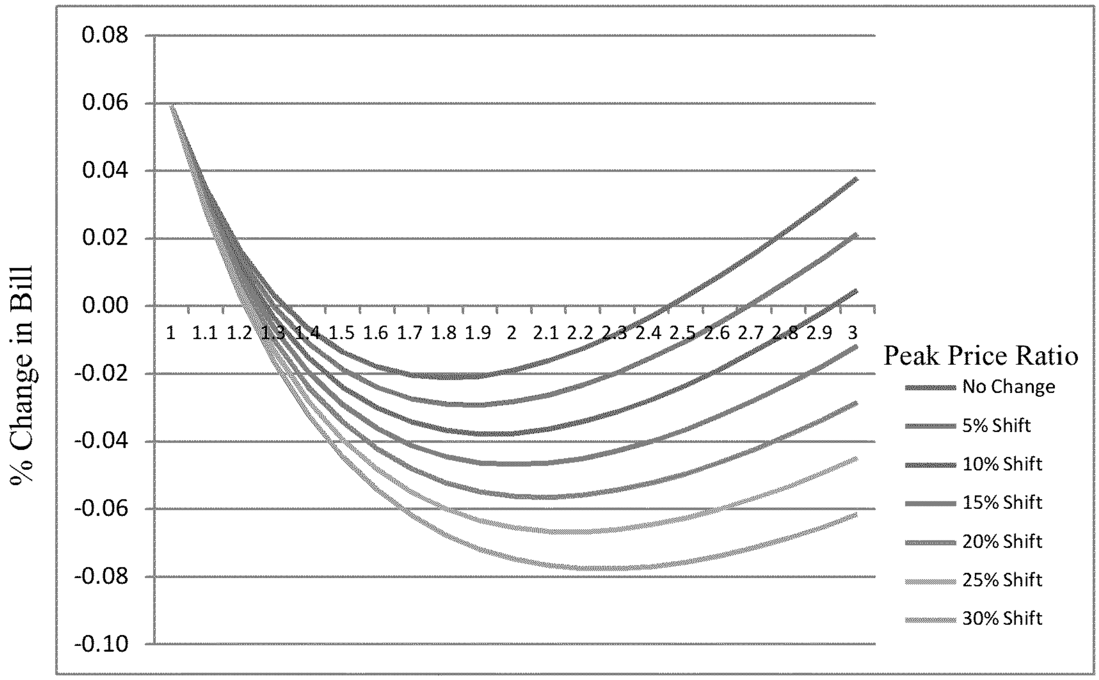


Figure 3a: 4 Hour Peak Window (varying prices and shifting)

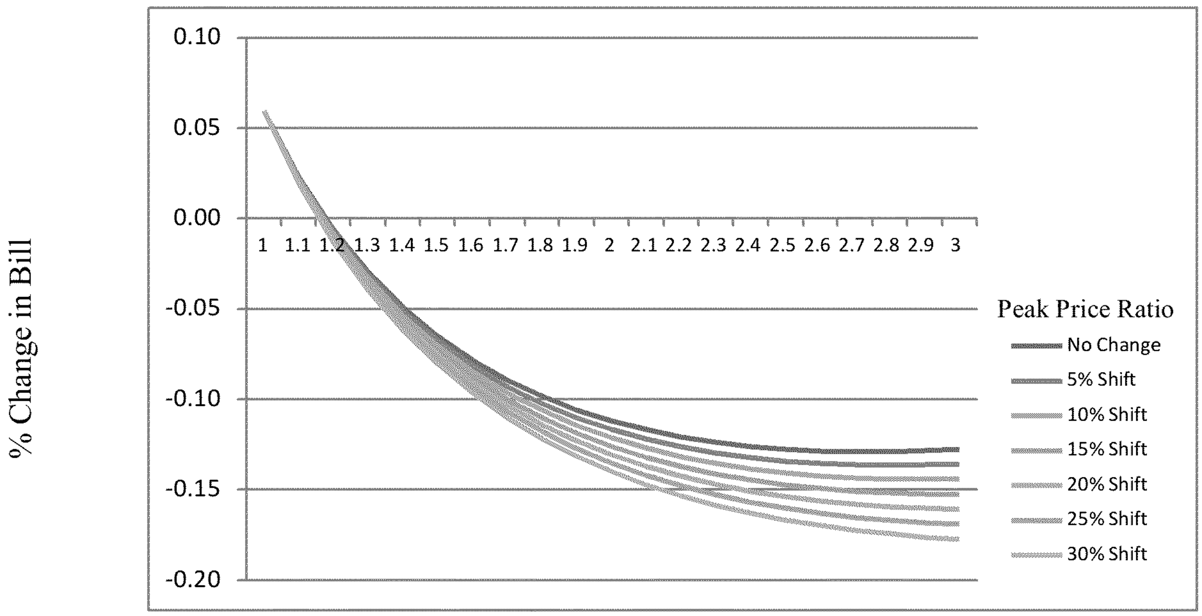


Figure 3b: 2 Hour Peak Window (varying prices and shifting)

These figures demonstrate that under a smaller peak window, shifting has less of an impact on the monthly energy bill. As a larger fraction of the energy is priced expensively, being able to shift away from peak time usage results in greater decreases in energy bills. For example, if the peak price is twice as expensive as the off-peak price (i.e., ratio equals 2), under a 4 hour peak window, 30% shifting results in almost twice as much bill reduction (relative to no shifting behavior) as under a 2 hour peak window.

Unfortunately, the ability of a household to shift between time periods decreases as the peak window increases, so large shifting behavior is less likely under a 4 hour peak window than under a 2 hour peak window. The amount of shifting that will occur under a TOU depends on the ability of the household to change their behavior, though the utility also can help influence the shifting behavior by increasing education and helping individuals adopt set-it-and-forget-it technologies to help shift consumption across hours.

This analysis demonstrates that there exist trade-offs between the size of the time window and price ratios, shifting, and peak prices. Essentially, as the size of the time window increases, the utility must either decrease the price ratio, incentivize household shifting, or lower peak prices in order to diminish the bill impacts on the customers.

Exhibit B: Recommendation for Peak and Super-Off Peak Price Windows

Hourly load data for the years 2006 through 2011 were provided by SCE and PG&E. The SCE data was also broken down by data type, with types of Domestic (total system load), Domestic Single Family (Dom-SF), Domestic Multi Family (Dom-MF) and Domestic Multi Meter (Dom-MM).

In an attempt to understand when peak load is occurring by season, the data were used to create an averaged, normalized load profile by season for each of the datasets. Only the last full year from the datasets were used. The data for each of the last four full seasons were used to create an averaged load profile by season, normalized so the total daily load per season is constant. In this way the shape of the load profiles by season can easily be compared to each other.

Figure 4 is the normalized load by season and for each data type from the SCE dataset, and Figure 5 is the normalized load by season for the total system load from the PG&E dataset. All the datasets show that peak load for the summer months occurs around hour 17 (5 PM), and that peak loads for all other months occurs slightly later, around hour 19 (7 PM). Normalized daily load curves are most similar in the SCE dataset for Spring and Fall seasons, with the Winter load curve showing a dip in the load shape around hour 16 (4 PM). Interestingly, the normalized load shapes for the PG&E data are flatter, ie the ratio between peak maximum load and off peak minimum loads are smaller than for the SCE data. Given that the PG&E load is considerably larger than the SCE dataset, the relatively flatter load profiles may be a result of averaging more individual load profiles across the PG&E territory, and may indicate that larger balancing areas result in flatter load profiles.

In moving from the current structure to TOU, the optimal peak and off peak time periods needs to be considered. It would be interesting to use the data presented here to determine these time periods. Clearly the location of the peak and off peak midpoints can be easily determined from these data. However, as can be seen from the data, simply creating a wider window around the peak and off peak midpoint hours will simply pick up more of the daily load into the respective time periods. In Table 2 we tabulate the peak and off peak midpoint hours by season for the SCE dataset, and show the percentage of total daily load that is captured around this midpoint hour as a function of the time window, as specified by "Hour Range." In Table 3 we tabulate similar results from the PG&E dataset. Determining the optimal width for peak and off peak periods under a TOU structure will depend on a variety of factors including the ability of such a rate structure to appropriately charge customers for the value of energy being delivered during various times of the day resulting from congestion costs as well as ancillary service costs such as capacity and flexible capacity needed to manage system ramping events.

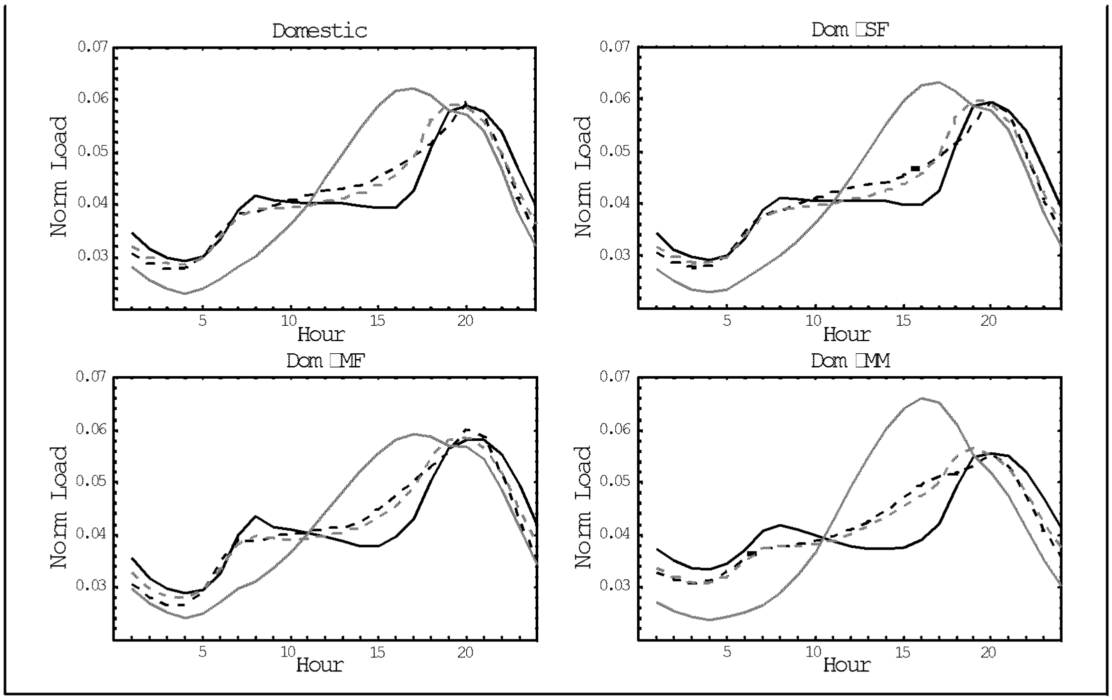


Figure 4: Normalized Load by Season and for each data type from the SCE load data. Only the last full year in the record was used (2010-2011) in this data analysis.

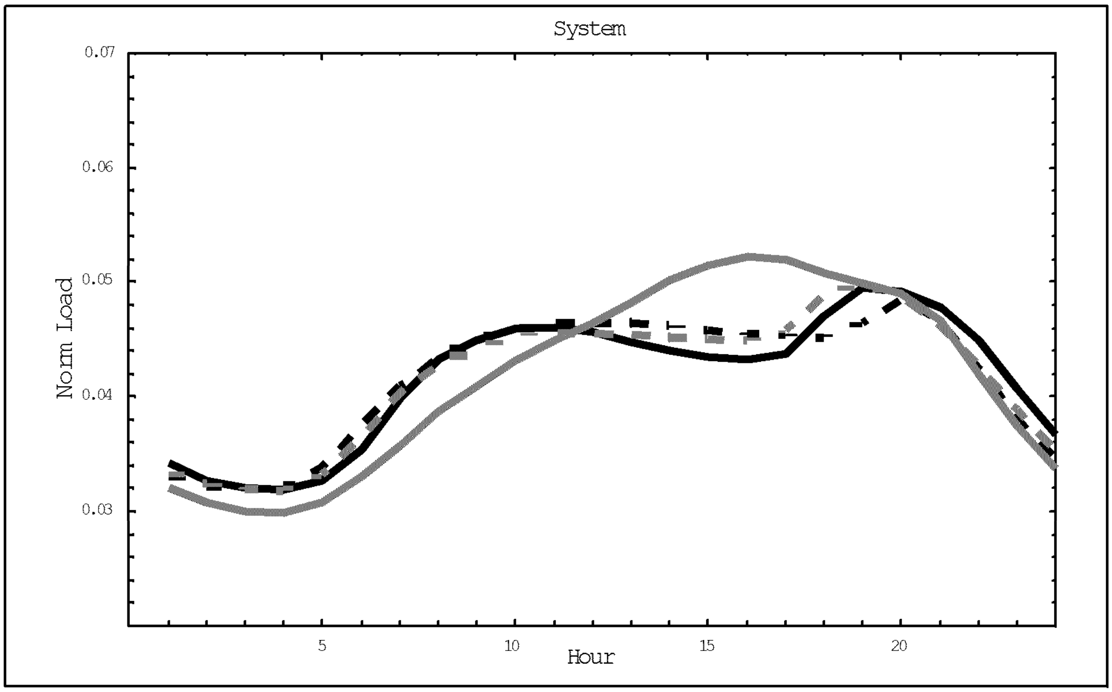


Figure 5: Normalized Load by Season for PG&E system load. Only the last full year in the record was used (2010-2011) in this data analysis.

			Hour Range					
Season	Time	Hour	1	2	3	4	5	6
Winter	Peak	20	5.91%	11.70%	17.49%	22.73%	27.97%	32.46%
Spring	Peak	20	5.91%	11.70%	17.49%	22.73%	27.97%	32.46%
Summer	Peak	17	4.93%	9.88%	14.83%	19.86%	24.89%	30.06%
Fall	Peak	19	5.52%	11.09%	16.66%	22.00%	27.34%	32.20%
Winter	Off Peak	4	2.32%	4.70%	7.09%	9.66%	12.23%	15.04%
Spring	Off Peak	3	2.39%	4.83%	7.26%	9.85%	12.45%	15.35%
Summer	Off Peak	4	2.86%	5.79%	8.72%	11.89%	15.07%	18.56%
Fall	Off Peak	4	2.86%	5.79%	8.72%	11.89%	15.07%	18.56%

Table 2: Hour at which peak and off peak loads occur by season for SCE domestic load dataset. Hours are given in military format (1 – 24). Also shown is the fraction of load occurring within a time window with width specified by "Hour Range."

			Hour Range					
Season	Time	Hour	1	2	3	4	5	6
Winter	Peak	19	4.96%	9.77%	14.58%	19.16%	23.73%	28.14%
Spring	Peak	20	4.92%	9.78%	14.65%	19.25%	23.84%	28.07%
Summer	Peak	16	4.55%	9.11%	13.66%	18.23%	22.79%	27.44%
Fall	Peak	19	4.65%	9.33%	14.01%	18.61%	23.21%	27.61%
Winter	Off Peak	4	2.98%	6.02%	9.06%	12.25%	15.44%	18.83%
Spring	Off Peak	3	3.01%	6.04%	9.07%	12.20%	15.34%	18.68%
Summer	Off Peak	4	3.18%	6.44%	9.70%	13.14%	16.58%	20.28%
Fall	Off Peak	4	3.18%	6.44%	9.70%	13.14%	16.58%	20.28%

Table 3: Hour at which peak and off peak loads occur by season for PG&E system load. Hours are given in military format (1 – 24). Also shown is the fraction of load occurring within a time window with width specified by "Hour Range."

Exhibits C.1 & C.2

A. Exhibit C.1: Making TOU Work for CARE Customers

In this exhibit EDF examines energy use profiles for CARE and non-CARE customers under existing tiered rates, the potentially beneficial implications of TOU to CARE recipients, and ways to ensure that implementation of TOU would benefit low-income households.

Tier Structure, Combined With CARE, Appears to Encourage Excessive Electricity Consumption

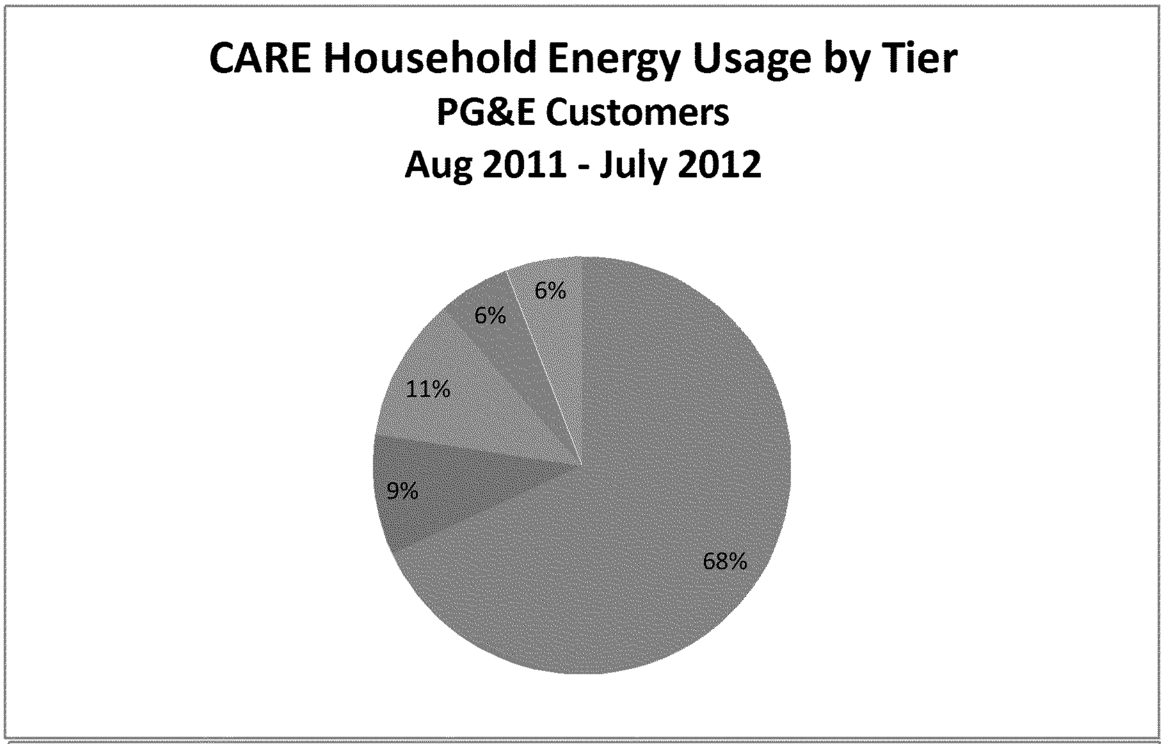
Although CARE reduces electricity bills for qualifying low-income families, significantly enhancing affordability for these households, provision of the subsidy is correleated with what appears to be excessive energy use. That is, CARE customers use more electricity, at top tiers, than non-CARE customers. This suggests that more cost-effective, conservation-oriented strategies for delivering assistance to CARE customers are warranted.

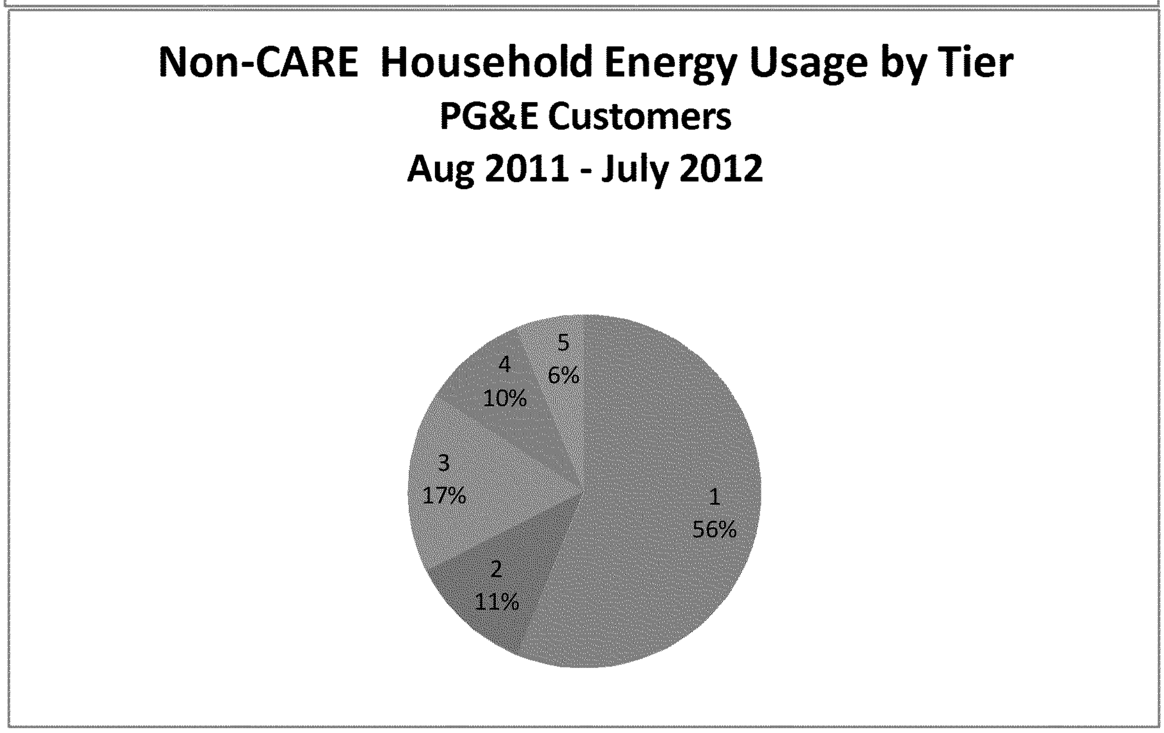
The CARE discount – at Tiers 3 and above bill reductions can be more than 30% - combined with tiered rate structures more or less eliminates any signal for CARE customers to conserve based on underlying utility costs of service. When the subsidy is highest, CARE customers pay less than 70 cents for every dollar of energy they purchase. Likewise, tiered rates themselves are delinked from underlying service costs, which are time- and place-based, and essentially result in one presentation, at the end of the month, of the relationship between household energy use and the associated bill. Given low-income households' limited abililty to invest in energy-saving appliances – and the reduced incentive to do so under tiered-based CARE subsidies – it is not surprising that many CARE households use more energy than non-CARE households.[64]

The pie charts in Figure C.1 show the proportion of energy use by tier for CARE and non-CARE households in PG&E's service territory. As indicated in the figure, CARE customers use more Tier 1 energy than non-CARE customers. This is partly an artifact of the greater Tier 1 baseline allocation in climate zones with a larger CARE customer population, such as the Central Valley.

Figure C.1: CARE Customers use More Tier 4 and 5 Energy than Non-CARE Customers

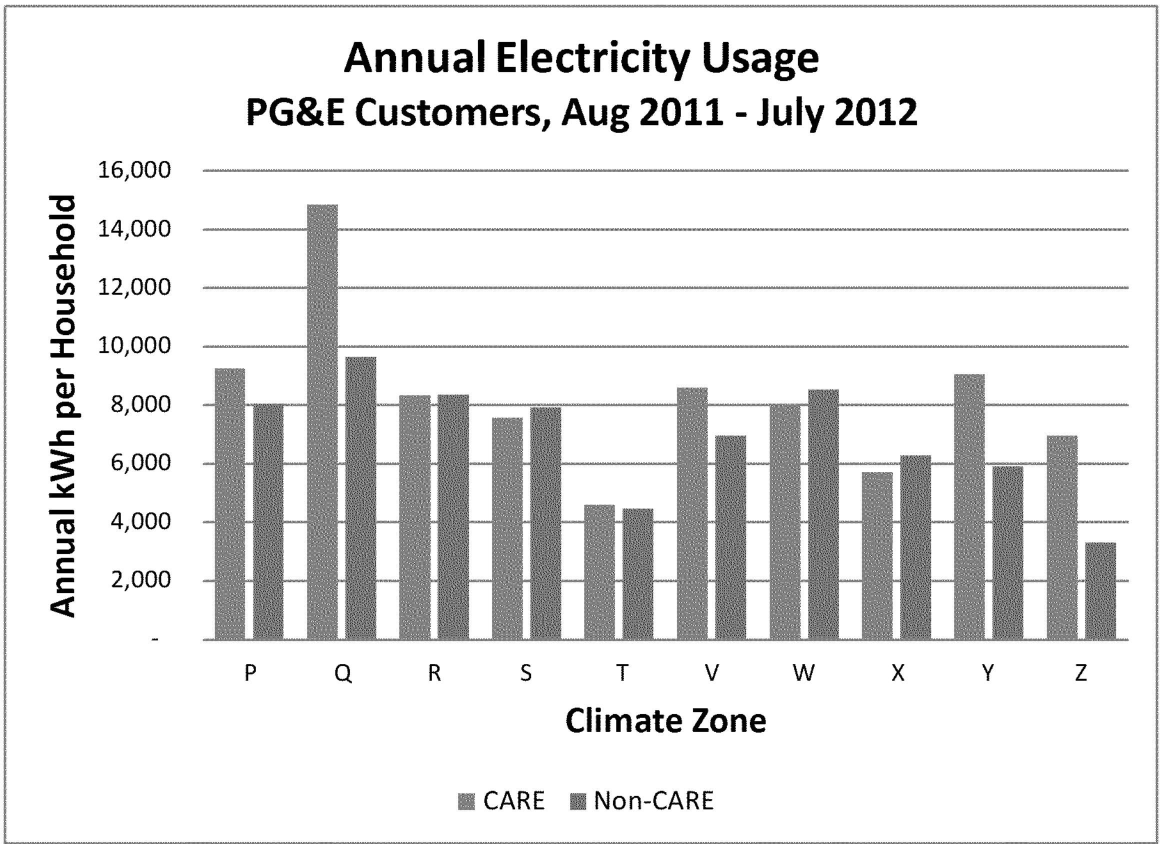
[64] As will be discussed later in this exhibit, there are other explanations for high energy use in CARE households, including lack of information, "split incentives," degraded buildings, and high implicit discounting of future benefits that undercuts efficiency investments. Indeed, work by Lucas Davis finds that renters, who are more likely to be CARE recipients, tend to be poorer and tend to have older appliances.





On a per capita basis, CARE customers use more energy than non-CARE customers in six of PG&E s ten climate zones. Figure C.2 shows household annual average energy use by customer type and climate zone. For PG&E s full service territory, the average CARE household used 6,679 kWh from August 2011 to July 2012, 5% higher than non-CARE homes, which consumed an average of 6,377 kWh.

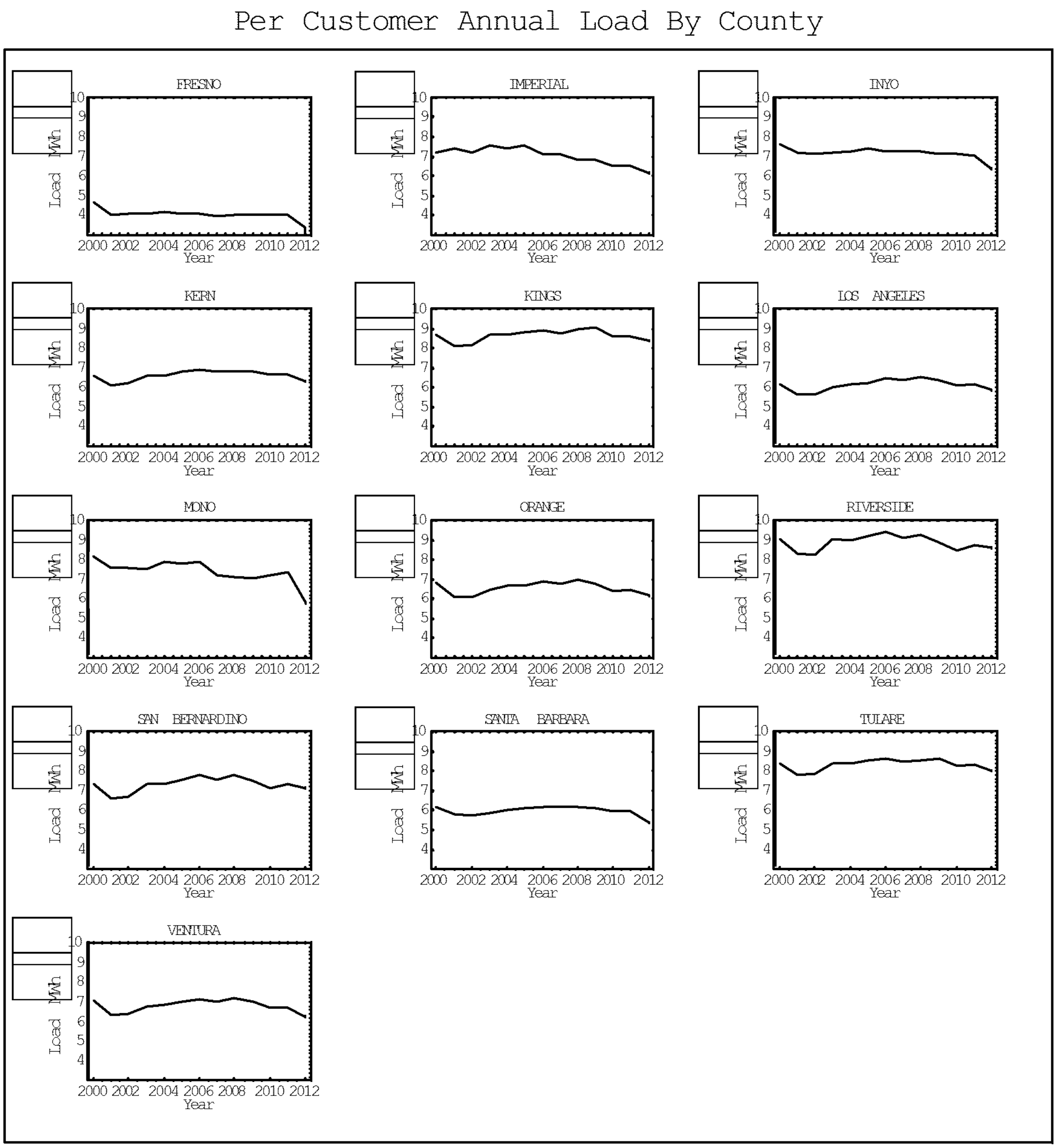
Figure C.2: Comparison of CARE and Non-CARE Household Annual Energy Use



Zones R, S, T, W and X contain 93% of CARE households in PG&E's service territory. None of the counties in these zones have average CARE household energy use above the non-CARE average. As indicated in Figure C.3, it is notable that that these five zones are the most heavily subsidized by CARE.

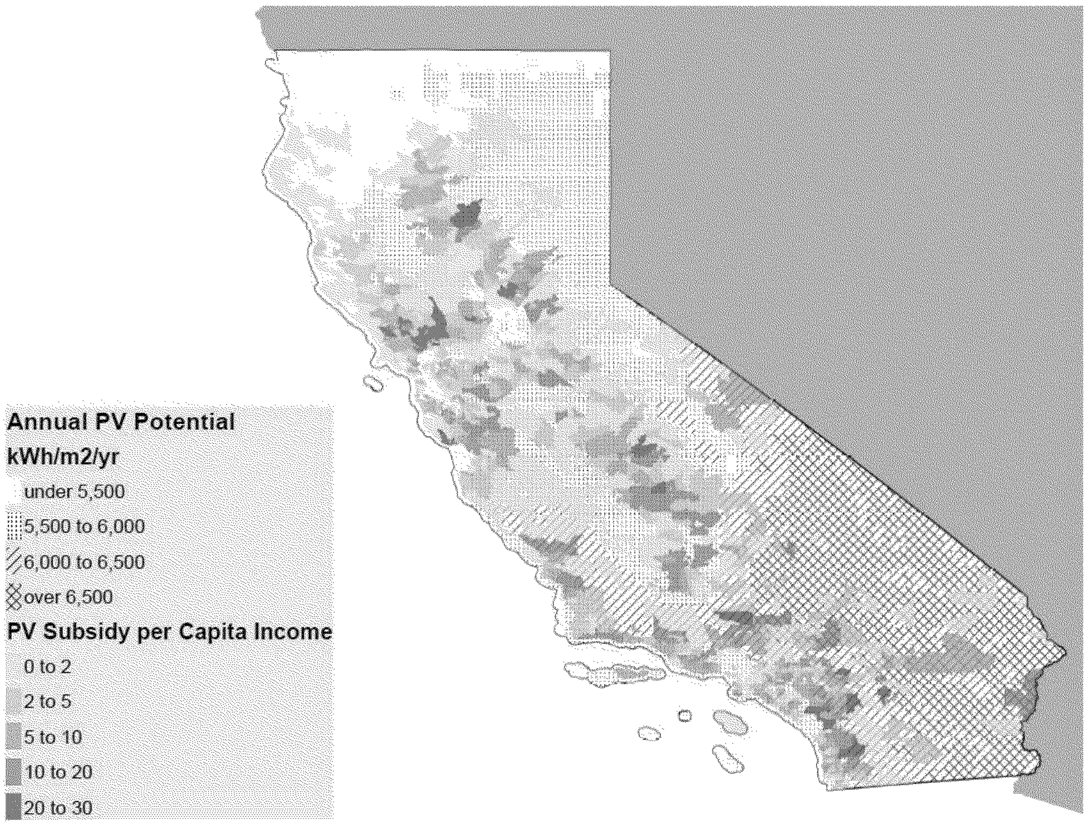
Central Valley climate zones include R and S. While the Central Valley zones do not appear to have higher household energy use by CARE customers, the per customer CARE subsidy in those two zones is, not surprisingly, generally higher than per customer CARE subsidies along the Central California coast. While high CARE subsidies and high per household energy use are evident in the Northern coastal zones (Climate zones V, X, Y and Z) the number of CARE customers is low in zones V, Y and Z, and a small number of homes are likely to be skewing the averages.

Figure C.3 Per Customer Energy Use from 2000 thru 2012



Rooftop Solar May be Located Where it's Needed Least

EDF also examined the relative locations of CARE subsidies, high household energy use, and investments in rooftop solar electricity generation based on the California Solar Initiative list of projects. As shown in Figure C.4, rooftop solar projects tend to be installed in higher income areas, but not where the solar resource is greatest, nor where per capita energy use and CARE subsidies are highest.



Low-Income Customers Significantly Reliant on Inefficient Appliances

As previously discussed, available data indicates that CARE customers use notably more electricity than non-CARE customers. This is the case for a myriad of reasons: they are frequently renters (e.g., face split incentives), lack capital to invest in new equipment, and face muffled price incentives. As a result, low-income families tend to rely on older, inefficient appliances that use excessive amounts of electricity. For example, more than half of households in PG&E's service territory with annual incomes of less than $75,000 rely on refrigerators that are eleven years or older – with more than 10 percent at least 20 years old – compared to roughly one-third of households with incomes above $75,000.[65]

The percentage of low-income households – those earning less than $75,000 – that depend on eleven years or older refrigerators in SCE's service territory is even higher: more than three-quarters, compared with less than one-third of households making more than $75,000. The higher population of older appliances in Southern California may be due to the fact that landlords are less likely to provide refrigerators in that region than in Northern California.[66] This is the case even after substantial expenditures on utility-managed efficiency programs; at historical investment rates, low-income energy efficiency programs serve less than 5 percent of eligible populations.[67]

While low-income households on the CARE rate have access to utility energy efficiency programs, their incentive to adopt offered measures – even if they're free – is muted by the CARE subsidy itself. Likewise, because they don't present ratepayers with clear and consistent price signals, tiered rates, combined with the way in which the CARE subsidy is applied, leads to greater energy consumption than is necessary even to provide low-income families affordable access to the energy services they need (e.g., heating and cooling). Instead, the subsidy encourages continued reliance on inefficient appliances and behaviors, and creates excessive polluting air and greenhouse gas emissions associated with the generating resources necessary to meet this inefficient demand.[68]

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[65] *See* KEMA, Cal. Energy Comm'n, *2009 California Residential Appliance Saturation Study*, *Vol. 2 Results* (October 2010) http://www.energy.ca.gov/2010publications/CEC-200-2010-004/CEC-200-2010-004-V2.PDF; *See* U.S Energy Info. Admin., U.S Dep't of Energy, *2009 RECS Survey Data* (last visited May 25, 2013), http://www.eia.gov/consumption/residential/data/2009/.

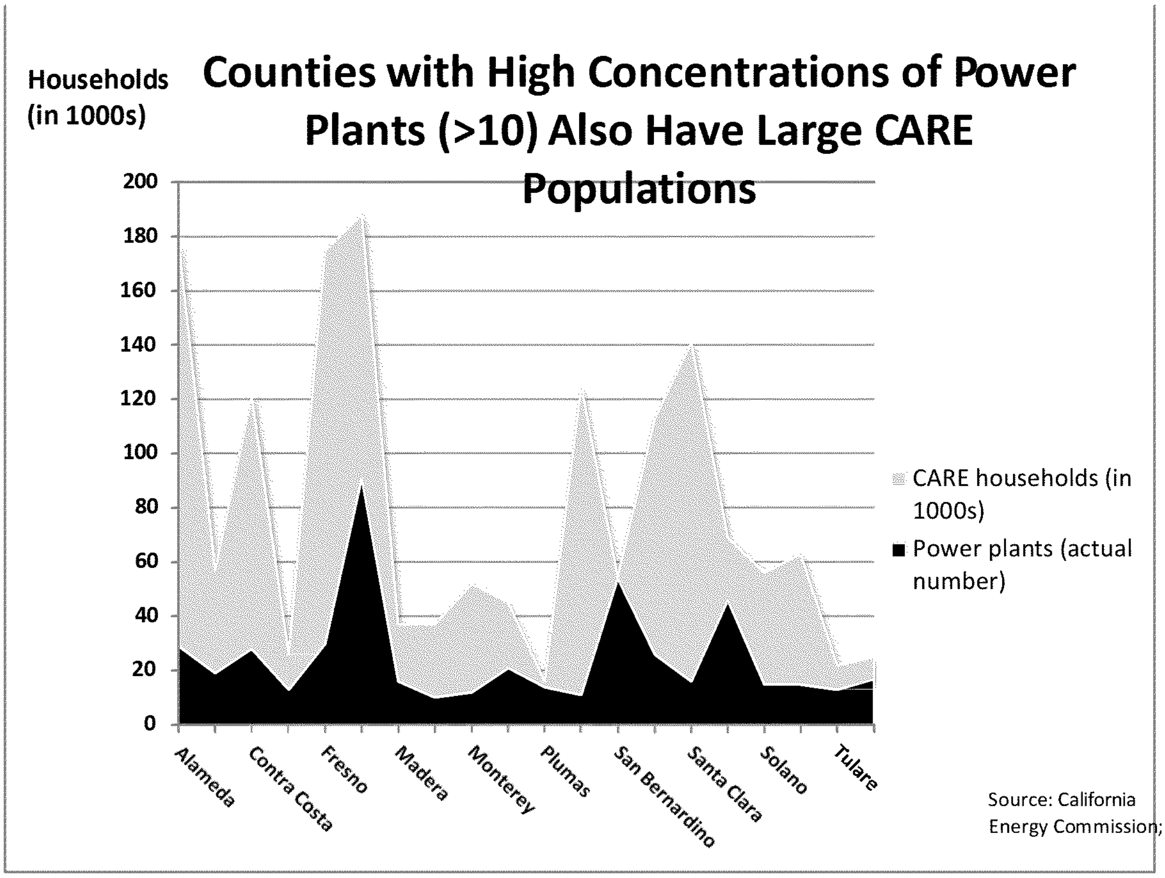
[66] SDG&E has roughly the same income-appliance age patterns as PG&E. Appliance ownership by renters eliminates the split incentive problem, but capital constraints and muffled price signals remain. It would be interesting to examine the role of split incentives in isolation of the influence of income status. *See* www.city-data.com/forum/los-angeles/544910-whats-lack-refrigerators.html.

[67] KEMA, *Final Report on Phase 2 Low Income Needs Assessment* 1-4 (September 7, 2007), http://www.liob.org/docs/Needs%20Assessment-Final%20Report-Sept-2007.pdf.

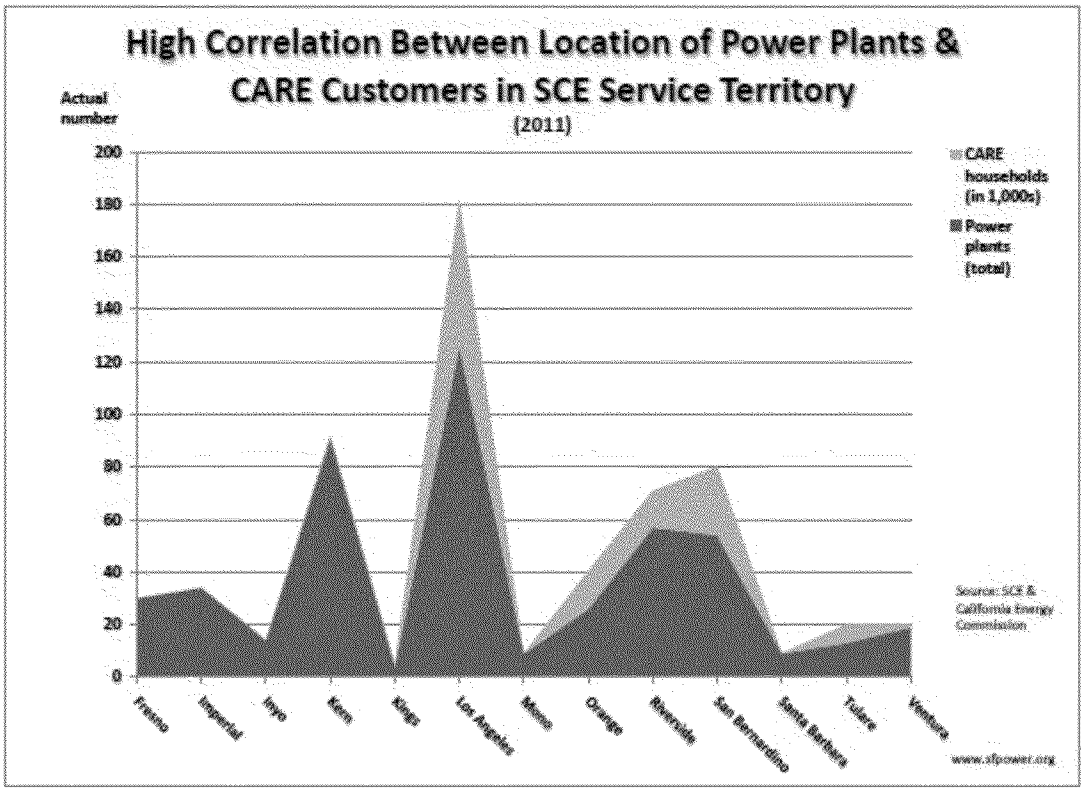
[68] "Detailed modeling results show that on average, households are made worse off by the effort to protect them from electricity price changes because it will lead to greater electricity consumption." *Before the S. Comm. on Fin.* 111th Cong. (August 4, 2009)(testimony of Dallas Burtraw, Senior Fellow, Ress. for the Future)

Energy Inefficiencies Visited on CARE Population through Greater Incidence of Power Plants

Polluting power plants tend to be disproportionately located in low-income communities. By encouraging inefficiencies and energy consumption, CARE subsidies can have the unintended impact of reinforcing the poor environmental and public health conditions in the communities in which CARE recipients live.[69] As indicated in the figures below, there's a striking correlation between concentrations of CARE customers and the number of power plants operating in a given county in both PG&E and SCE's service territories.



[69] *See e.g.* Van Jones, The Green Collar Economy (2008).



Significant Energy Savings Potential in CARE Population

A study by San Francisco Community Power (SF Power) found that CARE households that consume electricity at the tier three level or higher in either the summer or winter can lower their bills by more than the cost of the CARE subsidy by implementing cost- (or CARE-) efficient energy saving measures, such as replacing inefficient appliances (e.g., refrigerators) with efficient models; managing plug load, principally through the active use of power strips; and installing more efficient lighting. For example, SF Power found one household in San Francisco's Mission District in which more than two-thirds of the family's PG&E bill was associated with keeping an extremely inefficient refrigerator operating. Access to the $500 needed to replace that appliance paid for itself within less than two years. Other San Francisco households, located in the Bayview-Hunters Point neighborhood, were able to effectively reduce their energy use by using a Kill-o-Watt to identify excessive energy use by devices even when they were off, and deploying power strips to reduce plug load losses.

This finding is supported by a simple examination of inefficiencies within California's existing population of refrigerators. Purchasing a new refrigerator to replace one that's ten years or older would pay for itself in the form of energy savings during the life of the appliance. For example, a 20 year old 18 cubic foot (CF) refrigerator uses an estimated 1,176 kilowatt hours (kWh) a year, a 10 year old model consumes 840 kWh, while a new model uses 492 kWh.[70] At 15.4 cents per kWh,[71] energy savings alone – setting aside other benefits from a new appliance, such as keeping food fresher longer, and reducing smells – would pay for a new refrigerator, costing $500, within five years.[72]

The payback period would be even faster for larger, 22 CF, appliances, in which a 20 year model consumes 1,620 kWh annually, a 10 year old refrigerator eats 1,152 a year, while a new refrigerator uses just 672 kWh a year. For this size, replacing a two-decade old refrigerator with a new appliance would pay back in less than four years.

In addition to refrigerators, CARE customers have significant opportunities to increase the efficiency of their air conditioners. Almost half of households that earn less than $75,000 in PG&E's service territory rely on air conditioning equipment that is more than 14 years old, compared with only one-fifth of households that earn more than $75,000. Today's best air conditioners reduce electricity use by between 20 and 40 percent as compared with a ten years or older model.[73] With the average California household using perhaps 5,658 kWh a year to power air conditioners[74] - with much higher consumption levels in the Central Valley - at a cost of perhaps $871 or more a year, it would take less than a year for the purchase of an efficient wall unit to pay for itself, with a high-capacity, efficient heat pump paying back in less than six years.

TOU Offer Another Way to Save

Available evidence indicates that implementation of time-variant rates would likely lower utility bills for the majority of low-income ratepayers. For example, in one study almost 80 percent of low-income customers presented with a critical peak pricing rate experienced bill reductions without changing their behavior (i.e., "structural winners"). This percentage rises to more than 90 percent "winners" after households responded to the rate.[75] Likewise. "…low income customers are responsive to dynamic rates…many such customers can benefit even without shifting their load…" and "…even without responding to dynamic rates, a large percentage of low income customers will be immediate beneficiaries of dynamic rates due to their flatter load profiles. These results suggest that when evaluating dynamic pricing, it is important to recognize

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[70] *See* Efficiency Vt., *Electric Usage Chart* (last visited May 24, 2013), http://www.efficiencyvermont.com/for_my_home/ways-to-save-and-rebates/appliances/refrigerators/general_info/electric_usage_chart.aspx
[71] U.S Energy Info. Admin., U.S. Dep't of Energy, *Electric Power Monthly with Data for March 2013* (March 2013), http://www.eia.gov/electricity/monthly/pdf/epm.pdf
[72] Payback periods would vary depending on actual electricity use by the old and replacement appliances, and the marginal price being paid for the energy.
[73] Nat'l Renewable Lab., U.S. Dep't of Energy, *Energy-Efficient Air Conditioning* (June 1999), http://www.nrel.gov/docs/fy99osti/17467.pdf.
[74] U.S Energy Info. Admin., U.S. Dep't of Energy, *2005 Residential Energy Consumption* Survey, Tables (2005), http://www.eia.gov/emeu/recs/recs2005/c&e/airconditioning/pdf/tableac5.pdf
[75] Ahmad Faruqui, Brattle Grp., *Dynamic Pricing, The Top 10 Myths* (April 7, 2011), http://www.brattle.com/_documents/UploadLibrary/Upload936.pdf.

that such rates are not harmful, and, in fact, may be beneficial to a large percentage of low income customers.[76]

With the adoption of TOU, CARE customers will have another way to manage their electricity bills: by shifting load either through behavioral changes (e.g., pre-cooling, to reduce peak use), or with simple, non-communicating technologies like thermostats and timers. Changing energy consumption times as a way to reduce TOU-based electricity bills would provide CARE customers with a way to overcome split incentive barriers: permission from landlords isn't required to change the timing of washing and drying, nor to control air conditioning use by pre-cooling. Likewise, it's likely easier for a renter to install a new thermostat than to replace their refrigerator.

Advanced thermostats and timers could offer CARE customers with the ability to take full advantage of TOU. And opportunity to do so among low-income ratepayers is significant. Roughly two-thirds of households earning more than $100,000 a year in all three IOUs' service territories have programmable thermostats, compared with just one-third or fewer for those earning less than $35,000 a year. Advanced thermostats have the capability to receive setting updates via the Internet, enabling low-cost, remote yet directed assistance to households with access to that technology – which could be associated with Smartmeters – in managing the most energy intensive device in a typical home.

TOU Roll-Out Should be Accompanied by Enabling Devices for CARE customers

The roll-out of TOU will in itself benefit some CARE customers. Many will be structural winners, experiencing bill savings without changing their behavior or energy using equipment. Others will respond to the new price signals by shifting their electricity use to lower cost periods, by changing their behavior or taking advantage of existing utility programs. However, a segment of the CARE population will need assistance to negotiate the new pricing structures. This can be accomplished through a variety of means, including:

- *Try-it-Before-You-Buy-It*: Shadow billing and associated eduction could be provided along with directed customer energy management assistance. Likewise, in addition to bill limitor protection customers could be allowed to switch to alternative rates if they choose to do so.

- *Focus assistance on counties with high CARE consumption*. It would likely be most cost effective – from a total resource cost test – to direct weatherization, appliance and

[76] Ahmad Faruqui, Sanem Sergici & Jennifer Palmer, Inst. for Elec. Efficiency, The Edison Found., *The Impact of Dynamic Pricing on Low Income Customers* (revised September 2010).

building efficiency, distributed genertion and best practices to reduce electricity demand to customers in climate zones R and S (i.e., the Central Valley).

- *Provide CARE customers who voluntarily enroll in TOU set-it-and-forget technologies*. Recent analyses, including in the Sacramento Municipal Utility District's service territory, indicate that the provision of advanced thermostats – user-friendly thermostats that enable customers to program precooling and offsets for daily TOU peak load shifting, and display real-time electricity rates and home energy data – can significantly increase energy users' ability to respond to price signals.[77] These devices should be offered to all CARE customers who enroll in TOU, paid for by either higher rates on non-participating ratepayers and/or utility savings.

- *Offer on-bill repayment (OBR)*. Offering OBR to CARE customers would provide a way for lenders to invest private capital in energy efficiency to a population that might not otherwise qualify for a loan at competitive rates of interest and reasonable terms. OBR could also be accomplished by allowing CARE recipients to use their stream of subsidies to finance efficiency purchases (see below).

- *Offer efficiency-in-lieu opportunities*. As indicated in Figure C.7, from August 2011 to July 2012, $500 million in CARE subsidies were distributed in PG&E's service territory, with the average CARE household served by PG&E receiving a subsidy of $32 per month.[78] Given large energy use inefficiencies in CARE customers' hosueholds, high use CARE recipients could be allowed to re-direct a portion of their subsidy to purchase energy efficient items, so long as the investment results in at least as much bill savings as would occur under the allowable subsidy. For example, similar to Calfresh, also known as Food Stamps, CARE customers could be issued a debit card equivalent to what they otherwise would receive in bill subsidies, that could be used for any qualified purchase, which would consist of energy-saving or management (e.g., timers, thermostats) devices or direct energy purchases.

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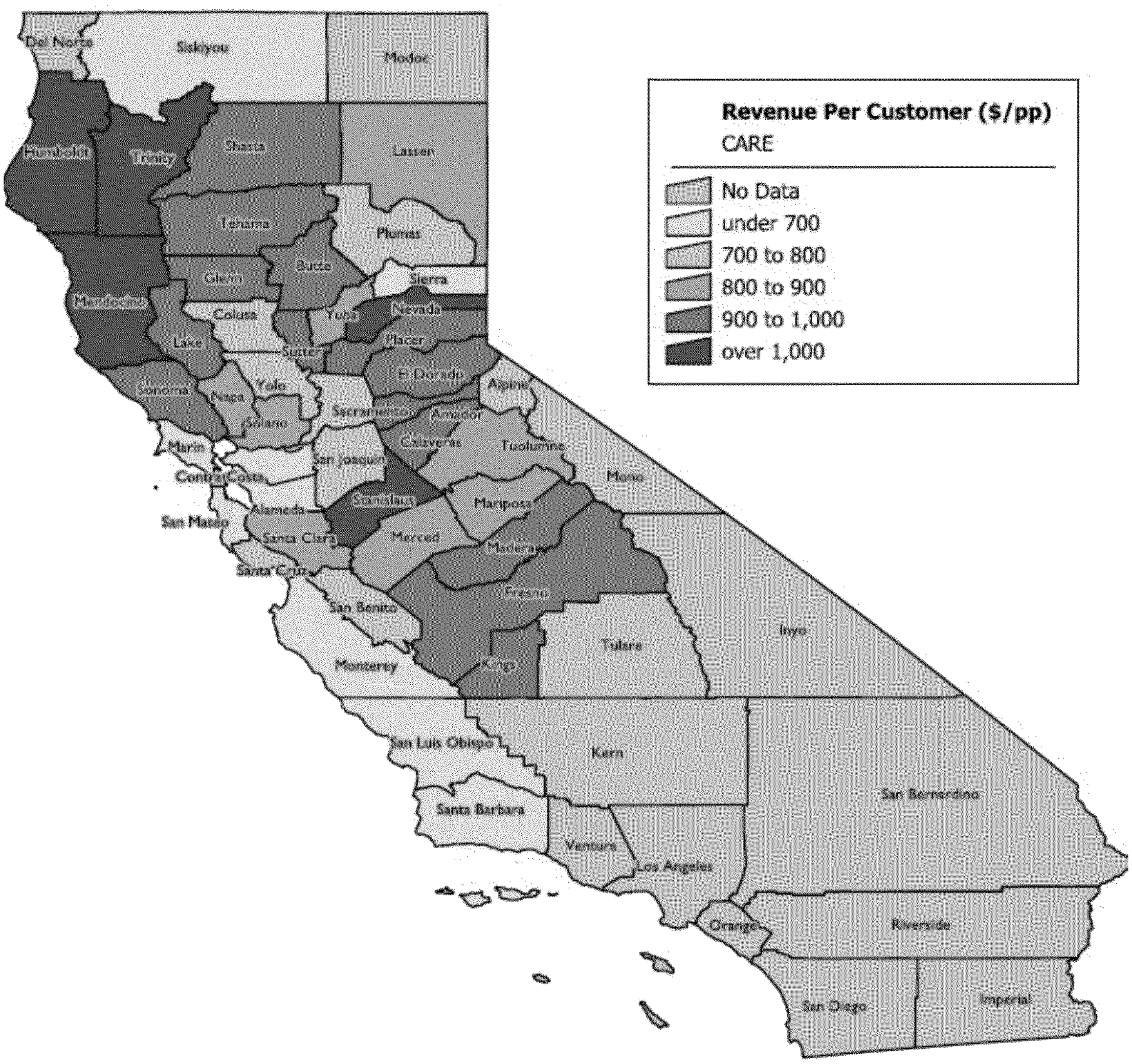
[77] Herter Energy Res. Solutions, *supra* note 13.
[78] This was estimated using electricity sales revenues and consumption data from PG&E for CARE and non-CARE customers for the period.

Figure C.7: CARE Revenues Per Capita



Focusing solar subsidies on CARE customers' homes located in the Central Valley. Solar subsidies, possibly supported by a solar-in-lieu concept, could be funneled to households in which energy use, and concomittant subsidy levels, are highest, which have the greatest potential for photovoltaic installations to be productive.

Other policies to safeguard low-income ratepayers should also be considerd as part of a TOU roll-out, including third-party ownership of appliances in rental units as way of better aligning incentives. Third-party ownership – possibly combined with "small box" efficiency outlets located in low-income communities – of appliances in tenant-occupied spaces could serve as a potentially powerful means to realign incentives in favor of reduced resource use.

The third-party – such as a residential energy services company (ESCO) – would package available utility and municipal incentives and offer energy-efficient equipment to tenants and their landlords. The third-party's capital and overhead costs could be paid for through municipally-provided low-cost financing, OBR, CARE in-lieu subsidies, and/or by capturing a portion of the resulting energy savings, either through direct payments from tenants, or through an arrangement with the landlord or utility.

As part of this concept a small box retail outlet could be opened in low-income, renter-dominated neighborhoods that displays energy and water efficient appliances; provides one-stop shopping, including bundling of available subsidies and programs; fully staffed by previously un- or underemployed community members trained in household conservation. Warranties could include proper equipment maintenance for maximum efficiencies, which would support local employment and provide for greater life-cycle benefits.

Distribution accounts for roughly half the cost of new appliances.[79] By creating community environmental "spokespeople" with relationships with local residents, and bundling together available subsidies and other income-generating or resource-saving opportunities a small box retail outlet could reduce distribution expenses while prompting economic development and job opportunities for hard-pressed communities.

The residential ESCO market is largely underdeveloped as a result of a number of barriers. A significant factor is the potentially high transaction costs required to service residential customers.[80] Other challenges include that third party contracts need to match the investment horizon for low-income renters, or, under a CARE in-lieu, their proxies; and even though efficiency projects may be cost-effective, opportunity costs can be high.

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[79] Transaction costs are a significant barrier to rapid adoption of residential energy efficiency programs. For example, a W.I.S.H. "notes that the true cost of the LIEE program appears to be reaching the home, rather than the measures themselves." *See* Decision No. 08-11-031 on 2009-11 Low Income Energy Efficiency and Cal. Alternate Rates for EnergyA. 08-05-022, at 44 (Cal. P.U.C. Nov. 10, 2008)(final decision).

[80] Nicole Hopper, et.al., Envtl. Energy Div., Energy Analysis Dep't, Ernesto Orlando Lawrence Berkeley Nat'l Lab., LBNL-62679, *A Survey of U.S. ESCO Industry: Market Growth and Development from 2000 to 2006* (May 2007), http://eetd.lbl.gov/EA/EMS/reports/62679.pdf.

A residential ESCO model would have to find a way to overcome these barriers. Previous EDF analysis suggests that OBR could significantly reduce transaction costs. Likewise, small box retail outlets could lower distribution expenses.[81]

The goal of the ESCO model is for participants to be at least revenue neutral, if not experience positive returns. This can be accomplished by calibrating appliance replacement so that it generates a minimum amount of bill savings. For example, a refrigerator may be ineligible for replacement unless by so doing at least $3 a month in bill savings are generated. As discussed previously, in some cases (e.g., highly inefficient refrigerators or air conditioners) savings could exceed $20 a month, thereby inducing rapid payback periods.

Similar to marketing, collections could also be managed in diverse ways, including creating payment arrangements with tenants, property owners, or another party, as follows:

- *Tenants*: There may be significant nonpayment risks associated with collections from low-income households, even if the annual cost is well less than $100, and the overall impact on household expenses is neutral. However, micro-financing programs have demonstrated that small sums can be collected from this population if the program is nested in the right cultural context.

- *Landlords*: Collecting from property owners is likely to pose minor nonpayment risks. The challenge would be for the landlord to be able to pass these costs onto their tenants (e.g., be at the appropriate time in the rent cycle; not be restricted by rent control requirements).

- *Another party:* The state, typically through direction to the IOUs, could pay the bills. This would be particularly attractive in cases where a utility offers on-bill financing, or under a CARE in-lieu policy.

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[81] Similar to Title 24 or local government codes, appliance replacement could be mandated at the time a property is sold or modified. Or state or local governments could require replacement of rental appliances once the efficiency gap reaches a stipulated level. Adoption of such policies could spur demand for a residential ESCO, and partially reduce the need for such an approach.

B. Exhibit C.2: Customers Enablement: SMUD Summer Savings Pilot Study

Research over the past several years by the Sacramento Municipal Utility District provides important evidence that customers can and will do well with time variant rates. This exhibit discusses two recent sets of findings pertaining to enabling programs and precooling as a strategy to manage bills during times of peak prices.

The field study conducted by SMUD during Summer 2011 was designed "to test residential customer response to and perceptions of an integrated energy efficiency and demand response (EEDR) program with real-time energy information, a dynamic rate, and thermostat automation."[82] (page 1, Executive Summary).

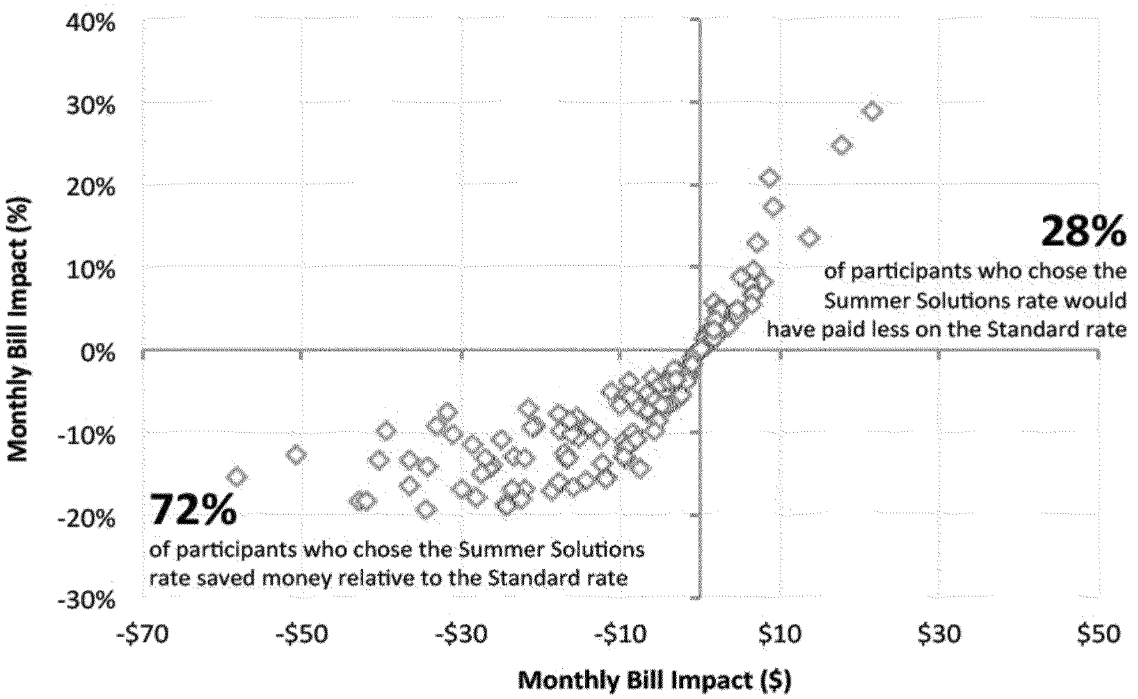
Methods

Homes were outfitted with programmable thermostats capable of precooling, and customers received several educational treatments. As well, some customers were given the option to be on time-variant "Summertime Savings" rates. The study emphasized evaluation of customer behavior, satisfaction and preferences using statistically valid before and after surveying.

Findings

Bill savings were significant and enjoyed by most customers to opted into the Summertime Savings time-variant rate.

[82] Herter Energy Res. Solutions, *supra* note 13, at 1.



Several correlates to successful load reductions were identified, including:

- Home size
- swimming pool pump
- thermostat
- central A/C

As well, as shown in table, several behaviors were statistically significant predictors of successful load reduction:

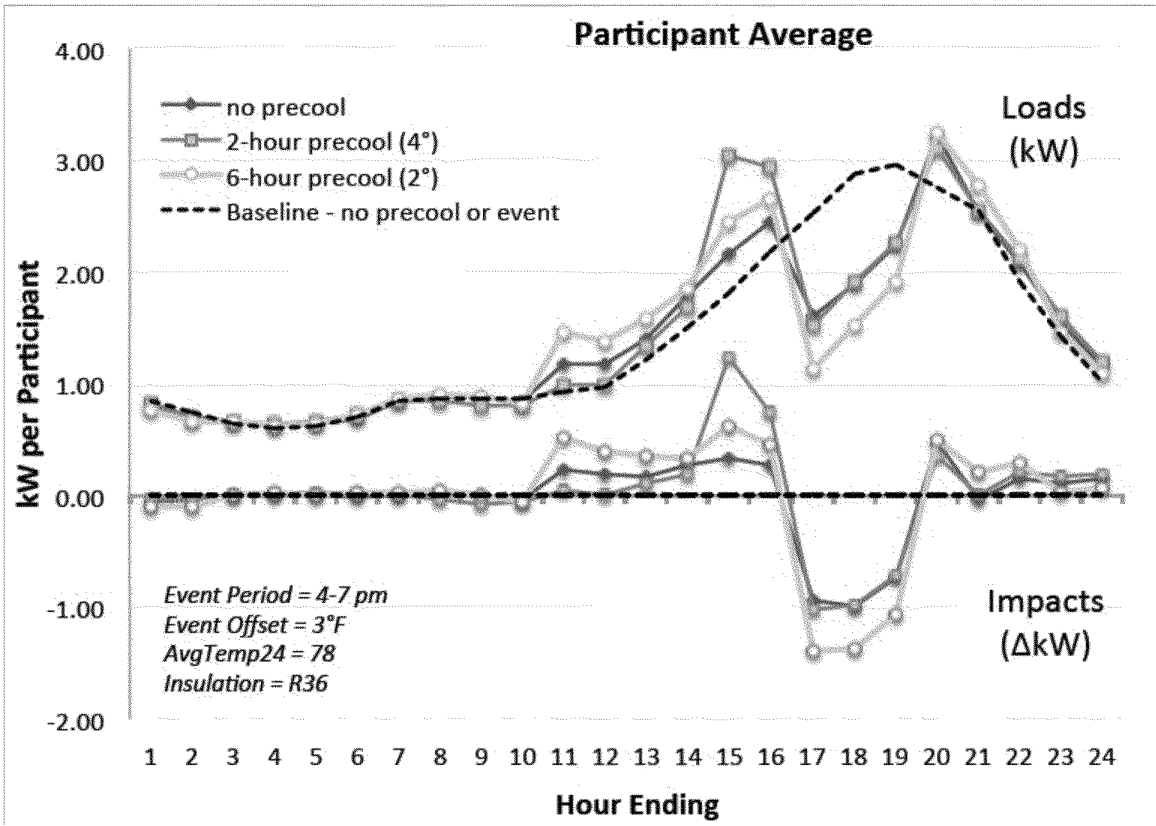
- pre-cooling
- thermostat adjustments
- vacated the home
- set pool pump to run off peak
- avoided using hot water if have electric hot water heater
- increased use of window shading

#	Behaviors Affecting Peak Energy Use (Post-Summer Survey)	2010 kWh Use	Overall Energy Impact	Non-Event Peak Impact	Event Peak Impact
Post1.1	I cooled the house at night and in the early morning hours by opening windows and/or running the whole house fan	-0.05	0.03	-0.03	-0.08
Post1.2	I closed all the windows and doors when the outdoor temperature exceeded the indoor temperature	-0.05	0.11	0.11	0.01
Post1.3	I pre-cooled my home several hours before the peak period	0.06	0.07	**-0.18**	**-0.20**
Post1.4	I increased the thermostat setpoint to a higher-than-normal temperature during the peak	0.00	**-0.15**	**-0.21**	**-0.20**
Post1.5	I used shades or awnings to keep sunlight out	**-0.14**	0.10	**0.16**	0.06
Post1.6	I turned off unnecessary lights and equipment	-0.08	-0.01	-0.04	-0.01
Post1.7	I changed into lighter clothing	**-0.16**	0.12	0.11	0.06
Post1.8	I left my home and went somewhere cool (e.g. a friend's house, the mall, the swimming pool)	-0.06	-0.10	-0.13	**-0.22**
Post1.9	I avoided taking hot showers because I have an electric water heater	-0.07	-0.05	-0.02	**-0.15**
Post1.10	I avoided using electricity to cook	-0.13	-0.01	-0.07	-0.10
Post1.11	I avoided tasks like laundry and dishes that can be done before or after the peak period	-0.12	0.04	-0.04	-0.11
Post1.12	I set the pool pump or hot tub to run off-peak	**0.23**	-0.13	-0.06	-0.12

Values in bold font are statistically significant ($p<0.05$)

Pre-Cooling As a Load Control Strategy

In a follow-up study in Summer 2012, the same research team examined pre-cooling as strategy for load reduction during times of peak prices. The graph, below, shows significant savings from pre-cooling strategies.



The study principle author, Karen Herter, made the following observations:

"…many customers without TOU will keep the default thermostat settings (CEC, EStar standards) or implement utility recommendations without a financial benefit. But having the financial TOU incentive, whether opt-in or default, would increase participation. Cooler at night and in the morning, warmer midday, and even warmer during peak is best for the system, best for TOU customer bills, and best match human biorhythms."[83]

She also summed up the relative contribution of information sharing through smart metering:

"Without communicating thermostats - just email/text/phone notification of events - we get 10-20% load shed during events. With smart thermostats, we get 25-50% load reduction per participant."[84]

Another important finding is that pre-cooling strategies lead to weatherization investments. That is, customers quickly learn that a poorly insulated home will not remain cool for long, so weatherization becomes the next step.

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[83] *Id.*
[84] *Id.*

Conclusions

TOU improve the performance of thermostat automation. Signicant load reductions are observed in statistically valid studies. Herter noted an important next step that EDF considers as part of a transition strategy:

"The next step is to use TOU to encourage DAILY load shifting with simple, non-communicating technologies like thermostats and timers. Today's thermostats are not designed for TOU pricing - i.e. do not accommodate precooling and peak offset - but the software could easily be modified to do this at no extra cost. Thermostat standards (CEC, Energy Star) should include TOU capabilities before requiring communicating thermostats."[85]

[85] *Id.*