

Residential Customer Understanding of Electricity Usage and Billing

**An exploration of the mental models residential electricity customers
in California use to make sense out of electricity pricing and billing**

Qualitative Research Conducted

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Background & Objectives

Electricity rates and billing practices can be complex and, as other research has suggested, often poorly understood by customers. Even so, however, whether accurate or not, customers have some notion of how their electricity bill is calculated, and that notion can play an important role in leading customers to conclusions about whether and how they should try to manage their energy use.

But the role of mental billing models extends beyond merely affecting the likelihood and character of any actions that customers may take to change their electricity use. As the California investor-owned utilities and the California Energy Commission (CEC) explore the potential impact and value of time-differentiated electricity pricing, it is clear that the mental billing models that customers already have and use for electricity will both affect the way they understand Time-of-Use (TOU), Critical-Peak-Pricing (CPP), and other time-differentiated prices, and affect the way they might respond to those pricing plans. Indeed, ultimately, the new electricity prices tested in the California Statewide Electricity Pricing Pilot will have their intended effects on electricity usage profiles only if customers are able to understand the way these prices are structured and can relate that understanding to an appropriate set of price-responsive behaviors. Making this translation will mean that customers have (or can adopt) a mental model for electricity billing that is both sensible to them and reasonably accurate in terms of its key features.

Understanding what will be necessary to achieve this end-state means developing, as a first step, a clear understanding of how mental models (or heuristics) for electricity use and billing function among residential customers now. As a derivative step, once reasonable information exists about current electricity billing heuristics, it should be possible to describe an approach to use in communicating with customers about time-differentiated electricity pricing that may be appropriate because it is both understandable and reasonably accurate. As an additional step, this analysis should also facilitate the specification of the key elements of electricity use and billing heuristics that could be tested for their accuracy.

With this background, a qualitative research project was implemented with the following primary objectives:

- Surface the heuristics that residential customers use to make their electricity usage and their electricity bill sensible
 - Describe the extent to which these notions about electricity use and billing are clear and consistent
 - Describe the key components of those heuristics both in terms of the way they explain electricity usage and the way they explain the way that usage is linked to bills
 - Explore the extent to which electricity billing heuristics are unique to electricity

- Develop, if possible, a typology of electricity billing heuristics and an anecdotal notion of which of these are more or less commonly employed
- Identify the implications of different heuristics for helping to explain:
 - How customers make sense of their electricity rates and usage
 - How customers think about using energy differently (when they do)
 - How customers think about the issue of “control” in their use of energy and their energy bills
 - How easily customers understand, interpret, and initially evaluate time-differentiated electricity pricing options
- Explore the availability to residential customers of billing designs that make sense of time-differentiated utility-related services and identify the potential difficulties associated with communicating to customers the key features of such pricing options for electricity
- Use the insight developed to specify a set of questions that can be used to evaluate differences in the level of understanding of rates across the Statewide Pricing Pilot participants.

A Note on Report Structure

*Please note that the results from the research are reported at three different levels of detail in this document. For the reader interested only in the topline results, a short selection of **Key Findings** is provided on the next two pages. A nine page **Executive Summary** of the results follows. The **Executive Summary** includes a summary and discussion of all of the important results, but does not include detailed analyses. Finally, the **Detailed Findings** section of the report provides a complete discussion of the results and includes example verbatim respondent comments that are instructive in interpreting the findings.*

Key Findings

- Nearly every respondent has some notion that the amount they are billed for electricity has something to do with the amount of electricity they use and that air conditioning is an important driver of electricity use. Beyond this, however, most customers cannot explain the details.
 - The billing and usage heuristics just described are both simple (if not simplistic) and complex; simple in the sense that they are easy to describe, but complex in the ways that they differ from the way billing and usage heuristics work for almost any other product or service, and complex as well in terms of their implications for how customers think about managing their electricity usage.
- Some respondents were able to describe additional information about electricity billing (e.g., that a baseline amount exists, that there are multiple pricing tiers), but in almost every case, this information is unclear and inconsistently applied.
 - Even the customers who mention more specific billing “facts” are not very clear, or typically very accurate, about the number of pricing tiers, the relative usage amounts by tier, or about relative pricing levels by tier, for example
 - While college-educated respondents tend to have more granular billing models, the reality is that even most college-educated respondents are still unclear about the details of their electricity billing arrangements, and ultimately, have the same “I get charged more the more I use” logic as do less well-educated respondents.
- Most customers are comfortable with their current price/value tradeoff for electricity, but most also are unsure what exactly they might do to significantly change or reduce their use of electricity, though in any case, most are sure that they would not like the lower use/lower cost tradeoff.
 - As a general rule, customers agree that their electricity use is largely “discretionary” (they could choose to use less), though at a day-to-day level, they do not see a large portion of their use as truly discretionary (making minor changes in the way they use a given appliance, they assume, will not have a meaningful impact on electricity costs)
 - As a general rule, customers tend to view the cost of using electricity the way they currently use it as an amount they are willing to pay for the “conveniences” (both physical and behavioral) they wish to have.
 - Though in addition, because the electricity usage heuristic is typically unclear in the details for most people, it is also not specific in identifying the outcomes that customers might expect to be associated with particular actions they might take to reduce energy usage.
 - As a result, while customers “know” (because their billing and usage models tell them) that managing energy usage is the key to managing

energy bills, they believe they have relatively few degrees of freedom in usage left to manipulate (once all of the various types of “non-discretionary” electricity usage are eliminated) and little clarity about the exact impact different behavioral changes will yield. Ultimately, this means that electricity billing and usage models which begin by appearing to provide clear direction for energy management end up appearing to suggest that once the “big decisions” are made, there is relatively little room – and therefore relatively little reason to invest the time in – managing energy

- These concepts do, however, lead customers to have a very articulated notion of their ability to “control” their energy costs. Most believe that they have little or no control over their energy provider or the rate(s) they are charged, but most do believe that they have ultimate control over the big drivers of energy use and cost, even if on a day-to-day basis, it feels like there is little discretionary control they can exercise (at least without significantly reducing their comfort and convenience).
 - Because of all of these issues, and further, because customers assume that significant reductions in energy use would necessarily require significant reductions in convenience and comfort – and they tend to like their current levels of convenience and comfort – most would rather not endure the sacrifices they assume would be necessary in order to gain the reward of a noticeable reduction in electricity costs.
- Billing heuristics for electricity use/energy use are similar to, though in important ways different from, billing heuristics used for other services:
 - Like many other consumer services (e.g., local and long distance telephone service, cellular telephone service (at least for some customers), water), electricity/energy billing is usage-based
 - Unlike other usage-billed services, however, electricity is measured and billed in units for which people do not have a reasonable referent (i.e., kilowatt hours vs. minutes or gallons)
 - Unlike other usage-billed services, electricity tends to have a very large share of use that feels non-discretionary
 - Customers tend to be more clear and consistent about the billing models that apply to non-energy services; there is, in other words, more diversity among customers in their description of how their energy bill is calculated than there is for any other service they buy
 - Examples from other services (primarily cellular telephone service) exist that make understanding both the fact of, and the reasons for, time-differentiated pricing for electricity easy to understand; in fact, there is reason to believe that time-of-use based pricing might be easier for customers to understand than inclining block rate pricing.
 - This does not mean that customers immediately view such pricing as appropriate, or fair, but it does mean that existing billing designs make such pricing easy to describe (at least in general terms).

Executive Summary

Overview

Heuristics are powerful. They act, essentially, as simple mental models – explanations, really – for how a specific portion of the world works. And their power comes from the fact that, because they provide an explanation for how something works, they implicitly provide a roadmap for what to do if we want that portion of the world to yield a different outcome.

Perhaps I need a new blender, but want to buy it as cheaply as possible. Depending on my “mental model” of appliance pricing practices, I might choose one of several different purchase paths. If I believe that Walmart always has the best prices on home appliances, I’ll just drive to Walmart and pick up whatever the store has that’s cheap. Alternatively, I may think that on any given day, sale prices will always be cheaper than “everyday low prices” at Walmart. If that’s the case, I’ll check around first before I select a store in which to make a purchase. But note that even the decision about how to “check around” will depend on what I assume about how pricing information works. I might assume, for example, that the Web – because it covers a broader range of options – will always list the best prices. Alternatively, I might assume that I’ll only find information on the Web that stores have paid to have listed. As a result, I may assume the information on the Web is a biased sample of true product availability and an unreliable indicator of “true” price availability.

The assumptions I make about how small appliance pricing works, in other words, will have an important effect on how I go about searching for a new appliance. These same assumptions might be called my “mental model,” or heuristic, for how small appliance pricing works. In general terms, the notion of a “heuristic” refers to the concept that people have about how something they can’t observe directly actually works. And we have these mental models for many, many things, including business processes, technology, the natural environment, and others.

One of the things that is interesting about heuristics is that they do not have to be accurate in their technical details, or even be particularly detailed in providing insight about why something works the way it does, in order to be useable. A customer does not have to know, for example, any details about Walmart’s inventory management systems or partnerships with manufacturers in order to make use of a heuristic that tells them that Walmart tends to have the best, or nearly the best, prices on day-to-day household goods. In fact, many things customers may think they “know” about what makes Walmart so cost efficient may be wrong. Whether very detailed or not, or even whether or not the details are accurate, however, a heuristic can still “work” if it tells customers what to do – with reasonable accuracy – in order to get the outcome they want.

In analogous fashion, customers also have heuristics that allow them to make sense of electricity usage and billing. The heuristics that customers use to understand their electricity bill (not the physical / paper bill and its concomitant design, but rather, the way the total bill amount is calculated and the way their usage decisions contribute to the amount of electricity they use) will likely have an effect on how, and whether, customers choose to change the way they use electricity. If customers decide they want to lower their electricity bills, they consult their mental model of what drives total electricity use and how electricity use is translated into electricity bills in order to identify a path of action that should yield the desired outcome. Different assumptions customers make about which electric end uses and/or appliances are the biggest drivers of electricity use, or different assumptions they make about how electricity usage is translated into billed dollar amounts can yield very different behavioral choices on the part of customers.

Note that just as with the appliance purchase example, however, customers do not need to have their electricity and billing heuristic be technically specific and/or correct in its details in order for it to be useful, or to direct customers to the kinds of actions that are likely to yield their desired outcome. If customers know that electricity prices go up the more they use in a given month (as with inclining block rates, for example), they don't need to know the specifics of block sizes and relative prices in order to have a reasonable understanding that adding a significant new end use will have a noticeable effect on their electric bill. If, however, their electricity usage model tells them that "chasing after people to turn off the lights when they are not in the room" is the best thing they can do to reduce their energy usage, then they are likely to engage in energy management behavior that is unlikely to be very productive.

Billing and usage models do not have to be technically accurate in order to be useful, therefore, but if they are inaccurate, they can lead (though they do not always lead) to inappropriate or wasted effort. Since electricity billing and usage models are relevant to understanding energy-related behaviors generally, it became clear that research into billing heuristics was particularly important to the California Statewide Electricity Pricing Pilot. The pilot assumes that customers can appropriately interpret, and act upon, the pricing signals that new electricity pricing plans are intended to send. If customers' electricity usage models are inaccurate, the end result might be that they respond to pricing signals in a manner that is not in their best economic interest, or at least respond in a way that is more inefficient than they intended.

As we noted above, it is not the case that customers must accurately understand all of the finer details of their electricity pricing arrangements in order to respond to price signals appropriately. Many customers reduced their use of electricity in California when prices rose after 2001, even though most probably did not understand the specifics of the tiered pricing arrangement under which they purchase electricity. Similarly in the pilot program, it is probably not necessary for customers to have a completely accurate understanding of the details of their new pilot pricing plan in order to respond appropriately during high price periods.

Alternatively, however, some levels or types of confusion or misconception about either how the new pricing plans work, or about how much energy different appliances use, might lead customers to take actions that do not yield the intended reductions in on-peak usage. One reason for exploring the nature and functioning of electricity billing heuristics is to explore the issue of whether or not existing heuristics hinder, or enable, customers to comprehend, and respond appropriately to, new time-differentiated pricing options.

The qualitative research reported here was designed to answer several important questions about the nature of the current billing and electricity usage heuristics existing among different types of residential customers, and to explore the implications of these models for customer response to new – particularly time-differentiated – electricity pricing plans. More specifically, the work was designed to find answers to the following questions:

- What are current billing and electricity usage heuristics among residential customers?
- How much specificity/granularity is there in these models?
- How accurate are these models?
- How much variability is there for these models across customers, and is it possible to develop a typology of billing heuristics that is both reasonably comprehensive and reasonably simple?
- How similar or different are electricity billing models from other products and services and what does this tell us that is useful about electricity service?
- How do billing heuristics help us to understand how customers think about using and managing energy and the extent to which they have control over energy?
- Do customers have readily available billing models that allow them to quickly, and reasonably accurately, understand time-differentiated electricity pricing (and do these heuristics lead them to appropriate conclusions about how to respond to changing prices)?
- Is it possible to develop questions that allow us to determine how accurate are the heuristics that customers apply to electricity billing and usage?

While this is a substantial set of objectives to be accomplished in a relatively constrained qualitative research effort, the work conducted provides direct and clear feedback on each of these issues and that feedback is summarized in the following sections of this document.

What Heuristics Currently Exist and How Granular And Accurate Are They?

Residential customers in this study demonstrated quite consistent, basic electricity billing and usage heuristics. At a fundamental level, nearly every customer has a basic notion that the amount they are billed for electricity is connected to the amount of electricity they use (“the more they use, the more they pay”) and that air conditioning use (for those who have air conditioning) is a (even the) key driver

of electricity use. Beyond this basic understanding, however, most customers are unclear and unable to provide very accurate descriptions of the details of the relationship.

We should stop at this point and say that the basic billing and usage heuristics just described are both simple (if not simplistic) and complex. These ideas are simple in the sense that they are uncomplicated and easy to describe. They are complex, however, in the ways in which these heuristics differ from the way they work for almost any other product or service. For while there are surface similarities between electricity and other products and services on these issues, the differences are ultimately the most important issues. At a surface level, for example, one might argue that many products or services are characterized by a billing design that says, basically, "the more I use, the more I am charged." Everything from apples to insurance might be said to be characterized by this structure. What is different about electricity, however, is the fact that residential customers (at least as these were represented by the customers in the focus groups) are uncertain about three specific features of the billing/usage model for electricity when they are rarely uncertain about these features for other products:

1. When a person purchases apples, for example, they know the units in which apples are denominated (either per apple, per pound, per box, or some similar physical definition). This is not true for electricity for most people (most residential customers appear to either not know the language "kilowatt hour" or do not know what it means).
2. When a person purchases apples, they know how the units of purchase connect to the price they are charged (since prices are typically specified for the units of denomination; i.e., per apple, per pound). This is also not true for electricity since most people do not know what price they are charged per kilowatt hour.
3. When a person purchases apples, they have a clear notion of what they are getting for each unit of cost, and as a result, have a clear notion of how to manage their cost for this resource (if they eat half as many pies, they will halve their monthly apple bill). This is also not true for electricity, since most customers do not understand well how their energy-related actions link to changes in electricity use (most would not be able to predict well the specific actions they would need to take to reduce their electricity bill by half).

The most important feature of the core billing heuristic for electricity, then, is not the simple statement that "greater use equals greater bill," but the reality that – apparently for most customers – so many elements of that formula are uncertain when, for other products and services, they are not.

Before moving on, it is also important to note that while there is a good deal of consistency across customers in the ideas they use to understand electricity billing and usage, there are differences as well. Some customers do have a more articulated and accurate understanding of these issues, and absent an assessment of accuracy, there is variability in some of the specifics of the ideas that people

have about how electricity billing works (we take up this issue in the following section).

On the issue of technical accuracy, for example, most customers have only the most basic notion of which appliances and/or end uses have the greatest impact on electricity usage. Some customers do have a more granular view of this issue, of course, and are able to list refrigeration, lighting, laundry, kitchen, and water heating uses and appliances as important contributors to total electricity usage, though even the most knowledgeable customers do not mention pool/spa pumps as important energy uses. On the billing side of the question, some, even many, respondents are aware that different price blocks exist, but even within this group, none were particularly clear about either the size of the blocks (the amount of electricity included in a block) or the relative block prices. Similarly, some customers have a conceptual understanding that electricity usage is measured in kilowatts hours and that they can compare kilowatt hour usage from one month to the next in order to compare actual usage vs. billed amounts. Even among these customers, however, it is the very rare person who can disaggregate a bill (even at a gross level) into the relative proportions accounted for by different appliances, and/or who can account for the contribution of weather effects to month-to-month kWh changes.

In summary, then, while the core billing and usage concepts described above are accurate for all customers, there is also variability in customer knowledge. Even among the most knowledgeable customers, however, there are important elements of the relationship between usage and billing that are more or less unclear (no one was completely, or even nearly, accurate).

To review, then, it is important in evaluating the implications of the core electricity and billing heuristics to understand that:

- First, for effectively every customer in the groups there was some point at which they end up saying that they have to trust that their utility is calculating their bill accurately (or not), since they really have no basis on which to determine if the calculation is accurate
- And that second, most customers in the groups quickly reach a point in evaluating their own energy usage at which they cannot readily (or indeed at all) tell what impact on usage a given change in behavior would have.

Is it Possible to Construct a Typology of Billing Heuristics?

Not only are customers somewhat different in terms of the accuracy of their billing/usage heuristics, however, but there are also differences in their notions of the underlying logic used to calculate electricity bills. Based on the open-ended Phase 1 discussions with customers, the team attempted to define the different specific ideas that customers appear to have about how electricity services (and other related products and services) are billed. While at a general level, all customers described a “the more I use, the more I’m charged” logic, there were

also specific differences in terms of how the “more I use” part was understood to be translated into a bill. In total, the Phase 1 customer discussions yielded ten different specific billing models for electricity (and, incidentally, for other services as well), each of which describes a specific way in which some group of customers believes that one of their household monthly bills is calculated. The first two models listed are more commonly applied to electricity than the others, but most were applied to electricity by at least one customer:

- Fixed monthly service fee that includes a baseline / starting usage allotment – any usage over the basic allotment is charged at a fixed price for each additional unit of usage per month
- Variable usage price – price charged per unit (hours, minutes, etc.) goes UP the more the service is used
- Variable usage price – price charged per unit (hours, minutes, etc.) varies by time-of-day / day-of-week service is used
- Fixed price for each unit of usage per month
- Average monthly usage fee – based on average usage or the average use of customers in the area per month
- Monthly fee based on usage – not clear on how this works, or there is no clear connection between usage and total monthly cost for you, but you know the more you use, the more you are charged per month
- Variable usage price – price charged per unit (hours, minutes, etc.) goes DOWN the more the service is used
- Fixed annual fee or cost divided into 12 equal monthly payments
- Fixed monthly fee
- Fixed price for each unit of usage per month plus fixed monthly service fees

Please note that each of the billing models listed above was not defined a priori or otherwise specified by the research team. The listed models were specified by group respondents as a logic that they believe is used to calculate either their electric bill, or some other monthly household bill they receive.

Do Heuristics Lead Customers To Important Conclusions About Energy Use and Control?

The core electricity billing heuristic (that usage is connected, in some uncertain way, to the billed amount) leads customers to conclude that they must modify their total monthly usage if they want to affect their electricity bill. Importantly, however, none of the specific billing structure differences (i.e., whether they think they are billed in inclining blocks, with or without an initial allotment) has more specific implications for action. Furthermore, there are other issues that make the core heuristic difficult to translate into energy management actions that customers are generally willing and able to take. These include that:

- Because the electricity usage heuristic is unclear in the details for most people, it is also not specific in identifying the outcomes that customers might expect to be associated with particular energy management actions
- Customers tend to be satisfied with their current level of convenience and comfort and believe the actions they take in terms of energy use are necessary for that level of convenience and comfort; they assume that different actions intended to reduce energy use would yield reduced outcomes in terms of convenience and comfort:
 - Note that this assumption follows from the central billing model as naturally as does the “other side of the equation” (i.e., what I’m charged for on my electric bill is linked to how much electricity I use, and analogously, what I get in terms of convenience and comfort from using electricity is related to how much electricity I use).
 - Note also that this does not mean that customers will never forego comfort and convenience in order to manage costs. Econometric evidence appears to exist to suggest that when electricity costs rise (in particular, when they rise quickly), customers respond by using less electricity. When the price is high enough, customers will forego comfort and convenience. The point here is simply to suggest that customers see using sufficiently less electricity to have a noticeable effect on their bill as requiring a set of actions that would necessarily have a noticeable and negative effect on their comfort and convenience (whether or not this is true in fact), and as a result, they tend not to pursue this course of action until they “have to.”
- Customers assume that once they have established a set of electricity usage boundary conditions (i.e., that they are going to live with refrigeration, with lights, with a certain level of temperature control/comfort, with “modern conveniences” and once they have purchased a given set of appliances with a given level of operational energy efficiency)¹, there is relatively little they can do to modify their electricity usage (since there is little remaining discretionary electricity usage) without having a significant effect on their comfort and convenience:
 - This issue is central to the notion of customer perceived “control” over energy use. This research makes it clear that the customers in this study have a coherent, accurate, and differentiated understanding of

¹ This discussion is not intended to suggest that there are no differences between customers in either the amount of energy they use for such things as refrigeration, or in the impact their day-to-day behavioral decisions (including both appliance purchases, but also simple use and maintenance decisions) can have on the energy used by a given appliance or end use, even given that they have decided to “live in the 20th century.” Such differences clearly exist and customers can and do make day-to-day decisions that affect the amount of energy consumed by a given appliance or end use. The point here is simply to indicate that, based at least on the perspectives articulated by the participants in these groups, customers appear to see the largest part of the energy impact of a given end use (refrigeration, for example) as embedded in the decision to have it or not (with the alternative not really an option for most customers). Day-to-day decisions about how to use and/or maintain the appliance appear to be viewed as having relatively little effect on the total energy impact of refrigeration (for example), whether or not this view is an accurate one from an engineering perspective.

the amount and type of control they have over their use of electricity and their electricity bills. They believe that they typically have no control over their supplier or over the rate structure under which they are charged for electricity. In addition, they believe that once the boundary conditions for electricity usage identified above are established, then this means that a large proportion of their electricity usage is in fact not subject to day-to-day control. When pushed, customers in this research agree that they could make different boundary-setting decisions, but prefer not to entertain what seem like drastic changes unless “forced” to do so by circumstances. As a result, while these customers might say in response to a surface question that they do not believe that they “have much control over their electricity use and their bill,” the reality is that they understand that some elements of the pricing/usage equation are out of their hands (what company provides their electricity and what rate structure is applied to them), while other important elements of this relationship are in their hands (even if they choose not to reconsider some of the most important decisions over which they have control very often).

- At a day-to-day energy management level, customers tend to focus on the energy uses they actively control (things they “turn on” and “turn off”). The focus on such appliances is entirely consistent with the logic of their core billing heuristic (if you want to be charged less, make different choices in using the appliances that you control on a day-to-day basis). Not surprisingly, these appliances include lights, televisions, and similar appliances, as well as the AC system (which they report changing use primarily by turning on and off, and leaving thermostat settings as they have already been established).

This research indicates, as an important conclusion, that the core billing heuristic does have significant implications for how customers in these groups think about using and managing energy, though this does not mean that it leads to simple behavioral changes, or to changes that have clear results. In fact, the opposite is more true. Given the lack of clarity in the billing and usage models held by these residential customers, and given the fact that they view a large portion of energy usage as non-discretionary, at least on a day-to-day basis, these customers tend to be unsure what outcome they can expect from a given set of actions intended to reduce their electricity use. Most appear to be reasonably sure, however, that they won’t like the tradeoff associated with lower energy use since they assume that the actions necessary to reduce electricity usage by a noticeable degree would necessarily have a negative and noticeable effect on their comfort and convenience.

Are Other Product Billing Models Instructive, Particularly In Helping to Communicate to Customers About Time-Differentiated Pricing?

Several things are clear on the basis of comparing the billing and usage heuristics used for electricity with those used for other similar products and services:

- Most other comparable, utility-like, usage-based services tend to have some version of a fixed-price per month component, and some portion of customers find the predictability of such options valuable.
- Electricity service is unique in the sense that it is usage-based, with unclarity on the part of customers about both “what uses how much” and how the usage units are translated into billed dollar amounts.
 - To take a simple alternative example, both cellular phone service and water service are often, at least in part, usage billed, but in both cases customers have a good understanding of the units of measurement (minutes and gallons) and what they “get” for each unit; even for customers who know that electricity usage is measured in kWh, as we noted above, nearly all are unsure of what they “get” for each such unit
- Time-differentiated pricing (with daytime prices higher) is a readily understandable concept for customers, and existing billing designs – most obviously from cellular phone service – can be easily “borrowed” to make sense of this type of pricing plan

Ultimately, the group discussions reported here suggest that customers tend to employ their core billing heuristics and make simple assumptions about whether or not TOU, or other, rates would “work” for them, and they tend to also make similar, simple assumptions about how much they would have to change their energy usage behavior in order to benefit from such pricing plans. Such feedback from these customers demonstrates the importance of instructive and persuasive information that customers would need if they are to make informed choices about participating in such pricing options, but for now, the critical issue is that customers can easily understand both the concept of, and the basic logic for, time-differentiated electricity pricing plans.

Can Appropriate “Test” Questions be Constructed That Evaluate the Accuracy of Customer Billing Understandings?

The fact that there is a core similarity across customers in terms of their electricity billing and usage models means that questions that attempt to identify differences in models will need to focus on specifics and on understanding the relative accuracy of those models. While we were not able to determine in the qualitative research if different billing models lead to systematically different behavioral responses to electricity pricing options, it is at least reasonable to suspect that such differences might exist. Customers with different notions of how their electricity pricing plan works might make different choices about how to use electricity. Under time-differentiated pricing arrangements in particular, different billing models might lead to different behavioral responses to pricing signals. For this reason, the research also pre-tested a series of questionnaire items that might be used to test both the accuracy and the basic nature of billing models across customers, thereby enabling an assessment of the relationship between billing model accuracy and behavioral price response in future research samples.

Methodology

The project started with a review of the relevant literature on the subject of the way that residential customers think about electricity usage and electricity pricing and billing. Following, and in part based on, this review, the team implemented two successive phases of primary qualitative market research.

Primary Research: Phase 1

The first phase of primary research was designed to explore in-depth with a small number of customers the logic that they use to understand electricity pricing and bills. The focus of these discussions was to generate a series of hypotheses about the different types of mental heuristics customers use for electricity and related products, the implications of these heuristics for perceptions about the meaning and use of electricity, and to determine if there are product categories for which time-differentiated pricing heuristics already exist.

A total of six group depth interviews were conducted with three to four participants in each group. Two groups were conducted in each of the three California investor-owned utilities' service areas – Costa Mesa, San Francisco, and San Diego. Half of the groups were conducted with people with a minimum education level of a four year college degree and the other half were conducted with those with less than a four year college degree. These groups were conducted September 18-23, 2003.

The groups lasted 1 ½ hours and each participant was paid \$60-\$65 for his or her participation in the group. The discussion guide for these groups can be found in the Appendix.

Primary Research: Phase 2

The second phase of primary research was designed to test a reasonable set of hypotheses about electricity pricing heuristics that were surfaced in the first phase, reflecting as much as possible customers' own language and logic.

A total of six focus groups were conducted with five-to-six participants in each group. Two groups were conducted in each of the following locations: Costa Mesa, San Francisco, and Fresno. Half of the groups were conducted with people with a minimum education level of a four year college degree and the other half were conducted with those with less than a four year college degree. These groups were conducted October 1-2 and October 21, 2003.

The groups lasted 1 ½ - 2 hours and each participant was paid \$65-\$75 for his or her participation in the group. The discussion guide for these groups can also be found in the Appendix.

Recruitment Criteria – Phases 1 & 2

The following criteria were used to screen for appropriate study participants.

- Must be 18 years of age or older
- Must be customers of Southern California Edison, Pacific Gas & Electric, or San Diego Gas & Electric².
- Must be billed for electricity directly by their electricity provider and must be the person primarily responsible for payment of the electricity bill (or shares responsibility)

Additionally, certain minimum quotas were established for each group.

- In phase 1, each group had one renter; in phase 2, each group had 2-4 renters
- In phase 1, one non-white participant was required; in phase 2, 3-4 non-white participants per group
- For the groups with less than a college degree, phase 1 attempted to have one participant in each of these groups with less than a high school diploma and phase 2 required 2-3 people per group with less than a high school diploma.
- In phase 1, at least one person per group was required to use their air conditioner (AC) 3-4 days per week; in phase 2 roughly half of the participants were required to use their AC 3-4 days per week in the afternoons (1-5 pm).
- In phase 2, roughly half were required to live in non-coastal areas.

Note on the Nature of Qualitative Research

The findings contained in this report are qualitative in nature. They are derived from a small sample of specially recruited participants and, as such, are not projectable in numeric terms to a larger population. They should be considered indicative rather than conclusive.

² Hereinafter referred to by the initials SCE, PG&E, and SDG&E, respectively.

Detailed Findings

Detailed Findings: Phase One Insights on Billing and Energy Usage Heuristics

As described in the methodology section of this report, Phase One of the research attempted to surface the diversity of customer thinking about energy billing and usage heuristics and to begin to identify the implications of different heuristics for energy control choices. Analysis of the Phase One results focused on building a typology of billing heuristics which the Phase Two activity then attempted to validate.

Phase One's discussions were open ended and included queries about how people make purchase decisions and how they understand pricing and billing for a variety of products and services, including electricity, with the objective of exploring the following specific issues:

- Can customers articulate a clear billing and usage heuristic for electricity?
- How granular/specific are those notions?
- To what extent do these ideas vary across customers?
- How do billing and usage heuristics link to energy management behaviors?
- To what extent are these billing and usage models for energy consistent with those used for other products and services?

The Phase One interviews provided very clear insight on most of these issues; insight that is instructive in helping us to understand the nature and role of energy usage and billing heuristics.

Can Customers Articulate Clear Billing and Usage Heuristics for Electricity?

Key Takeaway: Nearly every respondent has some notion that the amount they are billed for electricity has something to do with the amount of electricity they use and that air conditioning is an important driver of electricity use. Beyond this, however, most customers cannot explain the details.

Customers can, in other words, articulate their billing and usage heuristics and, at a summary level, they are very clear ("it's related to usage; the more I use the more I get charged"). On the other hand, customers are not very clear about the details here since their understandings on this subject are not very clear or very specific about the nature of the relationship between end uses and total electricity usage, nor about the specifics regarding how units of usage are translated into units of cost.

But while the summary findings just described are accurate, there are a number of complexities in customer perceptions on these issues that should be considered, and these include the following:

Caveats:

- Most customers in the groups reported that they read (or at least “looked at”) their electric bills each month, and some reported looking closely at the bills. Few, however, without their bills in hand, could describe accurately the structure of their pricing plan (leaving aside the question of specific prices and amounts).
- Some customers can talk meaningfully about kilowatt hours and about the end uses, beyond air conditioning, that contribute relatively more or less to total electricity use, but this number is small, and even among this group, significant inaccuracies occur.
- Even more importantly, very few, if any, customers have a meaningful referent for a kilowatt hour, even if they are aware of the term (that is, most customers have a notion of how much a “gallon” of gasoline is in both liquid measure and in terms of what they “get” by using it, but this is not true in either context for a kilowatt hour³).
- Most customers, at least as they were represented by customers in the focus groups, know that the electricity meter is used to measure electricity use, and some have even “experimented” by watching it move under different usage conditions, but few or none know how to read a meter or to interpret its activity.

In summary, then, we have a clear answer to the question of residential customer billing and usage heuristics. Yes, nearly all customers articulate some version of “the more I use the more I’m charged.” Beyond this, however, there is substantial variability in the specific understandings that are articulated by respondents as they describe the drivers of total electricity usage and the details of how usage amounts are translated into costs. Even with this variability, however, the number of customers who can be said to have an accurate billing or usage heuristic is very small.

How Granular Are These Heuristics?

- **Key Takeaway:** Some respondents were able to describe additional information about electricity billing (e.g., that a baseline amount exists, that there are multiple pricing tiers), but in almost every case, this information is unclear and inconsistently applied.

³ And while electricity is unusual in this regard, it is probably not unique. The same is likely true at least for natural gas (since customers likely have no meaningful referent for a BTU or a therm).

- Even customers who mention these facts typically cannot be specific about the number of pricing tiers, the relative usage amounts by tier, or about relative pricing levels by tier

While we take up the issue more specifically below, it is worth noting that the respondents taking part in this research tended not to have particularly specific, or granular, billing models for most products and services they purchase. While some customers scour pricing information carefully, most – even those who say they care a good deal about a given product category – are often not able to specify accurately the details of their pricing plans (e.g., even those customers who say they care about cell phone use are typically unable to specify the hours for on-peak and off-peak use and/or to specify the actual differences in cost for service during those periods).

Again, this should not be terribly surprising. Most customers who could articulate pricing specifics were able to do so only because they had recently been through an assessment and choice of alternatives (because they moved or because they chose to make an active decision about potentially changing service providers or plans). In between selections, customers appear to attend less to the way they are charged for different services.

To What Extent Do These Heuristics Vary Across Customers?

There was a striking difference in the Phase One discussions between the college educated and the non-college educated groups in the way they articulated their understanding of the way they are charged for electricity. College educated respondents were much more likely to use the term “kilowatt hours,” and to be aware of baseline amounts and the fact that prices went up by tier. Having said this, however, there were few if any, even among the college-educated group that had an accurate understanding of the number of pricing tiers and the relative magnitude of price differences across tiers.

Key Takeaway: While there are differences between customers in the relative specificity and accuracy of the way they understand the connections between energy use and energy bills, and college-educated respondents tend to have a more granular model, the reality is that even most college-educated respondents are still unclear about the details of their electricity billing arrangements, and ultimately, have the same “I get charged more the more I use” logic as do less well-educated respondents.

Probably the most telling indication on this subject is the observation that while college-educated respondents tend to be more knowledgeable about pricing tiers, none discussed the implications of the fact that this makes the last set of kilowatt hours used per month more expensive than those used earlier in the month. The additional “facts” held by some college-educated respondents, in other words, do not translate into a billing concept that connects meaningfully to a notion that some kilowatt hours in the month are more expensive than others.

In addition, college-educated respondents also appeared to be somewhat more willing to make appliance changes based on a basic “belief” in the value of energy efficiency. While this difference may be based in substantial part on the tendency of college-educated respondents to have higher average incomes, it may also be a result of the trust that college-educated respondents appear to have that they will actually realize the benefits of efficiency improvements and that such improvements will actually turn out to be “worth it,” even if it is not possible to track the arithmetic proving such gains.

This difference in behavior between these two groups is, in part an issue of billing heuristics and in part not. As we noted above, both groups have a common fundamental billing understanding (“the more I use, the more I get charged”). College-educated respondents, however, appear more willing to trust the claims about relative energy usage among more- versus less-energy-efficient appliances and the likely payback from such investments. Less than college-educated respondents, on the other hand, appear to be more suspicious of such claims, and/or of their ability to discern between credible and non-credible claims.

It is worth noting in addition here that respondents also raised the issue of trust in their utility as well as trust in the claims made about energy usage by appliance makers. As we noted earlier, all respondents recognize that, at some point, they have to trust that their electricity supplier is calculating their bill properly since they are unable to separately calculate what should be the “right” amount of their bill. A small number of respondents among those with both more, and those with less, education raised questions about the trustworthiness of their utility in this regard, and while there is some suggestion that less well educated respondents are more concerned about these issues, the trend is not sufficiently clear to allow us to reach a conclusion on this subject.

Do Billing and Usage Heuristics Link to Energy Management Behaviors?

A central reason for exploring the issue of billing heuristics is to understand how those concepts map to the way that customers think about, and choose to manage (or not), their energy use. The most important observations from Phase One on this subject are summarized as:

Key Takeaway: Most customers are comfortable with their current price/value tradeoff for electricity. As a general rule, customers recognize that their electricity use is largely “discretionary” (they could choose to use less), however, most view the cost of using electricity the way they currently use it as an amount they are willing to pay for the “conveniences” they wish to have. Customers “know” (their core billing model tells them) that they would have to use less electricity to pay less in their monthly bill. The lack of specificity in these ideas, however, means that they are not sure exactly

what impact different actions would have on their bill, but even so, few are incented to do so.

This is an important set of issues and it is worth noting the complications in perceptions that are relevant to the summary findings just described:

Caveats

- Many, even most, customers “attend” to their electricity bills more often than they do any other of their monthly bills.
 - Most customers report that they actually look at the detail of their monthly electric bill, in comparison to other bills for which they typically only look at the total amount due.
 - For the most part, customers report that when they look at their electric bill, they are looking for unusual changes in billed amounts (i.e., “big” changes from month-to-month or year-to-year, defined most often as more than \$20 above the expected bill value)
- The reason for attending to electricity bills is largely due to the perception that electricity charges are variable on a month-to-month basis, and not precisely predictable, and it is nearly the only bill (with natural gas) that falls into this category.
 - Most other bills are either fixed monthly amounts or are the result of more clearly discretionary behavioral choices made by customers (they might actively choose to use more minutes on their cell phone, but they are aware of this choice as they are making it; when they “choose” to use more electricity to heat their apartment because it is cold out, however, this choice is typically – though not always – less active).
- Customers sometimes say that they do not “know how” to save electricity or that they “do not have any control” over the amount of electricity they use; when asked to explain, however, most back away from these positions.
 - As we noted above, if questioned directly on the subject, most customers will agree that their use of refrigeration, water heating, space heating, and the like are “conveniences” that they could do without if they needed to do so. Ultimately, then, these customers know that they could significantly reduce their electricity use if they really chose to do so.
 - What most customers are less clear about is what actions might constitute the easiest (in terms of lifestyle impact) set of actions that would reduce their electricity usage by 10%, for example (this should not be surprising given the lack of clarity in the electricity usage heuristics most have). Implicitly, however, most customers appear to assume that the actions necessary to

yield the 10% savings outcome would be onerous, and/or difficult to implement.

The fundamental billing heuristic present among residential customers (“the more I use, the more I’m charged”) leads them directly to the recognition that energy usage is the core of energy management (managing energy means managing usage). The problems for customers in dealing with this relationship, and in getting from this understanding to decisions about the behaviors that are most appropriate, are that:

- First, only some portion of electricity usage appears on a day-to-day/hour-by-hour basis to be “discretionary” usage
 - Once customers have “decided to live in the 20th century” (and use lights, refrigeration, etc.), then much of what is “really” discretionary, they believe, is no longer so.
 - When questioned on the subject, respondents agree that the way they use and maintain appliances (such as refrigerators, for example) does affect how much energy the appliance uses; even so, their inclination appears to be that the effect they can have on the amount of energy an appliance uses is in most cases small relative to the baseline usage driven by simply having the appliance at all.
 - The efficiency of appliances purchased, which customers will also grant is at some level a discretionary selection with long-term impacts on energy use, is not a set of decisions that are viewed as discretionary on a day-to-day basis, but only relevant in replacement situations.
- Second, customers tend to make convenience and comfort decisions that are relatively persistent; they know they could change these decisions, but they have decided that “this is how comfortable we want to be,” and are willing to pay the price for doing so (at least up to a point)⁴.
- Additionally, the lack of clarity most customers have about the relative contributions of different appliances to total energy usage means that the impact of different energy management decisions is difficult to estimate.

Ultimately, therefore, while customers “know” (because their billing and usage heuristic tells them) that managing energy usage is the key to managing energy bills, they have relatively few degrees of freedom in usage left to manipulate (once all of the various types of “non-discretionary” electricity usage are eliminated) and little clarity about the exact impact different behavioral changes will yield. As a result, the understanding of energy billing and usage that begins by providing clear direction for energy management ends up appearing to suggest that once the “big decisions” are made, there is relatively little room – and therefore relatively little reason to invest the time in – managing energy.

⁴ Econometric evidence would suggest that there does come a point at which higher electricity prices do cause customers to reconsider their comfort and convenience decisions, and as a result, reduce their use of electricity.

To What Extent Are The Billing Models for Energy Similar to Those Applied to Other Products and Services?

As we have suggested already, billing models for electricity use/energy use are similar to, though in important ways different from, billing models used for other services. The most important of these similarities and differences are as follows:

- Like many other consumer services (e.g., local and long distance telephone service, cellular telephone service (at least for some customers), water), electricity/energy billing is usage-based
- Unlike other usage-billed services, however, electricity is measured and billed in units for which people do not have a reasonable referent (i.e., kilowatt hours vs. minutes or gallons)
- Unlike other usage-billed services, electricity tends to have a very large share of use that feels non-discretionary

While these differences are important, of course, customers are able to describe the way that bills for other consumer services are calculated on a monthly basis, and through the analysis we were able to identify a total of ten different methods that customers told us were used to calculate one or more of their monthly bills, including:

- Fixed annual fee or cost divided into 12 equal monthly payments
- Fixed monthly fee
- Fixed price for each unit of usage per month
- Fixed price for each unit of usage per month PLUS fixed monthly service fees
- Fixed monthly service fee that includes a baseline / starting usage allotment; any usage over the basic allotment is charged at a fixed price for each additional unit of usage per month
- Variable usage price – price charged per unit (hours, minutes, etc.) varies by time-of-day / day-of-week service is used
- Variable usage price – price charged per unit (hours, minutes, etc.) goes UP the more units are used
- Variable usage price – price charged per unit (hours, minutes, etc.) goes DOWN the more units are used
- Average monthly usage fee – based on average usage or the average use of customers in the area per month
- Monthly fee based on usage (Not clear on how this works, or there is no clear connection between usage and total monthly cost for you, but you know the more you use, the more you are charged per month)

There were typically no strong preferences for one type of billing model over another within respondents, nor across services. Most respondents were able to see an application for most of these billing models, depending on the service. Even

more interesting was the fact that respondents recognized that billing models could change for a service over time (that there were not natural and necessary linkages between billing models and services), since many had changed plans for services from unit-based pricing, for example, to flat fee per month plans for a specific service (i.e., long distance phone, internet access).

Note as well that one of the primary motivations for how billing methods are selected, when there are choices available, is the potential for savings. Participants had a fair amount of experience switching cell phone and long distance service providers and plans, which often involved a change in how the service would be charged or billed. In most cases, these switches were made in order to "get a better deal."

That said, there were some preferences expressed by a few respondents for a billing model that would give some measure of predictability to the monthly bill, whether that meant a simple fixed monthly fee or a fixed annual fee divided into 12 payments. This predictability was viewed as helpful in planning and budgeting by at least some respondents.

Detailed Findings: Phase Two Insights on Heuristics Validation

Phase 2 of this research effort had as its primary objective to validate (or reject) the typology of billing models developed in Phase 1. In addition, the discussions were designed to extend and clarify the relationships between billing and usage heuristics and customer perceptions about the meaning of energy usage and energy control. Finally, the Phase 2 discussions were designed to test respondent understanding and initial response to several time-differentiated electricity pricing options and several other specific questions of pre-test relevance to the Customer Preferences Market Research (CPMR) questionnaire that will provide a quantitative measure of statewide customer reaction to a variety of time-differentiated electricity pricing options.

Testing the Billing Models Typology

In the second phase of the research, respondents were given the typology of billing models that had been generated in Phase 1 and asked to select the one model that best described the way they were charged for electricity service (see page 7 above for a list of these options), as well as for a variety of other services. Recall that the models listed were not specified externally by the researchers or supplemented by a model that was the “correct” one for electricity. Rather, the list of billing models was simply a summary of the different understandings that Phase 1 respondents identified as relevant to household service purchases. The reasons for using this approach was to ensure that the billing models tested were the ones that customers themselves had articulated, represented as much as possible, using their own language.

Both college and non-college educated respondents were able to assign most services (including electricity and gas service) to a single billing model, though it is worth noting that many respondents appeared to find the task of assigning electricity to a single billing model difficult (and more difficult than assigning most other service to specific billing models), and that many respondents appeared to be unsure about their choices. Some respondents, for example, assigned electricity to a “variable” price per unit billing model, though in conversation it became clear that what they meant by this was that the total value of the bill “varied” depending on how much they used. This uncertainty⁵ was further evidenced by the fact that respondents ultimately assigned electricity to a much broader set of billing models than they assigned other services (multiple respondents, for examples, assigned electricity to nine out of the ten models tested), though two of the models were

⁵ It is probably true that customers could accurately describe more features of their electricity pricing plan if they had a physical copy of their bill in front of them (this was not done in the groups). The issue studied in the groups, however, was the sort of billing heuristics that customers “carry around with them” and use or apply on a day-to-day basis. Whether or not customers could more accurately describe their pricing plan with a bill in front of them, the notions that drive their day-to-day decisions are the concepts and perceptions that they have available to them without reference to any external documentation.

selected more commonly (fixed monthly fee with baseline usage allotment and variable usage price, with unit price increasing as use increases)⁶.

In part, of course, it is possible that this uncertainty in assignment was driven by the fact that several of the different billing models are partly accurate for electricity. That is, current electricity rates have characteristics that include some component of several of the different billing models tested (i.e., to some extent, electricity rates have elements of fixed price per unit of use, fixed price with a baseline, and variable price with the price increasing as usage increases). The fact that several of the different billing models offered have elements of “the correct” answer for electricity, may, then, have led respondents to be confused about which to specify as the single best response.

While this may have been the case for some respondents, however, it was the observation of the group moderator that this was not the typical problem. Rather, the results of this exercise, which showed substantial variation in the assignment of electricity across the different billing models is understood as evidence that customers tend to have a not particularly clear understanding of the way that electricity is billed. To be more specific here, the fact that there was so much variability in the assignment of electricity to a single – or limited number – of billing models is less evidence that customers felt that none of the models was completely accurate (with several being partly accurate) and more evidence that customers have a general notion that electricity billing is tied to usage, but a not very specific notion of how this connection is made at a detailed level.

Comparing responses across this small group of respondents suggests that AC usage is not *strongly* correlated with the type of billing model employed. However, most of those using the two most frequently used models did have high AC use, and have probably had an opportunity to directly experience the inclining block rates used by the California IOUs, which is suggested by these two models. Additionally, those with a college degree or higher level of education appeared slightly more likely to use the baseline-allotment and variable-usage-price-that-increases-as-use-increases billing models.

Most using the baseline allotment model were unclear how the baseline allotment was calculated or what it meant. Many had assumed that it represented some average or “normal” household usage and, as such, was intended to suggest what a “normal” household “should” use.

Linking Billing Models to Attention Paid to The Bill

As we observed in the Phase 1 discussions, while many respondents reported that they paid attention to their electricity bills, there were no consistent connections between the extent to which customers reporting attending to their bill and the specificity and accuracy of their billing model:

⁶ See the Appendix for a full description of the results of this exercise.

"...about the only thing you can compare is not the price, but your therms or kilowatt hours used..." – College, SF

"You can't argue, you can't change. There's only one provider. But if there's a \$20 difference, I'm suspicious." – College, Costa Mesa

"We usually just look at the totals to see if there's a jump." – College, Costa Mesa

"If we were home every day and if we were gone a week or so, I expect it to be less." – College, Fresno

"I don't [look at the bill]; whatever it says goes, unless it's astronomical, like 'what the heck.'" – Non-College, SF

While some respondents report that they review information about kWh usage on their bills, for example, most are unclear about what to do with this information (or for those who claim to understand the information, most say they do not actually end up doing anything differently):

"You really can't compare the dollars because you expect the price to go up...this information isn't included – you just get your usage...I keep my statements and I've pulled out them – but I don't look at the dollar amount." – College, Fresno

"I like to look at the usage from last year just to make sure the usage isn't completely different." – College, Fresno

"Well, I look at electricity but only very briefly only to see how much wattage I used or kWh. [And, what do you make of that?] Not much. I just compare to last year to see last year's usage if it went up or down." – College, Fresno.

"I look at both [bill amounts and kWhs] – because in last couple of years you can't really expect the amounts to be the same. But it's [kWhs] really just a point of interest to see how that changes." – College, Fresno

"I look at the therms, though I don't really know what it means. The bill is pretty consistent from month to month." – College, San Diego

An occasional respondent does report that they are able to see usage impacts as a result of changes in behavior they have made:

"I've done a lot of things to my home to cut down on the amount of power I use to cut down on the cooling, and heating, and I bought an up-to-date cooling system and my bill is a lot cheaper now." – College, Fresno

Linking Billing Models to Energy Management and Control

Group discussions in Phase 1 explored the issue of perceived control of electricity use at some length. In order to test the hypotheses developed from Phase 1 about customer notions of control, the research team developed a set of questions that attempted to parse the control issue in ways that provided a more meaningful look at how respondents think about this issue⁷. Summary results from those questions can be found in the Appendix, sorted by the billing models that respondents reported using for electricity. Because of the small sample sizes involved, and the fact that there was some diversity in the way that customers appeared to understand these questions, we have chosen not to include that table in the body of this report. While the general findings outlined below are, we believe, appropriate interpretations based on both the written responses respondents provided in the workbooks as well as the statements they made in conversation, the “data” alone provided in the workbooks may be subject to more interpretation than would be appropriate.

In conversation with group participants, it was clear that regardless of the billing model in place, most respondents appear to believe that they have no control over their electricity service provider or the rate they are charged by that provider.

“I don’t have any other choice except to suck it up and pay for it.” – College, SF

Furthermore, there seemed to be no relationship between billing model in use, the size of the electricity bill and the degree of perceived control over usage. Most respondents believe that most of the electricity they use is a “necessity” (recall the discussion above regarding respondent beliefs on the issue of boundary setting decisions that establish a context for defining a substantial portion of energy use as “non-discretionary”). In this same vein, most respondents believe that most of their energy use is not “optional,” and implicitly that they do not “waste” energy much, if at all. Even customers with large bills – typically heavy AC users – tend to see themselves as conscientious energy users. They understand that AC usage is a big driver of their bill, but this is largely seen as a necessity, with most perceiving the only strategy to reduce their AC usage being to turn it off. Most already employ this on / off strategy to reduce AC use by turning it off when no one is home, turning it off at night and not turning it on until “we have to” during the day. Making temperature adjustments to the AC thermostat setting as a method to conserve (a practice that was expected to be commonplace) was not mentioned by most respondents:

“You have control over what you use, but there’s a minimum that you have to use and you have some control over that – maybe \$20 here or there, but nothing significant.” – College, San Diego

⁷ See the session workbooks provided in the Appendix for a listing of the questions asked on this subject.

"[You indicated you run your AC in the summer a lot...Have you ever tried to reduce your summer bill?] The first year I lived up there I was not going to use that because it cost too much money. The second year I was dying, I had to use that. Then after I was over the hump, this was the third year that I lived up there, every time I come home and it was too hot, I turned on the AC." – College, SF

"The air conditioning really drives the bill in the summer and we've really tried to cut down on usage and turn it on only when we have to. We work at home and it's been a huge adjustment." – College, Costa Mesa

"I don't have to run my air conditioning, but I want to be comfortable." – Non-college, Costa Mesa

"[What would you do if you were trying to reduce your electricity bill?] It's not as important to me because I'm conscientious – I turn off lights when I'm not in a room. But, typically, it would be difficult for me to think about not doing something in the house to save." – College, SF

"[What other things might you do to reduce your electricity usage?] I don't think I would even go there, what you're asking." – Non-college, SF

"If I had to [reduce my electricity bill] there are things we could do without, but I'd really rather not." – Non-college, Costa Mesa

"When I use the AC, the bill goes way up." – Non-college, Fresno

"It gets awful hot here in the summer. You can limit your AC usage, but you still have to use it." – Non-college, Fresno

"I know that it's the AC that is the bulk of the bill. It can get pretty high." – Non-college, Costa Mesa

"You can always conserve a little more, but I'm pretty resigned to the fact that my bill is always going to be around \$150 a month." – College, Fresno

While AC use is generally recognized as the primary driver of electricity costs, respondents were able to identify other strategies for reducing their bill further *if* that were their goal (but note that it was not for most). Note, however, that because most customers lack a clear or comprehensive understanding of the way that appliance use beyond AC contributes to total electricity usage, this means that these alternative action plans have a good deal of uncertainty associated with them. Regardless of education level, as we have suggested, the first thing that tends to come to mind (and for reasons we have already outlined) when customers think about reducing electricity usage is turning off lights not in use. Other energy conservation suggestions made by participants included:

- Behavioral changes – Turning off lights / TV / radio / stereo / etc. when not in use; turning AC off at night and when no one is home
- Home improvements – Adding insulation; installing energy efficient windows; replacing old heating / cooling systems; adding solar heating; adding whole house fans
- Appliance improvements – Replacing older appliances with energy efficient ones; using Green Plug; using energy efficient light bulbs

"I leave my laptop on all the time. I put it on sleep mode, but I don't think that really works. I think it's still on. I don't know how much it contributes. It's just a little laptop. But I could be wrong – it could be a monster wattage user in a little package." – College, SF

"I always leave my electric toothbrush plugged in. That's some time of electric use." – College, SF

"I tried to make sure the TV and lights were off, but I didn't see a change." – Non-college, Costa Mesa

"If it's hot, I'm going to run my air conditioning; I don't leave lights on unnecessarily." – Non-college, Fresno.

"[Are there things you could do differently?] Yeah, I could, but it's hard. Not running the AC, that's really the only thing. Everything else is like a necessity, unless I unplug the computer. Everything else, the freezer, refrigerator, washer and dryer is a necessity." – Non-college, Fresno

"I know that to a certain extent we have control over what we use. But we're pretty cognizant of what we use, especially after we got that \$460 bill. So, we sit and eat breakfast in the morning without turning the lights on in the kitchen and sometimes at night when we're having dinner we don't turn the lights on...so, things like that and we're pretty careful about not leaving the lights on. I'll have to admit too that some of our use is more frivolous than necessity. We have a waterfall that we pretty much keep on all the time but that's to keep the mosquitoes away, so we'd rather have less mosquitoes and pay more on our electricity bill." – College, Fresno

Ultimately, for most respondents, the reality of adopting energy management and control behavior is that while they might like their bill to be lower, most believe they have reduced their usage such that they use only what they need and to reduce it further would mean having to sacrifice in terms of comfort and convenience. Whether or not they are correct on this issue is clearly another issue, but the reality is that customers start with the notion that meaningfully reducing their electric bill would require them to sacrifice in noticeable, and unappealing, ways.

Understanding / Impressions of Variable Pricing

Following the discussions of billing and usage heuristics and related issues, some time was also spent in the group discussions exploring respondents' understanding of other products that use time of use pricing as well their ability to understand various variable pricing options for electricity (including time-of-use (TOU), critical-peak-pricing (CPP), and real-time pricing, as well as other electricity pricing options). The reasons for exploring customer reaction to these concepts were primarily to determine if the basic notion of time-differentiated prices were comprehensible to customers, and if so, whether there were available billing heuristics for other products and services that could be linked to electricity in order to help customers understand such prices more easily (and implicitly, whether drawing such analogies created more problems than they solved). To be clear, the discussion of these rates was not meant to provide definitive guidance on whether or not residential customers will accept the rates, or to determine the best way to convince customers that they would benefit from these rates. Rather, the goal was to understand how easy, or difficult, it would be to explain the basic concept of time-differentiated rates to customers, and in doing so, determine the key issues that customers raise that will require further clarification.

Previous Familiarity with Time of Use Pricing

The most commonly named service that customers currently purchase under time-differentiated pricing plans is cellular phone service, the penetration of which was quite high in all groups. Many customers were very familiar with the cell phone model of on-peak/daytime minutes versus off-peak/night and weekend minutes, including the high rates charged for going over an allotted number of minutes, particularly during peak times. Cell phone users can typically recall the general time periods for "on-peak" ("daytime") and "off peak" periods, but were less clear about the specific time boundaries that marked the change from one period to another.

Most customers appeared to be comfortable dealing with this pricing model, though many reported that it took several months, or multiple different plans before they found an option that "worked" for them. It is important to note here that customers did not appear to view their choice of each plan as essentially "trialing" options until they found a good one. Rather, respondents appeared to describe each choice of plan they made as a choice of a plan that they thought was the right/best choice at the time. Only over time did they find, in some cases, that some key feature(s) of a pricing plan created problems for them, or caused them to have higher bills than they thought they would have at first.

The end result of changing pricing plans for cellular service, then, is that customers tend to believe that "now," they have a good plan (especially if they have just selected a new one). Having to change plans, however, is not viewed as a good thing (if for no other reason than that it takes effort to research alternatives), but rather as a necessary step when a given plan turns out not to work as well as had

been anticipated. The implication for electricity pricing plans to recognize that customers do not tend to adopt such plans with the notion that they are willing to “trial” options and “see how they work out.” Alternatively, customers appear to want to believe that each choice they make about adopting a pricing plan (currently, for cellular service, but implicitly for electricity service) will be the last time they need to make such a choice.

It is also worth noting that there were several participants who claimed to be on a time-of-use pricing arrangement already. In most cases, that impression seemed to derive from the “Flex Your Power” campaign. Based on the suggestions made in that campaign, some customers said they were delaying some electricity use until the evenings and weekends, and that they were doing so because they believed they were paying less for electricity during those times. Some customers, therefore, were both under the impression that they were being billed on under a TOU logic (fewer than 10%), but this population of customers thought the arrangement was reasonable and indicated that they were careful to move such “discretionary” uses as laundry and cooking, as much as possible, into the evening hours.

Of course, since a small number of customers in California actually are on a TOU pricing plan now (not counting SPP participants who were excluded from this research), it is possible that a small number of such customers might have been included in the groups, and as a result, might have been providing accurate information when they described their current rate plan as TOU-based. The number of such customers is undoubtedly small, however, and is unlikely to include all of those customers who described their electric bill as some version of a TOU-like billing arrangement.

In summary, the discussions suggested that most respondents could easily understand the logic of time-differentiated electricity prices, and most had ready billing heuristics available to help them make sense of such prices. In fact, the discussions suggested that customers understood time-differentiated pricing (at least of the on-peak/off-peak variety) more easily than they understood the notion of inclining block or declining block pricing.

It is also worth noting that, while customers readily understand the notion of time differentiated pricing, the details in their TOU-based billing heuristics for cell phone use, for example, are not particularly clear. Most cell phone users know, for example, that they have a limited number of on-peak minutes and that minutes over their allotted amount are “expensive.” Exact information about the hours that define on/off-peak, however, as well as the exact prices of “extra” on-peak minutes is not information that most customers have (suggesting that expecting customers to have equivalent information for similar electricity pricing plans is probably unrealistic).

TOU

Looking specifically at TOU electricity pricing options, we found in the discussions that participants readily accept a rationale for why prices might be higher during weekday afternoons and, regardless of education, understand the concept of TOU.

"I could see from the electric company's point of view because that's the time when they have to buy electricity, people selling it to them are going to want to charge them more, so they're going to have to recoup more of their costs and still make money at the same time." – Non-college, Fresno

However, we also found that the perceived "fairness" of this type of rate – or of any rate for that matter – is inevitably interpreted as "fair to me." That is, most people define a rate as more fair than one they are currently on if it means that they will see lower bills under the rate without any change in behavior, or with only "easy" changes in behavior. Any rate that would increase their bill, or require substantial load response behavior on their part to see either no impact or a small benefit, would typically be viewed as unfair⁸.

Those who are typically not at home during the day recognize that they would have to change little or nothing to benefit from TOU options, and as a result, these participants tend to view the TOU rate as "fair" since it would have little impact on how they use electricity, and might lower their bill. For those customers who assumed that they would have to change the way they use electricity – particularly when they assumed this meant they would need to air condition less – this rate option was not viewed as fair, at least initially.

"[What do you think of this idea?] For me, I think it rocks. I mean, for someone who's working until like 6 or 7 at night, you get home at night and you haven't paid those high bills in the afternoon." – College, SF

"For my situation, it would be ideal, because I'm not really home at all during the afternoon and the evenings and weekends is when I use the most electricity and it'd be the cheapest." – Non-college, SF

"I think it might work better that way. I'm like him, I work during the day most of the times so I don't get home until 6 or something anyway." – Non-college, Fresno

"I'm a late nighter; it would be easy for me to live that way." – Non-college, Costa Mesa

⁸ Implicitly, of course, this means that some customers would view the current inclining rate options as less fair than a variety of time-differentiated rates, some flat rate options, and perhaps other options as well. The critical point here is that "fairness to me" is viewed simply, for most respondents, as simply a question of the relative financial impact of the pricing plan on them.

"I don't like the time of use pricing. I don't work so I'm at home and it's silly to have to do everything at night. My housekeeper comes from 9-3pm. It would be too hard for me." – College, Costa Mesa

"[Is this a fair way to charge for electricity?] If I was back at work, yes, because I'm not there in the afternoon, but now that I'm off, no because that makes a difference." – Non-college, SF

Customers who would need to shift their energy usage in order to benefit from a TOU rate, then, tend to view such an option initially as punitive and unfair. Any required change in behavior tends to be viewed as onerous, and likely to be more difficult, and yield less value, than is promised. In fact, customers in this category tend to complain more about these rates the more they talk about them (raising issues, for example, about their perception that more complicated pricing arrangements give utilities more opportunity to "play games" with pricing and profits).

It is also worth noting that some respondents did view a TOU rate as an option that would actually give them *more* control over their bill by giving them the opportunity to shift their usage and save money. Some respondents also indicated that this kind of pricing plan could actually be easier to work with than the inclining block rate plan since customers generally do not know how much they have used in a month or when the rate goes up to the next level.

"[This would be] a lot more easy – I didn't realize the steps in pricing...but with this you know when the peak prices are. As it is now, I don't know how much I've used and when those blocks go up." – College, Costa Mesa

"I think it would be a benefit to a majority of people. It would be easier for me to understand it. It would be a little bit like my telephone. I know that after 5 or after 9 it's cheaper, so this would be easier to understand because I don't know how it's price for electricity now. If they're going to offer me a plan for saving, I would use that plan." – Non-college, Costa Mesa

If they were to adopt such a rate, several participants identified information that would help them to better work with the rate. Some of that information included:

- An analysis of what times of the day electricity usage typically occurs, coupled with a suggestion for how much usage would have to be reduced or shifted
- How much different appliances cost to use / how much electricity they use relative to each other
- Information on a website that gave up to date information on usage by time throughout the month
 - Though note that in broader discussions about the frequency with which customers access the websites of various service providers, the discussion was clear that little or none of this happens currently (the rare exceptions

are people who access their bank accounts online and/or their cell phone service plans)

- Other general tips for how to save money under the rate

In considering these findings, it is important to note that during the groups no attempt was made to persuade customers that energy shifting actions would be easy, or that the rate is “really” more attractive and fair than it might appear on the surface (because of the proportion of hours that are off-peak, for example, or because of the relationship between on-peak prices, off-peak prices, and current prices). Similarly, there was little or no discussion about the improvements in overall economic efficiency that would be expected to occur with peak load reductions and load shifting. The moderator did not pursue this discussion because convincing customers about the attractiveness of the pricing options was not an objective of this research. Rather, the goal of these discussions, as we noted above, was to establish whether or not customers can readily understand the logic of TOU (and other time-differentiated pricing plans) and to identify their initial reactions to these options (specifically as these relate, or not, to the issues raised in the billing heuristic discussions).

CPP

Reactions to a “pure” CPP option (one that had peak pricing periods only on critical days) were more mixed than those for TOU. Some respondents likened this type of rate to “pitching in” in a crisis and found it to be easier to deal with since it is something they could do for a limited number of days a year. Others felt the rate would be more difficult to deal with, however, since it does not occur every day and there might not be enough notice of the change in rate. This uncertainty with regard to when the high rates might be coming was a concern to some.

“I like it to be more consistent so I don’t have to think about or remember when I have to adjust my usage.” – College, SF

“Telling me the day before might not work. What if you’re going to have this party at your house the next day? If it’s a day’s notice, that’s kind of like you trying to tell me how to live my life.” – Non-College, SF

“I just wouldn’t turn on the air that day.” – Non-college, Fresno

Preference for Fixed Rate over TOU or CPP

Despite the possibility of saving money by having little or no use during peak periods, when given the option of a fixed rate over TOU or CPP, many still prefer a flat rate, at least on initial exposure. The most common reason for the stated preference for the flat rate was that it is easier to deal with and respond to. What this suggests is that the introduction of any new time of use rate will need to be accompanied by a strong marketing campaign that will clearly demonstrate the cost

savings potential as well as the ease with which customers should expect to be able to respond to the new rates.

"Overall, I still prefer a flat rate. Simply because you can just go about your business. But, I could deal with a time of use pricing or an emergency pricing, but I prefer a flat rate." – College, SF

"I prefer a flat rate as well, but I would experiment trying this time of use pricing, both options, this one and the 15 days, just to see what happens." – College, SF

"Flat rate pricing is more fair – I like to know what I'm paying for with no surprises." – College, Costa Mesa

"I prefer a fixed monthly fee so I know what I'm paying every month. It makes planning better." – Non-college, Costa Mesa

"I'd rather have it be 10 cents all the time than risk having it be 20cents." – College, Fresno

Inclining / Declining Block Rates (Use More, Pay More / Use More, Pay Less)

While very familiar with the "buy more, pay less" model used for other types of purchases, most group participants felt that the "use more, pay more" model made more sense given that electricity is considered a natural resource. A "use more, pay more" model would be more apt to discourage wasteful electricity use, most customers assumed, while a "use more, pay less" model is assumed to encourage people to use more electricity, potentially using too much or wasting it.

"It [the declining block rate] would just be ridiculous. Everybody would just leave everything on." – Non-college, Costa Mesa

That said, those that tend to use more electricity do not find the "use more, pay more" (which is, of course, the current inclining block) model fair. Those with larger households suggested that they would be penalized for having a family that uses more electricity not because they are wasteful, but rather simply because there are more people.

"I don't like that. I want to enjoy my lifestyle, but I don't want to be penalized. I don't want to have to worry about it." – Non-college, Costa Mesa

Participants suggest that information throughout the month on how much they are using would be helpful under a "use more, pay more" arrangement, since this would help them to better predict their monthly bill.

Real-Time-Pricing

As with the other pricing options, group participants appeared to readily understand this alternative, though reactions to the option were quite negative (though note again, no attempt was made to alleviate customer concerns; rather the focus of the discussion was simply to determine if customers understood the option and to hear their initial reaction). For most, the frequency and potential magnitude of pricing variability, on the face of it, would be too much to reasonably deal with. Even after it was suggested that a control device could be placed in the home to help customers react to the changing rates, many were concerned about the potential difficulty of programming and managing these devices.

"This would drive you nuts." – College, San Diego

"You'd have to program it. I have a hard enough time with my remote control." – College, San Diego

End of Summer Survey Question Pre-testing

A set of questions to be included in the Statewide Electricity Pricing Research Project End of Summer survey to evaluate pricing plan comprehension was also pre-tested in the Phase 2 groups. The various components of how an electricity rate could be designed were disaggregated and tested using a series of closed ended single and multiple choice questions. The specific questions tested in the Phase 2 groups were developed based on the Phase 1 discussions and can be found in the appendix to this report (in the Participant Workbook).

The pricing plan comprehension questions were constructed to address the different aspects of electricity pricing that appeared to be confusing or unclear to the largest number of respondents. Those areas included:

- The number of prices with which customers' bills are calculated
- Whether or not these prices vary by time of day, day of week, etc.
- The time of the day when prices are highest and lowest
- The degree to which the bill is calculated based on some average usage
- Whether the rate includes a baseline allotment and how this is calculated

For the most part, the questions tested were answerable, even by respondents less familiar with their bill. Every question provided a "not sure" option as well as the option to indicate that their bill did not work in any of the ways suggested to try and prevent leading respondents down a path they might not have otherwise chosen. However, the pre-testing did point out some comprehension problems with the way the questions were originally worded.

One comprehension problem surfaced among those customers with combined gas and electric bills. Getting these customers to think only about their electricity usage is a challenge. A few, for example, indicated that two different rates are used to calculate their bill – one for gas and one for electricity. Though the setup to this series of questions indicated they were all referencing electricity billing, it points to the need to clarify this orientation in every single question.

Additionally, the pre-testing identified a need to more clearly articulate that certain questions were referring to the unit price or rate charged for electricity. Without this reference, many interpreted "the prices you are charged for your electricity" as the total amount charged based on total usage, rather than a rate charged.

Our conclusion from testing these items is that they are a reasonable set (with appropriate modifications) to use in evaluating the accuracy of the billing heuristic held by customers in the End-of-Summer survey. The issue, of course, is that since customers in the survey are expected to effectively have a basically similar fundamental billing heuristic ("The more I use, the more I'm charged"), the focus of the research questioning will be on understanding the specific notions customers

have about the way that usage information is turned into the dollars that appear on the bill. A potentially useful addition to the series of questions for the survey, however, would be to add items that explore the customer's understanding of the granularity of the electricity usage heuristic (i.e., to better understand what customers see as the most important contributors to total electricity usage) as well.

Quantitative Survey Question Pre-testing

As with the End-of-Summer pre-testing, the project team used the qualitative sessions also as a mechanism for pre-testing several questions to be used in the quantitative Customer Preferences Market Research (CPMR) project. The objective of this pre-testing was to improve respondent understanding of the items, and ultimately, to improve the quality of the data collected. These questions can be found in the Participant Workbook examples provided in the Appendix. The Costa Mesa and San Francisco Participant Workbooks contain the original wording tested. The Fresno Participant Workbook contains the wording modified based on the previous groups' findings.

Question #5– Benefits of a TOU Rate

This question was included for pre-testing because there was concern that respondents would not be able to answer it without an explanation of how some of the benefits listed would be made possible by a TOU rate. However, while only a handful chose benefits other than financial benefits as the most important reasons for signing up for a TOU rate, this was not because an explanation of how those benefits would be realized was lacking. Rather, most had the mentality of needing to take care of themselves first and then worrying about the greater good later. Many indicated that the non-financial benefits of the rate are worthwhile, but not their primary motivator.

"[What about those other (non-financial) benefits?] Yes, those are nice things overall, but what it really comes down to is what's in your pocketbook." – College, SF

"My living situation is primarily most important." – Non-college, SF

"I'm going to go for something that helps me in the long run." – Non-college, Costa Mesa

Additionally, it was found that many took option "A" -- "To help me better manage my electricity use" to its logical conclusion (that better management would help them save money) and chose it before getting further into the list and noticing there were two other money saving options. While many in these groups saw option "A" as similar to the other two money saving options provided in this question, there was a desire to test the idea of "management" specifically. So, to prevent a respondent from mistakenly choosing "management" when they really meant "savings," option "A" was placed next to the two money savings options in the list.

"When I came to "A," better management of electricity use, I just assumed I would spend less money." – College, SF

Questions #6, #7 – Preference for Inclining, Declining Block Rates or Flat Rates

Many participants in the groups appeared to misunderstand these questions in their original form. Most interpreted “use more pay more” and “use more pay less” as total usage. That is, as total usage increases, the bill increases or, conversely, as total usage decreases, the bill decreases. The question as originally written did not clearly communicate that the unit price increased or decreased as usage increased or decreased. Additionally, “flat pricing” was interpreted by many as a fixed price per month, rather than a fixed unit price. The language in both of these questions was re-written to clarify these points.

The graphs were also a bit confusing and / or intimidating. Many, even the college educated, were a bit put off by charts. That is not to say that there is not a chart that could help communicate these concepts, but the ones used certainly did not work to further understanding of the concepts.

“The graphs kind of scared me and reminded me of math.” – College, SF

Question #8 – Preference for Fixed Rate When at a Premium

There was some confusion with people thinking this would be a fixed charge per month, rather than a fixed rate per month. To clarify this, there is a need to more clearly articulate that the price per unit or hour is fixed. Using hours as the unit of measure to describe the amount of electricity used may make more sense in this case, since fewer than half of the respondents refer to kWh when referring to electricity usage. Furthermore, hours may make more sense given many people’s experience with cell phones and long distance phone service.

Question #9 – Preference for Real-Time-Pricing

In listening to respondents discuss their reactions to this question, it became clear that they understood the pricing to be completely variable, rather than variable within ranges – that is lower still in the mornings, evenings and weekends, and higher during weekday afternoons. The question was re-written to clarify this point.

Background Literature Review

As part of this research effort, the project team reviewed much of the existing literature on the subject of residential customer mental models for utility service, and particularly for electricity service, pricing and billing. In addition, the team reviewed the experience reported so far of electric utilities that have offered time-differentiated rates to residential customers.

The first section below summarizes the key takeaways that the authors of this report believe are most clear and most relevant from the existing literature on mental models for utility service. Following this, the discussion takes up each of the substantive issues noted in the summary in more detail. The final section of this review explores the issue of the current experience of US utilities with time-differentiated rates with residential customers.

Key Takeaways on The Issue of Mental Models

- The existing literature on this subject suggests that residential customers appear to have a basic understanding of the notion that electricity usage is measured in “units,” but most do not have much clarity about what these units are or how to understand them; alternatively most customers tend to use dollars as the units of usage for comparison purposes⁹
 - Customers tend, according to this research, to think about using “\$30 worth of electricity,” rather than some number of kilowatts, or other direct measure of usage
 - This fact leads customers to undervalue the potential economic value of energy efficiency improvements
- The existing research also suggests that customers tend not to have an accurate sense of the electricity uses (with the exception of air conditioning among, especially heavy, AC users) that contribute most to their electricity bill; uses that are obvious to casual inspection (e.g., lighting, televisions) are more often listed as the places where energy usage control actions should be directed, rather than to larger, but more “invisible” uses (e.g., water heating, refrigeration)¹⁰
 - This result, these authors conclude, should not be surprising given that customers take many actions each day to “control” their use of lighting, televisions, and the like, by actively turning them on and turning them off, while they take actions to control or manage their use of water heating or refrigeration rarely (in most cases, only when they purchase a new appliance)

⁹ This set of findings appears in, for example, Kempton & Montgomery (1982) and Kempton & Layne (1994). See the discussion below for more detail.

¹⁰ These findings appear in, for example, Kempton & Montgomery (1982), Brown, et. al. (1975), and Egan, et. al.

- There is also some evidence in the literature¹¹ to suggest that providing customers with better information – more granular, more clear, more timely, and with better context – about energy usage can improve the accuracy of mental models for energy usage, and support better decisionmaking about how to both control energy use and to identify and implement appropriate energy efficiency improvements.
 - Note also, however, that the findings of the existing research on this subject are inconsistent in demonstrating the value of additional information. In addition, the authors of this report would note that some of the research reporting positive effects of information appeared to be potentially subject to Hawthorne-like experimental effects (in which behavioral changes are observed among respondents who believe/understand that they are part of an “experiment” purely as a result of that fact, rather than as the result of a real change in their situation). As a result, there is at least some question about whether or not any observed behavioral changes energy usage resulting, supposedly, from the provision of new information would persist once the “experiment” was concluded.
- **BOTTOM LINE:** In summary, the existing research appears to support the notion that billing/usage heuristics are important because they provide customers with an understanding of how a process works, and as a result, are suggestive of how customers should act if they want a different outcome. In the world of electricity billing and usage, however, prior research identifies only a limited set of findings, and does not provide much depth of insight in terms of the variability of billing/usage heuristics across customers, or whether and how different heuristics might engender different behavioral outcomes.

The Relevance of Mental Models

My blender is broken and I’m having a daiquiri party tonight. What do I do if I want a new blender today, but still want the cheapest price? Do I search the websites of all the stores in my area? Do I jump in the car and start driving from store-to-store (or perhaps mall-to-mall) and doing some comparison shopping? Or do I simply drive to Walmart and buy a blender there?

Depending on my “mental model” of appliance pricing practices, I might choose one or another of these options, and depending on the accuracy of my “mental model” I may or may not get the best deal. It may turn out, for example, that I believe that Walmart always has the best prices on home appliances. In this case, I’ll just drive to Walmart and pick up whatever the store has that’s cheap. Alternatively, I may think that on any given day, sale prices will always be cheaper than “everyday low prices” at Walmart. If that’s the case, I’ll check around first before I select a store in which to make a purchase. But note that even the decision about how to “check

¹¹ Evidence for this conclusion appears in, for example, Lord, et. al. (1996), Stern (1992), and Kempton & Layne (1992).

around” will depend on what I assume about how pricing information works. I might assume, for example, that the Web – because it covers a broader range of options – will always list the best prices. Alternatively, I might assume that I’ll only find information on the Web that stores have paid to have listed. As a result, I may assume the information on the Web is a biased sample of true product availability and an unreliable indicator of “true” price availability.

The assumptions I make about how small appliance pricing works, in other words, will have an important effect on how I go about searching for a new appliance and on how much time I spend on that search. These assumptions might be called my “mental model” for how small appliance pricing works. In general terms, the notion of a “mental model” refers to the concept that people have about how something they can’t observe directly actually works. And we have these mental models for many, many things, including business processes, technology, the natural environment, and others.

Several things are important about “mental models,” including that:

- People can have quite different mental models that provide different understandings of how the same process or piece of technology works (to take an extreme example, one person may see the functional character of a piece of technology as magic, while another sees it as a mechanical assemblage of many, small, interrelated parts that all must function properly);
- While it is possible to describe mental models for a given process, activity, or technology as more or less accurate, the most important thing about them is that people use them to decide how to behave in different situations
 - If I need a new blender today, the mental model I have for appliance pricing suggests that course of action I should take if I want to buy the cheapest blender
- Even more importantly, different mental models for the same process can lead to quite different behaviors
 - If I “know” that Walmart is cheaper, then I act in one way to buy the cheapest blender.
 - If I “know” that the Web has the most comprehensive pricing information, then I act in a different way to buy the cheapest blender.

Because of their importance in providing people with starting points for how to make decisions, mental models (or “heuristics”) have been studied by cognitive and social scientists in order to understand how people make sense of the world around them. A typical academic statement of the interest in mental models is as follows:

“A mental model is a representation formed by a user of a system and / or task, based on previous experience as well as current observation, which provides most (if not all) of their subsequent system understanding and consequently dictates the level of task performance.” (Wilson and Rutherford 1989, 619)

The relevance of mental models for the current research is that – as with other things – the heuristic that customers use to understand their electricity bill (not the physical/paper bill and its concomitant design, but rather, the way the total billed amount is calculated and the way their usage decisions contribute to the amount of electricity they use) will likely have an effect on how, and whether, customers choose to change the way they use electricity. The focus of our secondary research review, then, was to uncover what is known to-date about both the billing heuristics residential customers currently use for electricity, and the impact these heuristics have on electricity usage decisions.

Units of Usage Comparisons

One of the starting point issues for understanding energy usage and billing heuristics is the question of what are the units that customers use to measure/compare their usage of a product from one period to another. For pay-per-view movies, for example, the comparison is typically the number of discrete purchases from one month to the next. For electricity, however, how do customers compare usage from one month to the next? Do they think about having used 400 kilowatt hours last month compared to 300 kilowatt hours this month, or do they think about having used \$40 worth last month compared to \$30 worth this month. Is, in other words, their billing heuristic denominated in dollars or kilowatt hours?

Research conducted by Kempton and Montgomery (1982) concluded that the “folk units” used to compare energy use, including electricity was, more often than not, dollars. Even while some people do profess to examine the kWh used (Kempton and Layne 1994), most people were reported to find kWh comparisons less useful (because they are less meaningful) than dollar-to-dollar comparisons month-to-month.

An important implication of this outcome noted by Kempton and his colleagues is that an energy usage heuristic denominated in dollars tends to lead to erroneous underestimation of the potential value of energy conservation behaviors. Since customers tend to think of specific dollar value savings from energy efficiency improvements, rather than of saving a specific amount of kWh as a result of a given improvement, customers tend to miss the fact that kilowatt hours tend to increase in cost over time (as electricity prices rise), making them more valuable in the future. The resulting underestimation of the impact of energy efficiency investments leads to fewer such investments than might occur if customers used a different method for understanding bill comparisons.

The Drivers of Energy Consumption

A second important element of an energy usage/billing heuristic is the way that customers understand the drivers of energy consumption (that is, what energy end uses such as appliances contribute the most to total usage). The importance of this issue is clear since which energy uses customers assume have the greatest effect on total usage will have a direct impact on the way that customers might choose to modify their energy-using behavior if they wanted to change their total usage.

Existing research on this subject suggests that residential customer assumptions about which uses contribute most to total usage differ considerably from reality. In at least one study, for example, residential lighting, which consumes only a small portion of total residential energy used, was most frequently cited as a major area of energy consumption in the home (Kempton and Montgomery 1982). Other appliances and end uses that use considerably more energy than lighting (e.g., refrigeration, pool pumps, water heaters) were cited less often.

The Impact of Enhanced Electricity Bill Information on Mental Models for Energy Consumption and Conservation

Some research has suggested that utilities might be able to modify energy use mental models, and ultimately improve customer energy use decision-making capability, by providing better feedback in the form of a more detailed billing statement.

How do customers use their current bills, however? There is evidence to suggest that customers do use their electricity bills to evaluate conservation actions, as well as to check for unusual consumption (Kempton and Lane, 1994). The methods customers used for analyzing the impact of energy conservation vary, and can be quite creative (including summing each yearly total; comparing the current month to recent months; comparing the current month with the same month last year; and comparing the highest bill for the current year to the highest bill of the previous year (Kempton and Layne 1994)).

Even with so much creative arithmetic being conducted on occasion, however, other work suggests that customers typically do not know the price of electricity despite some knowledge of their electricity bills (Brown, et. al 1975), and that furthermore, customers often have problems reading their utility bills and making energy-efficiency decisions based on those bills (Kempton and Layne 1994).

Given these observations, and in particular, if they mean that customers only really look in detail at their bills intermittently, is it possible to provide feedback on the bill that can meaningfully improve the conclusions that customers draw about what drives energy usage and what they can and should do if they wish to change their use of electricity? One such attempt to provide residential customers with improved energy consumption information was the Energy Star Billing program. The team's research appeared to show that the program (which provided customers with a relative consumption comparison allowing them to determine whether they are on the high, average or low end of consumption) did stimulate energy conservation (Lord, et. al. 1996). When testing the various Energy Star Billing graphical displays that compared residential customer's usage to others in the same neighborhood, the majority indicated they would take action to reduce energy usage based on the information provided. However, the first course of action most indicated they would take revolved around less effective energy conservation behaviors, such as turning off lights and reducing clothes dryer use (Egan, et. al. 1996).

Other research on this subject has found that residential customers cut electricity use by 10-15% when receiving frequent (often daily) reports on meter readings,

with projected energy use or savings. It was hypothesized that providing information soon after any behavior change, in a vivid and easy to understand manner helped customers to reduce their electricity use (Stern, 1992).

Additional research cited by Lord, et. al (1996) and research done by Kempton and Layne (1994) also supports the finding that improved information results in reduced energy usage. However, some caution needs to be exercised when reviewing these results as it is possible that some of the energy conservation observed was due to a Hawthorne effect (in which study participants change their behavior in an experimental situation, at least in significant part, because they know they are part of a research effort) and not simply a result of changes that were made in the billing information provided to customers. The Kempton and Layne research, for example, included the following statement on the newly revised, information-rich bill – “We hope you find the new bill to be informative and helpful in your conservation efforts.” This notation, as well as other information provided as context for the research participants, all of which may have contributed to participants viewing themselves as part of a special “pilot” or “test” program may have contributed to the decrease in energy usage found, separate from any effect solely from the additional information provided. Further support for the notion that the link between additional billing/usage information provided and energy use may be tenuous is the fact that other research has found little or no measured savings resulting from energy information services provided to customers (Egan, et. al., 1996), though the authors suggest in this particular case that the result might have been due to poorly designed information feedback.

Finally in addition, this stream of research has also shown that to be effective in changing or modifying residential customers mental models for energy conservation and consumption, the information provided has to be credible and trustworthy, making the source of the information very important, and replacing the heavy reliance on friends and other non-experts for energy use information. Information not seen as such by the reader tends to have little or no impact on energy use behavior (Stern, 1992).

Conclusions on Mental Billing Models

While the literature considered in this review is informative to a limited degree about how residential customers think about their electricity use, none of the literature to-date specifically addresses the mental models or heuristics customers use to understand how they are billed for electricity, though it does touch marginally on the issue of how customers think about the drivers of energy usage. The primary market research conducted in the current project is intended to take this next step and to explore directly the billing heuristics in place among residential customers, as well as the impact of these models on perceptions of energy use control.

The Experience of US Utilities with Time Differentiated Rates for Residential Customers

Historically, some US utilities have offered time-of-use (TOU) rates to specific groups of customers (such as high usage customers or electric water heat customers), but these rates have typically not been marketed to broader customer populations, nor indeed, have they even been available to residential customers in general¹². Interest in using TOU or other time-differentiated rates to manage customer demand for generating system operating efficiency is a relatively recent concern, and as such, has been the genesis for pilot – or more broadly implemented – alternative pricing programs only recently.

A recently published study that surveyed state utility commissions, for example, (Barkett, Johnson, and Violette, 2003) found, for example, that more than half of their respondents reported that their states were currently involved in time-based pricing pilot programs, though most of these programs were recent and most involved only C&I customers. Within this context, however, there are two significant programs with residential customers that each provide interesting lessons about customer response to time-differentiated rates.

The Experience of Gulf Power

Gulf Power's GoodCents Select program combines a time-varying rate design with a near real-time pricing component together with an in-home customer-programmed, automated energy management (AEM) system to offer an innovative pricing program that appears to both yield real load responsive behavior and create positive customer sentiment. The GoodCents program (White 2003) began as a pilot effort, but has been expanded through program marketing (as a purely "opt-in" program) from several hundred households in 2000 to more than 4,000 households by September 2003. Key features of the program include:

- A three-part base TOU rate (with "low," "medium," and "high" prices that have a range from 4.2 to 10.0 cents per kWh in 2003)) that have predictable time periods, and a "critical" price (30.9 cents in 2003) that is only "called" for limited time periods(1-3 hours) contingent on system conditions.
- The provision to customers of an in-home energy controller that can be programmed either by the customer or for the customer to monitor and manage home appliance use under pre-set rules for each different type of pricing period (appliance controls, in other words, are specified by the customer, but are automatically implemented both for pre-scheduled TOU periods, and for critical pricing periods).

Customers on the program are reported (White 2003) to save an average of 15% on their average annual electric bills and to yield an average demand reduction of approximately 2 kW during Critical pricing periods. In addition, a higher percentage

¹² Chebra 2003 lists, for example, a total of 28 different TOU rates offered by US utilities, but notes that most of these are old, even outdated rate designs that tend to exist for unique historical reasons and apply typically to only small customer segments.

of GoodCents customers are reported to have described their satisfaction level with their utility service as “very satisfied” compared with non-participating customers.

Note, however, that while customers on the program have been positive about their experience, as an opt-in program, growth has been slow. In fact, the response rate to direct mail information about the program (the percentage of those requesting information) is reported to be approximately 2.5%, a reasonable proportion for direct mail, but not indicative of an overwhelming proactive demand.

The Experience of Puget Sound Energy

For almost a year (2001-2002), Puget Sound Energy’s (PSE’s) Personal Energy Management (PEM) program was receiving very positive reviews. Under the program, customers were charged an on-peak summer rate 6.25 cents per kWh and an off—peak rate of 4.7 cents (as well as a \$1 incremental charge to be on the rate). Based on the response of an initial pilot program group who appeared to reduce their on-peak usage by 5-6%, and on a survey of participants that suggested that nearly 90% said the program encouraged them to shift some of their electricity usage to off-peak periods and 49% who said they reduced their overall energy consumption (PSE 2001), the PEM offer was extended to all residential customers. In fact, what was unique about the PEM program is that it was extended to all 300,000 residential customers under an “opt-out” arrangement (that is, customers were put on the new rate unless they asked to be taken off).

What is particularly interesting about the PEM program is that very few customers chose to opt-out of the program until they began receiving comparison bills in late 2002. When those comparison bills arrived, opt-outs increased rapidly, however, and the program was ultimately abandoned. The issue for customers was that, for most of them, even though they had shifted their use of electricity, their bills had either not gone down, or had actually gone up compared to what they would have paid under the old rate.

Summary of Utility Experience with Residential Time-Differentiated Rates

The two significant programs described above seem to suggest several important takeaways:

- There is an enormous inertia effect for customers to stay on whatever rate they “have,” whether this is a historical rate, or a new rate to which they are assigned.
- Customers respond positively to time-differentiated rates if they save money on the rates, and are willing to make changes in the way they use electricity if they believe they will save money by doing so.
- Just the promise of saving money, however, is not enough to overcome the inertia effect noted above.
- If customers find that their load shifting efforts are not rewarded, on the other hand, they will quickly demand a return to their old rate.

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Appendix (See Supplemental Volume)

Screener – Phase 1

Screener – Phase 2

Discussion Guide – Phase 1

Discussion Guide – Phase 2

Participant Workbook – Costa Mesa & San Francisco – Phase 2

Participant Workbook – Fresno – Phase 2

Respondent Level Results from Phase 2 Workbooks

