Advanced Demand Response System Field Trial

2005 Market Research for the Statewide Pricing Pilot

A Boice Dunham Group Report for Invensys

On behalf of the ADRS Sponsors:

Pacific Gas & Electric
San Diego Gas & Electric
Southern California Edison

As mandated by:

The California Public Utilities Commission
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Executive Summary

Background

The Advanced Demand Response System (ADRS) field trial was a small-scale exploratory program deploying advanced energy management technology in 175 California households. Pacific Gas & Electric (PG & E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG & E) sponsored the program to host 75, 75, and 25 ADRS households respectively.

These three utilities created the ADRS program in response to decision D.03-03-036 of the California Public Utilities Commission (CPUC), which stated:

> *By July 1, 2003, respondent IOUs shall file and serve a final plan for evaluating the demand response capabilities of a full scale system, comparable to that proposed by Invensys, with the specific capabilities outlined in the preceding discussion, as well as a proposed method to integrate the installation of these devices at a representative sample of homes during the later stages of this pilot. The respondents shall follow the schedule outlined in the decision for all steps preparatory to making the July 1, 2003 filing. The incremental cost of this plan shall not exceed $1 million*[1].

In this environment of a deep, wide-ranging rethinking of the entire California electric industry, the particular role of the ADRS field trial was to help understand how residential customers might help solve the utilities' problem of unpredictable weekday afternoon peak loads during the summer.

Given the right tools, training, and pricing, would homeowners reliably reduce their electricity use during the summer weekday afternoon peak periods? Whether due to shifting, conserving, or both, such a change in residential behavior could result in substantial savings for both the participating customers and their electric utilities.

The utility sponsors began to execute their implementation plan in late 2003. The ADRS field trial ran in parallel to a series of other large-scale investigations by these utilities into time-of-use rates, advanced metering technologies, and non-residential demand response.

The ADRS sponsoring utilities and the CPUC elected to trial the Invensys GoodWatts system, which was bundled with a specific Critical Peak Pricing rate, ongoing education materials and an annual incentive payment[2]. Volunteers were recruited from randomly selected warmer ZIP codes in the three utilities' territories, and late in the spring of 2004, installers provided these volunteers with GoodWatts. The system

[1] OP3, D.03.03.036

[2] $100 for the first year of the program, $125 for the second year.

included a new programmable thermostat to control central air conditioning, a new electric rate, a website with personal energy information, and where applicable, a swimming pool control as well.

The sponsoring utilities then operated the ADRS program throughout the remainder of 2004 and across 2005, shifting the participants out of summer rates, into winter rates, and back again; addressing customer service issues; dealing with customers moving and dropping out of the program; and eventually leaving 150 participants for the 2005 research.

Most notably, the sponsoring utilities agreed to declare 12 days in 2004 and 11 days in 2005 as Super-Peak Days, when the electric rate for GoodWatts participants rose to approximately 73 cents/kWh[3] between 2 p.m. and 7 p.m. ADRS participants received 24 hours advance notice of these Super-Peak Days by telephone and e-mail. The 23 Super-Peak Days are identified in Table 1:

Table 1

2004 and 2005 Super-Peak Days

	July	August	September	October
2004 **12 Days**	14, Wednesday 22, Thursday **26, Monday** **27, Tuesday**	**9, Monday** **10, Tuesday** **11, Wednesday** 27, Friday 31, Tuesday	**8, Wednesday** **9, Thursday** **10, Friday**	None
2005 **11 Days**	**12, Tuesday** **13, Wednesday** **14, Thursday** 22, Friday	26, Friday	**28, Wednesday** **29, Thursday**	**6, Thursday** **7, Friday** **13, Thursday** **14, Friday**

Back-to-back days are in bold

Customer research concluded in December, 2005, after which Invensys and the sponsoring utilities concluded the ADRS field trial. The GoodWatts system was removed from the remaining 150 households, and these customers were restored to their original electric rates.

[3] Each of the utilities had unique rates, which changed over the course of the program period.

The Research Agenda

The research agenda of the ADRS was established by California utilities and regulators, and aimed to answer three kinds of questions:

First, the ADRS field test aimed to identify and rank-order those technical features and capabilities that would make an ADRS most appealing to residential customers and utility system dispatchers[4]. The trial provided participants with the GoodWatts system[5], and then asked them how they regarded that particular ADRS, and what they might have preferred instead. Participants ranked system features over time in three separate surveys, and we analyzed the results through quantitative conjoint analysis.

Second, the ADRS field test aimed to measure the demand response of participants, compare that demand response to other statewide pilots, and assess whether or not deployment of ADRS technology would be both cost-effective and appropriate according to the Total Resource Cost Test. That analysis has been conducted by RMI, and has been published as a separate report.

Third, the ADRS field test aimed to gain insight into the overall customer ADRS experience, exploring issues such as:

- What fraction of the participants considered the control technology installed to be useful and reliable?
- What fraction report that the technology worked, in the sense that it either reduced their bills or gave them more control over their energy use?
- Would some or all of these participants be willing to pay for all or most of these systems' installation costs, after they have experienced these systems' benefits over the course of the pilot?
- What was the average and range of customer satisfaction levels observed using this type of equipment?

[4] Although comparing the views of customers and field dispatchers was originally one objective of the research, early in the project the sponsoring utilities decided utility system dispatchers would not be involved in this field trial.

[5] The rate-enhanced Invensys GoodWatts system employed in this trial is only one of many varieties of advanced-demand response systems. Trial participants were not comparing alternative systems, but were instead experiencing one system and then discussing what they would prefer based on that experience.

To answer these questions regarding the overall ADRS customer experience, across the two years of the trial we employed customer interviews, surveys, and focus groups. This report summarizes our analysis of customer responses.

The Research Approach

These five research elements of this study are:

- ADRS Design
- Household Performance Differences
- Super-Peak Day Behavior
- Participant Willingness-to-Pay
- Participant Satisfaction Levels.

Our research approach to these diverse elements was shaped by the similarities and differences in circumstances across the 175 ADRS households.

The trial aimed to provide enough similarities to draw conclusions about customer behavior, attitudes, and beliefs. For example, participating households were all led by homeowners who had volunteered for a short-term experiment requiring the GoodWatts system to be installed in their home. They all lived with central air conditioning. During the field trial, they all received $100 in incentive payments in the first year, and $125 in the second year.[6]

All of the ADRS participants lived with a new time-of-use electric rate which changed their bills. With slight variations, the new electric rate charged ADRS volunteers 9 cents/kWh in off-peak times, 23 cents/kWh weekday afternoons between 2 and 7 p.m., and 73 cents/kWh on up to 12 selected Super-Peak Days. These new rates compared to the volunteers' typical previous rate of 13 cents/kWh. To help them cope with the new rate regime, all households received instruction manuals, online personalized energy information, and access to a customer service help desk.

These similarities in participating households were balanced by differences in their circumstances, which ranged well beyond variations in Super-Peak Day weather.

For example, ADRS trial customers lived in various neighborhoods. The trial required participants to be selected from those ZIP codes in Climate Zone 3 served by cable television companies who were cooperating with the trial, so we could operate the GoodWatts system. We needed 75 PG & E volunteers, 75 SCE volunteers, and 25 SDG & E volunteers. To enable efficient customer service, we also needed trial participants to live reasonably close to one another.

[6] During the second year of the trial, participants also received a meter charge on their bill. Many participants misinterpreted this charge as directly related to the trial, and a factor they should consider in assessing the trial's value.

So, by randomly selecting ZIP codes in reasonable proximity to one another in each utility territory, the program's direct marketing campaign yielded sets of program participants living very different lives in very different neighborhoods. Beyond their addresses and their status as homeowners, we didn't know much about who the ADRS volunteers were, or how they lived, or why they used electricity the way they did.

Recruiting materials employed by the three utilities were similar but not identical. The application and installation processes involved contacts with different representatives of Invensys, the sponsoring utilities, and the installers. These representatives explained different things about the program, in different ways, to different members of each participating household. Some participants controlled swimming pools as well as air conditioning, some did not. Some households required customer service, some did not.

Participants also brought different backgrounds to the ADRS study. Most obviously, their homes, families, electric uses, and utilities differed. Less evident but more important were their different motives for taking part in the study. While many of them signed up for the potential savings, some were trying to be good citizens, and some were curious about new technology to control their energy use.

The ADRS experience was similar, but far from identical, for the 175 households who took part in the program. Customer attitudes, beliefs, and expectations regarding the program differed from the outset. The program customers received varied in some respects from customer to customer, and from year to year.

Findings of the Study

1 - ADRS Design

Even though many ADRS trial participants saw their savings during the trial as minor, the typical ADRS volunteer viewed the ADRS, above all, as a savings system[9].

[9] The ADRS was not designed as a system to enable customers to save money on their electric bills. It was designed as a system for customers to reduce their utilities' peak electric loads. However, almost all customers report they are primarily motivated by saving money, rather than helping their utilities balance load.

Typical trial participants came to appreciate the program's technology because the technology might deliver savings to them. While the ADRS trial was not focused to deliver rapid feedback about customer savings, much less to celebrate these savings, most ADRS participants enjoyed the trial, and many enjoyed their role in the program as good citizens.

On balance, most trial participants were very satisfied with the ADRS they had, and wanted an even better system (an ADRS easier to use, providing more and better feedback, and offering more control). Participants found the unpredictability of Super-Peak Days to be frustrating, but the time-of-use rate to be acceptable. Participants found control of their air conditioners and swimming pools useful, but they wanted the option of controlling other appliances as well. Participants sought these improvements so they could save more money.

However, most trial participants did not take full advantage of the GoodWatts system. For example, initial system programming was a task most customers left to the installers; some customers similarly delegated reprogramming to GoodWatts customer service staff. Many customers experimented with the program's special features based on online interaction, but these features were used regularly by only a small segment of participants.

Of the financial incentives and disincentives provided by the ADRS other than savings, the direct payments were regarded as promotional, and not of lasting value. The CPP rate and Super-Peak Days were not widely understood in their design, or appreciated in their execution, but were often seen as the price of savings.

The information provided by the ADRS was very valuable to some customers, but was ignored by other customers. In general, participants found daily household energy usage information to be interesting, and training materials about online reprogramming to be important. Customers particularly valued customer service staff who could explain reprogramming over the telephone.

The measurement capabilities of the ADRS were technical features participants came to appreciate more and more as the program continued. Participants perceived the control provided by the ADRS as less than they expected, and much less valuable than other aspects of the program.

Many participants attributed their savings to the automatic programming installers or customer service representatives executed for them. Others attributed their savings to conservation measures they had taken apart from air conditioning and swimming pool control.

Customers identified the features and functions an improved ADRS would offer. A better ADRS would be a better savings system, and would also recognize the sacrifice participants saw themselves as making. The program's control would be enhanced through additional thermostat functions, and a broader range of

appliances linked to the system. Programming and analysis would be simple and easy, through the Internet or through telephone customer service staff.

Participants believed that in a better ADRS program, Super-Peak Days would be more predictable, and conservation training would be more extensive. Program variations in an improved ADRS would enable a wide variety of households to participate successfully: i.e., households with more family members, low-income households, senior households, technology-challenged households, and households where someone is home during the day.

The ADRS participants prefer would have promotional incentive payments to attract customers, but the main benefits would be savings and recognition. Information on savings would be updated daily, available real-time, and easy to analyze through the Internet or through telephone customer service staff. The savings information would be directly related to Super-Peak Days and the time-of-use rates, so customers could correlate their daily behavior with the program's conditions.

A preferred ADRS would also provide its customers with real-time and periodic recognition and reinforcement for what some repeatedly described as their sacrifice, and others characterized as their contribution. ADRS participants recognized that they were being asked to do something special. Program participants were shifting their energy use, and conserving energy, while other customers were not. Celebrating these contributions, and the good citizenship they reflect, would be an important aspect of a preferred ADRS.

Customers would prefer an ADRS that is easier to use, provided more and better feedback, and offered more control. A major obstacle is the additional volatility delivered to participants' lives through unpredictable Super-Peak Days.

2 - Household Performance Differences

We sought correlations between easily observable factors and a household's readiness to curtail power usage weekday afternoons. We found many factors where neither the segments of high performers nor low performers differed significantly from the general population of ADRS participants, or differed from one another.

Satisfaction with the local electric utility at the outset of the ADRS program was not a significant differentiator. Nor was subsequently reported satisfaction with the ADRS program. Neither the frequency of web site log-ins or customer service contacts could point us toward high or low performers. High performers were no more familiar or experienced with energy management systems than low performers or typical ADRS participants.

Through a standard California household energy survey, ADRS participants provided us with range estimates of home size and household income. More precise measurements of these two factors might well indicate that high performance in the ADRS program is correlated with both. It also stands to reason that home size and income will tend to be correlated with one another, and that electricity use will be correlated with both, thus offering larger peaks to control.

The attitudes and behaviors expressed in the focus groups and interviews ranged similarly for high and low performers. Other factors also proved to be poor differentiators. Some high performers reported accessing the website regularly and programming their homes remotely; some did not. Some low performers were also active computer users, some were not. Both high and low performers reported taking additional energy conservation measures during the program about as often as typical ADRS participants.

We conclude that high or low performance in the ADRS program as offered may not have been a function of who the participants were, how they lived when they were at home, or what they thought. The performance of an ADRS program is more determined by how many of its customers operate central air conditioning and swimming pools in a warm climate, and how many of them are home during Super-Peak periods.

It may also be that the lack of obvious correlations between performance and behavior reflects the participants' lack of understanding about how to impact performance.

3 - Super-Peak Day Behavior

Super-Peak Day customer behavior did persist from year one to year two of the ADRS program.

The ADRS was seasonal, but customers entered the new season ready to do more. In the second summer, customers remained committed, fine-tuning their behavior. Some continued to explore new measures to save energy, and some cut themselves small breaks. From the customers' perspective, they were settling into the program, and becoming more reliable.

Customers usually make their decisions about air conditioning and pool filtration well in advance, perhaps as long ago as when the installers programmed their system, and perhaps when they received their last Super-Peak notification call. ADRS customers were also encouraged to pre-program their appliances in anticipation of Super-Peak periods through newsletters and contacts with the GoodWatts service center. These features worked: e.g., 98% of ADRS participants programmed their pool pump filter to operate outside of weekday peak periods.

Thus, while GoodWatts customers had the capability to adjust their systems in real-time (e.g., through remote access), responding to next-hour events wasn't the objective of GoodWatts. Instead, the design of GoodWatts focused on automating peak reduction well in advance (either through technology, or through customer habits). When ADRS participants received a Super-Peak Day notification 24 hours in advance, they were being asked to consider if their programming and their next day's plans were suitable under a much more expensive rate regime.

Super-Peak Day customer behavior did persist from one Super-Peak Day to another. The most important determinants of participant performance during Super-Peak Days were the installers' initial programming, reprogramming through contact with customer service, self-adjustment through the GoodWatts web site, the decision to be home or away during the Super-Peak period and *ad hoc* thermostat or pool filter adjustments.

The determinants of Super-Peak Day behavior were a combination of programming and reactions (in other words, standard behaviors, and exceptions). Some customers had few exceptions, and some had many. Households could not predict Super-Peak Days, and they could not predict the weather, so their Super-Peak Day behavior varied somewhat.

But because household members had reasonably regular schedules on summer afternoons, and because these volunteers reported routines they tried to follow whenever a Super-Peak Day was called, we can note persistence in their behavior. The major exception we should note to this prevalence of habitual customer behavior on Super-Peak Days is the problem of back-to-back days.

Super-Peak Day customer behavior was similar from one customer to another. Customers had very different balances of costs and benefits, and learned at different paces. Their homes were different, their families were different, and their ZIP codes were different.

However, Super-Peak Day behavior can be quite similar from one customer to another, because the basic uses of energy combine to a similar result, and the basic patterns of life are similar for many of the program participants. There are only so many basic strategies for energy use that work on hot, expensive summer afternoons in California. We found basic patterns in Super-Peak Day energy use that seemed to represent a set of strategies most households were living within.

Super-Peak Day behavior revealed lapses in the ADRS feedback loop between customers' behavior and its results. The variability of weather and household conditions on any given Super-Peak Day meant that participants experienced their demands for energy on each Super-Peak day differently. The financial consequences of overriding the GoodWatts system were difficult for participants to estimate. Most participants did not understand why Super-Peak Days were designed

as they were, how they worked, how much they helped, or when they were likely to occur.

These lapses in the feedback loop were a mixed blessing. Because participants did not receive immediate feedback on the financial value of the program for them, most suspended judgment until they received their utility bill comparisons. In the process, they allowed themselves to learn through experience. They learned they could endure the program in some suboptimal fashion, and then they assessed their savings against that summer-long experience.

The biggest lesson visible in ADRS customer behavior on Super-Peak Days is that a large number of people pursuing their individual lives, learning in their own ways and at their own paces, can build a stable load control program.

Customers build stable load control through two basic strategies for handling changes imposed on their lives: control and coping. Routines are based in control, and customers cope with exceptions. As an automated control system, GoodWatts had much to offer control strategies. Control strategies are based on actively altering the external environment.

Coping strategies are based on new attitudes and personal behaviors. GoodWatts had less to offer coping strategies, but it did make participants mindful of their energy use. Invensys had designed the GoodWatts system to operate under a regime of traditional utility rates, but the California trial required an offering including the CPP rate and Super-Peak Days, and these new elements were outside the customers' control. Coping with these new elements proved a major challenge for trial participants, many of whom were mindful, but lacked coping tools. By and large, trial participants came to terms with their new rate, but adapted less well to Super-Peak Days.

The secondary benefit of ***lets us be good citizens by managing energy*** may have become prominent for ADRS customers in part because they were coping with volatility the program brought to their lives. Sacrifice for the sake of others is a typical coping strategy, and the reward is usually recognition. Many participants recognized themselves as coming to terms with their new rate (which varied by time but did so in a predictable pattern). Some participants were also proud that they had come to terms with Super-Peak Days (which varied by time unpredictably).

4 - Participant Willingness-to-Pay

Most participants believed the ADRS as offered was "a good deal," but they had pricing recommendations based on a cost/benefit framework including six factors:

- Compensation
- Recognition

- Comfort
- Time
- Control
- Coping

Participants recognized these factors in different respects as costs, benefits, and risks. They sought compensation, recognition, and comfort as fundamental factors of the program. The acceptable balances across these factors differed for every participant. Participants then invested time to pursue control and coping strategies aimed at these goals.

Program participants segmented by their participation strategies. Teammates practiced control, and Converts learned to cope, while Spectators expected the system to handle both tasks for them. GoodWatts was designed to deliver control, but turned out to deliver mindfulness as well - the key to coping successfully.

As they pursued their strategies, participants expected significant changes in their electric bills from the ADRS program. They also focused on the electric rate more than ever before. Their thermostats quickly cued them in that 73 cents per kWh had become the price of electricity on a summer afternoon - a rate more than five times what they had been paying on normal weekday periods. So participants anchored their perception of the ADRS program around the changes in their electric bills, the Super-Peak rate, and their experiences of Super-Peak Days.

ADRS customers did not experience their new rate as an isolated change. The ADRS was a set of changes in participants' lives: a new rate, new technology, new information, and new habits. Most ADRS volunteers didn't recall much about their old rate, and received their new rate as part of the ADRS package.

Many ADRS customers believed that they were paying for the system through altering behavior, learning, and suffering. The program sponsors had asked them to change their lives, and they had. For almost all of the customers, the benefits outweighed the costs: they would continue with the program, and they would recommend it to others. But the balance would shift for many participants if they were asked to pay a fee to receive the ADRS.

The ADRS volunteers agreed that 'a good deal' offered something free, or discounted, and packaged these discounted prices with a little inconvenience. Participants said good deals begin with customer awareness of this tradeoff.

Even in its trial, non-commercial version, offering modest savings, limited control and few tools for coping, GoodWatts seemed like a good deal to most volunteers. What participants wanted was an even better deal: more free stuff and discounts, more bundling with problems they could minimize or work around by being smart, and more awareness.

GoodWatts customers were willing to pay for the ADRS program in terms of their time, attention, and changes in routine. In return, they asked for a system that would help them control energy usage, cope with the discomfort of change, and save money on their electric bills.

5 - Participant Satisfaction Levels

The typical GoodWatts participant found in the program both something to like, and something to improve. Despite any issues they had, GoodWatts participants were generally quite satisfied with the program, would remain on the program if it were offered, and would recommend it to others.

However, customer dissatisfaction did emerge regarding many elements of the program, with many customers perceiving opportunities for improvement. In most cases, customers sought improved functionality and additional features.

Participants who had issues with the program raised many concerns: (1) they had not saved; (2) they didn't find the program (3) understandable, or (4) useful, or (5) reliable; (6) they noticed it getting warmer, and (7) they had difficulty getting program components to work. Participants who had negative views often had more than one of these concerns.

In contrast, participants who were more positive about the program were more likely to be satisfied across the board. The strong overall satisfaction ratings indicate that many participants who had one issue or another still believed the program to be positive, on balance.

GoodWatts promised high-technology tools to minimize discomfort in the pursuit of savings. A few ADRS participants had modest standards for both comfort and economy, and thus found GoodWatts easy to work with. A few ADRS participants required a great deal of both comfort and economy, and as a result, were unhappy with GoodWatts. Between these extremes, most customers used the program to investigate the balance between comfort and economy in their households.

GoodWatts households also differed in how they tried to balance these two factors. The behaviors and use strategies ADRS participants employed were diverse, and evolved. At the end of the program, some customers believed they had figured out how to work with GoodWatts, some customers were still experimenting, and some customers still didn't particularly understand the program.

The results emphasize that no single model of customer behavior is likely to work well for residential demand response. Instead, demand response systems will need to be very flexible. But we can reach four key conclusions about what ADRS customer satisfaction will require.

- First, ADRS participants will only be satisfied if the program saves them a significant amount of money, without making them too uncomfortable.

- Second, ADRS participants bring their own expectations, skills, experiences, behaviors, and performance standards to the program, so they engage with the system differently, with widely varying levels of engagement, and many different strategies for achieving their goals.

- Third, problems in system design and customer use of the system can create many feature and performance-related issues for ADRS participants.

- Fourth, if these issues are addressed by offering the ADRS customers prefer, the typical ADRS participant will be very satisfied with the program, and will recommend the GoodWatts program to friends, family, and neighbors.

Interpreting Field Trial Results

Satisfaction or disappointment with a service results as much from what the customer brings to the experience as the service itself. So with a great range of customer circumstances, we might expect a great range of customer reactions. Instead, the ADRS participants showed substantial consistencies in their behaviors, and in their levels of satisfaction with the program.

Because they overcame so many differences, we might conclude that these notable consistencies must be very powerful. We are eager to anticipate what many Californians might do, given a similar ADRS opportunity, so it would be easy to overinterpret the results of this initial GoodWatts field trial.

Instead, we must emphasize that our work has been qualitative and provisional. The results of the ADRS trial may be interesting, but they cannot be conclusive, for several reasons.

First, the 2004-2005 California ADRS field trial was not a controlled experiment. While program analyses may refer to "control groups" compared to the ADRS cohort, these comparisons match one group of customers who had diverse, experimental experiences against other groups of customers who had different diverse, experimental experiences. The weather, the Super-Peak Days that were selected, the experimental systems that were deployed, the times these customers lived in and reacted to in California: these elements may never be repeated.

Second, another issue arises within the ADRS cohort: customer experiences were neither controlled enough nor similar enough to justify most forms of quantitative

analysis. Results from these 175 households should not be extrapolated.[10] Wide variances underlie program-wide averages and summary conclusions, and any eventual commercial ADRS offering would be specific in its features, functions, service levels, and deployment conditions.

For example, if Super-Peak Days continue to be called back-to-back, called on some very hot days and not others, and called on some mild days and not others, customer testimony suggests satisfaction and participation would drop significantly. Whereas if Super-Peak Days were reliably called on every day when the exterior temperature exceeded 95˚ F, and only on those days,[11] customer testimony suggests satisfaction would substantially increase.

A third problem must be acknowledged: throughout this report, we have not identified individual customers, or supplied data which might be used to identify them. This confidential data includes the individual household data RMI received from the utilities on the customer's meter consumption and home energy survey data conducted at the onset of the program, the analytics RMI conducted to identify different classes of customers based on their performance, our survey results of individual customers, and the videotapes of our focus groups.

The ADRS program was conducted with the understanding that these data sources would remain confidential. Furthermore, while we believe our explanations of customer attitudes, beliefs and behavior based on these data are plausible; much of our work is based on selected quotes from unnamed participants. Other analysts could easily find other customer comments to be more important than those we emphasized. Independent researchers would find it challenging to duplicate the analysis this report provides, let alone the trial itself.

So, while we are impressed with the substantial consistencies in the behaviors and levels of satisfaction the ADRS participants displayed, these consistencies are only a starting point for any consideration of ADRS deployment.

The 2004-2005 California ADRS field trial was a highly suggestive field trial, providing useful but limited guidance for those who would design an improved ADRS for more rigorous market and product testing.

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[10] To avoid such unwarranted quantitative speculation, throughout our analysis below we refer regularly to "most," "many," "some," or "a few" of the ADRS participants.

[11] Customers would like to distinguish Super-Peak Days called due to temperature-driven peak loads, and Super-Peak Days called due to system emergencies.

1. ADRS Design

Objective:

Identify the ADRS design preferred by participants in the ADRS trial.

ADRS research in 2004 prioritized the importance of many features to customers, but in addition, the research revealed other features as quite important to customers (e.g., the rate on the thermostat, the telephone notification in advance of Super-Peak Days). The 2004 research also indicated that customers were sensitive to the nature of certain features (e.g., Super-Peak Days were tolerable individually, but not three in a row; pool control was valuable, but not if it was only available through a computer). Furthermore, the 2004 research did not reveal how best to combine features into the ADRS system customers prefer.

In 2005, the ADRS customers were experienced with the program and its features. They were able to describe what they preferred. In this research step, the ADRS customers reviewed the functionality and design of the program's individual features (e.g., the rate, the thermostat, the pool controls, print information, and the web site). The customers also indicated what combination of features would best comprise an ADRS.

Approach:

In 2005, All ADRS participants were surveyed regarding their design preferences, and then BDG recruited a subset of customers for further research in focus groups. Through these two activities, we identified individual preferences and explored the possibility of an ADRS design consensus.

The survey repeated a set of 2004 maximum-difference conjoint survey questions that compared ADRS features, allowing us to compare earlier customer views with later ones. We conducted three focus groups. Two groups were conducted in Pasadena with SCE ADRS participants, and one group was conducted in Sacramento with PG&E ADRS participants.

Customer load management requires that customers are motivated to change their normal pattern of electric usage, even if that change requires attention and causes discomfort. Traditional load management programs are designed to (1) motivate customers to change their normal patterns of electric use, and (2) measure those changes so the utility can confirm changes in load.

These traditional programs have motivated customers through both direct financial incentives, and information about energy use. They have measured customer

changes through standard metering and monthly billing. The GoodWatts program qualified as an advanced demand response system because it was enhanced in all of these respects.

First, the GoodWatts program not only provided direct financial incentives to customers for participation, it provided disincentives for not participating: e.g., the CPP time-of-use rate, and Super-Peak Days. GoodWatts customers were told that if they changed their habits, they would save money, and they were also told that if they did not change their habits, their bills would probably rise.

Second, the GoodWatts program not only provided typical information about energy efficiency and conservation, it provided online energy profiles, real-time energy usage information, and analytic tools. GoodWatts customers could observe the current electric rate on their thermostats. GoodWatts customers were told that if they learned more about energy uses and costs, they could save money, and they were told that they had new ways to learn.

Third, the GoodWatts program measured changes in load through real-time network connections, not only to enable time-of-use billing, but also to provide better customer service. GoodWatts customers could review their usual monthly bills, and they could also review daily load information online, and with GoodWatts customer service staff.

But the GoodWatts program also added a fourth category of load management program features: additional control over household energy usage. These technology-based features GoodWatts provided included advanced thermostats, pool controls, and online system access.

ADRS Features

So GoodWatts program customers received an ADRS with these key features:

Financial incentives and disincentives:

- Direct payments: $100 for in the first year for program participation and survey completion, with additional payments for participation in focus groups. As the program was expanded to another year, a second incentive payment of $125 was given for customers who remained with the program through the end of the summer pilot period (or October 31, 2005).
- CPP rate: a time-of-use rate charging program participants less in off-peak times approximately (9 cents/kWh), more in peak times (23 cents/kWh weekday afternoons between 2 and 7 p.m.), and most on Super-Peak Day afternoons (73 cents/kWh on up to 12 selected weekday afternoons between 2 and 7 pm), as compared to their current rate of 13 cents/kWh. These rates varied slightly by utility, and varied nominally from year to year.

- Super-Peak Days: up to 12 summer weekdays, selected statewide and announced to customers 24 hours in advance by e-mail and/or telephone, when Super-Peak Day rates apply

Information:

- Household energy usage information: hourly and daily household total energy use information available through a special GoodWatts website
- Energy education: program training materials, newsletters, bill comparisons, and customer service assistance provided by on-site installers, on-site field staff and telephone staff, to solve problems, answer questions, and reset programming
- Customized temperature profiles: daily temperature profiles for thermostat programming, set and revised by participants up to a year in advance, online or through customer service

Measurement:

- A home energy network: household energy controls and computers linked by wireless and cable-modem connectors to GoodWatts program headquarters, for real-time utility, program, and customer monitoring

Control:

- Programmable thermostats: new, accurate, sensitive and internet-programmable Invensys thermostats, linked to GoodWatts central operations through a cable-based network, indicating the rate in effect as well as the current temperature and settings
- Swimming pool controls: timing switches to control pool heating and filtration, linked to GoodWatts central operations through a wireless network, managed manually by the homeowners with magnets

The GoodWatts system was also designed so that these features would enable regular and continuous interaction between the program and its customers, beginning with recruitment, and continuing through installation, mailings, Super-Peak Day notifications, website access, customer service calls, and market research activities.

The ADRS was created in the belief that a combination of financial incentives, information, measurement, and control would motivate more customer load management than traditional systems. Certainly the results of the program RMI found seem to support that claim.

However, these features and benefits can be combined many ways into different versions of an ADRS. The GoodWatts ADRS trialed over the 2004-2005 period was only one version of an ADRS. Could customers guide us toward an even better

combination of features in an ADRS? As customers grew more experienced as GoodWatts participants from year one to year two, would their guidance change?

Factors Involved in the ADRS Experience

In selecting GoodWatts as an ADRS to test, the sponsoring utilities intended to pay particular attention to six factors the California Public Utilities Commission (CPUC) had designated:

- Ability to control multiple customer appliance loads based on customer programming
- Customer ability to override any price or emergency signal
- Ability to receive and send signals relating to pricing conditions, electricity load levels at the house, status of selected appliance loads (on or off), load drops achieved
- Capability of handling either pricing or load curtailment signals
- Capability of confirming the level of load reduction achieved within one hour of a price or emergency signal (operator and customer)
- Capability of using existing communication lines into the home to send and receive signals

But there was more to the customers' GoodWatts experience than these six factors, so in asking customers to assess which features of GoodWatts were most valuable to them, we included 14 other elements of the ADRS experience. The complete list of 20 factors is as follows:

Table 2

All Tested ADRS Factors

#	Factor
1	**Multiple Appliance Programming*** *We can control energy usage by programming appliances, such as the air conditioner or the pool pump.**
2	**Override***

*We can override any programming signal the utility sends to the system.**

3 Two-Way Signaling*

*The system can send and receive signals and information -- about pricing conditions, household electric use, appliance energy use, and energy reductions achieved.**

4 Price and Curtailment Signaling*

*The system can signal us when the electric prices change, and it can signal us when the appliances are reprogrammed to help curtail energy use.**

5 Load Reduction Confirmation*

*Within one hour of signaling us about a pricing change or a load curtailment, the system confirms any energy reduction we achieve in the household.**

6 Existing Communications Lines*

*The system works through communications lines we already had.**

7 Includes a new programmable thermostat

The system includes a new programmable thermostat.

8 Includes a website with my home's energy usage

The system includes a website where we can access information about our home's energy usage.

9 Lets us reprogram from any online computer

The system lets us reprogram the air conditioner or the pool pump from any online computer.

10 Includes a new electric meter

The system includes a new electric meter.

11 Includes a time-of-use rate

The system includes a time-of-use rate: during the summer, electricity costs us more than a standard rate on weekday afternoons, and less than a standard rate all the rest of the time.

12 Chance to save money by peak/off-peak shift

The new electric rate gives us a chance to save money by shifting our electric use from the peak period to the off-peak period.

13 Includes Super-Peak Days

When our utility really needs to reduce energy use, they can declare a Super-Peak Day, when peak period energy use will cost much more than it used to.

14 **Receive a total of $100 in incentive payments**

For participating in the program's market research, we receive a total of $100 in incentive payments

15 **Lets us be good citizens by managing energy use**

The system lets us be good citizens by managing our energy use at home.

16 **Provides more control over our home**

The system provides us with more control over our home.

17 **Lets us try out new technology**

Participating in the program lets us try out new technology.

18 **Could lower my electric bill**

The system could help lower my electric bill.

19 **Should help our environment**

The system could help our environment.

20 **Sponsored by my electric utility**

My electric utility is sponsoring this program.

**Indicates the original six technology features specified.*

BOLD TEXT indicates abbreviations used in report above
ITALICIZED TEXT indicates exact phrasing used in market research

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After installation of the GoodWatts system in each ADRS household, the participants were surveyed in July 2004 to identify their ranking of the system's features. We received responses from 149 households (85% of participants). Participants had received extensive marketing materials, and had experienced system installation at the time of the July survey, but they had little experience with the ADRS. The first Super Peak event was called on July 14, 2004.

In November 2004, once the participants had field trial experience with the GoodWatts system, the participants were again surveyed to determine their ranking of the system features. For several months, participants had experienced Super-Peak Days (some in succession) and the ADRS program. In this second survey, we received responses from 137 of 149 households (78% of participants).

Finally, in December 2005, after the participants had experienced two full summers of the GoodWatts program, we surveyed them a third time to determine their ranking of the system features. We received 90 responses (60% of participants).

The portions of the survey instruments assessing interest in ADRS features were designed for maximum-difference conjoint feature analysis. The surveys asked how important these features were to the participants' recruitment, retention, and evaluation of the program.

These participant interviews addressed the questions specifically raised by the CPUC regarding the six specific ADRS features noted above:

- What fraction of the participating customers were interested in installing technology with any of these six capabilities?

- Are there some of the six identified capabilities that are considered more or less important by customers?

Findings:

Ranking ADRS Features through Maximum-Difference Conjoint Analysis

The answers provided here to the CPUC's questions are quantitative and statistically significant. There were only modest differences between the feature rankings in July 2004 and those in November 2004. After a single summer's experience with the GoodWatts program, participants evaluated its features much as they had at the outset. However, there were strong differences between these two surveys, and the third survey in December 2005. Participants' views changed after two summers' experience.

We offer the usual caveats about the risks of comparing recruitment rankings to retention rankings to program evaluation ranking. We would also note that the cohort being surveyed was not identical in the three surveys, and grew smaller over time, as some customers opted-out of the program due to health reasons, change of residence, or dropping out. We thus have a survivorship bias as the surveys continue.

With those concerns in mind, we can now examine our list of 20 features to see how rankings changed with customers' ADRS experiences. In the table below, we indicate the results of the three surveys, and we rank order the features according to their standing in the final December, 2005 survey.

Table 3

Respondent Maximum Difference Index Ranking of ADRS Features: 7/2004, 11/2004, and 12/2005

Rank (12/05)	Feature(12/05 Rank Order)	Index Ranking (7/04)	Index Ranking (11/04)	Index Ranking (12/05)	Δ In Rank Order (11/04-12/05)
1	Chance to save money by peak/off-peak shift	230	219	140	1
2	Could lower my electric bill	489	295	138	(1)
3	Lets us be good citizens by managing energy use	84	76	137	10
4	*Two-Way Signaling*	74	87	126	7
5	Includes a time-of-use rate	96	118	122	(1)
6	Lets us try out new technology	69	58	120	10
7	*Price and Curtailment Signaling*	86	92	120	2
8	Includes a new electric meter	18	26	110	12
9	Includes a website with my home's energy usage	92	87	104	3
10	*Existing Communications Lines*	22	41	102	8
11	Includes Super-Peak Days	70	75	97	3
12	*Override*	63	93	95	(4)
13	*Multiple Appliance Programming*	121	118	88	(8)
14	Lets us reprogram from any online computer	72	98	87	(7)
15	Should help our environment	72	89	83	(5)
16	Sponsored by my electric utility	28	39	82	3
17	Receive a total of $100 in incentive payments	64	104	77	(11)
18	*Load Reduction Confirmation*	45	57	68	(1)
19	Provides more control over our home	153	155	59	(16)
20	Includes a new programmable thermostat	51	72	45	(5)
	The six specified technology features are italicized *95% CI = a ratio of 1.53 between features (12/2005)*				

The set of factors trial customers found most valuable in an ADRS shifted significantly in the final survey. Falling scale values revealed not only a broader view of the program and a better understanding of its technical aspects, but also a shift in

benefits as less-familiar factors were proven in as valuable. Seven factors are most significant:

First, we note immediately that ***the chance to save money by peak/off-peak shift*** has become the leading feature, albeit by an insignificant margin. New to time-of-use rates at the start of the program, customers came to understand this feature over time, and appreciate its direct link to savings.

Second, the dominant and leading feature in earlier surveys, ***could lower my electric bill***, fell one place in the rankings, but was less dominant as customers came to appreciate features beyond the one that led them to sign up for the program.

Third, in an unanticipated move, ***lets us be good citizens by managing energy*** use rose to third place in the rankings. This midlevel feature in the recruitment ranking had fallen lower in the second survey, and such a major leap in its final survey ranking is probably too much to be explained by differences in the surveyed cohort. The connection between GoodWatts and good citizenship took time to be appreciated by the program's participants, but emerged as a strong factor. Later in this report, we offer a possible explanation.

Fourth, ***two-way signaling*** also rose in the rankings notably, in a continual rise, demonstrating that technology-related features have more appeal with experience. Customers came to understand that two-way signaling was the functionality beneath their online data, their ability to reset their thermostats remotely, and the ability of GoodWatts customer service to help them.

Fifth, although ***includes a time-of-use rate*** fell a single insignificant place in the final survey rankings, its index value rose consistently throughout the program. An unfamiliar notion before the program, time-of-use rates also appealed more to customers as their experience with them grew.

Sixth, ***lets us try out new technology*** rose substantially in the rankings, as customers who had not previously done such found that technology trialing was a valuable activity for them. By and large, participants enjoyed the program (see the section below regarding customer satisfaction). Trialing technology was not much of a motivation for recruitment, but once the program was running, participants found it a valuable factor.

Finally, seventh, ***price and curtailment signaling*** was another technology factor that customers came to appreciate more as the program continued. Customers valued their Super-Peak Day notifications and their thermostat rate indicators. Other technical factors not ranked among the most valuable, but still rising notably in the final survey, e.g., ***includes a new electric meter*** and ***existing communications lines***.

Some factors fell in the final survey, significantly including ***provides more control over our home***, and ***multiple appliance programming***. For two reasons, participants

gained less control over their homes through the GoodWatts technology than might have been expected. First, the regime of Super-Peak Days and the bill impact of program participation were unpredictable, and thus, not immediately controllable. Second, the GoodWatts technology only controlled air conditioning and swimming pool operations.

Other specialized functions that fell in the ranking were those participants may have trialed, learned how to use, and then used less than anticipated. The ***override*** factor fell slightly in relative value. ***Lets us reprogram from any online computer*** fell in the rankings, although ***includes a website with my home's energy usage*** rose slightly. Many customers found the GoodWatts website friendly enough, although many never used it, and some found it time-consuming and confusing.

We would have expected ***receive a total of $100 in incentive payments*** to fall as it did in the rankings: with experience, bill savings had replaced incentive payments as the customers' measurement of program value. The extensive market research proved to the customers that they were going to have to work for their money. ***Should help our environment*** fell further from its mid-ranking, we believe, because it was a claim only some participants valued, and the program provided no evidence it had been validated.

That the system ***includes a new programmable thermostat*** was mid-ranked and fell to the lowest position: given options, customers reprogrammed online or through the telephone service representatives instead of through the thermostat. Some customers found the Invensys thermostat graphics confusing. The thermostat rate indicator was widely praised, but is not a programming feature *per se*.

There were also low-ranking factors in earlier surveys that remained low ranking in the final survey. ***Load reduction confirmation*** within one hour might be valuable to the utility, but was not particularly valuable for the customer. Nor did customers value that the program was ***sponsored by my electric utility***. These rankings are consistent with our findings that the typical residential utility customer does not desire a closer relationship with utilities, but does desire a more comfortable, economical home.

Finally, that the program ***includes Super-Peak Days*** was a mid-ranking factor until the final survey, when its index value rose notably, but not enough to place it among the most valuable elements of the program. In the market research we observed some participants understood the direct connection between Super-Peak Days and their savings. Other participants would be very hard-pressed to label Super-Peak Days as valuable.

We can conclude that of the financial incentives and disincentives provided by the ADRS, the savings define the entire program, whereas the direct payments were regarded as promotional, and not of lasting value. The CPP rate and Super-Peak Days were not widely understood in their design, or appreciated in their execution, but were often seen as the price of savings.

The information provided by the ADRS was very valuable to some customers, and not particularly valuable to others. Daily household energy usage information was interesting, but daily savings information would have been valuable. Training materials about online reprogramming were important, but customer service staff who could explain reprogramming were valuable.

The measurement capabilities of the ADRS were technical features participants came to appreciate more and more as the program continued. But the vital savings measurements arrived long after the customer decisions that led to them, and without interpretation. As discussed further below, the measurement capabilities that would have allowed customers to estimate when Super-Peak Days would arrive were missing.

The control provided by the ADRS proved to be less than participants might have expected, and much less valuable than other aspects of the program. Many participants attributed their savings to the automatic programming installers or customer service representatives executed for them. Others attributed their savings to conservation measures they had taken apart from air conditioning and swimming pool control.

From these rankings and changes in rankings we can recognize what these residential customers valued in the ADRS they tested. These customers want to save money on their electric bills, and they came to understand that shifting electric use out of expensive peak periods could be one way to save. Above all, according to customers the ADRS is a savings system.

As they grew more experienced with an ADRS, the trial customers came to appreciate the program's technology, and how the technology works to delivers savings to them. They enjoyed the trial, and they enjoyed their role in the program as good citizens. Some achieved substantial savings, and some became program advocates.

But these experienced trial customers also came to understand what their ADRS could not do. Their ADRS could not predict Super-Peak Days, could not control many of their appliances, and could not confirm their savings until well past summer's end. Special features based on online interaction were used regularly by only a small segment of customers, although many tried them. Programming was a task. Many customers saw their savings as minor, and the program did not recognize their savings, much less celebrate them.

Like most technology-intensive systems, GoodWatts, as offered, delivered the most benefit to those who were self-motivated to master the system, and who had the time to maintain their skills. Few trial customers were that ambitious. Most trial customers preferred less housework, and less homework.

What's Next: Customers Redesign the ADRS

We asked customers in focus groups how they would redesign the ADRS, based on their experience. We asked them to consider what a premium version and an economy version of an ADRS would include. A premium ADRS would include features participants wished for, but had not experienced. As one put it, *"I don't know if they necessarily should be premium, but they probably ought to have been on the original standard."* An economy ADRS would eliminate the features customers found nice, but not necessary.

Customers told us a premium version of the ADRS would begin with an improved thermostat, *"lighted so you could see it at night,"* and *"voice-activated"* with "*the option on the thermostat to hit some buttons and potentially be able to see your savings this year versus last -- and your monthly to date costs, now versus what your monthly would have been on the old plan."* The head of the household could *"put a code in the thermostat so nobody can change anything, and the kids can't fiddle with it."*

With a premium ADRS, the customer would also have *"the flexibility to add other things to be cut off or cut down during Super-Peaks. It could be your TV, your computer"* or *"lighting in your house, washer and dryer."* A premium ADRS would bring the customer many sources of real-time savings data, such as an *"email on savings from what your old rate was,"* or website access to *"real-time savings versus the old plan, so that we can access that to see what we're doing,"* and see *"what our savings are right away."* The bill would include *"the real life savings from year to year based on total kilowatt usage in the form of a rebate or bonus."*

In a premium ADRS, there could be either a series of optional peak times or a set and predictable peak time. The *"optional peak at different times"* would give older people, larger households, or *"the guy who's home all day…the option of choosing a different window. He doesn't necessarily need to feel the pain, because his lifestyle is different."* The set and predictable peak time would be *"based maybe alphabetically"* telling each participant *"your peak is going to be these three days of the month."* Different groups would have different peak days so *"you can plan ahead around your peak days."*

Customers told us an economy version of the ADRS would "*just keep the meter and the thermostat*." After all, "*you can regulate your thermostat manually…If I go out for 2 or 3 hours, I just put it off. You just need the thermostat and the meter.*" Some customers thought there should be "*no internet access*" but others said "*the computer would be optional*" and noted that "*they've got all that information there: they might as well let you see it all.*"

The economy version of the ADRS would feature "*a programmable thermostat that comes preprogrammed to not really operate between 2 and 7 pm*". Customers could *"customize it afterwards"* but the thermostat would come with instructions indicating that *"here are the peak time hours that you shouldn't be using it, so we already have programmed setbacks for you*."

Communications in an economy ADRS would be through the telephone, the bill, or the media. "*I don't think the website is that important, but the thermostat and telephone notification is*," one customer said. Another commented, "*It doesn't have to be by telephone. It could be a blurb like the weather in the newspaper.*" A third imagined that "*when you get your bill, on the bill it would be noted what your peak days are for the following month… it's in there: you don't need a computer, you don't need a phone call, it's right there.*"

The program would focus on air conditioning, and might "*not have the pool switch as a separate feature, because if you have a time clock, you could just see the time clock on your pool equipment.*" Customers recognized that with a more focused program, "*perhaps the discount on pricing may not be so deep with the economy version,*" and suggested "*you would still get notification by phone of Super-Peak events, but it would really be a time-of-use pricing plan.*"

We also asked customers in focus groups who the ADRS was for, and who it was <u>not</u> for, i.e., which kinds of people would find the ADRS valuable.

Customers told us an ADRS was <u>for</u> all sorts of "*people who are concerned about saving money.*" Those who are "*more interested in saving*" might be high or low income, because: "*even though a person may have enough money"* the saver is *"still going to go to the station that sells gas a penny cheaper because you save ten cents.*"

Perhaps *"everybody should have it"* some participants said, both because *"people that are interested in saving"* is such a broad class, and "*because certain people will be very conscientious about trying to save, and certain people won't, and I think it's only fair if we're going to work at it, and somebody else isn't, then they should pay.*"

However, customers recognized that only some people could make an ADRS work for them. While "*the computer-literate, or people that are interested in technology*" might find the program "*interesting,*" the most obvious targets were "*dual-income people who are not home during the day*." For these "*working people*" the program would be "*a no-brainer*." For those customers who were home weekday afternoons, the program would be for "*people who want to save money regardless of comfort*" because "*you have to be willing to sacrifice.*"

Many agreed with the participant who admitted that "*I don't know if a lot of people want to sacrifice,*" but there was also general agreement that "*you would want to market to people that are on a fixed income, or low income,*" because "*to them, a*

big electricity bill is a huge impact." The program was for *"fixed-income and seniors,"* participants believed, because "*if they were willing to fine tune it a little bit, they could make it work.*"

People willing to sacrifice were also those who were *"regimented compulsive people, who are interested in the environment.*" The discipline required to sacrifice didn't come easy: "*you have to regiment yourself not to use the washer/dryer and other things between 2 and 7:00,*" this participant explained, "*and I have some difficulty getting my wife to do that.*" Another added that it was "tough" to do the laundry late because "*by that time everyone is trying to unwind and get ready for bed rather than doing the laundry.*"

Customers told us an ADRS was <u>not</u> for most homeowners on the other side of the coin. "*People who are home during the day*" would find the program challenging, including "*housewives,*" many "*retired people and senior citizens*" and "*families with small children*" or "*school age kids who come home between 2 and 7 p.m.*" The program would also be challenging for "*people who work nights and sleep during the day*" and "*people with health issues who need to be able to keep their homes cool.*"

"*People who don't have air conditioning*" and "*people who don't use computers*" wouldn't get as much value as others from the program. "*The independently wealthy who don't care about money*" would also find the program less attractive.

Finally, less-disciplined, less-attentive customers might have problems. If the program asked "*don't use your air between 2 and 7 p.m.,"* one participant believed some people would *"say, 'oh, I'm sure I can use this a little bit.' And all of a sudden they do use it, and they get their bill, and they are absolutely shocked at how high it is. You really have to make sure you are willing to stick with the plan for twelve months."*

ADRS Design Consensus

Through these observations, our trial customers have told us how an ADRS should be designed, and for whom.

According to the trial participants, a better ADRS would be a <u>savings</u> system, and would also recognize the <u>sacrifice</u> participants were making. The program's control would be enhanced with a more fully-functioned thermostat and a broader range of appliances in the system. Programming and analysis would be simple and easy, through the Internet or through telephone customer service staff. Most casual users and many power users would prefer less housework, and less homework.

Super-Peak Days would be more selective and predictable, and conservation training would be more extensive: customers could cope with the program more easily. Program variations would enable larger households, low-income households,

senior households, technology-challenged households, and households where someone is home during the day to participate. Everyone could do their part. But these customers would hear that the program might be a burden for them.

The ADRS customers prefer would have promotional incentive payments to attract customers, but the main benefits would be savings and recognition. Information on savings would be updated daily, available real-time, and easy to analyze through the Internet or through telephone customer service staff. The savings information would be directly related to Super-Peak Days and the time-of-use rates, so customers could correlate their daily behavior with the program's conditions.

A preferred ADRS would also provide its customers with recognition for their sacrifice, through real-time periodic recognition and reinforcement. These celebrations of sacrifice and good citizenship would link customers' energy use shifting and conserving to benefits achieved: saving money for the community, avoiding brownouts, avoiding the construction of power plants, aiding the environment. Everyone who did their part would be recognized.

While a preferred ADRS would be available to all homeowners, it would be targeted to homeowners 25-75 years of age, who appreciate savings, and be able to achieve them. In these households both adults work, and they are likely to be active in the community, and appreciate technology. They learn about the ADRS through their employers and community organizations (e.g., schools), since they have little time at home to consider marketing messages. They like programs that reward discipline and patience. They appreciate that they can save and be good citizens at the same time.

What's Behind the ADRS Design Consensus

Customers would prefer an ADRS that is easier to use, provided more and better feedback, and offered more ability to control and cope.

Ease of use is always a challenge for new systems, and it is a particular challenge for the ADRS, given that few customers are eager to invest time and money in energy management. In addition to the time-consuming online routines in GoodWatts, pool controls were another notable issue for many customers. The ADRS trial was supposed to be a trial of a fully-functional commercial system, but many customers found it difficult to use.

A second area of ADRS design improvement would be more and better feedback. Participants had better, faster, and more useful information from GoodWatts about how to save energy, and what their daily usage had been, than they had ever had before. Participants also received bill comparisons *based on the load consumption during the ADRS program period,* between what they paid under the CPP rate, and what they would have paid had they stayed in their standard rate,

However, this bill comparison did not reach participants until mid-November, well after the summer. During the summer, program participants were missing their usual sources of feedback as well (bills they could compare meaningfully against last year, utility customer service representatives, bill comparisons with neighbors), because these sources were not part of GoodWatts.

Furthermore, participants had no easy means of translating the wealth of information they had into household economics. An ADRS customer who believed the program ***could lower my electric bill*** knew there was ***the chance to save money by peak/off-peak shift***, but knew neither how much it was possible to save, nor how much in savings they were accumulating by changes in behavior. End-of-summer bill comparisons were not timely.

Third, customers would also value more ability to control and cope in an ADRS. As noted above, being able to control a broader array of home appliances more easily would be very valuable to customers. Customers would also change the nature of Super-Peak Days, making them more predictable and easier to cope with.

Customers' ambition for more ability to control and cope illustrates a key point about the ADRS we will discuss all through this report. While changing habits always introduces a certain loss of control during the learning process, the ADRS program as designed also delivered additional volatility to its participants' lives. Super-Peak Days would arise suddenly, regardless of the weather or the season. The program was scheduled to end, and then extended. Some participants weren't sure which new habits made a difference, or would continue to.

The additional volatility the ADRS program introduced to customers' lives is a serious problem because ease of use, feedback, and control/coping strategies all depend on the program's predictability. Customers learn to behave in a predictable way their utilities appreciate. The utilities return the favor, rewarding and recognizing customers for adapting their lifestyles as requested. Customers save money and receive recognition in exchange for their adaptation, so they continue their new behaviors.

GoodWatts program participants sought a program which would train them to use energy more economically. They were ready to try out new behaviors, and then decide which new behaviors proved tolerable, and worth making into new habits. They sought confirmation that their new habits had paid off, and would be worth maintaining. What GoodWatts program participants received instead was a program working against itself. Ready to move to a new discipline of using energy more economically, customers found their lives more disorganized by the volatility the program introduced.

We believe the secondary benefit of ***lets us be good citizens by managing energy*** became prominent as the program continued in part because ADRS program

participants were coping with volatility the program brought to their lives, and choosing to recognize themselves for doing the best they could.

We cannot eliminate all of the additional volatility customers experienced: driven by weather and utility emergencies, Super-Peak Days are inherently unpredictable to some degree. Nor did the friction introduced by Super-Peak Days grind the program to a halt. The virtuous cycle of learning, behavior, and reward powered through. Despite delayed feedback about their savings and little recognition, almost all of the ADRS participants found their program worthwhile, would continue with it, and would recommend it to others.

But the ADRS could be better, and as we will see below in the discussion of Super-Peak Day behavior, customers can guide us on how to make those days the best they can be.

Limitations of the Research & Recommendations for Further Study:

We investigated ADRS design, and ranked its features, through a combination of quantitative and qualitative research. Our work on this task has at least three significant limitations.

First, the maximum-difference conjoint instruments we deployed reached a different cohort each time, with no control over which members of the household completed the surveys, or how seriously they took the task. Statistical analysis of the results assigns significance only to the broadest differences between high and low-ranking factors in each survey.

Furthermore, comparisons across the three surveys are complicated by the different perspectives customers had in each. The first survey concentrated on recruitment, the second on retention, the third on program evaluation. Differences among the survey might be explained by these differences in perspective, rather than by changes in attitude.

Second, our focus groups were comprised of volunteer participants who may not represent the set of ADRS customers, who in turn may not represent California homeowners. We conducted three focus groups including design questions in Pasadena, two in Sacramento, and none in San Diego. Recruiting for the groups was difficult, despite unusually high incentives, which in our experience indicates some participants will have been more interested in the incentive than in sharing their thoughtful views.

The groups reacted similarly to individual questions, but the reactions of individual participants were influenced by the comments of whoever else happened to be in their group. We selected their quoted comments to be representative of the group

discussion, but we cannot demonstrate that these same participants would express the same point of view were they asked the same question again, in another setting.

Third, in describing a preferred ADRS during our groups, customers were imagining systems that at the time they believed they might prefer to the one they had experienced. There is no evidence that once provided with the system they claim to prefer, they actually would prefer it, or would perform as well as they did with the trial system. Most consumers have difficulty predicting what they will do in the future.

Even if the participants could accurately describe what they would do, and even if we are quite interested in the views of those few homeowners who have experienced some kind of an ADRS for two years running, it may be that their views are misleading. The ADRS trial was operated as a product test, rather than a market test. GoodWatts was a system still in development with severe limitations and field-trial levels of service. These customers' preferences, based on their GoodWatts experience, may not correlate with what other homeowners would prefer.

We suggest more research around different ADRS designs. If a system with major limitations delivered performance and customer satisfaction (see below), an improved system would be expected to do even better. We now have strong hypotheses about the features and functions of an ADRS that should be more rigorously studied with a representative sample of the general population. We also recommend that major demand-response system vendors we challenged to assess their functionality against the system the ADRS trial customers seem to prefer.

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2. ADRS Performance Differences

Objective:

The second research task investigated performance differences among households participating in the ADRS trial.

Approach:

What makes a good performer in a peak-load control program? It might be argued that any customer using minimal load during the 2-7 p.m. period on Super-Peak Days was a good performer in the ADRS trial. Instead, we chose to define good performance as those customers who regularly dropped load during the first half-hour of the 2-7 p.m. period, Super-Peak Day or not.

Because Super-Peak Days were unpredictable, we reasoned that rating performance only on those days might capture good performance by chance, or would capture good performance unlikely to be sustained. Because load estimates might already capture customers who had conserved, we reasoned that only those customers who dropped load - rather than all those of low afternoon usage - were good performers. We had to exclude those customers from consideration who had l month or more of missing data.

Thus we examined one type of performance among those trial customers with sufficient data available. For these customers, RMI examined data for every weekday from June 2004 through September 2005. For each customer on each weekday, RMI then calculated average initial load drop from the 1:45-2 p.m. interval to the 2-2:15 p.m. interval, and from the 1:45-2 p.m. interval to the 2:15-2:30 p.m. interval. We chose these comparisons because the first half hour of the 2-7 p.m. peak period generally produces the largest load drop every day, and utilities would be most interested in the initial load drop. We examined two comparisons because system operations differed from household to household.

RMI thus had two values for average percent household load drop on weekday afternoons, and chose the larger of the two values as the comparative performance value for each ADRS participant. RMI then sorted these values of average initial load drops into three bins with numerical values: (1) less than 20 percent, (2) between 20 and 30 percent, (3) greater than 30 percent. To some degree, sorting daily results into bins smoothed individual daily household variations.

RMI then segregated the daily scores by event and non-event days, and calculated average event and non-event day scores by month. Thus, each ADRS customer had two average performance scores for each month: an average Super-Peak Period performance score across event days, and an average non-event day peak period

performance score. These monthly performance event day and non-event day scores were then each averaged again into overall 6/2004-9/2005 scores for each ADRS customer.

With some notion of individual customer performance on Super-Peak Days and on other weekday afternoons, RMI then sorted these scores. ADRS participants were ranked by event day overall performance score, and by non-event day overall performance score, and applied performance thresholds to distinguish particularly high and low performers.

The 16 ADRS customers with average performance scores of 2.8 or greater for event days and 2.0 or greater for non-event day peak period initial load drop were labeled high performers. The 17 customers with average Super-Peak Period initial load drop performance score of 1.4 or less were labeled as low performers.

We also identified five customers who showed increasing performance from month to month in the average Super-Peak Period initial load drop, and we labeled these improved performers. At the outset of the trial, these improved performers ranked with low performers. By the conclusion of the trial, improved performers ranked with high performers.

Six of the 16 high performers had one month where their results dipped below the high performance standard. Three of the low performers had one month where their results rose to the high performance standard. However, high and low performers generally remained in these categories throughout the program.

RMI's analysis thus identified some of the program's households who regularly experienced comparatively-high afternoon load drops, some of the program's households who regularly experienced comparatively-low afternoon load drops, and a few households who increased the afternoon load drops they experienced across the life of the program.

Some of these households we designated also participated in direct market research regarding their behaviors, attitudes, and beliefs about energy use. This market research ranged across in-home interviews, focus groups, and surveys. Not all of the designated households chose to participate in this direct market research, and not all of those who did participated in the same exercises.

Findings:

Survey Response Differentiation

Our first stage of analysis reviewed the responses high and low performers provided to the standard California household survey provided to all ADRS participants at the outset of the program.

Targeting households for an ADRS program would be aided considerably by significant correlations between easily observable factors and a household's readiness to curtail power usage weekday afternoons. But we found many factors where neither the segments of high performers nor low performers differed significantly from the general population of ADRS participants, or differed from one another.

High and low performers were spread across the three utilities, although low performers included half a dozen SDG&E customers, a result we believe is due to the relatively low temperatures and relatively low use of air conditioning in San Diego. Reported home age and number of people in the home were not significant factors. Nor was satisfaction with the local electric utility at the outset of the ADRS program. Nor was reported satisfaction with the ADRS program itself.

However, using a lot of electricity for activities which can be shifted out of the peak period with relatively little inconvenience or discomfort (e.g., pool filtration) proved to be a more promising indicator. Significantly more high performers had pools than low performers: an indication of the major contribution pool filtration control during peak periods could make to high ADRS performance.

Furthermore, several low performers who had pools seemed to rank low not because they weren't controlling their pools, but because they avoided filtration not only during the peak but well before, and thus showed little load drop at the start of the peak period. Because pre-cooling was not a universal habit of ADRS customers, air conditioning load may also have been low prior to 2 p.m. Thus the actual peak usage of these customers was much lower than it might have been.

More precise home size and income measurements might well indicate that high performance is correlated with both. It stands to reason that home size and income will tend to be correlated, and that electricity use will be correlated with both, thus offering larger peaks to control. The data available to us suggested these correlations, but we should also note that there are high performers of moderate home size and income, and there are low performers with very large homes and very high incomes.

Market Research Differentiation

Our second stage of analysis considered the responses high and low performers provided during our in-person market research. Of the 16 high performers, we had 2004 or 2005 surveys from 14. Of the 17 low performers, we had 2004 or 2005 surveys from 13. Of the five improved performers, we had 2004 or 2005 surveys from four. Five of the outliers also had hosted in-home interviews, and seven had attended focus groups.

Again, we were looking for correlations between easily observable factors and a household's readiness to curtail power usage weekday afternoons. But we again found many factors where neither the segments of high performers nor low performers differed significantly from the general population of ADRS participants, or differed from one another.

Satisfaction with the local electric utility at the outset of the ADRS program was not a significant differentiator. Nor was subsequently reported satisfaction with the ADRS program. Neither the frequency of web site log-ins or customer service contacts could point us toward high or low performers. High performers were no more familiar or experienced with energy management systems than low performers or typical ADRS participants.

There was little to differentiate the attitudes or behaviors expressed in the focus groups and interviews between high and low performers. For example, the set of low performers included participants who reported they were too busy to change behavior, and expected the technology to save them money on its own, as well as participants whose savings were substantial through active reorganizations of family behavior. High performers were similarly represented.

In fact, under the CPP rate many low performers saved more in 2005, on a percentage and absolute dollar basis, than many high performers. Typical savings across the program were 6-8%, and the list of low performers included several customers who saved more than 10%, and one who saved 16%. The list of high performers included many average savers, and one customer who saved less than $1.20 per month.

Some high performers accessed the website regularly and programmed their homes remotely; some did not. Some low performers were also active computer users, some were not. Both high and low performers reported taking additional energy conservation measures during the program about as often as typical ADRS participants.

Low performers were more likely to be away from home weekday afternoons, but this characteristic is an artifact of the analysis. The Super-Peak Day load shapes of low performers indicate that these participants usually had low usage before the peak period started - which would be true if they were away from home - and thus their load drop performance was less than that of participants who were home.

Both low and high performers seemed more likely to have adjusted their programming away from the initial installation than typical ADRS participants. We have some indications that high performers' adjustments emphasized pre-cooling, or a load pickup from 5 to 7 p.m., while low performers' adjustments favored on-peak relief.

We conclude that high or low performance in the ADRS program as offered may not have been a function of who the participants were, how they lived, or what they thought. Energy usage reflects all of these elements, and they are independent from one another in many senses. Put another way, the performance of an ADRS program is more determined by how many of its customers operate central air conditioning and swimming pools in a warm climate.

Of course, there may be strong differences between those who volunteered for the ADRS program, and the general run of California residential households, so there may be a strong place for psychographic and behavioral targeting in marketing an ADRS program.

Finally, as we discuss further below, it may be that the lack of obvious correlations between performance and behavior reflects the participants' lack of understanding about how to impact performance. They may have been confused or mistaken about what to do. They may have aimed at high performance, but acted in the wrong directions, or in not enough of the right directions.

Limitations of the Research & Recommendations for Further Study:

In identifying distinctive performance in 38 of the 150 ADRS households, we were working with a small data set and averages of averages. The broad comparisons we have identified have three limitations.

First, our approach does not distinguish performance through automatic system operations, and performance through deliberate choice by the householders. For example, many ADRS participants allowed the installers' initial settings to last the life of the program, while others had thermostat resets, overrides, and reconfigurations due to service issues. It is also the case that at the onset of the program, rather than program the customers' thermostats at an optimal setting that would maximize their observed load impact, several customers were left with the same programming as they had prior to their inclusion in GoodWatts, thus potentially understating how much they could have saved had their thermostats been programmed differently at the outset.

Furthermore, many ADRS participants reduced load through conservation measures not evident in a 2-2:30 p.m. load drop (e.g., washing clothes in the evening rather than the afternoon, setting pool filtration to occur only at night). We would like to have measured total drop in energy consumption as compared to prior years, as well as peak load drop, when evaluating performance.

Second, our categorization of performance based on percentage load drop favors certain households rather than others, because households differ. Households where air conditioning and swimming pool filtration comprise a larger proportion of total

load will experience a greater percentage load drop than others when these two controlled applications are curtailed.

Households which use these applications right up until 2:00 p.m. will experience a greater percentage load drop than those who have curtailed them earlier in the day. As we discuss elsewhere, it may be that peak usage foregone from early in the day is just as valuable as peak usage foregone suddenly at 2:00 or 2:15 p.m.

Third, our categorization of performance based on percentage load drop favors certain households rather than others, because household locations differ. Households experiencing more extreme temperatures (e.g., in Stockton or Valencia rather than San Diego) may use more air conditioning, and thus may display greater percentage load drops than households experiencing milder days.

If performance is a function of both weather and individual households, we would expect (as our results show) that better-performing households would be concentrated in warmer locations. As discussed below, if Super-Peak Days were also concentrated when it was hot, this performance effect could be enhanced.

We suggest more research around different definitions of performance. Originally this research task was slated to supply certain participants with extra information and training, to see if their performance would improve significantly as a result. Program organizers elected instead to supply some additional information to all participants at the start of the program's second year. We believe the true potential of ADRS performance still remains to be seen.

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3. Super-Peak Day Behavior

Objective:

Our third task aimed to identify Super-Peak Day behavior among participants in the ADRS trial, including experimental and persistent strategies. While our second task struggled to differentiate high and low performers across the entire program, focusing on Super-Peak Day behavior makes progress in that regard.

The ADRS offers many benefits to its participants, but the most important function of the program is to reliably shift energy use out of the weekday afternoon peak periods. Utilities are interested in understanding if household responses to Super-Peak Days are reliable. We aimed to address three dimensions of customer behavior regarding Super-Peak Days.

First, did Super-Peak Day customer behavior persist from year one to year two of the program? Many participants coped with the first year's Super-Peak Days, despite noticeable levels of discomfort. Was a second set of Super-Peak experiences too much to handle in year two? Did the novelty of Super-Peak energy conservation wear thin? Or did Super-Peak Days become more familiar, and more tolerable?

Second, did Super-Peak Day customer behavior persist from one Super-Peak Day to another? Super-Peak Days occur during a range of weather conditions, and during a range of household conditions, so the same customer might respond to different Super-Peak Days with a range of behaviors.

Third, was Super-Peak Day customer behavior similar from one customer to another? Although we might think that the installers' programming of automated air conditioning and pool filtration would deliver reliable control, customers had the option to change programming and override the system. Different households might respond to the same Super-Peak Day with a range of behaviors.

Approach:

Do individual households respond to each Super-Peak Day similarly?

Our theory was that either through automation or ad hoc choice, individual households might behave similarly on one Super-Peak Day after another. Furthermore, we might see patterns across many households on particular Super-Peak Days (however, a July day might display different patterns from a September day).

By combining load shape performance information with the results of our direct market research, we might gain insight into customer behavior. So for those

households where we had participation in customer surveys, focus groups, or in-person interviews, we examined Super-Peak Day load shapes.

RMI supplied 2004-2005 ADRS program data to us. Paragon Consulting helped us generate load shapes for participants on each Super-Peak Day. Where we had sufficient data, we then compared participant load shapes to identify patterns across each participant's load shapes during the set of Super-Peak days, and patterns across all participants on individual Super-Peak Days.

In these patterns, we looked to gain an understanding of customer strategies for engaging with the program.

When behaviors are deliberate, organized against objectives, and tied to beliefs, they comprise a strategy. It is known that 90% of ADRS customers saved money and energy in some fashion through the program[12], and it is also known that some of these customers had strategies for lasting changes in their household energy use which the ADRS enabled. These customers applied the ADRS to their daily lives, and used its features successfully.

In 2004, ADRS customers displayed three typical strategies:

- Spectators relied on the ADRS to automatically deliver its value based on the system's initial programming, with minor adjustments along the way.
- Converts launched into the program by curtailing their energy use: then relying on the ADRS to manage this new routine, and deliver lower bills as a result.
- Teammates used the ADRS to explore their own energy usage, defining new household routines, and quantifying the impact of their behaviors

In 2005, we looked for these strategies and others in Super-Peak Day behavior. We investigated whether customers seemed to switch from one strategy to another, and which strategies seemed to be successful.

Findings:

2004-2005 Super-Peak Day Persistence in Customer Behavior

Drawing on the statistical analysis RMI has provided in their ADRS reports, we can note two key points about 2004-2005 Super-Peak Day persistence in customer behavior:

[12] Based on year-end bill analysis.

- Compared to control customers, ADRS participants as a group achieved significant and stable load reductions across the range of 2004 and 2005 Super-Peak Days, across a range of days and temperatures

- Load reduction performance in both high and low-consumption ADRS households declined from 2004 to 2005, with high-consumption home load reduction declining by one-quarter, and low-consumption home load reduction declining by more than half

We can make three points about these conclusions.

First, the ADRS is a seasonal program, and the seasonality influenced behavior. The change from summer to winter rates confused some participants, but all realized there were no Super-Peak Days in winter, and *"there are probably many days that you don't run your heat."* As the program grew more distant, *"major appliances got used between 2 p.m. and 7p.m. in the winter period."*

One participant who maintained his behavior said that in the winter *"the only thing different for me was that you've got to turn the lights on and that uses a lot of power."* Another added that *"We're diligent in the summer. I think some of the things we've stayed pretty regular with -- dishwasher after hours in the winter."*

But three other customers agreed they were *"not quite as diligent"* in the winter. *"I don't pay attention to it in the winter,"* another participant said, *"the main focus is the air conditioning…when I'm not worried about running the air, I'm not that concerned about the other appliances."* Admitting *"I definitely slacked off,"* a participant estimated keeping *"probably 80%"* of summer habits.

So some participants abandoned or relaxed their energy use discipline during the winter, and thus had to reacquire their stricter habits as the summer of 2005 began. They had to remind themselves about shifting energy use, and conserving energy.

However, the second observation we make, looking at the Super-Peak Day customer load shapes, and asking customers about their behavior differences between the first and the second summer, is that most of them were eager to resume where they left off, and learn new techniques.

There were issues in the second summer: one customer admitted that she *"probably wasn't paying as close attention as I did the first year, when it was new and novel."* *"Last year was a no brainer,"* another participant said, *"but I had more problems this year with the hotter temperatures, and…my limited understanding in working with computers."*

One customer recalled, *"I went on more vacations the first year, so I saved more because I was gone more, and I just turned the whole thing off."* A less happy

customer said *"the second year was a disaster, because my daughter moved back in with us, and she has no concept of conservation."*

Another customer said *"it was the second year that I decided to be more comfortable, so I changed the settings*", while another said similarly that she had *"made the decision that I was going to remain more comfortable on those really hot days if we're in the house,"* so in the second year she was less "*strict with our usage.*" But she found that "*we had about the same amount of savings....Sometimes just a degree or two helps your comfort, but it doesn't change the bill."*

But far more common were customers who took new measures to shift and conserve energy use such as pre-cooling. Several participants agreed with the one who said "*the Super-Peak Days aren't easy, although I learned to pre-cool. That was sort of the nice thing*." Another reported, "*my wife was saying, 'why is this air conditioner running at nine in the morning?,' and I said, "we've got to get this thing cooled down before 2 o'clock, because at 2 o'clock it's going to cost 70 cents per kilowatt hour."* A third said, *"little by little I got it down to a science...I loved how I could pre-cool my house."*

Another customer reported that in the second year he changed his *"temperatures to have a window where the air conditioning doesn't even come on at all"* in a new program *"keeping the house at 80 degrees, in the summertime, and it won't bring it down into the 70s at all."* Still another customer said that the *"new thing this year"* was pool filtration *"starting at whatever time, and that's great, we run it for five hours every night."*

Customers support RMI's observation that they shifted load to non-peak periods while maintaining thermal comfort. *"I think that usage is just more habit now than it was. Before you had to force yourself,"* a customer commented, noting that the new habits *"were easier the second year."* Another customer recalled:

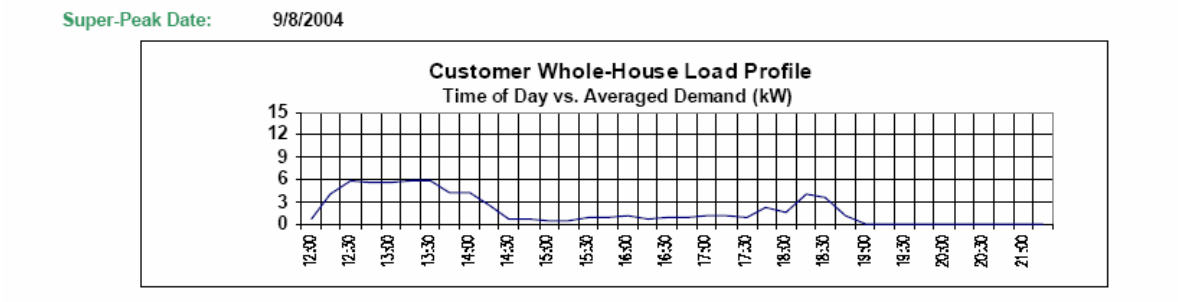
> *"Your change from year zero to year one was a big change, and you did everything you could to save that money. And you changed your habits in lost of different ways. And then in year two, you realized that, you know, we changed ten things. We're going to keep doing nine things we changed, and number ten -- we're going to tweak just a little bit."*

Another customer summed it up differently: *"It's like being on a long-term diet. First, you're really strict, and then when you get to where you want, you think, 'you know, I can have a piece of cheesecake every once in a while and everything's still going to be fine."*

So if ADRS was seasonal, but customers entered the new season ready to do more, our third observation needs to explain the apparently substantial differences between the program's first and second year performance. RMI has addressed this topic in terms of control group characteristics, but we can approach it more directly.

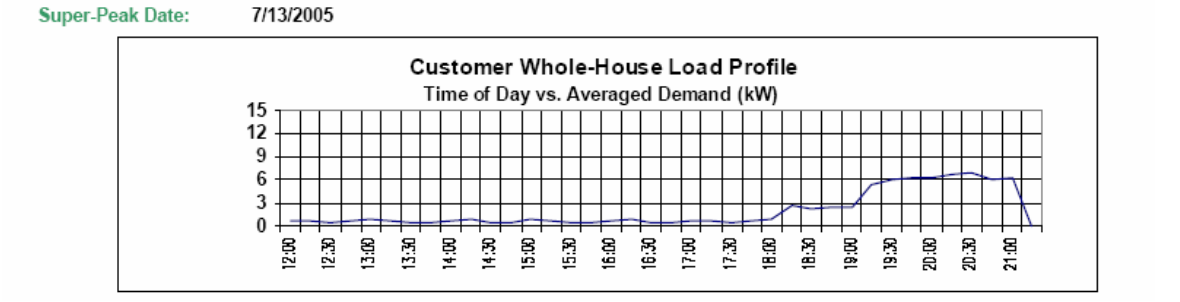
In interpreting how customers behaved versus how they apparently performed, we should again look closely at the definition of load reduction employed in the ADRS. Load reduction assumes that the customer was using more energy before 2 p.m. than afterwards. For one customer, a typical 2004 Super-Peak Day ran like Profile 1:

Profile 1



But in 2005, this customer's Super-Peak Day was more likely to look like Profile 2:

Profile 2

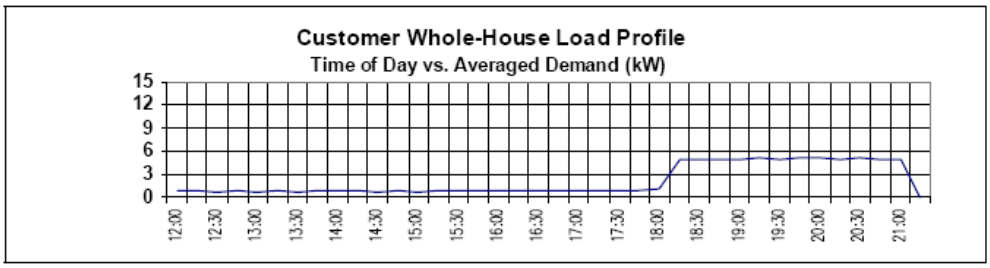


In other words, in 2005 this customer had less load to reduce at 2:00 p.m. than he typically had in 2004, so his average load reduction in the second year of the program did decline. But in fact, this customer's second-year participation in the program was, if anything, more vigorous. As noted above, several of 2005's "low performers" seemed to rank low because they avoided swimming pool and air conditioning control use not only during the peak, but well before.

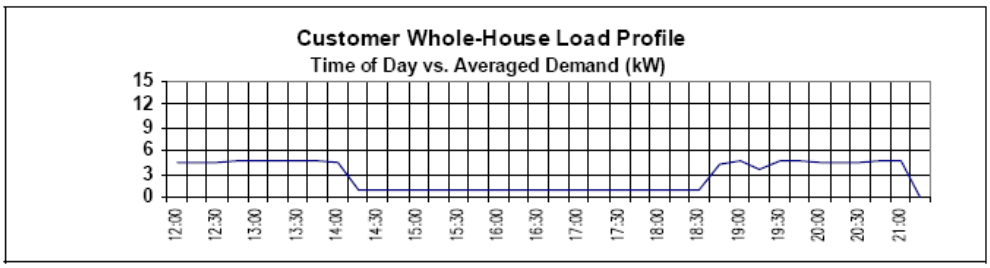
There were counter-examples, of customers who "improved performance" and showed greater load drops in 2005 than 2004. But as the two load shapes in Profile 3 indicate below (the last 2004 Super-Peak Day and the first 2005 Super-Peak Day for one participant), the load drop increased only because the morning load had increased:

Profile 3

Super-Peak Date: 9/10/2004



Super-Peak Date: 7/12/2005



From the utility's perspective, this customer learned to drop load reliably, and could contribute to the program. But note that Super-Peak Days are not called one hour in advance, they are called 24 hours in advance. The utilities are not basing Super-Peak designations on the usage they see at 1:30 or 2:00 p.m., they are basing their designations of what they anticipate the peak will be, a day in advance. Both of the customers just described would have offered such forecasts reliably low load during the 2005 peak periods.

Furthermore, the customers themselves are usually making their decisions about air conditioning and pool filtration well in advance, perhaps as long ago as when the installers programmed their system, and perhaps when they received their last Super-Peak notification call. Thus in its California implementation, GoodWatts was not a system primarily aimed at real-time, next-hour, demand response. In California, GoodWatts was a system for automating peak reduction (either through technology, or through customer habits).

We see that customers remained committed to the ADRS program in the second year, fine-tuning their behavior. Some continued to explore new measures to save energy, and some cut themselves small breaks. From the customers' perspective, they were settling into the program, and becoming more reliable.

Super-Peak Day Persistence in Customer Behavior from One Super-Peak Day to Another

Did Super-Peak Day customer behavior persist from one Super-Peak Day to another? Super-Peak Days occur during a range of weather conditions, and during a range of

household conditions, so the same customer might respond to different Super-Peak Days with a range of behaviors.

We might expect pre-programming to be the dominant influence on Super-Peak Day performance, and it is. Four determinants of participant performance during Super-Peak Days involved programming.

First, the most important determinant of participant performance during Super-Peak Days was the installers' initial programming. The installers discussed air conditioning and pool control settings with customers, and asked them what balance they wanted between comfort and economy. While some participants were engaged in these conversations and understood them, other participants told the installers to use whatever settings they thought best. In these cases, the installers duplicated the customers' current settings into the GoodWatts system. Many participants reported leaving their installation settings in place through the program, with occasional ad hoc adjustments.

Second, many participants reported reprogramming through contact with customer service. These participants called Invensys customer service to alter their settings when their equipment malfunctioned, or their settings proved to be uncomfortable, or they were changing household routines (e.g., vacations). Many participants also reprogrammed their behavior when customer service notified them in advance of Super-Peak Days by telephone, e-mail, or both. These various events led to customer change.

A third determinant of participant performance during Super-Peak Days was self-adjustment through the GoodWatts web site. Nearly one-third of participants learned how to use the web site, and adjusted their settings from time to time based on their energy use data, or their household activities, or merely because they were at a remote location and remembered that they needed to change their home thermostat settings. On these occasions, customers initiated change.

A fourth very important performance determinant, and a form of programmed behavior, was the decision to be home or away during the Super-Peak period. Our interviews and surveys indicated that very few participating homes had family members at home through entire Super-Peak afternoons. Work, errands, and decisions to avoid energy-intensive household tasks often limited the participants' experience of Super-Peak Days to a couple of hours at a time. Participants would heed the day-ahead warnings, and try to be away from home.

In these cases of programming and reprogramming, customers were forming expectations about the upcoming Super-Peak Day, and planning accordingly. They were reacting to how they expected to feel, and what they expected to be doing, and what they expected to receive for behaving properly, rather than the moment. In other cases, customers reacted to the moment.

Another key determinant of participant performance during Super-Peak Days was *ad hoc* thermostat or pool filter adjustments. Family members would elect to adjust their household devices, as they always had. Awareness of the program, the sophistication of programmable thermostats, and concern about higher rates (made obvious by the thermostats) reduced the number of these adjustments. But many participants restarted their air conditioning late in the afternoon still in the peak period, because family members had returned home from work or school, or dinner preparations were beginning.

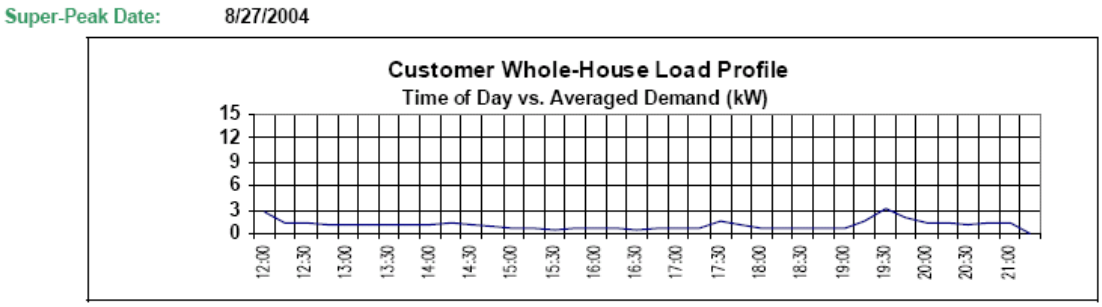
Other variations contributing to participant performance were interference with the system by other technicians (i.e., electricians or air conditioning technicians not affiliated with the ADRS GoodWatts program), and conversations with family members or friends.

In these cases of ad hoc adjustments, customers were reacting to conditions they were directly experiencing during a Super-Peak Day (i.e., how they were feeling, what they were doing), with passing consideration in a few cases of their decision's financial consequences.

So the determinants of Super-Peak Day behavior were a combination of programming and reactions - standard behaviors, and exceptions. Some customers had few exceptions, and some had many. Since programming is a definition of persistence, it is valuable to explore how many customers treated Super-Peak Days as key periods when their programming had to prevail, and how many customers were driven to treat them as exceptions.

So we might expect to see a mixture of programmed responses and ad hoc responses across a set of Super-Peak Days an individual household experiences. We see many customers whose usage is low across the afternoon and early evening, day after day after day, as in Profile 4:

Profile 4



Customers who start on this low-usage pattern tend to stay on this low-usage pattern, as the program continues. They include customers who were already conserving energy prior to the program, and saw the program as an opportunity to save more, and save through automation.

In contrast, we also see customers whose usage varies from evening peaks, to low usage, to in-peak usage, from one Super-Peak Day to the next (Profile 5):

Profile 5

These customers have no discernible pattern of response to Super-Peak Days, and in conversation seem to be (1) those customers who were unsure about program operations and even how many Super-Peak Days the program contained, and (2) those customers with volatile lives who were looking to save what they could through automation.

We also see customers who on successive Super-Peak Days, clip their curtailments short. Many of these customers were confident about what to do, but missed some of the finer points of the program. For example, one customer described the following Super-Peak Day strategy:

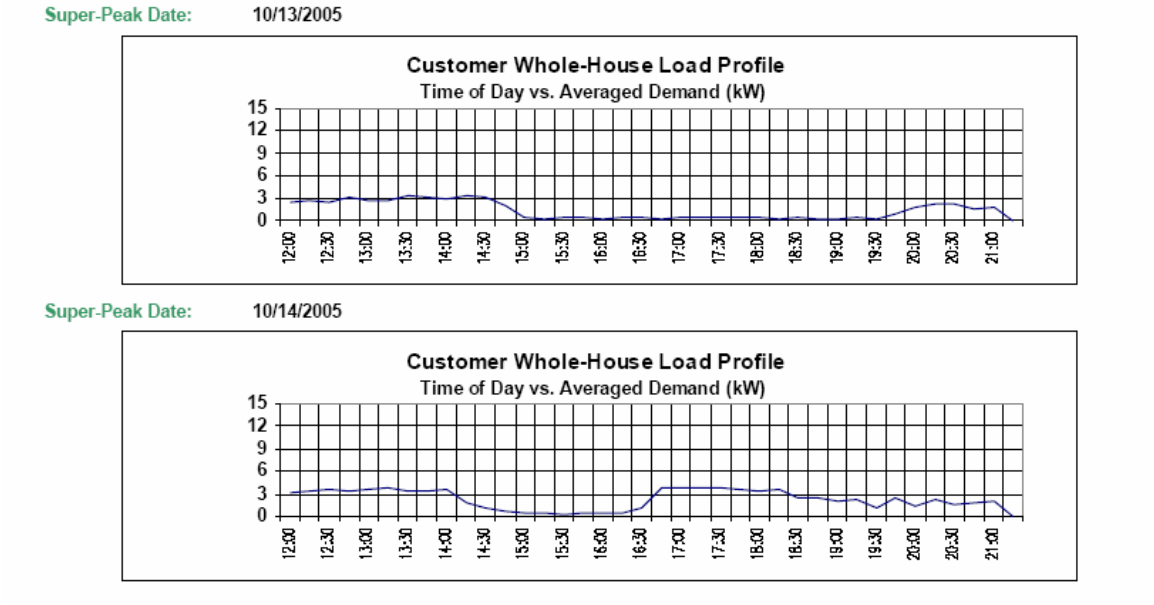
> *"We have a tendency to cool our house down between 1:00 and 3:00. We'll cool it down because we know we've got a Super-Peaker, so we'll bring the house down, and we'll try to get it below the 78 degrees we usually run, we'll*

> *try to get it down to 75…and then we know at 3:00 pm, that's it. We'll turn it off, and that's it until 7:00 pm."*

Pre-cooling until 3:00 pm, this customer achieved minor rate-based savings under the program, although other conservation measures left his household satisfied with their experience.

Others of these customers try to cooperate with the program, but find it difficult to stay comfortable (Profile 6):

Profile 6



Many of these are participants who are glad to use the program when they are out of the house, but who increase energy usage as they return home.

Households could not predict Super-Peak Days, and they could not predict the weather, so their Super-Peak Day behavior varied somewhat. But because household members had reasonably regular schedules on summer afternoons, and because these volunteers reported routines they tried to follow whenever a Super-Peak Day was called, we can note persistence in their behavior.

RMI agrees, telling us that:

> "…statewide, high consumption ADRS load reductions were relatively stable and consistent across event days….In 2005, load reductions varied modestly between 35% and 47% across seven event days called between July and September. Similarly in 2004, load reductions varied modestly between 47% and 56% across twelve event days called between July and September."

While RMI adds that "homes with ADRS technology produced a consistent and predictable load profile during Super-Peak and peak periods," this was not because individuals were behaving similarly. It was because individuals were behaving consistently, most of them understanding the general principles of a Super-Peak period with a 73 cent per kWh rate.

The major exception we should note to this prevalence of habitual customer behavior on Super-Peak Days is the problem of back-to-back days. As the first table in this report indicates, back-to-back Super-Peak Days occurred often, and most customers reported designing their Super-Peak Day strategies for a day at a time. As a result, back-to-back Super-Peak Days were an extraordinarily irritating experience for some participants.

"I would really like them to do something other than schedule three days in a row," a customer commented*, "because that is really hard to continue, not to override, because it affects my life too much."* While one customer thought *"there were sometimes that they did"* have two Super-Peak Days in a row, another customer noted that his most important recommendation for the program was to eliminate back-to-back Super-Peak Days.

A minor but important reason for variations in individual Super-Peak Day behavior was the lack of Super-Peak Day predictability. Not only could Super-Peak Days occur three days in a row, they could occur on very hot days or normal days; they could be absent for weeks, and then arise. Many participants wanted more predictability than 24-hour notice and a 2-7 p.m. weekday window offered.

Super-Peak Day Customer Behavior Similarity from One Customer to Another

Was Super-Peak Day customer behavior similar from one customer to another? Although we might think that the installers' programming of automated air conditioning and pool filtration would deliver reliable control, customers had the option to change programming and override the system. Different households are different, and might respond to the same Super-Peak Day with a range of behaviors.

Some participants had their settings set for economy, and were uncomfortable on very hot days, whether they were Super-Peak Days or not. Thus some participants reported that there were "many many" Super-Peak Days, or even that Super-Peak Days were almost every hot day. Conversely, there were also participants who said there were few Super-Peak Days, because they hadn't noticed many.

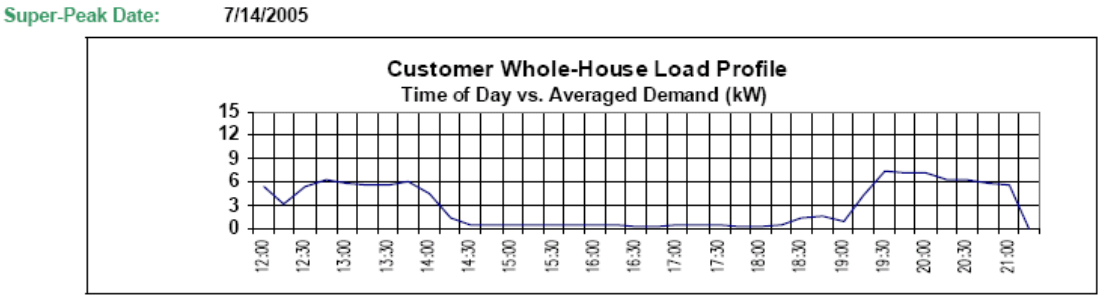
As noted below, customers had very different balances of costs and benefits, and learned at different paces. Their homes were different, their families were different, and their ZIP codes were different. Despite these differences, we found broad patterns in Super-Peak Day behavior which seemed to represent a set of strategies most households were living within.

We have labeled these patterns:

- ADRS Standard: what the program had in mind
- ADRS Curtailed: peak-reduction started late or stopped early
- ADRS Minor: small-scale peak reduction
- ADRS Evening Use: peak-reduction followed by evening bounceback
- ADRS False Curtailment: trivial curtailments quickly ended
- ADRS Flat Usage: no curtailment

We have illustrated these basic patterns of Super-Peak Day behavior with examples below. The first typical pattern is ADRS Standard (Profile 7). It represents what the program had in mind:

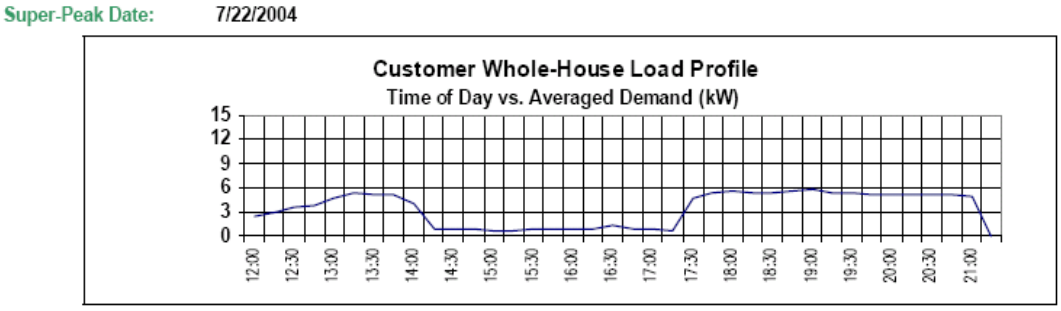
Profile 7



Above, we see a participant's load shape for Super-Peak Day July 14, 2005, which includes a healthy drop between 2:00 and 2:30 pm, and a rise well after 7:00 p.m.

However, a far more common Super-Peak Day pattern was one we termed ADRS Curtailed (Profile 8):

Profile 8

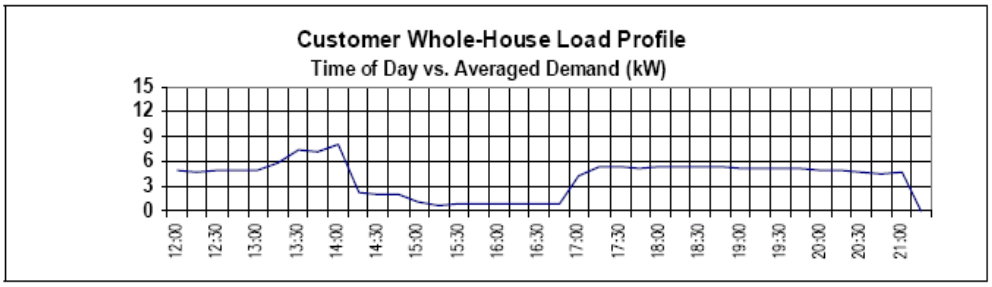


On Super-Peak Day July 22, 2004, the above participant provided a good load drop at the outset of the Super-Peak period, but resumed normal power usage at 5:15

p.m. The same customer followed the pattern again on Super-Peak Day August 11, 2004 (Profile 9):

Profile 9

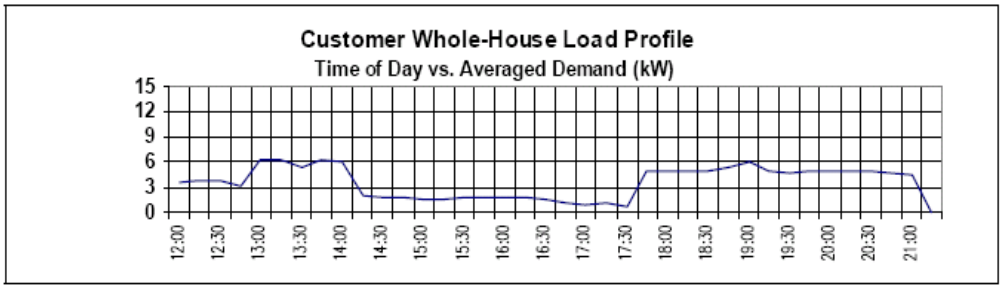
Super-Peak Date: 8/11/2004



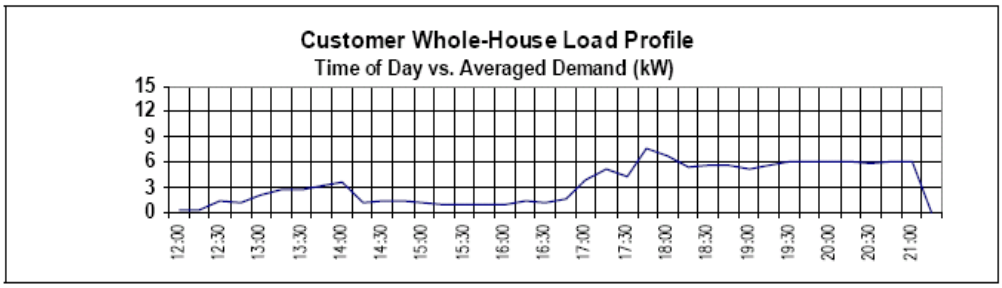
And again on the successive Super-Peak days July 13, 2005 and July 14, 2005 (Profile 10):

Profile 10

Super-Peak Date: 7/13/2005



Super-Peak Date: 7/14/2005

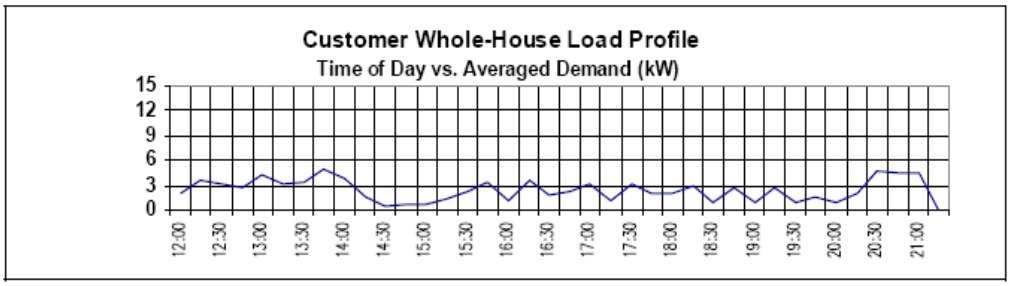


The ADRS Curtailed pattern illustrated above was the single most common pattern among higher performers on Super-Peak Days, usually those who were returning home from work.

San Diego participants, experiencing milder weather than others, had less prominent load drops even in the instances when customers performed well. For example (Profile 11):

Profile 11

Super-Peak Date: 7/26/2004

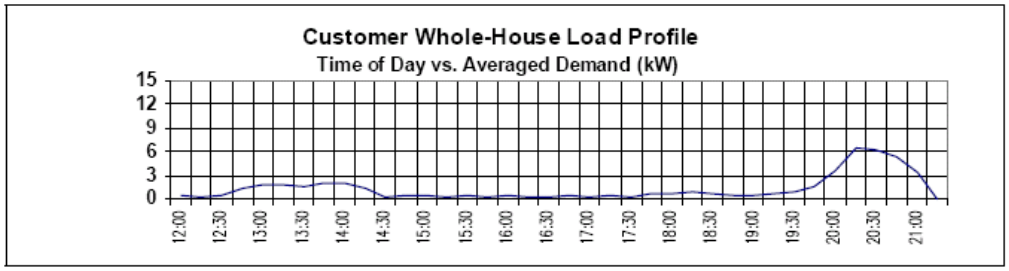


We call this pattern ADRS Minor, and it was very common for high-performers on Super-Peak Days, especially on milder days and among Converts whose air conditioning was turned off.

Many customers shifted non-air conditioning energy use to later hours, and followed a pattern of ADRS Evening Use (Profile 12):

Profile 12

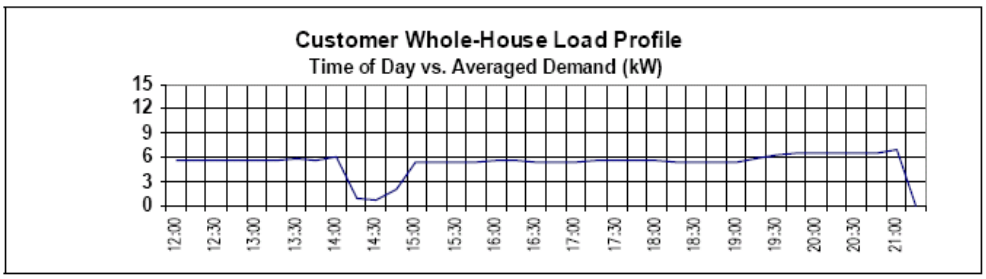
Super-Peak Date: 10/6/2005



Unfortunately, we also observed the ADRS False Curtailment pattern among some customers who misunderstood the program, or found a particular day intolerable (Profile 13):

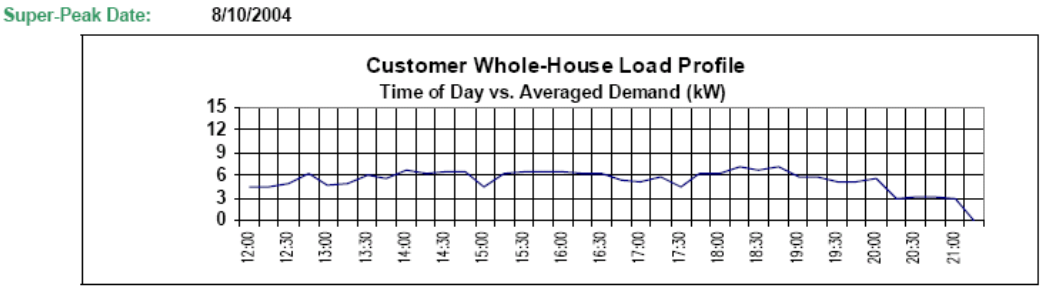
Profile 13

Super-Peak Date: 9/8/2004



Some participants claimed they were using electricity whenever they wanted, and their load shapes confirmed it, in a pattern of ADRS Flat Usage (Profile 14):

Profile 14



These six basic patterns are not an exhaustive or statistical list, but they do confirm that Super-Peak Day behavior can be quite similar from one customer to another, because the basic uses of energy combine to a similar result, and the basic patterns of life are similar for many of the program participants.

There are only so many basic strategies for energy use that work on hot, expensive summer afternoons in California. However, as we will see next, selecting a strategy and working it successfully are two different things.

The Lapse in the Feedback Loop

One theory underlying an ADRS says that the system aims for informed participants, who understand system programming, rates, household energy usage, and Super-Peak Day operations. These empowered customers can then experiment with different strategies of Super-Peak Day behavior (e.g., controlling and coping), and can identify the behaviors best balancing household economics and comfort.

However, while the ADRS program did supply advanced training and tools, the ADRS participants rarely seemed to use them in the pursuit of such rational optimization. We attribute this failure to make the most of GoodWatts to lapses in the feedback cycle. These lapses in the feedback cycles showed up in several ways.

First, the variability of weather and household conditions on any given Super-Peak Day meant that participants experienced their demands for energy on each Super-Peak day differently. Reprogramming might have been a solution, yet throughout the two years of the program, many participants reported difficulty with system programming (whether through installers, customer service, the website, or their own ad hoc adjustments). So ADRS performance cannot be taken as a direct expression of customer intent.

Second, even though the major disincentive for participants' energy use during Super-Peak periods was financial, the financial consequences of overriding the GoodWatts system were difficult for participants to estimate. Bills arrived monthly after the fact, and bill comparisons were only available in mid-November, after the Super Peak period ended on October 31. Many customers reported they either misunderstood or did not notice the rate indicator on their thermostats. As a result, few participants learned to associate Super-Peak Day behaviors with specific financial penalties.

Third, although most participants understood the basic rationale for Super-Peak Days (i.e., that the utility needed to curb peak usage), they did not understand why Super-Peak Days were designed as they were, how they worked, how much they helped, or when they were likely to occur. Indeed, despite the advance notification, newsletters, bills, and website information, very few customers knew how many Super-Peak Days there were, when they were, how their air conditioning and pool filtering would change on these days, and how the rates differed on these days.

Thus there were few perfectly-rational ADRS participants, who employed their household energy information to design routines of household behavior which would best balance economy and comfort. The effort required to redesign their lives proved too demanding for most participants, given how unpredictable both their lives and Super-Peak Days proved to be.

There were individual instances of insight into the energy consumption of particular appliances, or the energy use behavior of specific household members. Usage spikes made obvious by the online graphs or utility bills would cause attentive participants to search for causes for that spike, and in some cases, the data was available, specific, and recent enough for them to assign responsibility to a particular behavior on a given Super Peak day. But participants reporting explicit financial analysis of their own household patterns of energy use were the exception.

Instead, most participants relied on the programming recommendations from GoodWatts to limit their spending, and when they happened to think of it, participants shifted activities such as washing and cooking out of the peak period, and engaged in more general energy conservation. They had been reminded that electricity cost money, and it would help them to save where they could. So rather than an active and progressive process of learning, participants engaged in trial and error.

The feedback loop had lapsed. Participants guessed that their new approaches would save them money in the end, because they had been told they could save money when they signed up for the program if they actively engaged on shifting their load consumption behavior. They guessed that most Super-Peak Days would be endurable, because some had seemed to be so far - especially those when they weren't home. And even those Super-Peak Days which proved to be

"uncomfortable" or even "miserable" yielded some participants a certain pride in endurance, or in suffering through a program they were committed to.

Were these lapses in the feedback loop a problem for the ADRS sponsors?

It could be argued that participants would always benefit from faster, better, more convenient analysis of their own behaviors during Super-Peak Days, so they wouldn't have to wait an entire summer to assess the program. Indeed, customers specified the ADRS they would prefer would have more, better, and faster feedback.

However, there is a strong argument for requiring participants to wait for their evaluations. Even the smartest, best-informed, most analytic participants couldn't anticipate their reactions to that novel program feature called Super-Peak Days. Many participants didn't know how they would cope with an entire summer of Super-Peak Days until they had actually been through a summer, and had the benefit of hindsight. Once they had experienced a dozen Super-Peak Days, most participants described them as irritating, uncomfortable or unpleasant. Super-Peak Days were too long, and far too unpredictable.

Back-to-back Super-Peak Days illustrate this point: almost all of the participants recalled their experiences of back-to-back Super-Peak Days as quite unpleasant and distinct, for many the worst part of the program. Three Super-Peak Days in a row caused some participants to rethink their commitment to the program. Three customers in fact opted-out after experiencing three consecutive peak-days.

But by and large, participants remained with the program, and learned that back-to-back Super-Peak Days were an all-too-common exception, but not quite the rule. The combination of GoodWatts and Super-Peak Days made them mindful of their energy usage; they figured out how to cope.

Because participants did not receive immediate feedback on the financial value of the program for them, most suspended judgment until their bill comparisons arrived. In the process, they allowed themselves to learn through experience. They learned they could endure the program in some suboptimal fashion, and then they assessed their savings against that summer-long experience.

Of those participants who saved little during the first year of the program, several told us that they planned to try harder the second year, or things had changed for them, and they thought their results would improve. Of those who saved a significant amount during the first year of the program, several told us that they relaxed a bit in their behaviors during the second year, because they now knew they could afford to.

The biggest lesson visible in ADRS customer behavior on Super-Peak Days is that a large number of people pursuing their individual lives, learning in their own ways and at their own paces, can build a stable load control program. Construction will be an

experimental process containing its share of surprises and risks. We will need to help customers be patient enough to discover they can succeed. Customers will need to help us be patient with their misbehavior.

The ADRS trial results suggest the ADRS sponsors do not need to compel customers to live in an environment utilities have chosen for them. Rather, they can motivate customers. They can automate, enable, and educate. They can provide customers with a system, and show program participants how it might be used, and provide these participants with incentives and expectations.

Customers will then choose environments for themselves on their own terms, and if utilities have designed and deployed these systems properly, customer choices will also meet utility needs. With a little patience, utility response to customer demands will work for everyone.

The Volatility of Super-Peak Days

Even if we deploy an ADRS that proceeds by experimentation and choice, we cannot assume that customers would be content with utility experimentation and choice rather than their own. We need to focus for a moment on the problems created by the volatility of Super-Peak Days.

In the ADRS trial, the major obstacles to providing ADRS customers with more savings was not the range of GoodWatts functionality. Rather, the obstacles were the design of the CPP rate, and the design of Super-Peak Days. Invensys had designed the GoodWatts system to operate under a regime of traditional utility rates, but the California trial required an offering including these two features.

Learning to control household routines under the CPP rate was a challenge most trial participants took on successfully, and came to appreciate. But Super-Peak Days were a feature of the ADRS tested in California that worked directly against the customers' strategy of control. As discussed in more detail below, Super-Peak Days were unpredictable, often occurred back-to-back, and often occurred on cooler days. Customers could not plan for them.

Control systems like GoodWatts depend upon predictability to automate control routines. We saw two primary customer strategies for Super-Peak Days based upon control:

- Spectators relied on the ADRS to automatically deliver its value based on the system's initial programming, with minor adjustments along the way.

- Teammates used the ADRS to explore their own energy usage, defining new household routines, and quantifying the impact of their behaviors

However, the California ADRS program added volatility into customers' lives: unpredictable, expensive, uncomfortable summer afternoons. Super-Peak Days would arise suddenly, regardless of the weather or the season. Customers could learn new habits, and learn to use new technology in order to control their lives under a new rate, but Super-Peak Days remained an unpredictable factor. They were exceptional.

Many participants learned to pre-cool, and defined other contingency plans for Super-Peak Days, asserting as much control as they could. But learning how best to curtail electric usage for one or more afternoons on 24 hours notice is as more about coping than controlling. The most successful Super-Peak Day tactics among ADRS volunteers were largely based on adaptations in attitude and behavior. Go shopping. Eat out. Open the windows for a cross-current, and get used to being warm at home. These were the elements of strategies based on coping:

- Converts launched into the program by curtailing their energy use: then relying on the ADRS to manage this new routine, and deliver lower bills as a result.

As an automated control system, GoodWatts had less to offer coping strategies. Controlling and coping are different skills, and they require different learning, and training, and tools. Participants succeeded in coping with Super-Peak Days because they built new attitudes and behaviors based on their experience coping with other exceptions, such as bad weather and disruptions in daily life.

We believe the secondary benefit of ***lets us be good citizens by managing energy*** became prominent in part because ADRS program participants were coping with volatility the program brought to their lives. Sacrifice for the sake of others is a typical coping strategy, and the reward is usually recognition.

Limitations of the Research & Recommendations for Further Study:

Our Super-Peak Day behavior analysis has several obvious limitations:

First, the households we could examine this closely were not distributed evenly across the three utilities, nor is there any reason to suppose they are representative of either the ADRS cohort or the general residential customer population. Nor are the 23 Super-Peak Days these households experienced necessarily representative of future Super-Peak Days.

Second, the testwise ADRS customers differ and behave differently from typical utility customers. The ADRS customers were volunteers, and survivors of the program's first year, so they are two steps removed from the general run of utility residential customers.

Third, many behaviors of the ADRS customers are triggered by test conditions (e.g., financial incentives, service problems, beta-version technology and materials) which would not be reproduced in any commercial utility offering. Any commercial offering would also be years after the initial ADRS recruitment.

Fourth, a very real proportion of the test cohort behaved the way they did for reasons that have nothing to do with our program. Customers take vacations, have children, repair appliances, and host relatives, often drastically influencing their use of air conditioning in the summer. Customers also behave casually, resetting devices by mistake, or on a whim. These behaviors are merely the noise of everyday life at home, but with such a small sample, they can distort the picture.

Despite these limitations, it is clear to us that Super-Peak Day customer behavior is the key to the ADRS, and that behavior is more consistent than the utility standards for calling Super-Peak Days. Research into the utility energy supply implications of Super-Peak Days could allow them to be as predictable as possible, thus enabling automated systems like the ADRS to help as much as possible.

Alternatively, more coping mechanisms could be investigated, and designed into the ADRS. System emergencies can arise at any time, and Super-Peak Days won't always be predictable. The nature and levels of compensation and recognition required to motivate homeowners to endure Super-Peak Days should be identified, as well as the learning, training, and tools that would most help customers cope with these exceptional days.

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4. Participant Willingness-to-Pay

Objective:

Identify the ADRS pricing (e.g., level, type, rationale) best accepted by participants in the ADRS trial.

Approach:

"The way in which customers behave toward price is more complex and less informed than is assumed in traditional economics."[13] Willingness-to-pay is a complex issue, and best addressed with lasting, well-informed customers. So this research task had to be conducted after the summer of 2005, because serious reflection on ADRS pricing might well have influenced behavior among these customers.

BDG recruited 24 ADRS customers, one set of 12 among Southern California Edison ADRS participants, and one set of 12 among Pacific Gas & Electric ADRS participants, to participate in two panel meetings. These two meetings were spaced two weeks apart.

In the first session, we discussed how the ADRS rates work, how customer behavior leads to changes on the electric bill, and how the appreciation payments operate. We also discussed various alternatives for pricing the ADRS as a commercial full-scale utility program.

The interval between sessions gave participants a chance to think through their views. Between the first meeting and the second meeting, we asked participants to go to the GoodWatts web site and the CPUC website. We asked them to think about the concept of a 'good deal,' and to return to the second session with examples of good deals.

The second meeting discussed participants' willingness to pay for the ADRS, under different pricing methods. ADRS should be a 'good deal.' Alternatives include a monthly fee, a special rate, an installation and equipment charge, or a shared-savings plan with the utility. After the panel concluded, ADRS sponsor representatives joined the meeting briefly.

We asked customers to think about 'a good deal' because the ADRS program included a combination of elements rather than just a rate change. Like many 'deals' consumers are offered, the ADRS included promotional incentives, new information, bits of technology, new experiences, and yes -- new pricing. The ADRS

[13] Market-Oriented Pricing (1990) by Michael and Gene Morris (New York City: Quorum Books), p. 57

was a deal, but was it a good deal? To understand how the ADRS volunteers would approach this question, we should consider how the new CPP rate might be perceived, and how this new rate was packaged with the rest of the ADRS program.

First, we know that typical consumers will react to a new price of any offering in a band around a reference price, which most consumers will recall generally from when they last paid for the offering. Consumer reaction to a new price for a familiar offering depends in large part upon the relative change from its reference price.[14]

While recall and ranges vary across offerings, we should recall the rule of thumb that price must change more than 15% to be perceived by consumers as a noticeable difference.[15] Smaller price changes are likely to be viewed as promotional, or even incidental. In the ADRS, the sponsors were changing the price of electricity per kWh from a base of 13 cents to 9 cents off-peak, 23 cents peak, and 73 cents Super-Peak, on average[16]. Not only are these changes more than 15% each, the new prices are considerably more than 15% distant from one another.

However, we might be concerned that the reference for ADRS participants was rarely the rate -- it was usually the electric bill. The net effect of the CPP rate changes on a participant's bill might be considerably less than 15%, but participants didn't know that in advance of the trial. The marketing materials forecast savings (or perhaps a penalty), but didn't cite amounts. Participants' initial reactions to the rate change would be based on their expectations of future bills, rather than their experience. We learned last year that participants expected the effects of the program to be significant.

Not only did participants expect significant changes in their electric bills, they also focused on the electric rate more than ever before. Thinking about the time of electricity use was new to most of the ADRS customers, but even their thermostats quickly cued them in that 73 cents per kWh had become the price of electricity on a summer afternoon - a rate more than five times what they had been paying during off-peak periods. So participants anchored their perception of the ADRS program around the changes in their electric bills, the Super-Peak rate, and their experiences of Super-Peak Days.

Second, ADRS customers did not experience their new rate as an isolated change. The ADRS was a set of changes in participants' lives: a new rate, new technology, new information, and new habits. Most ADRS volunteers didn't recall much about their old rate, and received their new rate as part of the ADRS package.

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[14] The Weber-Fechner law asserts consumer responsiveness to price changes is a logarithmic function of the magnitude times a proportionality constant plus an integration constant. In other words, responsiveness depends on the offering.

[15] D. Loudon and A.J. Della Butta, Consumer Behavior, New York City: McGraw Hill, 1988.

[16] Rates were specific and unique to each utility and varied nominally throughout the program period.

The ADRS was a complete program, new to participants in the way a new relationship with a different utility might be if they had moved from one town to another. Household moves involve sets of changes just as the ADRS program did: new prices for familiar products, new technologies in the home, new information about the community, and new habits in daily life. Customers would view the ADRS as a package, the net impact of which could be read on their bill, and experienced on each Super-Peak Day.

Quality and price relationships become complex in packaged deals. One customer might frame an evaluation around a single factor, e.g., the remote access that makes it all worthwhile. Another customer might look to the bill to make sense of the whole experience. Two customers in the same household might differ on how to weigh the various factors included in the package.

We know from our design work how the ADRS volunteers value the individual elements in their package relative to one another, but do they consider the program as a whole 'a good deal?' In asking the ADRS customers to approach this question, we were asking them to explain their apparent satisfaction with the program, their willingness to remain in the program, and their willingness to recommend the program to others.

Findings:

The Cost/Benefit Framework

While customers did frame the ADRS program as a savings program, the range of cash costs and benefits proved to be less definitive than many participants had expected. Other factors intruded. The significance of these factors varied by customer segment.

After the first year of the program, the ADRS volunteers received their first utility bill comparisons: 90% of all household achieved real savings through the rate differential. But these savings amount to $10-20 per month, or less than 10% of the electric bill, for many participants. There were a few who did achieve substantial savings, and there were even a few customers who did not save, but remained with the program determined to try harder the second year. There were also some customers who regarded any savings at all on their electric bill as important.

After the second year of the program, the ADRS volunteers received their second utility bill comparisons, with similar results. We had learned that the ADRS volunteers had continued to change behavior from year one to year two, in some cases intensifying their conservation efforts, and in other cases easing off. As noted above, even in focus groups few customers focused on the on the year to year comparison, or the exact amount of their savings; some were unaware of the numbers.

When the 2006 ADRS research was initiated, we believed that willingness-to-pay had several aspects:

- Amount: how much?
- Timing: how often, how predictable, how flexible?
- Certainty: fixed, variable across a defined range, or volatile depending upon conditions?
- Visibility: bundled invisibly in a rate, a one-time initial charge, bundled in a program but visible on a bill, or unbundled into feature options or packages?
- Comparability: shared-savings with the utility, a better rate than others, or a way to do my part while others are doing theirs?
- Rationale: save money or save energy, good citizenship, control of the home, or experiment with new technology?

We had thought that given the CPP rate, the price elasticity of demand for electricity across a customer set might be the primary driver of customer behavior. Certainly the quest for cash savings was a driver, but customers were quite enthusiastic about the program, given that the bill comparisons told them their savings were modest.

We recognized that a partial explanation of the customers' reaction could be that they had saved more than the rate differential revealed. Not only had they shifted power usage, but in most cases they had conserved as well. Their mindfulness to energy usage paid off. One customer saved $10 per month merely by unplugging an idle compressor in his garage. Defining performance as load drop in the 2 p.m. hour had missed much valuable customer behavior; defining savings through a rate comparison had missed much customer savings.

But as the customer satisfaction surveys and focus groups indicated (see below), we also knew that many of these customers perceived their total savings from the program to be nominal, or even disappointing. Savings were minimal for some customers, and modest for most, yet by and large, ADRS customers were satisfied with the program. It was evident that the ADRS cost/benefit equation must range beyond the electric rate for these volunteers.

We discovered that for the ADRS, another important aspect of customer willingness-to-pay was the medium of payment. While customers in the program received its benefits "free", and were paid to participate, customers in the trial also paid for the program several ways:

- Compensation: expense incurred when misprogramming or overrides lead to high daily charges under the new CPP rate
- Recognition: as a guinea pig, a subject of curiosity and confusion for utility employees
- Comfort: suffering that could have been avoided by different energy usage

- Time: homework (learning how to program the system, and analyze energy data; educating family members) and housework (altering behavior, rescheduling activities away from normal or preferred times)
- Control: Super-Peak days arising unpredictably on short notice
- Coping: failing to handle unpredictable Super-Peak Days, inconvenience, and discomfort

From the customer perspective, the ADRS had more in common with dentistry or a long-term diet than it did with typical consumer services.

The benefits customers received from the ADRS program were also diverse:

- Compensation: savings received when programming or overrides lead to lower daily charges under the new CPP rate, promotional incentive payments
- Recognition: as a steward of the community, whose costs of the program were contributions, and not wasted
- Comfort: enjoyment from energy usage
- Time: learning (system programming, energy data analysis) and automation (new programming, habits, and behavior)
- Control: the ability to use the system and its information to manage household energy use, developed through mindfulness, attention, learning and practice
- Coping: the skills and attitude to handle unpredictable Super-Peak Days, inconvenience, and discomfort, also developed through mindfulness, attention, learning and practice

The ADRS experience involved a mix of costs and benefits. The ADRS was a packaged program, not just in its features, but in its costs and benefits as well. Customer "willingness-to-pay" for an ADRS involved a set of at least six factors:

Table 4
ADRS Cost and Benefits by Category

Category	Costs	Benefits
Compensation	Expenses	Savings
Recognition	A Guinea Pig	A Steward
Comfort	Suffering	Enjoyment
Time	Homework and Housework	Learning and Automation
Control	Being Controlled	In Control
Coping	Failing	Enduring

Furthermore, not only did the ADRS evoke a complex set of tradeoffs for customers, but in some cases these tradeoffs were between risks as well as returns. The costs the

ADRS imposed, as well as the benefits it delivered, were each to a degree uncertain and unknown.

The First Dimension of Compensation

Compensation was a fundamental factor in the ADRS program.

Customers could receive three forms of compensation in the ADRS program: (1) incentive fees for participation, (2) honoraria for market research activities, and (3) savings on their energy bills. Customers regarded the first two forms as promotional and the third as fundamentally motivating. Savings on energy bills were available through proper system programming and the timing of overrides.

Without these behavior changes, ADRS customers were likely to lose money. As one customer put it, *"I'd say it's like the carrot and the hammer. You have the low rate and the you have the high rate….We didn't know what it was going to be like when we started, but we did know that when that thing kicked up to 70 cents, we didn't want to have our air conditioning on."*

Risk entered the equation because the time-of-use rate was fixed, yet savings depended on novel behavior. While the maximum customer loss in fact was slightly over $100 per summer, the threat of loss was perceived to be great. Customers didn't want to lose money on a deal that offered potential savings.

As a result, customers most concerned about savings attended to their monthly bills, their bill comparisons, and the website information. Like other customers, they disliked the notion of a fee for the program, but their concerns tended to focus on how little they knew about the program's costs, so it would be hard for them to determine if a fee were fair. These customers were willing to share savings to some degree, to cover reasonable costs.

The Second Dimension of Recognition

Recognition was a fundamental factor in the ADRS program.

The ADRS promotional material and other mailings suggested to volunteers that participating in the program might be good for the community. Participants ranked this potential benefit strongly among features in 2005. Some customers also wanted to believe participating in the ADRS was good for the environment. Some customers saw themselves as stewards of the community, whose program costs were contributions, and therefore not wasted.

However, apart from its name, the GoodWatts program offered little recognition for these achievements. *"Sometimes,"* a participant reminded us, *"we're all human, we like a little recognition."*

Risk entered the equation as customers became a subject of curiosity and confusion for utility employees who were unfamiliar with the program. One customer referred to volunteers as "guinea pigs." Many customers saw a further risk as the lack of equity between GoodWatts participants (who they saw as sacrificing and suffering), and typical customers, who seemed to be leading normal lives using the energy that the GoodWatts customers had saved.

As a result, interviewed ADRS volunteers concerned about recognition agreed that everyone should pay the costs of the program, with the program's benefits accruing to the active participants. These volunteers were strongly opposed to a fee for the program, which they believed would penalize those who contributed the most.

The Third Dimension of Comfort

Comfort was a fundamental factor in the ADRS program.

Most customers realized that the ADRS program threatened their comfort. A few noted that some of the features (e.g., remote access) could increase their comfort. Almost all of the participants valued the mindfulness the program delivered, which made them appreciate their comfort more, and deal with their discomfort more directly. As explained below, the mindful pursuit of comfort led participants to two forms of active behavior, control and coping.

Risk entered the equation in the unpredictability of Super-Peak Days, which could foil the best-laid plans for comfortable days. As one customer noted, *"it was so hot, it was awful. It went up to 85 degrees in the house."* Risk also arose in the program's demand for changed behavior, which required investing time to learn how to control or cope, and offered no assurance of a successful outcome.

As a result, our discussions with ADRS volunteers about comfort reflected how far they were down the road to controlling or coping with their new environment. Many had learned to take comfort in smaller, more deliberate doses. These volunteers expressed irritation at the notion of paying a fee for their new discipline.

The Fourth Dimension of Time

Time was a resource in the ADRS program. It could be invested in control or coping to earn or protect compensation, recognition, or comfort.

A segment of customers we designated as teammates invested a great deal of time in the ADRS program learning how to program the system and analyze energy data, educating family members, altering behavior, and rescheduling activities away from normal or preferred times. Another segment we called converts invested time a different way, altering behavior and rescheduling activities merely on general principles.

As noted above, risk entered the equation because these investments of time offered no certain outcome. A third segment of customers called spectators therefore limited their investments of time as much as possible, relying on GoodWatts' automated performance.

Some of the time participants invested was continual: every load of washing done late at night is a chore in itself. But much of the time ADRS participants devoted to the program was a one-time investment: once they realized how to program their pool controls, they could remember how without much effort. For all three segments, adopting the program took more time than maintaining it would.

As a result, many participants emphasized that the rate alone or information alone would not be enough for the ADRS program. The time teammates and converts had invested in learning the system had personalized energy management for them. These ADRS volunteers were literally invested in the program.

On the other hand, spectators appreciated the system that someone else had designed to automate activities in their lives, because it minimized the time they had to invest. Almost all of the ADRS volunteers agreed that a rate alone was abstract, and information alone was "for somebody else" -- but their program was personal.

The Fifth Dimension of Control

Control was a strategy in the ADRS program. It could be achieved to earn or protect compensation, recognition, or comfort.

GoodWatts was designed with control in mind, automating household energy management. The GoodWatts controls were designed to be finer, more accessible, and analyzable in more detail than those the ADRS volunteers had before. They offered the opportunity to fine-tune energy use. Spectators enjoyed the automation; Teammates appreciated the ability to tinker. Both liked the ability to handle the new time-of-use rate to maximize savings and comfort.

Risk again entered the equation in the unpredictability of Super-Peak Days, which could frustrate control schemes. Risk also arose in the program's demand for learning the system. Mistakes proved expensive.

As a result, participants suggested that any fee for the ADRS might continue for only the first year or two of the program, while they learned the ropes. Once customer savings and comfort had also delivered reliable peak usage to the utility, any fee should expire. Participants also suggested that Super-Peak Days should be scheduled a month or more in advance, perhaps on a rotating basis -more of them were acceptable, if they were predictable.

The Sixth Dimension of Coping

Coping was a strategy in the ADRS program. It could be accomplished to earn or protect compensation, recognition, or comfort.

GoodWatts was not designed with coping in mind: participants invented their own approaches to enduring discomfort and high rates. Fortunately, the mindfulness GoodWatts generated helped ADRS volunteers to cope. Program Converts would typically turn off their air conditioning entirely and leave the house. They would eat dinner out on Super-Peak Days. They learned pre-cooling and cross-ventilation. Spectators would behave similarly within the confines of the programmed routine.

Risk entered the equation in the unfamiliarity of living at home under high temperatures. The unpredictability of Super-Peak Days was less of a problem and more of a challenge for those developing coping skills. *"I felt constrained when I basically had to follow the time-of-use,"* said one customer, *"it's one more penalty, that's just like beating me, and I don't like it.*"

As a result, participants who had worked to develop their coping skills were often proud of their accomplishments, and saw in this self-recognition and any kind of modest savings a justification for the program.

Paying It Forward: Problems with a Fee-Based ADRS

ADRS volunteers sought compensation, recognition, and comfort from the program. Investing some time, they aimed to achieve control and be able to cope with their new environment. The acceptable balances across these factors differed for every participants, as did the strategies for achieving them.

Broadly, we can suggest the Teammates practiced control, and the Converts learned to cope, while the Spectators expected the system to handle both tasks for them. GoodWatts was designed to deliver control, but turned out to deliver mindfulness as well - the key to coping successfully.

Many ADRS customers believed that they were paying for the system through altering behavior, learning, and suffering. The program sponsors had asked them to

change their lives, and they had. They were not comfortable with all of the changes, but they were being compensated for them.

The benefits these customers received were diverse: e.g., savings on their electric bill, recognition as good citizens, comfort in their daily life. For almost all of the customers, the benefits outweighed the costs: they would continue with the program, and they would recommend it to others. But the balance would shift for many participants if they were asked to pay a fee to receive the ADRS. There were several reasons for this shift.

First, participants varied widely in the savings they experienced with the program, and the discomfort the program exacted from them. There was little correlation between these factors, as we should expect. The program's relative economy for a given household depended not only on their prior energy usage, but also on the nature, frequency, and intensity of behavior changes they made. The program's relative comfort for a given household depended not only on the interior environment during a Super-Peak Day (a product of elements such as weather, construction, and precooling efficiency) but also on how comfortable the changed customer behaviors could be.

For example, one customer testified that his home was in a very hot and humid location, and he and his wife had changed household behavior radically on Super-Peak Days. He is retired, on a fixed income. His savings were modest, real, and more than enough to justify the program to him. On Super-Peak Days, he and his wife found it perfectly comfortable to just go outside and sit under a big shade tree. Occasionally they would go shopping instead. This customer was proud he and his wife could cope with the program's demands so easily, and still save money.

Another customer's home was in a very mild climate; she and her husband both worked, but her schedule had her home with their young children some weekday afternoons. She signed up for the program expecting substantial savings justifying behavior changes, as well as computer tools that would enable her to select the behaviors to change. While she experienced few Super-Peak Days, she found them quite uncomfortable and inconvenient. She found the GoodWatts computer interface tedious and unhelpful. She was irritated that the program implied she ought to be able to change more easily, and save more money.

The balance for each household between economy and comfort is difficult to identify in advance, even for household members. It changes as the households change, and the weather changes. The behaviors an ADRS incentivizes may prove simple for some households to adopt, and impossible for others. So a fee for the program would be a fixed cost limiting recruitment, experimentation, and retention.

Second, the measures the ADRS enables vary widely in what they require from the participants, and they are not possible for all participants. The contrast between swimming pool control and air conditioning control is particularly relevant.

Prior to GoodWatts, many program participants had left their pool controls entirely at the mercy of their pool service contractors, who set the systems to operate much of the day, particularly in the afternoons when pool usage was heavy, and contamination by dust and debris was common. Customers used their pools a small portion of the time, and were relatively insensitive to filtration levels, so adjusting the timing of pool operations produced little discomfort. In fact, the main source of dissatisfaction with GoodWatts pool controls was due to the inconvenience of the system itself (e.g., computer-only adjustment), rather than its operations.

Air conditioning was another matter: whenever they were home, customers were very sensitive to interior temperatures. Prior to GoodWatts, most customers had programmable thermostats and had used them to some degree. While precooling was a pleasant surprise for many of customers, it was an inconvenience. Many customers reported "suffering" on Super-Peak Days, to the point that they had to override the system.

Thus customers might accept a fee for the ADRS, and then find that their particular road to energy management was very difficult to follow. Learning how to cope with Super-Peak Days takes time. Furthermore, without a pool, or with a limited use of air conditioning, customer savings would be modest. Yet as we heard from many of these customers, they enjoyed the program, reduced what usage they had in the peak periods, and appreciated the limited recognition that participation provided.

GoodWatts the Good Deal

Customers described three major characteristics of good deals, and then considered GoodWatts in that context.

First, the ADRS volunteers agreed that 'a good deal' offered something free, or discounted. A *"new mobile appliance for $200,"* is a good deal, because *"it's a $400-500 piece of equipment that you're going to get for a much lower price."* Another good deal: *"you buy two toothbrushes and you get a free gallon of milk."* Reminded that milk had nothing to do with toothbrushes, the customer added *"**free** has a lot to do with it."*

"Whenever there is a free thing, I like that," another customer agreed. Examples of good deals included the 3% discount from a Safeway club card, no-charge city services to create parks and protect property, basic cable rates, family memberships in museums, and broadcast television. Fleet auto sales offer flat, discounted prices. Compact fluorescent bulbs last a long time and are economical. A warehouse operation sells damaged breakfast cereal boxes for 50 cents each.

ADRS customers said these are good deals because *"the dollar goes farther for the amount of product you get,"* and *"you feel smart because you looked for it yourself -- you researched."* Good deals often *"benefit other people."*

Second, good deals offer these discounted prices packaged with a little inconvenience, like *"my coffee table with the tiny little scratch,"* that let one customer *"save over $100 on a tiny little scratch that no one can see, except for me. That was an excellent deal, and it did make me feel like I was being intelligent."* Functionality was intact: *"It's not like a refrigerator that won't freeze. I figured if the scratch bothered me that much, I'll put a flower pot on it."* In other words, she would cope with the *"tiny little damage."*

Some customers were unaware the 'free' or discounted elements were bundled in with others - as one put it, *"how can that be?"* But most knew they were seeking *"a pretty good package, I thought, for value."* The 'free' elements, discounts, and double coupons *"make shopping more fun"* and reduce the price of a necessary purchase. They reward *"shopping around."*

Third, good deals begin with customer awareness, like the warehouse club that describes the added savings a little more spending would have earned. One customer suggested that GoodWatts could retain some of the program's savings to cover costs, and then explain to participants that *"had you been on this plan and fully used it to optimize your benefits, you could have saved X amount of money, or X percent."* He knew how much his bill comparison said he saved, but a better deal would have been knowing how much he could have saved.

Participants believed electricity in California generally wasn't a good deal, although *"you have to pay it"* and they didn't understand why rates were lower elsewhere, and California rates had increased so much in recent years. However, most customers said GoodWatts, *"this program here, this is a good deal"*, indeed *"an excellent deal."*

There were dissenters: a skeptic noted that the ADRS study might be *"interesting, and maybe it was a good deal for PG&E that we participated,"* but it wasn't a good deal for her. Another was *"undecided: I really want to try it for three or four years, although I'm not so sure I can convince my wife."* But most participants believed GoodWatts was a good deal on the three criteria they had identified.

First, GoodWatts was free in some respects, and discounted in others. There was in *"the GoodWatts thing, all the stuff we got -- the reduction, and you get this equipment,"* and you get customer service, and Super-Peak day notifications, and remote access, and many other features. The program also offered a nominal off-peak discount which struck customers as *"kind of like getting a pat on the back, thank you."* The discount said *"you did a good job. You get a lower rate because you are participating and you area trying to conserve energy."*

Second, GoodWatts also bundled these free and discounted elements with a little inconvenience. For many customers, it turned out that these choices of *"how much you give up"* were easier than they anticipated, because *"there are things you can do to plan ahead, so that you really minimize how much it costs you in terms of comfort so save money on the other end."* The program *"has a lot of flexibility,"* and *"if you are willing to do a little bit, you can save a lot."*

Third, GoodWatts was built around customer awareness, and making customers feel smart and informed. One customer said GoodWatts was *"a wise choice"* because, *"we were made aware of something, we made a choice to join it....when you make those choices, it gives you control."* GoodWatts was a program that provided the choices to control household energy use.

Another participant responded that *"I think it was more focused, paying attention a little bit more than you did before. I agree with you, I wasn't giving anything up."* The first participant considered that, and added, *"yes, we just kind of switched things around."*

So even in its trial, non-commercial version, offering modest savings, limited control and no particular help coping, GoodWatts seemed like a good deal to most volunteers. What they wanted was an even better deal: more free stuff and discounts, more bundling with problems they could minimize or work around by being smart, more awareness. Considering the CPP rate, one customer said, *"my question to you is, do they have a reason for allowing it to be so high? And what are those reasons? And what can we do around those reasons to make our bill lower?*

GoodWatts customers were willing to pay for the ADRS program in terms of their time, attention, and changes in routine. In return, they asked for a system that would help them control their energy usage, cope with the discomfort of change, and save money on their electric bills.

Limitations of the Research & Recommendations for Further Study:

While we have presented a complex but structured view of how ADRS customers describe their willingness to pay for the system, our work has a few serious limitations.

First, the compensation equation for ADRS customers was the product of a trial environment. These customers received promotional incentives, rate-based savings, a peculiar meter charge, and market research payments. We don't really know how they would have reacted had their sole financial benefit been bill savings.

Second, two years, 23 Super-Peak Days, and two all-summer bill comparisons may not be enough to establish new control and coping strategies for these customers, especially given how much trial-and-error these first two years included. Customers and program management alike spent a lot of time just getting the trial to work.

Third, the imaginative calculus we outline above may be just that. Much more work would be required to justify targeting based on the attitudinal/behavioral segments of Spectators, Converts, and Teammates.

Fourth, we have learned what GoodWatts customers might be willing to pay for a better ADRS, offering real recognition and broader control, but neither they nor we have experienced the system they would prefer.

Thus, given that the customers want more rather than less, we would recommend additional research into the commercial deployment of a more powerful ADRS.

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5. Participant Satisfaction Levels

Objective:

Identify program satisfaction levels and determinants among participants in the ADRS trial.

Approach:

BDG designed a 2005 customer satisfaction survey carrying over many questions from 2004, for comparability. We explored several dimensions of customer satisfaction, including perception, behaviors, problem resolution, and expectations addressed. The 2005 survey results are summarized below, in an Appendix.

All ADRS participants were surveyed. The survey was mailed, with telephone follow-up to non-respondents. Our findings below reflect the results from 95 usable surveys we received in 2004, and the 90 responses we received to our December, 2006 survey.

Our analysis is a straightforward comparison of results year to year, focusing on persistent scores and changing results. We are interested in whether loyalty builds or fatigue sets in; whether or not participants remain mindful; and if participants value the ongoing program prompting as much as they valued their initial learning.

Findings:

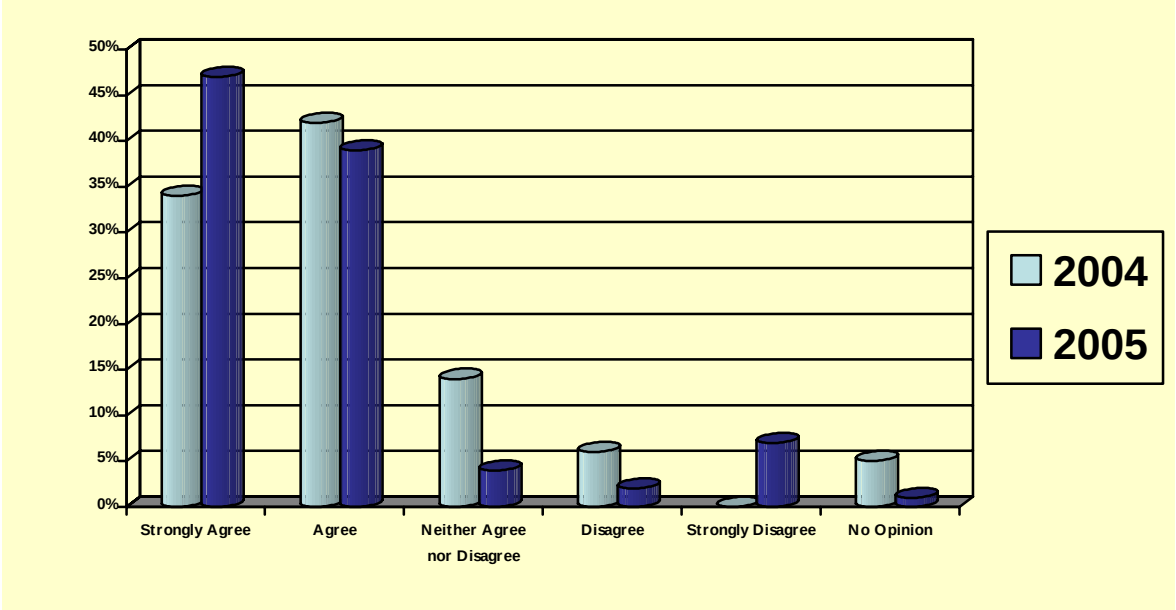
Perception

The typical GoodWatts participant found in the program both something to like, and something to improve. Despite any issues they had, GoodWatts participants were generally quite satisfied with the program, would remain on the program if it were offered, and would recommend it to others.

But customer dissatisfaction did emerge regarding many elements of the program, with many customers perceiving opportunities for improvement. In most cases, customers sought improved functionality and additional features.

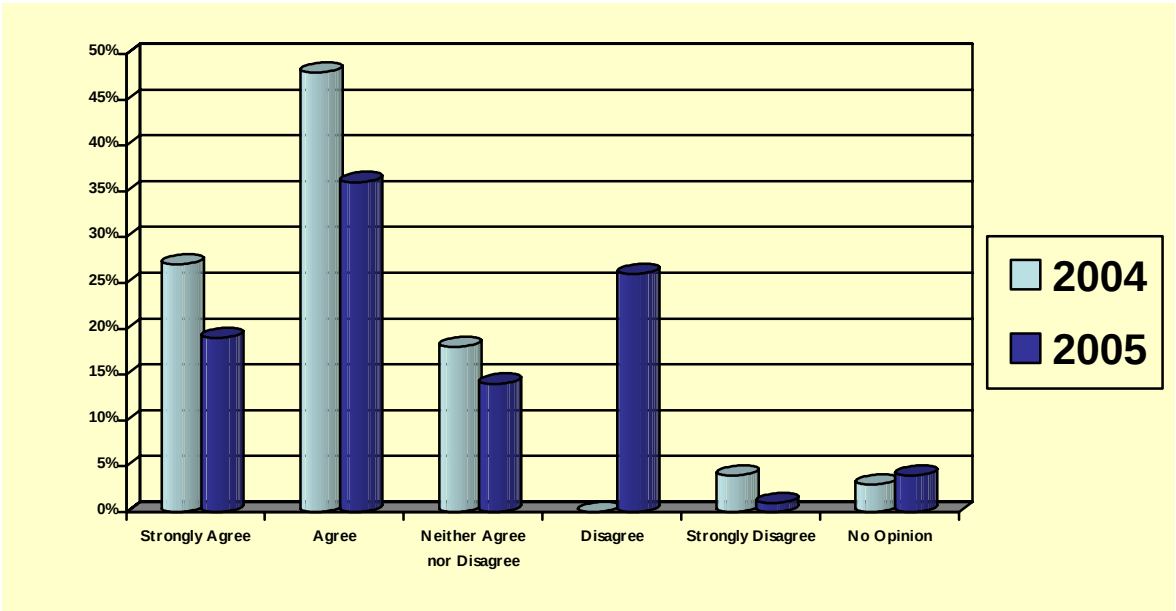
In 2005, most participants agree (39%) or strongly agree (47%) that they would recommend the program. These results were mildly improved over 2004, but a strongly dissatisfied segment had emerged (Chart 1):

Chart 1: "I would recommend this program to my friends and family."



We believe the dissatisfied segment correlates with those who disagreed (26%) that the system lowered their electric bills, even as a majority agreed (36%) or strongly agreed (19%) they saved (Chart 2):

Chart 2: "The GoodWatts energy management system lowered my electric bills."

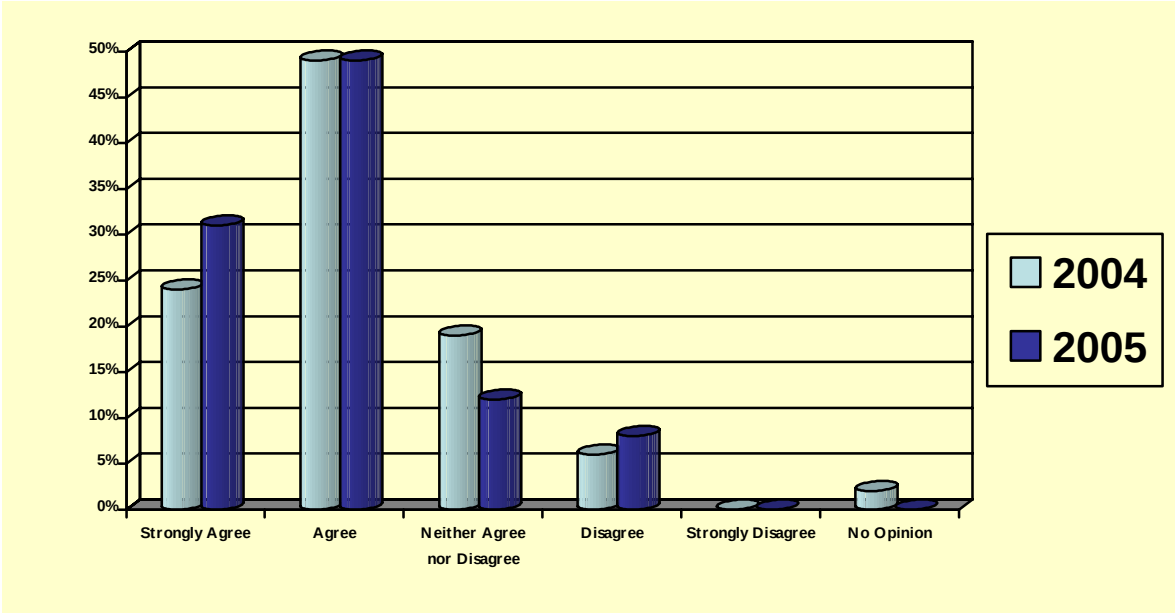


In 2005, the dissatisfied segment also matches strongly with those who believed that the GoodWatts participation payments were not fair (33%), even as a majority strongly agreed (11%) or agreed (48%) that the payments were fair.

We should note that the actual savings of participants may differ from their beliefs about savings for three reasons. First, some participants had not studied the bill comparisons they received from their utilities, or recalled them only in a general sense - and that general sense was often that the savings were not significant. Second, some participants were basing their satisfaction on what they expected to save, rather than what they actually saved. Third, not all participants believed that savings due to their own conservation behavior were attributable to the program.

We see that there must be more to GoodWatts than savings, because overall satisfaction with the program was quite strong. In 2005, 31% strongly agreed and 49% agreed that their participation in the program was satisfying. Only 8% expressed dissatisfaction (Chart 3):

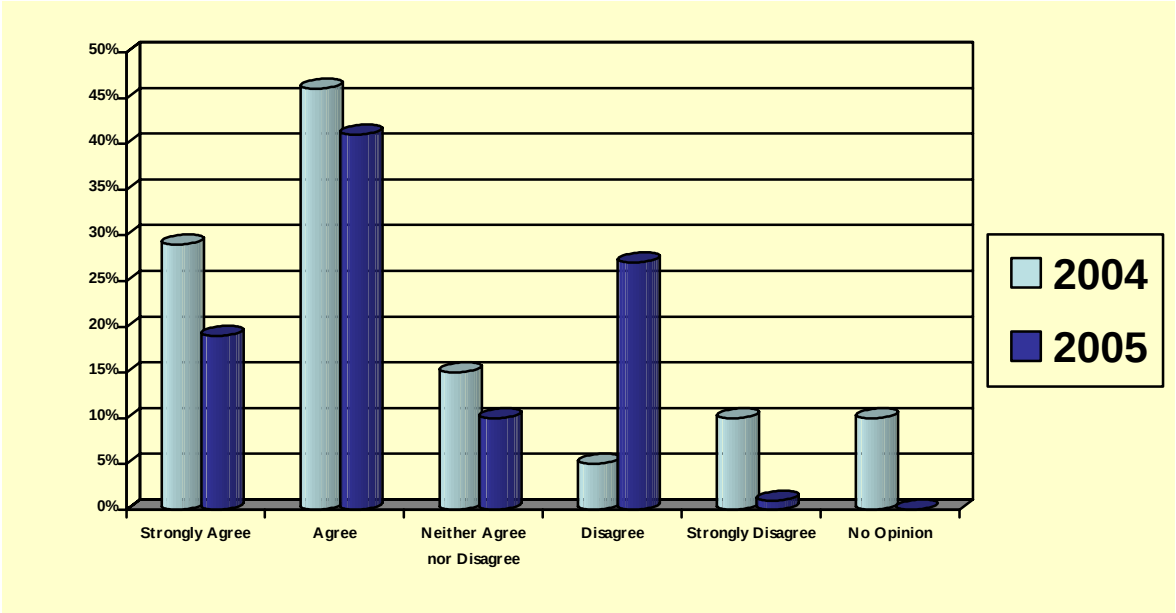
Chart 3: "I am satisfied with my participation in the GoodWatts energy management program."



These overall satisfaction numbers improved slightly over 2004, even as dissatisfaction was emerging regarding a variety of program elements.

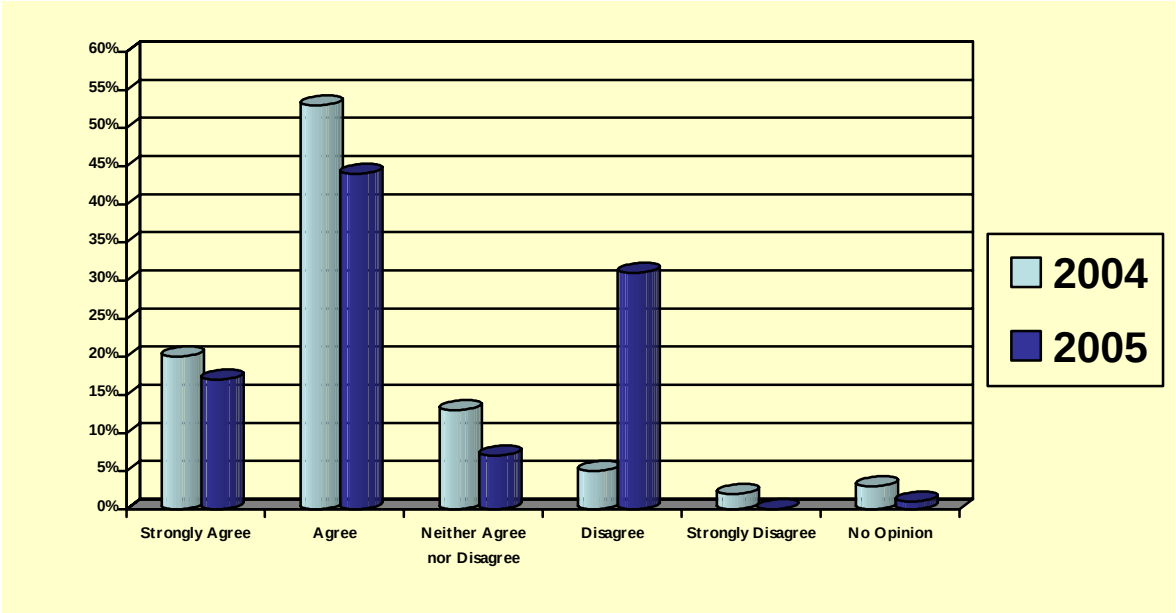
For example, in 2005, a majority strongly agreed (19%) or agreed (41%) that the GoodWatts system provided more control over energy use, while again a minority disagreed (27%). We see that the perception of control declined significantly for some participants between 2004 and 2005, and clarified for some others (Chart 4):

Chart 4: "The GoodWatts energy management system gave me more control over my energy use."



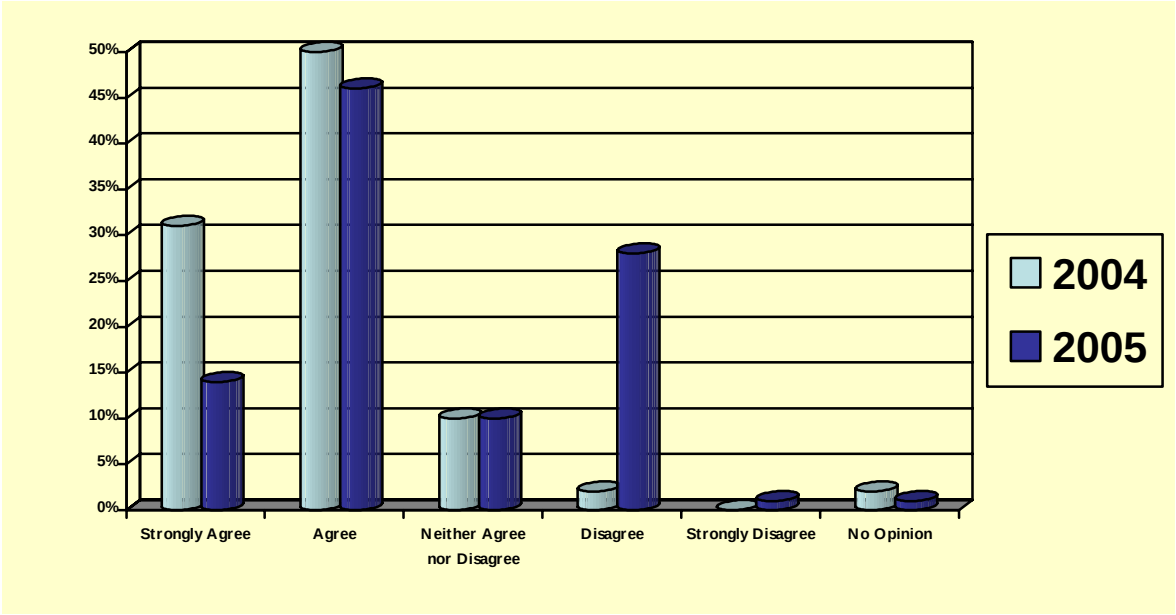
Similarly, in 2005 17% strongly agreed and 44% agreed that they understood how the program worked, but 31% disagreed (Chart 5):

Chart 5: "I understand how the GoodWatts energy management program works."



The emergence of dissatisfaction in 2005 was also reflected in the 28% of program participants who disagreed that the system was useful. However, 14% strongly agreed and 46% agreed that the GoodWatts management system was useful (Chart 6):

Chart 6: "The GoodWatts energy management system is useful."



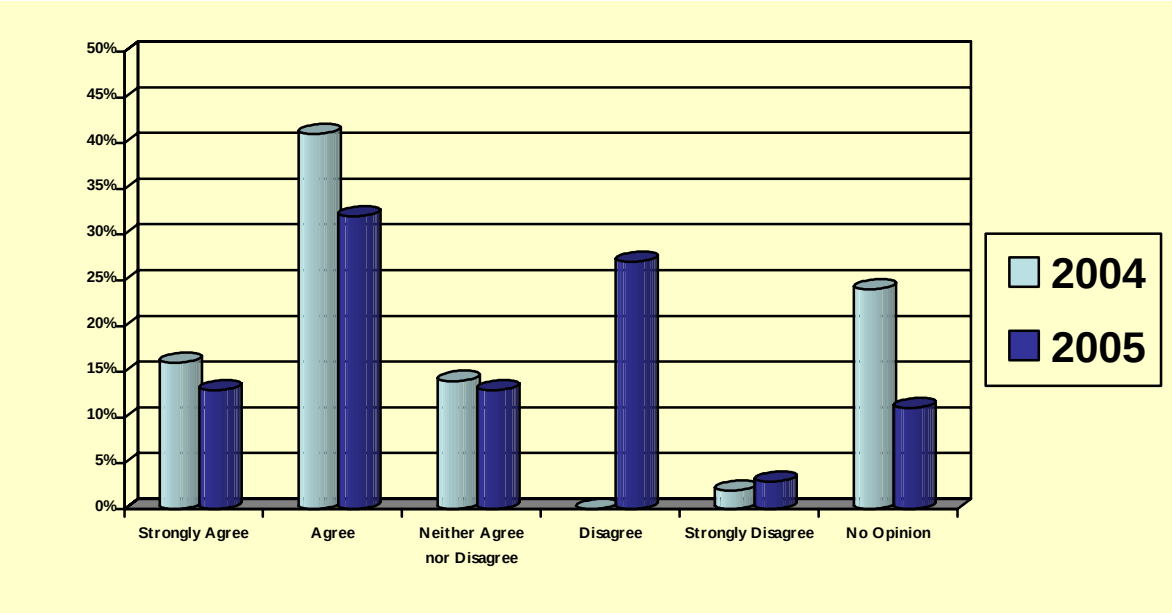
Furthermore, while nearly two-thirds of participants in 2005 found the GoodWatts system reliable (14% strongly agreeing and 51% agreeing), 23% disagreed and 2% strongly disagreed. Similarly, nearly two-thirds of participants found the GoodWatts system to have performed well in 2005, (20% strongly agreeing and 42% agreeing), but 31% disagreed and 2% strongly disagreed.

In 2005, over half of the participants strongly agreed (20%) or agreed (33%) that their new programmable thermostats were easy to program and use, but 32% disagreed. Fewer participants were satisfied with their pool controls: only 4% strongly agreed and 13% agreed that these controls were easy to program and use, while 13% disagreed and 30% strongly disagreed. Most customers strongly agreed (20%) or agreed (39%) that system installation was convenient.

The various issues participants had with GoodWatts components might have been expected to make participants more uncomfortable in the second year of the program. In 2005, nearly half of the participants strongly agreed (13%) or agreed (32%) that they noticed it getting warmer when the GoodWatts program reset their air conditioning.

However, these numbers were down from 2004, and in 2005 a significant segment emerged (30%) that disagreed or strongly disagreed that the air conditioning setbacks were noticeable (Chart 7):

Chart 7: "I notice it getting warmer when the GoodWatts program sets my air conditioning at a higher temperature."



Thus participants not only sharpened their views about the functionality of the ADRS, they also sharpened their views about the tolerability of Super-Peak Days. Thus there were many participants who had issues with the program, and who found both the savings and Super-Peak Days to be real but generally unremarkable.

There were correlations between participants who had negative views: (1) those who believed they had not saved; (2) those who were dissatisfied with the program because they didn't find it (3) understandable, or (4) useful, or (5) reliable; (6) those who noticed it getting warmer, and (7) those who had difficulty getting program components to work.

But these correlations were generally not strong across the various negative elements, and suggested that participants had a variety of reasons for concern. Furthermore, while many satisfied participants remained so from 2004 across 2005, and some dissatisfied participants remained dissatisfied, there were instances of changing views in both directions.

In contrast, participants who were more positive about the program were more likely to be satisfied across the board. The strong overall satisfaction ratings indicate that

many participants who had one issue or another still believed the program to be positive, on balance.

Behaviors

In 2005, fully 29% of participants reported that they let the installers program the system, and never changed it. Another 33% of participants reported reprogramming the installers' settings from the website, while 26% of participants reported reprogramming the installers' settings from the thermostat, and 12% of participants reported reprogramming the installers' settings through customer service representatives.

Thermostat adjustments were common in the summers, with participants reporting resetting their thermostats almost every day (11%), many times (22%), a few times (17%), or once or twice (28%). A few participants left their initial thermostat programming in place through the entire summer (13%) and some even left their initial thermostat programming in place through the entire year (9%).

The ADRS program created two new kinds of behavior: reprogramming thermostats through the website (undertaken at least once by 60% of participants), and reprogramming thermostats through customer service representatives over the telephone (undertaken at least once by 25% of participants)[17]. Many customers preferred these new methods to using the thermostat itself, and reported using them exclusively, or nearly so.

Some GoodWatts households reported that they didn't understand the program very well, so they just let it run automatically (9%), or didn't pay much attention to it (16%). These households were as likely to be satisfied as any others. Other households reported changing their energy use at the start of the program, and sticking with their new habits (33%). But nearly half reported returning to some of their old ways later (47%), as indicated elsewhere in this report.

In 17% of GoodWatts households, no one was home most weekday afternoons. Some of these households would nevertheless adjust their programming remotely. Nearly 10% of participants would leave the house rather than use air conditioning during peak periods. The remainder were home, and used as much air conditioning as they liked (13%), or found hot weekday afternoons not really uncomfortable (29%), a little uncomfortable (18%), or very uncomfortable (13%).

We had noted above that 45% of participating households noticed it getting warmer when the GoodWatts program reset their air conditioning, while 30% did not.

[17] Interviews and focus group testimony would indicate about half of the customers who reported reprogramming their thermostat through the website or using customer service to reprogram their thermostats made a habit of it (the others were merely experimenting)

Individual households have quite different standards of comfort. Equally important, households have quite different standards of economy. While everyone would prefer to be both comfortable and economical, some households sought more comfort, and some sought more economy.

GoodWatts promised high-technology tools to minimize discomfort in the pursuit of savings. A few customers had modest standards for both comfort and economy, and found GoodWatts easy to work with, while a few customers required a great deal of both values, and were much less pleased. Most customers used the program to investigate the balance between comfort and economy.

Only11% of ADRS participants admitted that they didn't try to change their energy use at all, relying solely on the program's automatic features to deliver savings. Active customers tried to reduce overall energy use (50%), and shift energy use away from the peak periods (29%). They reviewed their bills (53%), read the program manuals (49%), reviewed their energy data on the website at least once (42%), and read the program's newsletters (26%).

Not only did GoodWatts households differ in their desired balance of economy and savings, the behaviors and use strategies they employed to achieve these balances were diverse. Some customers believed they had figured out how to work with GoodWatts, some customers were still experimenting in 2005, and some customers still didn't particularly understand the program.

The results emphasize that no single model of customer behavior is likely to work well for residential demand response. Instead, demand response systems will need to be very flexible.

Problem Resolution

Many customers indicated problems with understanding GoodWatts program features, including thermostat programming (18%), thermostat reading (10%), pool control programming (7%), calculating financial savings (11%) calculating energy savings (9%), understanding the new rate (10%), understanding the electric bill (12%), and navigating the website (13%), Some customers reported multiple problems.

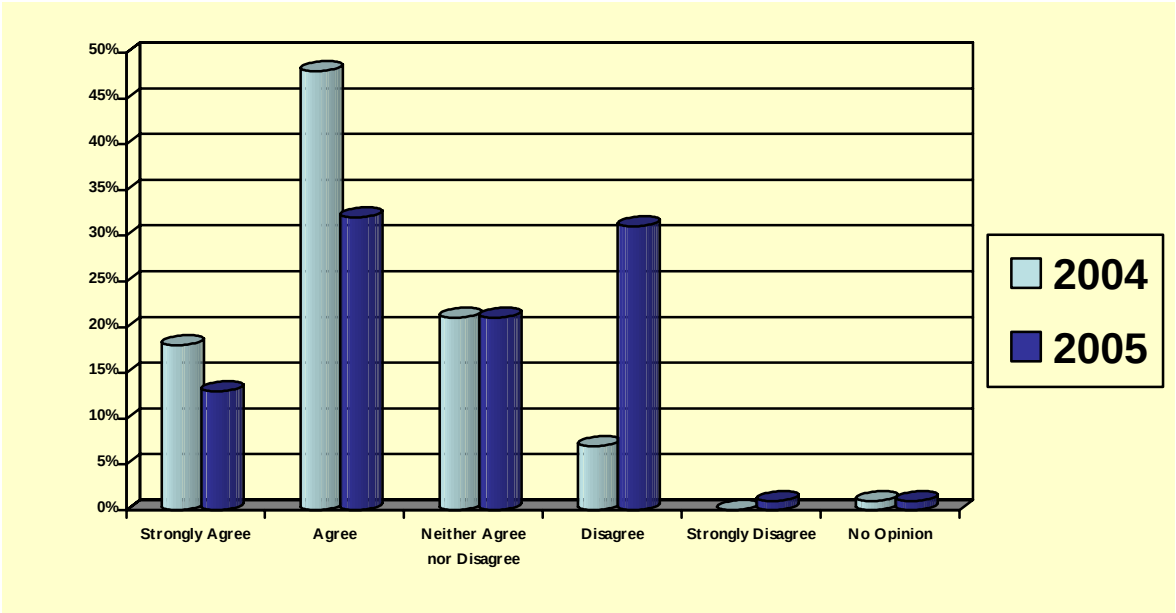
A surprising number of customers believed service representatives had been to their home five times or more to service the system (44%), and many customers believed this service was only fair (13%) or poor (31%). Many customers also claimed they had called GoodWatts customer service three or four times (17%), or even five times or more (27%). In fact, including the initial installation, GoodWatts customer service visited no household more than three times, and fewer than 10% of all households in the program were visited that often.

Customer perception of a high level of service interaction is often characteristic of pilot programs. So is a segment of customers who rate overall service quality as poor (in this case, 20%). However, more customers reported telephone service was good (9%) or excellent (36%). Furthermore, 69% were completely satisfied with problem resolution through customer service, and another 20% reported resolution "better than I asked for."

Expectations Addressed

In 2005, nearly half of these volunteers strongly agreed (13%) or agreed (32%) that the program met their financial expectations, but 21% were undecided, and 31% disagreed (Chart 8).

Chart 8: "The program has met my financial expectations."

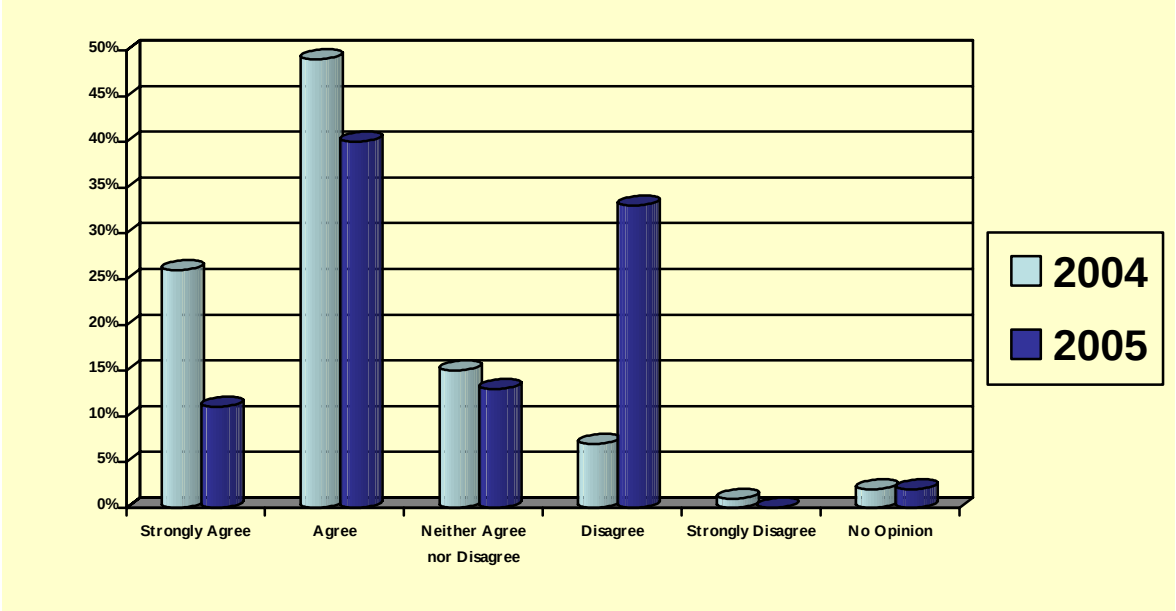


We noted earlier that some participants attributed their low levels of savings in 2004 to not trying hard. Some tried harder in 2005, and still were disappointed in their savings. Other participants cut themselves a break in 2005, or grew tired of their new behaviors (especially in households where members disagreed about how tolerable the program was).

Participants' expectations were shaped by the promotional material inviting them to join the program, and their own prior knowledge of energy use, but they had no experience with the financial implications of time-of-use rates. For some customers, the reality of how difficult it would be to achieve greater savings was bad news, but good to learn. More than a few participants were satisfied with the program because they were able to realign their expectations, even though their savings weren't what they anticipated.

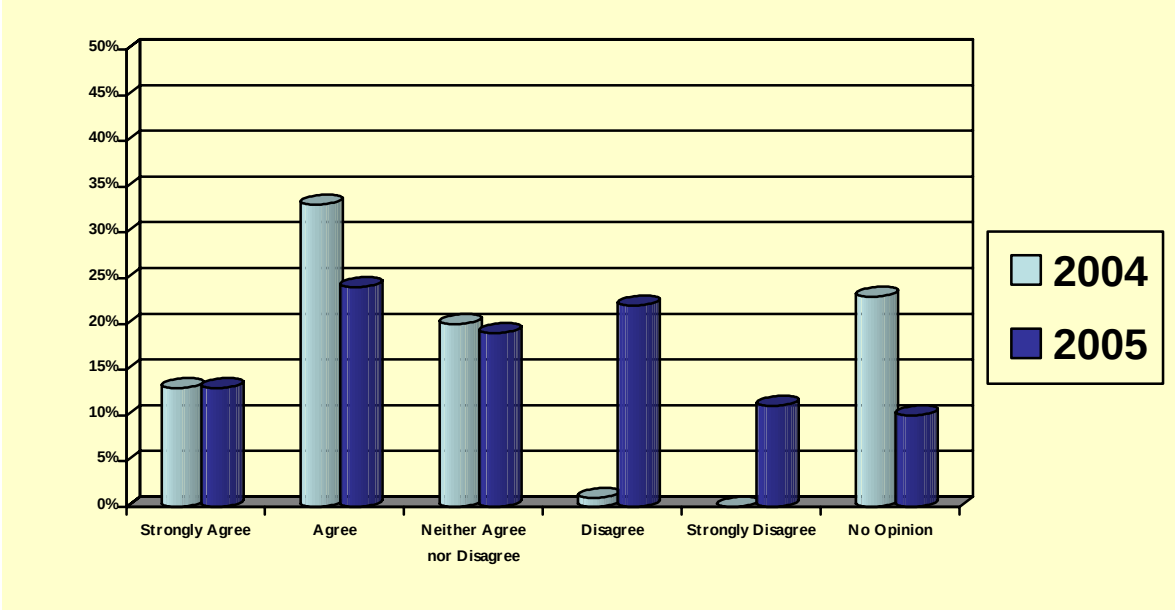
About half of the participants strongly agreed (11%) or agreed (40%) that the program met their expectations for saving energy. However, 33% disagreed, and many of these disappointed participants were dissatisfied with both the financial and the energy benefits from the program (Chart 9).

Chart 9: "The program has met my expectations for saving energy."



In 2004, participants were divided about whether or not the program helped their communities, with many unsure. By 2005, more participants had made up their minds, and were less positive (Chart 10):

Chart 10: "The program has helped my community."



Participants were still divided about whether or not the program helped their communities: 37% strongly agreed or agreed, 19% were undecided, and 33% disagreed or strongly disagreed.

In summary, our key conclusions about ADRS customer satisfaction are:

- ADRS participants will only be satisfied if the program saves them a significant amount of money, without making them too uncomfortable
- ADRS participants bring their own expectations, skills, experiences, behaviors, and performance standards to the program, so they engage with the system differently, with widely varying levels of engagement, and many different strategies for achieving their goals
- Problems in system design and customer approaches to the program create many feature and performance-related issues for ADRS participants: e.g., perceived shortfalls in financial or energy savings, control, usefulness, or community impact
- However, the typical ADRS participant was very satisfied with the program, and a very high proportion of participants would recommend the GoodWatts program to their friends, family, and neighbors

The ADRS participants ranged from those who would remain with the program even if it cost them money, to those who dropped out, but most of the ADRS volunteers shared the ambition of saving money without being too uncomfortable. The ADRS volunteers pursued this goal from many different directions, and with many different definitions of success. As we noted last year, spectators were passive, primarily relying on an automatic system; converts tried to save energy at every turn; and program teammates worked to learn the system.

GoodWatts was new to all of these customers, and customers were new to this version of GoodWatts. Consumer volunteers encountered a first-generation, nearly-commercial system complete with a new rate and Super-Peak Days. The interaction was experimental and not always pleasant. The determination of the volunteers and the capabilities of the system proved sufficient to overcome many operating issues.

The ADRS created awareness, changed behavior, usually managed discomfort, and delivered savings. While GoodWatts wasn't everything some customers hoped it would be, for the typical ADRS volunteer GoodWatts was more than enough to keep, and more than enough to recommend. The volunteers experienced the ADRS, and they wanted more of what an ADRS might provide. They wanted more financial and energy savings, more control, more usefulness, and more community impact.

Limitations of the Research & Recommendations for Further Study:

In identifying ADRS customer satisfaction through our surveys and focus groups, we encountered two significant limitations.

First, the respondent cohort differed between the two years, and we have neither measured those differences nor corrected for them. It may be that participants who felt strongly about the program in one year or another were those who replied in the surveys. It may be that one year we received a response from one member of the household, while another member responded the following year. It could be that respondents answers would differ from one day to the next, depending quite literally on the weather, and whatever else was going on in the household.

Second, the participants were compensated for both the program and the market research they participated in. While the surveys were completed individually, they were not anonymous, and they were neither validated nor binding in any sense. Thus the link between stated attitudes and actual decision-making is speculative. The participants were volunteering for a trial of a system they believed to be a good thing. We would expect their responses to be both more definite and more positive as a result of these factors.

The genuine product test of a truly-commercial ADRS with a suitable control group is clearly indicated by the results of the GoodWatts trial. We would expect results along the lines of those outlined above.

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Appendix A: Customer Satisfaction Survey Results

2005 Customer Satisfaction Survey of ADRS GoodWatts Customers: (figures in % of respondents)

A. Customer Service and Operations

1. After your GoodWatts energy management system was put in service, have you had occasion to have your installer or your utility come to your home to service the system?

30	never called them
6	once
3	twice
6	three or four times
44	five times or more

2. If you had your installer or your utility come to your home at least once to service the system, how was the overall quality of service?

23	excellent
7	good
0	neither satisfactory nor unsatisfactory
13	fair
31	poor
26	no opinion

3. During the GoodWatts program, have you experienced problems with the operations of these program features (*check all that apply*)?

43	thermostat
10	electric bill
9	air conditioner
7	pool control
7	cable bill
2	other
29	none

4. During the GoodWatts program, have you experienced problems understanding any of these program features (*check all that apply*)?

18	how to program the thermostat
13	how to navigate the website
10	how the new rate works
11	how to calculate my financial savings
10	how to read the thermostat
7	how to program the pool control
12	how the electric bill is calculated
9	how to calculate my energy savings
2	other
50	none

5. After your GoodWatts energy management system was put in service, have you had occasion to call your installer or your utility for customer service over the telephone?

27 five times or more
17 three or four times
6 twice
13 once
38 never called them

6. If you had occasion to call your installer or your utility for customer service over the telephone, how was the overall quality of service?

36 excellent
9 good
1 neither satisfactory nor unsatisfactory
14 fair
20 poor
20 no opinion

7. If your GoodWatts system required any kind of customer service, how satisfied were you with the resolution of your problems?

20 better than I asked for
69 completely satisfied
4 not completely satisfied, but acceptable
1 not completely satisfied, but some progress
6 not at all satisfied

B. Your Views of the GoodWatts Program

Please indicate the extent to which you are satisfied or dissatisfied with these aspects of the GoodWatts energy management program:

1. Installation of my GoodWatts energy management system was convenient.

20 strongly agree
39 agree
3 neither agree nor disagree
2 strongly disagree
27 disagree
1 no opinion

2. I would recommend this program to my friends and family.

47 strongly agree
39 agree
4 neither agree nor disagree
2 strongly disagree
7 disagree
1 no opinion

3. The GoodWatts energy management system lowered my electric bills.

19 strongly agree
36 agree
14 neither agree nor disagree
26 disagree

1	strongly disagree
4	no opinion

4. The payments for participation in the GoodWatts program are fair.

11	strongly agree
48	agree
3	neither agree nor disagree
33	disagree
3	strongly disagree
1	no opinion

5. The GoodWatts energy management system gave me more control over my energy use.

19	strongly agree
41	agree
10	neither agree nor disagree
27	disagree
1	strongly disagree
0	no opinion

6. I am satisfied with my participation in the GoodWatts energy management program.

31	strongly agree
49	agree
12	neither agree nor disagree
8	disagree
0	strongly disagree
0	no opinion

7. I understand how the GoodWatts energy management program works.

17	strongly agree
44	agree
7	neither agree nor disagree
31	disagree
0	strongly disagree
1	no opinion

8. The GoodWatts energy management system is useful.

14	strongly agree
46	agree
10	neither agree nor disagree
28	disagree
1	strongly disagree
1	no opinion

9. The program has helped my community.

13	strongly agree
24	agree
19	neither agree nor disagree
22	disagree
11	strongly disagree

10 no opinion

10. The information provided to me about my GoodWatts energy management program answered my questions.

14 strongly agree
39 agree
18 neither agree nor disagree
26 disagree
3 strongly disagree
2 no opinion

11. The GoodWatts energy management system is reliable.

14 strongly agree
51 agree
9 neither agree nor disagree
23 disagree
2 strongly disagree
0 no opinion

12. My GoodWatts energy management system has performed well.

20 strongly agree
42 agree
1 neither agree nor disagree
31 disagree
2 strongly disagree
3 no opinion

13. The program has met my expectations for saving energy.

11 strongly agree
40 agree
13 neither agree nor disagree
33 disagree
0 strongly disagree
2 no opinion

14. I notice it getting warmer when the GoodWatts program sets my air conditioning at a higher temperature.

13 strongly agree
32 agree
13 neither agree nor disagree
27 disagree
3 strongly disagree
11 no opinion

15. It was simple and convenient to join the GoodWatts program.

20 strongly agree
47 agree
1 neither agree nor disagree
28 disagree
3 strongly disagree

14 no opinion

16. Customer service for my GoodWatts energy management system has been satisfactory.

18 strongly agree
38 agree
3 neither agree nor disagree
36 disagree
1 strongly disagree
1 no opinion

17. The program has met my financial expectations.

13 strongly agree
32 agree
21 neither agree nor disagree
31 disagree
1 strongly disagree
1 no opinion

18. My thermostat has been easy to program and use.

20 strongly agree
33 agree
13 neither agree nor disagree
32 disagree
1 strongly disagree
0 no opinion

19. The program has met my expectations for providing environmental benefits.

12 strongly agree
33 agree
16 neither agree nor disagree
26 disagree
6 strongly disagree
6 no opinion

20. I have a swimming pool filter controlled by this program, and my swimming pool filter control has been easy to program and use.

4 strongly agree
13 agree
8 neither agree nor disagree
13 disagree
30 strongly disagree
31 no opinion

21. Which of the following statements best describes how your household managed your GoodWatts programming?

29 we let the installers program the system, and we never changed it
26 the installers set up an initial program, but we reprogrammed the thermostat
12 the installers set up an initial program, but customer service changed our programming for us when we asked
33 the installers set up an initial program, but we reprogrammed the system from the website

22. Which of the following statements best describes how your household participated in the GoodWatts program?

9 we didn't understand the program very well, so we just let it run automatically
7 we understood the program, but we didn't pay much attention to it
47 we tried to change our energy use at the start of the program, but we returned to our old ways of using energy later
33 we tried to change our energy use at the start of the program, and we were able to stick to our new ways of using energy
4 I don't remember

23. Which of the following statements best describes how your household uses air conditioning on a typical very hot weekday afternoon?

17 most of the time no one is home on weekday afternoons
10 if we can, we go out of the house rather than use air conditioning
13 use as little as possible, so we're very uncomfortable
18 use much less than we'd like, so we're a little uncomfortable
29 use less than we'd like, but we're not really uncomfortable
13 use as much as we like

24. Which of the following statements describes how your household used the GoodWatts program (*please check all that apply)*?

53 we reviewed our bills
49 we read the program manuals
42 we reviewed our energy data on the website
27 we talked to the program's service representatives
26 we read the programs newsletters

25. Which of the following statements describes how your household used energy during the GoodWatts program (*please check all that apply)*?

60 we reprogrammed our system online through the website at least once
50 we reduced our overall energy use
29 we shifted our energy use away from the peak weekday afternoon period
24 we didn't understand the program very well, so we just let the system run automatically
11 we didn't try to change our energy use

26. Which of the following statements best describes how your household managed your thermostat during the GoodWatts program?

9	we left our initial thermostat programming in place through the whole year
13	we left our initial thermostat programming in place through the summer, but we have changed it since
28	we adjusted our thermostat programming once or twice during the summer
17	we adjusted our thermostat programming a few times during the summer
22	we adjusted our thermostat programming many times during the summer
11	we adjusted our thermostat programming almost every day during the summer

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Appendix B: Performance Scores for Selected Customers

Performance Scores for Selected Customers: 06/2004 – 09/2005, and Overall (RMI Analysis)

	Utility	Usage Stratum	06/04 Non-SPP Days	07/04 SPP Days	07/04 Non-SPP Days	08/04 SPP Days	08/04 Non-SPP Days	09/04 SPP Days	09/04 Non-SPP Days	07/05 SPP Days	07/05 Non-SPP Days
High Performance	SCE	High	2	3	3	3	3	3	3	3	3
	SCE	High	1	3	3	3	3	3	3	3	3
	SCE	High	1	3	3	3	3	3	3	3	2
	SCE	High	1	3	3	3	3	3	3	3	3
	SDGE	Low	2	3	3	3	3	3	3	3	3
	SCE	Low	1	3	1	3	3	3	No Data	3	3
	SCE	High	1	3	3	3	1	3	3	3	3
	SCE	High	1	3	3	3	3	3	2	3	3
	SCE	High	1	3	No Data	3	3	3	2	3	3
	PG & E	High	1	3	3	3	3	3	1	3	2
	PG & E	High	2	3	3	3	3	3	3	3	3
	PG & E	High	1	2	No Data	3	3	3	3	3	3
	PG & E	High	1	3	3	2	2	3	3	3	1
	PG & E	High	1	3	3	3	3	3	3	3	3
	SCE	High	1	3	3	3	2	3	2	3	3
	SCE	High	1	3	1	3	2	3	3	2	2
Low Performance	PG & E	High	2	1	1	1	1	1	1	2	2
	PG & E	High	1	1	1	2	1	1	1	No Data	No Data
	SDGE	High	1	3	1	1	2	1	2	1	2
	PG & E	High	1	3	1	1	1	1	2	1	No Data
	SDGE	Low	1	2	1	2	1	1	1	1	1
	SCE	High	1	2	1	2	1	1	1	1	1
	SCE	High	1	2	1	1	1	1	1	1	1
	SDGE	Low	2	1	1	2	1	1	2	No Data	1
	SDGE	High	1	1	1	1	2	2	1	No Data	2
	SCE	High	1	2	1	1	1	1	1	No Data	No Data
	SCE	High	1	1	1	2	1	1	1	1	1
	SCE	Low	1	1	1	1	1	1	1	2	1
	SCE	High	1	1	1	1	1	1	1	1	1
	SDGE	Low	3	1	2	1	2	1	2	No Data	1
	SDGE	Low	1	1	1	1	1	1	1	1	1
	SCE	High	1	1	1	1	1	1	1	1	1
	SCE	High	1	1	1	1	1	1	1	1	1
Improved Performance	SCE	High	1	1	1	3	3	3	3	3	3
	SCE	High	1	2	2	1	1	3	1	3	1
	PG & E	High	2	1	1	3	3	3	3	3	3
	SCE	High	1	1	2	1	1	1	1	3	2
	SCE	High	1	1	1	1	1	1	1	3	2

Appendix B (continued):

Performance Scores for Selected Customers: 06/2004 – 09/2005, and Overall (RMI Analysis)

	Utility	Consumption Stratum	08/05 SPP Days	08/05 Non-SPP Days	09/05 SPP Days	09/05 Non-SPP Days	Average SPP 06/04-09/05	Average Non-SPP 06/04-09/05
High Performance	SCE	High	3	3	3	3	3.0	2.9
	SCE	High	3	3	3	3	3.0	2.7
	SCE	High	3	3	3	3	3.0	2.6
	SCE	High	3	3	3	2	3.0	2.6
	SDGE	Low	3	2	3	1	3.0	2.4
	SCE	Low	3	3	3	3	3.0	2.3
	SCE	High	No Data	3	3	2	3.0	2.3
	SCE	High	3	3	3	1	3.0	2.3
	SCE	High	3	3	3	1	3.0	2.2
	PG & E	High	3	2	3	1	3.0	1.9
	PG & E	High	2	3	3	3	2.8	2.9
	PG & E	High	3	3	3	3	2.8	2.7
	PG & E	High	3	3	3	3	2.8	2.3
	PG & E	High	3	2	2	1	2.8	2.3
	SCE	High	3	3	2	1	2.8	2.1
	SCE	High	3	3	3	2	2.8	2.0
Low Performance	PG & E	High	No Data	3	2	2	1.4	1.7
	PG & E	High	2	1	1	1	1.4	1.0
	SDGE	High	1	1	1	1	1.3	1.4
	PG & E	High	1	1	1	1	1.3	1.2
	SDGE	Low	1	1	1	2	1.3	1.1
	SCE	High	1	1	1	1	1.3	1.0
	SCE	High	1	1	2	1	1.3	1.0
	SDGE	Low	1	1	1	3	1.2	1.6
	SDGE	High	1	2	1	1	1.2	1.4
	SCE	High	1	1	1	1	1.2	1.0
	SCE	High	1	1	1	2	1.2	1.1
	SCE	Low	1	2	1	1	1.2	1.1
	SCE	High	2	1	1	1	1.2	1.0
	SDGE	Low	1	1	1	2	1.0	1.9
	SDGE	Low	1	1	1	2	1.0	1.1
	SCE	High	1	1	1	1	1.0	1.0
	SCE	High	1	1	1	1	1.0	1.0
Improved Performance	SCE	High	3	3	3	2	1.0	2.3
	SCE	High	3	1	3	1	2.0	1.1
	PG & E	High	3	3	3	3	2.7	2.6
	SCE	High	3	3	3	3	4.0	1.9
	SCE	High	3	3	3	2	5.0	1.6