Desperately Seeking Savings from Small Scale Demand Response: The California Experience

Robert M Wirtshafter, Wirtshafter Associates, Inc,, Rydal, PA
Kathryn Parlin, West Hill Energy and Computing, Chelsea, VT
David Hungerford, California Energy Commission, Sacramento, CA
Kevin McKinley, San Diego Gas & Electric, San Diego, CA
Rob Bordner, Energy Market Innovations, Inc., Seattle, WA

Abstract

The Statewide California "20/20 Program" Demand Response Program was one of the biggest energy efficiency/demand response programs ever offered, with $67 million in rebates given in 2005. The program offered customers an extra 20% reduction in their summer bills if they reduced their 2005 summer use by 20% as compared to their 2004 summer use. There was widespread promotion of the program by all three investor owned utilities. 885,000 households, representing 11% of the eligible households received rebates in 2005. Participants receiving rebates reduced their 2005 summer use by 1,184 GWh as compared to their 2004 summer use.

The unique challenge of this evaluation was measuring the awareness of the program and the potential incentive, the intent to participate, and the type of actions performed. With no enrollment process, all customers had the opportunity to participate, but only those who knew about the program and actively engaged in energy reduction activities could reasonably be considered to be participants. Consequently, the customer surveys conducted to assess the awareness and motivation of the utilities' customers formed the foundation of our evaluation. To estimate program savings, two types of adjustments were made to the 1,185 GWh savings estimate:

1. Decreased savings to account for the fact that some of the total reduction in energy use was incidental to the program and cannot be reasonably attributed to the program efforts.
2. Increased savings to capture legitimate reduction in energy use resulting from participants who tried to reach the 20% reduction but were ultimately unsuccessful.

The results indicate that almost 75% of the rebate dollars paid were to households that were not aware of 20/20 or were not actively trying to save energy in response to the program.

Introduction

The California Statewide 20/20 Programs include efforts conducted by SDG&E, PG&E, and SCE to develop and implement "price-responsive" programs that sought to reduce summer energy use among residential and smaller commercial/industrial (C&I) customers. The name "20/20" is derived from a common attribute: in each program, customers were urged to reduce energy by 20% and, in return, receive a 20% additional credit on their electric bill. Under this formula, energy use was compared against a similar time period, reflecting the baseline energy used to determine the percentage reduction in energy consumption achieved. No enrollment was required for the Statewide Program. A SDG&E pilot demand response program was also included in the portfolio of 20/20 programs, however, discussion of that pilot is not included in this paper.

Although the 20/20 program is categorized as one of the "demand response" (DR) programs designed to reduce overall demand (kW), the incentives were based upon decreased energy (kWh) use.

Given the lack of demand metering among this segment of the customer base, energy use was the only available proxy for demand. Consequently, the actual change in demand could not be directly measured, but was instead estimated on the basis of survey data and prototypical customer load shapes.

Evaluation Challenges

The major challenge in the evaluation of the Statewide 20/20 programs was developing a method to identify program participants. Estimating program impacts required us to separate program activity from the natural variations in energy consumption. With no enrollment process, all customers had the opportunity to participate, but only those who knew about the 20/20 program and actively engaged in energy reduction activities could reasonably be considered to be participants. Consequently, the customer surveys conducted to assess the awareness and motivation of the utilities' customers formed the foundation of our evaluation.

This evaluation was designed to estimate program impacts for both residential and small commercial customers. Surveys were conducted with residential customers, some of whom received the rebate and others who did not meet the 20% reduction threshold, to ascertain the influence of the 20/20 marketing efforts and overall program effectiveness. The data from these surveys were then combined with billing data to estimate the energy and demand reductions that can be attributed to the 20/20 Programs.

20/20 Incentive Calculation

Most of the residential and C&I customers were eligible to receive a 20/20 rebate in 2005. Only large C&I customers (above 200kW in SCE and PG&E, and above 20kW in SDG&E territories), and those customers without continuous billing records from May 2004 through September of 2005, were ineligible.

The three utilities calculated 2004 and 2005 use for each customer and calculated a percentage saving as follows:

$$\%saved = \frac{(2004SummerUse - 2005SummerUse)*100}{2004SummerUse}$$

Table 1 shows the number of accounts who qualified for the 20% rebate.

Table 1: Summary of Customer Rebates in 2005

	PGE		SCE		SDG&E	
Revenue Class	No. of Rebated Accounts	% of total accounts	No. of Rebated Accounts	% of total accounts	No. of Rebated Accounts	% of total accounts
Agricultural	24,373	31%	6,108	26%	14	24%
Small Commercial	52,932	14%	56,475	15%	12,564	13%
Med/ Large Commercial	4,255	6%	8,102	8%	20	10%
Total C&I	81,560	15%	70,685	14%	12,578	13%
Residential	332,576	11%	300,023	10%	89,383	10%
Total Program	**414,136**	**12%**	**370,708**	**11%**	**101,961**	**10%**

Table 2 shows the kWh savings associated with the customers who reached the 20% threshold.

Table 2: Total Change in kWh Use by Rebated Customers as Measured by Utility Bills (Summer 2004 kWh – Summer 2005 kWh)

	PG&E	SCE	SDG&E	Total
Total C&I	288,447	254,464	24,953	567,864
Residential	279,732	265,013	70,899	615,644
Total Program	568,179	519,477	95,852	1,183,508

The reductions shown in Table 2 are for all customers who received a rebate. However, this total reduction is not a true measure of the savings produced by the Statewide 20/20 Program. To estimate program savings, two types of adjustments must be made to the values in Table 2:

1. Decreasing savings to account for the fact that some of the total reduction in energy use was incidental to the program and cannot be reasonably attributed to the 20/20 program efforts.
2. Increasing savings to capture legitimate reduction in energy use resulting from participants who tried to reach the 20% reduction but were ultimately unsuccessful.

These adjustments are discussed in more detail in the following two sections.

Adjustments to Program Savings for Rebated Customers

These adjustments were developed to account for activity that does not reflect actual 20/20 program impacts. Adjustments needed to be made at two levels in order to estimate net program savings, as described below.

1. Inactive Customers and Free Riders Reduction in energy use related to homes or businesses that were not active or were free riders should be removed in their entirety. Some rebated customers may have been unaware of the existence of the program or have achieved the 20% reduction without taking any energy saving actions (inactive customers), and others may have pursued energy conservation strategies even if the rebates had not been offered (free riders). The savings associated with these inactive customers and free riders cannot be reasonably attributed to the program.
2. Incidental Activity Specific activities or events that resulted in lower energy use may have been incidental to the program, even within active homes and businesses. For example, customers may have pursued specific conservation strategies, and yet lower occupancy or production levels may also have contributed to their ability to achieve the 20% threshold. These incidental, non-program energy reductions within the home or business also cannot be reasonably attributed to the program.

Adjustments at the household or business level were based on the results of the customer survey and the energy reductions associated with incidental activities were estimated through combining the survey data with billing records. It was not possible to develop a firm estimate of the impacts of incidental activities in the C&I sector.

Adjustments at the Customer Level

We fielded a survey of 1,177 households and 810 businesses who received the rebate, the purpose of which was to assess customer awareness and actions. With this information, we were able to identify which customers were actively trying to reach the rebate savings levels and whether or not they were motivated by the offer of the rebate. The surveys asked questions about awareness, actions taken, customers' energy use, and housing characteristics.

From the survey, we categorized customers as active or inactive. To be *active*, a customer needed to meet the following conditions:

- have been aware of the program in time to take action,
- have taken deliberate action to try and receive the rebate, and
- been able to identify at least one energy saving action taken to reduce their 2005 summer energy use.

Active customers were considered to be program participants. Any reductions achieved by inactive customers were not included in the final 20/20 Program savings. However, some active customers may well have taken the same actions to lower their energy use in the absence of the 20/20 program and thus were considered free riders. Net program savings should not include the decrease in energy use from these homes. Active customers whose survey responses indicated that the rebate did not play a significant role in their energy related decisions are identified as *active free riders* and the savings from these homes were not included in the net program impacts.

In the residential survey, approximately one in three of the rebated customers in the sample met the criteria for active participation, and about one-third of these respondents stated that the 20/20 program was *not* an important factor in encouraging them to reduce energy use. Among the surveyed C&I customers, 20% were active and all reported that the rebates were a very important factor in making the decision to take energy savings actions, indicating that no reductions are necessary to account for free riders in the C&I sector.

Figure 1: Impacts of Active and Inactive Rebated Customers

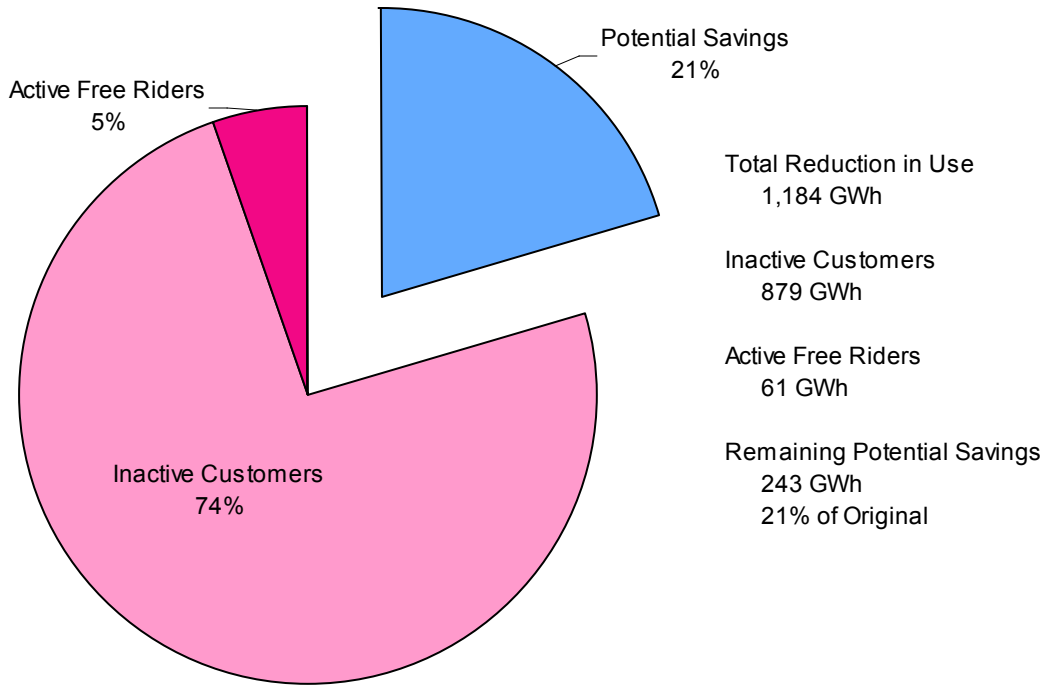


Figure 1 illustrates the adjustments made to the total reduction to account for inactive customers and active free riders. The net impact of these adjustments suggests that only 21%, or 243 GWh, of the total reduction associated with rebated customers could possibly be attributed to the program.

Energy Savings vs. Incidental Activity

The blue shaded area in Figure 1 indicates that 21% of the total reduction in rebated homes could potentially be attributed to the program. However, it is entirely possible that a portion of this reduction was due to incidental activity or events and should therefore not be attributed to the program. For example, a family member moving out will lower occupancy and decrease energy use, but such a move is most likely precipitated by events that are wholly unrelated to energy conservation. This issue was investigated through the customer surveys and, in the residential sector, by conducting a billing analysis for surveyed homes.

The surveys of the residential and C&I customers asked each respondent to recall "what actions did you take that would have lowered your electricity use in the summer of 2005?" The results of those responses are shown in Table 3. This table shows that the active households and businesses generally engaged in more energy saving activities than their inactive counterparts. (Numbers in bold are statistically significant at 95% and above.)

Table 3: Most Frequently Mentioned Energy Reducing Activities by Rebated Customers

	Residential		**C&I**	
	Active	**Inactive**	**Active**	**Inactive**
Purchased EE equipment or appliance	**53%**	**40%**	27%	18%
Turned off lights	**52%**	**35%**	48%	27%
Turned up Thermostat, turned off AC	**39%**	**29%**	44%	28%
Reduced no. of occupants	33%	28%		
Occupied house/operated business fewer hours	23%	29%	6%	1%
Turned off electronics or appliances	22%	16%	23%	6%
Reduced the use of energy consuming equipment			16%	14%
Used less hot water	**15%**	**6%**	10%	14%

By combining the residential survey results with billing records, we were then able to develop statistically valid models for the residential households that explain a portion of the variation in consumption. This approach was designed to estimate the savings associated with specific actions and explain the reductions among rebated homes in the 2005 program year. Separate models were constructed to estimate the changes in consumption related to base load activities and cooling-related actions, using a combination of disaggregation and regression techniques. Unfortunately, we were not able to explain, with acceptable statistical confidence, the variation in the C&I use patterns.

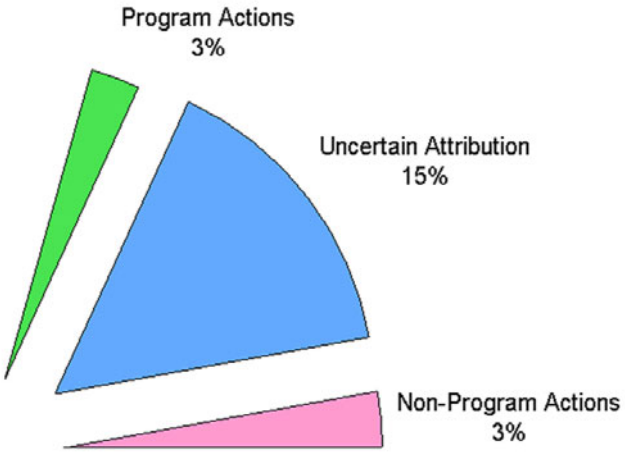
Of the 243 GWh of potential savings from Figure 1, only 30 GWh (3%) could be statistically attributed to energy savings associated with known cooling and baseload actions. About 32 GWh (3%) was associated with non-energy saving activities, particularly changes in occupancy levels and remodeling. The remaining 181 GWh represent the reductions in use that could not be definitively attributed to the program, i.e., it may represent program effects or just normal variations in summer use resulting from events incidental to the program. Figure 2 illustrates the impacts attributable to the program.

Figure 2: Attribution of Savings for Rebated Customers

Attributable to Program: 30 GWh

Uncertain Attribution: 181 GWh

Non-Program Activities: 32 GWh



Savings from Active, Non-Rebated Customers

Some customers may have tried unsuccessfully to reach the 20% reduction threshold, and their energy saving actions should be counted as program savings. Our survey of non-rebated customers covered 1,121 households and 958 businesses, and included the same battery of questions that was asked of the rebated customers.

For the residential survey, our sample was limited to those customers who reduced their 2005 use between 10 and 20%; in other words, they just missed receiving the rebate. Our purpose was to establish whether this group was conserving energy to try to meet the 20/20 threshold. Given the budget and time constraints, we concentrated only on this "Just Missed" sample.

Our survey results indicate that this group did save energy by taking specific energy saving actions. Since the survey was restricted to the Just Missed segment of the residential population, it does not provide direct evidence of the program impact on customers with reductions less than 10% or with increases in use. To estimate the potential impacts for this group, we extrapolated savings by establishing an active household trend line for the 20% to 10% households and projecting those figures to the remainder of the residential households.

Some differences between the rebated and Just Missed customers are summarized below.

- On average, the residential Just Missed sample was less active (27%) and consisted of more free riders (43%) than the rebated customers (at 31% and 32%, respectively).
- Active, rebated households were almost 350% more likely to have had a reduction in household size as the active, Just Missed group. The change in occupancy is a major determinant as to why households qualified for the rebate.
- The number of energy reduction activities was slightly lower among Just Missed respondents
- The active, Just Missed group was less likely to have purchased refrigerators and energy efficient lighting since the summer of 2004.

The same modeling approach for the Just Missed customers was also used for the analysis of rebated customers. The results indicated that the Just Missed residential group had 15.7 GWh of savings that were attributable to the program, and 23.7 GWh of savings that are of uncertain attribution. Based

on these results, we estimate that the remainder of the residential, non-rebated households may have generated an additional 31.6 GWh of attributable savings and 23.7 of uncertain attributable savings.

The business sample represents a random sample, stratified by utility, of all non-rebated customers. Thus, the sample included some customers who just missed receiving the rebate and others whose use in the summer of 2005 actually increased. Accordingly, unlike the residential sample, no extrapolation was necessary. Only 11% of the C&I sample of non-rebated firms were active in the program. All 36.9 GWh of the C&I non-rebated reduction is of uncertain attribution. The results of the model building for the non-rebated groups is shown in Table 4.

Table 4: Program Savings for Non-Rebated Customers

	Residential Just Missed Rebate	C&I Did Not Receive Rebate	Total
Potential Program Savings	53,040	36,901	89,941
Attributable to Program Just Missed	15,763		15,763
Uncertain Attribution	23,737	36,901	60,638
Attributable to Non-Program Activities	13,540		13,540
Extrapolation to All Residential Customer Who Did Not Receive Rebate	Residential Did Not Receive Rebate		
Attributable to Program	47,289		47,289
Uncertain Attribution	47,474	36,901	84,375

Demand Saving from Statewide 20/20 Program

Demand savings at coincident peak were estimated by adjusting the energy savings results on the basis of hourly load profiles and the peak month and hour provided by the utilities. The projected program savings for the residential sector is 21,200 kW, net of free riders.

Sixty-two percent of the active households and 19% of active businesses, who reported that they turned off their AC units during the summer of 2005, also reported that on the hottest summer days they reversed that practice and ran the AC units more than two hours. It is therefore possible that applying the average load profiles to the coincident peak day may overestimate the kW savings.

Net Program Savings and Cost-effectiveness

Table 5 combines all of the energy saving elements into an estimate of net program impacts. Savings are presented in two ways:

1. The first includes only those activities with statistically significant savings attributable to the program.
2. The second estimate includes all of the savings identified above, *plus* all reductions in use by active households with uncertain attribution.

This latter method produces the most generous estimate of savings. Actual program impacts are somewhere between these two extremes.

Table 5: Statewide 20/20 Program Savings in 2005

	Statewide Total (MWh)
Directly Attributable	
Rebated Customers	29,872
Active, Non-rebated Customers	47,289
Total Directly Attributable to Program (MWh)	77,161
Total Change in kWh Use by Rebated Customers as Measured by Utility Bills (Table 2)	1,183,508
Percentage of kWh saved that are directly attributable to program	6.5%
Add back: Uncertain attribution	
Rebated Customers	181,500
Active, Non-rebated Customers	84,375
Total Directly Attributable to Program and Uncertain Attribution (MWh)	265,875
Total Change in kWh Use by Rebated Customers as Measured by Utility Bills (Table 2)	1,183,508
Percentage of kWh saved that are could potentially attributable to program	22.4%

Table 6 provides the cost of efficiency and demand resources procured by this program. Even under the best of all possible indicators (when all potentially attributable savings is used), the program performs poorly in achieving the intended results. The estimated cost per kWh ranges from approximately $0.29 cents to $1.00, depending upon what is included in the savings estimates. The estimated cost per kW is over $3,600.

Table 6: Statewide 20/20 Program Costs Relative to Savings Achieved

	Total
Program Costs	
Rebates	$67,450,469
Admin	$9,753,452
Total	$77,203,921
Energy Savings (MWh)	
Directly Attributable to the Program	77,161
Including Uncertain Attribution to the program	265,875
Cost per kWh Saved	
Directly Attributable to the Program	$1.00
Including Uncertain Attribution to the program	$0.29
Demand Savings (kW)	21,200
Cost per kW Saved	$3,642

Statewide 20/20 Program Conclusions and Recommendations

The 20/20 concept represents a catchy message that the utilities can easily broadcast across the state. However, this evaluation demonstrates that the program distributes very large incentives, principally awarding customers who took no actions or took actions that they would have taken in the absence of the program, while at the same time ignoring actions taken by households who did not make the 20% saving threshold. The evaluation results indicate that the program is not cost-effective and should not be continued, as is demonstrated by the following findings.

- Customer surveys indicate that 30% or fewer of rebated customers were even aware of the program and had undertaken any effort to achieve the rebate.
- A substantial portion of the observed reduction among customers who actively tried to achieve the rebate was likely to be due to free ridership and incidental actions not related to the program, as indicated by the customer survey and residential modeling.
- The cost paid for each kWh by this program was at least $0.29, and maybe as high as $1.00, both are costs that far exceed the costs experienced by even the least effective energy efficiency program.
- The program was even less effective in achieving its intended goal of reducing peak demand; the cost per kW saved is estimated to be over $3,600. This figure may itself be an overstatement, as many survey respondents relaxed their conservation practices on the summer's hottest days.

Beyond the catchy message and the generous incentives, the program did little to assist customers in overcoming the market barriers that impede the adoption of energy saving actions and investments. The 20/20 Program did not provide direct education to consumers, support markets for energy-efficiency goods and services, or encourage the development of new products. Much of the savings generated by the 20/20 Program represents short-term energy conservation rather than long-term structural change.

In a state without a developed energy efficiency industry, there might be a short-lived role for a 20/20 type of effort in the event of an emergency. In such a situation, the population would be faced with many opportunities for improving efficiency but the infrastructure to deliver efficiency quickly and effectively would be lacking, and the program's simple message might produce enough benefits to be justified, particularly in the face of major power supply shortages. However, in California with its energy efficiency history and existing infrastructure, the Statewide 20/20 Program represents a wasteful alternative to additional funding of the existing energy efficiency programs.

References

Wirtshafter Associates, Inc. et.al.; "Evaluation of the California Statewide 20/20 Demand Reduction Programs," CALMAC # SDG0220, June 6, 2006.