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October 1, 2012

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Arizona Corporation Commission
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RE: Arizona Public Service Company's 2011 DSM Implementation Plan
Docket No. E-01345A-10-0219

In Decision No. 71950, dated November 1, 2010, the Commission ordered that:

Data from the Conservation Pilot program would be analyzed to determine the program's effectiveness, and program refinements would be identified. A report on the results would be provided to the Commission within 90 days after the conclusion of the pilot, with proposals regarding termination, redesign or expansion;

Staff has recommended that the pilot also be used to gather data on the Conservation Behavior pilot's impact on customer participation in other APS DSM programs, and that this data be evaluated and provided as part of the measurement and evaluation report APS would provide to the Commission following completion of the program.

Attached please find Arizona Public Service's Measurement Evaluation and Research report for the Conservation Behavior Pilot Program.

If you have any questions regarding this information, please contact me at (602)250-2661.

Sincerely,

Jeffrey W. Johnson
Jeffrey W. Johnson

JJ/cd

cc: Brian Bozzo
Barbara Keene



Arizona Public Service Company

Demand Side Management Residential Conservation Behavior Pilot Program

Measurement, Evaluation, and Research Report

October 2012

Table of Contents

1.	Executive Summary	1
2.	Arizona Public Service Residential Conservation Behavior Program Description and Background	1
3.	Program Goals, Objectives and Savings Targets	3
4.	Evaluation and Monitoring Activities	3
5.	Results	4
a.	Energy and Demand Savings	4
b.	Costs and Cost Effectiveness	6
c.	Impact of the Program on Other DSM Program Participation	7
d.	Customer Behavior Response	7
6.	Results Analysis	7
7.	Plan for the Future	11
8.	Conclusion	12
	Appendix – Independent Evaluations of Opower Programs	14

1. Executive Summary

Arizona Public Service Company (“APS” or “Company”) submits this measurement, evaluation and research (“MER”) report for its Demand Side Management Residential Conservation Behavior Pilot Program (“Conservation Behavior” or “Program”) as required by Arizona Corporation Commission (“ACC” or “Commission”) Decision No. 71950.

Navigant Consulting (“Navigant”) reviewed and evaluated the first year results of the Program. The evaluation approach focused on reviewing the estimated energy savings from the Program, investigating the Program’s cost effectiveness and evaluating the Program’s impact on customer participation in other Company DSM programs.

The pilot provided valuable information that will be used to inform APS energy efficiency program design and optimize the cost effectiveness of future programs. Savings results achieved during the initial one year pilot period were less than anticipated in the original program estimates. However, this appears to be largely a result of the timing of the Program launch and the ramp-up period required in a behavioral program to generate savings. The 2012 program is generating savings rates closer to steady state levels and is currently cost effective as discussed in section 5b. Additionally, a number of program improvements identified as a result of evaluating the Pilot will improve cost effectiveness of the program in the future.

Based on the findings of the pilot, APS recommends that the program should be continued as described in the Company’s 2012 and 2013 DSM Implementation Plans. This report provides a plan for the future that outlines modifications to the program that are designed to maximize savings and cost effectiveness.

2. Arizona Public Service Residential Conservation Behavior Program Description and Background

The Company contracted with Opower to design and implement the Program as described in ACC Decision No. 71950 and approved on November 1, 2010. The Program provides participating Residential customers with bi-monthly reports containing information designed to motivate them to improve their energy usage behaviors. This Program design and implementation model is consistent with cost effective program deployments in approximately 70 utilities across the country.

To drive conservation behavior, the Program direct mails comparative Home Energy Reports (“Reports”) to the participants that show how the energy usage in that customer’s home compares with similar homes. Coupled with the comparison data, customers receive recommendations for specific and targeted actions they can take to save energy.

Derived from best practices in behavioral science research, the Program uses the power of normative messaging to engage and motivate conservation actions of participating

individuals. Comparing an individual's energy use to what is "normal" in his/her neighborhood has proven to be an effective mechanism to motivate action. Normative messaging on energy use, combined with highly targeted recommendations on how to improve, is the basis of the concept for the Conservation Behavior program. The Program provides a benchmark for customers to achieve and instills a sense of competition to produce sustained conservation behaviors. During the pilot phase, the Program delivered energy efficiency savings from customers, as well as providing a vehicle to conduct research on the optimal program design and messaging for behavioral based conservation programs.

Eighty thousand APS residential customers were randomly selected within usage strata to be in the test group. Another 40,000 similar APS residential customers were randomly selected to be in the control group. The test group is the customer participant group receiving the Report and consists of 60,000 high annual usage customers, 10,000 average annual usage customers and 10,000 limited income customers.¹ These customer segments were chosen for the pilot to be able to quantify and evaluate the savings results among different customer groups. Testing the results from this pilot segmentation will influence future program design. The control group is the statistically similar usage group against which the test group is compared to determine Program weather normalized savings levels.

In addition to testing the savings results among customer groups, another test conducted and evaluated was the impact of minor changes in Report language. Fifty thousand customers received "neighbor" language and thirty thousand received "similar home" language. The data presented in each report was the same but the comparison group was referred to differently using these two language variations.

The Company estimated that the Program could launch and send the first reports within 8-12 weeks of ACC approval. However, during the deployment and planning phase, it became clear that APS would need additional time to implement a program of this complexity. Thus, the Program was launched in May of 2011.

The Program test group received seven mailed, paper reports between May 2011 and April 2012, (the pilot period). The first Reports were received by customers on about May 13, 2011. The impact of this first mailing would appear in June bills at the earliest and so, for purposes of bill analysis, the pilot period savings are considered to be from June 2011 to May 2012. Two additional mailings, subsequent to April 2012, were included in the analysis to capture the savings closer to a steady state level. The initial May 2011 report was followed by reports in June, July, September and November 2011 and January, March, May and July 2012.

¹ As defined by the Company's E-3 rate structure.

In addition to receiving paper Reports, the test group also has access to a Program portal designed to provide additional personal and similar home comparative data and a variety of energy saving tips in an extensive online library. This portal also provides a customer self service page where customers can opt out of the Program, change settings, or set personal savings goals. The portal launched to test group participants in late August 2011.

3. Program Goals, Objectives and Savings Targets

The goal of this Program is to use scientifically proven normative messaging techniques to motivate Program participants to save energy by changing their energy use behavior.

APS's 2011 DSM Implementation Plan estimated that the energy efficiency ("EE") savings from the Program could reduce peak demand by approximately 3.4 MW and save 25,000 megawatt-hours ("MWh") at the generator level (after adjusting for transmission and distribution line losses) or 23,365 MWh at the customer level (without accounting for transmission and distribution line losses). In ACC Decision No. 71950, Commission Staff projected a benefit-cost ratio of 1.27 for the pilot Program. These Program savings and cost effectiveness estimates were based upon the Program launching the first reports in January 2011.

Due to the nature of a conservation behavior program, it is expected that savings "ramp up" over time as participants become more familiar with the report and the savings recommendations provided. Therefore, sending a first mailing during the high usage summer months can result in lower initial savings in that month as compared to sending the first mailing several months prior to summer so that customers become accustomed to the report and result in action being taken by the summer period.

4. Evaluation and Monitoring Activities

Navigant reviewed and evaluated the results of the program. The evaluation approach focused on reviewing the implementation contractor's ("IC") savings estimates, investigating the Program's cost effectiveness and evaluating the Program's impact on customer participation in other Company DSM programs.

Savings Methodology Review and Description

The IC estimated savings using two regression models. Both models are based on the principle that Program savings are reflected in the difference between the energy use of Program test households and control households, where households have been randomly assigned across the two groups. The primary difference between the two savings regression models is that the first model provides a single estimate of the average annual or Program-to-date savings while the second model estimates savings on a month-to-month basis. Because it uses more information (in particular, it allows savings to vary month-to-month) the second model is more statistically significant, meaning that in

repeated sampling it generates lower standard errors on Program savings. The IC's reported savings are based on the second and more accurate regression model.

In addition to the regression model analysis, Navigant also looked at attrition calculations and analysis and determined that the IC accurately accounts for Program attrition when calculating average daily savings and total Program savings. Program attrition refers to the number of original pilot program participants who were removed from the Program during the pilot period. Two sources of attrition reduce the initial set of participants. The first are opt-outs—the set of households that stay at their current location but choose not to receive the home energy reports. The second are Program move-outs—the set of households whose accounts change or close during the Program. Specifically, program move-outs are defined as test group customers who disconnect service, transfer service, have return APS mail, install solar, ask not to be contacted for programs or research, divert energy or change their APS account number for any reason.

Opt-outs are included in the set of test group households throughout the analysis, and in the calculation of total savings, because the Program effect is properly defined as the opportunity to receive and act upon the home energy reports. In its impact evaluation, the IC keeps opt-out households in the regression model, but removes them on a month-to-month basis from the number of households involved in the calculation of total Program savings. This generates a conservative estimate of savings.

Households that are removed from the Program, called “move-outs,” are included in the calculation of total savings up to the month they are removed. Doing so generates a conservative estimate of total savings, because many of the move-out households stay in the service territory and continue to generate some level of savings based on what they learned from the home energy reports, even though they no longer receive the reports. Although program opt-outs were very low, the 10,000 move-out test group participants who were removed from the program were significantly higher than expected in the original program design. The highest percentage of test group move-outs (~92%) was from account disconnections and account transfers.

5. Results

a. Energy and Demand Savings

Calculation of Energy Savings

Comparing electric consumption data for the test group to the control group on a month-to-month basis, the average annual energy savings per participant is 236 kWh. Using the monthly estimates of savings weighted by the number of participants in the Program in each Program month (as reported by the IC), total Program savings for the pilot period (from June 2011 through May 2012) are 17,166 MWh² at the customer level.

² The energy savings derived by Navigant (17,166 MWh) are very close to those supplied by the IC (17,179 MWh). This difference is likely due to a slight variation in the calculation approach. Navigant multiplied

Savings Claimed by Other APS EE Programs

In its estimate of Program savings, the regression analysis takes into consideration the level of participation in other EE programs by test group households that *would have* occurred in the absence of home energy reports. In other words, the Program stimulates incremental participation in other EE programs that would not have occurred otherwise. While this is a significant benefit of the Program, in the absence of appropriate correction it is possible that the savings associated with this incremental participation ends up being counted in both the Behavioral Program as well as the rebate program in which an APS customer participated.

Navigant determined the IC properly estimated the uplift in participation in each EE program due to the Program and multiplied the uplift by the program's deemed savings to estimate double-counted savings. Summing across all programs generated 388 MWh in energy savings at the meter – approximately 2.3% of program energy savings – these savings were already claimed by other programs and therefore they are removed from the total savings attributed to the Conservation Behavior Program. However, it is important to note that the Program plays an important role not only in the direct savings that it creates, but in the greater awareness of energy efficiency that it instills, which helps drive participation in other APS programs. This is an important benefit of the Program which is not reflected in the Societal Cost Test, but which helps reduce marketing and education costs for other Company EE programs.

Savings Rates by Customer Category

One of the tests in the first year of the program was to evaluate the savings rate and savings for each customer segment (high annual usage customers, average annual usage customers and limited income customers). Results from the IC for the first year of the program indicate that the high annual usage customers save at the highest savings rate (1.3%) and have the highest annual consumption and therefore save more kWh than the average annual usage customer (1.0%) or the limited income customer (1.2%). This analysis provides additional insight into improving program cost effectiveness going forward.

Savings Rates by Report Language

Thirty thousand test group recipients received Reports that used “similar home” language instead of “neighbor” messaging. The comparisons and the reports were the same but the

the model coefficient estimates for savings per day during the Program month by the number of days in the month to obtain average household savings for the month. Multiplying this value by the number of participants in the month generates the month's total Program savings, and adding up these values generates total Program savings to date. The IC calculated its savings per month as the product of percent savings for the month multiplied by the average household usage in the month. This calculation generates the same average household savings for the month as obtained by Navigant's calculation, but because it involves a quotient (percent savings) it likely generates very small rounding errors not present in the Navigant calculation. In any event, the difference is negligible and not a cause for further investigation.

slight messaging changes were analyzed to determine which messaging resulted in higher savings rates. The IC analysis of this test indicated that “neighbor” language recipients saved a cumulative 1.4% as compared to the “similar home” recipient savings rate of 0.9%. This can be attributed to the increased power of normative messaging to a more specific labeling system.

Coincident Demand Savings

Coincident demand savings are estimated at approximately .023 kW per household, or a Program total of 1.65 MW³ at the generator, as reported by APS in their Planning Year (“PY”) 2011 Semi-Annual Report. Navigant conducted an independent analysis of hourly billing data from August 2011 to refine demand savings estimates. The reported estimate is within the confidence interval of that analysis and it is therefore appropriate to continue to use the estimate for demand savings.

b. Costs and Cost Effectiveness

Benefit Cost Analysis

After adjusting for savings already claimed by other programs and accounting for line loss factors and capacity reserve margins, the Program resulted in 1,648 kW and 17,952 MWh of demand and energy savings at the generator.⁴ Based on current avoided costs and the Company’s estimation of Staff’s benefit/cost test methodology, the program achieved societal benefits of \$809,708 with societal costs of \$1,039,870 as displayed in Table 1. This results in a Societal Cost Test (SCT) ratio of 0.78 using the Company’s estimation of ACC Staff methodology for the first 12 months of the program which included both the program startup and ramp period.

Table 1 - Program Costs

	Planning and Administration	Implementation	Total
2010	\$ -	\$ 475,000	\$ 475,000
2011	\$ 99,461	\$ 331,453	\$ 430,914
2012	\$ 28,900	\$ 105,056	\$ 133,956
Total	\$ 128,361	\$ 911,509	\$ 1,039,870

In order to access the steady state Program results, a societal cost test was also analyzed for January through August 2012 for those test group customers that have been receiving Reports since May 2011. When evaluating all costs and savings for this group during this period, the program is cost effective with an SCT ratio of 1.17. This secondary analysis

³ “Arizona Public Service Company Demand Side Management Semi-Annual Report - July through December 2011,” submitted March 1, 2012.

⁴ Based on line loss factors of 7.0% and 11.7% for energy and demand, respectively, and a capacity reserve margin of 15%.

is a solid prediction of savings rates and cost effective test results for the future, even before considering the possible program modifications proposed later in the report to enhance cost effectiveness.

c. Impact of the Program on Other DSM Program Participation

In ACC Decision No. 71950, the Commission noted the potential for the Program to lift other DSM program participation rates. In the first year of the Program, three programs were identified with the greatest lift in participation including the AC Rebate (55%), Home Performance with Energy Star (29%), and Pool Pumps (20%) programs. These numbers show that the Conservation Behavior program functions as an effective marketing channel, driving program participation in other APS EE programs with no additional marketing expenditure. Since these savings have already been counted in other programs, they were “backed out” of the savings attributed to the Program. However, it should be noted that the Program provides a significant addition to an overall energy efficiency portfolio by helping to raise consumer awareness and educate customers on opportunities for saving energy.

d. Customer Behavior Response

The Company completed a customer survey to over 280 test group customers in the fall of 2011. Results from the phone survey indicate that the Program provided test group customers with new ideas on ways to save energy. In response to open ended survey question, customers reported the following energy saving behaviors with the highest frequency:

Table 2 - Behavior Results

Behavior	Percent (%) Answered
Use energy during off-peak hours	30%
Turn down AC/adjust thermostat	17%
EE appliances	13%
Changing household habits	13%

These open ended responses indicate that test group participants received new, behavioral based energy saving ideas from the reports.

6. Results Analysis

Savings

Savings results achieved during the initial one year pilot period were less than anticipated in the original program estimates. However, this appears to be largely a result of the timing of the Program launch and the ramp-up period required in a behavioral program to generate savings. When eliminating the ramp-up period in 2011 and analyzing the 2012

program months, the Program is generating savings rates closer to steady state levels and is currently cost effective.

The graphs below reveal additional savings information. The first graph shows the monthly savings results (from June 2011 to August 2012). While savings rates are below what was anticipated, the graph shows the year over year results comparison and shows that the Program produced twice as much savings in June-July 2012 as in June-July 2011. Note that the latest month for which there is data (August 2012) produced the highest savings of any month for the Program to date. This can be expected due to the ramp up period required for behavioral programs. Now that participants have become more familiar with the report and its recommendations, their savings have “ramped up” to a level that is more consistent with original planning estimates. This year over year increase is further proof of the Program’s effectiveness and real potential to generate increased savings in the future.

Figure 1 – Monthly Savings (MWh)

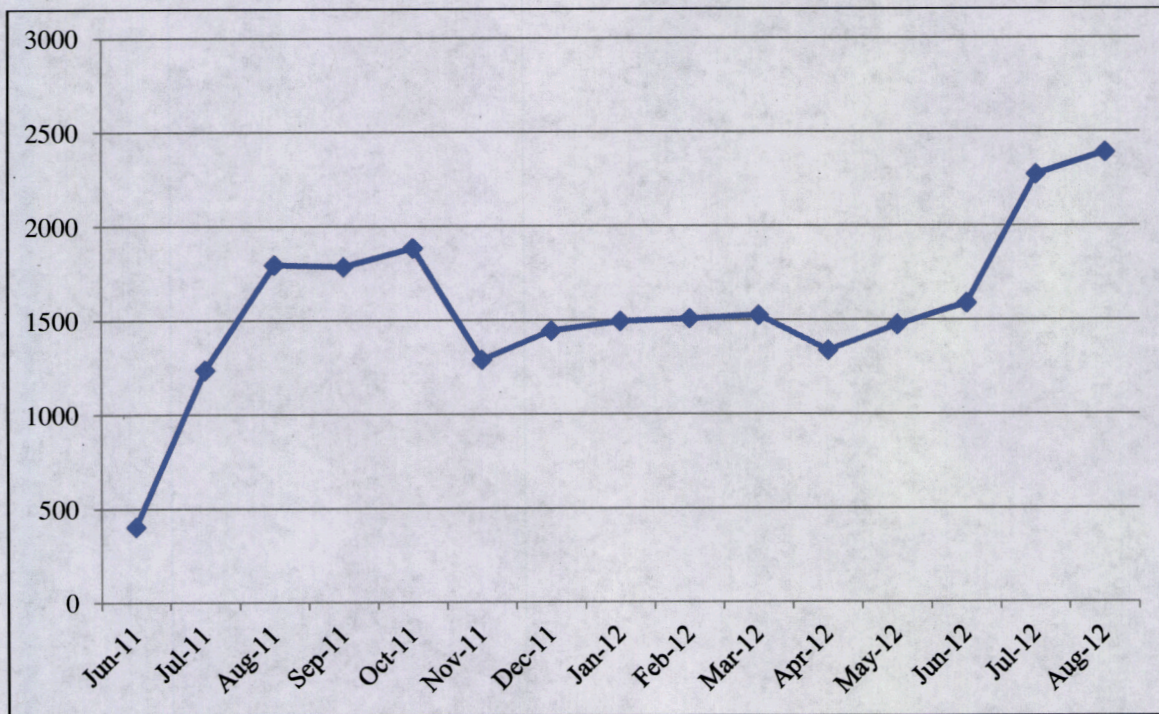
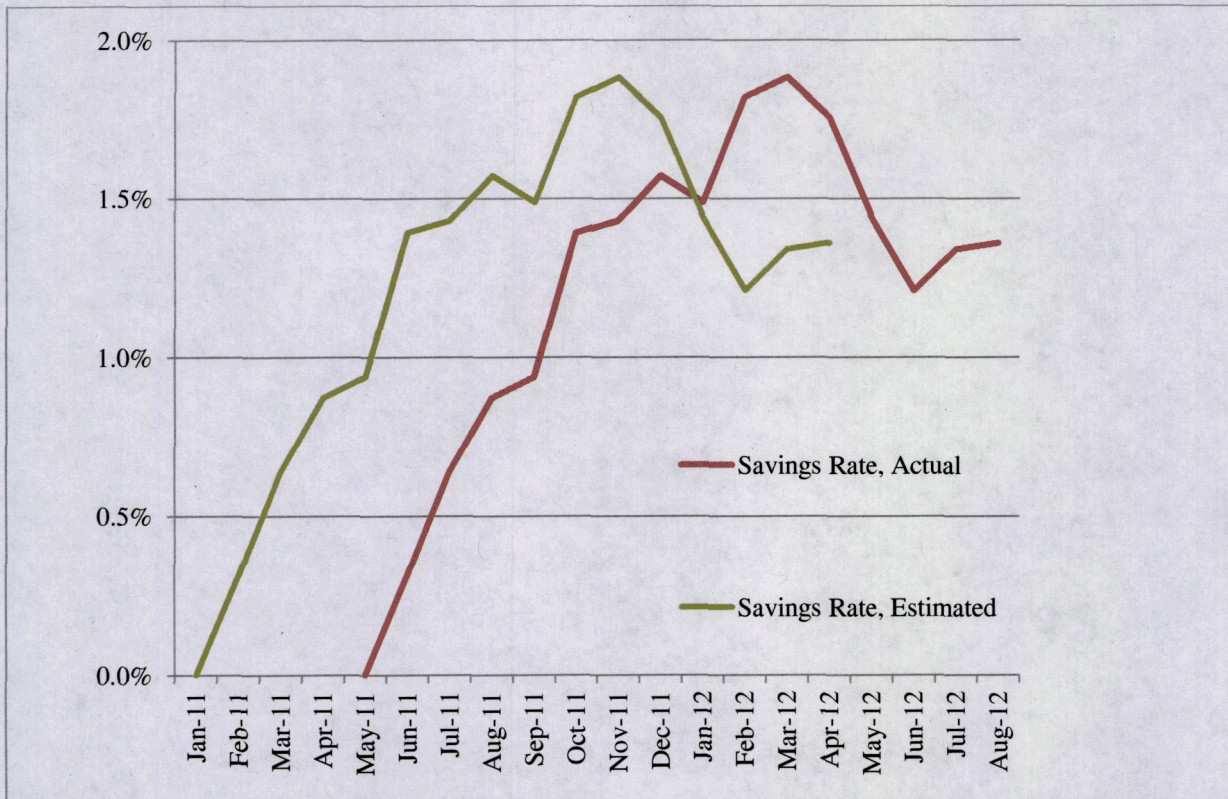


Figure 2 illustrates the impact of the Program launch delay. When designing the Program implementation plan, APS and Opower worked together to determine the monthly usage curve of the participant households. Seasonality of usage is a key aspect of behavioral program design and can impact the optimal timing of reports. For this Program deployment, usage peaks in the summer due to Arizona’s low desert climate, so the

optimal program launch would be in winter or early spring to allow for ramp up time before the summer.

Figure 2 – Savings Per Household



Due to the May Program launch date, the first reports were received by Participants during the summer high usage season, much later than optimal for achieving first year savings. If the program had launched earlier in the year and Participants had received a few reports before the summer season, it is anticipated that savings would have been greater during the summer as demonstrated by the results from August 2011. The graph shows what savings would likely have been if the Program had launched in January and the program ramp up period occurred during cooler months. Based on this analysis, the Program would have saved 19,745 MWh verses the achieved 17,166 MWh at the customer level, a 15% increase in savings.

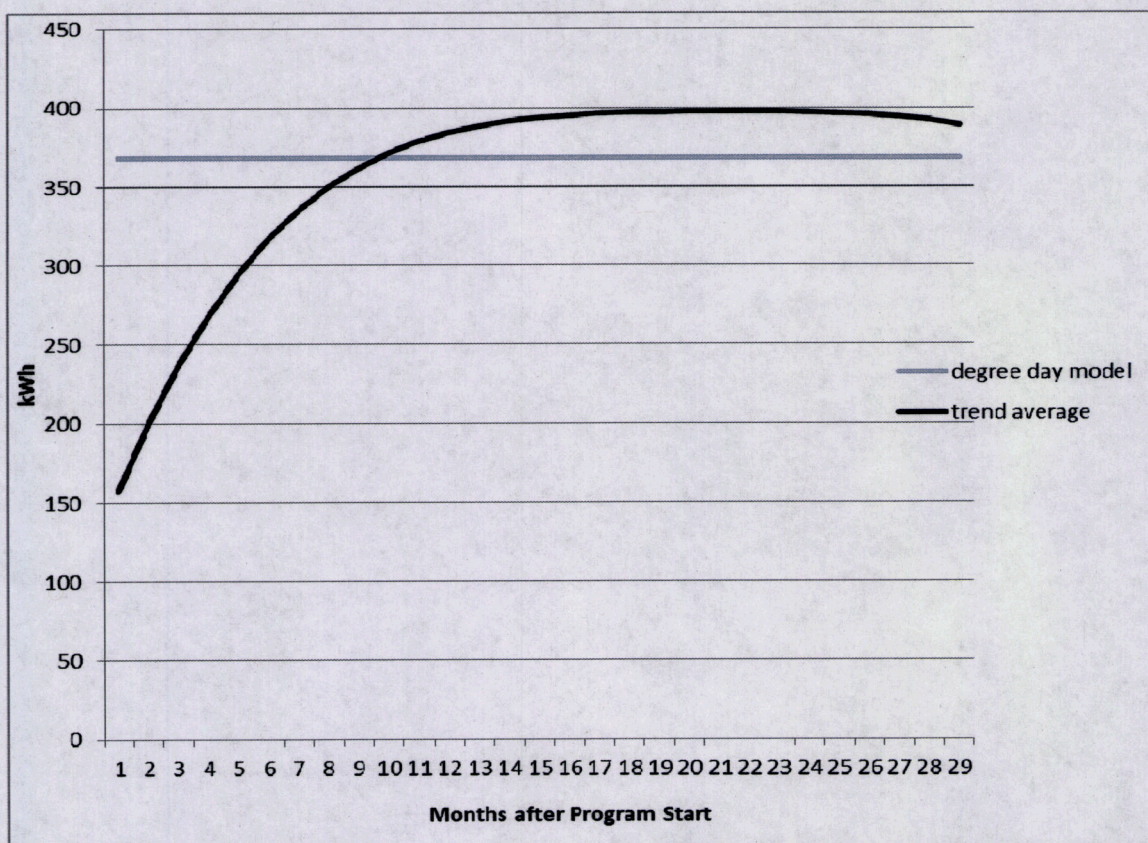
Cost Effectiveness

As evidenced from the cost effectiveness of the original recipient group results for 2012 to date, the program is a cost effective way to deliver energy savings. The cost-effectiveness of the Program in future years is likely to increase. As with most EE programs, constraining benefit cost tests to its initial year does not reflect the Program's full potential since it most likely understates savings.

Savings are likely to increase in future Program years because of:

- “Ramp up” is typical with behavioral programs: Customers will typically “ramp up” their savings over time. A past analysis of home energy report programs conducted by Navigant for the Sacramento Municipal Utility District (SMUD)⁵ found that the ramp-up period takes about 8-13 months. The “ramp-up” phase is shown in Figure 3 below. For this reason, it is difficult to accurately assess the effectiveness of behavioral conservation programs over less than a 2-3 year timeframe.

Figure 3 - Annualized savings trend average for High Consumption Households (SMUD)



- Peak demand analysis: APS conducted a preliminary analysis of peak demand. The results of that analysis were inconclusive and further study would need to be conducted. The current estimate of peak demand impacts of the program is extremely conservative; therefore we believe further demand savings analysis is warranted.

⁵ Evaluation Report: OPOWER SMUD Pilot Year2. Prepared by B. Provencher, Navigant. 2011. http://opower.com/uploads/library/file/lifetim6/opower_smud_yr2_eval_report_-_final-1.pdf

- Program launch timing: The Program was launched just prior to the cooling season of 2011. As a result, customers were becoming familiar with the Reports during the months where the Program could have its greatest impact, thus limiting the Programs' savings potential. As shown in Figure 2, it is estimated that first year program savings would have been 15% higher if the program had started earlier in the year.
- Program targeting: During the initial pilot phase of the Program, APS felt that it was important to test Program results among a wide cross section of APS residential customers, including high usage customers, average usage customers, and low income customers. In 2012, APS worked with Opower to "refill" the group of participants in the pilot to fill the gap left by program attrition. This refill group is comprised of all high usage customers, who generally provide the most savings per household and yield the highest Program cost effectiveness. Going forward, APS can effectively target the "refill" customers – new customers receiving reports to fill the gap left by attrition - to achieve the highest savings and cost effectiveness.
- Savings beyond what is being measured: This program provides important information that helps instill energy efficiency awareness among participants. It is a key educational tool that can be used to drive participation in other programs. These savings and other program benefits are not currently counted as part of the Program benefits calculation. For instance, it is likely that as participants move out of the program, energy savings through instilled conservation behaviors will persist. Currently, the program removes these customers from program savings calculations as soon as they leave the program. Therefore, additional evaluation should be considered to determine if move out customers continue to generate savings.

Lastly, approximately 70 utilities across the nation have implemented a similar program cost effectively. In addition to the information presented in this report, a full descriptive bibliography of other third party evaluations of this Program can be found in the Appendix.

7. Plan for the Future

Based on the results presented in this report of the overall Program and tests conducted, APS plans to continue the Program as filed and approved in the 2012 APS DSM Implementation Plan and as filed in the 2013 DSM Implementation Plan. Both of these plans were filed to continue with the original test and control groups with no additional expansion until further analysis of the Program could be completed. During this period, APS plans to make some program design modifications to optimize cost effectiveness based on some of the lessons from the pilot. The pilot was effective in providing valuable design information and performance results. Through 2013, APS will continue to monitor the effectiveness of this Program and make necessary modifications to improve the overall cost effectiveness. If during the continued Program implementation it appears that the Program will not be cost effective long term, APS will propose to significantly modify the Program design or terminate the Program.

With the one year MER results in this report, there are a number of things that APS has

learned and will modify going forward. These include:

- While opt-out numbers and percentages remain very low, attrition or move-outs in the Program remain high. All future Program planning should include conservative attrition percentages in line with the realized levels. APS included 10.5% attrition in the 2012 and 2013 Implementation Plan calculations for cost effectiveness.
- If the Program cost effectiveness is improved and expansion is feasible or if there is a need to refill the test group due to high attrition levels in the future, the expansion or refill group should only include the highest average annual usage customers. Also, when introducing new test group participants, it is ideal to launch reports to allow a ramp period prior to the summer peak period to maximize savings in this group.
- In addition to determining the target customer segment to maximize cost effectiveness of the program in the future, the neighbor and similar home language test also provided valuable insights. APS proposes to change all similar home language Reports to neighbor language to further increase the Program's savings potential by as much as 0.5% with no additional cost and minimal impact to Report recipients.
- APS and Opower will need to continue to work together to refine the tip targeting strategy and regularly review and refresh the tip library.
- As the Program evolves, we will continue to work closely with our vendor to achieve both increases in energy efficiency savings and reduced program costs. These improvements will be realized principally through ongoing optimization of program design. Some of the available strategies that APS may opt to employ in this regard include supplementing delivery of paper reports with electronic communications channels (such as email); and adjusting report frequency to further enhance the program's energy efficiency savings-cost ratio.

APS anticipates that the cost-effectiveness of this Program will continue to increase in the future based the proposed Program modifications.

8. Conclusion

A detailed MER evaluation of the APS Residential Conservation Behavior Program was completed for the first year of implementation. In the pilot year of the Program, APS looked at the Program launch and design and the associated impact of each on results. After careful analysis, the results indicate that larger than anticipated customer attrition and the timing of the launch had a significant impact on the savings and first year cost effectiveness due to the initial ramp up in savings from the Reports arriving during the highest test group consumption periods. The program is currently cost effective and APS will modify the Program based upon the lessons learned from the Program pilot year to improve this ratio. The pilot was effective in providing these valuable insights.

APS is confident that this Program will have increased cost effectiveness in the near term and will remain an effective option for delivering MWh savings at very low cost per MWh spending levels using evidence from current cost effectiveness. APS will continue

to monitor the Program closely and explore Program improvements to increase the cost effectiveness and cost benefit ratio of the Program. Upon continual monitoring of cost effectiveness, if the Program does not appear to be cost effective, APS will recommend major Program redesign or termination.

Appendix

Independent Evaluations of Opower Programs

A. Allcott, Hunt, October 2011.⁶ “Social Norms and Energy Conservation.” *Journal of Public Economics*, Vol 95 (9-10), pp. 1082 - 1095.

- *Utility (State)*: Report verifies savings achieved by 600,000 households across 17 Opower deployments in various geographic areas
- *Results*: Opower’s program is the most effective non-price efficiency intervention available at scale to date. Average savings range from 1.4 – 3.3% with an unweighted mean of 2.0%, equivalent to a short-term price increase of 11 – 20% (or long-term increase of 5%), at a cost-effectiveness of \$0.013 - \$0.054 per kWh with an unweighted mean of \$0.033 per kWh.

B. Dougherty, Anne, June 2011. “Massachusetts Cross-Cutting Behavioral Program Evaluation.” *Navigant Consulting and Opinion Dynamics*.

- *Utility (State)*: National Grid (Massachusetts)
- *Results*: 1.61% average savings, of which the majority came from actions that were taken outside other National Grid programs.

C. Davis, Matt, May 2011. “Behavior and Energy Savings: Evidence from a Series of Experimental Interventions.” *Environmental Defense Fund*.

- *Utility (State)*: Report verifies results from 11 different gas and electric utilities covering urban and suburban communities in 6 states in the Northeast, Midwest, and West. Specific utility names are not released for confidentiality purposes.
- *Results*: Reports have driven electricity savings ranging from 1.1-2.9% across the 11 deployments, and, if fully deployed in the US, OPOWER programs would lead to \$3 billion in annual savings.

D. Cooney, Kevin, February 2011. “Evaluation Report: OPOWER SMUD Pilot Year 2.” *Navigant Consulting*.

- *Utility (State)*: Sacramento Municipal Utility Department (CA)
- *Results*: (i) 2.89% savings in the second year, 22% increase over first year; (ii) Highest savings—3.56% savings in July/August of 2009—occurred during peak season; and (iii) only signs of impact stability over the first 30 months of the program.

⁶ Note: In reverse chronological order.

E. Todd, Annika, Steven Schiller, and Charles Goldman, October 2011.⁷ “Analysis of PSE’s Pilot Energy Conservation Project: “Home Energy Reports.” *Lawrence Berkeley National Laboratory*.

- *Utility (State):* Puget Sound Energy (WA)
- *Results:* “The evaluation study design for the HER pilot program utilized a randomized controlled experiment with an opt-out design, which is the best feasible method of inferring that a program caused energy savings.” Averaged 2.03% savings in the last 12 months for electricity, 1.40% for gas.

F. October 2010. “Puget Sound Energy’s Home Energy Reports Program.” *KEMA*.

- *Utility (State):* Puget Sound Energy (Washington)
- *Results:* The savings rate of the most recent 12 months was significantly greater than for the first 12 months – improving from 1.87% to 2.28% average electric savings

G. Ivanov, Chris, July 2010. “Measurement and Verification Report of OPOWER Energy Efficiency Pilot Program.” *Power System Engineering*.

- *Utility (State):* Connexus (MN)
- *Results:* With 99% confidence, the program demonstrated an average of 2.07% savings across three distinct approaches to measuring and verifying the results

H. Macke, Rich, June 2010. “Measurement and Verification Report of Lake Country’s OPOWER Energy Efficiency Pilot Program.” *Power System Engineering*.

- *Utility (State):* Lake Country Power (MN)
- *Results:* Average of 2.77% first-year savings with 99% statistical confidence

I. Allcott, Hunt and Sendhil Mullainathan, March 2010. “Behavior and Energy Policy.” *Science*, Vol. 327

- *Utility (State):* This article is a literature review
- *Results:* Using randomized, controlled trials with hundreds of thousands of utility customers across the United States, these [OPOWER] reports have been shown to reduce electricity consumption in the average household by over 2%

⁷ Though produced in October 2011, this is an analysis of a KEMA independent evaluation that was released October 2010. For this reason, we have included it at this position in the annotated bibliography, which is otherwise organized in reverse chronology.

J. Allcott, Hunt, February 2010. "Social Norms and Energy Conservation." *Working Paper, Massachusetts Institute of Technology's Center for Energy and Environmental Policy Research.*

- *Utility (State):* Connexus (MN)
- *Results:* Using data from a randomized natural field experiment at 80,000 treatment and control households in Minnesota, it is estimated that the monthly program reduces energy consumption by 2.3 – 2.4% relative to baseline

K. Ayres, Ian, et al., September 2009. "Evidence From Two Large Field Experiments That Peer Comparison Feedback Can Reduce Residential Energy Usage." *NBER Working Paper.*

- *Utility (State):* Sacramento Municipal Utility Department (CA) & Puget Sound Energy (WA)
- *Results:* There is evidence of a reduction in the early years of the program of 1.2% (natural gas) and 2.1% (electric) participants

L. Klos, Mary, September 2009. "Impact Evaluation of OPOWER SMUD Pilot Study." *Summit Blue Consulting, LLC.*

- *Utility (State):* Sacramento Municipal Utility Department (CA)
- *Results:* Summit Blue (d/b/a Navigant) verified an average of 2.2% savings in the first year, as well as a bump to 2.8% average savings in the first four months of year two.