

Pilot II has a similar story. The participant’s rate of disconnection increases from 1.48% to 4.33% (by 292%), while the comparison group increases from 4% to over 7%, an increase of 78%. The rate of increase is higher for the Pilot II participants, but the real disconnection rate is still around half of what the comparison group has been experiencing in the same timeframe.

Pilot III participants are the only Pilot participants that have experienced a decrease in their disconnection rate, which fell from 3.05% to 2.44%, a decrease of 20%, while the comparison group’s rate has increased by 10%.

Combining the Pilot participants, it is clear that the participants have a lesser chance of being disconnected than the comparison group. Overall, the Pilot participants have a 2.85% disconnection rate, while the comparison group’s disconnection rate has moved to almost 6%.

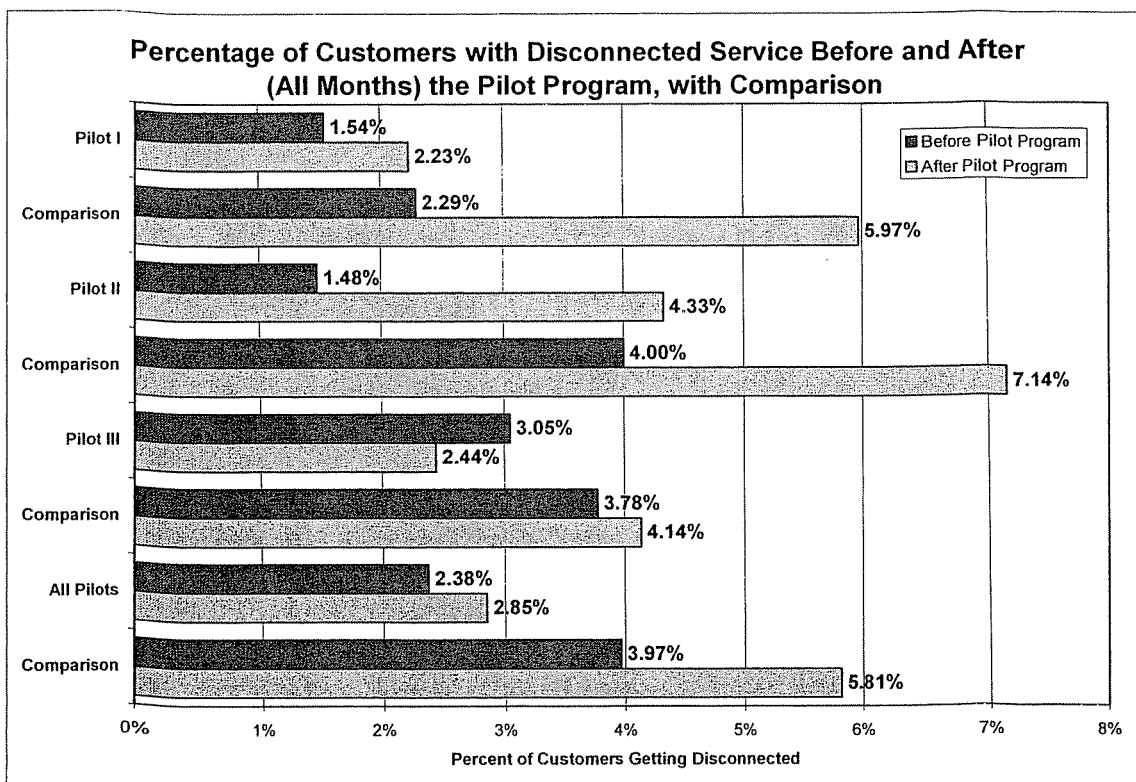


Figure 29 Percent of Customers with Disconnections

Days to Pay Bill

Another potential indicator of program effects is the change in the number of days it takes for participants to pay their bill relative to the comparison group.

During the pre-program period, Pilot I participants on average made a payment to Duke Energy (then Cinergy) 18 days after the billed date, and since participating their consumption has not changed (18.35 to 18.31). The Pilot I comparison group has shortened the number of days to payment from 17.64 to 13.19 during this same time period.

Every group in this analysis has shortened the number of days to pay their bill, but in every Pilot study, the comparison group did so by a larger degree.

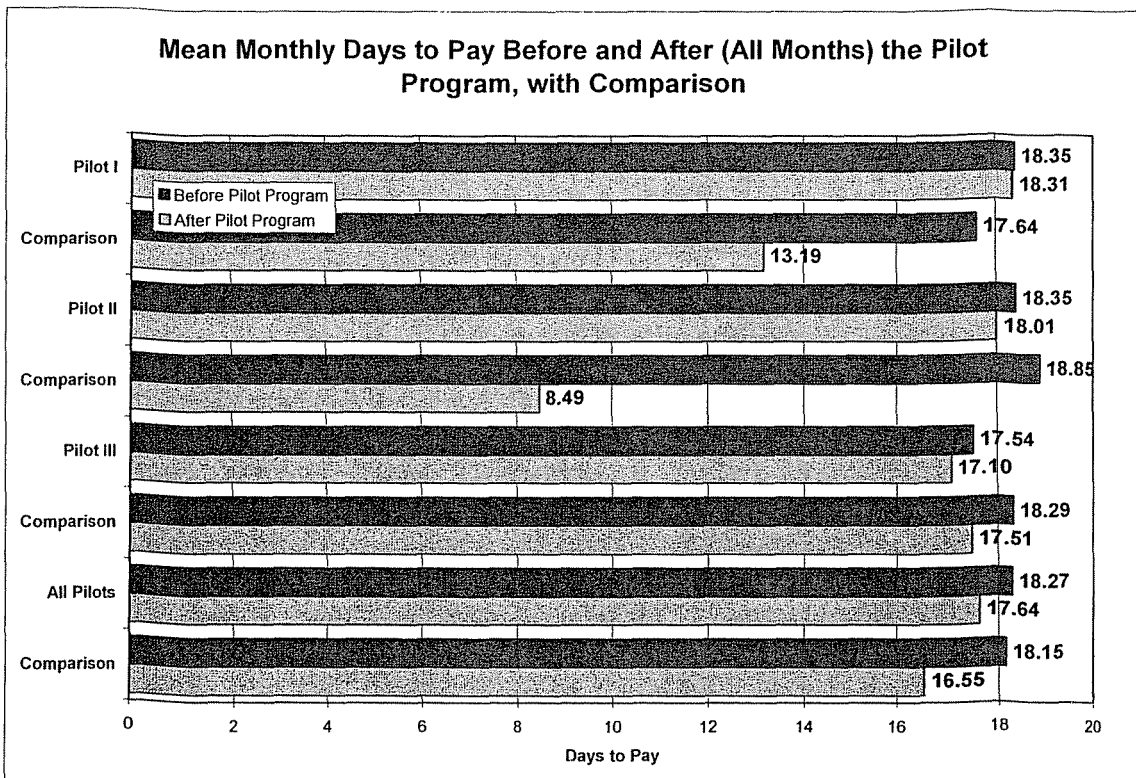


Figure 30 Mean Days from Billing to Payment for Pilot II Participants

Percent of Customers Making a Payment

Another potential indicator of program effectiveness is the percent change in the customers who are sending in a payment each month. The figures below show the percentage of customers in each of the Pilot groups that are paying any amount on their bill.

Pilot I participants, in the few months of data available from before the program, were making a payment of at least some amount an average of 60% of the time, while the comparison paid at least some of their bill 68% of the time. After the Payment Plus Program, the participants made a payment about 55% of the time, a drop of 8% compared to a 37% drop in the amount customers making at least some payment in the comparison group. This data indicates that the Pilot I participants are making a payment more frequently than the comparison group during the post-program period.

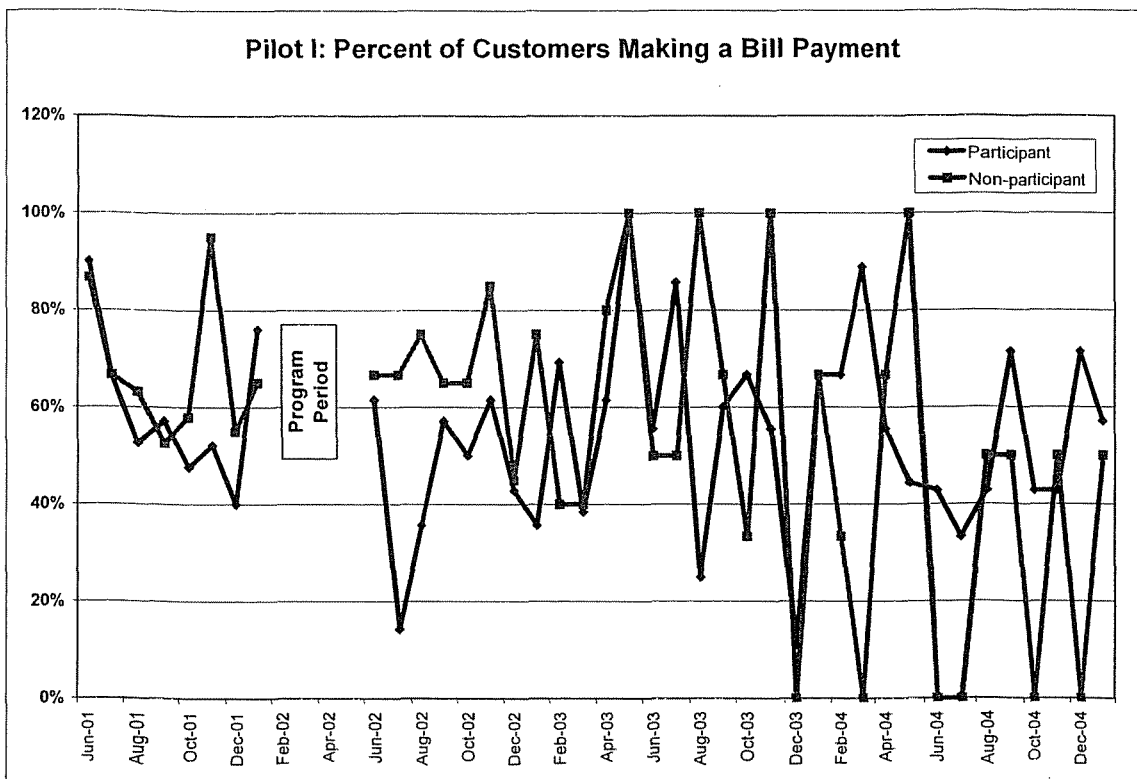


Figure 31 Mean Percent of Pilot I Customers Making a Payment Each Month

Pilot II participants made a payment 68% on their bills before the program, but only 43% of the bills in the twenty-two months after the program. The comparison group made a payment on 55% of their bills in the pre-program period, and 68% of their bills in the post-program period, making an improvement that in turn reflects poorly on the payment behaviors of the Pilot II participants.

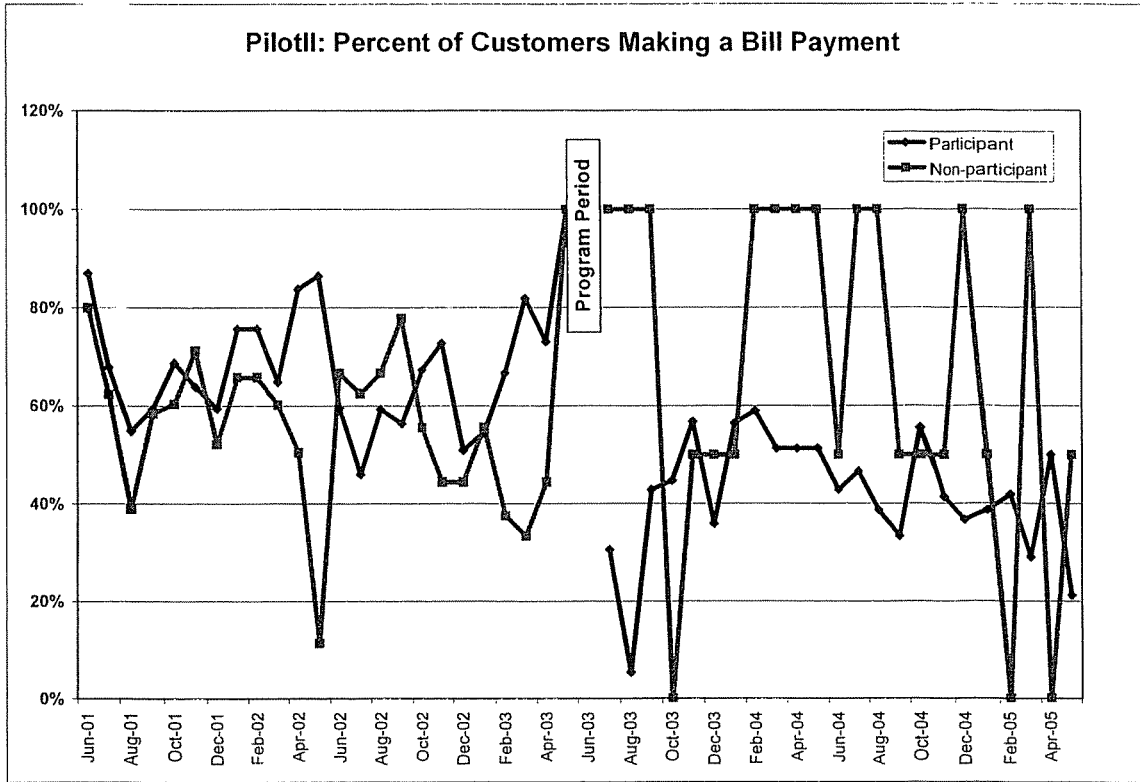


Figure 32 Mean Percent of Pilot II Customers Making a Payment Each Month

Pilot III has the most rigorous data, with higher numbers of customers. The Pilot III participants made a bill payment 62% of the time before their participation in the program, while the comparison group did only 43% of the time. In the post program period, Pilot III participants dropped from 62% of bills being paid in part or in full to 49%, a drop of 21%. The comparison group dropped to 31% making a payment on a bill, a drop of 28%.

Overall, all of the participants in the Pilot program studied made payments towards their bill less frequently in the post-program months. However, the comparison groups did as well in two out of three studies.

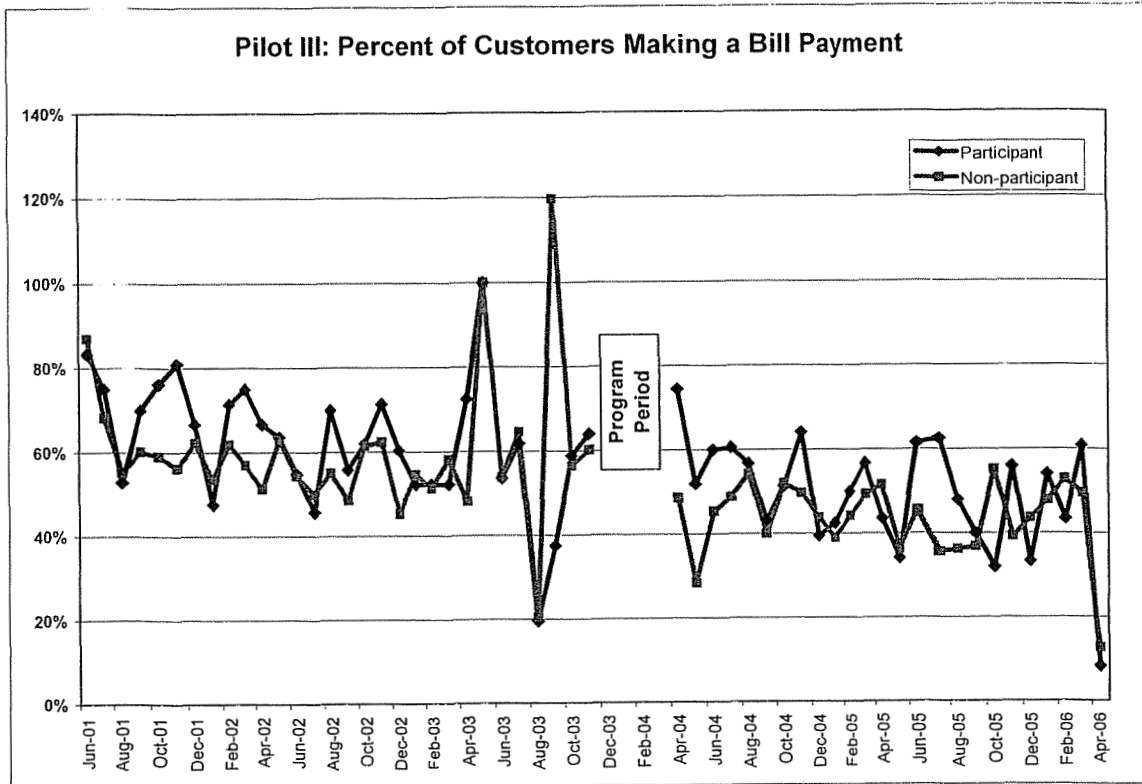


Figure 33 Mean Percent of Pilot II Customers Making a Payment Each Month

CONCLUSIONS

This evaluation involved four independent coordinated studies. The first study consisted of a process evaluation. The second focused on the energy use changes as a result of the Payment Plus Program, the third study focused on evaluating the arrearage and payment effects of the Pilot program. And finally, we performed a short interview with a sample of the Pilot IV participants to gauge customer satisfaction with the program.

The process evaluation examined the operations of Pilot Program IV, implemented from August through September of 2006. This study involved an examination of the management and operations of the Pilot Program as it is operating currently. The process evaluation included on-site interviews with key program designers, managers and implementers. The second study was an effects evaluation focusing on identifying how the program influenced participant energy consumption using weather-normalizing software, and the third examined arrearage levels and payment effects. The effects evaluations used a comparison group of low-income customers who were not weatherized to serve as the baseline from which changes to the participant group could be measured. The arrearage and payment effects evaluation examined the billing and payment histories of Pilot I, II and III participants.

From these studies we conclude the following overarching findings:

This program has been evaluated over a number of years in its “pilot” status. These evaluations show that the program has evolved to point where the implementation efforts are efficient and effective, and customer satisfaction is high. In addition, the evaluations show strong and long-term natural gas energy savings, short-term electric savings and to some degree, impacts on arrearage and payment levels. TecMarket Works recommends that the Payment Plus move beyond the pilot status into a standard program component of Duke’s low-income service portfolio. Process Evaluation Findings

Pilot IV

1. The process used to enroll Crisis participants has improved to the level at which the Northern Kentucky Community Action Commission (NKCAC) has to turn down applicants. The latest Pilot Program was at full capacity. All potential enrollees should continue to be pre-screened before the program is offered to make sure that the program is only offered to eligible customers.
2. The communications and working relationships between People Working Cooperatively (PWC) and NKCAC have significantly improved. There is better and more consistent coordination of services, with times and dates of Pilot training sessions rapidly communicated between the organizations, PWC has been available to attend training sessions and answer questions about the weatherization. This has increased enrollments into the weatherization program.

- In addition, Duke managers have been given advanced notice of meetings, allowing their participation.
3. PWC has made an effort to contact landlords to help Pilot participants obtain the needed permission for weatherization. While contact is difficult, when accomplished, the landlords have been positive about the program and allowed weatherization to go forward. However, this issue remains a participation barrier for renters.
 4. The interviewed managers at NKCAC and PWC report that they would like to see the following program changes:
 - a) Continue to try and reach the more rural areas of the targeted counties. If these customers can be cost effectively served, recruit and provide training sessions throughout the counties into more rural areas of the service territory to allow more rural low-income customers an opportunity to participate without having to travel great distances.
 - b) Let the service providers know that they are free to piggy-back or coordinate the program with other social services provided by the implementation agencies to expand services and increase demand and enrollment success.

Significant Participant Interview Findings

Pilot IV

1. The driving force for participation was to receive the bill credits. Eighty percent cited the credits as the primary reason they chose to enroll. Thirty-six percent said that they participated in order to learn how to save energy.
2. Program participants understood the program and the procedure for applying their credits better than in the past. This was an area of confusion for past participants that appears to have been eliminated.
3. Reported problems with getting the credits applied to their bills has dropped significantly. Very few of these issues are now being raised by participants. The process involved in applying credits was streamlined after the previous evaluation, with the intent of reducing or eliminating these types of complaints. This goal appears to have been achieved.
4. Participants are still very satisfied with the Training Sessions. On a scale of 1-10, average scores for all aspects of the training sessions were high across most response categories for both sessions (energy & budgeting). Satisfaction was particularly high when rating the instructor's knowledge (9.4 & 9.6),

comprehensiveness of subject matter (9.2 & 9.3), and presentation skills of instructor (9.2 & 9.4). The convenience of attending the session was the only response group that received satisfaction scores below 9 (8.6 & 8.8) indicating that there was less satisfaction with the convenience of attending the sessions, but these satisfaction scores are very good scores when using a 10-point scale.

Significant Energy Consumption Analysis Findings

Pilots I, II and III Combined

1. Over the longer period of this study the pilot participants have not been able to reduce their electrical consumption. This is different from the previous evaluation in which the participants experienced reduced electric consumption.
2. Pilot participants who were not weatherized are still able to decrease their consumption of natural gas in all Pilots but Pilot I. The weatherized participants over the successive pilots are saving even more natural gas.

Weatherization is a key component of the Payment Plus Pilot Program for savings natural gas over the long-term. While kilowatt-hour savings are no longer present, participants have experienced electric savings for a significant period of time in past evaluations. These savings have eroded as the months and years have passed. It may be possible to recoup some of these savings by re-communicating tips on how to save electricity with past participants, or by allowing past participants to re-enroll in the energy training session (with or without program credits).

Significant Billing Analysis Evaluation Findings

Pilot I

Each of the Pilots are discussed separately in this section.

1. Arrearage levels for participants have substantially decreased in the years following participation (from \$719 to \$434), and non-participant arrearage levels increased slightly.
2. Likewise, there is also a trend suggesting that participants are beginning to pay a higher portion of their bill following participation. Participants paid, on average, about 47% of their utility bill during any given month before the program. Since participation, they have increased the percent of the bill paid to just over 56%. Participants appear to be increasing this amount while non-participants appear to be decreasing this amount.
3. Pilot I participants have been successful at decreasing their disconnection rates relative to the comparison group. In the post-program years, the comparison

group has had a disconnection rate of 5.97%, while the participants have kept their disconnection rate quite low at 2.24%.

Pilot II

TecMarket Works examined customer billing and payment records for a period of two years prior to the program and for three years following the Pilot II program (although some months are excluded due to poor sample size). The results of this analysis are presented below and in Sections Three and Four of this report. Significant findings include:

1. Pilot II participants have experienced a decrease in their arrearage levels in the months after participation. In the two years of post-program months, arrearages decreased by an average of 13%, whereas the comparison group arrearages increased by 7%. However, the participants' arrearage levels in dollars are lower than those of the comparison group. That is, participants have been able to hold their level of arrearage below the level of non-participants, even though participant arrearage levels have increased.
2. Participants were able to limit the level of erosion of the amount of the payments they made each month relative to the total amount due on their bills. Participants were paying about 51% of the amount due before the program, after participation, they paid about 45% of the total bill. Likewise, the comparison group also decreased the amount they paid relative to what they owed during the same time, dropping from 45% to 30% of the bill paid.

Pilot III

Pilot III has the strongest sample size for this analysis. There were typically data from at least 30 participants in each of the months analyzed, and a very strong comparison group of about 100-500 customers.

1. The mean arrearages of the Pilot III participants have increased slightly since participating in the program, at about the same level as the comparison group. There has been little change in this area.
2. Disconnections have decreased since participation. Before the program, the disconnection rate was 3.1%, and since then it has dropped to 2.4%. The comparison group's disconnection rate has increased from 3.8% to 4.4% in this same time period.
3. The percent of the bill paid by Pilot III participants has remained steady, while the comparison group has been paying less of their bill during the same time period.

Appendix A: Process Evaluation Interview Protocol

Title: _____

Responsibilities associated with the Pilot Program: _____

Note: check the box next to each question that needs to be addressed by each interviewee.

Program Accomplishments and Objectives

- Using your experience and knowledge about the Pilot Program, please finish the rest of the following statement. I think this program can be viewed as a success if it accomplished the following things....
- 1.
 - 2.
 - 3.
- How well do you think the Pilot Program accomplished each of these things?

Customer recruitment and retention

- I understand that there were a couple different ways in which participants were identified, contacted and offered the program. Please describe each of the ways customers were identified, contacted and enrolled in the program.
- What aspects of this process worked well? Which worked least well? Why?
- Please describe how the targeted mailings used to inform customers worked and how successful you think this effort was as stimulating customer's interest and involvement in the program. How could this be improved?
- What system for identification, notification and enrollment do you think should be used in order to obtain participants and accomplish Duke Energy's program goals? Discuss how these might work.
- What screening tests were used to make sure the right customers were enrolled in Pilot IV? Please explain how the screening process worked. Walk through some different examples of how this worked. In your opinion, how well did this work? Why? Are any changes needed to the screening process?

- To be eligible for Pilot IV, LIHEAP participants needed to have been a Duke Energy customer for a while (12 months – then 6 to 9 months). What portion of the LIHEAP customers that were contacted or approached were actually eligible for Pilot IV because of the requirement for 6 to 12 months of account history?
- What percent of those contacted or approach were eligible because of the need to have \$500 or more in current utility debt?
- What percent of the non-crisis-mode customer that you presented the program to were interested in participating?
- What are the main reasons customers have for not wanting to participate?
- What percent actually enroll once they apply and are screened?

Drop-outs and No-shows

- Why did some of the Pilot IV participants offered the program not take advantage of it?
- Why do you think customers enroll in the program, but then do not take part?
- What can be done no decrease the program drop-out rate and keep them involved?
- What can be done to increase the interest in receiving the weatherization service?

Program process

- The current contract with Duke Energy requires the workshops to be out in the market so that participants can more easily attend the workshops allowing the program to experience higher workshop participation rates. How well is this working for NKCAC. Is the change to off-site workshops having the intended effect?
- What complaints or customer issues did you experience in Pilot IV? How were these handled?
- What can be done to help solve (complaint 1 / complaint 2 / complaint 3 / etc.)?
- I would like you to tell me about the customer's experiences with the program. What kinds of things did they like, what kinds of things did they dislike, and how do you think they feel about the program overall.

Program Management and Communication

- Were there any coordination and notification issues regarding the Pilot IV workshops? Please explain what these issues were and why they occurred?

If yes to above: What was done or can be done to improve this process?

- Describe the process used for obtaining weatherization applications from program participants and getting the applications into the weatherization planning stream.
- How well did this process work? Were there any problems in getting the applications to PWC after the participants filled them out? How can this process be improved?
- In the past there have been some issues relating to providing credits to participants after they attend a workshop. How are these credits being applied now? What is the system that is currently being used to credit accounts and how well is it working?
- Were there any participant tracking, accounting or processing problems, or issues associated with tracking and delivering services or incentives? What were they and how can these be avoided in the future?
- What other types of management or participant issues have come up and what were their resolutions?
- If you had one thing to change about the Pilot Program, what would it be? Why? How should this be incorporated into the program? Anything else that you would change?
- When you look at the help provided to participants by the program, and weigh the program costs and operational challenges; what would you say are the different types of benefits the participants receive from the program?
- Now I want to ask you about Duke Energy's ratepayers who are ultimately responsible for funding the Pilot Program. What are the benefits that the program provides to all of Duke Energy's northern Kentucky ratepayers?
- Do you **think** the cost and efforts associated with the Pilot Program justify the results achieved? Why do you say this?

Lastly, I would like to ask your opinion about program accomplishments that can be improved upon in future programs and about other added accomplishments that you think should be built into future programs. What are the kinds of things that you think program management should consider, or things that can be accomplished in a future version of this program?

- First, are there objectives that the program perhaps could have accomplished but for some reason was unable to fully achieve at the level expected? What are these? What can be done to more fully accomplish these in the future?
 - 1.
 - 2.
 - 3.

- And, are there things that could be accomplished in future programs, that were not a part of the past Pilot Program's objectives? What are these and how can they be incorporated into future program?
 - 1.
 - 2.
 - 3.

Appendix B: Participant Survey Instrument

A participant survey was completed in the previous evaluation of the Payment Plus Pilot Program. The results of which can be found in the following report:

An Evaluation of the Payment Plus Pilot Program: Results of a Process, Energy Consumption and Arrearage Effects Evaluation

Dated August 2004.

The questions below come from the Phase 2 survey. The original survey had 88 questions, and this shortened survey preserves 33 of those questions. The questions below require mostly short, scaled replies from the interviewee, and not all questions will be asked of all participants. This interview should take approximately 5 to 10 minutes, depending on the level of participation the customer experienced. The numbering of the questions are left as they were in the original survey to aid in the survey comparison effort.

Payment Plus Pilot Program

Participant Survey

Contact Module

SURVEY INTRODUCTION

If Payment Plus Pilot Program participant, and have completed one or more training sessions, then contact for survey. Use seven attempts at different times of the day and different days before dropping from contact list. Call times are from 10:00 a.m. to 8:00 p.m. EST or 9-7 CST Monday through Saturday. No calls on Sunday. (Sample size N =25)

SURVEY

Introduction

Note: Only read words in bold type.

Hello, my name is _____. I am calling on behalf of Duke Energy to conduct a **customer survey about the Payment Plus Program.** May I speak with _____ **please?**

*If person talking, proceed. If person is called to the phone reintroduce.
If not home, ask when would be a good time to call and schedule the call-back:*

- Call back 1: Date: _____, Time: _____ AM or PM
 - Call back 2: Date: _____, Time: _____ AM or PM
 - Call back 3: Date: _____, Time: _____ AM or PM
 - Call back 4: Date: _____, Time: _____ AM or PM
 - Call back 5: Date: _____, Time: _____ AM or PM
 - Call back 6: Date: _____, Time: _____ AM or PM
 - Call back 7: Date: _____, Time: _____ AM or PM
- Contact dropped after seventh attempt.

We are conducting this survey to obtain your opinions about the Payment Plus Program. We are not selling anything. The survey will take about 5-10 minutes and your answers will be confidential, and will help us to make improvements to the program to better serve others. May we begin the survey?

Note: If this is not a good time, ask if there is a better time to schedule a callback.

1. Do you recall participating in the Payment Plus Program?

- 1. Yes, *begin* → Skip to Q3.
- 2. No,
- 99. DK/NS

2. This program was provided through Northern Kentucky Community Action Commission. In this program, you took part in one or two training sessions on how to save energy and budget for household expenses. In exchange for attending these sessions, Duke Energy provided bill credits of \$200 for the energy conservation session, and \$150 for the household budgeting session. In addition, you may have had your home weatherized through the Duke Energy Weatherization Program, if so, another credit of \$150 was applied to your account for a total of \$500 in credits.

Do you remember participating in this program?

- 1. Yes, *begin* → Go to Q3.
- 2. No,
- 99. DK/NS

If No or DK/NS terminate interview and go to next participant.

2. What was the main reason you choose to participate in the Payment Plus Program? (do not read list, place a "1" next to the response that matches best)

- 1. _____ To receive the bill credits on my arrearage or past-due debt
- 2. _____ To help pay my current monthly utility bills (not arrearage or past-due debt)
- 3. _____ To avoid having my power shut-off
- 4. _____ To receive Crisis program money or help with my utility bills
- 5. _____ Friends/neighbors/family encouraged me
- 6. _____ To obtain weatherization services or home repairs – improve efficiency
- 7. _____ To make home more comfortable
- 8. _____ To find ways to reduce my utility bills
- 9. _____ To save energy in my home
- 10. _____ To learn how to budget or make ends meet

11. ____ Other (*fill in*)

99. ____ Don't know/don't remember/not sure (DK/NS)

If multiple responses: 4.a. **Were there any other reasons?** (number responses above in the order they are provided - Repeat until 'no' response.)

9. Were you aware that the credits offered through the program would be applied to only your past-due debt?

1. Yes 2. No 99. DK/NS

If No, 9a. Please tell me how you thought the credits would be paid.

10. Did you have any problems or issues with getting the credits applied to your bill?

1. Yes 2. No 99. DK/NS

If Yes, 10a. Please explain the problem.

Energy Education Training Session

I would now like to ask about your satisfaction with the Energy Education training session. I will read a list of items, after I read each item please tell me how satisfied you are with that item. Please indicate on a 0 to 10 scale with a 10 meaning you are very satisfied and a 0 to mean you are very dissatisfied.

How satisfied are you with...

18. The convenience of attending the Energy training sessions?

_____ Score

If 7 or less, How could this be improved? _____

19. The knowledge of the Energy Education instructor?

_____ Score

If 7 or less, How could this be improved? _____

20. The presentation skills of the Energy Education instructor?

_____ Score

If 7 or less, How could this be improved? _____

21. The comprehensiveness of the subjects covered?

_____ Score

If 7 or less, How could this be improved? _____

22. The materials and information handed out at the session?

_____ Score

If 7 or less, How could this be improved? _____

24. How about the amount of time for the Energy Education session, was it ...

- 1) Too long,
- 2) About right, or
- 3) Too short?

26. If you could change one thing about this session, what would that be?

Response:1 _____

Anything else? If no, go to Q27.

Response:2 _____

29. What actions, if any, have you taken in your home to save energy and reduce utility bills as a result of what you learned in this program?

Response:1 _____

Response:2 _____

Response:3 _____

Response:4 _____

Household Budgeting training session – *if didn't participate, skip to Q44.*

I would now like to ask about your satisfaction with the budgeting training session. I will read a list of items, after I read each item please tell me how satisfied you are with that item. Please indicate on a 0 to 10 scale with a 10 meaning you are very satisfied with that item and a 0 to mean you are very dissatisfied.

How satisfied are you with...

30. The convenience of attending the budgeting session? _____ Score

If 7 or less, How could this be improved? _____

31. The knowledge of the budgeting instructor? _____ Score

If 7 or less, How could this be improved? _____

32. The presentation skills of the budgeting instructor? _____ Score

If 7 or less, How could this be improved? _____

33. The comprehensiveness of the subjects covered? _____ Score

If 7 or less, How could this be improved? _____

34. The materials and information handed out at the session? _____ Score

If 7 or less, How could this be improved? _____

36. How about the amount of time for the budgeting session, was it ...

- 1) Too long,
- 2) About right, or
- 3) Too short?

38. If you could change one thing about this session, what would that be?

Response:1 _____

Anything else? If no, go to Q39.

Response:2 _____

41. What actions, if any, have you taken in your home to better manage your household budget as a result of what you learned in this program?

Response:1 _____

Response:2 _____

Response:3 _____

Response:4 _____

Skip to Q46.

44. **Our records indicate that you chose not to participate in the Budgeting session that was offered with this program. What were the main reasons why you did not attend this session?** *Do not read list, check those that apply and fill in open-ended response as appropriate.*

- 1) Privacy issues – did not want to share financial circumstances
- 2) Forgot
- 3) Don't have enough money to budget, owe a lot anyway
- 4) Not interested in budgeting, don't care
- 5) Didn't have good records of finances/budgeting
- 6) Didn't think I would learn anything new, already know this material
- 7) Have already attended other budgeting classes
- 8) Could not make the training session due to:

9) Other: _____

99) DK/NS

45. **What do you think the program can do to increase people's interest in attending the budgeting sessions?**

Response:1 _____

Response:2 _____

Response:3 _____

Response:4 _____

Weatherization – *if didn't participate, skip to Q58. If not yet completed...skip to Q55*

Next I want to ask you about your satisfaction with the weatherization service that inspected your home and installed items that made your home more energy efficient. I will read a list of several items, after I read each item please tell me how satisfied you are with that item. Please indicate on a 0 to 10 scale with a 10 meaning you are very satisfied with that item and a 0 to mean you are very dissatisfied.

How Satisfied are you with...

46. The ease of scheduling the energy examination of your home? _____ Score
If 7 or less, How could this be improved? _____

47. The convenience of scheduling the installation of the weatherization measures? _____ Score
If 7 or less, How could this be improved? _____

48. The quality of the measures installed in your home? _____ Score
If 7 or less, How could this be improved? _____

49. The information provided by the weatherization staff about what was installed in your home? _____ Score
If 7 or less, How could this be improved? _____

50. The Weatherization services overall? _____ Score
If 7 or less, How could this be improved? _____

58. Our records indicate that you chose not to receive the weatherization services offered through this program. What were the main reasons why you did not want these services?

- 1) Privacy issues – did not want anyone in home
- 2) House is already energy efficient, service not needed
- 3) Not interested in weatherizing home, don't care
- 4) I didn't send or forgot to send forms to the landlord
- 5) Landlord did not want the service or did not return the forms
- 6) Could not contact my landlord to get approval
- 7) Don't own the house, not my responsibility
- 8) Other: _____

99. DK/NS

Overall Program Satisfaction

I would now like to ask about your satisfaction with certain aspects of the Payment Plus Pilot Program. I will read a list of items, after I read each item please tell me how satisfied you are using a 0 to 10 scale with a 10 meaning you are very satisfied and a 0 meaning you are very dissatisfied.

How satisfied are you with...

60. ...The application process and the ease of filling out the application forms?

_____ Score

If 7 or less, How could this be improved? _____

61. ...The interactions and communications you had with the program staff during the application process?

_____ Score

If 7 or less, How could this be improved? _____

63. And, overall how satisfied are you with the program?

_____ Score

If 7 or less, How could this be improved? _____

66. What additional services would you like the program to provide that it does not now provide?

Response: _____

67. Are there any other things that you would like to see changed about the program?

Response: _____

APPENDIX F

Power Manager Impact Evaluation Study

**Duke Energy Indiana
Duke Energy Kentucky**

2007 Event Year

**Impact Modeling/Metering
conducted by Duke Energy staff/contractors**

**Report Compilation and Review
conducted by Integral Analytics**

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Independent Review and Assessment of the 2007 Duke Energy Kentucky Power Manager Impact Estimates

Dr Michael Ozog, Vice President, Integral Analytics

In September/ October, 2007, I reviewed the enclosed text, findings, datasets, conclusions and load reduction estimates related to the Duke Energy Kentucky Power Manager program. The objective of this review was to provide an expert and independent third party assessment of the reliability and validity of the load reduction estimates and overall evaluation activities and findings contained within this report. Given that the Power Manager program evaluation efforts significantly depend on Duke Energy meters, staff, sampling and operations, this third party review and assessment is an important exercise to glean not only an independent perspective on the evaluation effort and load reduction estimates, but to also offer possible improvements and recommendations for subsequent evaluation activities.

Overall, I found the 2007 Duke Energy Kentucky load reduction estimates to be reasonable and accurate. The sampling protocols, coverage of load research meters across the service territory, paging and operational testing, duty cycle modeling, regression methods and load reduction estimations were satisfactory and reasonable. Sufficient sample sizes were employed to yield the desired precision and accuracy in load reduction forecasts, and considerable attention was afforded to correcting the switch, operating and paging problems previously identified in the 2006 Duke Energy Kentucky Power Manager evaluation study. The past year's efforts and attention to quality control and assessment appear to have increased the load reduction capability and reliability of the program significantly. As such, I am confident that the average household load reduction forecast of 1.04 KW is a reasonable and accurate load impact for the program, given this 2007 group of customers. This level of impacts is comparable to impacts I have found for similar programs in other areas of the country.

For future evaluations, I recommend the following possible improvements or enhancements to help improve program effectiveness and load reduction forecast precision. First, it would be useful to migrate load research meters from current year sample to new homes for the 2008 season. This sample migration will insure that any potential sampling bias is mitigated and does not confound the load reduction impact estimates. Second, continued, and perhaps expanded use of, supplementary logger and instantaneous demand measures are relatively inexpensive ways to boost sampling power and improve load reduction forecasts at a reasonable cost. Third, expanded use of a "nested" sample of logger and interval end-use meters to better understand the relationship between duty cycle and air conditioner load. In all cases, additional sample points would be desirable, though not required.

And finally, the approach used in this analysis relied upon the average duty cycle (per unit) to estimate run time. This is a reasonable assumption. However, there may be significant benefits to developing statistical models that relate the individual run-time to such things as the time of day, day of week, month, and weather, or other influential

variables. This approach may produce more meaningful estimates of the program effect. Therefore, future analysis should look into using more advanced statistical methods to estimate of the impacts of the Power Manger program.

DR. MICHAEL OZOG

AREAS OF QUALIFICATION

Econometrics, energy economics, energy policy modeling, program evaluation

EMPLOYMENT HISTORY

- Integral Analytics, Fort Collins, CO 2007-present
- Senior Consultant, Summit Blue Consulting, LLC, Boulder, CO, 2002-2007
- Senior Associate, Stratus Consulting Inc., Boulder, CO, 2001-2002
- Senior Consultant, E Source, Boulder, CO, 2000

EDUCATION

- Boston College, PhD, Economics, 1991
- Pennsylvania State University, MS, Mineral Economics, 1985
- Massachusetts Institute of Technology, BS in Geology, 1982

PROFESSIONAL EXPERIENCE

At Integral Analytics (IA), Dr. Ozog is the leader of economic evaluation practice, which develops innovative statistical analysis techniques which can be used by the energy industry to understand and predict the behavior and preferences of their customer's. Dr. Ozog is also responsible for the support and improvement of IA's existing product base, including DSMore.

While at Summit Blue, Dr. Ozog was leading the quantitative research efforts into the impacts of energy efficiency programs, demand response and innovative pricing. He evaluated Sacramento Municipal Utility District's mass-market DR programs, Idaho Power Company's load management programs, and Com Ed/Chicago Cooperative Real Time Pricing program. A list of his recent projects includes:

- Multi-year evaluation of the Community Energy Cooperative's Energy-Smart Pricing Plan (ESPP). ESPP is a large-scale residential real-time pricing program in the Chicago area that uses market-based hourly electricity prices.
- Multi-year evaluation of PSE&G's residential and small commercial direct load control programs
- Multi-year valuation of KCP&L's residential air conditional load control program.
- Multi-year evaluation of Idaho Power Company's (IPCo) Residential Air-Conditioning Cycling Pilot Program.
- Evaluation of IPCo's Irrigation Peak Clip program, a program which uses switches to curtain irrigation during peak demand periods.

- Evaluation of Louisville Gas & Electric Company (LG&E) residential direct load control program for water heating and air conditioning.
- Evaluation of California Working Group 2 (WG2) demand response. The WG2 evaluation investigated the demand impacts associated with industrial demand response programs.
- A multi-year impact Evaluation of Sacramento Municipal Utility District's (SMUD's) PowerStat and PowerChoice programs.
- Multi-utility evaluation of New Hampshire's Home Energy Solutions (HES). The HES program is a residential retrofit program that is implemented by all electric utilities in New Hampshire (i.e., Granite State, New Hampshire Electric Cooperative, Unitil, and Public Service of New Hampshire).
- Evaluation of LG&E WE Care low-income weatherization program.

PUBLICATIONS

REFEREED JOURNAL ARTICLES

"Modeling Overnight Recreation Trip Choice: Application of a Repeated Nested Multinomial Logit Model" (with W. Shaw). *Environmental and Resource Economics*. October 1998.

"Residential Electricity Use and the Potential Impacts of Energy Efficiency Options in Pakistan" (with Mark Eiswerth). *Energy Policy*. March 1998.

"Decomposing Energy Conservation into Natural and Incentive-Induced Components" (with D. Waldman). *Southern Economic Journal* April 1996.

"Model Specification and Treatment of Outliers in the Evaluation of a Commercial Lighting Program" (with R. Davis). *Energy Services Journal*. Vol. 1, No. 1, September. 1995.

"Weighing Enriched Samples in Voluntary Energy Conservation Program Evaluation" (with D. Waldman). *The Energy Journal*. Vol. 15, No. 1, March. 1994.

Introduction

Duke Energy offers residential customers a load control program called Power Manager. This program offers customers a monetary incentive for reducing their air conditioning during peak demand periods. This report presents the load impact analysis for 2007 Power Manager control periods. The first two sections below are devoted to estimating the potential average (i.e., per-participant) impact from Power Manager load control; the first section describes data collection and the next section focuses on models derived from this data. The following section presents the operability study conducted in 2007 to identify an explicit de-rating factor for Power Manager load control. This is an important difference from the 2006 load impact analysis, where de-rating was implicit in the impact estimates and not separated from other influential factors such as weather. Hourly load impact estimates for Power Manager control days are given in the next section, in Tables 5-12(d). The maximum impact was 39 MW for Duke Energy Indiana and 8 MW for Duke Energy Kentucky on August 8. It should be noted that Duke Energy Indiana impacts during August were reduced about 4 MW by an IT change unrelated to the program, and this problem is now resolved. The final section describes Duke Energy's plan for diagnostic field testing to be conducted over the next few weeks at customer locations identified in the operability study where switches failed to shed during control periods this summer. Results from these tests will be used to improve future load impacts.

To ensure that Duke Energy maximizes the impacts of the program a quality assurance action plan was put in place prior to the 2007 control season. An assessment of the accuracy of the data and quality of the equipment and procedures being used to evaluate the program was done. One of the factors for the evaluation was the low impacts that were discovered during the 2006 control season. The impact estimates for the 2006 control season were significantly below the targeted load reduction. Details of the quality assurance plan and the impacts measured in 2006 are found in appendix 8.

Load Research Sample

A fresh load research sample (“RS” group) was recruited for summer 2007, with no holdovers from 2006. For each RS participant, HOBO U-9 state data loggers were installed on all AC units and the household kWh meter was replaced with an interval meter. Data logger’s records times at which the AC unit turns on or off, allowing duty cycle to be constructed at any desired temporal resolution. To enable efficient collection of logger data, prospective candidates for the research sample were randomly selected with a two stage cluster sampling method. The clusters are based upon zip code, and required to contain at least 120 Power Manager customers to provide an adequate pool for recruitment. Prior to sampling (in January, 2007), small zip codes were combined with adjacent zip codes into a single cluster, so that all clusters meet the minimum size requirement. In the first stage of sampling, eight clusters were randomly selected in Indiana and four clusters in Kentucky. These clusters were drawn in such way that the probability of selection for a cluster was proportional to the number of Power Manager participants in that cluster.

In the second stage of sampling, customers were classified as high, medium, or low users based upon billed kWh for the months June – September of 2006. The kWh breakpoints used for classification were determined at the state level, so that equal numbers are assigned to each category in both Indiana and Kentucky. Clusters selected in the first stage were separated into six groups based upon kWh usage level and program option (1.5 kW or 1.0 kW). Using randomized selection within these groups, two participants were recruited from each 1.5 kW group and one participant from each 1.0 kW group, for a total of nine recruits in each cluster.

Due to a mistake in the preparation of randomized lists for recruiting, several customers were recruited from a zip code cluster that had not been selected in the stage 1 random draw. This cluster was substituted for a nearby cluster which had been selected in the random draw but where no recruits had yet been obtained.

Load Impacts with the Duty Cycle Method

The duty cycle method will be used to estimate load impacts during Power Manager control periods. Air-conditioner (AC) natural duty cycles are measured with HOBO data loggers for the Power Manager load research samples during 2006-2007 summer seasons. Together with connected loads for research sample AC units, the natural duty cycle data enables evaluation of the average load reduction achieved by a cycling strategy within the research sample. Hourly models have been constructed for average load reduction within the research sample as a function of weather conditions and cycling strategy. The potential load impact during a Power Manager control period is determined by evaluating these models with the cycling strategy employed and weather conditions during the control period. The potential load impacts estimated in this manner represent the load reduction which would be achieved if all switches controlled as expected.

Validation of Logger Data

We have found that HOBO U-9 state data loggers, when properly installed record the start and end times of AC duty cycles with good reliability. Installation procedures are given Appendix 1. Nevertheless, it is to be expected that some logger data will not accurately reflect AC cycles, and should be discarded. Premise interval kWh (15-minute) collected for customer sites where data loggers are installed is used to validate the logger data. The validation process is accomplished with a sequence of computer programs that: 1) convert the time stamp data collected from U-9 data logger into interval duty cycle; 2) display time series plots of premise kWh and duty cycle with control over time resolution enabling visual comparison of plot detail; 3) calculate cross-correlation between interval kWh and interval duty cycle and display cross-plots of kWh vs. duty cycle. Every logger data file collected from a customer site is reviewed in this fashion, and added to the duty cycle model database when the interval kWh provides confirmation of the AC cycles in the logger data.

Connected Load

Connected load is the average power demand (kW) of a running AC unit over a full cycle. It determines the load reduction (kWh) achieved when AC run time is reduced. Connected load is specified for research sample AC units through the basic engineering formulas,

$$\text{Apparent Power (kVA)} = (\text{Compressor Amps} + \text{Fan Amps}) * 240 \text{ Volts} / 1000$$

$$\text{Connected Load (kW)} = \text{Power Factor} * \text{Apparent Power}$$

Rated amps for the compressor (FLA) and fan (RLA) are typically listed on the AC faceplate, and were obtained for 107 of the 112 research sample AC units.

Power factor in this formula is actually different for different AC units, and even varies somewhat for different cycles of the same unit, increasing at high temperature and humidity. However, we can use the synchronous AC duty cycle and interval kWh data obtained from the research sample to estimate a single, best-fitting power factor within

the research sample. The first step is a regression, for each sample participant with adequate data, of interval kWh on duty cycle,

$$kWH_i = a + b * DC_i + \epsilon_i$$

Notice that if the AC unit runs for an entire 15-minute interval, so that $DC_i = 1$, then the regression coefficient b equals the kWh attributed to the unit during that interval. Dividing by the length (in hours) of the interval converts to kW, so $4*b$ is the appropriate estimate of the unit's connected load. Next, the results for connected load obtained in the previous step become the independent variable, and are regressed on Apparent Power (from faceplate FLA and RLA). The slope computed in this regression (Apparent Power vs. connected load) is the best-fitting power factor for the group. The power factor obtained for the 2006 research sample was 0.834, and for the 2007 research sample it was 0.826.

For AC units where information on rated amps is not available, the first regression above provides an estimate of connected load for the unit which can be used instead.

Hourly Models for Load Reduction

The key parameter to a Power Manager control strategy is the shed percentage, the percentage of time within a control interval that AC units are prevented from running. When the natural duty cycle of an AC unit exceeds the complement of the shed percentage within a control interval, then run time for the unit is reduced and load reduction is realized. For shed percentage and natural duty cycle expressed as fractions between zero and one, hourly load reduction can be calculated as follows:

$$\text{Run time reduction} = \text{MAX}[\text{Duty cycle} - (1 - \text{Shed percentage}), 0]$$

$$\text{Load reduction} = \text{Connected load} * \text{Run time reduction}$$

These calculations can be performed in any hour of any day (i.e., hour 16 on June 13) for all AC units of the RS group with valid natural duty cycles in that hour to get average load reduction within the RS group for that particular hour. Hourly average load reductions computed in this manner comprise the dependent variable data in the load reduction models.

Hourly weather is represented in the load reduction models with heat index, which combines temperature and humidity into a single variable. Appendix 2 describes how heat index is calculated from temperature and relative humidity. Separate models for load reduction as a function of heat index are fit for each combination of shed percentage and hour of the day needed in the impact evaluation. The heat index variable in the models is a composite based on weather observations from Cincinnati airport, Indianapolis airport, and Louisville airport. Further detail on model fits is given in appendix 3.

Operability Study

Some switches fail to perform as expected when load control is initiated. A study has been conducted during summer 2007 to estimate the proportion of Power Manager switches in Indiana and Kentucky (Model ACP/F032803 manufactured by Corporate Systems Engineering) that shed the AC unit for the prescribed length of time during Power Manager load control events. The operability study involves about 250 Power Manager participants selected randomly, but in such a way as to ensure adequate geographic representation. The RS group described above is included, and 150 additional Power Manager participants (the "OP" group) were selected randomly from zip codes not represented by the RS group. A large proportion (100-200) of these customer sites were visited after each control day (or group of consecutive control days), and the contents of switch registers downloaded into a Palm PC device designed for this purpose. Switch data is transferred to a PC and aggregated into spreadsheet files for analysis. The de-rating factor (or net-to-gross ratio) obtained from the operability study is incorporated into the load impacts reported for the Power Manager program in this report. The remainder of this section describes in detail the switch data collected and how this data is used to obtain a statistically reliable estimate for the de-rating factor.

Based upon the structure of switch registers and the operation of the Power Manager program, the de-rating factor is constructed as a product of two distinct components: the programming factor and the shed factor. In general terms, the programming factor involves switch register settings that can be established prior to a control day and need not be modified from one control day to the next, while the shed factor measures correct switch response to paging signals sent immediately prior to and during a load control event.

The switch registers which are examined to set the value of the programming factor are shown in Table 1.

Table 1. Switch data for programming factor

Register Identifier	Register Value	Power Manager Code
OpReg1 (upper:lower)	1:3	DEI
	1:1	DEK
	2:37	RS group
OpReg5 (upper:lower)	1:2	1.5 kW
	1:1	1.0 kW
	1:3	0.5 kW
Wildcard (hh:mm:ss)	00:22:12	1.5 kW
	00:16:12	1.0 kW
	00:09:18	0.5 kW

Intended values for these registers are shown in column 2 of this table, and column 3 shows what determines correct values for a particular switch. Correct values depend upon the customer's choice of program option, the customer's location, and whether the

customer is in the RS group. The wildcard register sets the amount of shed time within a 30-minute control period, so the correct values in Table 1 correspond to shed percentages of 74% for the 1.5 kW option, 54% for 1.0 kW, and 31% for 0.5 kW. If values of the three registers in switch data collected from a customer site match the correct values for that customer, then the programming factor for that observation is set to one. If there is any discrepancy in the register values, then the programming factor for that observation is usually zero, although there are infrequent cases with values between zero and one (discussed further below).

The shed factor is a conditional statistic, conditioned on correct programming, or more precisely programming factor greater than zero. Aside from this, the switch registers examined to determine a value for the shed factor are the activation counter and cumulative shed time. The activation counter records the number of times that the switch has shed since the last clear counters command was received. For example, a three hour control event with 30 minute control period should increment the activation counter by six. The cumulative shed time records the total minutes that the switch has shed since the last clear counters command was received, where shed time during a control period is rounded to the nearest minute for accumulation in this register. Table 2 gives the expected increments to these registers associated with each control day of summer 2007. Table 2 also indicates if counters were cleared immediately prior to a control day.

Table 2. Increments to Activation Counter and Cumulative Shed Time

Control Date	Groups Controlled	Control Period (min)	Counters Cleared	Activation Counter Increment	Cumulative Shed Increment (min)	
					1.5 kW	1.0 kW
May 30	RS	30	Yes	4	88	64
June 7	DEI; DEK	30	Yes	6	132	96
June 21	RS	30	Yes	6	132	96
July 17	DEK	30	Yes	4	88	64
Aug 1	DEI; DEK; RS	30	Yes	8	176	128
Aug 8	DEI; DEK	30	Yes	6	132	96
Aug 9	DEI; DEK; RS	30	No	4	88	64
Aug 16	DEI; DEK; RS	45	Yes	4	120	90
Aug 23	DEI; DEK; RS	30	Yes	4	88	64
Aug 29	DEI; DEK	30	No	4	88	64

For switch data collected on a given date from a particular customer site, the information in Table 2 is sufficient to determine the expected contents of the activation counter and cumulative shed time registers. If the collected data values match these expected values (and programming factor is nonzero), then the shed factor for this observation is set to 1. The most common discrepancy encountered is when the activation counter and cumulative shed time collected from a switch are zero, and in this case the shed factor is set to zero. Other cases require further inspection to determine an appropriate shed factor for the observation, and occasionally result in a value between zero and one.

A computer program has been constructed to process switch data and identifies observations for which values in registers described above do not match the values expected for that observation. Because of rounding issues, the value for cumulative shed time is considered to match if it is at least as large as the appropriate value from Table 2, and no larger than that value plus one minute for each expected activation. Observations not matching expected values were examined individually to determine if the observation should be retained (i.e., not off-program due to a dropout or tenant change), and to assign appropriate programming and shed factors.

Results for Programming Factor

The RS group has special programming, as shown in Table 1, to enable it to be controlled independent of the general population. Special attention was devoted to achieving proper programming of the RS group. For these reasons, it is not appropriate to include switch data from the RS group in determining a programming factor for the general population. Results described below for the programming factor are based entirely on data from the OP group.

Although there were multiple observations for more than half of the OP switches, only three showed a change in the program factor over the summer. For all three switches, an incorrect factor observed after June 7 was corrected in subsequent observations. Normal programming changes to switch registers, such as tenant transfers, were excluded from the analysis. Programming factor data is aggregated by switch for statistical analysis, using the average value for the few switches with observations not all identical. Of 151 OP switches, 121 were correctly programmed (factor = 1) in all observations and 27 were incorrectly programmed in all observations (factor = 0). Table 3 shows statistical results.

Table 3. Programming factor statistics
 (OP switch data only)

Switch count	151
Sample mean	0.809
Standard error	0.032
90% confidence	0.757 – 0.861

A variation adopted in the analysis of the programming factor for 1.5 kW switches in Indiana requires some further explanation. Early in the 2007 control season, it was decided to refresh the programming of all Power Manger switches. To do this efficiently, a global command was issued on June 27 to reprogram all Power Manager switches in Indiana and Kentucky, and this command set the program option in all switches to 1.0 kW. The plan was to reset appropriate switches to program option 1.5 kW with individual paging commands. This process was completed July 9 for Kentucky switches, but stalled midway through the list of Indiana switches. The reason was eventually identified and corrected – a Duke Energy IT change unrelated to the Power Manager program. But for control days in August approximately 50% of Indiana 1.5 kW customers were actually programmed to 1.0 kW (see OpReg5 in Table 1). This discrepancy was temporary in nature and not related to switch performance, and so it was

disregarded in setting the programming factor. The discrepancy is incorporated into the impacts reported for August control days by modifying the Indiana participant counts for 1.5 kW and 1.0 kW in Tables 7-12(a) below.

Results for Shed factor

The registers examined for the shed factor (activation counter and cumulative shed time) function in exactly the same manner for correctly programmed RS and OP switches, so it is appropriate to use switch data from both groups to derive shed factor statistics. The shed factor for a single observation is normally zero or one, although there are a few observations with activations and cumulative shed greater than zero but less than expected for the control period. It is much more common for multiple observations of a switch to result in a shed factor of one on some control days and zero on other control days. Nevertheless there is correlation between multiple observations of the same switch. To allow for this correlation, a random effects model has been adopted to analyze shed factor observations, which allows for distinct variances within and between switches. Statistical results with this model are given in Table 4.

Table 4. Shed factor statistics
 (OP and RS switches correctly programmed)

Observation count	566
Switch count	208
MS between	0.282
MS within	0.062
Sample mean	0.823
Standard error	0.023
90% confidence	0.785 – 0.861

August 16 Shed Avoiding the Wildcard Register

Incorrect wildcard register settings have been identified as a persistent problem for a significant proportion of switches in the OP group, and are the principal source of deficit in the programming factor. Shedding with the wildcard register enables complete flexibility in specifying the shed percentage that is imposed, and for this reason Power Manager protocols have relied upon configuring the wildcard register. However, the switches allow an alternate shed mechanism which involves selecting from a limited number of fixed shed times, with no need to configure the wildcard register. This alternate mechanism was used on August 16, and data was collected from more than 20 switches with incorrect wildcard registers. Careful examination of the activation counts and cumulative shed time in this data found no evidence any shed on August 16 among those switches with incorrect wildcard registers. In view of these findings, the de-rating factors derived above (Tables 3 and 4) are used for the August 16 load impacts in spite of the different shed mechanism employed.

Load Impacts for 2007 Control Days

In all control periods of 2007 except on August 16, the shed percentages were 74% for program option 1.5 kW, 54% for 1.0 kW, and 31% for 0.5 kW. These shed percentages were chosen to achieve the corresponding load reduction target under typical (median) weather conditions at the summer peak, which correspond to a temperature of 93 deg-F and dew point of 73 deg-F (heat index about 103) .

Hourly weather observations from three weather stations are used in the impact evaluation; Cincinnati airport (CVG), Indianapolis airport (IND), and Louisville airport (SDF). Power Manager customers are assigned to weather region by zip code. Kentucky zip codes and zip codes in southeast Indiana are assigned to CVG, zip codes in south-central and southwest Indiana to SDF , and in central Indiana to IND (Indianapolis airport). Indiana zip codes assigned to CVG or SDF are listed in appendix 4. The blended heat index for Duke Energy Indiana in Tables 5-12(b) is calculated as a weighted average of the corresponding hourly heat index in these weather regions. The weights used for each program option correspond to the counts of Power Manager customers for that program option in the three weather regions.

Average shed kW in Tables 5-12(c) is computed with the hourly load reduction models described in that section and appendix 3. The model developed for the indicated hour and shed percentage is evaluated at the appropriate heat index for the prior hour shown in Tables 5-12(b). The CVG heat index is used to compute shed kW for Duke Energy Kentucky, and blended heat index for the corresponding program option is used to compute shed kW for Duke Energy Indiana.

Hourly potential load impacts in Tables 5-12(d) are computed with the participation counts in Tables 5-12(a) and the average shed kW in Tables 5-12(c). A de-rating factor is applied to these potential impacts to get the de-rated impacts appearing in Tables 5-12(d). This factor is 0.666, the product of sample means obtained for the programming factor (0.809, from Table 3) and shed factor (0.823, from Table 4) in the section discussing the Operability Study. August hourly impacts for Duke Energy Indiana in Tables 7-12(d) were reduced about 4 MW by the reprogramming problem discussed in the previous section. The weather normalized, de-rated, per-participant impact is 1.22 kW for option 1.5, 0.80 kW for option 1.0, and 0.39 kW for option 0.5 (hour 17, heat index 103).

Table 5. Load Impacts for June 7

(5a)

	Participant Count		
	1.5 kW	1.0 kW	0.5 kW
DEI	20539	13675	23
DEK	4445	2784	2

(5b)

Hour	Heat Index			Blended Heat Index for DEI		
	CVG	IND	SDF	1.5 kW	1.0 kW	0.5 kW
14	92.6	91.5	93.8	91.8	91.9	91.7
15	92.6	91.0	93.8	91.4	91.5	91.3
16	93.8	91.5	95.5	92.1	92.2	91.9
17	93.3	91.5	94.9	92.0	92.1	91.9

(5c)

Hour	Duty Cycle Model Average Shed kW					
	DEI			DEK		
	1.5 kW	1.0 kW	0.5 kW	1.5 kW	1.0 kW	0.5 kW
15	1.12	0.65	0.28	1.16	0.68	0.30
16	1.17	0.69	0.30	1.24	0.74	0.32
17	1.30	0.79	0.35	1.38	0.85	0.39

(5d)

Hour	Potential Impact (MW)		De-rated Impact (MW)	
	DEI	DEK	DEI	DEK
15	24.0	5.3	16.0	3.5
16	33.5	7.5	22.3	5.0
17	37.4	8.5	24.9	5.7

Table 6. DEK Load Impacts for July 17

(6a)

	Participant Count		
	1.5 kW	1.0 kW	0.5 kW
DEI	-	-	-
DEK	4447	2816	2

(6b)

Hour	Heat Index			Blended Heat Index for DEI		
	CVG	IND	SDF	1.5 kW	1.0 kW	0.5 kW
14	92.6	91.5	93.8	-	-	-
15	92.6	91.0	93.8	-	-	-
16	93.8	91.5	95.5	-	-	-
17	93.3	91.5	94.9	-	-	-

(6c)

Hour	Duty Cycle Model Average Shed kW					
	DEI			DEK		
	1.5 kW	1.0 kW	0.5 kW	1.5 kW	1.0 kW	0.5 kW
15	-	-	-	1.16	0.68	0.30
16	-	-	-	1.24	0.74	0.32
17	-	-	-	1.38	0.85	0.39

(6d)

Hour	Potential Impact (MW)		De-rated Impact (MW)	
	DEI	DEK	DEI	DEK
15	-	5.3	-	3.5
16	-	7.6	-	5.0
17	-	8.5	-	5.7

Table 7. Load Impacts for August 1

(7a)

	Participant Count		
	1.5 kW	1.0 kW	0.5 kW
DEI	20563	13993	23
DEK	4442	2812	2
DEI Reprogram	10282	24274	23

(7b)

Hour	Heat Index			Blended Heat Index for DEI		
	CVG	IND	SDF	1.5 kW	1.0 kW	0.5 kW
14	91.4	89.9	93.9	90.5	90.6	90.3
15	90.6	89.9	95.0	90.6	90.7	90.4
16	92.0	92.5	96.1	92.9	93.0	92.8
17	93.0	92.0	94.0	92.3	92.4	92.3

(7c)

Hour	Duty Cycle Model Average Shed kW					
	DEI			DEK		
	1.5 kW	1.0 kW	0.5 kW	1.5 kW	1.0 kW	0.5 kW
15	1.06	0.61	0.26	1.10	0.64	0.28
16	1.13	0.66	0.28	1.13	0.66	0.28
17	1.34	0.82	0.37	1.29	0.78	0.35
18	1.38	0.85	0.38	1.41	0.87	0.40

(7d)

Hour	Potential Impact (MW)		De-rated Impact (MW)	
	DEI	DEK	DEI	DEK
15	22.7	5.0	15.1	3.3
16	32.6	6.9	21.7	4.6
17	39.0	7.9	26.0	5.3
18	40.2	8.7	26.8	5.8

Table 8. Load Impacts for August 8

(8a)

	Participant Count		
	1.5 kW	1.0 kW	0.5 kW
DEI	20554	13987	23
DEK	4439	2819	2
DEI Reprogram	10277	24264	23

(8b)

Hour	Heat Index			Blended Heat Index for DEI		
	CVG	IND	SDF	1.5 kW	1.0 kW	0.5 kW
14	102.9	103.0	109.4	103.9	104.0	103.6
15	108.1	104.0	107.9	104.6	104.8	104.5
16	104.2	105.4	109.2	105.9	105.9	105.7
17	91.9	106.8	109.7	106.8	106.6	106.4

(8c)

Hour	Duty Cycle Model Average Shed kW					
	DEI			DEK		
	1.5 kW	1.0 kW	0.5 kW	1.5 kW	1.0 kW	0.5 kW
15	1.71	1.08	0.50	1.66	1.05	0.49
16	1.85	1.21	0.56	2.02	1.33	0.63
17	1.97	1.32	0.65	1.89	1.25	0.62

(8d)

Hour	Potential Impact (MW)		De-rated Impact (MW)	
	DEI	DEK	DEI	DEK
15	37.8	7.8	25.2	5.2
16	54.8	12.7	36.5	8.5
17	58.9	11.9	39.2	7.9

Table 9. Load Impacts for August 9

(9a)

	Participant Count		
	1.5 kW	1.0 kW	0.5 kW
DEI	20533	13968	25
DEK	4442	2815	2
DEI Reprogram	10267	24234	25

(9b)

Hour	Heat Index			Blended Heat Index for DEI		
	CVG	IND	SDF	1.5 kW	1.0 kW	0.5 kW
14	105.5	101.6	109.7	102.8	103.0	102.4
15	105.1	98.9	108.8	100.3	100.6	99.9
16	104.6	98.9	108.8	100.3	100.6	99.9
17	105.1	100.2	106.7	101.2	101.4	101.0

(9c)

Hour	Duty Cycle Model Average Shed kW					
	DEI			DEK		
	1.5 kW	1.0 kW	0.5 kW	1.5 kW	1.0 kW	0.5 kW
16	1.63	1.05	0.47	1.87	1.22	0.57
17	1.70	1.11	0.52	1.90	1.27	0.62

(9d)

Hour	Potential Impact (MW)		De-rated Impact (MW)	
	DEI	DEK	DEI	DEK
16	36.0	8.8	24.0	5.9
17	50.4	12.0	33.6	8.0

Table 10. Load Impacts for August 16

(10a)

	Participant Count		
	1.5 kW	1.0 kW	0.5 kW
DEI	20495	13942	29
DEK	4433	2813	4
DEI Reprogram	10248	24189	29

(10b)

Hour	Heat Index			Blended Heat Index for DEI		
	CVG	IND	SDF	1.5 kW	1.0 kW	0.5 kW
14	107.2	101.6	107.8	102.6	102.8	102.4
15	104.2	97.5	106.0	98.8	99.1	98.5
16	104.7	104.1	107.8	104.6	104.7	104.4
17	99.7	92.2	93.2	92.5	92.7	92.8

(10c)

Hour	Duty Cycle Model Average Shed kW					
	DEI			DEK		
	1.5 kW	1.0 kW	0.5 kW	1.5 kW	1.0 kW	0.5 kW
15	1.43	0.93	0.31	1.64	1.07	0.37
16	1.34	0.88	0.29	1.60	1.06	0.36
17	1.68	1.15	0.41	1.68	1.15	0.42

(10d)

Hour	Potential Impact (MW)		De-rated Impact (MW)	
	DEI	DEK	DEI	DEK
15	31.7	7.7	21.1	5.1
16	39.7	10.1	26.5	6.7
17	50.5	10.7	33.6	7.1

Table 11. Load Impacts for August 23

(11a)

	Participant Count		
	1.5 kW	1.0 kW	0.5 kW
DEI	20456	13946	32
DEK	4428	2801	5
DEI Reprogram	10228	24174	32

(11b)

Hour	Heat Index			Blended Heat Index for DEI		
	CVG	IND	SDF	1.5 kW	1.0 kW	0.5 kW
14	100.8	98.0	103.0	98.8	98.9	98.5
15	101.3	99.3	103.5	99.9	100.0	99.7
16	101.4	98.6	103.5	99.3	99.4	99.0
17	100.8	98.6	102.7	99.2	99.3	99.0

(11c)

Hour	Duty Cycle Model Average Shed kW					
	DEI			DEK		
	1.5 kW	1.0 kW	0.5 kW	1.5 kW	1.0 kW	0.5 kW
15	1.46	0.90	0.41	1.56	0.97	0.45
16	1.60	1.02	0.46	1.68	1.07	0.49

(11d)

Hour	Potential Impact (MW)		De-rated Impact (MW)	
	DEI	DEK	DEI	DEK
15	31.9	7.2	21.2	4.8
16	47.1	10.4	31.3	7.0

Table 12. Load Impacts for August 29

(12a)

	Participant Count		
	1.5 kW	1.0 kW	0.5 kW
DEI	20453	13937	33
DEK	4429	2796	6
DEI Reprogram	10227	24163	33

(12b)

Hour	Heat Index			Blended Heat Index for DEI		
	CVG	IND	SDF	1.5 kW	1.0 kW	0.5 kW
14	97.9	95.1	95.8	95.3	95.4	95.3
15	96.1	96.1	101.1	96.8	96.9	96.4
16	96.7	94.5	101.3	95.5	95.6	95.0
17	98.0	95.8	95.5	95.8	95.8	95.9

(12c)

Hour	Duty Cycle Model Average Shed kW					
	DEI			DEK		
	1.5 kW	1.0 kW	0.5 kW	1.5 kW	1.0 kW	0.5 kW
16	1.45	0.90	0.40	1.41	0.87	0.39
17	1.46	0.92	0.42	1.52	0.96	0.45

(12d)

Hour	Potential Impact (MW)		De-rated Impact (MW)	
	DEI	DEK	DEI	DEK
16	31.6	6.5	21.1	4.3
17	42.7	9.4	28.4	6.3

Action Plan for Improving Load Impact

The operability study has identified many customer sites where switches have not been effectively configured with paging signals (62 in Indiana, 16 in Kentucky), or where properly configured switches appear not to have not shed during any of the 2007 control intervals (8 in Indiana, 6 in Kentucky). Diagnostic testing of these sites and switches will begin immediately, to identify the cause of these problems and determine whether the problems are associated with the customer site (e.g., a problem with the paging signal or switch installation) or with the switch itself. The customer locations are displayed in appendix 5 and 6.

A technician will visit several of these customer sites with problematic switch performance. The technician will communicate by phone with someone using the paging software and document results of several switch tests. He will also use the handheld device to observe and download the results of the tests. The type of additional testing on the switches will include:

- Observing whether or not our test on/test off commands are being transmitted to the switch
- Sending a test paging command to a different paging device at the same location as the switch to determine if the page can be transmitted successfully
- Plugging in a special test switch to an outside outlet if available at the site and sending commands to it to determine if the paged commands get transmitted.
- Open/close the disconnect and repeat the paging tests and record results
- Observe and record any indication of tampering
- Record location of possible physical structures that could impede paging commands

A checklist showing actions to be performed during site visits for diagnostic testing is attached as appendix 7. Switches that appear to be completely non-functioning will be removed at a later time and taken to the switch vendor for internal component testing. A technical resource from the switch vendor has already been assigned to this project.

In addition to these tests, we will revisit a sampling of switches that were found to be incorrectly reprogrammed last year. Again the registers will be read with the hand-held device and the data downloaded. The purpose of this will be to assess the success of the reprogramming effort.

Appendix 1. HOBO U9 Logger Installation and Data Retrieval Procedure for 2007

HOBO U9 Logger

The HOBO U9-001 logger records the change of state of the compressor by direct connection. Each time the compressor starts or stops, the logger records the new state, along with the date/timestamp. The logger directly reads the continuity of a set of relay contacts that close when the compressor is started. The relay is field installed at the time of the logger installation. The relay has a 240 volt coil wired in parallel with the compressor and when the compressor is energized by the compressor contactor, the relay coil is simultaneously energized, pulling in the contacts. The logger interprets this as a change of compressor state (the start of the compressor). When the contactor deenergizes the compressor windings, the relay contacts open and the logger interprets this as another change of state (the end of the compressor run cycle).

The loggers will be installed in a weatherproof enclosure to keep them dry.

Definitions:

HOBOWare – the software application that is used to launch and readout the HOBO loggers.

Launch – Process that turns on the logger, checks its battery and prepares it to begin logging data. A logger must be launched initially and after each data readout. Launching deletes all on/off state data in the logger.

Readout – off-loads the data from the logger. When reading out a logger, it is possible to either stop the logging process or to continue logging. The data in the memory is not deleted simply by reading out the logger. You must launch the logger to delete the old data.

Procedures

Update your HOBOWare version. The version on the CD is out of date. You need to update to HOBOWare Pro.

PC Time Set

Each HOBO U9 logger is launched by the HOBOWare application on the PC – this sets the clock in the logger. Set the PC time each day before connecting the PC to a logger. This can be done by either the time-syncing feature of the Microsoft operating system (if your version supports that feature) or by connecting over the Internet to a site to sync with the atomic clock. Here are links to free utilities that can sync the PC to the atomic clock.

<http://www.analogx.com/contents/download/network/ats.htm>

<http://www.worldtimeserver.com/atomic-clock/>

During the initial launch, install new battery in all loggers.

Replacing Batteries

1. Remove logger from weather proof case
2. Unplug grey wire from logger
3. Remove battery using a pencil.
4. Install new battery with positive side facing up.
5. Plug the grey wire back into the logger.

Installation

Suggested tools: Nut driver, screw drivers, small diagonal cutters.

Materials: Logger, relay, 2 conductor wire, nylon cable ties, extra sheet metal screws.

1. Do not install on rainy days or when humidity approaches 95% (near dewfall).
2. Set the PC time before leaving home.
3. Open disconnect switch or pull fuses.
4. Open A/C unit.
5. Determine which relay to use.
 - a. If voltage is present on the load side of the contactor, a 24 volt coil relay must be used (Part number 90-293q). To energize this relay, low voltage from the contactor must be connected to 1 and 3. The black and white wire from the logger should be connected to numbers 2 and 4 on the relay (normally open).
 - b. If voltage is NOT present on the load side of the contactor, a 240 volt coil relay must be used (Type 91 relay). To energize the Type 91 relay, connect wires on the load side of the contactor to each side of the coil on the relay. The logger should be connected to 1 and 3 (normally open).
 - c. If voltage is NOT present and there are clearance issues, the part number 90-295q should be used. To energize this relay, connect two wires from the load side of the contactor to 1 and 3 on the relay. The logger should be connected to 2 and 4 (normally open).
6. Mount the relay in the control compartment of the A/C unit, near the contactor.
7. Mount the black case outside of the ac unit. Attach black case to the conduit between the Power Manager switch and the air conditioning unit with a wire-tie. Locate the black case containing the logger in the shade and out of direct rainfall if possible.
8. Run the grey wire from the logger along the conduit and through a grommet leading to the air conditioning unit control compartment.
9. Connect the black and white wires from the logger to the relay as described above in step 5.
10. Secure all wiring with cable ties.
11. Connect the logger to the PC with the USB cable and launch the logger by clicking the Launch Logger icon.
12. HOBOWare Launch Logger screen. These fields are to be completed at time of launch:
 - Description: must be set to **serial number**
 - State channels S-1: name = State Sensor, open = State Off, closed = State On

Channels to log: **UN-check** Logger's Battery Voltage
Launch Options: **Now**.

13. After all fields have been set, click **Launch**.
14. After the logger has been relaunched, click the Logger status icon and verify that the current status is "Launch, Logging" and the proper state of compressor running, On or Off, is being displayed.
15. While in the logger status mode, verify that the logger is correctly recording the compressor starts and stops. To do this, close the disconnect switch, manually engage the contactor to force the compressor to start, taking care to avoid the high voltage terminals on the contactor or start capacitor. Verify the state sensor display on the screen indicates State On when the compressor is running and State Off when the compressor is off. If you are not getting the correct response, see the **Troubleshooting** section below.
16. After verifying proper operation, disconnect the USB cable, close the logger enclosure, remount the logger.
17. Close A/C unit, replacing any lost or damaged sheet metal screws.
18. If still open, close disconnect switch or replace fuses. Make sure fuse holder is properly oriented.

Readout/Relaunch

The readout schedule for U9 loggers is every four weeks.

Do not readout the logger during a Power Manager event. You can call 877-392-4848 to see if there is an event under way. If the red LED on the Power Manager device is lit, there is an event under way and you should wait until a non-event day to readout the loggers.

Loss of good data will be minimized if you can avoid readouts during afternoon hours (12:00 - 6:00 PM), especially when temperature exceeds 85 deg-F. However, this is not an essential requirement, and can be disregarded when it would significantly complicate data collection.

Suggested tools: Nut driver, screw drivers, small diagonal cutters.

Materials: nylon cable ties, extra sheet metal screws, logger batteries

1. Do not readout on rainy days or when humidity approaches 95% (near dewfall).
2. Set the PC time before leaving home.
3. Connect logger to PC using the USB cable.
4. Using HOBOWare, click the Readout logger icon. It will ask if you want to stop logging. Click **Stop**.
5. While doing the readout, HOBOWare will suggest a file name based on the Description that was defined at the time of last launching. This file name should be the logger serial number perhaps with additional numerical suffixes if you are saving to a folder with other files with the same name. Click **Save**.
6. The Plot Setup screen will now appear. Click **Cancel**.
7. You must relaunch the logger to clear its memory. Click the Launch Logger icon.
8. HOBOWare Launch Logger screen.

9. If the battery level is 25% or less, you must replace the battery in the logger.
10. To replace battery, remove logger from weather-proof case.
11. Unplug grey wire from logger.
12. Remove battery.
13. Install new battery with positive side facing up.
14. Plug the grey wire back into the logger.
15. These fields to be completed at time of launch:
 - Description: must be set to **serial number**
 - State channels S-1: name = State Sensor, open = State Off, closed = State On
 - Channels to log: **UN-check** Logger's Battery Voltage
 - Launch Options: Now.
16. After all fields have been set, click **Launch**.
17. After the logger has been relaunched, click the Logger status icon and verify that the current status is "Launch, Logging" and the proper state of compressor running, On or Off, is being displayed.
18. After verifying proper operation, disconnect the USB cable, close the logger enclosure, remount the logger.
19. Helpful tip on closing weather-proof case: Place logger in case such that grey wire is on the hinge side of the case lid. The length adjustment of grey wire can be accomplished by loosening the outside nut on the case and adjusting the wire so that the lid of the case closes easily. A 2 ½ inch length of grey wire on the inside of the case will allow the lid to close easily.

Email the all data files to Carol Burwick at amanda.goins@duke-energy.com . Save a backup copy of the data files to a diskette or CD.

Troubleshooting

You can check the green LED to see if the logger is recording the A/C start but in sunlight it will probably be easier to look at the Logger Status screen in HOBOWare. The status should be Launched, Logging and the State should be On when the compressor is running and Off when the compressor is off.

If the logger is not logging, it needs to be launched.

If the State does not change to On when the compressor starts, the problem is either with relay or the wiring. Make sure the relay contacts close when the compressor starts and they open when the compressor stops. You can do this by checking the stereo plug with an ohm meter. Connect the meter to the tip and sleeve of the plug (the middle ring is not connected to anything) and measure the resistance when the compressor is off and again when the compressor is running. When the compressor is running, the resistance should be near zero (less than 5 ohms). When the compressor is off, the resistance should be infinity. If this is not the case, make the same check at the terminals of the relay contacts to determine if the problem is with the relay or the cable. Also verify that the relay coil is energized with 240 vac when the unit is running. If not, rewire it.

Appendix 2. Heat Index

The basic formula we use to calculate heat index is a 16 element polynomial in temperature (T, deg-F), and relative humidity (H, 0-100),

$$\begin{aligned} \text{HI} = & 1.6923\text{e}+1 + 1.85212\text{e}-1 * T + 9.41695\text{e}-3 * T^2 \\ & - 3.8646\text{e}-5 * T^3 + 5.37941 * H + 7.28898\text{e}-3 * H^2 \\ & + 2.91583\text{e}-5 * H^3 - 1.00254\text{e}-1 * (T * H) \\ & + 3.45372\text{e}-4 * T^2 * H + 1.42721\text{e}-6 * T^3 * H \\ & - 8.14971\text{e}-4 * T * H^2 + 1.97483\text{e}-7 * T * H^3 \\ & + 1.02102\text{e}-5 * T^2 * H^2 - 2.18429\text{e}-8 * T^3 * H^2 \\ & + 8.43296\text{e}-10 * T^2 * H^3 - 4.81975\text{e}-11 * T^3 * H^3 \end{aligned}$$

This formula is not used for temperature below 70, and in this case we define heat index to be identical to temperature. To achieve a smooth transition, we use the following definition for temperature between 70 and 80,

$$\text{Heat index} = 0.1 * (T - 70) * \text{HI} + 0.1 * (80 - T) * T$$

For temperature above 80, the heat index is HI.

Appendix 3. Hourly Load Reduction Model Fits

The model specification for hourly load reduction is of the form

$$LR = a + b * \text{MAX}[(HI - HI_0), 0]$$

Coefficients a, b and the knot point HI_0 are model parameters to be determined through the model fit procedure. Data for average load reduction (LR) used in the model fit procedure was obtained from the RS group as described in section 2.3. The data for hourly heat index (HI) is a composite of heat index computed from hourly weather observations at the weather stations CVG, IND, SDF. Each RS group participant is associated with a weather station, as described in Section 4 (see also Appendix 4). The relative weighting of each weather station in the composite HI is determined on an hourly basis according to the counts of valid RS duty cycles in that hour associated with the three weather stations. Weather observations are collected near the end of an hour. Since we want HI in the above formula to be heat index at the beginning of the hour of the LR data, HI must correspond to the weather observations for the prior hour.

For impact evaluation during 2007 control periods, models are needed for hours 15-18 and shed percentages 74%, 54%, 31%, 67%, 50%, 22% (not all combinations are required). The general approach of the model fit procedure is to perform a sequence of regressions with the equation given above, resulting in values for parameters a and b, as the knot point HI_0 varies over a grid. The model with highest R-square is selected. Model parameters obtained with this procedure are given in the table below:

Shed%	Hour	Knot	a	b	R-sq
74	15	85.9	0.831	0.490	0.711
74	16	87.2	0.958	0.509	0.685
74	17	85.2	0.960	0.487	0.637
74	18	85.2	1.015	0.507	0.609
54	15	85.9	0.441	0.356	0.714
54	16	87.2	0.525	0.387	0.713
54	17	85.2	0.525	0.382	0.655
54	18	85.2	0.564	0.397	0.607
31	15	86.3	0.183	0.184	0.667
31	16	87.2	0.215	0.198	0.673
31	17	85.2	0.209	0.214	0.644
31	18	87.3	0.269	0.227	0.567
67	15	85.9	0.676	0.451	0.712
67	16	87.2	0.791	0.475	0.700
67	17	85.2	0.794	0.456	0.647
50	15	86.0	0.385	0.326	0.712
50	16	87.2	0.456	0.354	0.710
50	17	85.2	0.456	0.354	0.656
22	15	86.0	0.110	0.122	0.626
22	16	87.2	0.136	0.134	0.665
22	17	85.2	0.127	0.149	0.638

Appendix 4. Indiana Weather Regions

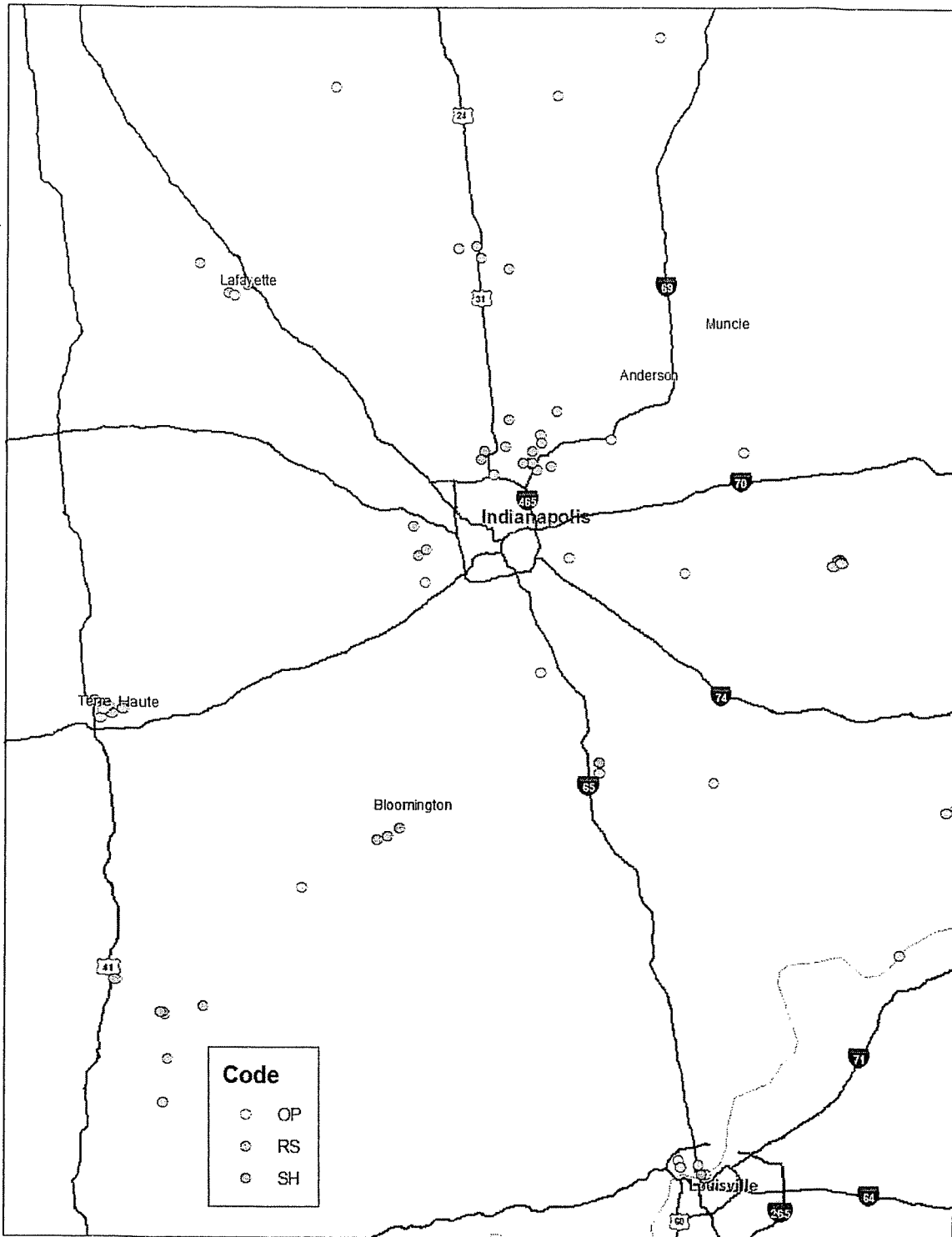
Indiana Zip Codes Assigned to Weather Region CVG:

47001	47023	47036
47003	47024	47037
47006	47025	47041
47010	47030	47042
47012	47031	47043
47016	47032	47060
47018	47034	47223
47022	47035	47250

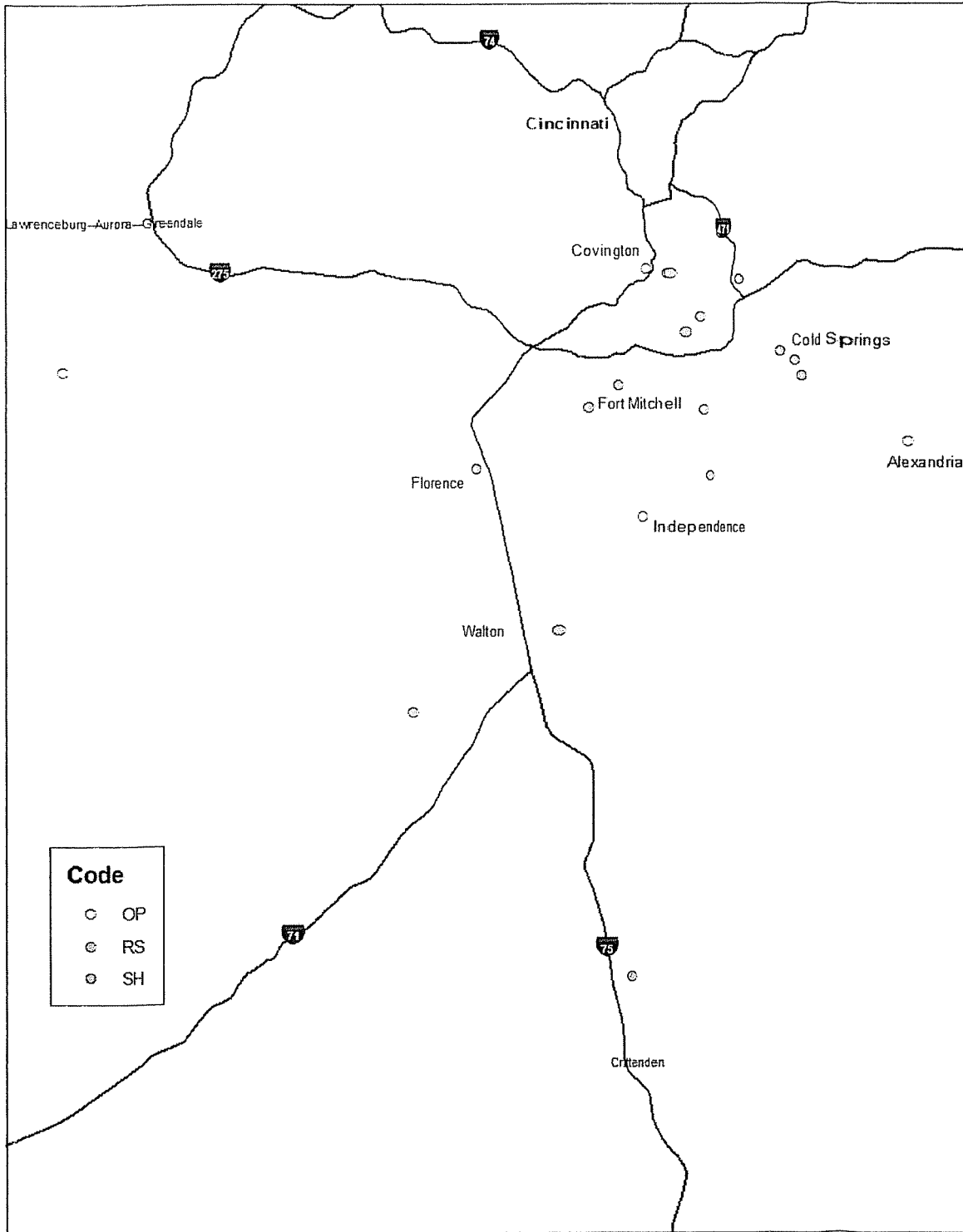
Indiana Zip Codes Assigned to Weather Regions SDF:

47102	47161	47524
47104	47162	47553
47106	47164	47557
47108	47165	47567
47111	47166	47581
47112	47167	47584
47114	47172	47591
47115	47220	47597
47118	47227	47612
47119	47229	47613
47120	47230	47616
47122	47231	47619
47123	47243	47633
47124	47260	47639
47125	47270	47640
47129	47281	47647
47130	47282	47649
47136	47432	47654
47137	47446	47660
47138	47452	47665
47140	47454	47666
47145	47469	47670
47147	47470	47683
47150		

Appendix 5. Indiana - Field Testing Locations



Appendix 6. Kentucky- Field Testing Locations



Appendix 7. Power Manger QC Field Test Check List

Date _____
 Time _____

Address _____
 Temperature _____

Switch ID _____

- Once at the house have Rose send the test to the plug in switch.
- Plug into the switch and read the register information:

Switch Data	
Option (Register 5)	
Opco (Register 1)	
Substation (Register 3)	
Feeder (Register 4)	
Group (Register 8)	

Activation Information	
Relay #1 Activation Counter	
Relay #1 Cumulative Shed	
Frequency	

General Inspection

- Verify that the switch is still connected to the air conditioner
 - Yes
 - No
- Check if the amber light is flashing on the switch
 - Yes
 - No
- Check the test on/ off light- (Green is on)
 - On
 - Off
- Verify the Paging signal 1.....2.....3
- Call Rose and have the switch put in the special test group

- Plug into the switch and read the register information

Switch Data	
Option (Register 5)	
Opco (Register 1)	
Substation (Register 3)	
Feeder (Register 4)	
Group (Register 8)	

- If the switch was verified in group _____ have Rose send a short event to the switch. Plug into the switch and read the register information

Switch Data	
Option (Register 5)	
Opco (Register 1)	
Substation (Register 3)	
Feeder (Register 4)	
Group (Register 8)	

Activation Information	
Relay #1 Activation Counter	
Relay #1 Cumulative Shed	
Frequency	

- If the switch responds to one or both of the tests above, move on to the next switch
- If the switch doesn't respond to the tests, open and close the disconnect and retry both tests.

Disconnect opened and closed:

- Call Rose and have the switch put in the special test group
- Plug into the switch and read the register information

Switch Data	
Option (Register 5)	
Opco (Register 1)	
Substation (Register 3)	
Feeder (Register 4)	
Group (Register 8)	

- If the switch was verified in group _____ have Rose send a short event to the switch. Plug into the switch and read the register information

Switch Data	
Option (Register 5)	
Opco (Register 1)	
Substation (Register 3)	
Feeder (Register 4)	
Group (Register 8)	

Activation Information	
Relay #1 Activation Counter	
Relay #1 Cumulative Shed	
Frequency	

Appendix 8: Power Manger Customer and Impact Evaluation Study 2006

Power Manager Customer and Impact Evaluation Study

**Duke Energy Indiana
Duke Energy Kentucky**

2006 Event Year

**Impact Modeling/ Metering
conducted by Duke Energy staff/ contractors**

**Customer Evaluation
conducted by Integral Analytics**

**Report Compilation and Review
conducted by Integral Analytics**

Quick Summary

Duke Energy currently offers a residential load control program called Power Manager to qualifying residential customers. This program offers customers a monetary incentive for reducing their air conditioning during peak demand periods. Duke is evaluating the current program to find ways to increase participation, insure customer satisfaction and improve the impact of the program. Several different methods of analysis were used to evaluate the program. A mail satisfaction survey was conducted with current participants. A conjoint study was conducted with participants as well as non-participants to discover what attracts customers to sign up for the program. Finally, a load research impact evaluation was completed using data loggers, end use metering and whole house metering equipment.

The Power Manager satisfaction survey revealed that the participant's satisfaction with the phone representative that handled their call was the most important indicator of overall satisfaction of the Power Manager program. The survey also revealed that the level of the participant's comfort during a control event was the second most important factor of participant's satisfaction. This important finding suggests that Duke needs to pay just as much attention to the process and operational aspects of participant sign up as it does on the program design and/or financial incentives.

Further, It was discovered through the conjoint analysis that the current program incentive offering of \$25 and \$35 was the most attractive incentive to customers to participate in the program. Alternatives like free thermostats held less appeal. It was also uncovered that a per event incentive is the most important feature to customers when they are considering signing up for the program. Presumably, this event savings is attractive in that it is shared with customers, and it increases as the level of potential interruptions increases.

Finally, It was discovered through the impact evaluation of the program that load impact estimates of the load control events done during the summer were substantially below the targeted load reduction. However, the report details possible reasons for the low impacts, cites a plan to diagnose the source of the problem, and fix it. At present, it is believed that the most likely reason for the low impacts is due to operational problems experienced with the signaling software tested among just the metered homes, and perhaps did not occur to the same extent, or perhaps not at all, among the population participants at large.

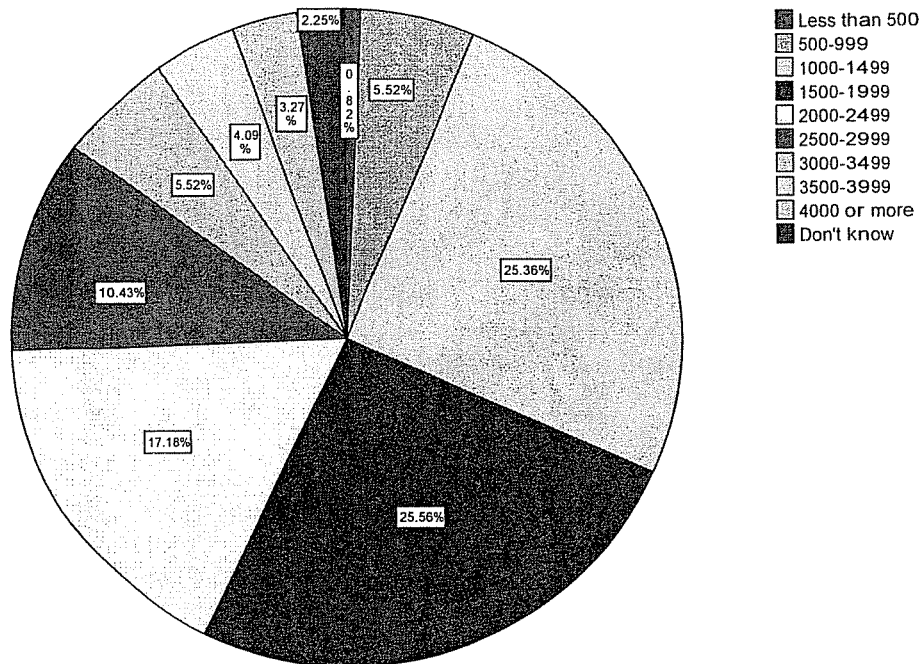
Although, the load impact estimates were substantially below the targeted load reduction expected, the program still passed cost-effectiveness tests. The Utility Cost Test result was 2.38.

Power Manager Satisfaction Survey

A Power Manager Satisfaction study was conducted in September 2006. A survey was sent to a random sample of 3,000 current Power Manager customers, 2,000 Indiana and 1,000 Kentucky. Of the 3,000 surveys that were sent out 1,392 customers responded for a 46% response rate. The intent of the study was to discover ways to increase the number of customers signing up for the program as well as to increase the satisfaction of the customers currently on the program.

Power Manager Participants Square Footage

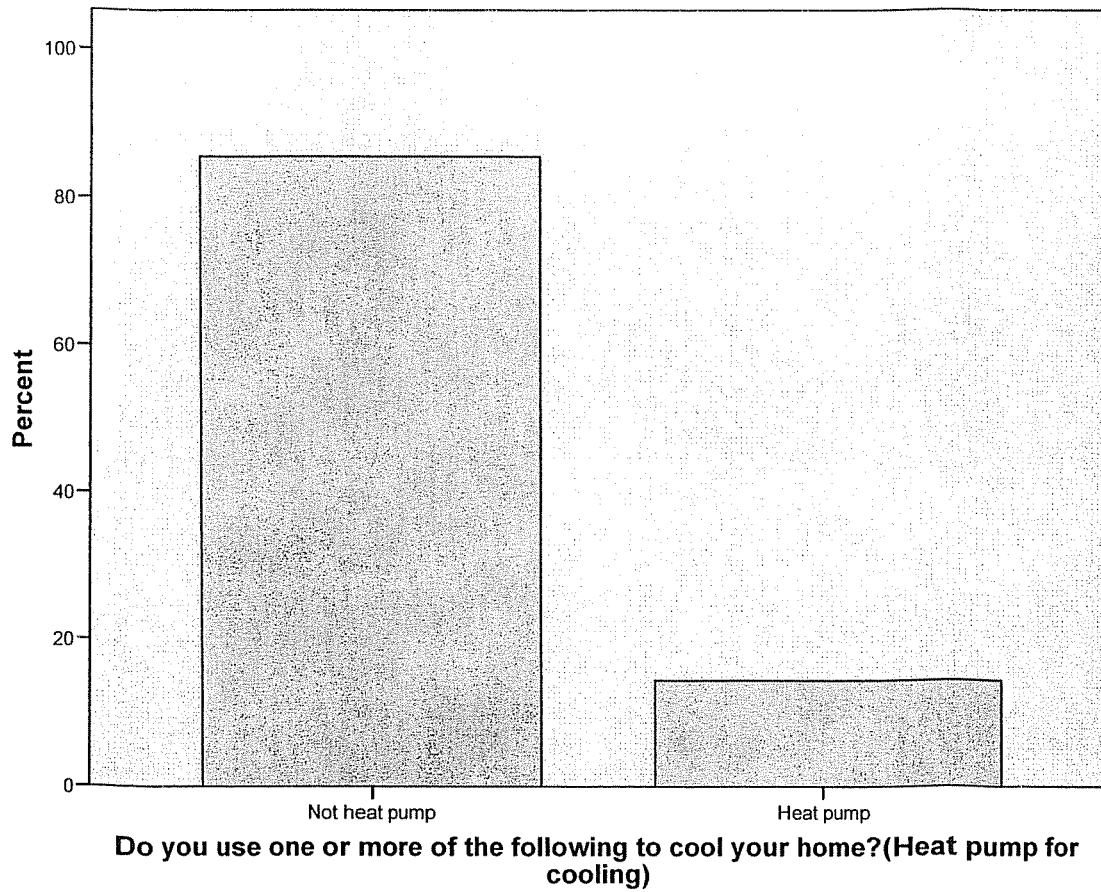
More than 50% of respondents live in a house between 1,000 and 2,000 square feet. Less than 1% lives in home smaller than 500 square feet. About one quarter of the population lives in homes between 2,000 and 2,999 square feet.



About how many square feet of living space are in your home?

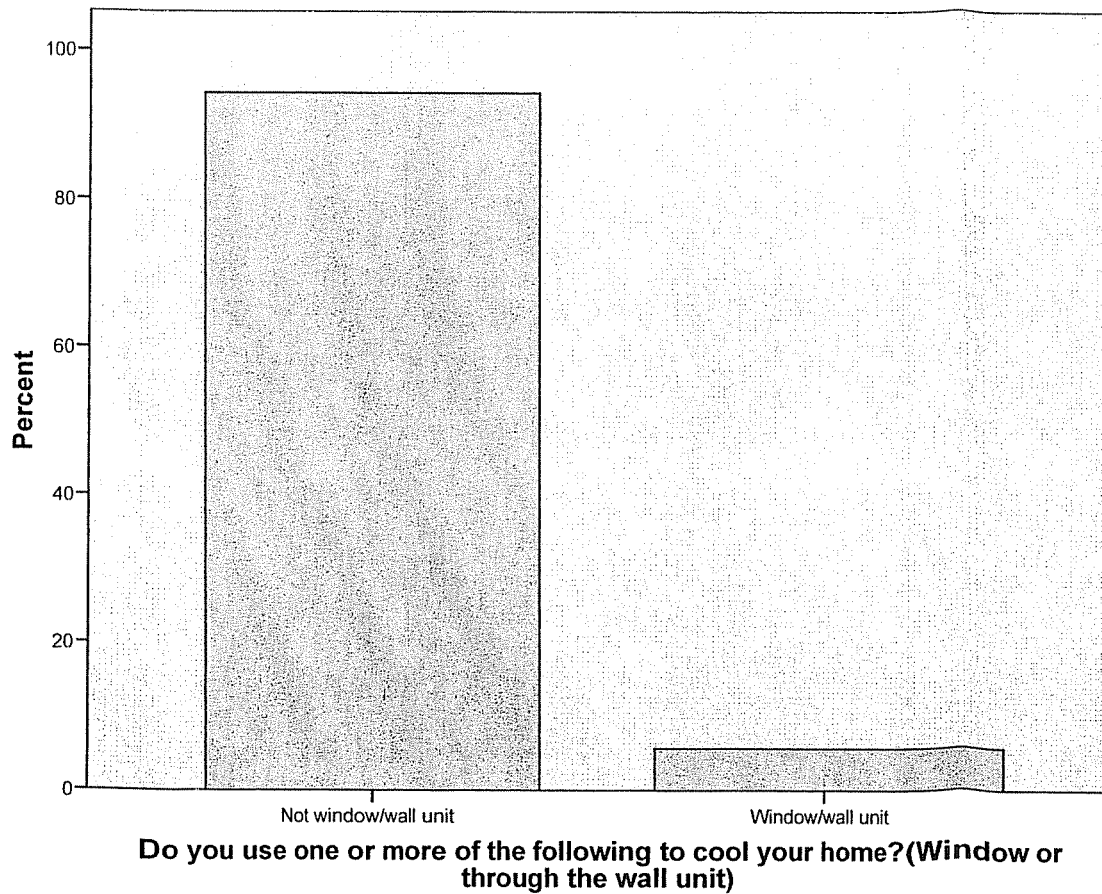
Heat Pump Participants vs. Central Air Participants

The primary source of cooling among participants currently is central air systems. Only 14.4% of the respondents use heat pumps for cooling their homes.



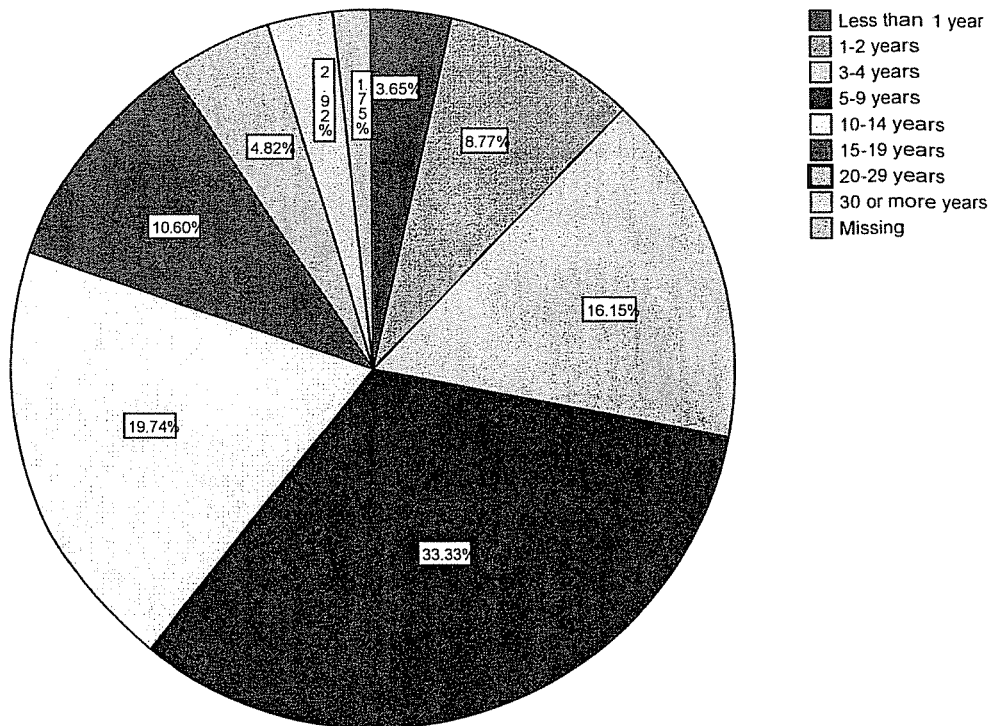
Window Unit Participants vs. Other Cooling System Participants

Although window unit cooling systems are not usually as efficient 5.7% of participants use window/wall units (sometimes in conjunction with AC). This group would make a good candidate for participation in the program due to high usage during peak hours.



Age of Cooling System

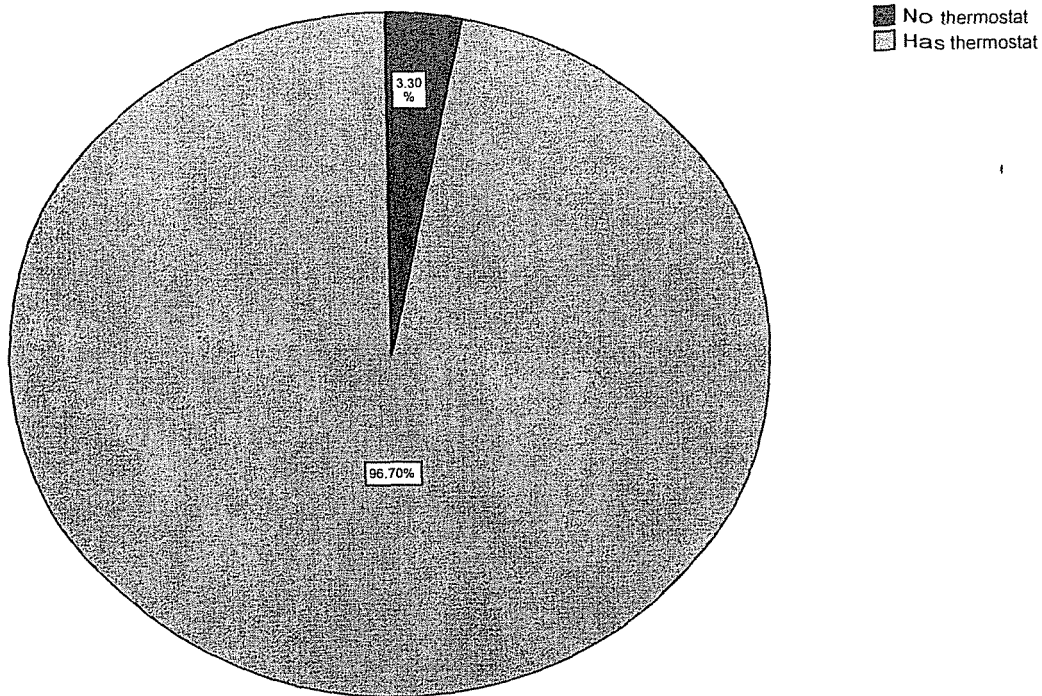
More than half of the sample population has cooling systems that have been installed between 5 and 14 years ago. One third of the cooling systems were about 5 to 9 years old. 18.34% of participants had cooling systems that were 10-30 years old or more. Only about 12.42% are using newer high efficient cooling systems that have been installed during the past two years. It is suggested to try and not target customers with high efficient cooling systems.



How old is your cooling system?

Thermostat Participants vs. No Thermostat Participants

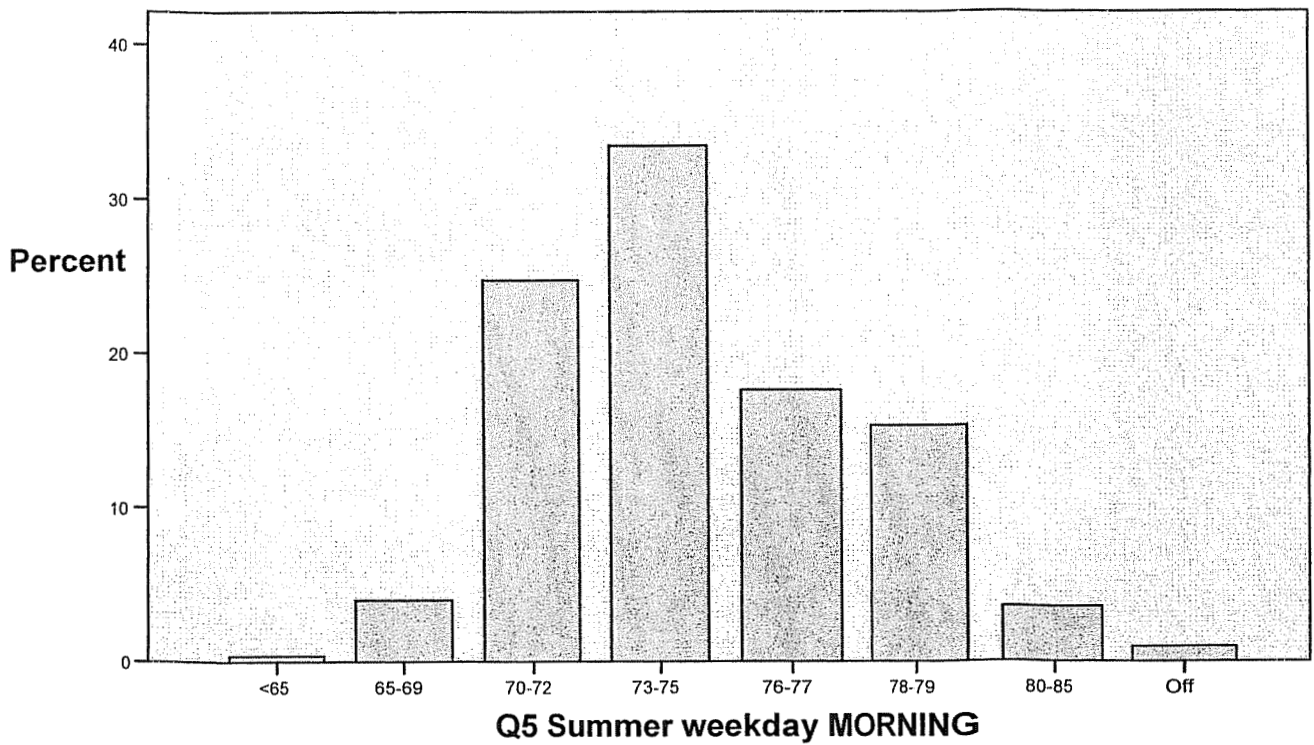
Only about 3.3% of participants have no thermostat. Not having a thermostat is a good indication of an older cooling system. Older systems with no thermostat are less efficient.



Do not have a thermostat

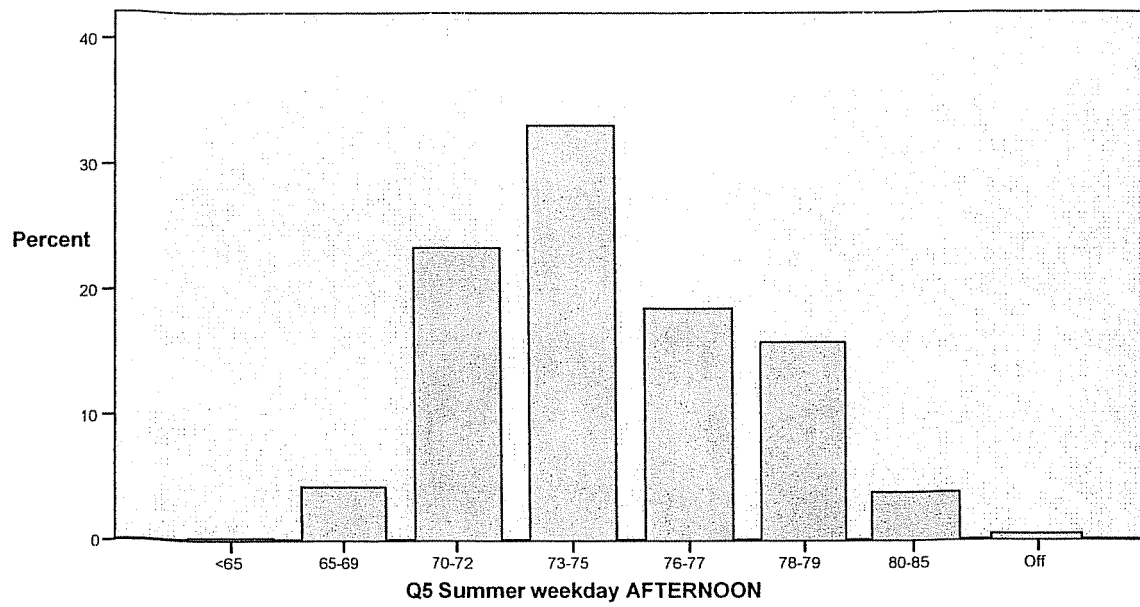
Temperature of Thermostat Summer Weekday Morning

About one third of respondents set their thermostat between 73 to 75 degrees in summer weekday mornings. 37.1% of customers set their thermostat above 76 degrees with .9% of which turn it off during summer morning weekdays.



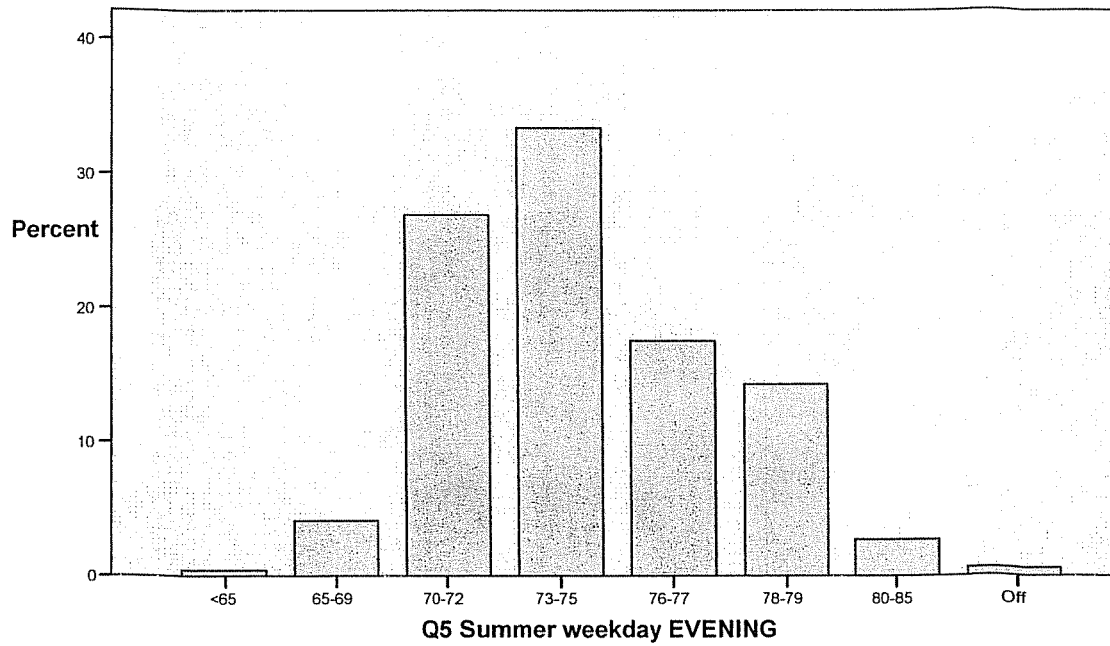
Temperature of Thermostat Summer Weekday Afternoon

About one third of respondents set their thermostat between 73 to 75 degrees.
38.9% of customers set their thermostat above 76 degrees with .5% of which turn it off during summer afternoon weekdays.



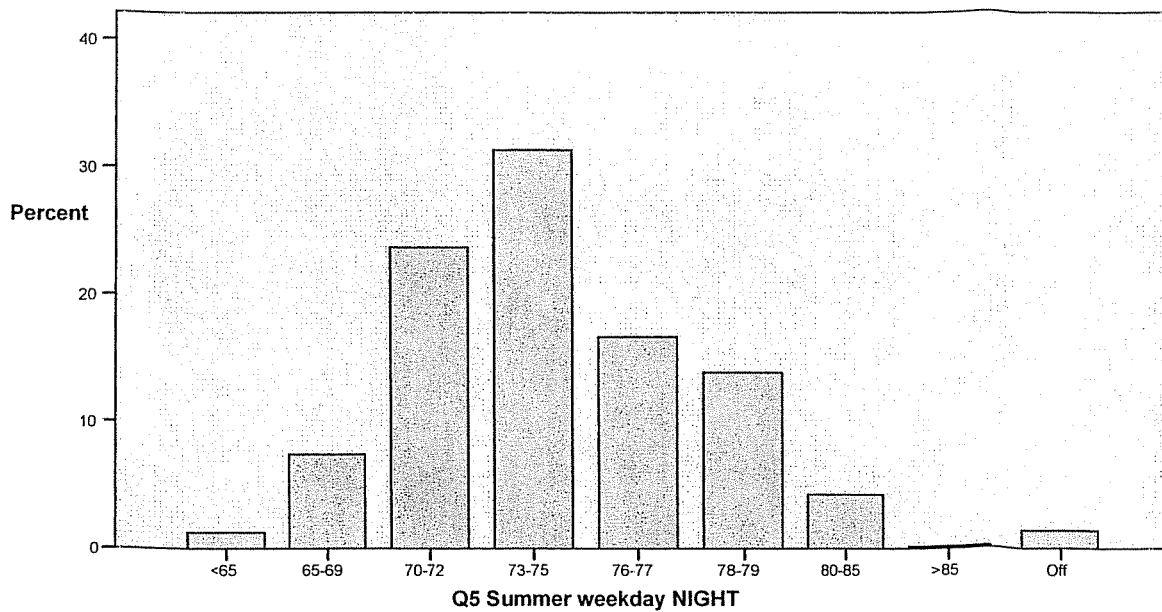
Temperature of Thermostat Summer Weekday Evening

About one third of respondents set their thermostat between 73 to 75 degrees.
35.1% of customers set their thermostat above 76 degrees with .6% of which turn it off during summer evening weekdays.



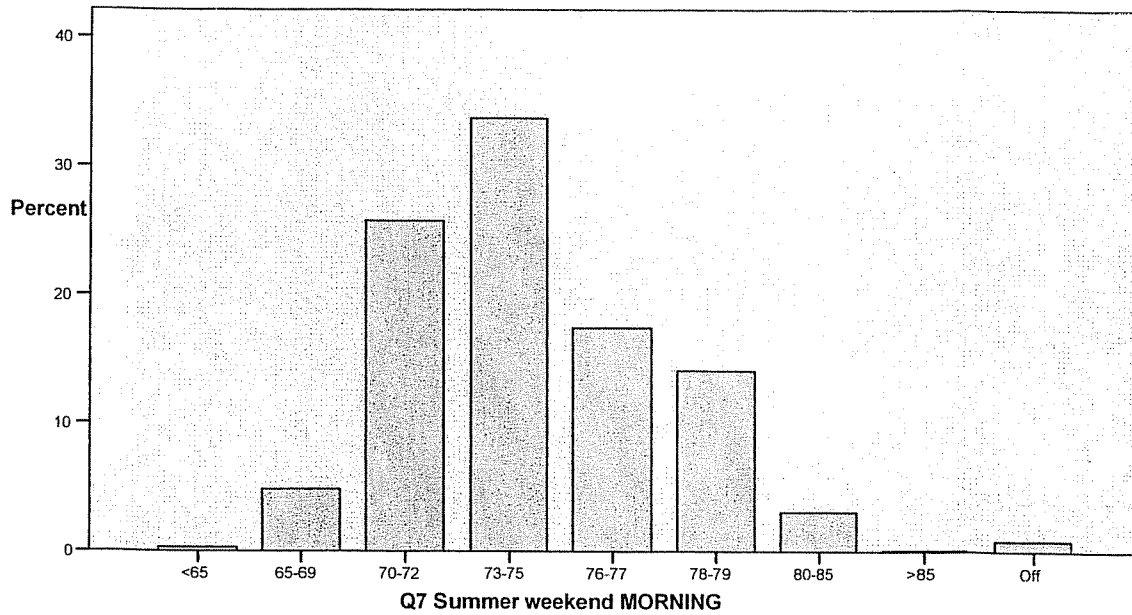
Temperature of Thermostat Summer Weekday Night

Less than one third (31.3%) of respondents set their thermostat between 73 to 75 degrees. 36.4% of customers set their thermostat above 76 degrees with 1.4% of which turn it off during summer night weekdays.



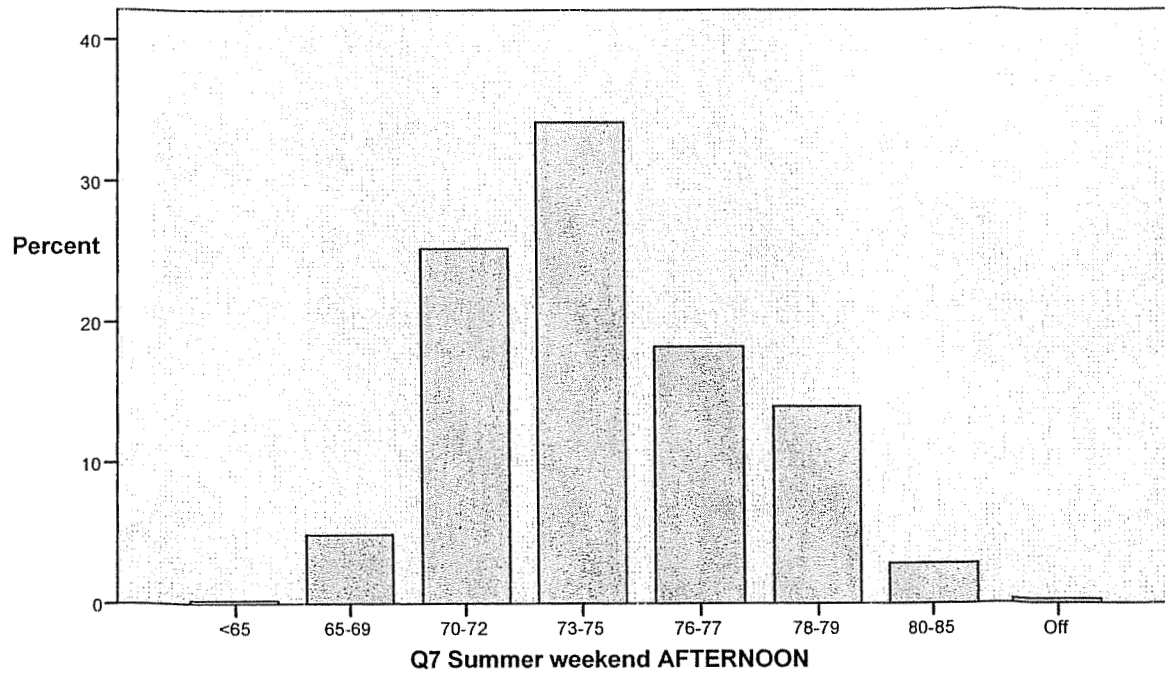
Temperature of Thermostat Summer Weekend Morning

About one third of respondents set their thermostat between 73 to 75 degrees.
35.5% of customers set their thermostat above 76 degrees with .9% of which either set it on higher than 85 degrees or turn it off during summer weekend mornings.



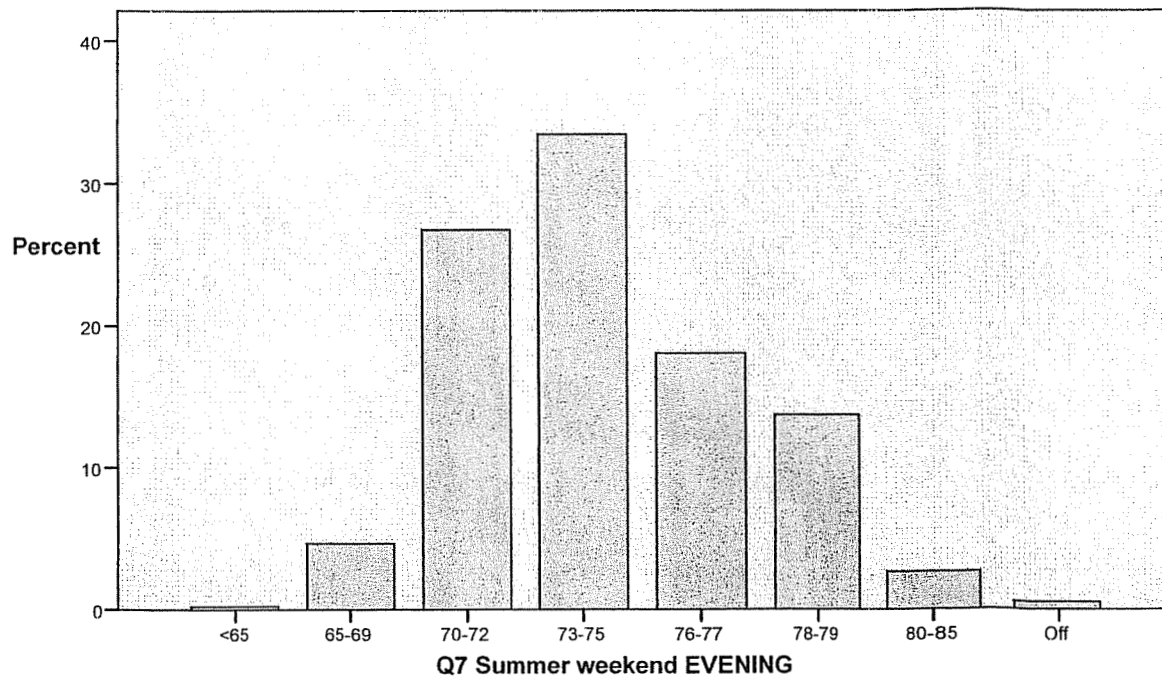
Temperature of Thermostat Summer Weekend Afternoon

More than one third of respondents set their thermostat between 73 to 75 degrees. 35.5% of customers set their thermostat above 76 degrees with .3% of which turn it off during summer weekend afternoons.



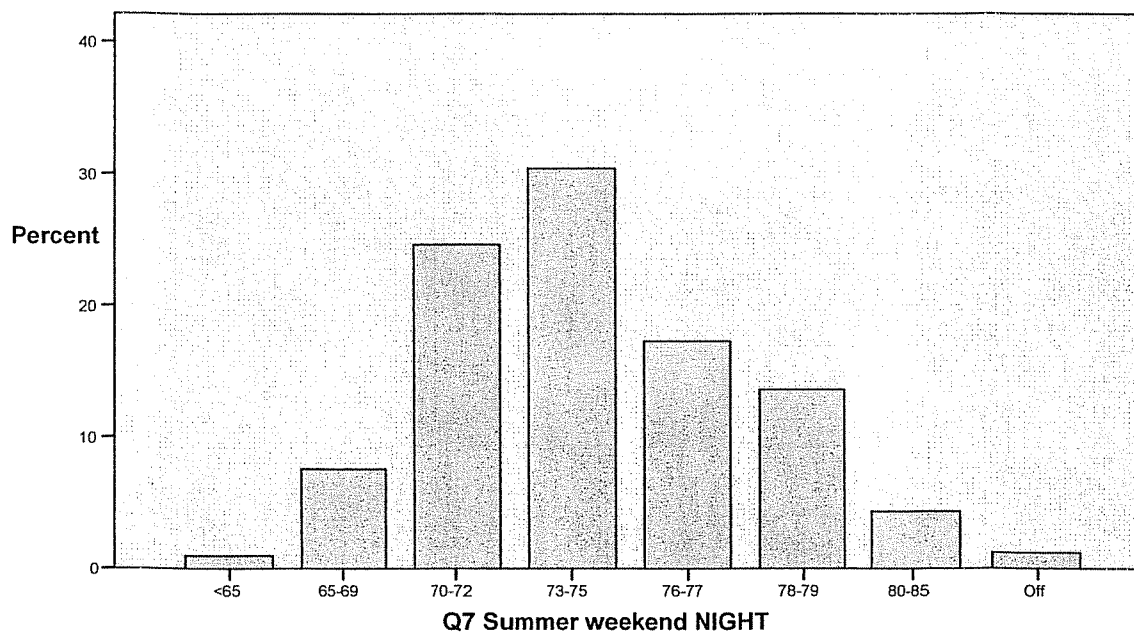
Temperature of Thermostat Summer Weekend Evening

About one third of respondents set their thermostat between 73 to 75 degrees.
35% of customers set their thermostat above 76 degrees with .5% of which turn it off during summer weekend evenings.



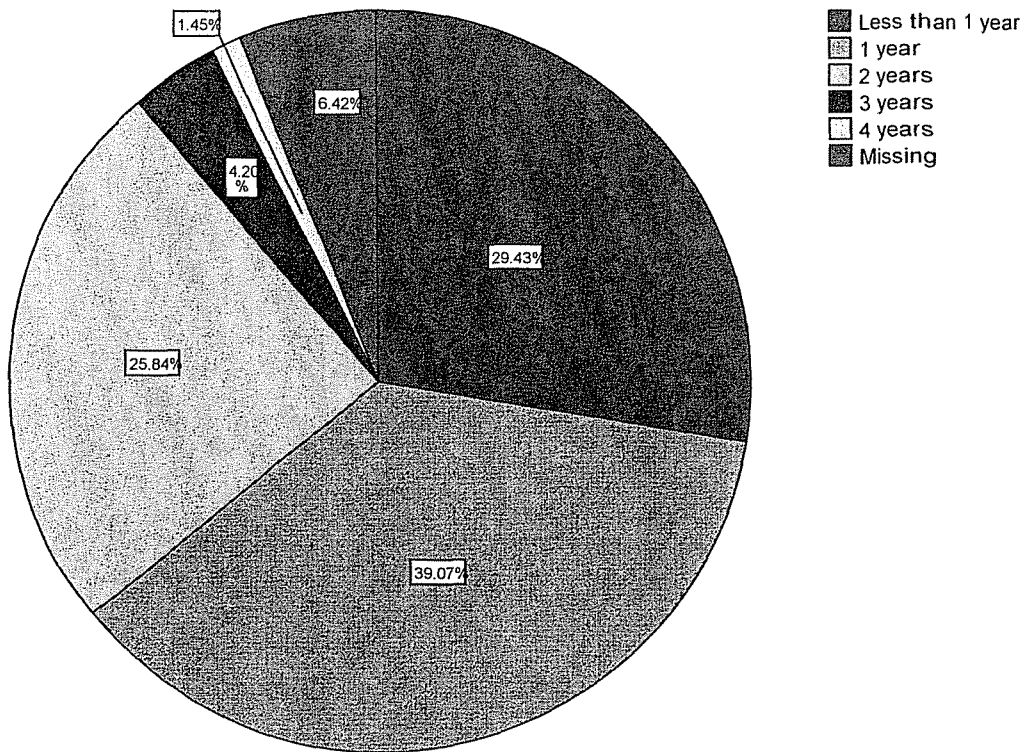
Temperature of Thermostat Summer Weekend Night

Less than one third of respondents set their thermostat between 73 to 75 degrees. 36.4% of customers set their thermostat above 76 degrees with 1.2% of which turn it off during summer weekend nights. It is recommended to target customers with thermostats set in cooler degrees during peak hours of weekdays.



Length of Participation in Power Manager Program

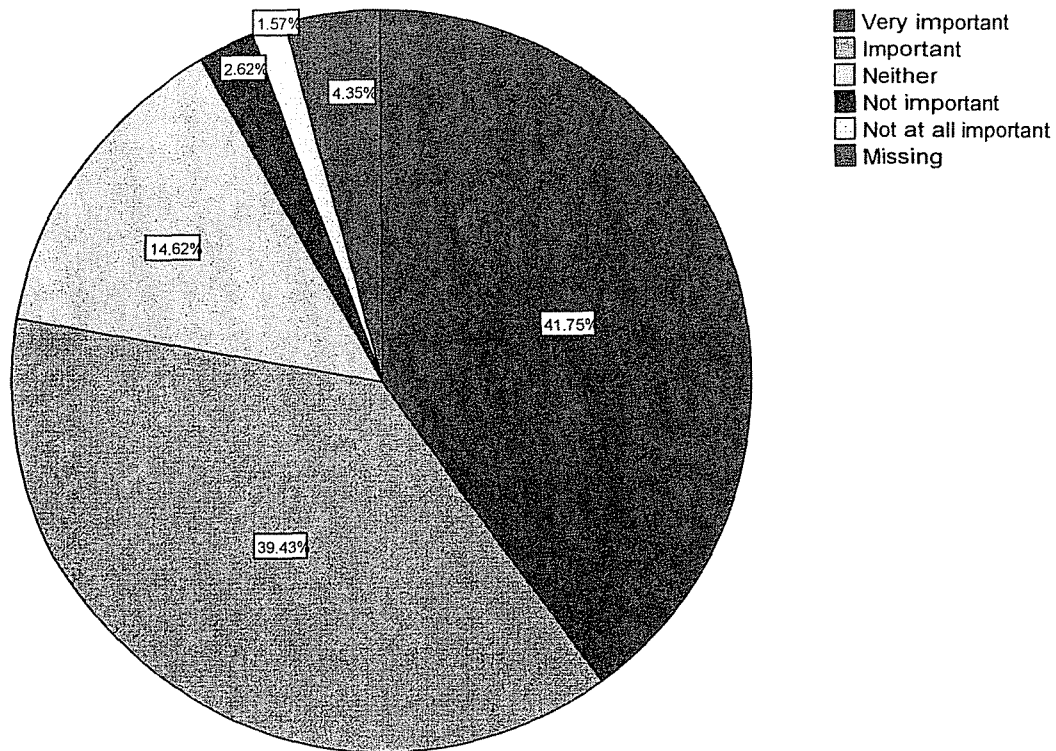
Less than one third of the customers have been participating in the program for less than 1 year, while 39.07% have been in the program for one year. One fourth of participants have been with the program for two years and less than 6% have been with the program for three to four years. It might be a good idea to send an appreciation note to customers who are in their first or second year of participation.



How long have you participated in the Power Manager Program?

Importance of Monetary Incentive

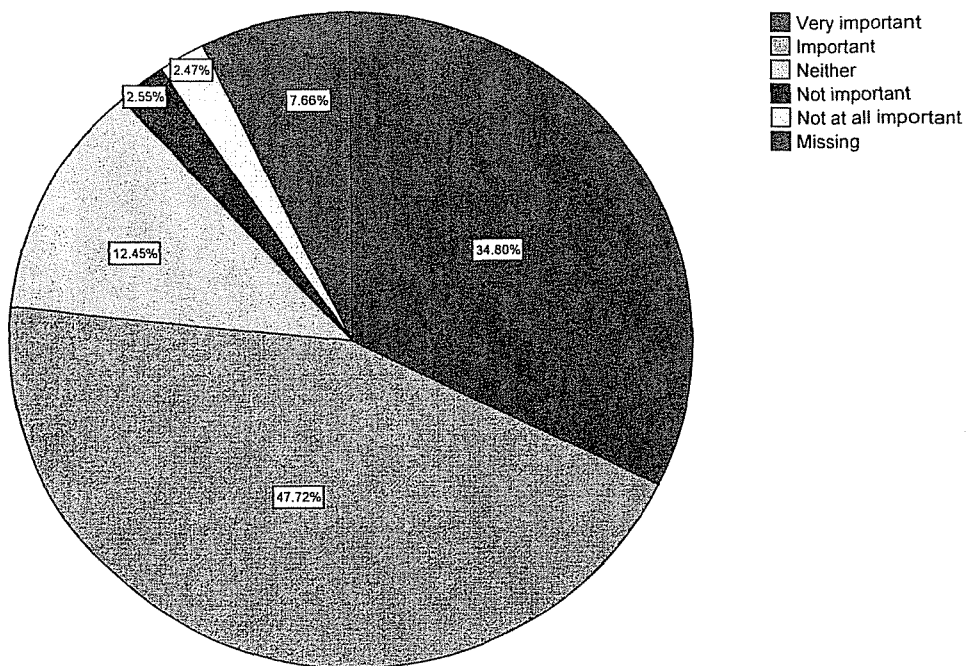
Money is a significant factor for more than 80% of participants while only less than 4% of participants claim that money is not an important factor for them. Depending on budget limitations, increasing monetary rewards would satisfy most participants.



Q10 Factors - MONEY

Importance of Environment

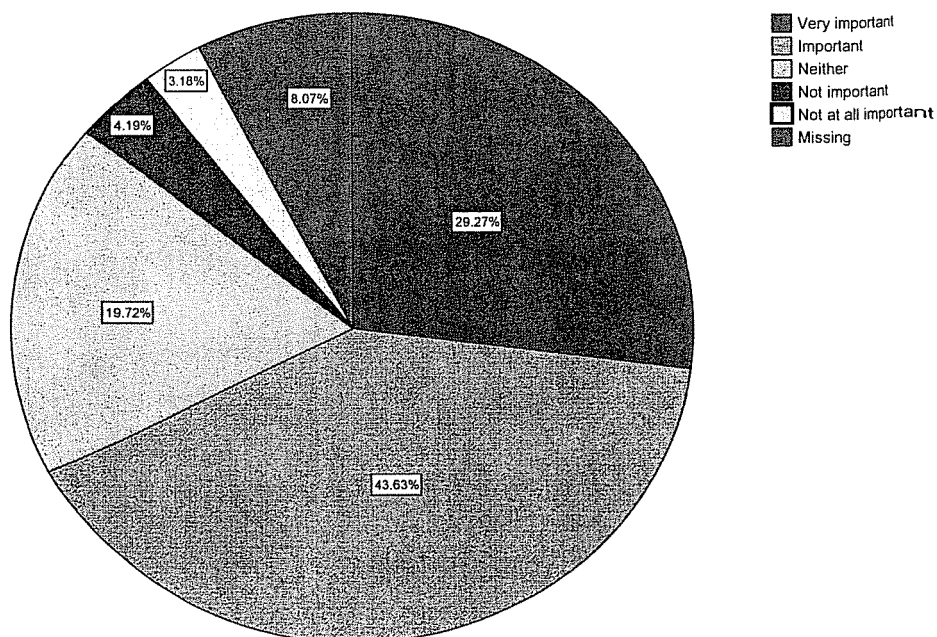
More than 82% of participants consider environment as an important or very important factor while only about 5% claimed that environment is not an important factor for them. Improving the environment is as strong of a factor as monetary rewards. It is recommended to send participants information on the impact their participation in the program is making on the environment.



Q10 Factors - ENVIROMENT

Importance of Not Building Power Plants

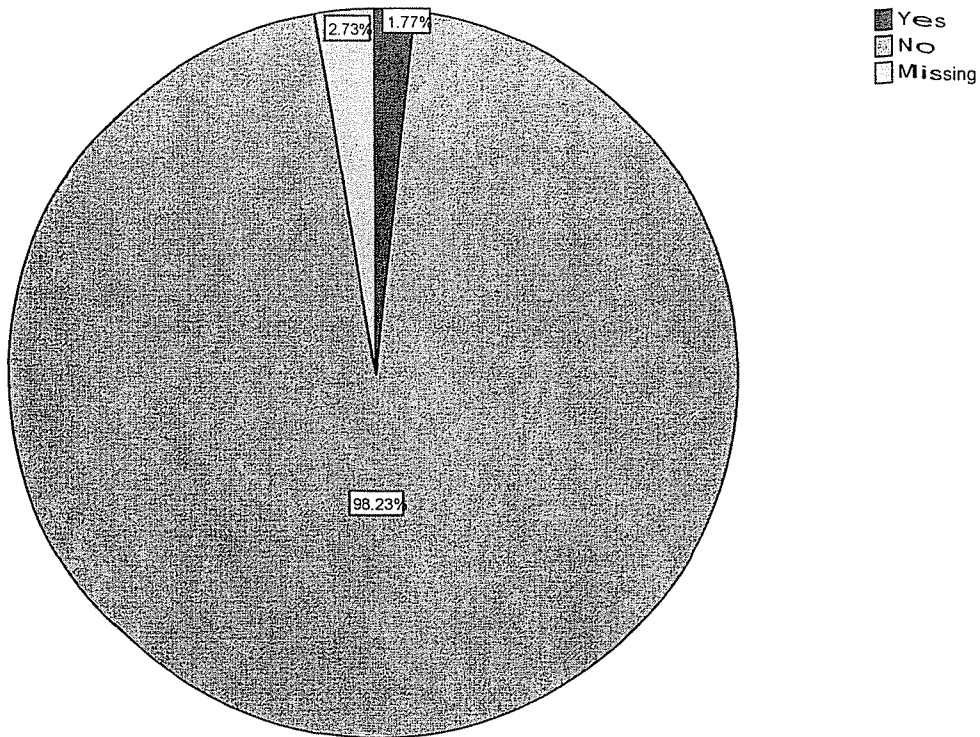
For almost two third or 67.5% of participants “Not Building a Power Plant” is either important or very important. About 20% of participants are indifferent. While only 7.37% of participants believe that “Not Building a Power Plant” is not important. It could be beneficial to send participants information on the impact that their participation in the program has on plans to build additional power plants since for the majority of participants not building a Power Plant is an important factor.



Q10 Factors - NOT BUILD POWER PLANTS

Option to Opt out of Control Event

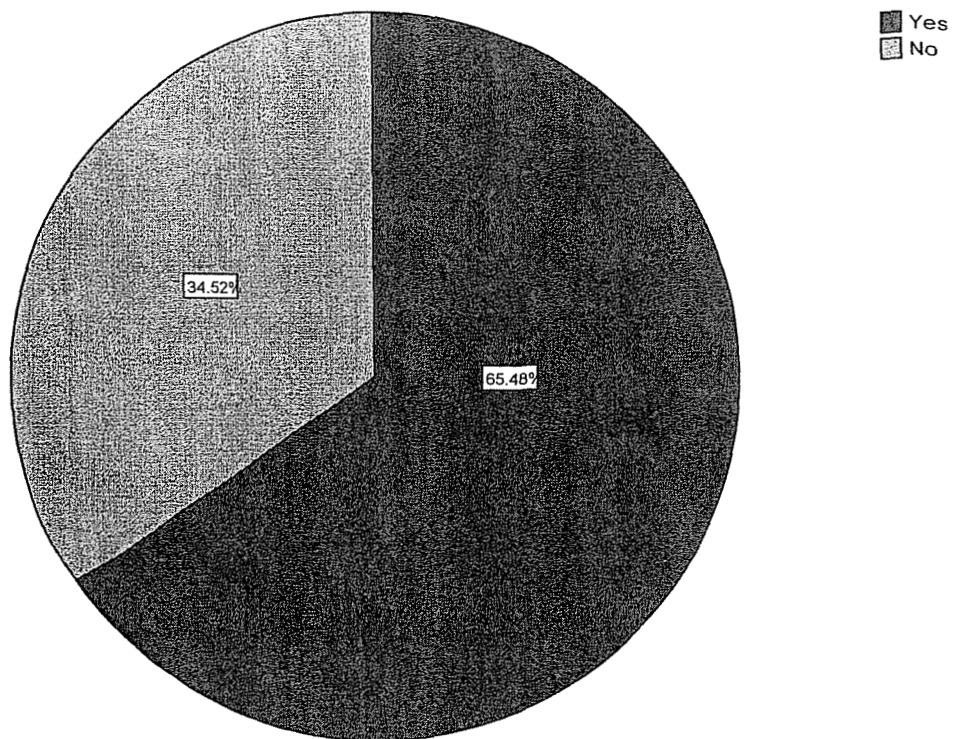
Only about 1.77% of participants would choose to opt out of one of the control events.



Did you ever choose to opt out of one of the control events?

Participants that were Home during Control Events

About two third of participants were home during the control events. 30.22% of participants did not answer this question suggesting that they might not have noticed when the control event happened, indicating they did not experience any discomfort.

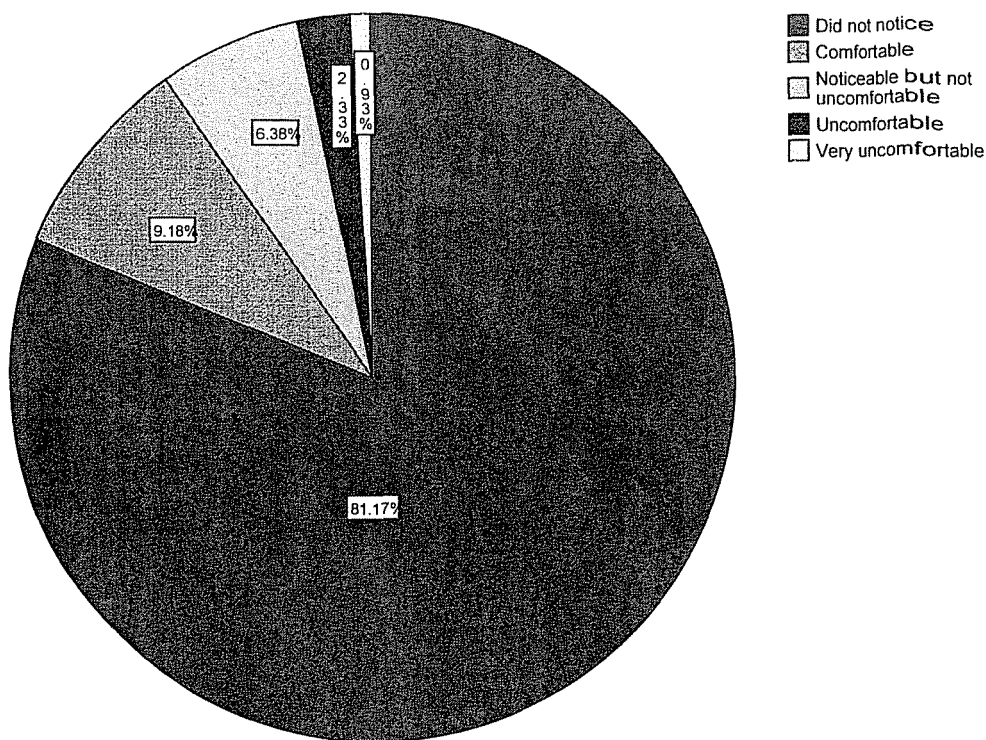


Were you usually home during control events that occurred?

How Comfort Level was Affected during Control Event

More than 90% of participants either did not notice or were comfortable during the control event.

Only less than 1% of participants were very uncomfortable while 3.2% were either uncomfortable or very uncomfortable. It could be recommended to give the people who are uncomfortable the option to receive a notice a day in advance about the control event occurring and give them the option to opt out.

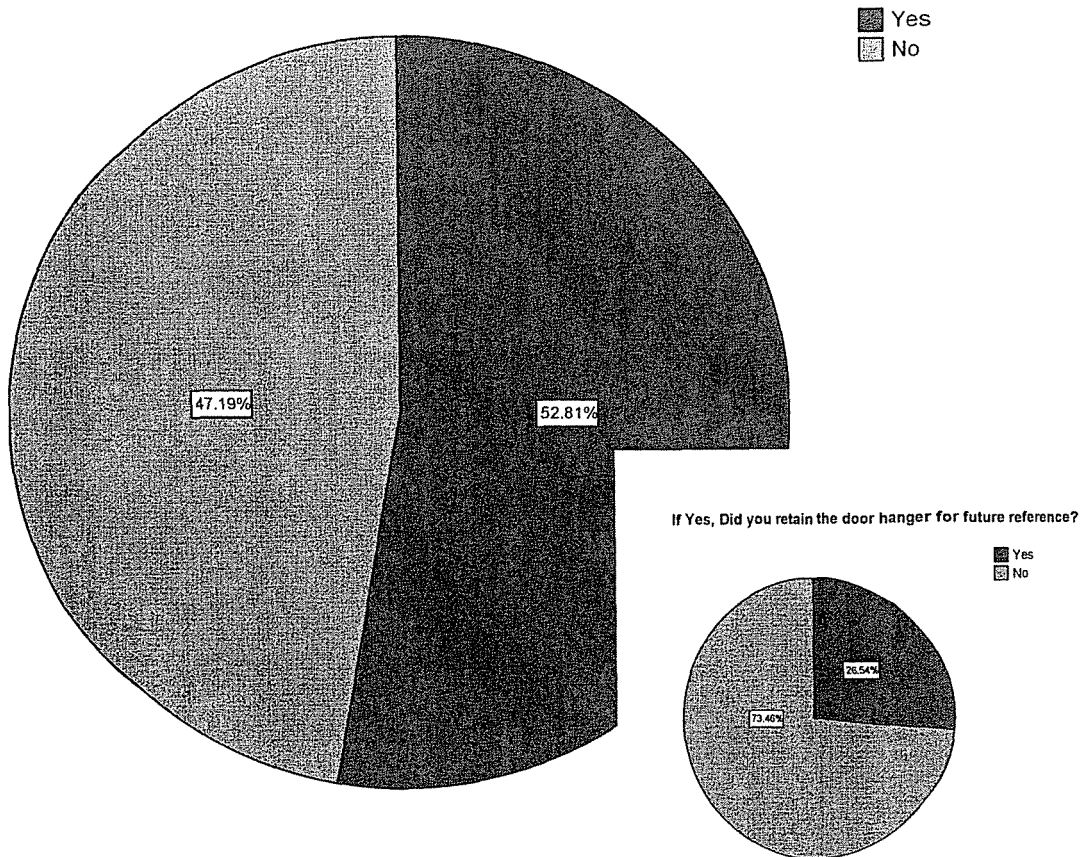


How much did the control event affect your comfort level?

Retention of Informational Door Hanger

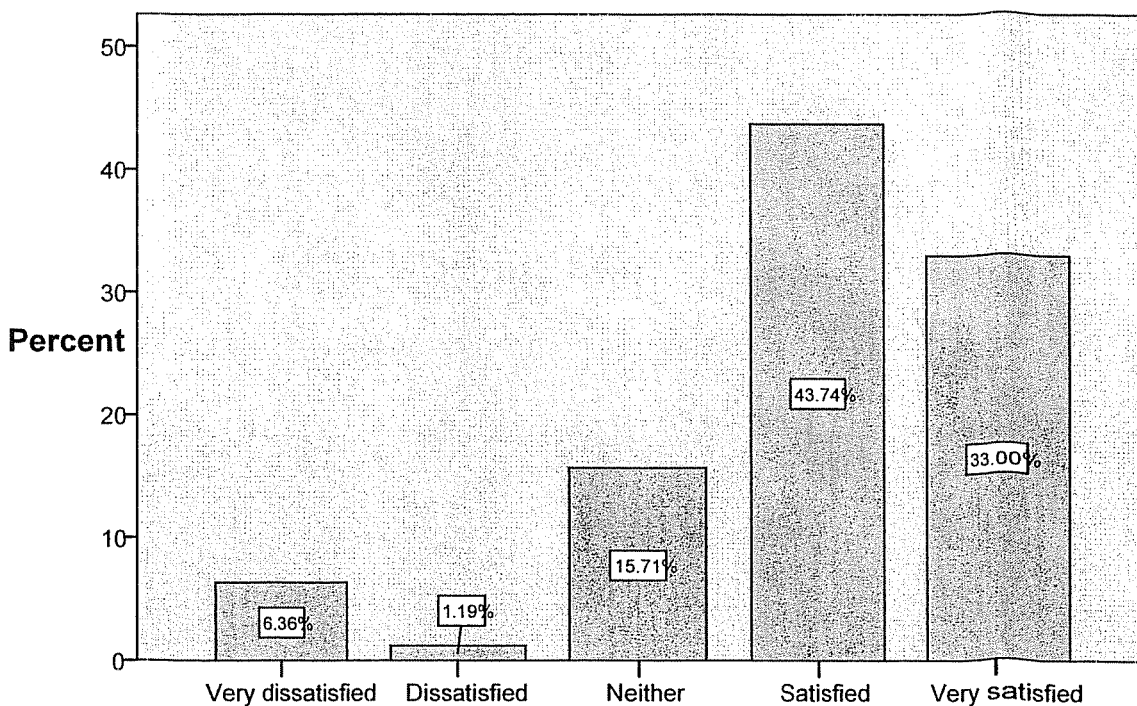
More than half of the participants received a door hanger with the power manager 1-800 number on it, more than one fourth of which kept it.

Did you receive a door hanger with the Power Manager 1-800 number when your switch was installed?



Satisfaction with Power Manager Phone Representative

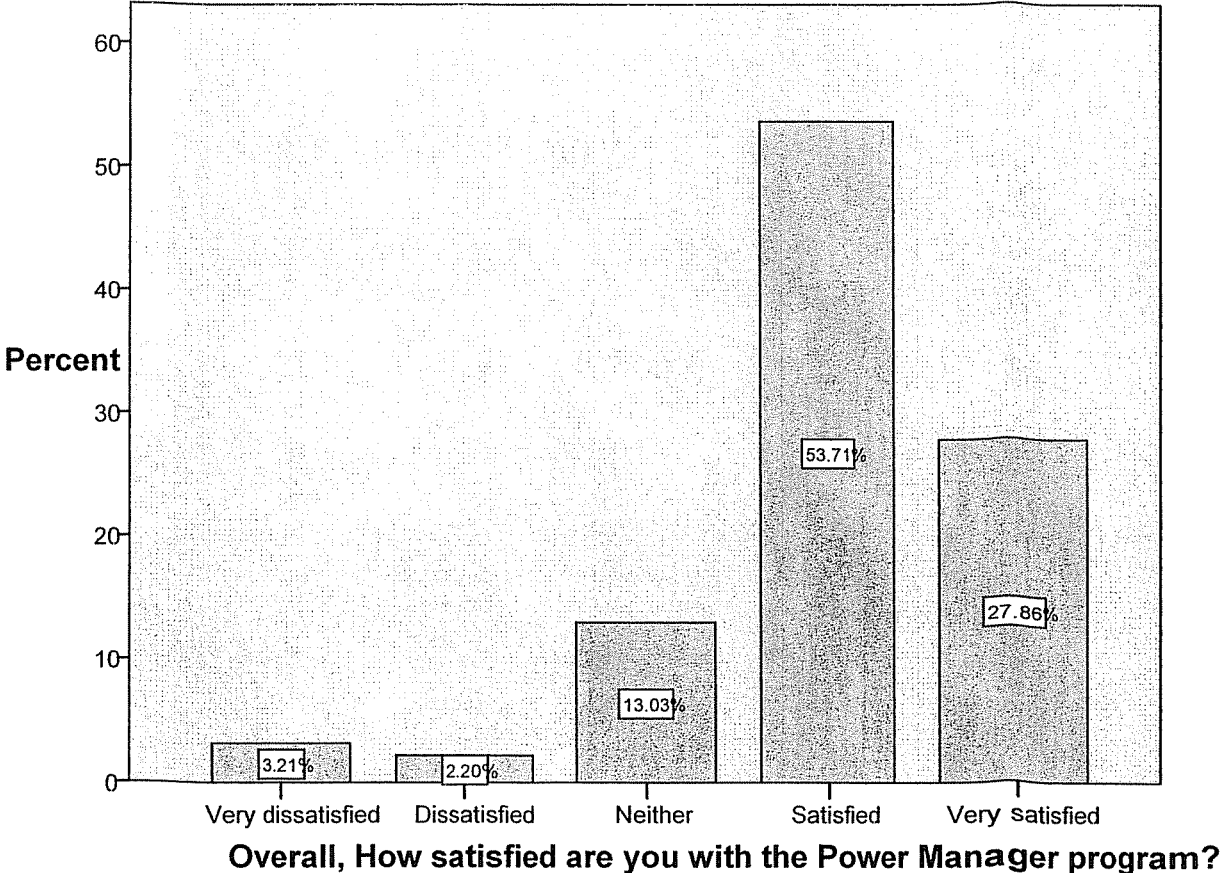
76.74% of participants were either satisfied or very satisfied with the Power Manager phone representative whereas 7.55% were dissatisfied or very dissatisfied with the phone representative. More research could be done to uncover what made them unsatisfied with the phone representative. Based on the research the phone representative could then be trained better in those areas.



Overall, how satisfied were you with the Power Manager phone representative who handled your questions?

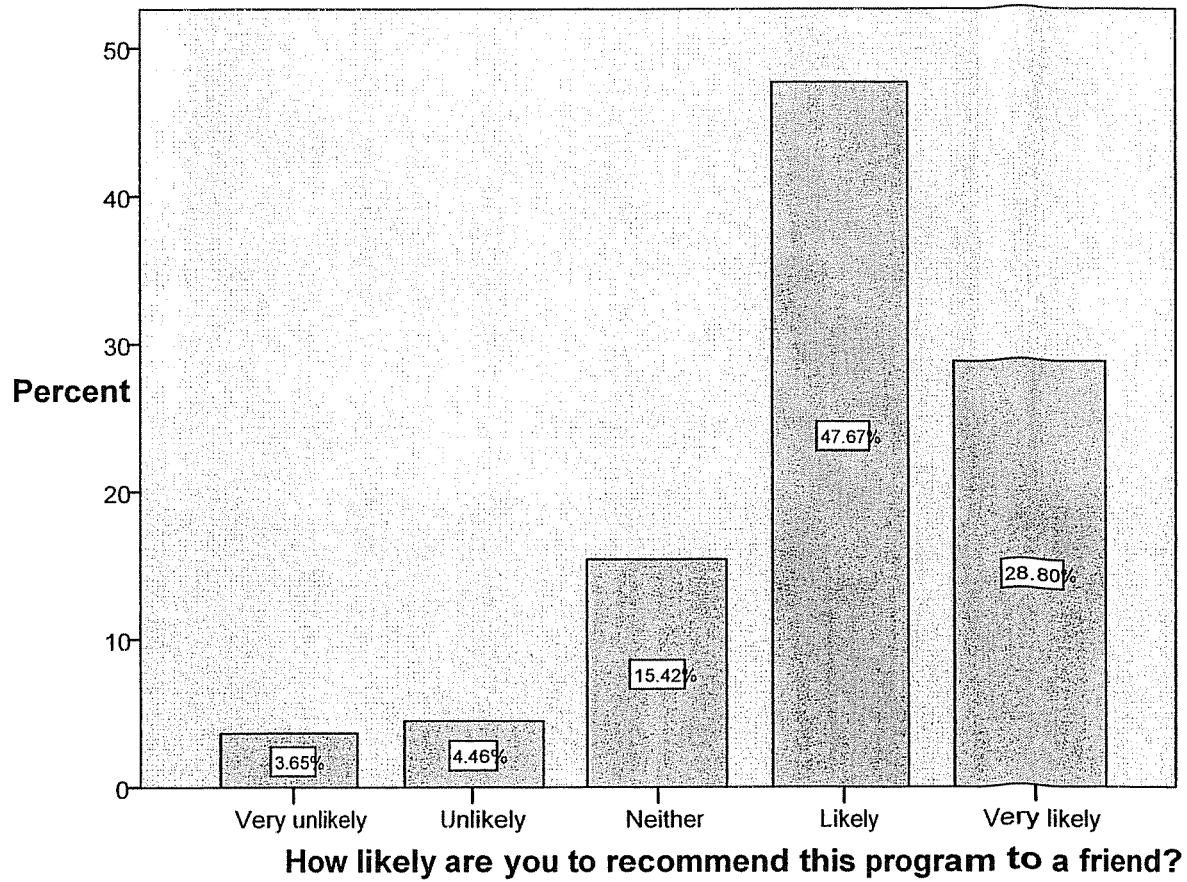
Overall Satisfaction with Power Manager Program

81.57% of participants were either satisfied or very satisfied with the Power Manager program whereas only 5.41% were dissatisfied or very dissatisfied.



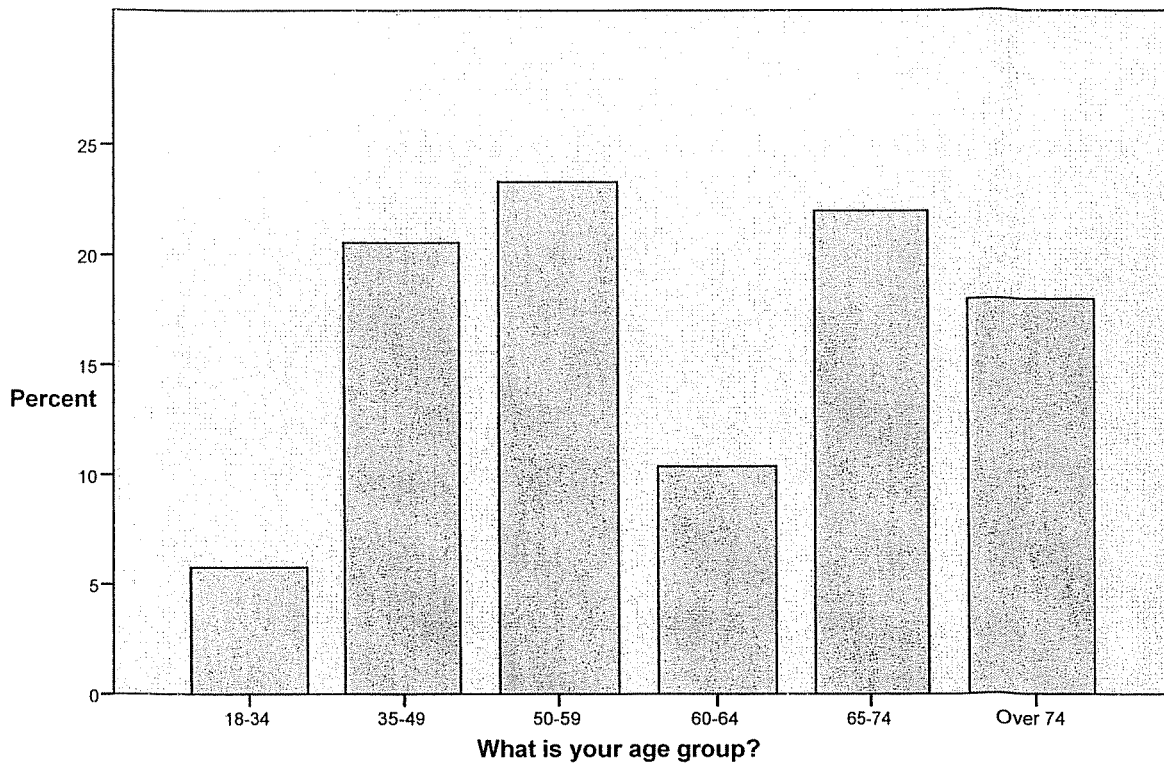
Likelihood to recommend Power Manager to a Friend

76.47% of participants are either likely or very likely to recommend this program to a friend whereas 8.11% of them are unlikely or very unlikely to do so. To increase the word of mouth about the program, a monetary reward to get a friend to sign up could be implemented.



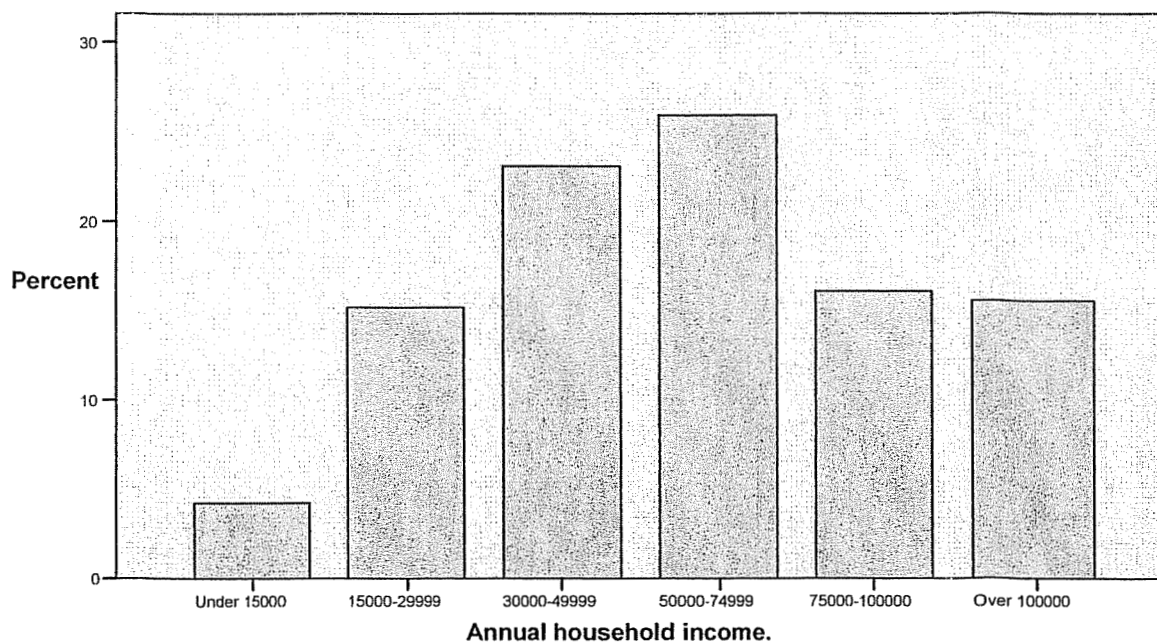
Age of Participants

More than half of the participants (53.8%) are between 35 and 59 years of age while 40% of them are 65 and over.



Annual Income of Participants

About 49% of the participants had annual income of 30,000 to 74,999. While 19.4% of people had annual income of less than 30,000, over 31% of participants have an annual income of 75,000 or more.



Drivers of the Power Manager Program Participant's Satisfaction

A regression analysis was done to discover which variables are the most important attributes at contributing to satisfaction of the Power Manager program. The following is the results of the analysis.

Participant's satisfaction of how the power manager phone representative handled their questions is the most important indicator of overall satisfaction of the power manager program. This may suggest:

- Special attention to training phone representatives is viable.
- Constant tracking of the performance of phone representatives is important.
- Placing courtesy thank you calls after control events may sustain/increase satisfaction.

To what extent participants become uncomfortable during control events is the second most important indicator of participant's satisfaction. The more uncomfortable they become the greater the dissatisfaction. Recommendations are:

- Targeting younger customers may increase participation as they are less sensitive to change in temperature during control events.
- Targeting customers who are not at home during control events is recommended.

Helping the environment is an important factor in satisfying participants. Recommendations are:

- Emphasizing on environmental outcomes in marketing campaign is an effective tool in obtaining customers in the program.
- Reminding participants of the environmental benefits when they call the 800 number.

There is a relationship between temperature settings and summer weekend nights. This indicates that participants who have the habit of setting their thermostat on higher degrees during the summer are generally more satisfied with the program since they have a higher tolerance for heat. This may suggest:

- Targeting customers with such habits as turning their thermostat up in the summer.

Target Marketing Recommendations

A correlation analysis was performed on the most important Power Manager attributes from the regression analysis to discover how those attributes related to each other. Using focused cluster and regression analysis makes it possible to have a better understanding of causes of satisfaction and dissatisfaction of participants and will provide more effective ways to promote and keep these participants.

Details regarding the correlation analysis can be found in Appendix A.

Grouping the participants based on income and age provides very accurate results for deciding which groups to target for future marketing in the program.

Participants with lower income are more likely to witness the control event and call the 1-800 number and in general feel more uncomfortable during the event. On the other hand the very wealthy people are more likely to have newer and more efficient cooling system and are less likely to have heat pumps in their homes. In general, the wealthy people are less concerned about the Power Manager Program. So we could conclude that the very low income and very high income households would not make a good candidate for the program while the middle income households (income between 30,000 and 100,000) would be the best candidates.

Older people are more likely to own older cooling systems as well as using window unit as cooling systems. Older people are also more likely to have less income and to keep the informational door hanger. They are also less likely to call the 1-800 numbers and they tend to stay in the program longer. Despite the fact that in general participants who were home during control events experienced more discomfort and would leave the program, the older group of participants tend to stay longer in the program even though they were more likely to be home more often during control events than the younger participants.

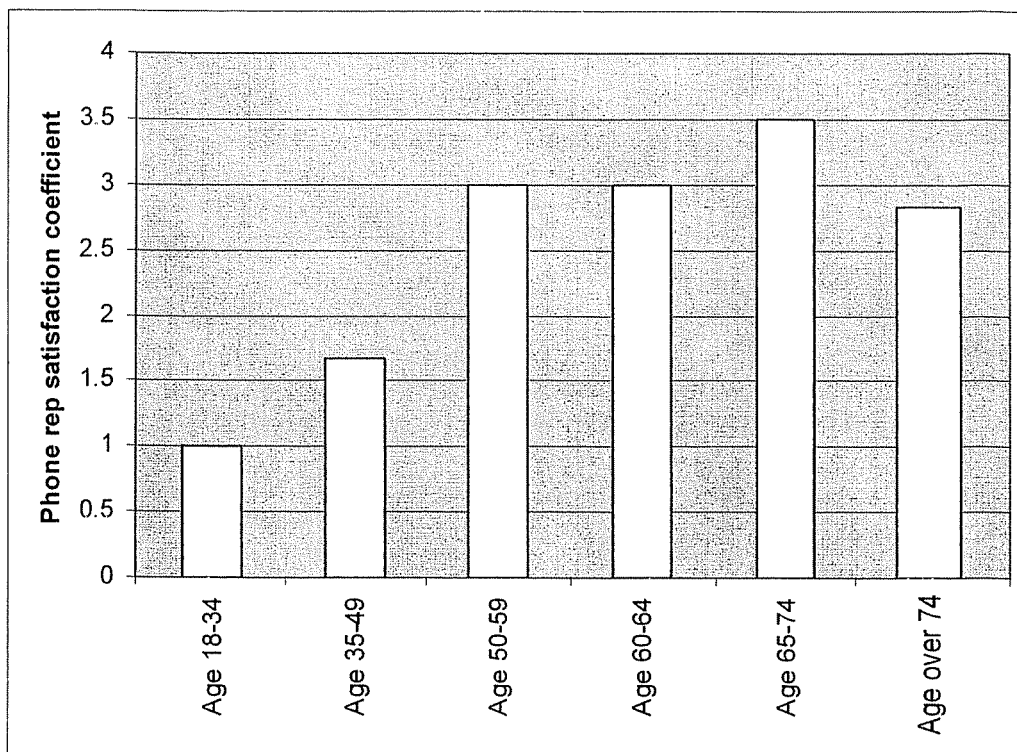
In order to maximize participation in the future, the study also suggests a closer look at people with homes between 1,000 and 2,999 square feet. Customers with homes in the above mentioned range make up 75% of total participants in the program thus a significant target for any promotional campaign. Targeting residents of smaller homes (less than 500 square feet) does not seem to be effective since these are low usage customers also make up less than one percent of participants in the program.

Satisfaction of the Power Manager Phone Representatives

The most important indicator of overall satisfaction was the participant's satisfaction of the power manager phone representative that handled their call. Due to this attributes importance further analysis was done on the satisfaction of the phone representative and overall satisfaction.

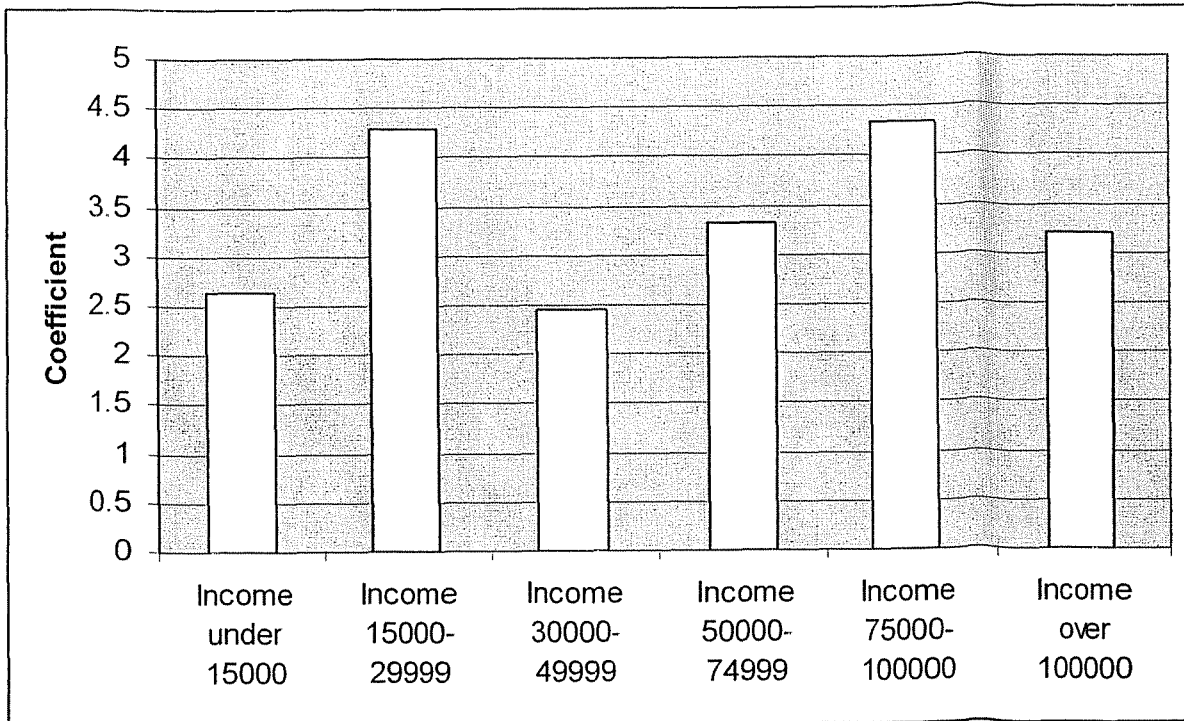
Satisfaction of Power Manager Phone Representative by Age Groups

Regressing overall satisfaction against satisfaction of phone representatives for different age groups for those customers who called power manager phone representative shows a lower coefficient for younger customers. This suggests that participants younger than 50 years, especially age 35 and below, are less satisfied with the service they received from the Power Manager phone representative.



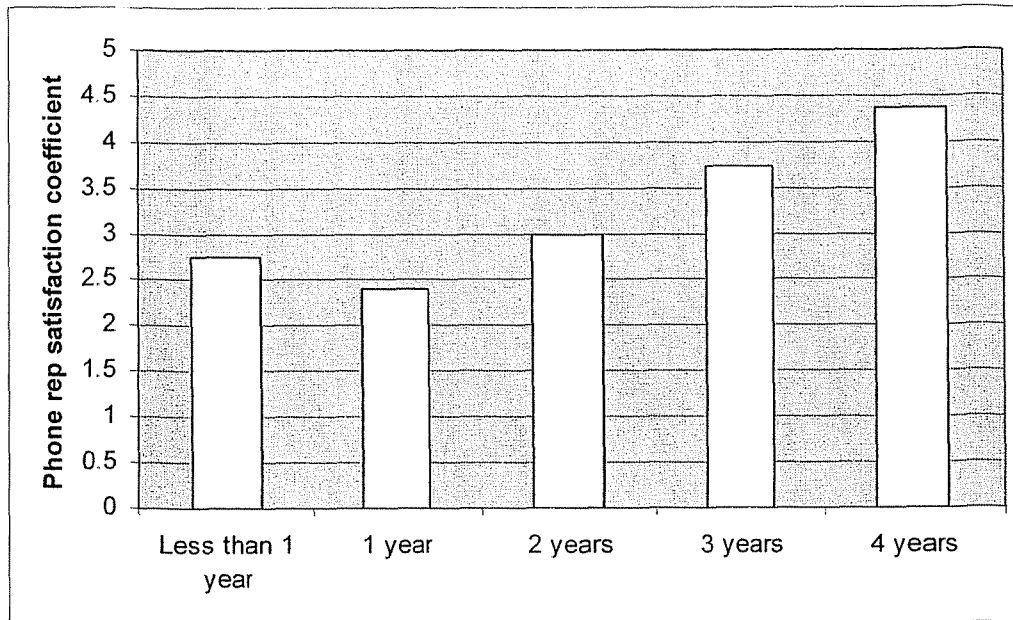
Satisfaction of Power Manager Phone Representative by Income Groups

Regressing overall satisfaction against satisfaction of phone representatives for different household income groups shows a lower coefficient for customers with annual income of 50K to 30K as well as customers having lower income of fewer than 15K suggesting these income groups are less satisfied with the service they received from the Power Manager phone representative.



Satisfaction of Power Manager Phone Representative by Length of Participation

The results of regressing overall satisfaction against satisfaction of phone representatives for different participation time period shows a higher coefficient for customers who have been with the program longer. This might suggest that participants who stay longer with program find the phone representatives more helpful or the upward coefficient trend is because satisfied participants stay longer in the program.

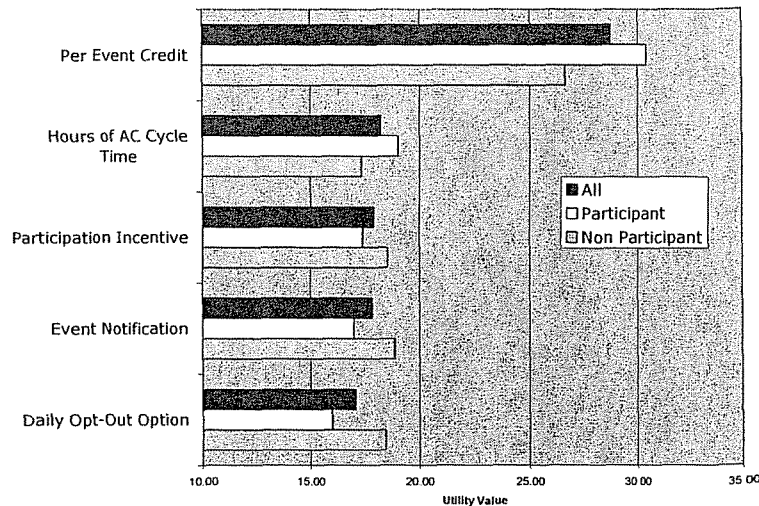


Additional insight on increasing participation in the Power Manager Program

To gain further insight on ways to increase participation in the Power Manager program a conjoint study was conducted in November 2006 in the Duke Energy Midwest Region to over 100 respondents. Respondents included a blend of current Power Manager Customers, and non-Power Manager Customers. All customers surveyed were eligible for the Power Manager program.

Results indicate that the current program offering sign up incentive of \$25 (and \$35) obtain the highest participation likelihood scores compared to a proposed free thermostat as a participation incentive. The free thermostat sign up incentive was still a viable option, but would need a considerable amount of marketing to communicate the benefits and value of a programmable thermostat, as well as educational material and additional features such as a toll free technical assistance phone number for operational questions. Over 60% of the customers indicate they do not adjust their thermostats settings (programmable or non-programmable) throughout the day.

Additional results indicate a per event incentive is the most important feature to customers considering signing up for a Power Manager program option, compared to features such as sign-up incentive, event credit, notification, and opt-out options.



(How important the attribute is compared to the others)

The current program offering includes a \$25 sign-up incentive for a 1 kW reduction in load, and a \$35 incentive for 1.5 kW reduction in load. Average AC cycle times for 2006 in total were around 3 hours. Event credits were given on a per kW basis. Customers were offered a 1 time per month opt-out option. This current opt-out offering is preferred by customers, and increases participation. Offering more than 1 opt-out option is not recommended, as it will not increase participation likelihood significantly.

Based on the conjoint results, three (3) hours of AC cycle time obtained a positive utility value. Increasing the cycling time from three (3) hours to five (5) hours reduces the probability of participation from 37% to 27%. But adding program feature enhancements will offset this difference.

Increased sign-up likelihood can come from program enhancements such as an email notification of an event occurring 1 day ahead, which moreover would be the least cost notification method. Respondents preferred email notification to phone call notification, and some notification to no event notification.

Additional suggestions include a per event credit instead of a per kW credit. Per Event is defined as any day that Duke Energy cycles a customer's AC unit on and off.

	Option A	Option B	
Sign Up Incentive	\$25	\$35	
Hours Cycle Time	3	3	
Event Credit	1	2	
Event Notification	None	None	
Monthly Opt-Out	1	1	
CURRENT OFFERINGS	10%	15%	Relative Share
Increase Cycle Time to 5 hours	7%	13%	New Relative Share
Add Event Notification	11%	17%	Final Relative Share

Relative Share of preference can be thought of as how many consumers would chose one option over another in the same menu. Share of Preference scores capture information about what product is most preferred and also the relative desirability of the remaining products. Share of preference does not represent market share potential. However, to some extent it can be viewed as a relative gauge, if both programs were offered by Duke Energy to every eligible customer and external effects were applied. An external effects multiplier can be included to better represent a market share potential, but again does not represent market share, as it is missing factors such as level and effectiveness of advertising, length of time on the market, and competitive or similar programs on the market. External Effects have been applied above to obtain the relative share estimates based on current share of participants to eligible customers. Current share of eligible customers is .047 for Option A and .082 for Option B.

Temperature Settings

- On average, respondents set their thermostats in the summertime to between 73 and 75 degrees.

- Regardless of temperature setting, it can be determined that having a thermostat set at 2 degrees warmer than current setting, customers will experience no difference in comfort level.
- 4 degrees warmer, causes customers to feel slightly less comfortable, except those setting their temperatures initially at 65 – 69.

Evaluating the impacts of the Power Manager Program

To evaluate the impacts of the program a load research study was conducted during summer 2006 of Power Manager. During summer 2006, nearly 29,000 Duke Energy Indiana residential customers in Indiana and 5,900 Duke Energy Kentucky residential customers in Kentucky participated in Power Manager load control events. The main purposes of the load research study is to evaluate how well load reduction targets were achieved during load control events and provide data for modeling purposes to support the program in future years. A new control model was developed for the 2006 Power Manager program based on data captured during 2005. This model called for substantially greater cycling percentages to achieve 1.0 or 1.5 kw target reduction levels than were in effect in the 2005 model. Overall load reduction achieved in 2005's program was generally too low according to the impact evaluation. The difference in the model is largely due to better capturing the "flattening" of the AC KW curve at higher temperatures. The summer of 2005 had many days with temperatures above 89 degrees; so this flattening was well represented in the dataset. This was not the case for the summer of 2004, the basis for 2005's model.

The results from this study are estimates of the load impact of the Power Manager program during five load control events conducted in summer 2006. These estimates are significantly below the targeted load reduction. Potential sources of this discrepancy include failures in paging communication and incorrect programming of switches, both of which have been encountered in spot field tests. A QA plan addressing how these problems will be investigated and remedied is presented. It may also be that expected load reductions from the Power Manager control model are too high for the moderate to low temperatures that prevailed during control periods this summer (see Table 2 below). To address this possibility, model methodology and data sources will be carefully reviewed and model results will be compared to studies in other areas. Lastly, model error in estimating realized shed kWh within the research sample during load control periods may also contribute to the discrepancy. Other results in this study include a small study with apartments, and estimates of payback during the two hours immediately following Power Manger load control events.

Power Manager Control Events

In a Power Manager control event, air conditioner units on the program are cycled off for a portion of each 30-minute interval; a random delay of up to 30 minutes at the beginning of the control period is used to stagger the off and on periods. The cycling percentage (i.e., percentage off) is chosen to achieve a specific load reduction target. This is accomplished with the Power Manger control model, which uses forecasted weather for

the control period to calculate the cycling level needed to achieve a specified target reduction, on average, over the program population. A choice of program options with different target reduction levels is offered. The two commonly used program options are identified by typical target levels, “1.0 kW” and “1.5 kW,” but other load reduction targets can be specified for either program option.

Power Manager load control was implemented on five days during summer 2006; July 17, 19, 26 and August 2, 7. The time period for each load control event was 2:00 – 5:00 PM (EDT). A simplified cycling strategy was adopted this year. Rather than modifying the cycling in each hour to achieve a fixed hourly load reduction, a fixed cycling percentage was imposed in all hours of an event. This cycling percentage was calculated with the Power Manager control model to achieve the load reduction target over the event as a whole, but not necessarily in each hour of the event. The load reduction targets (total kWh for the three hour event) and corresponding cycling percentages specified for the control events of summer 2006 are shown in Table 1. Cycling percentages for Duke Energy Kentucky were calculated with the CVG weather forecast, and cycling percentages for Duke Energy Indiana were calculated with the IND weather forecast.

Table 1. Control Event Cycling

	1.5 kW			1.0 kW		
	Target	DEK %	DEI %	Target	DEK %	DEI %
July 17	3.3	62	58	3.0	58	52
July 19	3.6	65	65	3.0	58	58
July 26	3.9	76	73	3.0	63	60
August 2	4.5	71	71	3.0	48	48
August 7	4.5	75	75	3.0	56	56

An initial estimate of load impact after a control event can be obtained with the control model algorithm, using actual weather during the control period together with the cycling percentages imposed. Deviation of actual weather from the weather forecast results in a total impact estimate different than the load reduction target. These estimates are the starting point for load impact results developed later in this report (see Table 6-a). Table 2 provides an overview of the weather experienced during Power Manager load control events of summer 2006, showing average hourly temperature and heat index during the control period. Notice the very low temperature at IND during the August 7 event.

Table 2. Temperature and Heat Index (deg-F) during Control Periods

	CVG		IND		SDF	
July 17	90	93	89	93	91	95
July 19	91	97	89	95	93	100
July 26	86	89	83	88	88	95
August 2	91	99	91	99	94	104
August 7	90	96	77	80	94	101

Load Research Sample

The 2006 load research sample consists of 159 single-family residences in the main load impact study, and 12 apartments in a side study of the effectiveness of Power Manager for multi-tenant properties. Interval KWH (15-minute) is collected for all research sample participants. State data loggers were installed on the air-conditioner units for about half (83) of the main study and all in the apartment study, which allow air-conditioner duty cycles to be constructed. The research sample for the main study was chosen to achieve reasonable geographic representation of the Power Manager population in Indiana and Kentucky, while also allowing for reasonably efficient data collection (residences with data loggers were visited every 4 weeks for data collection). Participants with data loggers are distributed in clusters in the Indianapolis area (32), Kokomo (10), Terre Haute (9), Jeffersonville-New Albany (9), and Cincinnati area (23). The rest of the sample for the main study, with interval meters only, was selected from areas not represented in the clusters.

Research sample participants with data loggers were separated into two control groups, RS1 and RS2, with about an equal split in each cluster. In Power Manager events, one group was controlled along with the general population and the other group was not controlled, and so provided information on the natural duty cycle. For evaluation of load impact, participants in the main study are grouped according to weather region (CVG, IND, SDF), and control group. The control group is RS1 or RS2 for participants with data loggers, or MET for participants with interval meters only. Table 3 below shows the breakdown into these evaluation groups.

Table 3. Evaluation Groups

Weather Region	Control Group	Participants
CVG	RS1	11
CVG	RS2	12
CVG	MET	17
IND	RS1	26
IND	RS2	25
IND	MET	49
SDF	RS1	5
SDF	RS2	4
SDF	MET	10

Weather regions are assigned by zip code. All Kentucky zip codes are assigned to CVG (Cincinnati airport). Zip codes in southeast Indiana are assigned to CVG, in south-central and southwest Indiana to SDF (Louisville airport), and in central Indiana to IND (Indianapolis airport). Appendix E lists Indiana zip codes assigned to CVG or SDF.

The research sample was also chosen to achieve balanced representation of high and low kWh usage. Quartile statistics of monthly kWh during summer 2005 were used to divide

(separately for DEI and DEK) Power Manager participants into low (below Q25), medium (between Q25 and Q75), and high (above Q75) usage segments. About 25% of the research sample participants were drawn from each of the low and high segments, and the remaining 50% were drawn from the medium segment. Table 4 illustrates this balance, comparing quantiles of overall 2006 summer usage for the research sample (main study) and the Power Manager population in each weather region. The numbers in Table 4 are total monthly KWH for June – September, 2006 billing cycles.

Table 4. Quantile Statistics for Summer-2006 KWH

Q	CVG		IND		SDF	
	Population	Sample	Population	Sample	Population	Sample
0.1	3312	3020	3154	2758	3106	3571
0.2	3853	3794	3786	3586	3782	3786
0.3	4351	4199	4266	3930	4215	4050
0.4	4819	4580	4743	4488	4721	4744
0.5	5315	5518	5259	5099	5255	4822
0.6	5828	6160	5832	5616	5902	6600
0.7	6505	6807	6529	6032	6569	8114
0.8	7446	7139	7446	7465	7552	8803
0.9	8824	8564	9024	9678	9164	10011

Load Reduction within Research Sample

This section describes the method used to estimate load reduction within the portion of the research sample controlled during each Power Manager event of summer 2006. Group MET was controlled on all event days, group RS1 was controlled July 17, 26 and August 2, and group RS2 was controlled July 19 and August 7.

Impact evaluation is based on separate models for average 30-minute interval KWH within each of the evaluation groups in Table 3. Explanatory variables in these models are linear temperature splines based at 66, 77, and 88 deg-F, a humidity adjustment factor, the hour of the day, and interventions for intervals during control events. The humidity variable in the model depends upon both temperature and humidity, and is defined as the natural logarithm of the ratio of heat index to temperature. The models are estimated with research sample interval KWH for 1:00–7:00 PM (EDT) on non-holiday weekdays from Memorial Day to Labor Day (May 30 – September 1, 2006). By including the hour prior to control period and two hours subsequent to the control period in the model, it will be possible to investigate additional effects such as autocorrelation and payback. Interaction variables between temperature splines and hour of the day were investigated but discarded from all models. The temperature spline at 88 deg-F was retained in IND models, but was not significant and was dropped from CVG and SDF models.

The load reduction achieved within each evaluation group of Table 3 during load control is estimated by coefficients of corresponding intervention variables in the model for this group. A unique intervention variable is specified for each 30-minute interval during a control event, and so the models estimate average load reduction within each group during every 30-minute interval of the control event. Intervention variables are also specified for the intervals subsequent to a control event (four 30-minute intervals for the period 5:00 – 7:00), and coefficients of these variables estimate payback, which will be discussed further later in the report.

For overall impact evaluation of the Power Manager program, we focus on the total load reduction achieved in evaluation groups on a control event day. This is the sum of intervention coefficients for the control period, 2:00 – 5:00 PM for all control days in summer 2006. In summing estimated intervention coefficients, a positive coefficient is treated as zero load reduction. Table 5 gives the results obtained for total load reduction within evaluation groups on control event days. In blocks with results, the middle row is the weighted average of total KWH reduction for two evaluation groups identified in the leftmost column. The top row gives the expected total KWH reduction calculated with the Power Manager control model using actual weather and event cycling levels, and reflecting the mix of program option (1.5 KW or 1.0 KW) in the evaluation groups. The bottom row shows the ratio of realized KWH reduction (middle row) to expected KWH reduction (top row). A complicating factor is that MET groups are subject to a random delay of up to 30 minutes in the start of the control period, the same as for the general program population. This means that initial MET intervention coefficients (for 2:00 – 2:30) will be somewhat reduced. The remaining MET intervention coefficients during the control period are not affected. RS1 and RS2 groups are not subject to random delay. To deal with this, sums were calculated both with and without the initial 30-minute interval of the control period. Results with the greater ratio appear in Table 5 and are used in the impact evaluation.

Table 5. Estimated load reduction within research sample by weather region.

Group	July 17	July 19	July 26	August 2	August 7
CVG	2.80		3.41	3.25*	
RS1-MET	0.49 18%		1.06 31%	1.42 44%	
CVG		2.82*			3.63
RS2-MET		1.77 63%			1.32 36%
IND	2.42		2.38*	3.12*	
RS1-MET	0.35 14%		1.36 57%	1.90 61%	
IND		2.69*			0.93
RS2-MET		1.35 50%			0.0 0%
SDF	2.34*		3.06*	3.55*	

RS1-MET	1.23 52%		0.74 24%	1.02 29%	
SDF RS2-MET		3.61 1.55 43%			3.75* 0.85 23%

* load reduction excludes initial half-hour of event period

Figures 1(a)-(c) provide a graphic representation of load reduction estimates within the research sample - Figure 1(a) shows estimates for the CVG weather region, Figure 1(b) for IND and Figure 1(c) for SDF. The horizontal axis in each individual graph corresponds to the period 1:00 – 7:00 PM, the hours covered by our model, on a Power Manager control day. The vertical axis corresponds to KWH within 30-minute intervals. The solid blocks show KWH at 30-minute intervals averaged over research sample groups controlled that day. The line with open blocks shows the composite model fit for the controlled groups, excluding intervention terms. Moving left to right in the graphs, the first two points (open or closed blocks) correspond to the hour prior to the control period, the next 6 points correspond to the three-hour control period, and the final 4 points correspond to the two hours immediately after control is released (ignoring random delay, which complicates the picture a bit for the first interval of the control period and the first interval after the control period). During the control period, the distance of the solid block below the line is the estimated load reduction. After the control period, the distance of the solid block above the line is the estimated payback. In both cases, since the estimate is for a 30-minute interval, it must be doubled to correspond to kWh.

Figure 1(a). Controlled Groups in CVG Weather Region

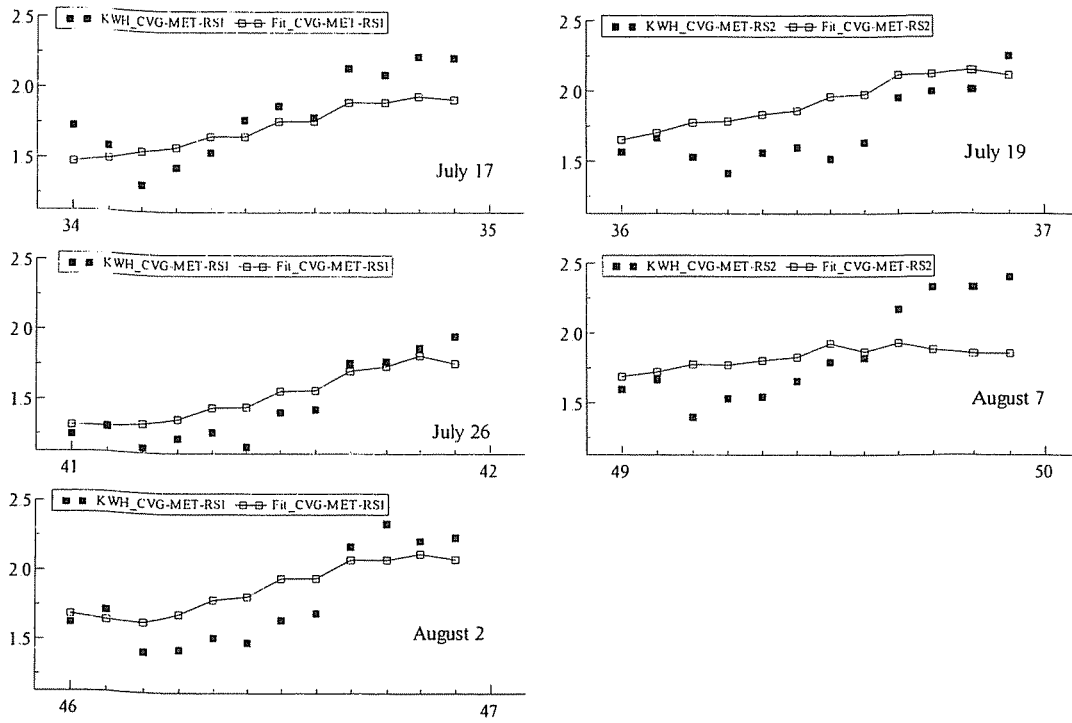


Figure 1(b). Controlled Groups in IND Weather Region

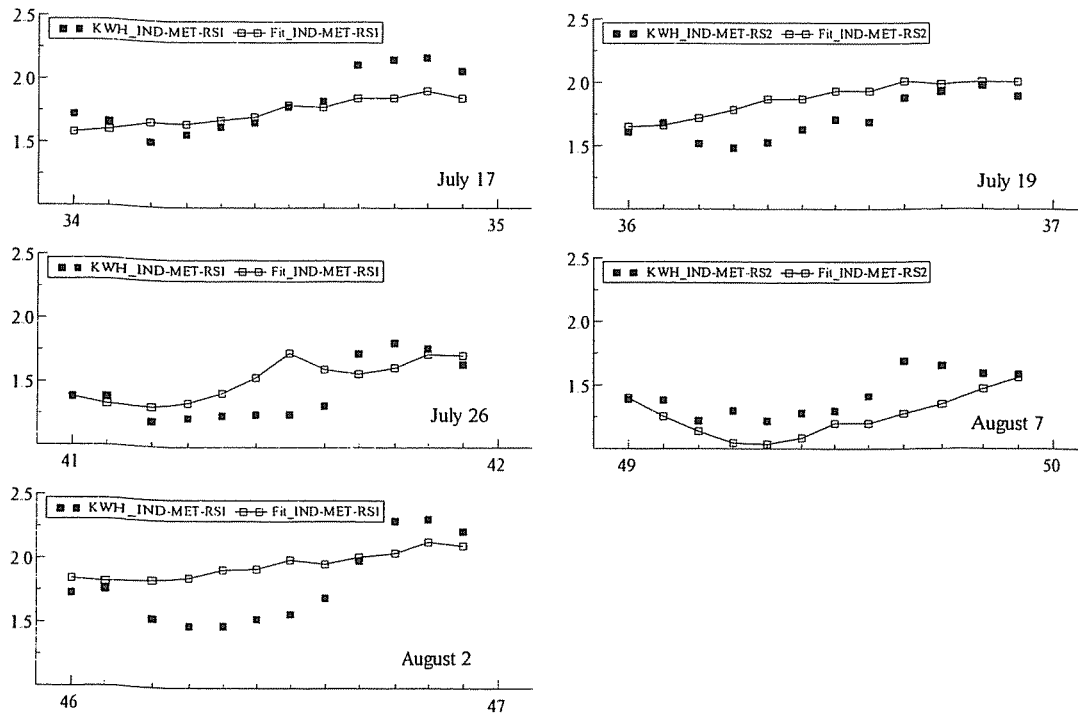
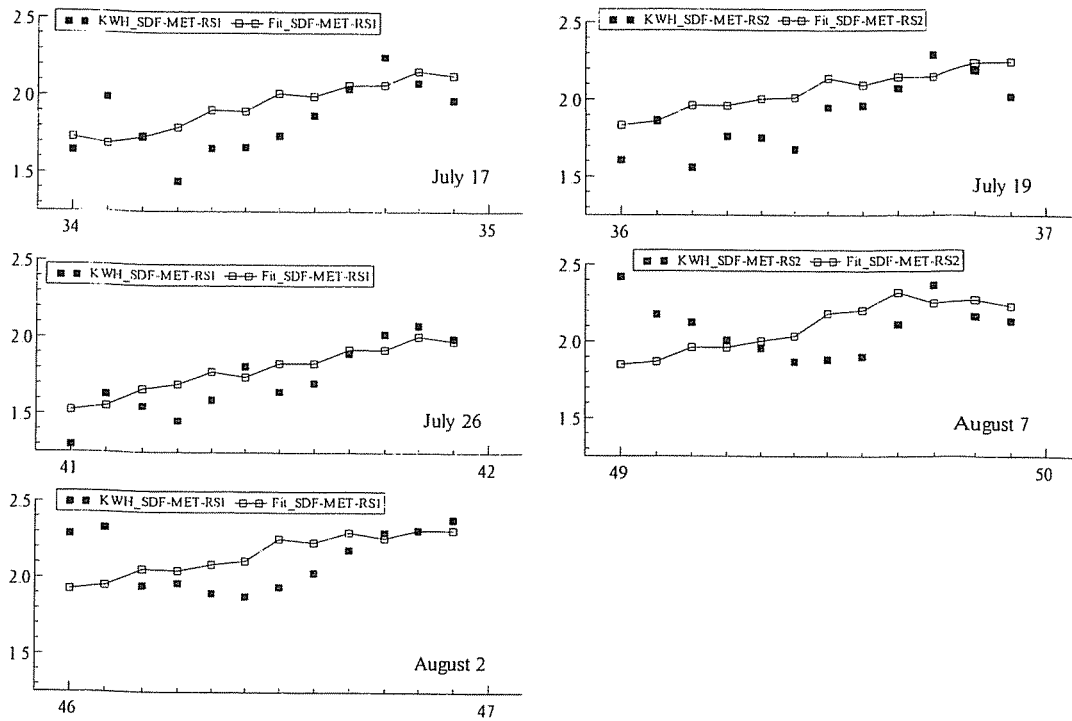


Figure 1(c). Controlled Groups in SDF Weather Region



Power Manager Program Load Impact

This section presents hourly impact estimates for Power Manager load control events of summer 2006. Tables 6(a)-(b) illustrate intermediate steps in the calculation of these estimates, and final impact results are in Table 6(c).

Table 6(a) shows separate estimates of average hourly shed kWh during control events for each weather region (CVG, IND, SDF) and program option (1.5 kW, 1.0 kW). These estimates were computed with the Power Manager control model algorithm using the control event cycling percentage (see Table 1) and actual weather during the control period. Also shown in Table 6(a) are participant counts by operating company (DEI, DEK) for each weather region and program option. Participants are assigned to weather regions according to their zip code.

In Table 6(b), the results from Table 6(a) are accumulated for each operating company. These numbers represent expected impacts immediately after an event, before any consideration of results from the research sample.

The upper section of Table 6(c) lists the adjustment factors from Table 5 of the previous section, derived from the research sample. The lower sections of Table 6(c) contain the final hourly impact estimates by operating company. These estimates start with the product of three factors which have been described:

- 1) Control model average kWh reduction with event cycling and actual weather;
- 2) Participant count by operating company;
- 3) Adjustment within weather regions based upon research sample results.

Factors 1 and 2 appear in Table 6(a) and factor 3 is from the upper section of Table 6(c) (and also Table 5). For each operating company, these products are summed over weather regions and program options to get overall hourly impact estimates.

Table 6(a). Expected Hourly Shed with Control Model Algorithm

	Jul_17	Jul_19	Jul_26	Aug_2	Aug_7
CVG-DEK 1.5_kw					
Model Shed - Hr 15	0.85	1.00	1.08	1.22	1.18
Model Shed - Hr 16	0.94	1.14	1.18	1.35	1.36
Model Shed - Hr 17	1.06	1.27	1.31	1.48	1.40
Count	4210	4215	4228	4264	4260
CVG-DEK 1.0_kw					
Model Shed - Hr 15	0.77	0.84	0.77	0.71	0.77
Model Shed - Hr 16	0.86	0.97	0.86	0.82	0.90
Model Shed - Hr 17	0.98	1.10	0.98	0.92	0.92
Count	1465	1470	1482	1565	1550
CVG-DEI 1.5_kw					
Model Shed - Hr 15	0.77	1.00	0.99	1.22	1.18
Model Shed - Hr 16	0.86	1.14	1.09	1.35	1.36
Model Shed - Hr 17	0.98	1.27	1.21	1.48	1.40
Count	483	483	483	480	480
CVG-DEI 1.0_kw					
Model Shed - Hr 15	0.67	0.84	0.69	0.71	0.77
Model Shed - Hr 16	0.75	0.97	0.78	0.82	0.90
Model Shed - Hr 17	0.85	1.10	0.89	0.92	0.92
Count	358	358	358	355	354
IND-DEI 1.5_kw					
Model Shed - Hr 15	0.73	0.99	0.82	1.23	0.24
Model Shed - Hr 16	0.85	1.08	1.17	1.38	0.37
Model Shed - Hr 17	0.92	1.20	0.96	1.42	0.44
Count	16568	16579	16596	16643	16623
IND-DEI 1.0_kw					
Model Shed - Hr 15	0.62	0.82	0.55	0.73	0.10
Model Shed - Hr 16	0.74	0.91	0.84	0.83	0.16
Model Shed - Hr 17	0.79	1.01	0.67	0.85	0.20
Count	6969	7059	7104	7316	7238
SDF-DEI 1.5_kw					
Model Shed - Hr 15	0.84	1.10	1.17	1.32	1.33
Model Shed - Hr 16	0.93	1.25	1.23	1.47	1.50
Model Shed - Hr 17	1.04	1.29	1.35	1.60	1.66
Count	2533	2552	2561	2575	2568
SDF-DEI 1.0_kw					
Model Shed - Hr 15	0.73	0.94	0.86	0.81	0.90
Model Shed - Hr 16	0.81	1.07	0.91	0.93	1.05
Model Shed - Hr 17	0.91	1.11	1.01	1.03	1.20
Count	1422	1463	1480	1529	1521

Table 6(b). Operating Company Total Expected Hourly Shed (MW)

	Jul_17	Jul_19	Jul_26	Aug_2	Aug_7
DEK					
Hr 15	3.5	4.1	4.3	4.7	4.7
Hr 16	5.2	6.2	6.3	7.0	7.2
Hr 17	5.9	7.0	7.0	7.8	7.4
DEI					
Hr 15	15.1	20.4	16.9	23.5	7.7
Hr 16	23.5	30.0	30.8	35.1	13.7
Hr 17	25.4	33.0	26.5	36.6	15.9

Note: First event hour reduced 25% to account for random delay

Table 6(c). Operating Company Hourly Impact Estimates (MW)

	Jul_17	Jul_19	Jul_26	Aug_2	Aug_7
Research Sample Adjustment					
CVG	18%	63%	31%	44%	36%
IND	14%	50%	57%	61%	0%
SDF	52%	43%	24%	29%	23%
DEK Impact					
Hr 15	0.6	2.6	1.3	2.1	1.7
Hr 16	0.9	3.9	1.9	3.1	2.6
Hr 17	1.1	4.4	2.2	3.4	2.7
DEI Impact					
Hr 15	3.0	10.0	8.4	13.1	1.1
Hr 16	4.6	14.8	15.8	19.6	1.6
Hr 17	5.1	16.3	13.2	20.3	1.8

Note: First event hour reduced 25% to account for random delay

Apartment Study

Twelve participants were recruited from apartment complexes in Franklin, IN (IND weather region) and New Albany, IN (SDF weather region) to investigate the suitability of multi-tenant properties for Power Manager program. Both state data loggers and interval meters were installed for the apartment sample, but data for the bulk of summer 2006 is available for only 8 of these participants. These apartment accounts are listed in Table 7 below, with apartment size and total kWh for June – September bill cycles. Notice the comparatively low kWh usage for two accounts, even though one is the largest apartment in the study.

Table 7. Apartment Research Sample Characteristics

Account	Size (Sq Ft)	Summer KWH
26502594	1066	3577
90602594	833	3311
79802594	962	3189
06202929	1360	3797
91602946	1000	3756
45602946	840	4740
93302929	1440	1943
96302929*	1080	1845

* tenant changes in July and August

Separating apartment accounts into evaluation groups and modeling average kWh usage within these groups is not feasible due to the small sample size. Instead, load reduction by apartment accounts is estimated individually for each account by comparing kWh usage during a control period to kWh usage during the same time period on days with similar weather. For each control event and account, three weekdays are selected to most closely match temperature and heat index during the control period, avoiding any days where load control was implemented or kWh data is not available for that account. Total kWh during the control period is subtracted from total kWh during the same time period, averaged for the three comparable days. Table 8 below gives results for each apartment account and Power Manager control event. The layout of Table 8 is similar to Table 5; the top row in each block is the estimated load reduction for the apartment, the middle row is the expected load reduction computed by the Power Manager control model (with 1.0 kw program option and appropriate weather region), and the bottom row is the ratio between the top and middle rows. The bottom row of Table 8 shows averages for all apartments controlled in each Power Manager control event.

Table 8. Estimated Load Reduction for Apartments

Account	July 17	July 19	July 26	August 2	August 7
26502594 IND-RS1	2.48 2.15 115%		1.29 2.06 63%	1.43 4.02 36%	
90602594 IND-RS1	0.00 2.15 0%		1.39 2.06 67%	0.00 4.02 0%	
79802594 IND-RS2		0.00 2.74 0%			0.00 0.46 0%
06202929 SDF-RS1	2.05 2.45 84%		0.55 2.78 20%	1.42 4.40 32%	
91602946 SDF-RS1	3.57 2.45 146%		1.06 2.78 38%	0.00 4.40 0%	
45602946 SDF-RS2		1.65 3.12 53%			0.00 3.15 0%
93302929 SDF-RS2		0.00 3.12 0%			0.00 3.15 0%
96302929 SDF-RS2		1.57 3.12 50%			0.00 3.15 0%
Event Average	2.03 2.30 88%	0.81 3.03 27%	1.07 2.42 44%	0.71 4.21 17%	0.00 2.48 0%

Payback

As discussed previously, the models used to measure average kWh impact within the evaluation groups during control events include intervention coefficients for four 30-minute intervals subsequent to each control event (the time period 5:00 – 7:00 PM). These intervention coefficients measure the increase in average kWh usage within evaluation groups above the expected level (i.e., the model) immediately after a control period, which is often referred to as payback. The sum of these intervention coefficients estimates the total payback during the two hours immediately after a control event, on average within the evaluation group. Payback results are given in the bottom row of blocks in Table 9. For comparison, the top row of these blocks contains the estimated total load reduction during the control period (the sum of intervention coefficients during the control period).

Table 9. Payback (kWh) over Two-Hour Period After Control

Group	July 17	July 19	July 26	August 2	August 7
CVG RS1-MET	-0.49 1.02		-1.06 0.34	-1.63 0.61	
CVG RS2-MET		-2.03 0.0			-1.32 1.83
IND RS1-MET	-0.35 1.04		-1.48 0.33	-2.20 0.54	
IND RS2-MET		-3.16 0.0			0.0 -
SDF RS1-MET	-1.23 0.0		-0.85 0.19	-1.13 0.10	
SDF RS2-MET		-1.55 0.0			-0.85 0.0

Power Manager Quality Assurance Action Plan

As a result of the Power Manager impact evaluation analysis, and in order to maximize the impact of the program, Duke Energy has developed the following action plan for 2006-7 to insure that the full program impacts can be realized prior to the execution of the 2007 control season. During November and December, 2006, discussions took place with Duke Energy personnel and service provider partners, so that we could better understand control equipment performance issues. The lower than expected load reductions during the 2006 season could possibly have been due to somewhat milder peak temperatures than expected, but it is also possible that other structural causes may be the cause. To insure that all causes are systematically analyzed and corrected, where needed, prior to the 2007 season, Duke Energy intends to pursue the following quality assurance action plan.

Validate Data and Complete On-site Assessments

Work started in December 2006 is targeted to insure that the data used to complete the analysis of impacts is accurate and representative of the actual load reductions during the control events. Verification of the data received from the interval meters (measures actual energy usage in 15 minute intervals), data loggers (shows time stamped on/off cycling of A/C units) and weather data will be completed before Jan 2007. The modeling logic used to forecast load reduction potential will also be reviewed to ensure proper representation.

An on-site visit will be made to more than 100 homes that encompass the representative data sample. Technicians will visit each site with portable diagnostic equipment that will determine the operational condition of each switch. The inspection will evaluate the following:

- Switch programming
- Event history – did the switch receive the commands
- Signal strength
- Proper installation and functionality
- Switch tampering

If required, technicians will make repairs while on site and they will document their findings, so that the system integrity can be evaluated.

Analyze the results

The information gathered from the site visits will point the way to improving system performance and ultimate load reduction potential. The data will be analyzed and a list of prioritized initiatives will be developed and implemented to maximize performance for the 2007 Power Manager event season. A list of modification or repairs includes, but is not limited to the following:

- Programming enhancements to software (switch or command software)
- Changes in the paging or command protocol
- Paging company coverage improvements
- Antennae modifications
- Additional site visits assessments
- Switch replacement
- On site monitoring during a simulated command event

These options and others will be considered as opportunities to improve load reduction impacts. The items listed above have varied timeframes for implementation, so a comprehensive solution will incorporate short and long term solutions. Ideally, the chosen remedies will be implemented in parallel when possible and test will be conducted to verify results. The following chart represents the proposed timeline for implementing the action plan.

	<i>Dec</i>	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>
<i>Actions</i>											
Consult with experts											
Validate data											
On-site assessments											
Analyze the on-site data											
Develop an improvement plan											
Phase 1 improvements											
Phase 2 improvements											

Initial results

The initial stage of the Power Manger QA program involved site visits to 96 program participants in late December and early January. 45 of these were selected from the 2006 research sample, after analysis of interval load data indicated little or no load reduction from these households during load control events. 51 were selected from the general population of Indiana program participants. Key registers in the switches still contained values from the final Power Manger event of the summer, on August 7. Analysis of the switch register data collected in the test has identified two types of switch problems that contributed to lower than expected impact: some switches were not correctly programmed prior to the August 7 event, and many switches (24 from the research sample and 8 from the other group) apparently correctly programmed did not actually shed during the event period. The first problem will be addressed by re-programming all Power Manger switches (remotely, by paging) prior to next summer. Further QA tests

will be conducted early in 2007 to identify the source of the second problem. No significant problems with paging signal strength, installation, or switch tampering were found in the site visits.

CONFIDENTIALITY AND NON-CIRCUMVENTION AGREEMENT

This Confidentiality and Non-Circumvention Agreement (hereinafter "Agreement") is made and entered into as of this _____ by and between Duke Energy Generation Services Inc. ("Duke"), located at 139 E. Fourth Street, EA502, Cincinnati, OH 45202 and Synagro-WWT, Inc. ("Synagro"), located at 7014 East Baltimore Street, Baltimore, MD 21224 (collectively, the "Parties").

WHEREAS, the Parties have expressed an interest in obtaining information from each other for the purpose of evaluating possible business relationships between themselves (each, a "Project"); and Synagro is aware of a specific Project opportunity with a New Jersey municipal wastewater treatment facility (the "New Jersey Project"); and

WHEREAS, in connection with each proposed Project, either Party (a "Disclosing Party") may disclose to the other party (a "Receiving Party") confidential, nonpublic or proprietary technical information or strategic business concepts relating to the business, products or services of the Disclosing Party or third party business affiliates of the Disclosing Party; and

WHEREAS, the Parties are willing to disclose such information to each other only pursuant to the terms of this Agreement.

NOW THEREFORE, the Parties, on behalf of themselves and their affiliates, employees, officers, directors, and agents, hereby agree as follows:

1. All information provided at any time by a Disclosing Party to a Receiving Party in connection with or in furtherance of a proposed Project, whether written or oral, and all information developed jointly or cooperatively by the parties in connection with or in furtherance of a Project, shall be deemed to be "Confidential Information" within the meaning of this Agreement. Notwithstanding the foregoing, however, Confidential Information shall not include information that: (i) is or becomes publicly available other than through a violation of this Agreement; (ii) is received by a Receiving Party on a non-confidential basis from a source other than the Disclosing Party, which source is not prohibited from disclosing such information by any legal, contractual or fiduciary obligation to the Disclosing Party; (iii) was already known, as proved by supporting documentation only, by the Receiving Party at the time of receipt from the Disclosing Party; or (iv) is developed by an employee, agent, affiliate or consultant of the Receiving Party who did not have access to the Confidential Information.

2. Any Confidential Information obtained by a Receiving Party shall be used solely for the purpose of allowing the Receiving Party to evaluate a proposed Project and, except to the extent required by law or judicial order, shall not be disclosed, discussed or distributed by a Receiving Party to any third party. Each Party shall be permitted to disclose the Confidential Information to those affiliates, officers, employees, agents, consultants, and advisors who have a need to know the Confidential Information for the purpose of evaluating a proposed Project, who are informed by said Party of the confidential nature of the Confidential Information, and who agree to be bound by this Agreement ("Permitted Recipients"). Each Party will be responsible for any breach of any provision of this Agreement by its Permitted Recipients.

3. Duke agrees that, with regard to any Project, it will not at any time prior to 18 months after the date of any initial disclosure from Synagro about a Project, either directly or indirectly approach/solicit or otherwise offer to provide services or equipment of any kind whatsoever to the municipal wastewater treatment facility/owner/operator identified in the course of communication between Synagro and Duke about a Project, without prior written approval from Synagro.

4. When requested by the Disclosing Party, a Receiving Party shall promptly destroy (or at the Disclosing Party's request, return) all copies of Confidential Information received by the Receiving Party in written or other physical form and will promptly destroy all summaries, analyses, compilations, or other documents prepared by the Receiving Party. If destroyed, such destruction will be confirmed in writing upon request of the Disclosing Party.

5. Except to the extent required by law, no Party will disclose to any third party (except Permitted Recipients) the fact that the Parties are investigating a possible Project involving each other, that the Parties have entered into this Agreement in anticipation of any Project or otherwise, or that the Parties have undertaken a Project.

6. The Parties acknowledge and agree that any breach or threatened breach of the terms of this Agreement regarding the treatment of Confidential Information may result in irreparable damage to the Disclosing Party for which there may be no adequate remedy at law. Therefore, the Parties agree that in the event of any breach of this Agreement by a Receiving Party, the Disclosing Party will be entitled, in addition to any other rights and remedies available to it, to injunctive relief requiring the immediate return of all Confidential Information in the possession of the Receiving Party, its Permitted Recipients and any other third party to which the Receiving Party has made available Confidential Information, and enjoining the Receiving Party, all Permitted Recipients and any such third party from using Confidential Information in violation of this Agreement, without showing or proving any actual damages have been sustained.

7. The disclosure of Confidential Information under this Agreement shall not be construed as the granting of any rights or license for any purpose other than as set forth herein, nor shall there be implied or construed any obligation in the future to grant such rights or license.

8. The Confidential Information provided shall remain the confidential property of the Disclosing Party.

9. This Agreement shall survive the termination of any business relationship between the Parties.

10. This Agreement and the rights and obligations hereunder shall not be assigned by either Party.

11. For purposes hereof, "Disclosing Party" and "Receiving Party" shall include said Party as well as its affiliates, employees, officers, directors and agents.

* * * * *

[signatures on next page]

IN WITNESS WHEREOF, the parties have executed this Agreement as of the date first above written.

Duke Energy Generation Services, Inc.

Synagro-WWT, Inc.

By: _____

By: _____

Name:

Name:

Title:

Title:

APPENDIX G

**Energy Impact Evaluation
in Kentucky**

Final Report

**Prepared for
Duke Energy**

139 East Fourth Street
Cincinnati, OH 45201

October 15, 2007

Submitted by:

Dr. Michael Ozog, Ph.D.
Vice President, Integral Analytics
Fort Collins, Colorado

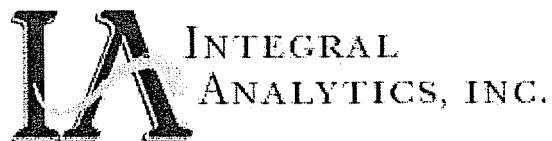


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Quick Summary

Duke is evaluating the impacts of a few of their energy efficiency programs in Kentucky. Several different methods of analysis were used to evaluate the impacts. A mail survey was sent to customers who participated in the Kentucky ENERGY STAR lighting program. Customers were asked about their satisfaction with the CFL's or torchiere that they purchased as well as the number of bulbs they installed. There was an online survey that was conducted of customers that visited the energy efficiency section of the Duke Energy website. These customers were asked about the effectiveness of the energy efficiency tools that were on the website as well as if they installed the items they received in the energy efficiency kit sent to them. Finally, a billing analysis of the Personalized Energy Report (PER) of customers that received an energy efficiency kit was completed.

The ENERGY STAR lighting program evaluation revealed a net impacts savings per customer of 755kWh per year. Over half of participants (61%) purchased 7 or more CFLs at the promotional price. Participants purchased on average a little over 9 CFLs at the special price. Slightly over half (53.6%) of participants purchased only 1 or 2 torchiere lamps at the promotional price. The majority of participants (69%) were very satisfied with the CFLs they purchased. Most participants, (60.2%) did not have a CFL in their house before they purchased bulbs through the ENERGY STAR lighting program.

The evaluation of the energy efficiency web tools on the Duke Energy website showed 613.92 kilowatt hours and 17.23 therms saved per customer. This savings is from taking the recommendations found on the website. The most frequently taken actions were replacing furnace filters, switching from hot to cold water to do laundry and managing the drapes. The majority of respondents (83%) thought the website was useful in providing them information about energy use in their home. The energy efficiency calculators found on the Duke Energy website seemed to be the most useful feature as well as most visited area of the site. The lighting calculator found on the site encouraged customers to purchase CFL's. After using the lighting calculator 62.3% of respondents purchased and installed additional CFLs. Overall, half (50.7%) of respondents thought that the website alone caused them to take energy conserving actions.

The billing analysis of the Personalized Energy Report (PER) program for customers within Duke Energy Kentucky apply only to electric customers which have received the energy efficiency kit. The estimated model used for the billing analysis shows that the PER kits results in a savings of 16.22 kWh/month, or 195 kWh a year. The parameter coefficient estimates suggest that there is some interaction between the month variables and the temperature and degree day variables, but this is expected due to the use of a single weather station for the entire service territory. Applying unique weather data more closely aligned to the customer's location would improve modeling accuracy, but would not likely change the overall average impact estimate overall.

ENERGY STAR Lighting Program Evaluation - Kentucky

This evaluation is based on surveys conducted with customers who participated in the Kentucky ENERGY STAR lighting program. These customers purchased either compact fluorescent bulbs or torchiere floor lamp and filled out an instant rebate form at the store from where they purchased the lighting.

The survey was mailed out to 4,717 participants. There were 409 responses received for an 8.7% response rate.

Impacts From the Program

Based on the responses to this survey, the following impacts were developed shown in the table below. The net impact savings per customer was 755kWh per year. There was an average reduction in consumption of 56 watts per bulb. The survey did not address the actual time-of-use, so we are unable to determine the daily load shape. Based upon our previous work on evaluating similar residential CFL programs in other areas, we believe that a conservative estimate of coincident diversity is 10%.

ENERGY STAR Lighting Program Impacts

	Value
Average Installed Bulb/Torchiere	6.5
Average Hours of Use	6.4
Average Watts reduced per bulb	56
Gross Impacts, per customer	897 kWh/year
Free Ridership	16%
Net Impacts, per customer	755 kWh/year

The remainder of this report presents the statistics of each of the questions of the survey. The actual survey instrument can be found in appendix 1.

Promotions

Just over a third (37.9%) of participants found the store advertising and displays and signs in the store very useful. As did slightly over a third (38.1%) of participants think the sales associates in the store were very useful in providing information about the ENERGY STAR program.

How useful was the following in providing you information about energy use in your home?

	Very Useful (3)	Somewhat Useful (2)	Not at all Useful (1)	Total	Mean
Store Advertising	135	149	72	356	2.2
	37.9%	41.9%	20.2%		
Displays and signs in the store	131	145	70	346	2.2
	37.9%	41.9%	20.2%		
Sales Associate at the store	126	101	104	331	2.1
	38.1%	30.5%	31.4%		

Slightly more than a third (31.3%) of participants thought the store advertising was very influential in their decision to purchase the CFLs or torchiere lamp. Participants also thought that the displays and signs in the store had an influence on their purchase decision, with 28.4% very influential. The sales associates were not found to be quite as influential, 41.6% stated they had no influence at all on their decision to purchase.

How influential was the following in your decision to purchase the CFLs or torchiere lamp?

	Very Influential (3)	Somewhat Influential (2)	Not at all Influential (1)	Total	Mean
Store Advertising	105	125	105	335	2.0
	31.3%	37.3%	31.3%		
Displays and signs in the store	96	137	105	338	2.0
	28.4%	40.5%	31.1%		
Sales Associate at the store	94	87	146	327	1.8
	28.7%	26.6%	44.6%		

Performance Ratings

Over half of participants (61%) purchased 7 or more CFLs at the promotional price. Participants purchased on average a little over 9 CFLs at the special price. The average number of CFLs that would have been purchased goes down to 3 when asked how many bulbs the customer would purchase without a rebate or incentive. Slightly over half (53.6%) of participants purchased only 1 or 2 torchiere lamps at the promotional price. There was an average of around 4 torchiere lamps purchased by participants.

We would like to understand how you have used the CFLs and torchiere lamps you have purchased

	1-2	3	4	5	6	7-11	12+	Total	Mean
How many CFLs did you purchase for the special price?	30	7	35	9	71	75	168	395	9
	7.6%	1.8%	8.9%	2.3%	18.0%	19.0%	42.5%		
How many torchiere lamps did you purchase for the special price?	98	14	11	2	16	13	29	183	4
	53.6%	7.7%	6.0%	1.1%	8.7%	7.1%	15.8%		
How many bulbs would you have bought without the rebate or incentive?	202	29	40	7	25	5	14	322	3
	62.7%	9.0%	12.4%	2.2%	7.8%	1.6%	4.3%		

Price of CFL Bulbs

Participants were asked how many CFL bulbs they would purchase at the same price as a standard bulb, if they were \$1.00 more, \$2.00 more, \$3.00 more or free with a rebate. As expected, participants would purchase the most CFLs if the bulbs are free with a rebate, with an average number of 9 bulbs. Participants would almost purchase as many if the CFLs cost the same as a standard bulb, with an average number of 8. The average number of bulbs decreases as the price goes up. The average number of bulbs at \$1.00 more is 5, \$2.00 more is 3, and \$3.00 more is 2.

How many CFL bulbs would you purchase if...

	1-2	3	4	5	6	7-11	12+	Total	Mean
They were the same price as a standard bulb	40	13	29	14	51	43	163	353	8
	11.3%	3.7%	8.2%	4.0%	14.4%	12.2%	46.2%		
They were \$1.00 more than a standard bulb	84	25	34	25	50	23	39	280	5
	30.0%	8.9%	12.1%	8.9%	17.9%	8.2%	13.9%		
They were \$2.00 more than a standard bulb	115	33	34	9	18	4	11	224	3
	51.3%	14.7%	15.2%	4.0%	8.0%	1.8%	4.9%		
They were \$3.00 more than a standard bulb	147	24	15	3	9	1	7	206	2
	71.4%	11.7%	7.3%	1.5%	4.4%	0.5%	3.4%		
They were free but you had to mail in a rebate form to get your money back	39	13	21	10	40	30	164	317	9
	12.3%	4.1%	6.6%	3.2%	12.6%	9.5%	51.7%		

Bulb Installation

Over half of participants (60.2%) installed 6 or more CFL bulb that they purchased. The average number of bulbs participants installed was 7. The typical wattage (47.2%) that the CFL bulb replaced was 45-70 watts. The bulb that the CFL replaced was used an average of 6.9 hours.

Of the bulbs you bought...

	1-2	3	4	5	6	7-11	12+	Total	Mean
How many did you install?	45	32	58	22	76	77	84	394	7
	11.4%	8.1%	14.7%	5.6%	19.3%	19.5%	21.3%		

For each of those bulbs that you installed, what was the typical wattage of the bulb that was replaced?

Wattage of the bulb that was replaced	<44	45-70	71-99	>=100	Total
	5	167	79	103	354
	1.4%	47.2%	22.3%	29.1%	

About how many hours do you use this bulb?

Number of hours bulb is used	<1	1-2	3-4	5-9	10-12	13-24	Total	Mean
	9	29	118	133	57	33	379	6.9
	2.4%	7.7%	31.1%	35.1%	15.0%	8.7%		

The majority of participants (80.8%) did not remove any of the CFLs that they installed. Of the participants that did on average they removed 2 bulbs. Slightly more than one fourth of the participants (26.1%) that removed a CFL did so because the bulb was not bright enough.

Did you remove any of the CFLs you installed?

	Yes	No	Total
Did you remove any of the CFLs you installed?	77	323	400
	19.3%	80.8%	

If yes, how many did you remove?

	1-2	3	4	5	6	7-11	12+	Total	Mean
How many bulbs were removed	47	12	6	0	5	0	0	70	2.0
	67.1%	17.1%	8.6%	0.0%	7.1%	0.0%	0.0%		

Why did you remove them?

	Not bright enough	Did not like the light	Too slow to start	Other	Total
Why the bulb was removed	18	6	5	40	69
	26.1%	8.7%	7.2%	58.0%	

Future CFL Purchases

Participants purchased CFL to install now and for future use. Participants are storing an average of 4 CFLs for later use. The majority of participants (77.8%) have not purchased additional CFL for the standard retail price. Of those participants that have purchased additional bulbs they purchased on average 5 CFLs.

How many CFLs that you purchased did you store for a later time?

	1-2	3	4	5	6	7-11	12+	Total	Mean
CFLs stored for a later time	106	35	48	20	66	31	19	325	4
	32.6%	10.8%	14.8%	6.2%	20.3%	9.5%	5.8%		

	Yes	No	Total
Have you bought any CFLs for retail price after buying these CFLs through the Duke program?	86	301	387
	22.2%	77.8%	

	1-2	3	4	5	6	7-11	12+	Total	Mean
If yes, how many did you purchase?	22	12	18	6	14	4	7	83	5
	26.5%	14.5%	21.7%	7.2%	16.9%	4.8%	8.4%		

Well over half (69%) are very satisfied with the CFLs they purchased. The majority, (60.2%) did not have a CFL in their house before they purchased bulbs through the ENERGY STAR lighting program. Those participants that already had CFLs in their home had on average 4 in their home.

	Very Satisfied (3)	Somewhat Satisfied (2)	Not at all Satisfied (1)	Total	Mean
Overall, how satisfied are you with the CFLs	271	109	13	393	2.7
	69.0%	27.7%	3.3%		

	Yes	No	Total
Did you have any CFLs in your house before you bought these discounted CFLs?	160	242	402
	39.8%	60.2%	

	1-2	3	4	5	6	7-11	12+	Total	Mean
If yes, how many?	71	24	28	4	14	8	7	156	4
	45.5%	15.4%	17.9%	2.6%	9.0%	5.1%	4.5%		

awareness of CFLs

Almost all of the participants (83.2%) were aware of CFLs before they saw the store promotion. Under half (44.9%) were definitely planning on buying CFLs before they saw the promotion in the store. A large number (85.6%) of the participants felt the in store promotion lead them to purchase more CFLs than they were originally planning to when they walked in the store. The in store promotion lead them to purchase an additional 7 CFLs on average.

	Yes	No	Total
Were you aware of CFLs before you saw the promotion at the store?	328	66	394
	83.2%	16.8%	

	Yes	No	Total
Were you planning on definitely buying CFLs before you saw the promotion?	172	211	383
	44.9%	55.1%	

	Yes	No	Total
Did the promotion lead you to buy more CFLs then you were - planning?	297	50	347
	85.6%	14.4%	

	1-2	3	4	5	6	7-11	12+	Total	Mean
If yes, how many did you purchase?	32	21	31	13	65	51	67	280	7
	11.4%	7.5%	11.1%	4.6%	23.2%	18%	23.9%		

Energy Star Awareness

Most of the participants (68.2%) have not added any electrical appliances to their home in the past year. The majority of customers (63.9%) were aware of the ENERGY STAR label. Slightly over half look for the ENERGY STAR label when they are purchasing a new appliance.

	Yes	No	Total
Have you added any electrical appliances to your home in the past year?	128	275	403
	31.8%	68.2%	

	Yes	No	Total
Are you aware of ENERGY STAR?	253	143	396
	63.9%	36.1%	

	Yes	No	Total
Do you look for the ENERGY STAR label when purchasing an appliance?	219	155	374
	58.6%	41.4%	

Most of the customers (82.2%) that participated in the ENERGY STAR lighting program have never used the Duke Energy website.

	Often (3)	Sometimes (2)	Never (1)	Total	Mean
Do you use the Duke Energy Website?	16	55	327	398	1.2
	4.0%	13.8%	82.2%		

General Information About Your Home

The majority of customers (83.1%) participating in the ENERGY STAR lighting program live in a single family detached dwelling. Over half (58.4%) of the participants homes were built after 1959. More than half (59%) live in a home that has 1,900 or less heated area square footage. Over one fourth (26.5%) of participants were not sure of the square footage of their home. A large percentage (71.9%) of the participants has 1 to 2 people living in their home. Almost all (95.0%) of the participants own their home.

	Detached Single Family	Townhouse	Condo	Apartment	Manufactured Home	Total
Type of home in which you live?	329	7	31	18	11	396
	83.1%	1.8%	7.8%	4.5%	2.8%	

	After 1959	1960-1979	1980-1989	1990-1997	1998-2000	>=2001	Total
What year was your home built?	167	103	47	42	18	24	401
	41.6%	25.7%	11.7%	10.5%	4.5%	6.0%	

	<1200	1201-1600	1601-1900	1901-2400	2401-3000	>=3001	Don't know	Total
Approximate square footage (heated area) of your home?	53	83	47	57	51	19	82	310
	17.1%	26.8%	15.2%	18.4%	16.5%	6.1%	26.5%	

	1	2	3	4	5	6	7	Total
How many people live in your home?	78	209	55	34	17	6	1	399
	19.5%	52.4%	13.8%	8.5%	4.3%	1.5%	.3%	

	Own	Rent	Total
Do you own or rent your home?	380	20	400
	95.0%	5.0%	

Energy Efficiency Web tool

This evaluation is based on an on-line survey conducted with customers who visited the Duke Energy website and used the energy efficiency calculator. These customers were mailed an energy efficiency kit which contained a showerhead, faucet aerators, compact fluorescent light bulbs, and other items to help them save energy. Customers received \$20 for filling out the survey.

The survey mailed out to 159 participants. There were 71 responses received for a 44.6% response rate. For the energy efficiency kit, the impacts are assumed to be the same as the impacts from the kits associated with the Kentucky Personalized Energy Report (PER) impact analysis, as the kits were identical. For the energy efficiency recommendations, the PER and website are sufficiently different in their approach (though the measures are identical) that the energy savings from the website are expected to be different from the savings associated with PER.

Therefore, to determine the savings associated with the Energy Efficiency Web tool, the results of the customer behavior from this survey were combined with the engineering based measure savings from the PER analysis to give an estimate of the savings associated with the website recommendations. A summary of the savings are:

Measure	Percent Installed	Website Useful >=4	Average kWh Savings	Total kWh Savings	Average kW Savings	Total kW Savings	Average Therm Savings	Total Therm Savings
Furnace	0.042	0.330	0.00	0.00	0.000	0.000	16.63	0.23
Heat Pump	0.028	1.000	3373.91	94.47	1.750	0.049	0.00	0.00
AC	0.042	1.000	1339.19	56.25	1.194	0.050	0.00	0.00
Window Kits	0.155	0.727	85.22	9.61	0.056	0.006	1.54	0.17
Sidewall	0.085	0.500	796.35	33.84	0.706	0.030	32.38	1.38
Attic	0.113	0.750	350.21	29.68	0.188	0.016	6.66	0.56
Duct Repair	0.099	0.571	542.15	30.67	0.159	0.009	12.29	0.70
Rplace Filter	0.803	0.596	-36.06	-17.27	-0.018	-0.009	-0.12	-0.06
Stop heating room	0.652	0.644	308.74	129.73	0.214	0.090	3.85	1.62
Cleaned Baseboards	0.739	0.647	23.00	11.00	0.000	0.000	0.00	0.00
Drapes	0.812	0.677	75.63	41.56	0.000	0.000	0.00	0.00
Insul. Water Heater	0.217	0.677	175.53	25.77	0.020	0.003	18.31	2.69
Cold water wash	0.812	0.677	202.55	111.29	0.023	0.013	14.00	7.69
Lower water temp	0.812	0.677	101.28	55.65	0.000	0.000	4.00	2.20
Closed Fireplace	0.145	0.677	17.16	1.68	0.005	0.000	0.36	0.05
Total per Cust. Savings		32%		613.92		0.258		17.23

Note that the column denoting the percentage of responses with the “website usefulness >4” shows the percentage of respondents undertaking the action who stated that the website was more than “somewhat useful” in affecting the decision to affect the action. Thus, one minus this amount is assumed to be the level of freeridership, which is shown to be 32% overall.

The remainder of this report reviews the individual results for each measure.

Energy Efficiency Recommendations from the Website

The Duke Energy website has an energy efficiency section that provides suggestions for customers on how to make their home more energy efficient. The tables below provide the results of what measures respondents installed after visiting the website.

Installed New Furnace

Most of the respondents (95.8%) did not install a new natural gas furnace after visiting the website. Of the respondents that did more than half of them installed a furnace that the exhaust goes up a chimney similar to a standard efficiency unit.

Frequency of Recommendation Taken: Installed Natural gas furnace

	Count	Col %
Installed a new natural gas furnace		
Yes	3	4.2%
No	68	95.8%
Total	71	100.0%
Type of high efficiency furnace		
the exhausts exit out a plastic pipe coming through the side of the home	1	33.3%
the exhausts go up a chimney similar to a standard efficiency unit	2	66.7%
Total	3	100.0%

Installed New Heat Pump

A very small number of respondents installed a new heat pump after visiting the website. Of those that did, all of them installed a high efficiency unit.

Frequency of Recommendation Taken: Installed Heat Pump

	Count	Col %
Installed a new heat pump		
Yes	2	2.8%
No	69	97.2%
Total	71	100.0%
Efficiency of heat pump		
High Efficiency Unit	2	100.0%
Standard Unit	0	0%
Total	2	100.0%
SEER number for heat pump		
<=11	0	0%
12	0	0%
13	0	0%
>= 14	1	50.0%
Don't Know	1	50.0%
Total	2	100.0%

Install New Air Conditioner

Most all of the respondents (95.8%) that visited the website did not install a new air conditioning unit. The respondents that did install a new unit installed a high efficiency unit. All the respondents that installed a new unit were unsure of the SEER number for the unit.

Frequency of Recommendation Taken: Installed New Air Conditioning Unit

	Count	Col %
Installed new air conditioner		
Yes	3	4.2%
No	68	95.8%
Total	71	100.0%
Efficiency of air conditioner		
High Efficiency Unit	3	100.0%
Standard	0	0%
Total	3	100.0%
SEER number for air conditioner		
<=11	0	0%
12	0	0%
13	0	0%
>= 14	0	0%
Don't Know	3	100.0%
Total	3	100.0%

Plastic Wrap-Type Window Kits

A small percentage of respondents (15.5%) purchased and installed additional window kits after visiting the website. Most of the respondents that did install additional kits covered 1-3 windows, that were averaged sized windows.

Frequency of Recommendation Taken: Plastic Wrap-Type Window Kits

	Count	Col %
Purchased and installed window kits		
Yes	11	15.5%
No	60	84.5%
Total	71	100.0%
Number of windows covered		
1-3	8	72.7%
4-7	0	0%
8-10	3	27.3%
11+	0	0%
Total	11	100.0%
Size of window		
Small window	0	0%
Average sized window	7	63.6%
Large window	4	36.4%
Total	11	100.0%

Sidewall Insulation

few customers (8.5%) installed sidewall insulation as a result of visiting the website. The respondents that did insulate their sidewalls did so on an average of 2 walls.

Frequency of Recommendation Taken: Insulated sidewalls

	Count	Col %
Sidewalls Insulated		
Yes	6	8.5%
No	65	91.5%
Total	71	100.0%
Number of sidewalls insulated		
1	1	20.0%
2	2	40.0%
3	1	20.0%
4+	1	20.0%
Total	5	100.0%

Attic Insulation

Not very many respondents (11.3%) took the recommendation to insulate their attic. Half of those that did take the suggestion insulated part of their attic and the other half insulated their whole attic. Most of those that insulated their attic used 4-6 inch thick insulation.

Frequency of Recommendation Taken: Attic Insulation

	Count	Col %
Attic Insulated		
Yes	8	11.3%
No	63	88.7%
Total	71	100.0%
All or part of ceiling insulated		
Insulated part of the attic	4	50.0%
Insulated the entire attic	4	50.0%
Total	8	100.0%
Inches of thickness added		
1-3	1	14.3%
4-6	5	71.4%
13+	1	14.3%
Total	7	100.0%

Duct Insulation/Repair

Respondents were more likely to repair the ducts (19.7%) than to insulate them (9.9%).

Frequency of Recommendation Taken: Duct Insulation or Repair

	Count	Col %
Insulated ducts		
Yes	7	9.9%
No	64	90.1%
Total	71	100.0%
Repaired or fixed holes in ducts		
Yes	14	19.7%
No	57	80.3%
Total	71	100.0%

Replacing Furnace Filters

The majority of respondents (80.3%) replaced their furnace filters after visiting the website. Most of the customers changed their furnace filter monthly before visiting the website. After visiting the website most respondents started changing their furnace filter on a quarterly basis, which is not as frequently as before visiting the website.

Frequency of Recommendation Taken: Furnace Filter Replacement

	Count	Col %
Replaced furnace filter		
Yes	57	80.3%
No	14	19.7%
Total	71	100.0%
Frequency of filter changes before visiting website		
Monthly	32	56.1%
Quarterly	20	35.1%
Yearly	2	3.5%
*Other	3	5.3%
Total	57	100.0%
*Other Responses		
Every 2-3 months		
Every 2 months		
Monthly in the winter months		
Frequency of filter changes since visiting website		
Monthly	14	24.6%
Quarterly	32	56.1%
Yearly	6	10.5%
*Other	5	8.8%
Total	57	100.0%
*Other Responses		
6 months		
Every 3-4 months		
Just moved		
Quarterly in winter months		
Whenever I thought it needed it		

Stopped Heating Unused Rooms

Over half of customers (65.2%) that visited the website stopped heating rooms in their home that they were not using after visiting the website. On average respondents would stop heating 2 unused rooms in their home.

Frequency of Recommendation Taken: Turn Off Heat in Unused Rooms

	Count	Col %
Stopped heating unused rooms		
Yes	45	65.2%
No	24	34.8%
Total	69	100.0%
Number of rooms no longer being heated		
1	16	36.4%
2	22	50.0%
3	5	11.4%
5	1	2.3%
Total	44	100.0%

Cleaned Electric Baseboards

This measure only applies to those respondents that have both electric heat and baseboards. Many of those that said they took the action did not have electric heat, so most of the cases were removed from the impact estimation calculation. These responses indicate that many respondents do not know what baseboard unit are, and most likely cleaned the warm air registers from their central heating unit.

Frequency of Recommendation Taken: Clean Baseboards of Dust

	Count	Col %
Cleaned electric baseboards		
Yes	51	73.9%
No	18	26.1%
Total	69	100.0%
Number of electric baseboards cleaned		
1-3	3	6.0%
4-7	12	24.0%
8-12	23	46.0%
13+	12	24.0%
Total	50	100.0%

Install Dual Heating System

Most none of the respondents (97.1%) installed a dual heating system after visiting the website. Of the few that did, half manages the system to only heat the rooms needed.

Frequency of Recommendation Taken: Install Dual Heating System

	Count	Col %
Installed dual heating system		
Yes	2	2.9%
No	67	97.1%
Total	69	100.0%
Manage this system to only heat the rooms needed		
Yes	1	50.0%
No	1	50.0%
Total	2	100.0%

Manage Draperies

This recommendation has one of the highest response rates, with a little over 80% of respondents indicating that they are now managing their drapes at night and letting the sun shine in during the day. Respondents are managing on average 6 windows after visiting the website.

Frequency of Recommendation Taken: Keep draperies open on sunny days and closed at night

	Count	Col %
Manages draperies		
Yes	56	81.2%
No	13	18.8%
Total	69	100.0%
Number of window coverings managed		
1-3	10	20.8%
4-7	20	41.7%
8-12	13	27.1%
13+	5	10.4%
Total	48	100.0%

Insulated Water Heater

A little under a quarter (21.7%) of respondents insulated their water heater after visiting the website. Most of those respondents had a 50 gallon water heater. The majority of the water heaters (80%) were heated by gas.

Frequency of Recommendation Taken: Insulated water heater

	Count	Col %
Insulated hot water heater tank		
Yes	15	21.7%
No	54	78.3%
Total	69	100.0%
Capacity of water heater, in gallons		
1 -30	3	20.0%
50	7	46.7%
60	2	13.3%
75		
80+	3	20.0%
Total	15	100.0%
How water tank is heated		
Electricity	3	20.0%
Gas	12	80.0%
Total	15	100.0%

Using Cold Water for Laundry

A large percentage of respondents (81.2%) switched from hot to cold water to do their laundry after visiting the website. The respondents do on average 6 loads of laundry per week.

Frequency of Recommendation Taken: Wash laundry in cold water

	Count	Col %
Switched from hot to cold water for laundry		
Yes	56	81.2%
No	9	13.0%
Does Not Apply	4	5.8%
Total	69	100.0%
Number of loads per week		
1-2	6	10.7%
3-4	12	21.4%
5-6	17	30.4%
7-8	12	21.4%
9-10	4	7.1%
11-12	2	3.6%
13+	3	5.4%
Total	56	100.0%

Lowering the Temperature in the Winter

The majority of respondent (81.2%) lowered the temperature of their home in the winter as a result of visiting the website. Over half of the customers (62.5%) that lowered the temperature did so both at night and during the day.

Frequency of Recommendation Taken: Lower Thermostat Temperature in Winter

	Count	Col %
Lowered the temperature in the winter		
Yes	56	81.2%
No	6	8.7%
Does Not Apply	7	10.1%
Total	69	100.0%
Time of day lowered temperature		
At night	16	28.6%
During the day	5	8.9%
Both at night and during the day	35	62.5%
Total	56	100.0%

Closed Off Fireplace

A small percentage of customers (14.5%) stopped using their fireplace unless it is one that uses outside air after visiting the website. Around the same percentage (15.9%) closed off their fireplace as suggested. It appears there are a large number of respondents that do not have a fireplace, which would prevent them from taken the recommended actions.

Frequency of Recommendation Taken: Closed Off Fireplace

	Count	Col %
Stopped using fireplace unless it is one that uses outside air		
Yes	10	14.5%
No	5	7.2%
Does Not Apply	54	78.3%
Total	69	100.0%
Closed off fireplace		
Yes	11	15.9%
No	14	20.3%
Does Not Apply	44	63.8%
Total	69	100.0%

Purchased and Installed CFLs after reviewing the lighting calculator

On the Duke Energy website there is a lighting calculator that calculates your energy savings if you switch from a standard bulb to a CFL based on wattage of bulb, number of bulbs and hours on per day. After using the lighting calculator 62.3% of respondents purchased and installed additional CFLs. Customers on average purchased and installed an additional 7 CFLs after reviewing the lighting calculator. Most of the customers installing a CFL were replacing a bulb that was between 45-70 watts. The bulbs are used on average 7 hours a day.

Purchase and Install Compact Florescent Light (CFLs)

	Count	Col %
Purchased and installed CFLs after reviewing the lighting calculator		
Yes	43	62.3%
No	26	37.7%
Total	69	100.0%
Number of CFLs purchased and installed since visiting the website		
1-2	9	21.4%
3-5	9	21.4%
6-9	6	14.3%
10+	18	42.9%
Total	42	100.0%
Average wattage of bulb removed		
<=44	3	7.0%
45 - 70	29	67.4%
71 - 99	9	20.9%
>=100	2	4.7%
Total	43	100.0%
Average hours bulbs are used per day		
1-2	3	7.0%
3-4	7	16.3%
5-9	25	58.1%
10-12	5	11.6%
13-24	3	7.0%
Total	43	100.0%

Usefulness of Website

The majority of respondents (83%) thought the website was useful in providing them information about energy use in their home. The calculators seemed to be the most useful feature on the website as well as most visited area of the site. Most of the respondents 67.6% found the Home energy calculator useful, 66.2 found the lighting calculator useful and 59.2% found the Appliance calculator useful.

How useful was the website in providing you information about energy use in your home?

	Not at all Useful 1	2	Somewhat Useful 3	4	Very Useful 5	Total	Mean
Count	1	1	10	37	22	71	4.1
Row %	1.4%	1.4%	14.1%	52.1%	31.0%	100.0%	

Which components in the website did you review and how useful were they?

		Not at all Useful 1	2	Somewhat Useful 3	4	Very Useful 5	Did Not Visit	Total	Mean
Home Energy Calculator	Count	0	1	18	24	24	4	71	4.1
	Row %	0%	1.4%	25.4%	33.8%	33.8%	5.6%	100.0%	
Appliance calculator	Count	1	2	14	22	20	12	71	4.0
	Row %	1.4%	2.8%	19.7%	31.0%	28.2%	16.9%	100.0%	
Lighting calculator	Count	2	2	10	25	22	10	71	4.0
	Row %	2.8%	2.8%	14.1%	35.2%	31.0%	14.1%	100.0%	
Interactive home	Count	3	4	15	19	8	22	71	3.5
	Row %	4.2%	5.6%	21.1%	26.8%	11.3%	31.0%	100.0%	
Energy library home energy system	Count	1	6	13	20	10	21	71	3.6
	Row %	1.4%	8.5%	18.3%	28.2%	14.1%	29.6%	100.0%	
Energy library fundamental of electricity	Count	2	5	14	23	6	21	71	3.5
	Row %	2.8%	7.0%	19.7%	32.4%	8.5%	29.6%	100.0%	
For kids	Count	12	3	10	9	3	34	71	2.7
	Row %	16.9%	4.2%	14.1%	12.7%	4.2%	47.9%	100.0%	

Almost all (95.8%) respondents thought the website was easy to navigate through. The following suggestions were made to make the site better:

- Full site map needed
- I like it the way it is.
- I wonder if the calculator also takes into account location of the home? i.e. in an open flat area or hilltop, or in a valley all play into air cooling.
- Include info on even bigger things to do - like education on alternative sources of energy (particularly in Covington and especially for heating).
- Large buttons and clear text. Clear colors are a must.
- Put everything on one page rather than clicking links to get to other "hidden" links.

Was the site easy to navigate to get to the information you wanted?

	Yes	No	Total
Count	68	3	71
Row %	95.8%	4.2%	100.0%

Most of the respondents (88.7%) did look at the details in the home energy calculator report and the majority of them (85.7%) though that the results reasonably reflected their usage. Over half (57.2%) of the respondents that looked at the home energy calculator found it to be useful.

Did you look at the Home Energy calculator report details?

	Yes	No	Total
Count	63	8	71
Row %	88.7%	11.3%	100.0%

Did you feel that the estimate reasonably reflected your usage?

	Yes	No	Total
Count	54	9	63
Row %	85.7%	14.3%	100.0%

Was the report very useful?

	Not at all Useful 1	2	Somewhat Useful 3	4	Very Useful 5	Total	Mean
Count	0	0	27	26	10	63	3.7
Row %	0%	0%	42.9%	41.3%	15.9%	100.0%	

The most popular actions that respondents took based on tips from the website were replacing the furnace filter, cleaning baseboards of dust and turning off the heat in unused rooms. Of the respondents that completed those actions 59.8% found the tip to replace the furnace filters helpful, 64.7% found the tip on cleaning the baseboard helpful and 64.4 thought the tip to turn off heat in unused rooms useful.

How useful was the website in determining whether to take any of the following actions

		Not at all Useful 1	2	Somewhat Useful 3	4	Very Useful 5	Total	Mean
Natural gas furnace	Count	0	0	2	1	0	3	3.3
	Row %	0%	0%	66.7%	33.3%	0%	100.0%	
Heat pump	Count	0	0	0	1	1	2	4.5
	Row %	0%	0%	0%	50%	50%	100.0%	
Central air conditioning	Count	0	0	0	1	2	3	3.7
	Row %	0%	0%	0%	33.3%	66.7%	100.0%	
Plastic wrap-type window kits	Count	0	0	3	3	5	11	4.2
	Row %	0%	0%	27.3%	27.3%	45.5%	100.0%	
Insulated sidewalls	Count	0	0	3	1	2	6	3.8
	Row %	0%	0%	50.0%	16.7%	33.3%	100.0%	
Attic insulation	Count	0	1	1	5	1	8	3.8
	Row %	0%	12.5%	12.5%	62.5%	12.5%	100.0%	
Heating or cooling duct insulations	Count	0	2	1	4	0	7	3.3
	Row %	0%	28.6%	14.3%	57.1%	0%	100.0%	
Repair duct	Count	0	2	3	6	3	14	3.7
	Row %	0%	14.3%	21.4%	42.9%	21.4%	100.0%	
Furnace filter replacement	Count	1	5	17	22	12	57	3.7
	Row %	1.8%	8.8%	29.8%	38.6%	21.1%	100.0%	
Turn off heat in unused rooms	Count	2	2	12	20	9	45	3.7
	Row %	4.4%	4.4%	26.7%	44.4%	20.0%	100.0%	
Clean baseboards of dust	Count	2	2	14	23	10	51	3.7
	Row %	3.9%	3.9%	27.5%	45.1%	19.6%	100.0%	

Overall Effect of the Website

Overall, half (50.7%) of respondents thought that the website alone caused them to take energy conserving actions. The website did a good job of reassuring customers about what energy conserving actions to take. The majority of customers 76.8% stated that website was effective in confirming the energy conserving actions they did before visiting the website. A large percentage of respondents (82.4%) felt that the website inspired them to take the energy conserving actions sooner. Receiving the energy efficiency kit caused 66.7% of respondents to take energy conserving actions that they did not think of before visiting the website.

Overall, how much did the website alone cause you to take energy conserving actions that you had not thought of prior to visiting the site?

	Not at All	2	Somewhat	4	Very Much	Total	Mean
Count	1	3	30	22	13	69	3.6
Row %	1.4%	4.3%	43.5%	31.9%	18.8%	100.0%	

If you had energy conserving actions that you did before visiting the website, how effective was the website in confirming that these actions were the correct thing to do?

	Not at all Effective	2	Somewhat	4	Very Effective	N/A	Total	Mean
Count	1	0	14	20	33	1	69	4.2
Row %	1.4%	0%	20.3%	29.0%	47.8%	1.4%	100.0%	

Did the website inspire you to take these actions sooner?

	Yes	No	Total
Count	56	12	68
Row %	82.4%	17.6%	100.0%

How much did the addition of the kit cause you to take energy conserving actions that you had not thought of prior to visiting the site?

	Not at All	2	Somewhat	4	Very Much	Total	Mean
Count	2	2	19	24	22	69	3.9
Row %	2.9%	2.9%	27.5%	34.8%	31.9%	100.0%	

General Information about your home

	Count	Col %
Type of home in which you live		
Detached single-family	59	85.5%
Manufactured/Modular home	2	2.9%
Condominium	2	2.9%
Duplex/2-family	2	2.9%
Multi-family (3 or more units)	4	5.8%
Total	69	100.0%
Year home was built		
Before 1959	28	40.6%
1960 - 1979	15	21.7%
1980 - 1989	4	5.8%
1990 - 1997	4	5.8%
1998 - 2000	5	7.2%
After 2000	13	18.8%
Total	69	100.0%
Approximate square footage (heated area) of your home		
< 1,200	18	26.1%
1,201-1,600	17	24.6%
1,601-1,900	8	11.6%
1,901-2,400	6	8.7%
2,401-3,000	7	10.1%
>3,000	7	10.1%
Don't Know	6	8.7%
Total	69	100.0%
Number of rooms in home (excluding bathrooms but including finished basements)		
1-3	5	7.2%
4	8	11.6%
5	8	11.6%
6	12	17.4%
7	10	14.5%
8	11	15.9%
9	6	8.7%
greater than 9	9	13.0%
Total	69	100.0%
Number of people that live in the home		
1	9	13.0%
2	26	37.7%
3	19	27.5%
4	8	11.6%
5	6	8.7%
7	1	1.4%
Total	69	100.0%

Own or rent home		
Own	60	87.0%
Rent	9	13.0%
Total	69	100.0%

Information about your heating and cooling system

	Count	Col %
Primary type of fuel used to heat the home		
Electricity	15	22.1%
Natural Gas	47	69.1%
Propane	1	1.5%
Oil	3	4.4%
Other/Don't Know	2	2.9%
Total	68	100.0%
Type of heating system in home		
Central furnace fueled by natural gas, propane, or oil with a duct system	52	76.5%
Central furnace with an electric heat pump and a duct system	7	10.3%
Central electric furnace with a duct system	6	8.8%
Other/Don't know	3	4.4%
Total	68	100.0%
If have central furnace system, number of years old		
0-4	22	32.4%
5-9	20	29.4%
10-14	17	25.0%
greater than 14	9	13.2%
Total	68	100.0%
Type of cooling system in home		
Central air conditioner	56	82.4%
Room/window unit air conditioner	8	11.8%
Heat pump	4	5.9%
Total	68	100.0%
Number of room/window unit air conditioners		
2	4	5.6%
3	1	1.4%
4	2	2.8%
5	1	1.4%
Total	8	100.0%
If have a cooling system, number of years old		
0-4	28	41.2%
5-9	19	27.9%
10-14	13	19.1%
greater than 14	8	11.8%

Total	68	100.0%
-------	----	--------

Information about your water heating, kitchen and laundry systems

	Count	Col %
Primary fuel used by water heater		
Electricity	21	30.9%
Natural gas	46	67.6%
Propane	1	1.5%
Total	68	100.0%
Age of water heater (in years)		
0-4	28	41.2%
5-9	30	44.1%
10-14	8	11.8%
greater than 14	2	2.9%
Total	68	100.0%
Fuel used for indoor cooking		
Electricity	53	77.9%
Natural gas	15	22.1%
Total	68	100.0%
Primary fuel used by clothes dryer		
Electricity	61	89.7%
Natural gas	7	10.3%
Total	68	100.0%

PER Billing Analysis

This analysis presents some of the results of the billing analysis of the Personalized Energy Report (PER) program for customers within Duke Energy Kentucky. These results apply only to electric customers which have received the kit.

For this analysis, data are available both across households (i.e., cross-sectional) and over time (i.e., time-series). With this type of data, known as “panel” data, it becomes possible to control, simultaneously, for differences across households as well as differences across periods in time through the use of a “fixed-effects” panel model specification. The fixed-effect refers to the model specification aspect that differences across homes that do not vary over the estimation period (such as square footage, heating system, etc.) can be explained, in large part, by customer-specific intercept terms that capture the net change in consumption due to the program, controlling for other factors that do change with time (e.g., the weather).

Because the consumption data in the panel model includes months before and after the installation of measures through the program, the period of program participation (or the participation window) may be defined specifically for each customer. This feature of the panel model allows for the pre-installation months of consumption to effectively act as controls for post-participation months. In addition, this model specification, unlike annual pre/post-participation models such as annual change models, does not require a full year of post-participation data. Effectively, the participant becomes their own control group, thus eliminating the need for a non-participant group. We know the exact month of participation in the program for each participant, and are able to construct customer specific models that measure the change in usage consumption immediately before and after the date of program participation, controlling for weather and customer characteristics.

The fixed effects model can be viewed as a type of differencing model in which all characteristics of the home, which (1) are independent of time and (2) determine the level of energy consumption, are captured within the customer-specific constant terms. In other words, differences in customer characteristics that cause variation in the level of energy consumption, such as building size and structure, are captured by constant terms representing each unique household.

Algebraically, the fixed-effect panel data model is described as follows:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it},$$

where:

- y_{it} = energy consumption for home i during month t
- α_i = constant term for site i
- β = vector of coefficients
- x = vector of variables that represent factors causing changes in energy consumption for home i during month t (i.e., weather and participation)
- ε = error term for home i during month t .

With this specification, the only information necessary for estimation is those factors that vary month to month for each customer, and that will affect energy use, which effectively are weather conditions and program participation. Other non-measurable factors can be captured through the use of monthly indicator variables (e.g., to capture the effect of potentially seasonal energy loads). The effect of the program, in the case the

Personal Energy Report kit, is done by including a variable which is equal to one for all months after the customer received the kit.¹ The estimated electric model is presented in Table 1.

Table 1: Estimated Model – dependent variable is monthly kWh usage, January 2005 through April 2007.

Independent Variable	Coefficient	t-value
Customer received kit	-16.22	-14.0
Humidity	0.02	0.1
Temperature	-0.08	-4.9
Cooling Degree Days	-0.03	-17.0
Heating Degree Days	8.76	5.4
Indicator for February	-10.09	-5.6
Indicator for March	-29.24	-13.5
Indicator for April	-71.92	-35.5
Indicator for May	-42.14	-9.8
Indicator for June	-14.94	-2.3
Indicator for July	-8.47	-1.3
Indicator for August	-40.93	-14.0
Indicator for September	-61.38	-33.3
Indicator for October	-47.10	-24.4
Indicator for November	-3.02	-1.7
Sample Size	9,688 obs (346 homes)	
R-Squared		
With fixed effect terms	64.9%	
W/O terms	38.8%	

This estimated model shows that the PER kits results in a savings of 16.22 kWh/month, or 195 kWh a year. This estimate is precisely estimated, with the 90% confidence interval extending from savings of 14.3 kWh/month to 18.1 kWh/month. In general, the model performs well, with very high R-squared values and high t-values. The parameter coefficient estimates suggest that there is some interaction between the month variables and the temperature and degree day variables, but this is expected due to the use of a single weather station for the entire service territory. Applying unique weather data more closely aligned to the customer's location would improve modeling accuracy, but would not likely change the overall average impact estimate overall.

¹ The model was estimated in this case only for electrical customers who received the kit. Other models were estimated that included all customers irrespective of whether or not they received a kit, and the pre vs. post effect comparisons were negligibly small, as expected (~3 kWh/month decrease) relative to estimated change per month.

Appendix 1



Dear Customer,

Duke Energy is continuously trying to improve our services for you. To help us improve the ENERGY STAR lighting program, we would like your input. Please let us know what you think about the compact fluorescent bulbs or torchiere floor lamp you purchased through our Energy Star program.

Monica Redman
 Research Manager

PLEASE ANSWER THE QUESTIONS BELOW RELATED TO THE CFLs OR TORCHIERE LAMPS YOU PURCHASED.
 FILL IN THE CIRCLES COMPLETELY USING BLUE OR BLACK INK.

Promotions

How useful was the following in providing you information about energy use in your home?

	Very Useful	Somewhat Useful	Not at all Useful
Store Advertising	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Displays and signs in the store	<input type="radio"/> <input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sales Associate at the store	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How influential was the following in your decision to purchase the CFL or torchiere lamp?

	Very Influential	Somewhat Influential	Not at all Influential
Store Advertising	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Displays and signs in the store	<input type="radio"/> <input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sales Associate at the store	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Performance Ratings

In this section of the survey, we would like to understand how you have used the CFLs and torchiere lamps you have purchased

	1-2	3	4	5	6	7-11	12+
How many CFLs did you purchase for the special price?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How many torchiere lamps did you purchase for the special price?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How many bulbs would you have bought without the rebate or incentive?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How many CFL bulbs would you purchase if...	1-2	3	4	5	6	7-11	12+
They were the same price as a standard bulb?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
They were \$1.00 more than standard bulbs?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
They were \$2.00 more than standard bulbs?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
They were \$3.00 more than standard bulbs?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

They were free but you had to mail in a rebate form
 to get your money back?

Bulb installation

Of the bulbs you bought...

How many did you install? 1-2 3 4 5 6 7-11 12+

For each of those bulbs that you installed, what was the typical wattage of the bulb that was replaced?

<44 45-70 71-99 >=100

About how many hours do you use this bulb? <1 1-2 3-4 5-9 10-12 13-24

Did you remove any of the CFLs you installed? Yes No

If yes, how many did you remove? 1-2 3 4 5 6 7-11 12+

Why did you remove them?

Not bright enough Did not like the light Too slow to start Other

More on Back 

How many CFLs that you purchased did you store for a later time? 1-2 3 4 5 6 7-11 12+

Have you bought any CFLs for retail price after buying these CFLs through the Duke program?

Yes No

If yes, how many did you purchase? 1-2 3 4 5 6 7-11 12+

Very Satisfied

Somewhat Satisfied

Not at all Satisfied

Overall, how satisfied are you with the CFLs?

Did you have any CFLs in your house before you bought these discounted CFLs?

Yes No

If yes, how many? 1-2 3 4 5 6 7-11 12+

Were you aware of CFLs before you saw the promotion at the store?

Yes No

If yes...

Were you planning on definitely buying CFLs before you saw the promotion?

Yes No

If yes...

Did the promotion lead you to buy more CFLs than you were planning?

Yes No

	1-2	3	4	5	6	7-11	12+
If yes, how many more did you purchase?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

ENERGY STAR Awareness

Have you added any electrical appliances to your home in the past year? Yes No

Are you aware of ENERGY STAR? Yes No

Do you look for ENERGY STAR label when purchasing an appliance? Yes No

	Often	Sometimes	Never
Do you use the Duke Energy Website?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

General Information About Your Home

To be able to group your responses, please respond to the following categories.

How would you best describe the type of home in which you live?

Detached single-family Townhouse Condominium
 Apartment Manufactured home

In what year was your home built?

Before 1959 1960 - 1979 1980 - 1989
 1990 - 1997 1998 - 2000 >=2001

What is the approximate square footage (heated area) of your home?

<1,200 1,201 - 1,600 1,601 - 1,900
 1,901 - 2,400 2,401 - 3,000 >=3,001
 Don't know

How many people live in your home?

1 2 3 4
 5 6 7 >=8

Do you own or rent your home?

Own Rent

THANK YOU FOR YOUR RESPONSES

APPENDIX H

**Energy Impact Evaluation
of the Personalized Energy Report
Program in Kentucky**

Final Report

**Prepared for
Duke Energy**

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Summary of Findings

The measures provided in the Energy Efficiency Starter Kits are installed and used by program participants in a way that provides significant energy savings to the participants and to Duke Energy. For the Kentucky participants, the installation of the measures provided in the kit provides an annual energy savings of 4,443 therms, 157,414 kWh and reduced peak load by 16.492 kilowatts.

	Total Savings	Mean Savings
Kentucky Kits (n = 741)		
kW	16.492	0.022
kWh	157,414	212.4
Therms	4,443	6.0

The Personalized Energy Report also included recommendations for the customers to reduce their energy consumption. These recommendations were provided to those that received the Energy Efficiency Starter Kits, and to those that did not. The annual first year savings estimated as a result of these actions are summarized in the table below:

	Total Savings	Mean Savings
Kentucky Kits (n = 741)		
kW	180.600	0.244
kWh	485,709	656
Therms	10,925	14.7
Kentucky No Kits (n = 1,879)		
kW	185.923	0.099
kWh	1,062,698	566
Therms	29,042	15.5

These savings can be expected over the effective useful life of the installed measures.

The impact estimates are based on survey responses of what actions were taken and the use conditions associated with these actions for the weather zone in which the participants reside. The energy savings estimates are based on DOE-2 simulations of measure impact in residential buildings. This type of modeling and assessment approach is an industry standard and can be expected to provide accurate estimates of program impact that are consistent with the accuracy of the survey information provided by the program participants. It should also be noted that the energy savings estimates included in this report include substantial discounts for self-selection bias and false response bias. At this time the impacts of these two response biases are largely un-quantified within the energy program evaluation industry and substantial research is needed to accurately predict the impacts of these biases on the analysis results. These biases and the resulting discount factors are discussed in the main body of the report.

Introduction

This document presents the evaluation report for Duke Energy's Personalized Energy Report Program as it was administered in Kentucky. An impact analysis was performed for each of the measures in the Personalized Energy Report Kit. The impacts are based on the responses to two customer surveys, attached to this report as Appendices A and B.

This report is structured to provide energy savings impact estimations per measure and per recommendation adopted by participants. The impact tables reporting total savings are based on the number of respondents indicating that they have taken actions as a result of their participation in the program. The number of customers installing the different measure varies widely, however the average savings per customer for each measure and/or recommendation can be calculated from the information in the tables. After each of the measures are discussed individually, the report presents the estimated energy savings achieved per distributed PER with or without the Energy Efficiency Starter Kit.

This evaluation is based on surveys conducted with customers who participated in the PER program and who may have received the kits mailed by the program. The study did not use on-site verification efforts to confirm if the survey information provided by the customer is accurate or if the measures taken were correctly installed, or used in a way that provides the projected savings. However, we have no reason to believe that the kit-related information provided by the participants is inaccurate or that the measures reported to be installed by the participants were not installed, nor do we believe these measures once installed, were ineffectively used to acquire energy savings. In the opinion of the authors of this report, the biases associated with the kit-provided measures are not significant. As a result, the evaluation contractors consider the kit associated analysis of the study a reasonable estimate of kit-induced savings. However, because of the greater uncertainty around the two key biases associated with the installation of program-recommended measures (self-selection bias and false response bias) we do not consider the savings estimates based solely on the participant's responses to be a reliable indicator of actions taken. As a result, the authors have substantially reduced the estimated savings resulting from the participant's responses regarding the recommendations that were reported as being taken by the participants.

The evaluation was conducted by TecMarket Works and Architectural Energy Corporation (AEC) with assistance from Integral Analytics. The survey instruments were developed by TecMarket Works and AEC. The survey was administered by Integral Analytics via an automated response reading system. The survey was designed to be easily completed by participants by shading a box that best represents their response to the questions. Integral Analytics finalized the survey and formatted the instrument for electronic reading of survey results. The questions were designed to support energy savings calculations for actions that were taken as a result of the program.