APPENDIX F

Final Report

An Evaluation of the Kentucky Small Commercial and Industrial Incentive Program

Results of a Process and Impact Evaluation

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Prepared for

Duke Energy
139 East Fourth Street
Cincinnati, OH 45202

Prepared by:
Nick Hall, Johna Roth

TecMarket Works
165 West Netherwood Road, Suite A
Oregon, WI 53575
Voice: (608) 835-8855
Fax: (608) 835-9490
Mail@TecMarket.net

Pete Jacobs

AEC
2540 Frontier Ave
Boulder, CO 80301
Voice: (303) 444-4149
Fax: (608) 835-9490
pjacobs@archenergy.com

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Executive Summary

About This Report

This report presents the results of a process and impact evaluation of Duke Energy's Small Commercial and Industrial Incentive Program as it operates in Kentucky. This program provides incentives for commercial and industrial electric customers not on rate TT (Time-of-Day Rate for Service at Transmission Voltage) . The incentives can be applied to new buildings or retrofits, and cover lighting, HVAC and Pumps/Motors. This report presents the results from a process and impact evaluation.

The first section provides the results from the process evaluation. The process evaluation employed in-depth interviews with program design, planning and implementation staff, and short interviews with program participants.

The second section provides findings from the impact evaluation efforts. The impact evaluation employed a tracking system review, engineering review of lighting energy savings calculations, and building energy simulation modeling of typical commercial buildings to estimate the HVAC program savings.

Summary of Findings

An overview of the key findings identified through this evaluation is presented in this section.

Significant Process Evaluation Findings

Program Technologies

The equipment incentivized under the Kentucky C&I Program are selected by a panel of industry experts and reviewed regularly. This practice ensures that the most efficient technologies are covered and incentivized by the program.

Changes in technologies and incentives will bring on customer dissatisfaction, but are necessary as the technologies in the market become more efficient. When the technologies being offered are updated and certain equipment is no longer incentivized, there should be two to three month window for those technologies to remain on the list and be incentivized for those that provide receipts showing that the purchase was made before the equipment was removed from the program.

The Incentives

The incentives are altered according to the suggestions of the industry expert panel and are subject to change, resulting in some participant dissatisfaction when they change. However, this condition cannot be avoided. The incentives are not to exceed 50 percent of the incremental price of the energy efficient equipment. As a result, when changes to the incremental efficiency costs are observed, changes are required in the incentives accordingly.

The participants are generally happy with the level of the incentives, however some participants believe it takes too long for the incentives to be processed. At the current size of the program this is not a substantial problem, however, this issue should be addressed by the program's management. Incentives should be paid quickly to support strong participant satisfaction and encourage participation. If the program expands to serve more customers, it is recommended that additional efforts be implemented to reduce incentive payment durations. Participants report that incentives take from 4 to 8 weeks to obtain, so we recommend changes to the processing process be incorporated into the process to allow payments within two weeks of the receipt of the appropriate applications for non-inspected participants and 4 weeks for inspected participants. We understand that changes to the rebate process are underway. An outside contractor has been hired and beginning March 1, 2007, all checks should be delivered to the customers within 2-3 weeks provided that the applications are accurate and complete.

Program Satisfaction

The participants are satisfied with the program overall, and think it is a great program that provides an extra push to help customers make an energy efficient choice.

Significant Impact Findings

Energy and demand savings from this evaluation exceeded the tracking system estimates and the program planning estimates used by Duke Energy by a significant margin. The differences are due to a combination of data entry errors within the tracking system and differences in the methods used to estimate savings. The gross energy and demand savings estimated by this evaluation are summarized in Table 1 and Table 2 below:

Table 1. Lighting Program Gross Energy and Demand Savings

Savings Basis	Source	kW	kWh
Savings/measure	Planning Estimate		130
	Tracking System	0.12	56
	Evaluation Estimate	0.11	365
Savings/participant	Tracking System	28.5	13,186
	Evaluation Estimate	26.1	86,743

Table 2. HVAC Program Gross Energy and Demand Savings

Savings Basis	Source	kW	kWh
Savings/measure	Planning Estimate		130
	Tracking System	0.16	443
	Evaluation Estimate	0.69	763
Savings/participant	Tracking System	1.3	3,673
	Evaluation Estimate	5.7	6,336

The impact analysis was confounded by several factors that could be improved in the future:

1. **Uncertainty in lighting measure baseline**. The tracking system contained information on lighting fixtures installed, but no data were available on the type of lighting fixtures removed. We made assumptions on the type of fixture removed based on a review of the program engineering documentation. Recording the number and type of fixtures removed within the tracking system will remove this uncertainty. We understand that this information is not always readily available or reliable, but applying some effort in this regard should improve the overall impact estimates in the future.
2. **Ambiguity in measure descriptions**. The lighting measure descriptions in the tracking system for T-8 fluorescent lamps were somewhat ambiguous. Although the lamp type, length and number of lamps per fixture were recorded, the lamp watts were not. Several styles of T-8 lamps with varying input watts are available, and adding a lamp wattage description will better define the specific type of the installed measure.
3. **Lack of building type information.** Lighting and HVAC measure savings calculations rely on an understanding of the building type. We were able to identify the building type from the customer name in most cases, but an additional field indicating the building type or customer SIC or NAICS code would be helpful in making this determination in the future.

Introduction

This report presents the results of a process and impact evaluation of the Small Commercial and Industrial Incentive Program as it is provided in Kentucky. To conduct the process evaluation we interviewed program managers and program participants. To conduct the impact evaluation, we relied on an engineering analysis of information provided in the program tracking system.

Program Description

Duke Energy encourages its business customers to increase the energy efficiency of their facilities through their Commercial and Industrial Energy Efficiency Rebate Program. The equipment rebates provided through this program are available to Duke Energy's Kentucky commercial and industrial customers who are not in rate group TT (Time-of-Day Rate for Service at Transmission Voltage). Eligible products include lighting, HVAC and Motors/Pumps. The energy efficient equipment can be installed in new or existing facilities, however some of the lighting product rebates apply only to retrofit applications (this change to retrofit only application was made on 4/15/06). Customers may, depending on the size of the project, install the equipment themselves, however, those installations have to be inspected by Duke Energy before the rebate is awarded.

Evaluation Methodology

The study methodology consists of the following general parts:

1. A process evaluation in which TecMarket Works surveyed 15 participants from a pool of available Kentucky customers, and an in-depth interview with the program manager.
2. An impact analysis that combined a review of the program tracking system, engineering review of lighting program savings estimates, and building energy simulations of typical buildings to estimate HVAC program savings.

Process Evaluation

The process evaluation included a telephone interview with the Duke Energy program manager and interviews with program participants. The management interview focused on the design, planning, and implementation of the program and a review of the program's goals and objectives. This interview was conducted with Connie Rhodes, Duke's Small Commercial and Industrial Program Manager. Interviews were also conducted with participants, these interviews focused on their participation experiences, satisfaction with the program, the operations of the program and other subjects presented in this report.

The interviews were conducted in January 2007. Both sets of interviews followed formal evaluation interview protocols. These protocols are provided in Appendix A and B of this report and allow the reader to examine the range and scope of the questions addressed during the interviews.

Ninety-six participant interviews were conducted with both Indiana (81) and Kentucky (N=15) participants. The low number of interviews with Kentucky participants is because of the small number of participants in that program, consistent with the current level of the budgeted offerings in that region. The Indiana interviews are discussed in this report in order to compare the two programs and to provide information on programs that are operated with a similar approach. While the two programs are not identical, the differences are minor from a process evaluation perspective. The participants interviewed were randomly selected from the following location/technology groups: Kentucky-HVAC, Kentucky-Lighting, Indiana-Lighting, Indiana-HVAC, and Indiana-Motors. Table 3 below presents the number of participants in each of the five groups, and indicates the number that were randomly targeted from each group. Due to the low numbers of customers in HVAC and Motors, we were unable to obtain the number of interviews planned due to refusals, closed businesses, and personnel changes.

Table 3. Interviewed Participants in the Small C&I Incentive Program

Program	Number of Participants	Target: Number of Interviews, n=100	Conducted: Number of Interviews, n=96
Indiana HVAC	61	15	11
Indiana Lighting	260	61	68
Indiana Motors	7	5	2
Kentucky HVAC	10	8	4
Kentucky Lighting	46	11	11

Energy Impact Evaluation

The impact evaluation used an engineering-based approach to estimate program savings. Separate impact analyses were conducted for the lighting and HVAC components of the program. The evaluation effort consisted of the following steps:

1. Review of program savings estimates developed by Balance Engineering
2. Review of program participation data
3. Review of secondary research relevant to the measures covered under the program
4. Development of building energy simulation models of typical buildings treated under the program
5. Development of revised engineering estimates for lighting and HVAC measures

Engineering review of the lighting program savings involved review of lamp wattage, light output and lamp life assumptions against manufacturers' catalog data. The assumptions regarding the equivalencies between the assumed baseline and efficient lighting fixtures were reviewed. Lighting design and measure applications issues identified during the data review were highlighted. Operating hour assumptions embedded in the program estimates were identified for later comparison to data gleaned from the secondary research review. Engineering review of the HVAC program savings involved a review of the measure baseline efficiency assumptions and measure energy savings calculation methodology. These data were compared to program savings calculations used in other programs in other states through a secondary research review.

The secondary research review focused on program design "workpapers" and other research conducted in support of program design efforts elsewhere in the country. The review incorporated research conducted in support of the California Database for Energy Efficiency Resources (DEER), the Pacific Gas and Electric Company (PG&E) commercial mass markets program, the Southern California Edison Company (SCE) workpapers for their commercial retrofit programs, and the Efficiency Vermont technical reference manual[1]. The research review collected information on lighting system operating hours and coincidence factors by lamp and building type, HVAC baseline efficiency assumptions, and HVAC system equivalent full-load hour data. These data were used to test the assumptions used in the Duke program, as well as to develop data resources for conducting the impact study.

The tracking system review was used to identify the measures and building types covered under the program, thus focusing the scope of the engineering analysis. Tracking system savings estimates were also compared to the program assumptions to identify potential problems with tracking system data entry or data processing algorithms.

The secondary research revealed a lack of sufficient data for estimating HVAC measure impacts with the level of rigor that we would like, therefore detailed impacts were established by using a set of prototypical building models were developed using the DOE-2.2 building energy simulation program. Prototype models were developed for small retail, small office and full service restaurant, covering the building types represented by the HVAC program participants. The prototypes are based on the models used in the California DEER study, with appropriate modifications to adapt these models to local design practices and climate. Energy savings estimates were developed from the prototype models and applied to the HVAC program tracking system to estimate program savings.

The databases received from Duke Energy contained participants from January 2005 through October 2006. Since the program period ended in December 2006, the analysis is based on most but not all of the program participants. Thus, the results are normalized per participant and per measure installed. These results will be applied by Duke Energy to the final participant database to estimate the final program savings.

[1] Efficiency Vermont Technical Reference Manual, Master Manual #4. Measure Savings Algorithms and Cost Assumptions, January, 2003.

Section I: Process Interview Results

A total of ninety-six interviews were conducted with participants of the Small C&I Incentive Program, 15 of which were Kentucky customers. All of the interviewees took part in one or more program offerings. At the time of the evaluation, there was a small sample of Kentucky customers that had completed the full participation process for TecMarket Works to interview.

There are suggestions for improvement for the program discussed in this report, however, the program is meeting its objectives as it is currently operated. In summary, some participants would like to have energy audits made available through the program, or have more program-related contact with their vendors when program offerings are changed or when new technologies are added to the program. The program seems to be experiencing a slow but steady increase in participation. This may be due to marketing and participant networking, to higher energy costs increasing interests in the program, to the falling price of energy efficient technologies relative to the program incentive levels, or a combination of these reasons. The participant population, at this time, is too small to be able to define the exact cause of the increased interest. However, the program managers have noticed the increase. This increase has led to the program being able to process the program's budget allocations to participants. Additional participation will require additional program budgets.

Awareness and Understanding of the Program

All of the Kentucky customers contacted remembered participating in the program. Most of the customers found out about the Program through a brochure mailed by Duke (40%), or from their contractor (33%). Other sources were Duke's web site and word of mouth. Table 4 below presents the responses.

Table 4. Awareness of the Kentucky Small C&I Program

	Number	Percent
Remember Participating	15	100%
How Participants Discovered Program		
Duke brochure	6	40%
Contractor	5	33%
Duke web site	1	7%
Owner of business told me	1	7%
Owner of another business told me	1	7%
Don't recall	1	7%

Over half (60%) of the customers were able to make a participation decision based on the information they received when they first learned about the program, while the other 40 percent had to obtain further information about the program in order to decide to participate. Of the customers that had to find more information, five of them (83%) were able to have their questions answered by visiting the program web site, calling their contractor, or calling Duke Energy. One customer with further questions went to the web site to find more information about the program, but found the information there was too vague and confusing for a "lay person", yet decided to participate without a complete understanding of the program. The other customer with additional unanswered questions could not recall what the specific issue was.

Table 5. Understanding of the Kentucky Small C&I Program

	Number	Percent
The Program Information was Adequate	**9**	**60%**
Not adequate: went to web site	3	20%
Not adequate: called contractor	2	13%
Not adequate: called Duke	1	7%
Did you have Questions About the Program that were not Answered?		
Yes	2	13%
No	13	87%

Program Paperwork

The participants themselves filled out the application forms 60 percent of the time, while the others were filled out by their contractors. However, the participants were more likely to submit the forms (73%). All the participants indicated that the program's forms were easy to understand. This finding indicates that at this time, there does not seem to be an issue with the complexity or structure of the participation forms that acts as a barrier to participant understanding of the form's requirements.

Table 6. Participants' Reaction to the Small C&I Program Paperwork

	Number	Percent
Who Filled Out the Forms?		
Participant	9	60%
Contractor	6	40%
Who Submitted the Forms?		
Participant	11	73%
Contractor	4	27%
Were the Forms Easy to Understand?		
Yes	15	100%
No	0	0%

While a participant may understand a form, that does not mean that they are satisfied with its structure, function and use. To help get at satisfaction we asked participants about their satisfaction with the forms. Of the 15 participants interviewed 13 were able to address this question. These participants rated their satisfaction with the forms on a 1 to 10 scale, with 1 meaning very dissatisfied and 10 meaning very satisfied. The mean score from this question is 7.15 indicating acceptance, but some level of dissatisfaction among the participants. The median satisfaction score was 8. Satisfaction scores for this and other aspects of the Kentucky program are covered later in this report.

Program Incentives

We asked the participants about the program's incentives. First, we asked if participants had any problems receiving the incentive. Only three of the 15 (20%) indicated that they had problems. When we asked the participants to explain the problem, the following explanations were provided:

- Our two incentive checks were sent to our old address, one was returned to Duke, but they are now waiting for the second check to be returned before re-processing.
- Duke lost our paperwork.
- We did the remodeling in mid-2005 and put the new equipment in service in 2006. When filling out the application I put 2006 as our date of installation, however, the efficiency level changed in that period and I was no longer eligible to receive the incentive. If I would have put 2005 as the year on the installation I would have received the incentive.

Program Participation

Reasons for Participating

We asked the participants what their primary reason was for their participation decision. Thirty-three percent of the participants indicated that the primary reason for purchasing or upgrading their equipment was for the energy savings. Another 33 percent said the reason for the purchase was because of a remodeling project. Twenty-five percent of the participants indicated that the main reason for the purchase was because it was recommended by their contractor. The other reasons provided relate in one way or another to the project. These responses are presented in Figure 1 below.

We then asked the participants how important the incentive was in the decision to purchase a more energy efficient model. We asked if it was the primary reason, an important reason, one of the reasons but not the most important, one of the reasons but a minor one, or not a reason at all. Forty percent indicated that it was an important reason, and 33 percent indicated that it wasn't a reason at all.

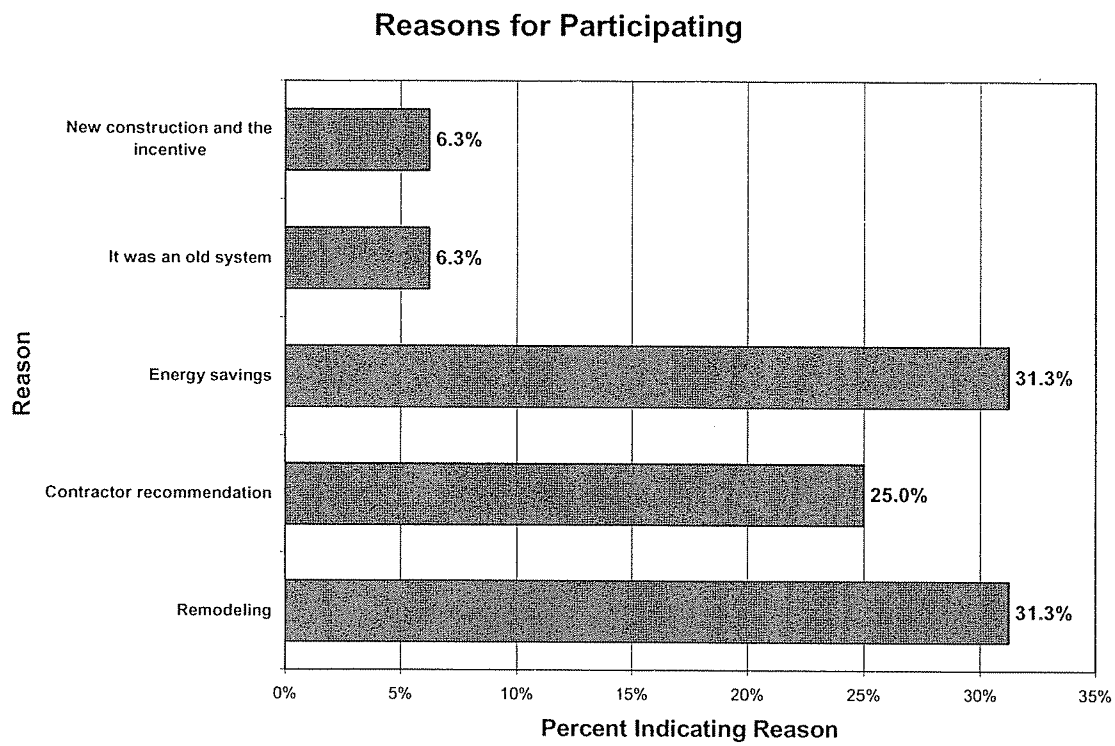

Figure 1. Reasons for Participation

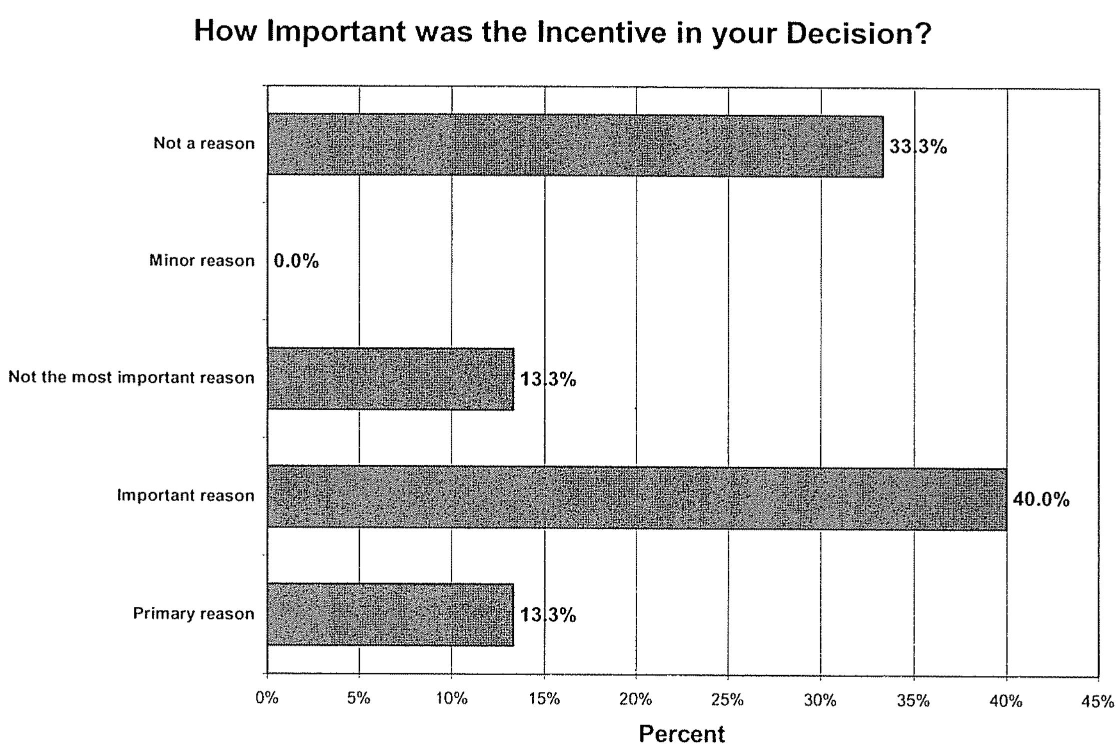

Figure 2. Importance of Incentive in Decision

Other reasons given for the participants deciding to go with the more energy efficient options include:

- Had to fit existing space, and this option fit
- Energy efficient model is cheaper to run
- EPACT credit
- Improved lighting quality
- It makes sense to go as efficient as feasible on new projects
- The lights put out the lumens we wanted, and were high quality
- It was recommended by our contractor

Other Actions (Spillover)

We asked the participants if they had taken any other energy efficiency actions as a result of their experiences with the program. Twenty percent indicated that they had taken other steps towards more energy efficient operations that were in some way influenced by their participation. These included:

- Chalking, sealing and weatherstripping
- replacing lights with energy efficient bulbs
- putting in skylights
- working with other programs, such as KEEPS

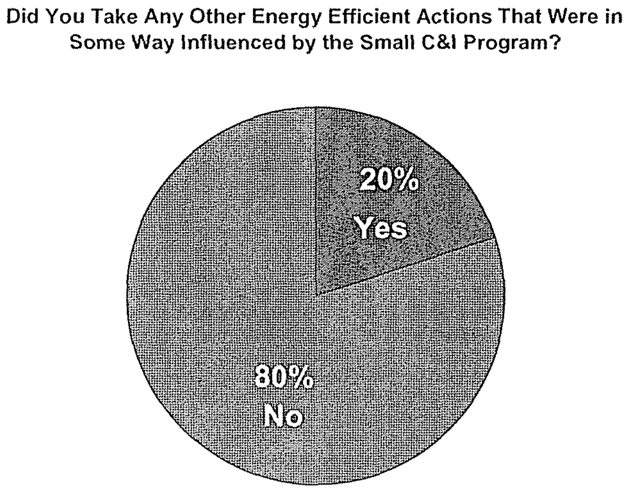

Figure 3. Participants Taking Other Energy Efficiency Actions

Freeridership

Participants were asked a series of questions about why they participated, their intentions before discovering the program, what they would have done if the program were not offered, etc. These and other questions in this section determine the levels of free-ridership with the Kentucky program.

We asked the participants the following question: "*Did you originally plan on purchasing the exact same efficiency level in the equipment you purchased before you knew that there was an incentive offered by Duke Energy*?" The responses to this question indicate that the program is not the motivating factor for these participants to make an energy efficient choice. Most (67%) of the participants said that they had already planned on purchasing the exact same efficiency level before they knew about the program. While we are not suggesting that the freerider rate is 67 percent, (as discussed in the impact section of this report) this strongly suggests that there is a need to focus attention on ways to reduce the level of freeridership. See Figure 4 below.

The next question asked: "*In your decision process, did you search for or consider other less energy efficient equipment that might have cost less*?". The responses to this question confirmed the responses of the previous question, as 73 percent did not consider less energy efficient equipment, indicating that a significant majority of the participants had intended to buy the energy efficient models regardless of the program's objectives (see Figure 5 below).

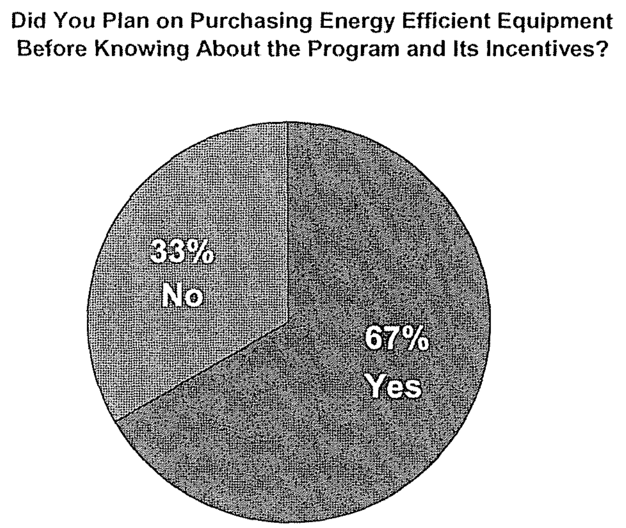

Figure 4. Intended Efficiency Levels Before the Program

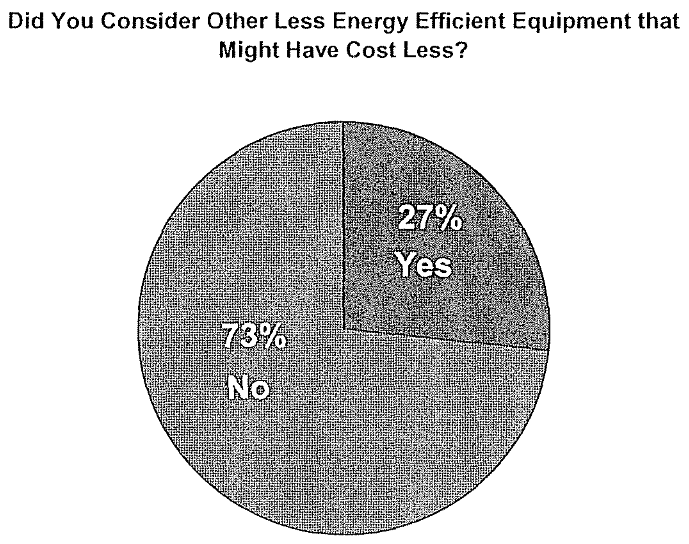

Figure 5. Participants Searching for Less Energy Efficient Options

We also asked the participants if they would have delayed their purchase if the incentives offered through the program would not have been available. The responses to this question reduce the level of free-ridership slightly, because half (47%) said that the project would have been delayed if the incentive was unavailable, meaning that the incentive pushed several participants forward with their energy efficient project. Likewise, some of the participants indicated that they would have never implemented their project without the incentive, or that it would have been delayed indefinitely. The length of delay varied from less than one year to indefinitely (see Figure 6 and Table 7 below).

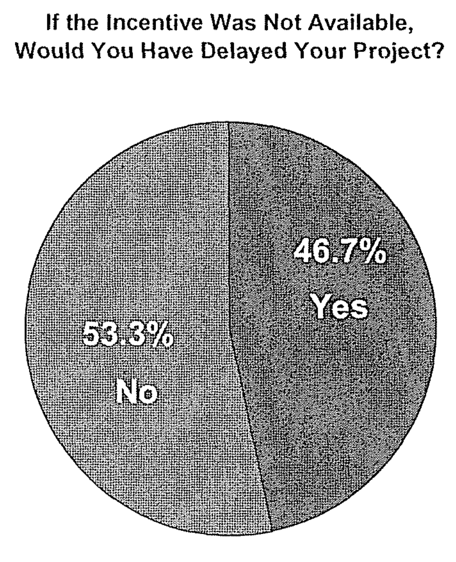

Figure 6. Effects of Incentive on Timing of Project

Table 7. Length of Delay of Project if Incentive Was Not Available

n=	Length of Delay
1	Less than a year
1	1-2 year
2	Don't Know
2	Indefinitely
1	Wouldn't Have Done Project

Calculation of Freeridership

Because the sampling frame within Kentucky alone was not large enough to calculate freerider levels exclusively for Kentucky programs as a stand alone program, we combined the freerider question results from the Kentucky participants with the participants from the Indiana Small Commercial Program evaluation. The Kentucky and Indiana programs are operated in the same way, using the same technologies and rebate levels, and are managed by the same program staff. Together, the two evaluations provided 85 participants who were able to answer the freerider questions to support the analysis.

In calculating freeridership levels we used a per-participant calculation of the influence of the program on their decision to make the change, on the role the incentive played in the decision to go to the high efficiency model, and the amount of delay that would have occurred to the upgrade without the incentive. We informed this analysis by the responses to the questions on whether or not the participant searched or considered equipment of lower efficiency and the reason for upgrading to the high efficiency equipment. As in all freerider analysis this process requires the application of professional judgment because typically from 20 to 40 percent of the participants give responses that are not consistently logical. For example, customers will say that they that they originally planned on buying the same level of efficiency, and then respond that the incentive was important to their decision to go to the energy efficient model. In cases where the responses appear contradictory we gave a partial credit to the program for helping to speed the project forward when the incentive was important in that timing. For these reasons the approach for estimating freeridership is controversial within the evaluation community, with many top-of-the-field evaluation professionals agreeing that it is an inexact and problematic science. However, the use of a partial credit is a standard practice in the freerider estimation process and is used in all evaluation approaches.

Using this approach we provided the following credits based on the responses received:

Type of participant	Credit provided to the program for driving the energy efficient decision	Number of respondents in group
Before hearing about the program did not originally plan on going with the energy efficient equipment and the rebate was a reason for the decision.	100	33
Had originally planned on the same efficiency level, but the rebate was a reason and the project would have been delayed without it	75	9
Not sure if they considered the same equipment at first, but the rebate was a reason for going forward with the project with or without a delay	75	8
Did not originally plan on the energy efficient equipment before hearing about the program incentive, but said the incentive had no effect on their final decision	50	2
Had originally planned on going with the same equipment, but said the incentive was a reason for the choice, but did not speed the project forward	25	15
Planned on the same equipment, the incentive had no effect, did not speed the project.	0	29
Calculated freerider level	Average .50	N=85

Using the distributions presented above, the average freerider rate for this program is 0.50. This means that it is estimated that somewhat less than half of the energy saved would have been saved even if the program had not provided the incentives to the participants. While the field of evaluation has no reliable approach for estimating freeridership, our professional judgment suggests that the rate for this program is in the .4 to .6 range and can be assumed to be from 45 to 55 percent as currently implemented. Within the field of evaluation, freerider rates for these types of programs range from a low of 25 to 30 percent for programs with enrollment screeners that refuse participation to customers who say they are going to take the same actions, to a high of 60 to 65 percent for programs that allow open enrollment. Duke's program holds a position about mid-point in the range of expected values. However this rate indicates that there is a need to educate both customers and equipment contractors and trade allies that the program's incentives are to be provided only to the customers that will not take the energy efficient choice without the incentive.

We also point out that the above freerider estimate is not adjusted to account for spillover. As with most purchase decisions, the decisions that are considered to be successful or correctly made are often repeated by the same decision makers. For example, if a participant has two facilities and takes the action because of the program in one of the facilities, that same individual is likely to take the same action in the second facility with or without the program. Thus, program spillover, or the replications of actions taken via the program, often offset the freerider rate and act to increase the net energy impacts associated with a program. When we asked participants what additional actions they took at their facilities because of the information provided by the program, about 35 percent of the respondents indicated that they took one or more actions (see Other Actions – Spillover section of this report). While the calculation of the savings from the other program-influenced actions is beyond the scope of this study, these actions act to increase the savings from the program. As a result, while the freerider rate for this program is estimated at 0.47, the net rate, once the freerider rate is adjusted for spillover, appears to be in the .20 to .30 range. Again, this estimate is beyond the scope of this study.

Contact with Duke Energy

Almost half of the participants had to contact Duke at some point during their participation experience. Of the participants that contacted Duke for program information or clarification, 43 percent did not think their questions or needs were handled effectively by Duke Energy. However, a review of the comments indicate that the problem may not rest in the communication approach, but with the processes used for processing rebates. Never-the-less, this data indicates that it may be necessary to monitor the communications between Duke and the program participant to determine if there is a communication issue that needs to be addressed. Because of the small sample size and the nature of the comments, these data should not be considered conclusive of an issue that needs to be resolved, yet when 43 percent of interviewees indicate that they do not think Duke handled their issues effectively there is cause for concern over why these were not handled effectively.

Often times vendors would call in and ask for exceptions to be made to the rules for different measures (different configurations, different technologies) and they would get very frustrated with managers when they were told that this is a prescriptive, not a customized program. There was a lot of frustration with the "first come- first served" but program managers have since implemented a "reservation" process driven by the number of applications we received and the amount of the incentives.

	Number	Percent
Participant Contacted Duke		
Yes	7	47%
No	8	53%
Were your Questions Effectively Handled?		
Yes	4	57%

No	3	43%

The reasons for their dissatisfaction with the responses are:

- Duke answered my questions with vague responses
- The incentive should be sent within a month, takes too long now
- Still waiting for my incentive check, takes too long, it's a mess
- It would be better if the incentive check was sent within 2 months, it takes too long
- Duke needs to fully explain the reasons for changes in efficiency levels

Increasing Participation

We asked the participants for ways in which Duke Energy could increase interest and participation in the program. The most popular response received centered around a suggestion to increase the incentive levels. Thirty-nine percent of the participants provided this response. Fifteen percent had other suggestions including:

- Provide energy audits through the program
- Eliminate $50,000 cap so you get bigger projects
- Provide potential customers with objective case studies to support claims
- Decrease the amount of paperwork involved, speed up the process, takes too long

The program manager interviewed in this study suggested that increasing the marketing efforts would result in an increase the levels of participation. This is something that should be assessed to identify cost effective ways to market the program. For example, other programs use bill inserts to their commercial customers, presentations and discussions with trade ally groups, presentations and discussions with contractors and business partners, advertising or public service announcements in trade journals, case stories in business publications, journals, industry newsletters, industry awards ceremonies, etc. etc. Duke should explore these potential avenues to see which marketing efforts are cost effective and can be developed within the programs management and marketing budgets.

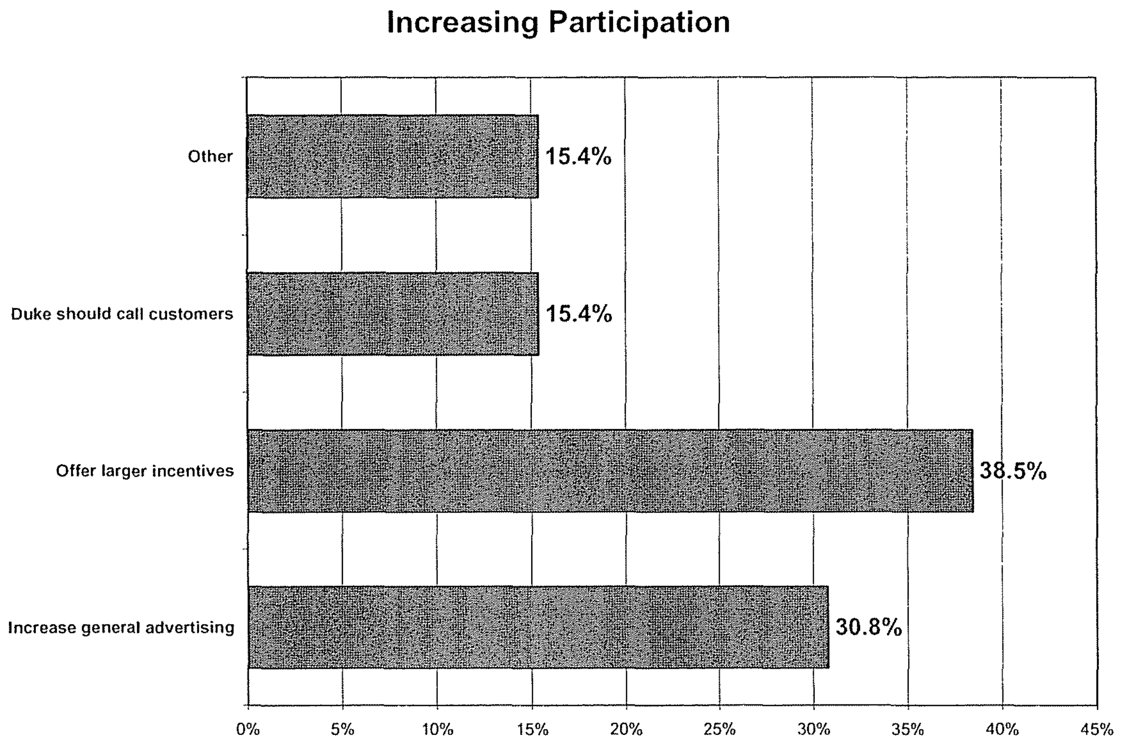

Figure 7. Suggestions for Increasing Participation

Program Satisfaction

We asked the participants about their satisfaction with various program components. We asked them to rate their satisfaction on a 10-point scale with 1 meaning they were very dissatisfied and 10 meaning they were very satisfied. If a participant scored any of the aspects with a score of 8 or lower, we asked the participant how that aspect could be improved. The program overall received an average score of 7.42 and a median score of 8. This indicates that the program has some areas in which at least half the participants are, to some degree, dissatisfied with some component of the program. Dissatisfaction with a program impacts the level of support that participants can provide to the program. This in-turn impacts the most effective information dissemination method by which word of the program spreads in a market – peer-networking. If 50 percent of the participants in some way are dissatisfied with a program, that program cannot be expected to ever have strong demand. Each of the program aspects that contractors voices some level of dissatisfaction with are discussed below. The contractor's satisfaction scores are provided in Figure 8.

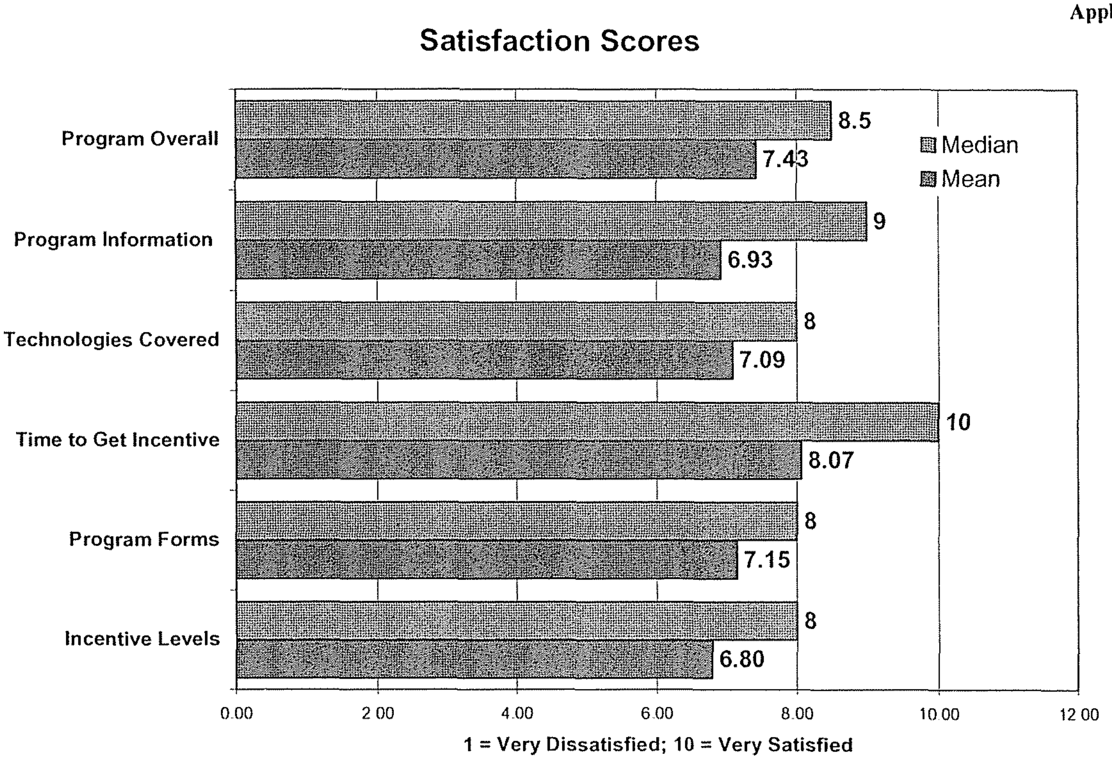

Figure 8. Program Satisfaction Scores

Incentive Levels

The incentive levels are set by a panel of industry experts and are limited to rebate no more than 50 percent of the incremental equipment cost difference between the standard efficiency model and the high efficiency model. This differential is set by policy. When prices change, the advisors review the typical equipment cost and the appropriate changes to the incentives are made so that the 50 percent level is maintained.

The median satisfaction score for the incentive levels is 8, meaning that half of the respondents scored their satisfaction with the incentive levels at 8 or above and the other half scored less than eight. However, the mean score for the incentive levels is 6.80. This data means that while most participants scored the incentive level higher, a few were significantly dissatisfied with the incentive to provide a significantly lower score. This somewhat low mean-score can be explained by the participants' comments on how to improve satisfaction with the incentive amount. These comments are:

- remove the $50,000 incentive cap so more energy can be saved
- the incentive was cut in half from the time we viewed the web site [and decided to participate] and the time we talked to someone [about the rebate amount]
- the incentives decreased to covering 25 percent of added cost [rather than 50 percent]
- they [incentives] were cut in the middle of the project
- too much program hassle for the amount of money we received

- too much time to participate and too little incentive
- my installation no longer qualified because it was installed in 2005, but instead started in 2006 [even thought our participation decision was made in 2005]. The program changed in the middle of our process

While a few participants indicated that the incentive levels are too low compared to the effort it takes to be a participant, others participants stated that they were dissatisfied because of the changes that took place during the time of their participation (see above comments).

Program Forms

Satisfaction with the program forms received a median score of 8, and a mean score of 7.14. These scores indicate that while the forms were not an issue for most of the participants, for a few the forms presented challenges. The reasons given for the scores 8 or lower are below.

- some of it was confusing to me, had to ask the electrician to get some of the answers
- they are not written for the lay person to understand
- more explanations are needed for the technologies covered and the participation and incentive requirements
- I had to resend the forms, the first copies I sent were lost by Duke

Time to Get Incentive

Over half (53%) of the participants gave the time it took to receive the incentive check from the time they submitted with the forms with a 10, indicating very strong satisfaction with the time to get paid. The mean score provided by the participants is 8.07, also a good score. However, the distance between the 10 score and the mean score is almost a full two points, indicating that there is some significant level of dissatisfaction with a subset of the participants. Those that gave a score of 8 or lower provided the following comments:

- it should only take 2-3 weeks to get the check
- they need to send us the incentive within a month
- I am still waiting for the payment, it's a mess
- Payment in less than 2 months would be better

While most customers are very satisfied with the payment periods, the frequency of these comments in relationship to the small sample size suggests that there is a need to monitor these periods to determine if there is a process issue. The small sample size of this study precludes definitive conclusions, but the fact that there are a several participants who are not receiving payments in what they consider to be a reasonable period suggest that attention be placed into determining if there is a process issue and if so, how it can be solved.

Technologies Covered

The technologies covered by the program are determined by a panel of industry experts, and the participants seem satisfied with the options available. The changes in technologies that are rebated are needed in order to keep the participants moving towards increasing efficiency. However, given the current estimate of 50 percent free ridership, it is likely that the number and/or type of appliances and equipment incented should be reviewed and updated once more.

Participants scored their satisfaction with the technologies covered by the program with a mean score of 7.09 and a median score of 8. These are reasonable technology satisfaction scores. It is not unusual to find some level of dissatisfaction with the technologies or with the program's conditions relating to the technologies. However, one of the responses is more about the efficiency level change than the technology itself. Two of the low scores were provided by participants who felt that their equipment should have been covered by the program, and in one case, the exact model and efficiency was covered in 2005 when she purchased it, but not covered when she installed it. This goes back to the issue of timing, which is discussed earlier in this report. While this participant is not talking about changes in the incentive level, but rather the dropping of a covered technology from a decision that was made when the technology was covered. These conditions damage the reputation of the programs if they are not well structured with plenty of advanced notice provided to match the business decision cycle. Other comments received included:

- include more lights - some were the same fixtures but not included (T8 was limited to 6 bulbs, they needed 8-bulb)

Program Information

The level of satisfaction with the program information provided received a low mean satisfaction score of 6.93, however, this aspect also received a high median score of 9, again indicating that most participants were very satisfied and a few participants were not satisfied. Comments received include:

- keep the web site's program language simple
- materials are too complicated for the general public

What Works

The program's web site is a good tool that allows customers to see what technologies are covered by the program and identify the incentives levels at the time the examination is made. The web site has the most up-to-date information available on the program and is the least expensive method of providing the information to a large number of customers. As a result, the program should continue to encourage customers to visit the site to learn more about the program and current program offerings. Expanded use of the web site can help eliminate the problem of incentive and technology changes. That is, the web site can be structured to post the changes months before they become active. At the same time the program promotional materials should instruct customers to check the web site for the most up-to-date information on what technologies are covered and the incentive levels.

Another effective promotional approach rests in the technology vendors and contractors that can tell their customers about the program. If the vendors and contractors are kept current on program operations they can pass the information on to their customers. Vendors and contractors need to be encouraged to check the web site for current information when they deal with their customers. To help ensure that the vendors are keeping up with the program's operations and changes, they are required to apply to Duke to be listed as a program vendor every 18 months and become exposed to the program's current information. They are also encouraged to help the customers with the applications to help reduce application error rates. This information, provided by the program manager, linked to the participant comments may indicate that the application forms may need to be adjusted to help the "typical" customer deal with the application process. Discussions with the program manager indicate that vendors and contractors are able to provide more accurate application forms because they are used to dealing with the equipment and are more familiar with the application terminology.

We asked the participants to tell us what they thought worked well, and provided them an opportunity to say what they liked most about the program. Their responses are listed below:

- it's an effective tool for helping to install more costly equipment that will save businesses money in the long run (3 responses)
- the program helps shorten the payback period (2 responses)
- the program provides an extra push to make the right choice, it gave us confidence that it would work and save us money
- it provided us with a financial incentive in exchange for Duke getting energy savings
- gave us another incentive to save energy (3 responses)
- gives us money-back on our upgrades

What Doesn't Work

We also asked the participants what they thought did not work well. We received about half as many responses to this question than to the question of what worked well. The following responses were provided by participants:

- the incentive cap is too low (2 responses)
- [not] getting the incentive check as promised by Duke
- not enough people know about the program
- nobody would give me accurate incentive information, I spent 5 hours of my time to get a $34 incentive check
- the decrease in the incentives did not help

- too much paperwork required from us

We also asked the program manager what changes are needed to the program operations and management. The managers noted that the program is working reasonably well for the available resources and staff time. The manager noted that the program was managed and staffed by two people and that the staffing was recently reduced to a single individual, however, a subcontractor has been hired to assist Duke Energy with the program.

Section II: Energy Impact Analysis and Findings

Overview of Impact Evaluation Approach

The impact evaluation used an engineering-based approach to estimate program savings. Separate impact analyses were conducted for the lighting and HVAC components of the program. The evaluation effort consisted of the following steps:

1. Review of program savings estimates developed by Balance Engineering
2. Review of program participation data
3. Review of secondary research relevant to the measures covered under the program
4. Development of building energy simulation models of typical buildings treated under the program
5. Development of revised engineering estimates for lighting and HVAC measures

Program Savings Calculation Review

Measure savings estimates used by Duke Energy for program planning purposes were developed by Cascade Engineering. Savings estimates were developed for the following lighting and HVAC measures:

- **Compact Fluorescent Lamps (CFL).** This measure category covers replacement of incandescent lamps with screw-in compact fluorescent lamps in standard incandescent fixtures and installation of compact fluorescent fixtures utilizing compact fluorescent lamps with integral ballasts. Energy savings estimates were developed for eight different CFL sizes ranging from 5 watts to 42 watts.

- **Linear fluorescent lamps (T-5 and T-8).** This measure category covers replacement of fixtures with T-12 lamps and magnetic ballasts with efficient fixtures utilizing T-5 lamps or T-8 lamps and electronic ballasts. The T-5 measure category contains 14 specific measures developed from combinations of 2, 3 and 4 lamp fixtures with 4 foot normal light output and high output (HO) lamps. The T-8 measure category contains 28 specific measures developed from combinations of 2, 3 and 4 lamp fixtures with 2, 4 and 8 foot normal and HO lamps.

- **Light tubes.** This measure category addresses installation of light tubes (also know as daylight pipes or tubular skylights). These devices capture natural light through a dome-shaped skylight on the roof and channel it down through an internal reflective system to the building interior. At the ceiling level, a diffuser resembling a recessed lighting fixture spreads the light evenly to the designated space. During daylight hours a photocell or control system shuts off a conventional 400-watt probe-start metal halide fixture in response to the availability of natural light.

- **High Bay Fluorescent and Pulse Start HIDs.** This measure category covers the use of high bay fluorescent and pulse-start metal halide fixtures as a replacement for 400-

watt probe-start metal halide fixtures. Four specific measures are covered: a 4 lamp high output T-5 fixture, a 6 lamp normal light output T-8 fixture, an 8 lamp compact fluorescent fixture with 42 watt CFLs, and a 320 watt pulse-start metal halide fixture.

- **LED Exit Signs.** This measure category covers replacement of incandescent and CFL exit signs with energy efficient LED exit signs.

- **Packaged HVAC systems.** This measure category covers the upgrade of standard efficiency packaged HVAC systems with high efficiency units. The program addresses single package rooftop air conditioners and heat pumps, split system air conditioners and heat pumps, packaged terminal air conditioners and heat pumps, and ground source and water loop heat pumps in a variety of size ranges. The program baseline is defined by the National Appliance Energy Conservation Act (NAECA) minimum efficiency for single phase equipment and ASHRAE 90.1 – 2004 minimum efficiency for three phase equipment.

The measure savings estimates for each of these measure categories were reviewed by energy engineers and lighting designers at Architectural Energy Corporation. The review comments are listed below:

Compact Fluorescent Lamp Measure Review Comments

Light output. The energy savings estimates are based on replacement of standard incandescent lamps with compact fluorescent lamps at an equivalent level of light output. Lumen output is generally consistent between incandescent and the CFL equivalents, but diverges at the higher wattage end. The 150W and 200W incandescent lamps put out 18 percent more initial lumens than their CFL equivalents. (See Figure 9, below.)

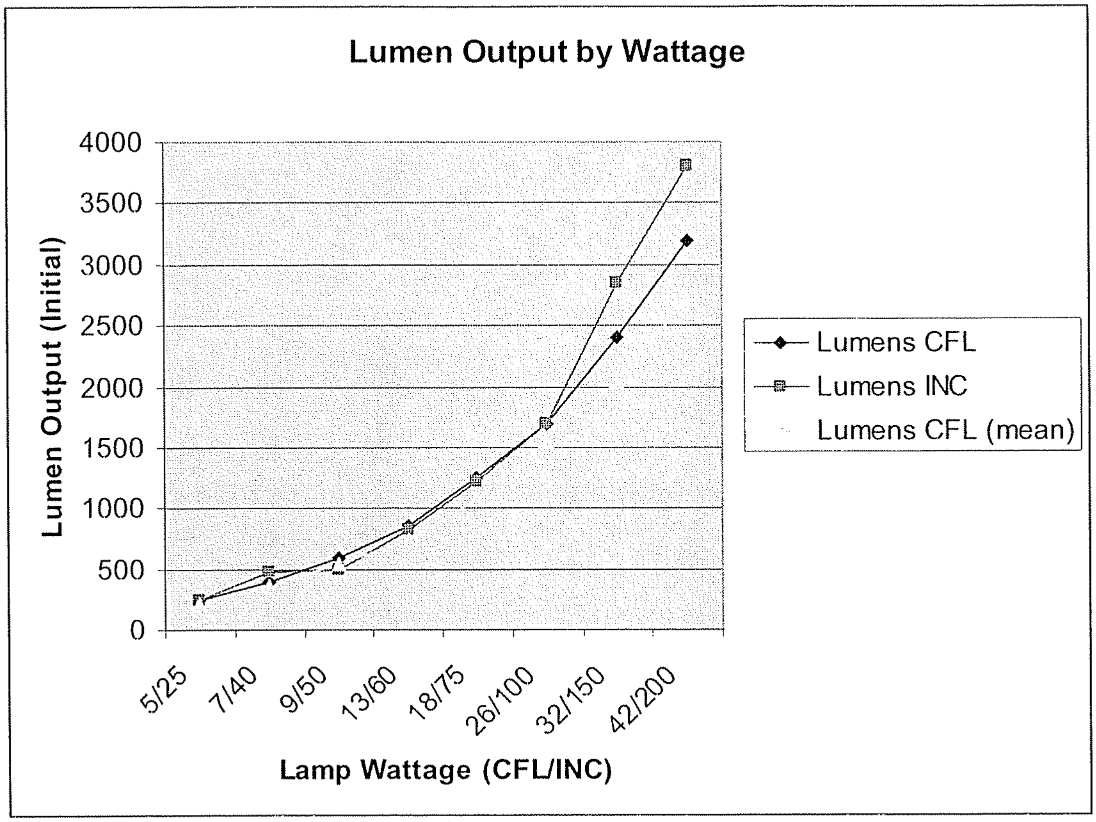

Figure 9: Lamp Lumen output by Wattage[2]

When one considers *mean lumens* instead of initial lumens, there is between an 8 percent and 39 percent decrease in output between the incandescent lamp and the replacement compact fluorescent lamp, again with the disparity increasing with the higher wattages. There is no clear alternative to better match the lumen output differences at the upper end of the wattage range, either. The 42W lamp has been the highest-wattage lamp available in the compact fluorescent line for some time. Philips recently released a 57W lamp, but the mean lumens are significantly *higher* than the 200W incandescent, and as brand-new technology, facilities managers may be reluctant to adopt this product.

Lamp life. The lamp life for incandescent lamps is a reasonable average between the commonly-used "long life" and regular incandescents; CFL lamp life is accurate and consistent with industry sources.

Lighting design issues. In general, we have a concern about the way the program is pushing the higher wattage CFLs as screw-in replacements for incandescent lamps. In our view, the higher the lamp wattage, the higher potential for glare. The higher wattage incandescent lamps tend to be significantly larger than their CFL replacements, with higher mean operating lumens. As a result, high-wattage screw-in replacements tend to be improperly shielded in fixtures designed for incandescent sources. Additionally, the

[2] Lumen figures derived from 2006 Philips lamp catalog for typical lamps for each wattage

luminaire efficiency generally suffers, as the "luminous centers" of the lamps are different.

Fixture watts and measure kW savings. The screw in CFL and incandescent lamp wattage assumptions are quite reasonable. The hardwired CFL measure does not take into account the additional ballast loads that will be incurred; wattage savings are still directly compared lamp-to-lamp. We recommend revising the fixture watts and energy savings assumptions to include ballasts losses in these fixture types.

Annual Operating Hours. Program savings estimates are developed for two operating hour assumptions – a minimum level of 1800 hours per year and a typical commercial building assumption of 4160 hours per year. The typical operation assumes lighting system operation for 16 hours per day, 5 days per week, 52 weeks per year. Naturally, the lighting system operating hours vary by building type and lamp application. As is evident from the secondary research review, 4160 hours per year is on the high end of most commonly accepted estimates of lighting operating hours.

Linear Fluorescent Lamp Measure Review Comments

Measure Baseline. The baseline fixture assumes a 34W T-12 lamp, however the *basest* baseline lamp for this fixture and application is the 40W T-12, which is still commercially available. Additional energy savings will result when upgrading from a 40W T-8 system, thus the savings estimates used by the program are conservative.

T-8 lamp types and ballast factors. There are additional T-8 lamp types available beyond the lamp wattages covered in the program calculations. There is a trend in the lighting industry to treat lamps and ballasts as a "system," thus a particular lamp may perform differently depending on the ballast used in the fixture.

Lighting Design Issues. Given the large increase in light output with the newer system, consideration should be given to the potential for overlighting the retrofit spaces. A T-8 rather than a T-5 solution may make more sense to realize some energy savings while better matching the existing designed luminous environment. Philips offers a range of 4' T-8 lamp wattages to balance energy savings with light output. For example, their "Energy Advantage" product comes as a 25W T-8, which produces 2280 mean lumens -- the same light output as the 34W T-12 current baseline system. This solution would use roughly the same energy at the proposed T-5 system, but with a light output that is better matched to the baseline. It can be argued that in some environments, "more is not better". Another consideration is that the T-5HO is proposed to replace two-lamp T-12 fixtures in one case. This could become an issue if there was any stepped switching scheme employed, as the T-5HO solution utilizes a single lamp.

Luminaire Efficiency. There is a wide range of fixtures that could utilize the lamp and ballast combinations offered under the program, with an attendant wide range in luminaire efficiencies. While this does not affect energy savings per se, there could be significant impacts on the amount of light delivered to the task plane. Typically, T-12 luminaires are utilitarian fixtures such as open reflector striplights and troffers with 100 percent direct components (i.e. no indirect, uplight component, to the distribution). These typically range in efficiency from between 92-75 percent (the lower efficiency fixtures being the lensed variety). Luminaires for T-5 and T-8 lamps are available in direct/indirect versions with efficiencies as low as 40 percent. Perhaps a lower limit on luminaire efficiency should be included in the measure specification.

Lamp Life. Rated lamp life estimates are in line with manufacturer's data.

Fixture watts and measure kW savings. The fixture wattage assumptions for the lamp and ballast combinations presented are quite reasonable and consistent with industry sources.

Light Tubes Measure Review Comments

Based on the program participation data received from Duke Energy, light tube measures were not adopted by program participants. Therefore, we did not do an extensive analysis of this measure. However, we do offer the following general comments on the measure savings calculations.

Energy Savings Estimates. The light tube analysis assumes 13,900 lumens as the average output, but this is more appropriate for sunnier climates such as those found in Colorado. Energy savings from light tubes (a.k.a. tubular skylights) is difficult to quantify, as output data only exists for a few select cities. The nearest cities to the Duke Energy territory that have tubular skylight data are Chicago, IL and St. Louis MO. The use of climate-driven performance numbers for cities that are potentially far from the retrofit site makes these savings numbers somewhat dubious.

Measure Installation Issues. There are certainly practical issues associated with the tubular skylight retrofit scenario. Because these units need an interface between the roof and the ceiling, and because the tubes must be as straight as possible to limit efficiency losses, a successful retrofit can be difficult in an existing plenum that was not designed with the skylights in mind. Efficient, uniform skylight lens layouts may be difficult or impossible given the realities of typical plenum spaces.

The success of this strategy is highly dependent on proper design and execution of the tubular skylight additions. Since this is not a simple one-for-one swap, some thought must be applied to the layout of the skylights. Since the spacing criteria is different for the skylights than it is for the luminaires, this adds complexity to the design of the layout.

Measure Cost Assumptions. The cost assumption is reasonable for the unit itself, but the complexity of the installation can vary widely, so the actual installed cost is a large variable in this strategy. Also, for energy savings to be realized, a photosensor needs to be ties into the lighting system so that the metal halide fixtures get turned off when the tubular skylights are delivering adequate light. This does not appear to be accounted for in the analysis.

High Bay Fluorescent and Pulse-start HID Measure Review Comments

Fixture watts and lumen equivalents. We are in agreement with the Balance Engineering analysis of the fixture wattage and equivalent lumen output.. The 16 percent decrease in lumen output of the 4 lamp T-5 HO retrofit scenario is most likely acceptable for most applications, but the 28 percent decrease in lumen output in the 6 lamp 32W T-8 scenario is not.

Lighting Design. The T-5 and T-8 luminaire/lamp measures have different physical characteristics. These high bay fluorescent fixtures are large-footprint, area sources, whereas the pulse-start metal halide sources they are replacing in a retrofit application are more like the point sources. This may have implications regarding the original design intent.

Measure Baseline. The most probable alternate baseline fixtures other than 400 watt metal halide likely to be found in this scenario are low pressure sodium, high pressure sodium, and mercury vapor. These lamps have varying efficacies and therefore different wattages would be found for the 400W Metal halide baseline scenario. Depending on the lamp type replaced, a significant *increase* in energy use could result.

LED Exit Sign Measure Review Comments

The input power assumptions for the standard and energy efficient exit sign systems are fair, conservative averages. There is a range of system input power available under the general description of "LED Exit sign". The range is from 1.3 - 5.0 watts, according to our research. Four watts is a good average for these systems.

HVAC Measure Review Comments

Energy and demand savings calculations for HVAC measures developed by Balance Engineering were reviewed. The savings calculations covered single package rooftop air conditioners and heat pumps, split system air conditioners and heat pumps, packaged terminal air conditioners and heat pumps, and ground source and water loop heat pumps in a variety of size ranges. The program baseline was defined by the National Appliance Energy Conservation Act (NAECA) minimum efficiency for single phase equipment and ASHRAE 90.1 – 2004 minimum efficiency for three phase equipment. The equipment covered, the size ranges, and the program baseline efficiency assumptions are shown in Table 8.

Table 8. HVAC Equipment Baseline Efficiency Assumptions

Equipment Category	Capacity Range Btu/hr	Baseline Efficiency		Source
		SEER	EER	
Packaged Terminal A/C	All		10	ASHRAE 90.1-2004
Packaged Terminal HP	All		10	ASHRAE 90.1-2004
Unitary A/C (1) phase	<65,000 1 Ph	13		NAECA
Unitary A/C (3) phase	<65,000 3 Ph	12		ASHRAE 90.1-2004
Unitary A/C (3) phase	65,000 - 135,000		10.1	ASHRAE 90.1-2004
Unitary A/C (3) phase	135,000 - 240,000		9.5	ASHRAE 90.1-2004
Unitary A/C (3) phase	240,000 - 760,000		9.3	ASHRAE 90.1-2004
Unitary A/C (3) phase	>760,000		9	ASHRAE 90.1-2004
Unitary HP (1) phase	<65,000 1 Ph	13		NAECA
Unitary HP (3) phase	<65,000 3 Ph	12		ASHRAE 90.1-2004
Unitary HP (3) phase	65,000 - 135,000		9.9	ASHRAE 90.1-2004
Unitary HP (3) phase	135,000 - 240,000		9.1	ASHRAE 90.1-2004
Unitary HP (3) phase	>240,000		8.8	ASHRAE 90.1-2004
Rooftop A/C (1) phase	<65,000 1 Ph	13		NAECA
Rooftop A/C (3) phase	<65,000 3 Ph	12		ASHRAE 90.1-2004
Rooftop A/C (3) phase	65,000 - 135,000		10.1	ASHRAE 90.1-2004
Rooftop A/C (3) phase	135,000 - 240,000		9.5	ASHRAE 90.1-2004
Rooftop A/C (3) phase	240,000 - 760,000		9.3	ASHRAE 90.1-2004
Rooftop A/C (3) phase	>760,000		9	ASHRAE 90.1-2004
Rooftop HP (1) phase	<65,000 1 Ph	13		NAECA
Rooftop HP (3) phase	<65,000 3 Ph	12		ASHRAE 90.1-2004
Rooftop HP (3) phase	65,000 - 135,000		9.9	ASHRAE 90.1-2004
Rooftop HP (3) phase	135,000 - 240,000		9.1	ASHRAE 90.1-2004
Rooftop HP (3) phase	>240,000		8.8	ASHRAE 90.1-2004
Ground Source HP Closed Loop	<135,000 & 59 F EWT		16.2	ASHRAE 90.1-2004
Ground Source HP Closed Loop	<135,000 & 77 F EWT		13.4	ASHRAE 90.1-2004
Water Source Heat Pump	<17,000		11.2	ASHRAE 90.1-2004
Water Source Heat Pump	17,000 - 65,000		12.0	ASHRAE 90.1-2004
Water Source Heat Pump	65,000 - 135,000		12.0	ASHRAE 90.1-2004

Energy savings estimates per HVAC unit were developed based on difference the baseline and as-installed unit efficiency and the unit size. A representative unit was selected for each size range, and an estimate of the typical annual cooling load and cooling kWh consumption at a variety of efficiency levels was developed. Savings were estimated by subtracting the cooling kWh at the baseline efficiency assumption from the cooling kWh at the installed measure efficiency.

An estimate of the annual equivalent cooling full load hours was developed from the program assumptions. The results of these calculations are summarized in Table 9.

Table 9. HVAC Annual Cooling Load Assumptions by Unit Size

Typical Building	Unit size (ton)	Total cooling load (kBtu/yr)	Equivalent Full-load Cooling hours
1	1	17,139	1,428
2	5	41,355	689
3	10	113,804	948
4	20	227,608	948
5	25	438,026	1,460
6	65	1,206,401	1,547

As is evident from the table above, the equivalent full-load hour estimates vary according to unit size. In general, equivalent full load hours are a function of building type and operating schedule, HVAC system type and control, and climate. Estimating equivalent full load cooling hours by building type may be more representative than by unit size alone.

Secondary Research Review

Secondary research review was conducted to obtain estimates of engineering parameters used in the energy savings calculations. The secondary research review focused on program design "workpapers" and other research conducted in support of program design efforts elsewhere in the country. The review incorporated research conducted in support of the California Database for Energy Efficiency Resources (DEER), the Pacific Gas and Electric Company (PG&E) commercial mass markets program, the Southern California Edison Company (SCE) workpapers for their commercial retrofit programs, and the Efficiency Vermont (EVT) technical reference manual. The research review collected information on lighting system operating hours and coincidence factors by lamp and building type, HVAC baseline efficiency assumptions, and HVAC system equivalent full-load hour data. These data were used to test the assumptions used in the Duke program, as well as to develop data resources for conducting the impact study.

Lighting Operating Hours

Review of lighting operating hour assumptions in the literature showed a wide variety of average lighting operating hours across the different types of commercial buildings. A summary of the assumptions used by various groups across the country, along with our best judgment on a representative value for use in this study is shown in Table 10.

Table 10. General Lighting Operating Hours by Building Type

Building Type	PG&E	SCE	EVT	DEER	Evaluation Assumption
Assembly				3164	3164
Education - Community College	3,792	3,900	5,010	2180	3,846
Education - Primary School	1,440	2,150	2,080	1579	1,440
Education - Secondary School	2,305	2,150	2,080	1666	2,305
Education - University	3,073	3,900	5,010	2172	3,487
Grocery	5,824	5,800	4,612	4081	5,812
Health/Medical - Hospital	8,736	4,400	4,532	6229	8,736
Health/Medical - Nursing Home	8,736	4,400	4,532	3817	8,736
Lodging – Guest Room	8,736	5,500	2,697		8,736
Lodging - Hotel	8,736	5,500	2,697	6971	8,736
Lodging - Motel	8,736	5,500	2,697	4754	8,736
Lodging- Blend	8,736	5,500	2,697		8,736
Manufacturing - Light Industrial	2,860	4,400	2,235	2730	2,548
Office - Large	2,808	4,000	3,435	4006	3,414
Office - Small	2,808	4,000	3,435	3025	3,414
Process Industrial	2,860	6,650	2,235		6,650
Restaurant - Fast-Food	6,188	4,600	4,156	6348	6,188
Restaurant - Sit-Down	4,368	4,600	4,156	3366	4,375
Retail - 3-Story Large	4,259	4,450	3,068	3221	4,355
Retail - Single-Story Large	4,368	4,450	3,068	3981	4,409
Retail - Small	4,004	4,450	3,068	3094	4,227
Storage - Conditioned	2,860	3,550	2,388	3695	2,624
Storage - Unconditioned	2,860	3,550	2,388	3695	2,624
Warehouse - Refrigerated	2,600	3,550	2,388	3379	2,494
Other		4500	2278		3,389

Appropriate values for CFL operating hours in commercial buildings has been the subject of intense study recently, especially in California. Traditionally, programs have not assigned different operating hours to CFLs verses general lighting systems. Due to the importance of CFLs in commercial program energy savings portfolios, specific operating hour assumptions for both screw-in and hardwired CFLs have been developed. A summary of the literature on screw-in and hard-wire CFL operating hours is presented in Table 11 and Table 12. These data are shown along with our best judgment on appropriate operating hour assumptions for this study.

Table 11. CFL Hard-wired Fixture Operating Hour Assumptions

Building Type	PG&E	SCE	EVT	Evaluation Assumption
Education - Community College	3,792	3,900	5,010	3,846
Education - Primary School	1440	2,150	2,080	1,440
Education - Secondary School	2,305	2,150	2,080	2,305
Education - University	3,073	3,900	5,010	3,487
Grocery	5,824	5,800	4,612	5,812
Health/Medical - Hospital	8,736	4,400	4,532	8,736
Health/Medical - Nursing Home	8,736	4,400	4,532	8,736
Lodging – Guest Room	8,736	5,500	2,697	8,736
Lodging - Hotel	8,736	5,500	2,697	8,736
Lodging - Motel	8,736	5,500	2,697	8,736
Lodging- Blend	8,736	5,500	2,697	8,736
Manufacturing - Light Industrial	2,860	4,400	2,235	2,548
Office - Large	2,808	4,000	3,435	3,414
Office - Small	2,808	4,000	3,435	3,414
Process Industrial	2,860	6,650	2,235	6,650
Restaurant - Fast-Food	6,188	4,600	4,156	6,188
Restaurant - Sit-Down	4,368	4,600	4,156	4,375
Retail - 3-Story Large	4,259	4,450	3,068	4,355
Retail - Single-Story Large	4,368	4,450	3,068	4,409
Retail - Small	4,004	4,450	3,068	4,227
Storage - Conditioned	2,860	3,550	2,388	2,624
Storage - Unconditioned	2,860	3,550	2,388	2,624
Warehouse - Refrigerated	2,600	3,550	2,388	2,494
Other		4500	2278	3,389

Table 12. CFL Screw-in Lamp Operating Hour Assumptions

Building Type	PG&E	SCE	EVT	Evaluation Assumption
Assembly				
Education - Community College	3,792	3,900	5,010	3,846
Education - Primary School	1,440	2,150	2,080	1,440
Education - Secondary School	2,305	2,150	2,080	2,305
Education - University	3,073	3,900	5,010	3,487
Grocery	5,824	5,800	4,612	5,812
Health/Medical - Hospital	8,736	4,400	4,532	8,736
Health/Medical - Nursing Home	8,736	4,400	4,532	8,736
Lodging -- Guest Room	1,145	5,500	2,697	1,145
Lodging - Hotel	8,736	5,500	2,697	8,736
Lodging - Motel	8,736	5,500	2,697	8,736
Lodging- Blend	3,675	5,500	2,697	3,675
Manufacturing - Light Industrial	2,860	4,400	5,913	5,157
MF Housing	1278			1278
Office - Large	2,739	4,000	3,435	3,391
Office - Small	2,492	4,000	3,435	3,309
Process Industrial	2,860	6,650	5,913	6,282
Restaurant - Fast-Food	6,188	4,600	4,156	6,188
Restaurant - Sit-Down	3,444	4,600	4,156	4,067
Retail - 3-Story Large	4,259	4,450	3,068	4,355
Retail - Single-Story Large	4,368	4,450	3,068	4,409
Retail - Small	3,724	4,450	3,068	4,087
Storage - Conditioned	2,860	3,550	2,388	2,624
Storage - Unconditioned	2,860	3,550	2,388	2,624
Warehouse - Refrigerated	2,600	3,550	2,388	2,494
Other		4500	2278	3,389

Summer coincident diversity factors (CDF) have been developed by PG&E and SCE for their commercial programs. This factor is defined as the ratio of the connected lighting load that is on during the summer peak hour to the total connected lighting load. The values used by the California utilities are derived from load research studies that examined hourly commercial building lighting load by building type, and the coincidence of lighting use with the utility peak period. A summary of these data is shown in Table 13.

Table 13. Lighting Coincident Diversity Factors for PG&E and SCE

Building Type	CDF
Church	0.76
College	0.68
Community Center	0.76
Elem/Middle School	0.42
hotel/motel	0.67
Industrial	0.99
Medical Office	0.81
Multifamily	0.67
Office	0.81
Police/Fire	1
Restaurant	0.68
Retail	0.88
University	0.68
Warehouse	0.84
Other/DK	0.76

HVAC equivalent full load hour (EFLH) and coincident diversity factor assumptions were also researched. Equivalent full load hours are defined as the ratio of the total annual consumption (Btu) to the peak cooling load (Btu/hr). In some contexts, this is also defined as the annual cooling electricity consumption (kWh) divided by the peak cooling demand (kW). Strictly speaking, differences between the HVAC system efficiency under seasonal average and peak conditions make these different definitions incompatible. Cooling equivalent full-load hours are highly influenced by local climate, building operating schedule, building design, HVAC system design and controls, making it difficult to transfer data from different parts of the country. However, it is useful to examine full load hour assumptions from various utilities as an overall reasonableness check against the assumptions used in the Duke program. The coincident diversity factor also estimates the fraction of the total connected HVAC load that is running during the utility peak period. A compilation of the cooling EFLH used in the PG&E and SCE program is shown in Table 14.

Table 14. PG&E and SCE Equivalent Full Load Cooling Hours for HVAC Technologies

Building Type	Equivalent Full-Load Cooling Hours	HVAC CDF
Office	1,000	0.87
Retail	800	0.85
University	1,200	0.73
School	500	0.24
Grocery	600	0.83
Restaurant	1,300	0.86
Health Care/Hospital	1,900	0.89
Hotel/Motel	700	0.77
Warehouse	300	0.8
Process Industrial	800	0.75
Assembly Industrial	2,100	0.75
All Other	1,200	0.78

The Efficiency Vermont commercial programs use EFLH assumptions based on HVAC system type, not building type. Since heating is an important end-use in Vermont, both heating and cooling EFLH data have been developed. These data are shown in Table 15.

Table 15. Efficiency Vermont Equivalent Full Load Cooling Hours for HVAC Technologies

HVAC System Type	Equivalent Full-load Cooling Hours	Equivalent Full-load Heating Hours
Split system and single package rooftop A/C units	800	
Split system and single package rooftop heat pumps	800	1600
Packaged terminal A/C	830	
Packaged terminal heat pumps	830	1640
Water source heat pumps	2088	2248

In the Efficiency Vermont programs, the summer coincident diversity factor is set to 0.36, and the winter coincident diversity factor is set to 0.372.

Tracking System Review

Lighting and HVAC program participation records covering the period from January, 2005 through October, 2006 were obtained from Duke Energy. The data, delivered as a series of Excel spreadsheets, contained customer name and address, installing vendor contact information, measure descriptions, unit energy savings estimates, number of measures installed, rebate amounts, and so on. Separate spreadsheets were obtained for lighting and HVAC measures. These data were examined to identify which of the measures promoted by the program were adopted by program participants and in what numbers, how the energy savings in the tracking system compared to the program savings estimates, and the availability of any customer description data that could be used in the analysis.

Lighting program participation

The lighting program tracking system showed lighting measures installed in a total of 47 buildings. Since some installations were done in multiple buildings owned by the same company, a total of 41 individual companies participated in the program. Customer name and address data were used to assign a building type to each customer in the database. In most cases, the customer name was recognizable (e.g. a national chain). In other cases, customer name and address information was searched over the internet to determine the building type. The building type and number of participants by building type are show in Table 16.

Table 16. Lighting Program Participation by Building Type

Building Type	Count
Church	1
College	1
Community Center	1
Elem/Secondary School	4
Grocery	1
Industrial	8
Medical Office	1
Office	4
Other/DK	1
Restaurant	1
Retail	17
University	2
Warehouse	5
Total	47

The types and quantity of measures installed are shown in Table 17.

Table 17. Lighting Measures Installed Under Program

Measures Installed	Measure Group	Count
CFL 26W HARDWIRED	CFL hard-wire	16
CFL 5W HARDWIRED	CFL hard-wire	12
CFL 7W HARDWIRED	CFL hard-wire	6
CFL 13W SCREW-IN	CFL screw in	131
CFL 18W SCREW-IN	CFL screw in	93
CFL 26W SCREW-IN	CFL screw in	156
CFL 32W SCREW-IN	CFL screw in	210
CFL 42W SCREW-IN	CFL screw in	53
CFL 5W SCREW-IN	CFL screw in	80
LED Exit Signs	Exit sign	340
T-5 HO 4 ft 4 lamp high bay	High Bay	1,049
T-8 4 ft 6 lamp high bay	High Bay	4,072
T-5 - 4 ft 4 lamp 28W	Linear Fluorescent	5
T-5 HO 4 ft 1 lamp 54W	Linear Fluorescent	95
T-8 2 ft 1 lamp	Linear Fluorescent	9
T-8 2 ft 2 lamp	Linear Fluorescent	360
T-8 3 ft 1 lamp	Linear Fluorescent	26
T-8 3 ft 2 lamp	Linear Fluorescent	5
T-8 4 ft 1 lamp	Linear Fluorescent	341
T-8 4 ft 2 lamp	Linear Fluorescent	1,671
T-8 4 ft 3 lamp	Linear Fluorescent	374
T-8 4 ft 4 lamp	Linear Fluorescent	1,920
T-8 8 ft 2 lamp	Linear Fluorescent	121
T-8 8 ft 2 lamp HO	Linear Fluorescent	15

Energy and demand savings estimates were provided for each measure in the tracking system. The watts saved per fixture by fixture type in the tracking system matched the values recommended in the Balance Engineering reports. The 4 foot T-8 lamp measure description in the database is not complete, since there are a variety of T-8 lamp wattages available, including 28W, 30W and 32W T-8 lamps. The database wattage savings estimates indicated that 30W T-8 lamps were assumed to be installed.

Several of the database entries showed no kWh savings, presumably due to data entry errors. The equivalent full load hours for measures with energy savings varied from 4800 to 5400 hours per year, with the exception of exit signs, which were based on 8760 hours per year. Based on the secondary literature research review, the lighting full load hour estimates used in the database are high for most building types, and exceeded the values recommended by Balance Engineering.

HVAC program participation

The HVAC program tracking system showed measures installed in a total of 10 buildings. Customer name and address data were used to assign a building type to each customer in the database. In most cases, the customer name was recognizable (e.g. a national chain). In other cases, customer name and address information was searched over the internet to determine the building type. The building type and number of participants by building type are show in Table 18.

Table 18. HVAC Program Participants by Building Type

Building Type	Number
Office	2
Full Service Restaurant	2
Retail	6
Total	10

HVAC unit make and model number were also provided in the tracking system database. These data were used to assign an equipment type, cooling capacity and cooling efficiency to each unit in the database. A combination of manufacturers' catalog data and the Air-conditioning and Refrigeration Institute (ARI) searchable database was used to assign these data.

The HVAC units installed under the program included packaged terminal heat pumps, packaged terminal air conditioners and rooftop air conditioners. The number and size range of the measures installed are summarized in Table 19.

Table 19. Type of HVAC Equipment Installed Under the Program

Unit type	Size Range	Number installed
Packaged terminal air conditioner	All sizes	2
Packaged terminal heat pump		35
Rooftop air conditioner	< 5.4 tons	15
	5.4 tons – 11.25 tons	10
	11.25 tons – 17.5 tons	21

Unit kW and kWh savings data were included in the database. From these data, the equivalent full-load cooling hours for each unit were inferred. The estimated cooling full load hours ranged from about 2300 to 3100 hours, which are substantially higher than the estimates in the Balance Engineering calculations.

Summary of Energy Savings

The energy savings calculations and program savings results for the lighting and HVAC programs are summarized as follows:

Lighting Gross Energy and Demand Savings

Energy and demand savings estimates were developed for each measure in the database using the following engineering equations:

$$kW_{savings} = \sum_{i}^{buildings} \sum_{j}^{measures} units_{i,j} \times kWsaved_j \times CDF_i$$

$$kWh_{savings} = \sum_{i}^{buildings} \sum_{j}^{measures} units_{i,j} \times kWsaved_j \times FLH_{i,j}$$

where:

units	= quantity of each measure installed in each building type
kWsaved	= unit kW savings for each measure
CDF	= coincident demand factor by building type
FLH	= full load lighting hours by measure and building type

The unit kW savings assigned to each lighting measure are shown in Table 20.

Table 20. Lighting Fixture Wattage Savings Assumptions

Measure	Unit kW savings	Notes
CFL 13W SCREW-IN	0.047	
CFL 18W SCREW-IN	0.057	
CFL 26W HARDWIRED	0.073	Hardwired CFL savings revised to reflect ballast losses
CFL 26W SCREW-IN	0.074	
CFL 32W SCREW-IN	0.118	
CFL 42W SCREW-IN	0.158	
CFL 5W HARDWIRED	0.016	Hardwired CFL savings revised to reflect ballast losses
CFL 5W SCREW-IN	0.020	
CFL 7W HARDWIRED	0.030	Hardwired CFL savings revised to reflect ballast losses
LED Exit Signs	0.013	
T-5 - 4 ft 4 lamp 28W	0.024	
T-5 HO 4 ft 1 lamp 54W	0.015	
T-5 HO 4 ft 4 lamp high bay	0.212	
T-8 2 ft 1 lamp	0.010	
T-8 2 ft 2 lamp	0.002	
T-8 3 ft 1 lamp	0.011	
T-8 3 ft 2 lamp	0.010	
T-8 4 ft 1 lamp	0.016	F30T8 savings used per database
T-8 4 ft 2 lamp	0.019	F30T8 savings used per database
T-8 4 ft 3 lamp	0.034	F30T8 savings used per database
T-8 4 ft 4 lamp	0.040	F30T8 savings used per database
T-8 4 ft 6 lamp high bay	0.231	
T-8 8 ft 2 lamp	0.020	
T-8 8 ft 2 lamp HO	0.050	

The lighting full-load hours and coincident diversity assumptions were developed from the secondary research described in the previous section. These data were applied to each measure according to the measure type and building type.

The lighting program gross energy and demand savings were summed across all entries in the database, and normalized on a per-measure and per-program-participant basis. The estimates embedding in the program tracking system, the savings estimated by this evaluation, and the estimates used by Duke Energy for program planning purposes are compared in Table 21.

Table 21. Lighting Program Gross Energy and Demand Savings

Savings Basis	Source	kW	kWh
Savings/measure	Planning Estimate		130
	Tracking System	0.12	56
	Evaluation Estimate	0.11	365
Savings/participant	Tracking System	28.5	13,186
	Evaluation Estimate	26.1	86,743

Since the evaluation is based on partial participation data for 2006, the total program savings will be calculated by Duke Energy from these averages applied to the final program tracking database. Note, the demand savings estimates from the evaluation match quite well with the tracking system estimates. However, the energy savings estimates vary substantially, due to apparent errors in the tracking system noted above.

The energy and demand savings were also tabulated by measure group for the partial database. These results are shown in Table 22.

Table 22. Lighting Program Gross Energy and Demand Savings by Measure Group

Measure group	Measures installed	Total kWh savings	Average kWh savings per measure	Total kW savings	Average kW savings per measure
CFL hardwired	34	4,231	124.	1	0.033
CFL screw-in	723	180,067	249.	39	0.054
Exit	340	38,719	114	4	0.011
High Bay	5,121	3,503,784	684.	1,071	0.209
Linear Fluorescent	4,942	350,109	71	110	0.022

Note, the high bay fixture measure group accounted for the majority of the lighting installations and energy savings for this set of participants.

HVAC Gross Demand and Energy Savings

Secondary research conducted for this evaluation did not reveal any reliable sources of data for estimating cooling full load hours. Thus, a series of prototype building energy simulation models were developed for the building types served under the program. The prototypical simulation models were derived from the California Database for Energy Efficiency Resources (DEER) study, with adjustments make for local building practices and climate. A description of each prototype simulation model follows.

Small Retail Prototype

A prototypical building energy simulation model for a small retail building was developed using the DOE-2.2 building energy simulation program. The characteristics of the small retail building prototype are summarized in Table 23.

Table 23. Small Retail Prototype Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	6400 square foot sales area 1600 square foot storage area 8000 square feet total
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-11
Roof construction and R-value	Wood frame with built-up roof, R-19
Glazing type	Single pane clear
Lighting power density	Sales area: 3.4 W/SF Storage area: 0.9 W/SF
Plug load density	Sales area: 1.2 W/SF Storage area: 0.2 W/SF
Operating hours	10 – 10 Monday-Saturday 10 – 8 Sunday
HVAC system type	Packaged single zone, no economizer
HVAC system size	Sales floor: 240 SF/ton Storage area: 380 SF/ton
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the small retail building prototype is shown in Figure 10.

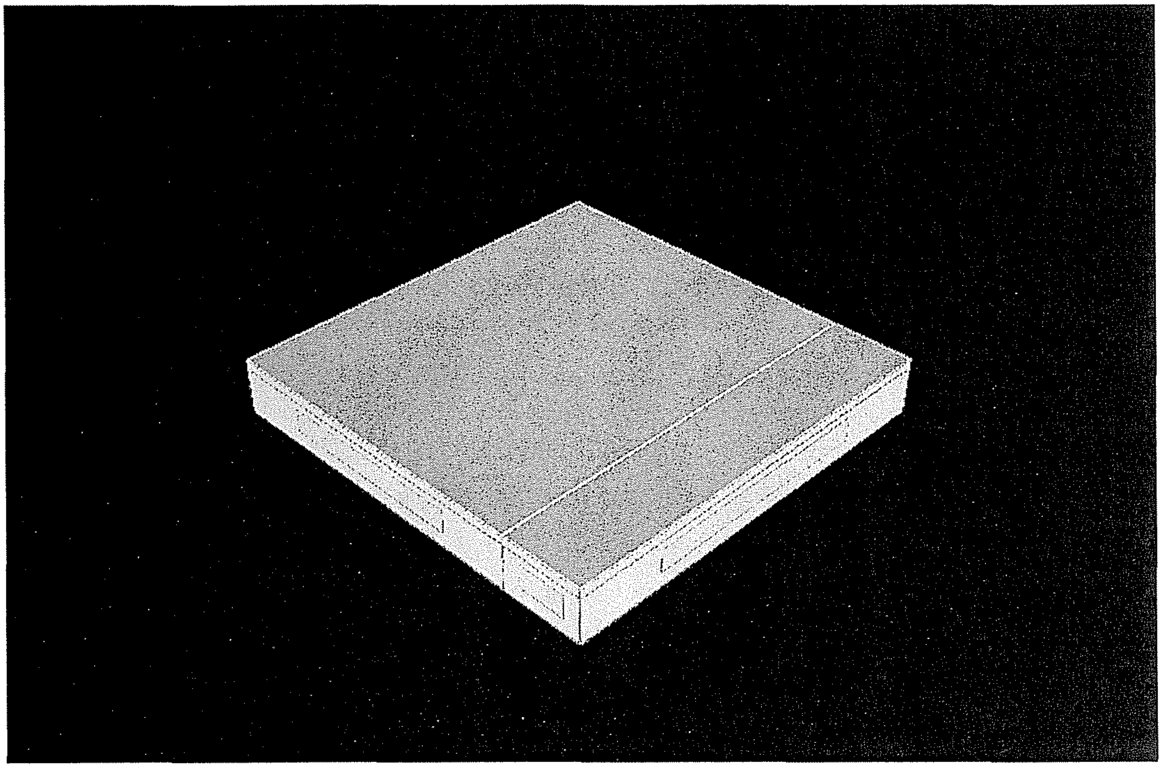

Figure 10. Small Retail Prototype Building Rendering

The energy performance of the prototypical building was simulated using long term average weather data for Covington, Kentucky. Savings were estimated for a representative high efficiency option corresponding to a set of HVAC system type and size combinations. The energy and demand savings were normalized per ton of cooling capacity. The results of the simulation runs are shown in Table 24.

Table 24. Small Retail Demand and Energy Savings

HVAC System Type and Size	Base Efficiency	Measure Efficiency	Demand savings (kW/ ton)	Energy savings (kWh/ton)
AC <65,000 1 Ph	13	14	0.078	73.9
AC <65,000 3 Ph	12	13	0.058	55.4
AC 65,000 - 135,000	10.1	11	0.081	76.1
AC 135,000 - 240,000	9.5	11	0.142	134.9
AC 240,000 - 760,000	9.3	10	0.074	70.7
AC >760,000	9	10	0.110	104.4
HP <65,000 1 Ph	13	14	0.078	113.1
HP <65,000 3 Ph	12	13	0.058	67.8
HP 65,000 - 135,000	9.9	11	0.081	126.2
HP 135,000 - 240,000	9.1	10	0.142	141.0
HP >240,000	8.8	10	0.074	176.4

Full-service Restaurant Prototype

A prototypical building energy simulation model for a full-service restaurant was developed using the DOE-2.2 building energy simulation program. The characteristics of the full service restaurant prototype are summarized in Table 25.

Table 25. Full Service Restaurant Prototype Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2000 square foot dining area 600 square foot entry/reception area 1200 square foot kitchen 200 square foot restrooms
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-11
Roof construction and R-value	Wood frame with built-up roof, R-19
Glazing type	Single pane clear
Lighting power density	Dining area: 1.7 W/SF Entry area: 2.5 W/SF Kitchen: 4.3 W/SF Restrooms: 1.0 W/SF
Plug load density	Dining area: 0.6 W/SF Entry area: 0.6 W/SF Kitchen: 3.1 W/SF Restrooms: 0.2 W/SF
Operating hours	9am -- 12am
HVAC system type	Packaged single zone, no economizer
HVAC system size	Dining area: 150 SF/ton Entry area: 90 SF/ton Kitchen: 220 SF/ton Restrooms: 190 SF/ton
Thermostat setpoints	Occupied hours: 77 cooling, 72 heating Unoccupied hours: 82 cooling, 67 heating

A computer-generated sketch of the full-service restaurant prototype is shown in Figure 11.

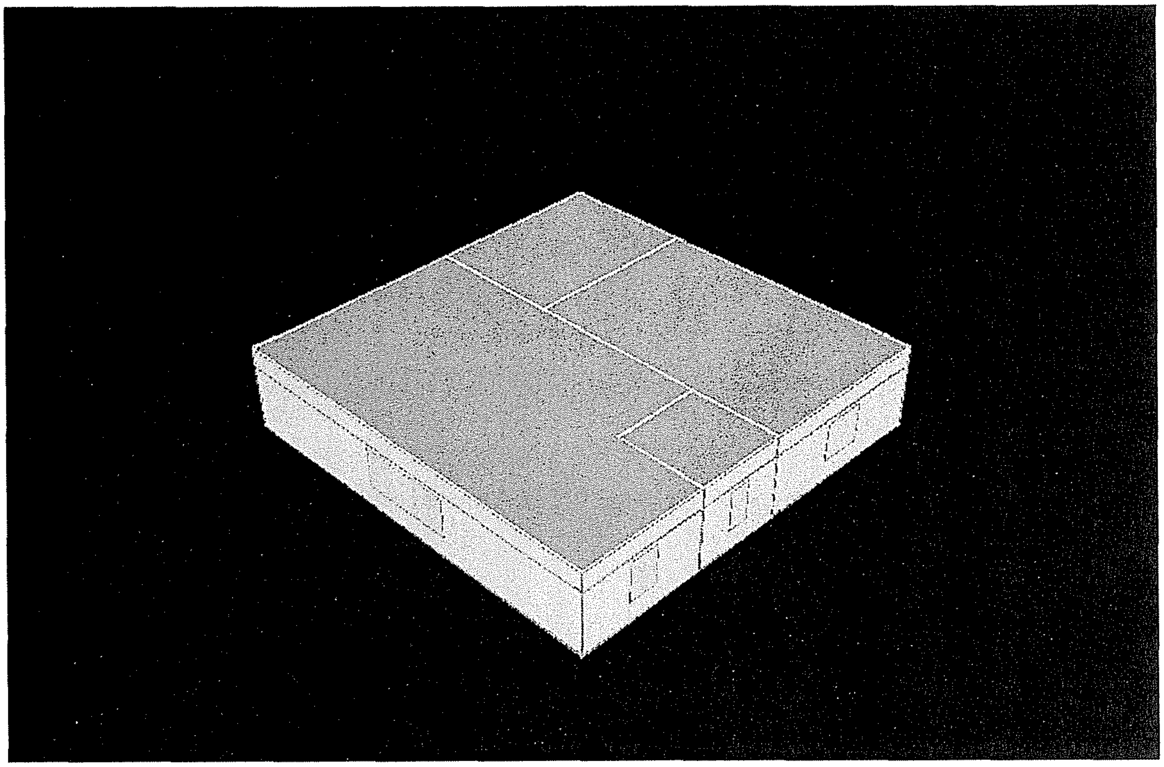

Figure 11. Full Service Restaurant Prototype Rendering

The energy performance of the prototypical building was simulated using long term average weather data for Covington, Kentucky. Savings were estimated for a representative high efficiency option corresponding to a set of HVAC system type and size combinations. The energy and demand savings were normalized per ton of cooling capacity. The results of the simulation runs are shown in Table 26.

Table 26. Full Service Restaurant Demand and Energy Savings

HVAC System Type and Size	Base Efficiency	Measure Efficiency	Demand savings (kW/ ton)	Energy savings (kWh/ton)
AC <65,000 1 Ph	13	14	0.072	54.1
AC <65,000 3 Ph	12	13	0.056	40.5
AC 65,000 - 135,000	10.1	11	0.075	55.7
AC 135,000 - 240,000	9.5	11	0.136	98.8
AC 240,000 - 760,000	9.3	10	0.068	51.8
AC >760,000	9	10	0.102	76.5
HP <65,000 1 Ph	13	14	0.072	111.6
HP <65,000 3 Ph	12	13	0.056	60.2
HP 65,000 - 135,000	9.9	11	0.075	117.9
HP 135,000 - 240,000	9.1	10	0.136	142.5
HP >240,000	8.8	10	0.068	168.6

Small Office Prototype

A prototypical building energy simulation model for a small was developed using the DOE-2.2 building energy simulation program. The characteristics of the small office prototype are summarized in Table 27.

Table 27. Small Office Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	10,000 square feet
Number of floors	2
Wall construction and R-value	Wood frame with brick veneer, R-11
Roof construction and R-value	Wood frame with built-up roof, R-19
Glazing type	Single pane clear
Lighting power density	Perimeter offices: 2.2 W/SF Core offices: 1.5 W/SF
Plug load density	Perimeter offices: 1.6 W/SF Core offices: 0.7 W/SF
Operating hours	Mon-Sat: 9am – 6pm Sun: Unoccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	180 SF/ton
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the small office prototype is shown in Figure 12.

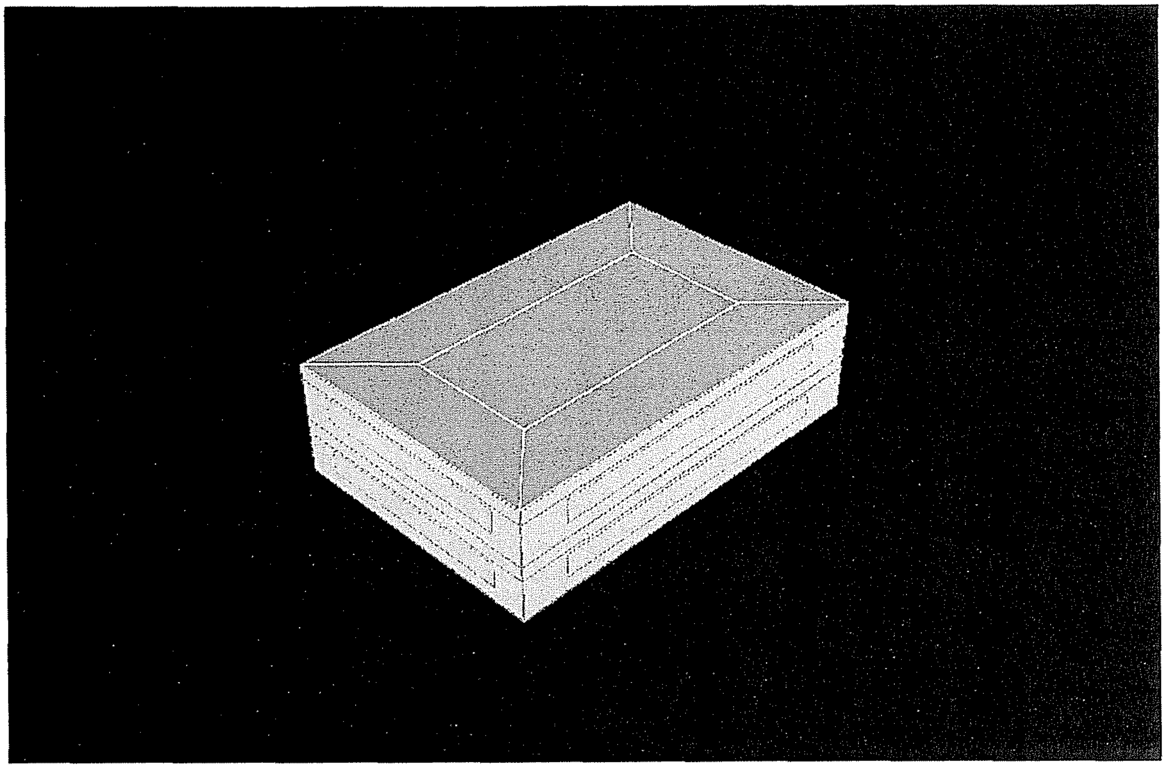

Figure 12. Small Office Prototype Building Rendering

The energy performance of the prototypical building was simulated using long term average weather data for Covington, Kentucky. Savings were estimated for a representative high efficiency option corresponding to a set of HVAC system type and size combinations. The energy and demand savings were normalized per ton of cooling capacity. The results of the simulation runs are shown in Table 28.

Table 28. Energy and Demand Savings for Small Office

HVAC System Type and Size	Base Efficiency	Measure Efficiency	Demand savings (kW/ ton)	Energy savings (kWh/ton)
AC <65,000 1 Ph	13	14	0.061	61.0
AC <65,000 3 Ph	12	13	0.047	45.7
AC 65,000 - 135,000	10.1	11	0.065	62.8
AC 135,000 - 240,000	9.5	11	0.114	111.3
AC 240,000 - 760,000	9.3	10	0.059	58.4
AC >760,000	9	10	0.087	86.1
HP <65,000 1 Ph	13	14	0.061	85.2
HP <65,000 3 Ph	12	13	0.047	52.8
HP 65,000 - 135,000	9.9	11	0.065	96.8
HP 135,000 - 240,000	9.1	10	0.114	105.2
HP >240,000	8.8	10	0.059	134.3

Energy and demand savings estimates were developed for each measure in the database using the following engineering equations:

$$kW_{savings} = \sum_{i}^{buildings} \sum_{j}^{measures} units_{i,j} \times ton \times kWsaved/ton_j \times F_{adj} \times CDF_i$$

$$kWh_{savings} = \sum_{i}^{buildings} \sum_{j}^{measures} units_{i,j} \times ton \times kWhsaved/ton_j \times F_{adj}$$

$$F_{adj} = \frac{1 - \dfrac{EER_{base}}{EER_{installed}}}{1 - \dfrac{EER_{base}}{EER_{measure}}}$$

where:

Units	= quantity of each type of HVAC measure installed
Ton	= cooling capacity of HVAC unit
kW/ton	= demand savings per ton from prototype model runs by building and measure type
kWh/ton	= energy savings per ton prototype model runs by building and measure type
Fadj	= efficiency adjustment factor
CDF	= coincident diversity factor by building type

An efficiency adjustment factor was used to account for differences in the installed equipment SEER or EER verses the SEER or EER assumptions used for high efficiency equipment in the simulations. Since HVAC energy consumption is an inverse relationship with SEER and EER, a simple scaling of the EER or SEER differences is not appropriate. This adjustment accurately reflects the influence of efficiency differences on energy and demand savings. The coincident diversity factors from the PG&E and SCE programs as shown in the secondary research section of this report were applied.

The HVAC program gross energy and demand savings were summed across all entries in the database, and normalized on a per-measure and per-program-participant basis. The estimates embedding in the program tracking system, the savings estimated by this evaluation, and the estimates used by Duke Energy for program planning purposes are compared in Table 29.

Table 29. HVAC Program Gross Demand and Energy Savings

Savings Basis	Source	kW	kWh
Savings/measure	Planning Estimate		130
	Tracking System	0.16	443
	Evaluation Estimate	0.69	763
Savings/participant	Tracking System	1.3	3,673
	Evaluation Estimate	5.7	6,336

Appendix A: Process Evaluation: Program Manager Interview Protocol

Name: ____

Title: ____

Position description and general responsibilities:

____

____

____

We are conducting this interview to obtain your opinions about and experiences with the Small Commercial and Industrial Program. We'll talk about the Program and its objectives, your thoughts on improving the program and its participation rates, and the technologies the program covers. The interview will take about an hour to complete. May we begin?

Program Objectives

1. In your own words, please describe the Small Commercial and Industrial Incentive Program's objectives.

2. In your opinion, which objectives do you think are being met or will be met? How do you think the program's objectives have changed over time?

3. Are there any program objectives that are not being addressed or that you think should have more attention focused on them? If yes, which ones? How should these objectives be addressed? What should be changed? Do you think these changes will increase program participation?

4. Should the program objectives be changed in any way because of market conditions, other external or internal program influences, or any other conditions that have developed since the program objectives were devised? What changes would you put into place, and how would it affect the objectives?

5. Do you think the incentives application process offered through the small C&I program is easy to understand and complete?

6. Do you think the incentives offered through the program are large enough to entice the C&I community to purchase the high efficiency items? Why or why not?

7. Do you think the incentives cover the right equipment? Do you think there is equipment that is currently incentivized that should not be, or equipment that is not covered that should be?

8. Which measures have been most used? Why, and why have other measures not been adopted? Why is there a difference between states? (Note in KY the program got off to a fast start and we had to throttle it back, now IN is begging to pick up. Why are these difference there?)

9. What kinds of marketing, outreach and customer contact approaches do you use to make your customers aware of the program and its options? Are there any changes to the program marketing that you think would increase participation?

10. How do you inform trade allies and contractors about the program? How effective has this been in getting participation from the contractors?

11. Are there any changes to the incentives or marketing that could possibly increase participation in the program?

12. The program has experienced a drop in participation over the last year or so and then recently picked up in Indiana, why do you think this has occurred? What can be done to boost participation overall?

13. Thinking about how your program enrolls participants, what do you think your level of freeridership is for this program? (*That is, what percent of the equipment rebated through the program would have been purchased and installed without the program's incentive?*)

14. What do you think the level of spillover is for this program? *(That is, what percent of the participants take similar actions in their business that are not rebated through the program?)*

Overall Small C&I Incentives Management

15. Describe the use of any advisors, technical groups or organizations that have in the past or are currently helping you think through the program's approach or methods. How often do you use these resources? What do you use them for?

16. Overall, what about the Small Commercial and Industrial Incentive Program works well and why?

17. What doesn't work well and why? Do you think this discourages participation?

18. Can you identify any market or operational barriers that impede a more efficient program operation?

19. If you had a magic wand and could change any part of the program what would you change and why?

Program Design & Implementation

20. What market information, research or market assessments are you using to determine the best target markets or market segments to focus on?

21. What market information, research or market assessments are you using to identify market barriers, and develop more effective delivery mechanisms?

22. How do you manage and monitor or evaluate contractor involvement or performance? What is the quality control and tracking process? What do you do if contractor performance is exemplary or below expectations?

23. In your opinion, did the incentives cover enough different kinds of energy efficient products?

    1. ❑ Yes 2. ❑ No 99. ❑ DK/NS

    If no, 22b. What other products or equipment should be included?

___

___

24. In what ways can the Small Commercial and Industrial Incentive Program's operations be improved?

25. Do you have any suggestions for how program participation can be increased?

Appendix B: Participant Survey Instrument

Name: ____

Title: ____

Hello, my name is ______. I am calling on behalf of Duke Energy to conduct a customer survey about the Commercial and Industrial 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 Commercial and Industrial Efficiency Program. We are not selling anything. The survey will take about 10-15 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?

1. Our records indicate that you participated in the Commercial and Industrial Incentive Program in <date> **and that you installed** <technology> **through the program and received an incentive for your purchase. Do you recall participating in this program?**

1. ❑ Yes, *begin* *Skip to Q2.*
2. ❑ No,
99. ❑ DK/NS

1a. **This program was provided through Duke Energy. In this program, you purchased an energy efficient lighting, HVAC, motor, or pump. In exchange for purchasing the energy efficient option, Duke Energy provided your company with an incentive.**

Do you remember participating in this program?

1. ❑ Yes, *begin* → *Go to Q2.*
2. ❑ No,
99. ❑ DK/NS

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

2. How did you become aware of the C&I Incentive Program?

- **a.** ❑ Duke Energy sent me a brochure
- **b.** ❑ Duke Energy called and talked to me about it
- **c.** ❑ Duke energy website.
- **d.** ❑ A contractor I was working with told me about the program
- **e.** ❑ An equipment supplier
- **f.** ❑ I saw an ad in ______________________________
- **g.** ❑ Other ______________________________________
- **h.** ❑ DK/NS

3. When you first heard about the program and considered taking advantage of the incentive, did you do any additional investigation to confirm the program's offering, or was the information you had adequate to make a participation decision?

- **a.**❑ The information was adequate
- b.❑ Didn't need to confirm/Nothing
- **c.**❑ Went to the web site
- **d.** ❑ Called or emailed Duke Energy
- **e.**❑ Called or emailed a contractor
- f. ❑ Called or emailed a salesperson
- g.❑ Other: ____
- h.❑ DK/NS

If c, d, e, f, g: **4. How well did this work for you, were you able to acquire a more complete understanding of the program?** *Note: many may have only heard about this through their contractors and thus had minimal involvement, so this question may only apply to a few of them.*

1. ❑ Yes 2. ❑ No 99. ❑ DK/NS

5. Did you have additional questions that were not answered? Were their questions that you were unable to answer or information that you were unable to obtain?

1. ❑ Yes 2. ❑ No 99. ❑ DK/NS

5a. What were they?

____

____

6. **Who filled out the program incentive forms for your company?**
   - **a.** ❑ I did
   - **b.** ❑ Someone from my company did
   - **c.** ❑ The contractor
   - **d.** ❑ The salesperson
   - **e.** ❑ Someone from Duke Energy

7. **Who submitted the forms to Duke/Cinergy?**
   - **a.** ❑ I did
   - **b.** ❑ Someone from my company did
   - **c.** ❑ The contractor
   - **d.** ❑ The salesperson
   - **e.** ❑ Someone from Duke Energy

8. *If they filled it out.* **Was the incentive form easy to understand?**

   1. ❑ Yes 2. ❑ No 99. ❑ DK/NS

   If not, 8b. **Do you remember what it was that was not clear or which part of it was difficult?**

____

____

9. **Did you have any problems receiving the incentives?**

   1. ❑ Yes 2. ❑ No 99. ❑ DK/NS

   If yes, 9b. **Please explain the problem and how it was resolved. Was it resolved to your satisfaction?**

____

____

10. Did you originally plan on purchasing the exact same efficiency level in the equipment you purchased before you knew that there was an incentive offered by Duke Energy?

1. ❑ Yes 2. ❑ No 99. ❑ DK/NS

11. In your decision process, did you search for or consider other, less energy efficient equipment that might have cost less?

1. ❑ Yes 2. ❑ No 99. ❑ DK/NS

12. **What was the primary reason that you decided to purchase or upgrade your equipment?**

1. ❑ Remodeling
2. ❑ Equipment failure
3. ❑ Contractor recommendation
4. ❑ Energy Savings
5. ❑ Got a good deal
6. ❑ It was an old system
7. ❑ Combination of above: *list*:

____

13. **I would like to ask how important the program incentive was in your decision to buy the more energy efficient model. Would you say the incentive was…** *(read and check the best response).*

a. **# The primary reason why you purchased the high efficacy model,**
b. **#An important reason, along with other reasons,**
c. **#One of the reasons, but it was not the most important,**
d. **#One of the reasons, but it was a minor or unimportant reason, or**
e. **#It was not a reason at all,**
f. **#DK/NS.**

14. If the incentives were not available from the program, would you have delayed your purchase, or would you have made the purchased at the exact same time?

a. # The purchase would have been delayed – **How long do you think you might have waited to make the purchase?** ________________________
b. # The purchase would have been made at the same time
c. #DK/NS

15. Were there other reasons in addition to the incentive that you went with the high efficiency <technology> **instead of something less expensive to purchase?**

____

____

16. When firms have experience with energy efficiency programs or products they sometimes make similar decisions to continue the energy savings in other parts of their business. Have you taken any other energy efficiency actions that may have been, in some way, influenced by your experiences with the Duke program?

1. ❑ Yes 2. ❑ No 99. ❑ DK/NS

a. *If yes,* **What have you done?**
b. *If yes,* **How much money do you think you have saved as a result?**

____

____

17. One of the objectives that the program would like to see over the next year is increased participation of businesses like yours. Can you think of things that the program can do to help increase participation or help increase interest from people like yourself?

a. #Increase general advertising
b. #Increase advertising in trade media
c. #Present the program in trade or associated meetings
d. #Offer larger incentives
e. #Offer incentives on other items/include other items
f. #Have program staff call small C&I customers
g. #Make the process more streamlined for customers
h. #Make the process more streamlined for contractors
i. #Other: ____________________________________

18. **During your participation process, did you need to contact Cinergy/Duke to obtain information about the program?**

1. ❑ Yes 2. ❑ No 99. ❑ DK/NS