EVALUATION OF BUILDING EFFICIENCY PROGRAM 2004 & 2005

Final Report

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EXECUTIVE SUMMARY

This report presents the results of the impact evaluation of the Building Efficiency (BE) Program that Energy Trust of Oregon (Energy Trust) offered for commercial buildings in Oregon during 2004 and 2005.

The main features of the approach used for the impact evaluation are as follows:

- Data for the study have been collected through interviews with BE program staff, review of program materials and processes, on-site inspections, end-use metering, and interviews with participating firms. Based on data provided by Energy Trust, sample designs were developed for on-site data collection for the impact evaluation and for the telephone survey to collect decision-making information for the net-to-gross analysis (and process evaluation). Sample sizes were determined that would provide savings estimates for the BE Program with ±10 precision at the 90% confidence level.
- On-site visits were used to collect data for savings impacts calculations, while telephone surveys provided the information for the net-to-gross analysis and process evaluation. The on-site visits were used to verify installations and to determine any changes to the operating parameters since the measures were first installed. Facility staff were interviewed to determine the operating hours of the installed system and to locate any additional benefits or shortcomings with the installed system. For some sites, monitoring of lighting, HVAC equipment, or motors/VFDs was conducted to obtain more accurate information on hours of operation. Table ES-1 shows the sample sizes for these various types of data collection. The 67 sites visited from the 2004 BE program accounted for about 77% of expected kWh savings and 44% of expected therm savings for program year 2004. The 80 sites visited from the 2005 BE program accounted for about 56% of expected kWh savings and 60% of expected therm savings for program year 2005.

Table ES-1. Sample Sizes for Data Collection Efforts

Type of Data Collection	***2004***	***2005***
Project file review	132	207
Participant site visits	67	80
Short-term metering:		
HVAC	6	6
Lighting	17	16
Motors		2
VFD	3	4
Custom building	3	
Survey of participant decision makers	52	90

The major findings and recommendations from the study of the 2004 and 2005 BE projects were as follows.

- Discrepancies between expected and verified savings were examined on a site-by-site basis for a sample of projects.
  - For lighting projects, the examination of individual sites focused on major discrepancies between expected and verified energy savings that could be attributed to (1) differences in the operating hours for the areas where the energy efficiency light fixtures were installed and (2) the use of fixture wattages that can be inconsistent from project to project. Data on operating hours for lighting were verified using monitored data, information obtained by interviewing facility personnel, and some physical evidence (e.g., posted operating hours of the facility). The monitored data revealed that in a majority of cases the difference between monitored and expected operating hours was at or less than 10% of the expected operating hours. Based on these results, it was concluded that the expected operating hours are highly consistent with the actual operating hours at the site.
  - For HVAC, Building, and VFD measures, most discrepancies were found where engineering calculations were used to estimate the energy savings in lieu of modeling, especially for those projects where weather data was not used as the basis of calculations. In such instances, very broad assumptions were made, which may not be applicable or consistent year round. However, discrepancies of more than 10% were found in 16 out 51 sites where HVAC, Building, Motor and VFD projects were implemented, and the majority of these discrepancies fall within the plus and minus 10-30% range. The source of discrepancies cannot be generalized for these measures. However, it is recommended that all of the measures other than lighting projects be reviewed and analyzed on a case-by-case basis.
  - Estimated realization rates for gas-saving 2005 BE projects, realization rates were lower than the realization rates for 2004 gas-saving projects or for electric-saving projects. Most of the gas-saving projects with lower realization rates were projects in which custom measures were installed to save gas. Because the measures were custom, the reasons for the lower realization rates differed case by case and no general reasons provide a complete explanation. However, in several cases it did appear that the heating usage estimated in this study through DOE-2 simulations was somewhat higher than had been used in developing the *ex ante* expected savings for the measures.
- Analysis of billing data for a set of participants confirmed the engineering analyses in showing that reductions in electric and gas usage occurred after energy efficiency measures were installed. However, the analysis of electricity billing data showed reductions, particularly for larger users, that were larger than expected, suggesting that other factors were also working to reduce energy use. The analysis of gas billing

data showed reductions in gas usage that were consistent with but somewhat lower than the reductions estimated through the engineering analysis.

- In general, the monitoring performed for the 2004 and 2005 projects resulted in confirmation of the expected energy savings.
  - The monitored data for lighting projects revealed that on average, the monitored data are consistent with the claimed hours.
  - The monitored data for Building, HVAC and VFD projects confirmed the expected variation in operating loads introduced by the addition of the energy efficient hardware and/or improved control system.
- Although the monitored data are not used in the savings calculations for HVAC categories, which rely more on DOE-2 modeling, they serve as a good confirmation that the monitored system is operating as intended (e.g. HVAC, lighting or other building system). It is recommended that for the next evaluation, monitoring be performed whenever possible for all measures as an additional confirmation that the system is functioning properly, especially where an Energy Management System that provides data trending is not available.

Gross savings were estimated using proven techniques, including engineering calculations using industry standards and verification of computer simulations developed by program contractors to determine energy savings.

Survey-based techniques for estimating free-ridership in a program were applied to the data collected through a telephone survey of decision-makers. Data collected through this survey were also used to assess qualitatively the extent of program spillover effects.

The results of the impact evaluation of the Building Efficiency Program for 2004 and 2005 are summarized in Table ES-2.

Table ES-2. Summary of kWh and Therm Savings and kW Reductions for Building Efficiency Program in 2004 and 2005

	Expected Gross	***Realization Rate***	***Achieved Gross***	***Net-to-Gross Ratio***	***Achieved Net***
			2004		
kWh savings	37,499,950	98.9%	37,082,583	84.1%	31,191,919
Therm savings	85,529	94.5%	80,821	64.7%	52,291
kW reductions	Not available	Not applicable	6,213	84.1%	5,226
			2005		
kWh savings	56,462,658	104.4%	58,967,894	79.8%	47,076,661
Therm savings	442,955	75.4%	334,028	94.7%	316,325
kW reductions	Not available	Not applicable	18,183	79.8%	14,516

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MEMO

Date: February 13, 2008
To: Board of Directors
From: Philipp Degens, Evaluation Manager
Greg Stiles, Sr. Business Sector Manager
Subject: Staff Response for the 2004-2005 Building Efficiency Impact Evaluation

The Building Efficiency program (now renamed the Existing Buildings (EB) program) was very active in 2004 and 2005 providing incentives for measures in over 1,300 nonresidential buildings. The evaluation has shown that the program is running smoothly in the realm of delivering the predicted electric savings.

Realization rates of 99% and 104% were respectively achieved for electric measures in 2004 and 2005. These realization rates will be used in truing-up the 2004 and 2005 savings as well as calculating the reportable savings for 2007 and 2008. For lighting measures assumed hours and wattages tended to be quite similar to those found during evaluation site visits and metering. As a result future evaluations will commit fewer resources to validate these numbers.

In the area of gas savings the results vary a bit more, as the realization rate for gas measures was 95% in 2004 but only 75% in 2005. No specific overarching reason for this lower realization rate was determined as savings came from a variety of custom HVAC measures from a diverse group of buildings. The variability is attributed to the program still learning how to estimate gas energy savings. This parallels the commercial natural gas industry as knowledge of sizing of gas furnaces/boilers, system control parameters, and how systems are actually operated and maintained is still a growing field.

The results of the participant electric billing analysis were inconclusive in that the estimated drop in energy consumption after installation was far in excess of the savings that could be attributed to the measures installed. Energy Trust is in agreement with the evaluators that other factors are present that are reducing the electricity consumption of the participants. In the 2006-2007 program evaluation a billing analysis will also be performed. We hope that a larger sample and the inclusion of more building characteristics data will yield better results.

Participant satisfaction with the program was high in 2004 and 2005 with 85% of the surveyed participants stating that they were satisfied or very satisfied. Additionally participants representing over 21% of the savings reported that the program had influenced them to install additional energy efficiency measures for which they did not receive incentives. Market spillover rates from comparable studies were used in calculations of reportable and trued-up savings. Program spillover will be researched in greater in the 2006-2007 evaluation through the use of nonparticipant surveys and inspecting measures that did not receive incentives when performing site visits.

The evaluation estimated a free rider rate of 16% and 20% for electric measures in 2004 and 2005. The 2003-2004 program process evaluation estimated a free rider rate of 17% which falls within the range of these two estimates. Gas measure free rider rates varied more from year to year with a 35% rate estimated in 2004 and 5% in 2005. With a greater number of participants and savings in 2005 we would expect the later estimate to be a better indicator of the free rider rate. These realization rates will be used in truing-up the 2004 and 2005 savings as well as calculating the reportable savings for 2007 and 2008.

1. INTRODUCTION

Under contract with Energy Trust of Oregon (Energy Trust), ADM Associates, Inc. (ADM) has performed an impact evaluation of the Building Efficiency (BE) Program that Energy Trust offered for businesses in Oregon in 2004 and 2005. This report provides the results of the impact evaluation of the BE Program for 2004 and 2005.

1.1 DESCRIPTION OF PROGRAM

The Building Efficiency Program offered by Energy Trust was designed to help businesses in Oregon identify and implement energy saving projects without affecting their customers or operations. The Building Efficiency Program offers incentives and technical support for energy efficient measures in existing commercial, institutional, and agricultural facilities.

- The BE Program offered both standard and custom incentives for the retrofit of electric motors, lighting equipment and HVAC equipment. A standard incentive amount was offered for each qualifying unit of equipment that a facility purchased, but with a maximum on the amount that could be paid per site per year. Custom incentives were offered for equipment and projects that saved energy using equipment not eligible for standard incentives. The amount of a custom incentive was based on the incremental cost of the energy efficiency project, but again with a maximum on the amount that could be paid per site per year.
- Several types of services were also offered through the BE Program to help businesses in implementing energy efficiency improvement projects. These services included No-Cost Energy Audits, assistance in finding and working with a contractor for an energy efficiency project, and providing post-installation inspections of equipment and measures installed.

Further information on the BE Program can be found at the Program's website: http://www.energytrust.org/buildingefficiency.

Expected kWh and therm savings by type of energy efficiency project are shown for 2004 in Table 1-1 and for 2005 in Table 1-2.

- For 2004, there were 488 sites that participated in the BE Program, which were expected to provide savings of 37,499,950 kWh and 85,529 therms. [1]
- For 2005, there were 823 sites that participated in the BE Program, which were expected to provide savings of 52,462,658 kWh and 442,955 therms.

Table 1-1. Expected kWh and Therm Savings for Building Efficiency Projects in 2004

Type of Energy Efficiency Improvement	***Number of Sites***	***Expected kWh Savings***	***Expected Therm Savings***
HVAC			
Custom HVAC	46	8,235,603	9,185
Standard HVAC	40	239,413	
Lighting			
Custom Lighting	180	9,119,681	
Custom Delamping	2	23,965	
Standard Lighting	261	11,252,936	
Motors			
Custom Motors	13	1,215,613	
Standard Motors	41	716,559	
Custom VFD	17	1,577,728	995
Custom Building	19	4,403,078	7,250
Custom Other	15	696,608	29,587
Custom Gas	19	18,766	38,512
Totals		37,499,950	85,529

[1] Regarding number of sites, note that some sites may have projects affecting more than one type of end use and are therefore counted under more than one category. For example, of the 488 sites in the BE Program in 2004, 357 sites had projects affecting only one end use, 125 sites had projects affecting two end uses, 5 sites had projects affecting three end uses, and 1 site had projects affecting four end uses. Also note that the expected savings estimates are derived from the working engineering savings estimates from EnergyTrust's FastTrack database. The year in which an energy efficiency measure began reporting savings as reported in EnergTrust's FastTrack database, determines the year of program participation. Sites may participate in multiple programs over multiple years.

Table 1-2. Expected kWh and Therm Savings for Building Efficiency Projects in 2005[*]

Type of Energy Efficiency Improvement	*Electric Savings*		*Gas Savings*	
	Number of Sites	*Expected kWh Savings*	*Number of Sites*	*Expected Therm Savings*
HVAC				
Custom HVAC	31	5,581,806	7	38,228
Standard HVAC	30	153,389		
Lighting				
Custom Lighting	263	18,581,717		
Custom Delamping	26	252,624		
Standard Lighting	349	11,012,968		
Motors				
Custom Motors	8	595,099		
Standard Motors	39	840,015		
Custom VFD	71	9,512,026	4	21,519
Custom Building Controls	25	4,319,318	12	111,264
Custom Other	17	5,506,346	6	78,532
Custom Gas			25	77,116
Boiler			4	4,242
Dishwashing	85	106,671	60	12,144
Food Equipment			6	10,514
Furnace			7	1,213
Gas Heat			14	34,490
Insulate	2	679	15	52,875
Tankless			4	668
Other			1	150
Totals		56,462,658		442,955

* Expected savings estimates are derived from the working engineering savings estimates from Energy Trust's FastTrack database. The year in which an energy efficiency measure began reporting savings (as reported in the FastTrack database) determines the year of program participation. Sites may have participated in multiple programs over multiple years.

1.2 OVERVIEW OF EVALUATION APPROACH

The overall objective for the impact evaluation of the Building Efficiency Program was to determine the gross and net electricity and natural gas savings and demand (kW) reductions resulting from participation in the program during 2004 and 2005.

The approach for the impact evaluation had the following main features.

- Available documentation (e.g., audit reports, savings calculation work papers, etc.) was reviewed for a sample of sites, with particular attention given to the calculation procedures and documentation for savings estimates.
- On-site data collection was conducted at a sample of sites to provide the information needed for verifying savings and demand reductions. Monitoring was also conducted

at some sites to obtain more accurate information on the hours of operation for lighting, HVAC equipment, and motors/VFDs.

- Gross savings were estimated using proven techniques.
  - Analysis of lighting savings was accomplished using ADM's custom-designed Lighting Evaluation Model with system parameters (fixture wattage, etc.) based on information on operating parameters collected on-site and, if appropriate, industry standards.
  - For HVAC measures, the original analyses used to calculate the expected savings were reviewed and the operating and structural parameters of the analysis were verified. For custom measures or relatively more complex measures, simulations with the DOE-2 energy analysis model were used to develop estimates of energy use and savings from the installed measures.
  - Electric and gas billing data for a group of participant sites were also analyzed, with the resulting estimates compared to the estimates derived through the engineering analyses.
- A telephone survey was conducted of a sample of program participants to gather information on their decision making, their likes and dislikes of the program, and other factors determining net-to-gross savings ratios for the program.
- Net savings refers to those savings that are attributable to the program. Data collected in the telephone survey of participants regarding their decisions to install energy efficiency measures were used to determine net-to-gross ratios.

1.3 ORGANIZATION OF REPORT

This report on the impact evaluation of the 2004 and 2005 Building Efficiency Program is 0organized as follows.

- Chapter 2 presents and discusses the methods used for and the results obtained from estimating gross savings for measures installed under the Building Efficiency Program. Gross savings estimates are presented for different categories of energy efficiency improvement projects (e.g., lighting, HVAC, motors, etc.). For each category of projects, there is a discussion of the methodology used to determine savings for that category.
- Chapter 3 presents and discusses the methods used for and results obtained from estimating net savings for the Building Efficiency Program.
- Chapter 4 presents and discusses the results from a survey of decision makers for facilities that participated in the Building Efficiency Program in 2004 and 2005.
- Appendix A provides a copy of the data collection form used during on-site visits.
- Appendix B provides a copy of the questionnaire used for the survey of decision making.

- Appendix C provides detailed tabulations for the data collected from surveys of decision makers in 2004 and 2005.
- Appendix D provides further analysis comparing expected hours of use for lighting to estimated hours of use as developed from data collected through monitoring.
- Appendix E provides alternative estimates for free-ridership for the BE program for 2004 and 2005, based on how survey respondents are grouped for purposes of the free-ridership analysis.

Separate volumes provide summary discussions of expected and verified savings for individual sites.

2. VERIFICATION OF GROSS SAVINGS

This chapter addresses the verification of gross kWh and therm savings and kW reductions resulting from measures installed in facilities that participated in the Building Efficiency Program in 2004 and 2005. Section 2.1 describes the methodology used for verifying gross savings. Section 2.2 presents the results from the effort to verify savings for a sample of sites that participated in the BE Program. Section 2.3 uses the realization rates presented and discussed in Section 2.2 to estimate program-level savings.

2.1 METHODOLOGY FOR VERIFYING GROSS SAVINGS

The methodology used for verifying gross savings is described in this section.

2.1.1 Sampling Plan

Data for verifying the gross savings achieved through the Building Efficiency Program were collected for samples of sites that participated in the BE Program during 2004 and 2005. Data provided by Energy Trust showed the following about participation in the program in 2004 and 2005.

- During 2004, there were 488 sites that participated in the BE Program, which were expected to provide savings of 37,499,950 kWh and 85,529 therms.
- During 2005, there were 823 sites that participated in the BE Program, which were expected to provide savings of 52,462,658 kWh and 442,955 therms.

Because most of the sites had kWh savings, the initial sampling focused on selecting sites according to kWh savings. However, a check was made on how well sites that were chosen for the evaluation sample on the basis of kWh savings also covered expected gas savings. The sample selected using kWh savings alone covered only about 8% of therm savings for 2004. Given that this coverage percentage was low, a supplementary sample of sites was selected using therm savings for selection purposes.

For the sampling according to expected kWh savings, inspection of data on kWh savings for individual sites that Energy Trust provided indicated that the distribution of savings for each year was generally positively skewed, with a relatively small number of projects accounting for a high percentage of the estimated savings. A sample design for selecting sites was used that took such skewness into account and allowed estimates of savings to be determined with ±10% precision at the 90% confidence level.

To accomplish the sampling, an approach suggested by Hidiroglou[2] was used. With this approach, a number of sites with large kWh and therm savings were selected for the

[2] See Hidiroglou, M. A., "The Construction of a Self-Representing Stratum of Large Units in Survey Design," **The American Statistician**, February 1986, Vol. 40, pp. 27-31.

sample with certainty, and a random sample was taken of the remaining sites. Table 2-1 shows the breakdown of the sample by sector and by number of projects and sites. The certainty sites were sites selected based on the large representation of energy savings, and these did not have backup. To further improve the precision, non-certainty sites (i.e., those sites selected with probability) were selected for the sample through systematic random sampling. That is, a random sample of sites remaining after the certainty sites had been selected was selected by ordering them according to the magnitude of their savings and using systematic random sampling. Sampling systematically from a list that is ordered according to the magnitude of savings ensures that any sample selected will have some units with high savings, some with moderate savings, and some with low savings. Samples cannot result that have concentrations of sites with atypically high savings or atypically low savings. Substitute sites were selected to potentially replace probability sites that could not be evaluated for any reason.

Table 2-1. Number of Sites Selected for Sample

How Selected	***Population***		***Certainty Sites***		***Probability Sites***	
	Number of Sites	***Expected Savings***	***Number of Sites***	***Expected Savings***	***Number of Sites***	***Expected Savings***
2004						
Sites selected by kWh savings	488	37,499,950 kWh	36	20,619,445 kWh	84	3,186,881 kWh
Sites selected by gas savings	31	85,529 therms	6	49,070 Therms	6	8,405 therms
Totals for Numbers of Sites Selected			42		90	
2005						
Sites selected by kWh savings	758	52,462,658 kWh	36	25,848,131 kWh	144	6,285,621 kWh
Sites selected by gas savings	154	442,955 therms	12	234,730 Therms	15	24,279 Therms
Totals for Numbers of Sites Selected			48		159	

2.1.2 Review of Documentation

After the samples of sites were selected, Energy Trust provided documentation on the energy efficiency projects undertaken at these sites. The first step in the evaluation effort was to review this documentation and other program materials that were relevant to the evaluation effort.

For each site, the available documentation (e.g., audit reports, savings calculation work papers, etc.) for each rebated measure was reviewed, with particular attention given to the calculation procedures and documentation for savings estimates. Documentation that was reviewed for all sites selected for the sample included program forms, data bases, reports, billing system data, weather data, and any other potentially useful data. Each application was reviewed to see whether the following types of information had been provided:

- Documentation for the equipment changed, including (1) descriptions, (2) schematics, (3) performance data, and (4) other supporting information
- Documentation for the new equipment installed, including (1) descriptions, (2) schematics, (3) performance data, and (4) other supporting information
- Information about the savings calculation methodology, including (1) what methodology was used, (2) specifications of assumptions and sources for these specifications, and (3) correctness of calculations

2.1.3 On-Site Data Collection Procedures

On-site visits were used to collect data that were used in calculating savings impacts. The on-site visits to the sampled sites were used to collect primary data on the facilities participating in the program.

During an on-site visit, the field staff accomplished three major things.

- First, they verified the implementation status of all measures for which customers received incentives. They verified that the energy efficiency measures were indeed installed, that they were installed correctly and that they still functioned properly.
- Second, they collected the physical data needed to analyze the energy savings that have been realized from the installed improvements and measures. Data were collected using a form that was prepared specifically for the project in question after an in-house review of the project file.
- Third, they interviewed the contact personnel at a facility to obtain additional information on the installed system to complement the data collected from other sources.

At some sites, monitoring was conducted to gather more information on the operating hours of the installed measures. Monitoring was conducted at sites where it was judged that the monitored data would be useful for further refinement and higher accuracy of savings calculations. Monitoring was not considered necessary for sites where project documentation allowed for sufficiently detailed calculations. Monitoring was conducted at 29 sites in 2004 and at 28 in 2005. The number of sites monitored are categorized by end use in Table 2-2.

Table 2-2. Monitored Sites by Year and End Use Category

End Use Category	***Number of Sites Monitored***	
	2004	***2005***
Custom Building Controls	3	3
Custom HVAC	6	3
Custom Motor		1
Custom Other		2
Custom VFD	3	3
Lighting/Custom Lighting	17	16
Total	29	28

2.1.4 Procedures for Verifying Savings from Measures Installed through BE Projects

The procedures used to verify savings resulting from BE projects depended on the type of measure being analyzed. The different types of measures included the following:

- Lighting measures;
- HVAC measures;
- Non-HVAC motors and adjustable speed drives

The following discussion describes the procedures used for verifying savings from these different types of measures.

Procedures for Verifying Savings from Lighting Measures. The lighting measures that were examined in this evaluation study included retrofits of existing fixtures, lamps and/or ballasts with energy efficient fixtures, lamps and/or ballasts. These types of measures reduce demand, but operating hours for fixtures are the same pre- and post-retrofit. Also examined were any proposed lighting control strategies that might include the addition of energy conserving control technologies such as motion sensors or daylighting controls. These measures typically involve a reduction in hours of operation and/or lower current passing through the fixtures.

Analyzing the savings from such lighting measures required data for retrofitted fixtures on (1) wattages before and after retrofit, (2) hours of operation before and after the retrofit and (3) number of fixtures affected by the measure. The documentation file was reviewed for these parameters.

The fixture wattages as claimed in the documentation were verified against existing databases and industry sources based on the rated power of the original lamps. These claimed wattages were used for the purpose of calculations unless they deviated

significantly from published databases or manufacturers' claims. The hours of operations were also evaluated for the type of facility and functionality of the areas where the measures were installed.

For the sites chosen for site visits, the three parameters above were verified during the onsite visit. An interview was conducted with the facility personnel to verify the operating hours and determine the areas where the measures were applied. In general, the operating hours provided by facility personnel correlate very well with the hours originally provided during incentive application. The field engineer then collected the lamp information and count of fixtures, including the quantity of fixtures affected by lighting control systems such as motion sensors and daylighting control.

Procedures for Analyzing Savings from HVAC Measures. For sites with HVAC measures, the model used in the calculations of savings was evaluated. The emphasis of the savings verification was on the Equivalent Full Load Hours (EFLH) of the affected equipment with regards to its geographical location and type of operations.

For the projects whereby the energy savings calculations were modeled using DOE-2 or other models, the input values and assumptions made for the model were analyzed and verified. In the event that no modeling information was available, ADM attempted to contact the engineering firms to obtain more information for the site in question and perform simulation using building simulation software.

The facility inspection and verification was focused primarily on the proper installation of equipment and operating hours from interview with the site contact. The characteristics for the equipment installed were also verified. For example, where a VFD was installed on supply fans, data on the operating parameters of the motor were obtained, and it was verified that the VFD was fully functional at the time of inspection. For projects where additional control components were added, the programming inputs were checked and verified to make sure that they were consistent with those provided in the original calculations.

For sites where HVAC or custom VFD measures had been installed, monitoring was conducted to obtain more accurate information on the hours of operation for the equipment. The HVAC and Custom VFD monitoring data have been used to verify that the VFD is functioning as designed (exhibiting fluctuations based on changing input conditions). In most cases, the data have not been used to perform the savings calculations because the two-week data may not reflect the operation of the HVAC system year round. Instead, saving calculations rely more on energy simulation based on the operating parameters collected year round (such as building schedule, construction and occupancy). It should be noted that in general, a large majority of the Custom VFD projects involve HVAC applications. All monitored Custom VFD projects involved HVAC applications.

Procedures for Analyzing Savings from HVAC and Non-HVAC Motors (including Variable Frequency Drives). To verify the savings from motors and VFDs, the documentation file for a project with these measures was reviewed, with particular attention to the parameters used to calculate the savings derived from motor replacement or installation of adjustable speed drives. For high efficiency motor replacement, these parameters included the efficiency of the old motor, efficiency of the new motor, load factor and usage factor. The motor efficiencies were then compared against existing databases including manufacturers data, MotorMaster®, and ADM's own motor database. During an on-site visit, information was collected on the motors using the motor nameplate and other technical materials that the facility contact had on-site. In some instances, one-time power measurements were performed to verify the load factor of the motor. Operating hours of the motors were verified by interviewing the facility contact.

Estimates of the energy savings from use of high efficiency motors on HVAC and non-HVAC applications were derived through an "after-only" analysis. With this method, energy use was measured only for the high efficiency motor and only after it had been installed. The data thus collected were then used in estimating what energy use would have been for the motor application *if the high efficiency motor had not been installed.*

For installation of variable frequency drives, any modeling provided in project documentation that was substantiated by monitored data was evaluated based on the accuracy of the information, validity of the assumptions and the methodology used in arriving at the energy savings. Energy savings derived from an engineering model deemed technically sound were considered acceptable. The field verification in this case focused on proper installation of the rebated equipment and verification of the operating parameters.

To gather more accurate information on the operating hours of installed motors or VFDs, monitoring was conducted at 12 sites where such measures had been installed through a BE project.

2.2 GROSS SAVINGS FOR BE PROJECTS

2.2.1 Gross Savings for 2004 BE Projects

To verify gross kWh and therm savings and kW reductions for the BE Program in 2004, data were collected and analyzed for a sample of 132 sites that participated in the BE Program in 2004 . The data were analyzed using the methods described in Section 2.1 to verify the energy (kWh and therm) savings and kW reductions and to determine realization rates by type of measure. The results of that analysis are reported in this section. Section 2.2.1.1 discusses the results of the verification for individual sites, while Section 2.2.1.2 presents the results when BE projects are grouped by type (e.g., lighting, HVAC, etc.).

2.2.1.1 Verification of Gross Savings for Individual Sites

The first step in the verification effort was to examine the data for individual sites to identify any major discrepancies between expected and verified energy savings. Summary information on the differences between expected and verified savings identified for individual sites is provided in Appendix D.

For lighting projects, the examination of individual sites focused on major discrepancies between expected and verified energy savings that could be attributed to (1) differences in the operating hours for the areas where the energy efficiency light fixtures were installed and (2) the use of fixture wattages that can be inconsistent from project to project.

Data on operating hours for lighting were verified using monitored data, information obtained by interviewing facility personnel, and some physical evidence (e.g., posted operating hours of the facility). The monitored data for 17 lighting projects revealed that in a majority of cases (20 out of 26 areas) the difference between monitored and expected operating hours was at or less than 10% of the expected operating hours. The highest difference recorded was 36% longer than the original expected hours. Table 2-3 presents a summary of operating hours data for the sites where such information was collected. Based on these results, it was concluded that the operating hours expected is highly consistent with the actual operating hours at the site. Therefore, the operating hours for sites not monitored were accepted "as is." (Further analysis of the relationship between monitored and expected hours of use for lighting is provided in Appendix D , using data from both 2004 and 2005 projects.)

The fixture wattages for existing and new light fixtures vary from contractor to contractor, and to ensure consistency in the calculations of energy savings, the wattages for frequently installed fixtures have been standardized. The wattages originally used have been revised to reflect these new values and the energy savings recalculated accordingly. The list of the standardized light fixtures and the assigned wattages can be found in Table 2-4.

Table 2-3. Monitored Data for Lighting Projects in 2004

ADM Site ID	***Monitored Hours/Week***	***Expected hours/Week***	***Difference (Monitored – Expected)***	***% Difference***
04C11	168	168	0	0%
04C11	168	168	0	0%
04C12	63	60	3	5%
04C17	162	166.5	(4)	-2%
04C17	162	166.5	(4)	-2%
04C23	130	144	(14)	-10%
04C22	114	119	(5)	-4%
04C22	119	119	0	0%
04C22	114	119	(5)	-4%
04C18	168	168	0	0%
04C18	66	58	8	13%
04C18	95	95	0	0%
04C29	85	85	(0)	0%
04C07	110	110	(0)	0%
04C07	168	168	0	0%
04C25	168	168	0	0%
04P18-1	82	84	(2)	-3%
04C06	67	51	16	31%
04P07-1	69	72	(3)	-4%
04P10-1	66	60	6	10%
04P06-1	53	45	8	17%
04P06-1	46	45	1	3%
04P06-1	50	45	5	11%
04P02-1	89	71	18	25%
04P02-1	89	71	18	26%
04P16-1	87	81	6	8%
04P19-1	81	72	9	12%
Average (unweighted)			2	2%

Table 2-4. Standardized Fixture Wattage: Analysis of 2004 Sites

Fixture Type	***Nominal Lamp Wattage***	***Standardized Fixture Wattage (Lamp and Ballast)***
1LF40T12	34/40	44
2LF40T12	34/40	82
3LF40T12	34/40	123
4LF40T12	34/40	164
2LF96T12	60	138
2LF96T12	75	173
1LF96T12HO	110	121
2LF96T12HO	110	223
1LF32T8 (b.f. 0.98 - standard)	32	32
2LF32T8 (b.f. 0.98 - standard)	32	62
3LF32T8 (b.f. 0.98 - standard)	32	88
4LF32T8 (b.f. 0.98 - standard)	32	112
6LF32T8 (b.f. 0.98 - standard)	32	176
1LF32T8 (b.f. 0.88)	32	28
2LF32T8 (b.f. 0.88)	32	55
3LF32T8 (b.f. 0.88)	32	83
4LF32T8 (b.f. 0.88)	32	108
1LF32T8 (b.f. 0.78)	32	25
2LF32T8 (b.f. 0.78)	32	48
3LF32T8 (b.f. 0.78)	32	73
4LF32T8 (b.f. 0.78)	32	95
1LF28T8 (b.f. 0.88)	28	25
2LF28T8 (b.f. 0.88)	28	48
3LF28T8 (b.f. 0.88)	28	73
4LF28T8 (b.f. 0.88)	28	95
2LF59T8	59	115
4LF59T8	59	230
MH	variable	variable
4L54WT5HO	54	234

For HVAC, Building, and VFD measures, most discrepancies were found where engineering calculations were used to estimate the energy savings in lieu of modeling, especially those where weather data was not used as the basis of calculations. In such instances, very broad assumptions were made, which may not be applicable or consistent year round. Discrepancies of more than 10% were found in 16 out 51 sites (31%) where HVAC, Building, Motor and VFD projects were implemented, and the majority of these discrepancies fall within the 10-30% range. The source of discrepancies cannot be generalized for these measures, and it is recommended that all of the measures other than lighting projects be reviewed and analyzed on a case-by-case basis.

Table 2-5 presents the evaluated projects in the Custom Other category. The scope of projects in this category varies widely, ranging from DDC expansion to installation of additional roof insulation. Therefore, the savings in this category cannot be generalized.

Table 2-5. Review of 2004 Custom Other Projects

MASTER SITE ID	***Expected kWh Savings***	***Verified kWh Savings***	***Expected Therms***	***Realized Therms***	***Overall Realization Rate (kWh)***	***Overall Realization Rate (Therm)***	***Comments***
S00000115488	130,531	108,084			83%		Installed VFDs on condensing tower and optimized air side circulation. The air side circulation was only partially (50%) complete at the time of inspection
S00000115945	506	506	7,363	8,820	100%	120%	Installation of high efficiency water heater, laundry machines and stack dryers. Savings for stack dryers was underestimated because the original calculations did not account for size of the machines.
S00000115718	34,813	34,338	7,100	4,738	99%	67%	Various HVAC measures, including outdoor air reset and thermostat calibration. Energy simulations showed that the original gas savings was overstated.
S00000115527	18,766	1,558	1,267	188	8%	15%	Adding R-19 insulations to the attic/roof. Original savings was overestimated, based on DOE-2 simulation, Building this size should not have that much of savings.
S00000115131	121,535	78,720	3,633	1,600	65%	44%	Expansion of DDC system and addition of window film. The savings are lower because of the higher minimum CFM ratio for the VAV system.
S00000115828	52,119	48,233			93%		Installation of new air compressor with VFD. Savings have been adjusted to account for the same CFM requirements before and after.

Most of the evaluated projects in the Custom Gas category involved replacement of gas equipment. Three out of the six Custom Gas projects involved replacement of conventional space heaters with infrared radiant heaters. Two out of three sites were visited for verification. The customers at both sites were satisfied with the new infrared radiant heaters and had the impression that the new heaters were more efficient than the old heaters because the radiant heaters provided heating only to objects that needed heating. It should also be noted that the savings from this type project came from the installation of the new heaters that are significantly smaller in size than the original heater(s) since the new radiant heaters are more effective in providing heat for the building occupants. Therefore the savings was immediately observable even if the new heaters remain operational for the same number of hours as the old heaters. The deemed savings values for radiant heating were further validated through a separate, supplemental study of radiant heating.[3]

It should be noted that the energy savings for projects using deemed savings were not re-calculated. In this case, the quantity and type of equipment installed was verified, but the deemed savings was used as the verified savings.

[3] ADM Associates, Inc., *Report on Radiant Heater Study*, September 2007.

In general, the monitoring performed for the 2004 projects resulted in confirmation of the expected energy savings.

- The monitored data for lighting projects revealed that on average, the monitored data is consistent with the claimed hours.
- The monitored data for Building, HVAC and VFD projects confirmed the variation in operating loads introduced by the addition of the energy efficient hardware and/or improved control system.

Although the monitored data is not used in the savings calculations, which rely more on DOE-2 modeling, it serves as a good confirmation that the monitored system is operating as intended. It is recommended that monitoring be performed whenever possible for all measures as an additional confirmation that the system is functioning properly, especially where an Energy Management System that provides data trending is not available.

2.2.1.2 Verification of Gross Savings for Types of BE Projects

The results of the verification effort were used to develop realization rates by type of energy efficiency measure. The realization rates developed are shown in Table 2-6 for kWh savings and in Table 2-7 for therm savings. Table 2-6 shows that realization rates for kWh savings varied among the different end uses, ranging from a low of 8.3% for Custom Gas projects to a high of 111.7% for Custom VFD projects.

Table 2-6. Verification of kWh Savings for Building Efficiency Projects in 2004

Type of Energy Efficiency Improvement	*Number of Projects for Verification*	*Expected kWh Savings*	*Verified kWh Savings*	*Realization Rates*
HVAC				
Custom HVAC	18	6,809,190	6,963,582	102.3%
Standard HVAC	8	71,552	72,187	100.9%
Lighting				
Custom Lighting	52	4,830,711	4,535,172	93.9%
Standard Lighting	63	6,425,102	6,481,056	100.9%
Motors				
Custom Motors	2	826,394	826,394	100.0%
Standard Motors	5	39,539	39,531	100.0%
Custom VFD	7	1,032,528	1,152,880	111.7%
Custom Building	11	3,840,726	3,691,424	96.1%
Custom Other	6	359,495	269,881	79.6%
Custom Gas	2	18,766	1,558	8.3%

Table 2-7. Verification of Therm Savings for Building Efficiency Projects in 2004

Type of Energy Efficiency Improvement	*Number of Sites for Verification*	*Expected Therm Savings*	*Verified Therm Savings*	*Realization Rates*
Custom Building	1	4,868	3,161	64.9%
Custom HVAC	2	7,239	10,310	142.4%
Custom VFD	1	995	1,363	137.0%
Custom Other	40	24,352	20,645	84.8%
Custom Gas	6	21,535	20,427	95.0%

The tracking system data maintained by Energy Trust for BE projects in 2004 and 2005 does not contain estimates of kW reductions for the projects. However, the verification effort for this evaluation estimated kW reductions for the sites in the evaluation sample. Thus, a ratio of kW reductions to verified kWh savings could be calculated, as follows:

- Verified kWh savings = 24,033,665 kWh
- Verified kW reductions = 4,027 kW
- kW reduction per kWh saved = .000168

2.2.1.3 Estimation of Program-Level Gross Savings for 2004

As shown in Table 2-2, BE energy efficiency projects were completed at 488 sites in 2004. Using the realization rates calculated in Table 2-6 and Table 2-7, estimates were developed of program-level achieved kWh and therm savings and kW reductions. These estimates are reported in Table 2-8 for kWh savings and in Table 2-9 for therm savings.

Table 2-8. Estimated Program-Level Achieved Gross kWh Savings for Building Efficiency Projects in 2004

Type of Energy Efficiency Improvement	*Number of Sites*	*Expected kWh Savings*	*Realization Rates*	*Achieved Gross Program-Level kWh Savings*
HVAC				
Custom HVAC	46	8,235,603	102.3%	8,422,338
Standard HVAC	40	239,413	100.9%	241,539
Lighting				
Custom Lighting	180	9,119,681	93.9%	8,561,746
Custom Delamping	2	23,965	100.9%	24,174
Standard Lighting	261	11,252,936	100.9%	11,350,934
Motors				
Custom Motors	013	1,215,613	100.0%	1,215,613
Standard Motors	41	716,559	100.0%	716,559
Custom VFD	17	1,577,728	111.7%	1,761,628
Custom Building	19	4,403,078	96.1%	4,231,915
Custom Other	15	696,608	79.6%	554,579
Custom Gas	19	18,766	8.3%	1,558
Totals		37,499,950	98.9%	37,082,583

Table 2-9. Estimated Program-Level Achieved Gross Therm Savings for Building Efficiency Projects in 2004

Type of Energy Efficiency Improvement	*Number of Sites*	*Expected Therm Savings*	*Realization Rates*	*Achieved Gross Program-Level Therm Savings*
Custom Building	19	7,250	64.9%	4,705
Custom HVAC	46	9,185	142.4%	13,082
Custom VFD	17	995	137.0%	1,363
Custom Other	15	29,587	84.8%	25,090
Custom Gas	19	38,512	95.0%	36,581
Totals		85,529	94.5%	80,821

Applying the kW reductions per kWh saved of 0.000168 to the estimated achieved gross program-level kWh savings of 37,082,583 kWh gives an estimated kW reduction of 6,213 kW.

2.2.2 Gross Savings for 2005 BE Projects

To verify gross kWh and therm savings and kW reductions for the BE Program in 2005, data were collected and analyzed for a sample of sites that participated in the BE program in 2005. The data were analyzed using the methods described in Section 2.1 to verify the energy (kWh and therm) savings and kW reductions and to determine realization rates by type of measure. The results of that analysis are reported in this section. Section 2.2.2.1 discusses the results of the verification for individual sites, while Section 2.2.2.2 presents the results when BE projects are grouped by type (e.g., lighting, HVAC, etc.).

2.2.2.1 Verification of Gross Savings for Individual Sites in 2005 Program

The first step in the verification effort was to examine the data for individual sites to identify any major discrepancies between expected and verified energy savings. Summary information on the differences between expected and verified savings identified for individual sites with a discrepancy of larger than 10% is provided in Appendix D.

For lighting projects, the examination of individual sites focused on major discrepancies between expected and verified energy savings that could be attributed to (1) differences in the operating hours for the areas where the energy efficiency light fixtures were installed, (2) the number of light fixtures claimed versus installed, and (3) the use of fixture wattages that can be inconsistent from project to project.

Data on operating hours for lighting were verified using monitored data, information obtained by interviewing facility personnel, and some physical evidence (e.g., posted operating hours of the facility). Tables 2-10 and 2-11 present a summary of operating hours data for the sites where such information was collected. Table 2-10 presents information for sites where differences between operating hours could be used for comparison purposes, whereas Table 2-11 provides information for sites where

conditions precluded meaningful comparison of operating hours. While lighting was monitored at 16 sites, more than one lighted area was monitored at some sites, providing data for 24 areas in total. (Further analysis of the relationship between monitored and expected hours of use for lighting is provided in Appendix D, using data from both 2004 and 2005 projects.)

Table 2-10. Monitored Data for 2005 Lighting Projects Where Operating Hours Could Be Compared

Logger #	***Annual Operating Hours***	***Original Annual Hours***	***Difference (hr/yr)***	***%***
960304-22	8760	8760	-	0.0%
951103-32	8760	8632	128	1.5%
950113-21	5800	4576	1,224	26.7%
951103-48	5498	4576	922	20.1%
960603-39	2044	5200	(3,156)	-60.7%
960603-03	3559	5200	(1,641)	-31.6%
960304-50	4836	4732	104	2.2%
960513-71	3762	3224	538	16.7%
951103-22	7838	8760	(922)	-10.5%
960603-99	2859	2080	779	37.5%
950807-47	2928	2600	328	12.6%
950807-48	7432	6136	1,296	21.1%
950807-47	2336	2600	(264)	-10.2%
950807-64	2327	2600	(273)	-10.5%
960603-97	3259	2600	659	25.3%
Averages (unweighted)			(19)	2.7%

Table 2-11. Monitored Data for Lighting Projects Where Operating Hours Could Not Be Compared

Logger #	***Annual Operating Hours per Monitoring***	***Original Annual Hours***	***Reasons Hours Not Comparable***
951114-14*	8760	7488*	New lights on motion sensors
951114-29*	8760	7488*	New lights on motion sensors
960603-4*	8760	5616*	Old hours is average for the entire building
961114-14*	3548	5616*	Old hours is average for the entire building
960603-03*	381	2808*	New lights on motion sensors
960603-39*	1910	2808*	New lights on motion sensors
9603021-24*	2354	3224*	New lights on motion sensors
960603-13*	5637	7280*	New lights can be turned off (thus lower hours)
950807-64*	4602	7280*	New lights can be turned off (thus lower hours)

In general, the monitoring performed for the 2005 projects resulted in confirmation of the expected energy savings. The monitored data for lighting projects revealed that on average, the operating hours as monitored data were consistent with the claimed hours. In most cases the monitored operating hours varied from the claimed operating hours by

30% or less. For monitored areas where comparison of hours could be made, the average difference between the monitored and claimed operating hours appear to not be very significant (i.e., less than 3% of the claimed operating hours). Based on the trends observed in monitored lighting data for 2004 and 2005, it is recommended that the claimed hours for all unmonitored projects should be kept the same.

Review of the documentation on fixture wattages for existing and new light fixtures that were used in the original energy savings calculations showed that apparent variations among contractors. Although in the majority of projects, the fixture wattage used for the same lamp-ballast combination is uniform, there were some projects were there were different values used for the same combination. For example, both 223W and 227W were used to represent the energy consumption of the 2LF96T12HO fixture. To ensure consistency in the calculations, a single value for each ballast/lamp combination was adopted and values for the same fixture not corresponding to this standardized value were revised. As a result, the energy savings in some of the projects have been revised slightly to reflect this change in fixture wattage. The list of the standardized light fixtures and the assigned wattages can be found in Table 2-12.

Table 2-12. Standardized Fixture Wattage: Analysis of 2005 Sites

Fixture Type	***Nominal Lamp Wattage***	***Standardized Fixture Wattage (Lamps and Ballasts)***
1LF40T12	34/40	44
2LF40T12	34/40	82
3LF40T12	34/40	123
4LF40T12	34/40	164
2LF96T12	60	138
2LF96T12	75	173
1LF96T12HO	110	121
2LF96T12HO	110	223
1LF32T8 (b.f. 0.98 - standard)	32	32
2LF32T8 (b.f. 0.98 - standard)	32	62
3LF32T8 (b.f. 0.98 - standard)	32	88
4LF32T8 (b.f. 0.98 - standard)	32	112
6LF32T8 (b.f. 0.98 - standard)	32	176
1LF32T8 (b.f. 0.88)	32	28
2LF32T8 (b.f. 0.88)	32	55
3LF32T8 (b.f. 0.88)	32	83
4LF32T8 (b.f. 0.88)	32	108
1LF32T8 (b.f. 0.78)	32	25
2LF32T8 (b.f. 0.78)	32	48
3LF32T8 (b.f. 0.78)	32	73
4LF32T8 (b.f. 0.78)	32	95
1LF28T8 (b.f. 0.88)	28	25
2LF28T8 (b.f. 0.88)	28	48

Fixture Type	***Nominal Lamp Wattage***	***Standardized Fixture Wattage (Lamps and Ballasts)***
3LF28T8 (b.f. 0.88)	28	73
4LF28T8 (b.f. 0.88)	28	95
2LF59T8	59	115
4LF59T8	59	230
MH	Variable	variable
4L54WT5HO	54	234

For HVAC and Custom VFD projects, monitoring data were used to verify that the VFD was functioning as designed (i.e., exhibiting fluctuations based on changing input conditions). The short-term monitored data (i.e., for two- to four-week periods) were not used directly to perform the savings calculations because the two-week data may not reflect the operation of the HVAC system year round. Instead, saving calculations were made using energy simulation based on the year-round operating parameters (e.g., building schedule, construction, occupancy) as collected during the site visit. The short-term monitored data were used to calibrate and check the validity of the assumptions used in the DOE-2 simulation models. The trends, including the minimum and maximum settings (especially for VFD applications) that were observed through the monitoring data were used to calibrate the DOE-2 energy simulations that were used to estimate the savings.

For measures involving HVAC applications, most discrepancies were found where engineering calculations, rather than energy simulation modeling, had been used to estimate the claimed savings. For Custom VFD projects, where a Variable Frequency Drive was installed on HVAC fan or pump motors, the savings projected through DOE-2 simulations and those claimed by the contractors could differ significantly. In most cases, when engineering calculations were used in lieu of simulation modeling, broad assumptions were made. In general, it appeared that the contractors used very conservative assumptions in coming up with the savings.

With respect to savings from gas projects, the savings resulting from the implemented measures were often higher than the savings estimated through energy simulation analysis. The reasons for these discrepancies varied from project to project. However, in most cases, it appeared that the original calculations used rather generous assumptions about the operation of the heating systems. It should also be noted that while savings calculations as presented in the project file provide adequate documentation on electricity savings, documentations on how the gas saving were calculated were found inadequate in the majority of cases. Despite efforts to model the buildings based on the information provided in the project files, the same gas savings that were projected originally could not be replicated in several cases.

For HVAC-related projects, it is recommended that future evaluations be based upon project review on a case-by-case basis because of the varying scope and complexity of the measures implemented through this program.

Table 2-13 presents the projects evaluated for 2005 in the Custom Other category. The scope of projects in this category varies widely, ranging from DDC expansion to installation of additional roof insulation. Therefore, the savings in this category cannot be generalized.

Table 2-13. Review of 2005 Custom Other Projects

Mastersite ID	***kWh Savings***			***Therm Savings***			***Comments***
	Expected kWh Savings	***Verified kWh Savings***	***Realization Rate for kWh Savings***	***Expected Therms***	***Verified Therms***	***Realization Rate for Therm Savings***	
S00001111910	251,538	245,193	97%	-	-	-	Performed a comprehensive recommissinoning of the building, including repairing economizer and swapping out chiller and steam pre-heat valves. Savings estimated based on DOE-2 is consistent with the claimed savings.
S00000115944	948,000	948,000	100%	-	-	-	Installed a software management system that put idle computers to sleep and minimize the idle time before the call to sleep is activated. Monitoring results were presented and accepted as valid.
S00001169865	586,130	590,043	101%	-	-	-	Reprogrammed the EMS to reflect more current schedules, and installed demand based ventilation. Savings estimated based on DOE-2 is consistent with the claimed savings.
S00000115752	153,468	159,333	104%	-	-	-	Performed a comprehensive recommissinoning of the facility. Savings estimated based on DOE-2 is consistent with the claimed savings.
S00000115341	147,410	34,050	23%	26,085	4,866	19%	Calibrated the fan supply (CFM) back to design conditions. The original claimed savings was based on a 10-year projection. This is revised to reflect a more realistic annual savings.
S00000115895	186,444	202,301	109%	15,189	5,619	37%	Performed retro-commissioning of the building including adjustment of operation schedules, and sensors repair and calibration. Savings estimated based on DOE-2 simulation is consistent with claimed savings.

Mastersite ID	*kWh Savings*			*Therm Savings*			*Comments*
	Expected kWh Savings	*Verified kWh Savings*	*Realization Rate for kWh Savings*	*Expected Therms*	*Verified Therms*	*Realization Rate for Therm Savings*	
S00001163883	127,760	22,775	18%	-	-	-	Installed window tinting on south-facing windows. Based on DOE-2 simulation, there are reasons to believe that the original simulation was highly overstated. A similar building receiving incentive for the same measure projected savings more in line with the verified savings.
S00001171059	22,112	19,620	89%	-	-	-	Installed window tinting on building windows. The DOE-2 simulation shows lower savings than claimed.

Table 2-14 presents the projects evaluated for 2005 in the Custom Gas category. Most of the projects in this category involved replacement of gas equipment. It should be noted that the energy savings for projects using deemed savings were not re-calculated. In this case, the quantity and type of equipment installed was verified, but the deemed savings was used as the verified savings.

In general, the monitoring performed for the 2005 projects resulted in confirmation of the expected energy savings.

- The monitored data for lighting projects revealed that on average, the monitored data is consistent with the claimed hours.
- The monitored data for Building, HVAC and VFD projects confirmed the variation in operating loads introduced by the addition of the energy efficient hardware and/or improved control system.

Table 2-14. Review of 2005 Custom Gas Projects

Mastersite ID	*Custom Gas Claimed Savings (Therms)*	*Custom Gas Verified Savings (Therms)*	*Realization Rate*	*Comments*
S00000115753	4,500	1,397	31%	Installed an Energy Recovery Heat Wheel. The original savings assumptions appeared to be very generous for this weather zone, and based on the DOE-2 simulation and baseline consumption, a much lower savings estimate should be anticipated.
S00001157811	13,967	16,157	116%	Installed automatic control valves at each convector and replaced steam control valves and traps to avoid overheating. DOE-2 simulation on this measure came up with a higher savings estimate.

Mastersite ID	***Custom Gas Claimed Savings (Therms)***	***Custom Gas Verified Savings (Therms)***	***Realization Rate***	***Comments***
S00000115961	12,702	5,014	39%	Rezoned the HVAC at the facility to avoid cooling and heating of core and perimeter zones. DOE-2 simulation arrived at a much lower savings estimate than originally projected.
S00001162291	3,289	3,289	100%	Installed radiant heaters to replace older units. Claimed savings based on Deemed Savings.
S00001159221	1,337	1,357	102%	Installed attic and wall insulation. Claimed savings based on Deemed Savings.
S00001173831	4,588	-	0%	No verified savings attributed because radiant heaters did not replace older heating units but were installed as new equipment.
S00000115304	3,684	1,352	37%	Retrofitted old burner for gas boiler with a new high efficient burner. The DOE-2 energy simulation predicted a significantly lower gas consumption for the boiler based on the facility parameters and historical weather data.

Although the monitored data are not used in the savings calculations for HVAC projects, which rely more on DOE-2 modeling, the monitored data provide confirmation that the monitored system is operating as intended. It is recommended that monitoring be performed whenever possible for all measures as an additional confirmation that the HVAC system is functioning properly, especially where an Energy Management System that provides data trending is not available.

2.2.2.2 Verification of Gross Savings for Types of 2005 BE Projects

The results of the verification effort were used to develop realization rates by type of energy efficiency measure. The realization rates developed are shown in Table 2-15 for kWh savings and in Table 2-16 for therm savings. Table 2-15 shows that realization rates for kWh savings varied among the different end uses, ranging from a low of 91.5% for lighting projects to a high of 126.0% for Custom VFD projects.

The tracking system data maintained by Energy Trust for BE projects in 2004 and 2005 does not contain estimates of kW reductions for the projects. However, the verification effort for this evaluation estimated kW reductions for the sites in the evaluation sample. Thus, a ratio of kW reductions to verified kWh savings could be calculated, as follows:

- Verified kWh savings = 27,620,343 kWh
- Verified kW reductions = 8,517 kW
- kW reduction per kWh saved = 0.000308

Table 2-15. Verification of kWh Savings for Building Efficiency Projects in 2005

Type of Energy Efficiency Improvement	*Number of Projects for Verification*	*Expected kWh Savings*	*Verified kWh Savings*	*Realization Rates*
HVAC				
Custom HVAC	10	3,613,652	3,968,660	109.8%
Standard HVAC	7	39,603	39,603	100.0%
Lighting				
Custom Lighting	65	9,681,803	10,052,281	103.8%
Custom Delamping	7	36,313	36,641	100.9%
Standard Lighting	84	4,973,283	4,549,913	91.5%
Motors				
Custom Motors	4	232,952	231,058	99.2%
Standard Motors	7	367,589	368,532	100.3%
Custom VFD	21	4,346,835	5,479,065	126.0%
Custom Building	6	1,376,466	1,428,790	103.8%
Custom Other	9	2,422,862	2,221,315	91.7%
Dishwashing	2	118	118	100.0%

Table 2-16. Verification of Therm Savings for Building Efficiency Projects in 2005

Type of Energy Efficiency Improvement	*Number of Sites for Verification*	*Expected Therm Savings*	*Verified Therm Savings*	*Realization Rates*
Custom Gas	7	44,067	28,566	64.8%
Custom Building	3	22,081	10,738	48.6%
Custom HVAC	2	14,468	28,585	197.6%
Custom VFD	5	32,285	25,783	79.9%
Custom Other	3	41,754	11,125	26.6%
Dishwashing	2	352	352	100.0%
Food Equipment	1	2,346	2,346	100.0%
Furnace	1	120	120	100.0%
Gas Heat	3	15,918	15,918	100.0%
Insulation	4	25,687	25,686	100.0%

2.2.2.3 Estimation of Program-Level Gross Savings for 2005

As shown in Table 2-2, BE energy efficiency projects were completed at 832 sites in 2005. Using the realization rates calculated in Table 2-15 and Table 2-16, estimates were developed of program-level achieved kWh and therm savings and kW reductions. These estimates are reported in Table 2-17 for kWh savings and in Table 2-18 for therm savings.

Applying the kW reductions per kWh saved of 0.000308 to the estimated achieved gross program-level kWh savings of 58,967,894 kWh gives an estimated gross kW reduction of 18,183.13 kW.

Table 2-17. Estimated Program-Level Achieved Gross kWh Savings for Building Efficiency Projects in 2005

Type of Energy Efficiency Improvement	*Number of Sites*	*Expected kWh Savings*	*Realization Rates*	*Achieved Gross Program-Level kWh Savings*
HVAC				
Custom HVAC	31	5,581,806	109.8%	6,130,167
Standard HVAC	30	153,389	100.0%	153,389
Lighting				
Custom Lighting	263	18,581,717	103.8%	19,292,755
Custom Delamping	26	252,624	100.9%	254,905
Standard Lighting	349	11,012,968	91.5%	10,075,446
Motors				
Custom Motors	8	595,099	99.2%	590,261
Standard Motors	39	840,015	100.3%	842,170
Custom VFD	71	9,512,026	126.0%	11,989,644
Custom Building	25	4,319,318	103.8%	4,483,509
Custom Other	17	5,506,346	91.7%	5,048,298
Dishwashing	85	106,671	100.0%	106,671
Insulation	2	679	100.0%	679
Totals		56,462,658	104.4%	58,967,894

Table 2-18. Estimated Program-Level Achieved Gross Therm Savings for Building Efficiency Projects in 2005

Type of Energy Efficiency Improvement	*Number of Sites*	*Expected Therm Savings*	*Realization Rates*	*Achieved Gross Program-Level Therm Savings*
Custom Gas	25	77,116	64.8%	49,990
Custom Building	12	111,264	48.6%	54,108
Custom HVAC	7	38,228	197.6%	75,529
Custom VFD	4	21,519	79.9%	17,185
Custom Other	6	78,532	26.6%	20,924
Boiler	4	4,243	100.0%	4,243
Dishwashing	60	12,144	100.0%	12,144
Food Service	6	10,514	100.0%	10,512
Furnace	7	1,213	100.0%	1,213
Gas heat	14	34,490	100.0%	34,490
Insulation	15	52,875	100.0%	52,873
Tankless	4	668	100.0%	668
Other	1	150	100.0%	150
Total		442,955	75.4%	334,028

2.3 ESTIMATION OF GROSS SAVINGS THROUGH ANALYSIS OF BILLING DATA

To complement the engineering analysis of savings from BE projects, monthly billing data on electric and gas usage for participants in the BE Program in 2004 and 2005 were also analyzed. The results of that analysis are presented in this section.

2.3.1 Description of Monthly Billing Data

Staff of Energy Trust made available two data files (in Excel format) that contained electric and gas billing data and other information for a sample of the buildings that were participants in the BE Program in 2004 and 2005. (One file contained electric billing data and the other gas billing data.)

Billing data were provided for 188 buildings with kWh savings and 61 buildings with therm savings. Billing data for the total number of buildings that participated in the BE Program in 2004 and 2005 could not be provided because account numbers were not provided or were incorrect or because irregularities in the billing data resulted in an insufficient amount of data for analysis. (The most common irregularity was infrequent missing monthly reads.)

Table 2-19 lists the contents of the two data files containing the electric and gas monthly billing data.

Table 2-19. Contents of Billing Data Files

Data Field	***Description***
Site ID	Unique Energy Trust site identifier
Read Date	Date of meter reading
Title	Title of the project, or name of the site
Meter number	Utility meter number
Formatted Account	Utility account number
kWh	kWh reading
Therms	Therm reading
Day	Day of the month meter was read
Month	Month of the year meter was read
Year	Year meter was read
Multiple meters [4]	Flag for an account with multiple meters that could not be aggregated
Read days	Number of days since last meter read
City	Site city
Zip	Site zip code
Site 2004	Flag for a 2004 site
Site 2005	Flag for a 2005 site
Weather group	Location of weather data reading site
PAC	Flag for a PacifiCorp site
PGE	Flag for a PGE site
HDD	Heating degree days
CDD	Cooling degree Days

[4] Although commercial buildings often have several meters, most of the sites included in the provided data had only one meter or the meter reads had been aggregated. There were five sites for which data could not be aggregated because readings were not on the same day. There were also sites for which data could not be provided for separate meters because the correct meter and site could not be distinguished in the information when provided to the Energy Trust. These sites were flagged in the data files as "multiple meter" sites.

Also provided in the files were data on heating and cooling degree days with which to normalize the billing data for weather. The degree days were calculated using data on average daily temperature and a base temperature of 65° F according to the following formulas:

- HDD = 65 – average daily temperature if average daily temperature is less than 65°F. HDD = 0 if average daily temperature is greater than 65°F.
- CDD = average daily temperature – 65 if average daily temperature is greater than 65°F. CDD = 0 if average daily temperature is less than 65°F.

The sites were grouped into seven different weather zones in Oregon. The average daily temperatures for seven different cities representative of these weather zones were used to calculate HDD and CDD.

2.3.2 Preliminary Analysis of Billing Data

A review of the billing data that Energy Trust provided for 188 participants in the BE Program in 2004 and 2005 showed that monthly billing data for the five years from 2002 through 2006 were available for 137 of these participants. To ensure compatibility of data over time, only the data for these 137 participants were used for the analysis.

Before undertaking a regression analysis of the billing data, a preliminary analysis of the data was conducted by comparing average daily kWh usage for the 137 participant sites before and after they installed energy efficiency measures through the BE Program. These comparisons were made for all 137 sites and for the sites when divided by average daily kWh usage (i.e., under 1,000 kWh per day and over 1,000 kWh per day). The results of these comparisons are provided in Table 2-20.

Table 2-20. Comparisons of Before and After Daily kWh Use for BE Program Participants

	All Sites	***Sites with Daily kWh Use Under 1,000 kWh***	***Sites with Daily kWh Use Over 1,000 kWh***
Number of sites	137	78	58
Average daily kWh use before measure installation	2,329	319	5,070
Average daily kWh use after measure installation	2,180	291	4,755
Decrease in average daily kWh use	149	28	315
Expected average daily kWh savings from measures (from tracking system)	56	23	83

As can be seen from Table 2-20, average daily kWh use decreased after installation of the energy efficiency measures. Moreover, the decrease was greater than the savings expected from the measures installed. However, not all of the decrease can be attributed

to the effects of the installed measures. Figure 2-1 shows annual MWh sales to the commercial sector in Oregon over the five-year period 2002-2006. As can be seen, there is a drop in sales from 2004 to 2005. For BE sites that installed measures during 2004 and 2005, savings from the measures could therefore be confounded with the general decrease in usage that occurred from 2004 to 2005.

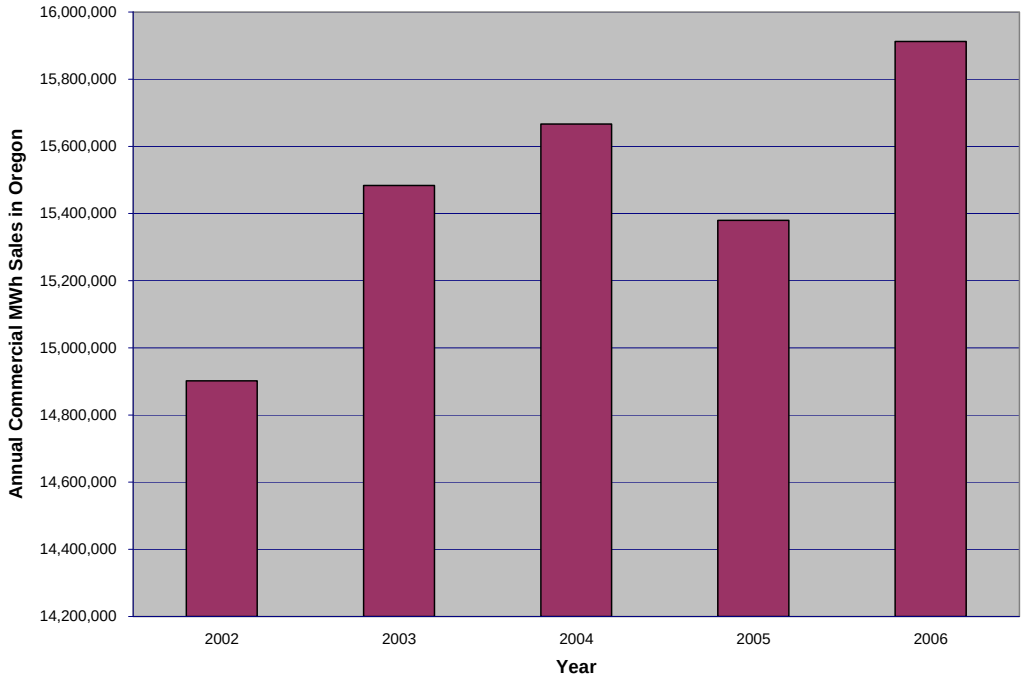

Figure 2-1. Commercial MWH Sales in Oregon: 2002-2006

2.3.3 Regression Analysis of Billing Data

To more fully address the factors affecting changes in kWh use for BE participant sites, regression analysis was applied to the monthly billing data for electric and gas usage for participants in the BE Program in 2004 and 2005 before and after measures for which participants received rebates were installed. This regression analysis was directed at explaining observed electricity and gas consumption records in terms of different types of variables (e.g., representing general kWh sales in the commercial sector, weather, and before-after measure installation status).

The starting equation used to formulate the regression analysis of the monthly billing data was as follows

$$U_t = \alpha_0 + \alpha_1 HDH_t + \alpha_2 CDH_t + E_{et}$$

where

- U_t is average daily electricity or gas use for billing period t for a participant (determined by dividing billing period usage by number of days in that billing period);

- HDH_t is the average daily heating degree days per day for billing period t for the participant (calculated at a base temperature of 65^oF);
- CDH_t is the average cooling degree days per day for billing period t for the participant (calculated at a base temperature of 65^oF);
- E_{et} is an error term;
- α_0 is an intercept term;
- α_1 is a coefficient showing the changes in electricity or gas use that occurs for a change in the heating degree hour variable;
- α_2 is a coefficient showing the changes in electricity or gas use that occurs for a change in the cooling degree hour variable;

To account for the effects of general changes in the market for commercial sector electricity use, a variable measuring kWh sales to the commercial sector in Oregon was included in the equation. Monthly data on commercial sector electricity sales were obtained from the Energy Information Administration.

The effects of energy efficiency measures installed at sites that participated in the BE Program in 2004 and 2005 are captured in the regression analysis by including shifter terms for the intercept term (α_0)

- Many of the sites that participated in the BE Program in 2004 and 2005 installed lighting efficiency measures. The effect of such measures is captured in the regression analysis by including a shifter term as follows:

  α_{01}*ESavings_Lighting

  where ESavings_Lighting is the expected savings (in kWh per day) from lighting measures (after measures are installed).

- A similar shifter term was defined for non-lighting measures as follows:

  α_{02}*ESavings_Not_Lighting

With this formulation, the equation to be estimated was:

$$U_t = \alpha_{00} + \alpha_1 HDH_t + \alpha_2 CDH_t + \alpha_3 Commercial\_Sector\_MWh\_Sales_t + \alpha_{01} ESavings\_Lighting + \alpha_{02} ESavings\_Not\_Lighting + E_{et}$$

This equation was estimated using time-series (monthly) observations of electricity use for program participants pooled across a cross-section of participants. A least squares dummy variable (LSDV) covariance estimation procedure was used.[5] A "fixed-effects" specification was used for the regression model in which the estimated equation contains

[5] For a discussion of this approach, see Kmenta, J., **Elements of Econometrics**, 2nd Edition, Macmillan Publishing Company, 1986, pp. 630-635.

a constant term that is unique to each participant site. In this approach, a binary dummy variable is created for each participant included in the cross-section sample, and the full set of these dummy variables is included in the regression analysis.[6] Use of these dummy variables means that the estimated equation contains a constant term that is unique to each participant. The purpose of this constant term is to capture all the determinants of that participant's energy use that are constant over time. In effect, this approach automatically controls for differences among participants that influence the average level of consumption across participants. The specification of customer-specific effects allows the model to capture much of the baseline differences across participants while obtaining reliable estimates of the impacts of the measures installed.

There are several significant advantages to using this fixed-effects panel model:

- The panel model does not require a fixed participation window. Rather, each customer essentially has a unique participation window that is defined by the point in time when the measures were installed.
- By using monthly observations, the model has several observations on each participant. This has three significant benefits. First, the precision associated with these models is generally high. Second, the model can give significant results even if a small number of participants are in the model. Finally, experience has shown that these models tend to be more robust with respect to outliers.

Separate regression analyses were conducted for participants with electric billing data and for participants with gas billing data. The results of the regression modeling for kWh use are reported in Table 2-21 for sites with average daily kWh use under 1,000 kWh and in Table 2-22 for sites with average daily kWh use over 1,000 kWh. The results for the regression modeling of gas usage are reported in Table 2-23.

Table 2-21. Results of Regression Analysis of Electric Billing Data for BE Program Participants in 2004 and 2005 with Average Daily kWh Usage Under 1,000 kWh

Variable	***Estimated Coefficient***	***Standard Error***	***T Value***	***Pr > |t|***
Site-specific intercepts				
Commercial MWh sales	33.88	19.88	1.70	0.0883
Heating Degree Days per day	1.54	0.24	6.53	<.0001
Cooling Degree Days per day	11.05	0.96	11.53	<.0001
Expected Lighting Savings	-2.46	0.36	-6.85	<.0001
Expected Non-lighting Savings	-0.54	0.09	-6.25	<.0001
Number of sites: 72	Number of Observations: 3,772			
Mean of dependent variable: 343 kWh per day				
R-squared: 0.896	Root Mean Square Error: 87.2			

[6] In practice, we implement this approach using PROC GLM in SAS, with site identification used as a class variable.

Table 2-22. Results of Regression Analysis of Electric Billing Data for BE Program Participants in 2004 and 2005 with Average Daily kWh Usage Over 1,000 kWh

Variable	***Estimated Coefficient***	***Standard Error***	***t Value***	***Pr > |t|***
Site-specific intercepts				
Commercial MWh sales	1,124.04	616.36	1.82	0.0683
Heating Degree Days per day	10.47	7.32	1.43	0.1527
Cooling Degree Days per day	147.96	33.59	4.40	<.0001
Expected Lighting Savings	-10.78	1.94	-5.57	<.0001
Expected Non-lighting Savings	-3.89	0.85	-4.58	<.0001
Number of sites: 54	Number of Observations: 2,796			
Mean of dependent variable: 5,158 kWh per day				
R-squared: 0.771	Root Mean Square Error: 2,333.3			

Table 2-23. Results of Regression Analysis of Gas Billing Data for BE Program Participants in 2004 and 2005

Variable	***Estimated Coefficient***	***Standard Error***	***t Value***	***Pr > |t|***
Site-specific intercepts				
Year 2003 dummy	-57.13	28.51	-2.00	0.0453
Year 2004 dummy	-51.99	28.46	-1.83	0.0679
Year 2005 dummy	-45.63	28.39	-1.61	0.1081
Year 2006 dummy	-39.08	28.40	-1.38	0.1689
Heating degree days per day	4.73	0.25	18.88	<.0001
Cooling degree days per day	0.34	1.21	0.28	0.7768
Expected Gas (therm) savings	-0.55	0.21	-2.61	0.009
Number of sites: 55	Number of Observations: 1,842			
Mean of dependent variable: 90.8 Therms per day				
R-squared: 0.776	Root Mean Square Error: 61.5			

The following can be observed for the electricity use regressions.

- The R-squared values for the regressions are reasonably high.
- For sites with daily kWh use under 1,000 kWh, all variables except commercial GWh sales show high statistical significance, with commercial GWh sales being statistically significant at the 10% significance level. Both heating degree days and cooling degree days have significant effects on daily kWh usage for sites in this group. The coefficients on expected lighting savings and on expected non-lighting savings are negative and statistically significant.
- For sites with daily kWh use over 1,000 kWh, all variables except heating degree days show statistical significance at the 10% level or better. The coefficients on expected lighting savings and on expected non-lighting savings are negative and statistically significant.

The estimated coefficients on expected lighting savings and expected non-lighting savings can be interpreted as realization rates. While the estimated coefficients on the savings variables show values that appear reasonable for sites with daily kWh use under 1,000 kWh, the coefficients on the savings variables for sites with daily kWh use over 1,000 kWh appear to be high. However, as alluded to in Section 2.3.2, it is probable that these coefficients are also picking up the effects of more general changes in electricity use for these sites. Disentangling these effects would require additional data in two respects.

- First, more data on other changes occurring for participant sites would be useful. For example, participant sites may have installed other energy efficiency measures for which they did not receive an Energy Trust rebate or otherwise remodeled, renovated, or changed their facility or equipment. Knowing which, if any, sites had such other changes and the nature of those changes (e.g., lighting changes versus changes in HVAC equipment) could improve the analysis. Similarly, knowing which sites also received a BETC would help refine the analysis.
- Second, data for a reasonably matched sample of sites that had not participated in the BE Program would also be useful to control for other factors more generally affecting the use of electricity in commercial facilities. Data were presented above that showed changes over time in the overall use of electricity in the commercial sector in Oregon. However, data for a sample of non-participant sites would allow the analysis to be more specific and refined.

For the gas usage regression, year dummy variables have been included to capture overall changes in gas usage from year to year. These variables show different degrees of statistical significance. Heating degree days have a significant effect on gas usage, but cooling degree days do not. The coefficient on expected gas savings is negative and statistically significant. The implied realization rate is about 55%.

Qualitatively, the analysis of the billing data for a set of participants confirmed the engineering analyses in showing that reductions in electric and gas usage occurred after energy efficiency measures were installed. However, the analysis of electricity billing data showed reductions, particularly for larger users, that were larger than expected, suggesting that other factors were also working to reduce energy use. The analysis of gas billing data showed reductions in gas usage that were consistent with but somewhat lower than the reductions estimated through the engineering analysis.

3. ESTIMATION OF NET PROGRAM SAVINGS

This chapter reports the results from estimating the net impacts of the BE Program during 2004 and 2005, where net savings represent that part of gross savings achieved by program participants that can be attributed to the effects of the program.

3.1 PROCEDURES USED TO ESTIMATE NET SAVINGS

The basic issue in net savings analysis is determining what part of gross savings achieved by program participants can be attributed to the effects of the program. That is, to what extent were the savings achieved by program participants induced by the program? The savings induced by the program are the "net" savings that are attributable to the program.

Net savings may be less than gross savings because of free-ridership impacts, which arise to the extent that participants in a program would have adopted energy-efficiency measures and achieved the observed energy changes even in the absence of the program. Free riders for a program are defined as those participants that would have installed the same energy efficiency measures without the program.

The goal of the net-to-gross analysis was to estimate the impacts of energy efficiency measures attributable to the Building Efficiency Program that were net of free-ridership. That is, because the energy savings realized by free riders are not induced by the program, these savings should not be included in the estimates of the program's actual impacts. Without adjustment for free-ridership, some savings that would have occurred naturally would be attributed to the program. The measurement of the net impact of the program requires estimation of the marginal effect of the program over and above the "naturally occurring" patterns for installation and use of energy-efficient equipment.

Information collected from a sample of program participants during a telephone survey was used for the net-to-gross analysis. Based on review of this information, the preponderance of evidence about free-ridership inclinations was used to attribute a customer's savings to free-ridership.

3.1.1 Procedures for Estimating Free-Ridership

Several criteria were used for determining what portion of a customer's savings for a particular project should be attributed to free-ridership. The first criterion was based on the response to the question: "Would you have been financially able to install the equipment or measures without the financial incentive from the Building Efficiency Program?" If a customer answered "No" to this question, a free-ridership score of 0 was assigned to the project. That is, if a customer required financial assistance from the Building Efficiency Program to undertake a project, then that customer was judged to not be a free-rider.

For sites that indicated that they were able to undertake energy efficiency projects without financial assistance from the Building Efficiency Program, three criteria were applied to determine what percentage of savings should be attributed to free-ridership. The three criteria applied are essentially associated with the following factors that appear important as explainers of free-ridership:

- Previous experience of a firm with a measure installed under BE Program;
- Plans and intentions of firm to install a measure even without support from BE Program; and
- Influence that the BE Program had on the decision to install a measure.

For each of these factors rules were applied that provided a binary indicator of whether or not a participant's behavior showed free-ridership. These rules made use of answers to questions on the decision-makers survey questionnaire. (A copy of the questionnaire is provided as Appendix B.)

The first rule considered whether a participant in the BE Program indicated that he/she had previously installed an energy efficiency measure similar to one that they installed under the Building Efficiency Program. A participant indicating that he had installed a similar measure is considered to be showing free-ridership. Operationally, this meant using the answer to the following question on the decision-makers survey questionnaire as an indicator of free-ridership:

- "Before participating in the Building Efficiency Program, had you installed any equipment/measure similar to the measure for which you received a financial incentive from the Building Efficiency Program?"

This first rule therefore was used to create a Yes/No indicator variable for free-ridership behavior based on the answer to this question.

The second set of rules considered whether a participant stated that his/her intention was to install an energy efficiency measure even without the BE Program. The answers to a combination of two questions were used with this set of rules to determine whether a participant's behavior shows free-ridership.

- "Did you have plans to install the measure before participating in the BE Program?"
- If a customer answered "Yes" to the preceding question, the customer was then asked: "Would you have gone ahead with this planned installation of the measure even if you had not participated in the BE 0Program?"

The answers to these questions were used to create a Yes/No indicator variable as to whether the participant's plans and intentions show free-ridership behavior. For a participant who answers "Yes" to the two questions, the indicator variable for plans and

intentions is set to "Yes", indicating that the plans and intentions of the customer show free-ridership behavior.

The third set of rules considered whether a customer indicated that a recommendation from a BE Program representative (i.e., either the PMC or an ATAC) was influential in the decision to install a particular piece of equipment or measure. To gauge this influence, a decision-maker was asked the following questions:

- "How important was previous experience with the Building Efficiency Program in making your decision to install [Equipment/Measure]?
- "Did a representative of the Building Efficiency Program recommend that you install [Equipment/Measure]?"
- If a customer answered "Yes" to the second question, he/she was then asked: "If the representative had not recommended installing [Equipment/Measure], how likely is it that you would have installed [Equipment/Measure] anyway?"

Operationally, BE influence was considered to be measurable by a binary Yes/No indicator variable: Yes, BE Program did influence/No, BE Program did not have influence. Thus, if a customer answered "Very important" to the question of how important was previous experience, then the BE Program did have influence. Similarly, if a customer answered "Probably would not have installed" or "Definitely would not have installed" to the question of how likely they would have been to install the measure without the BE recommendation, then that customer is also considered to have been influenced by the program.

With respect to BE influence, a set of rules that considered partial free-ridership was also applied. That is, a participant whose savings might have been attributed to free-ridership by the previous set of rules might still have been induced by the program to install energy efficient equipment in greater numbers or of higher efficiency than he otherwise would have. That is, a participant could have installed equipment with higher efficiency than the baseline even without the incentive offered by the Building Efficiency Program but not as high as the efficiency actually installed because of the program's incentive. Moreover, the program might have induced the purchase and installation of energy efficient equipment earlier than otherwise was planned. Under these circumstances, part of the savings a participant realized with a measure could be attributed to the influence of the BE Program.

The three sets of rules just described produced three different indicator variables that address free-ridership behavior. For each customer, a free-ridership value was assigned to each factor and the sum of these values across the three factors was used as a free-ridership score for that customer. The values for the different indicator variables under this scoring scheme are shown in Table 3-1.

Table 3-1. Free-ridership Values for Equal Weighting of Indicator Variable Responses

Definition of Indicator Variable	***Free-ridership Value if Indicator Variable = "Y"***	***Free-ridership Value if Ind0icator Variable = "N"***
Before participating in the Building Efficiency Program, had you installed any equipment/measure similar to the measure for which you received a financial incentive from the Building Efficiency Program?"	0.33	0.00
Were customer's plans and intentions to install energy efficiency measures even without participation in BE Program?	0.33	0.00
Did the BE Program have an influence on customer's decision to install energy efficiency measure?	0.00	0.33

With three binary indicator variables, there were eight possible combinations for assigning free-ridership scores for each customer, depending on the combination of answers to the questions creating the indicator variables. Table 3-2 shows these values under the assumption that each indicator variable is given a free-ridership value of 1/3,.

Table 3-2. Free-ridership Scores for Combinations of Indicator Variable Responses

Indicator Variables			***Free-ridership Score***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program had influence on Decision to Install Measure?***	
No	No	Yes	0.00
No	No	No	0.33
No	Yes	Yes	0.33
Yes	No	Yes	0.33
No	Yes	No	0.67
Yes	Yes	Yes	0.67
Yes	No	No	0.67
Yes	Yes	No	1.00

As Table 3-2 shows, a customer who had previous experience with an energy efficiency measure, had plans/intentions to install the measure even without participation in the BE Program, and was not influenced in his decision by the BE Program would be assigned a free-ridership score of 1.00 (i.e., would be considered a complete free-rider).

3.1.2 Procedures for Estimating Spillover (Free-drivership)

With respect to spillover or free-drivership, the analysis focuses primarily on additional energy efficiency actions that participants might have undertaken at the same time or after their participation in the program that were caused primarily by the program, but for which they received no additional financial incentive. For example, after their experience with energy efficient lighting for which they received financial incentives through the program, some customers may have installed additional energy efficient lighting (as the need arose) that they would not have otherwise, but for which they did not seek additional incentives. Given that some program participants installed measures without receiving an incentive, the question associated with free-drivership impacts is the extent to which installation of these measures were induced by participation in the BE Program.

Participant free-drivership impacts could be associated with those program participants who had *not* previously installed energy efficient measures but who had installed some measures without incentives and indicated that the program had some influence on that decision. Information with which to assess the extent of such participant spillover effects was collected through the telephone survey of program participants. The answers to two were used in analyzing whether there were "free driver" effects associated with non-rebated purchases by program participants. These questions were as follows:

- Before you knew about the Energy Trust's energy efficiency incentive programs, had you purchased and installed any energy efficient equipment at this facility?
- Has your experience with the Business Efficiency Program led you to buy any energy efficient equipment for which you did not apply for a rebate?

If a participant answered "no" to the first question, and "yes" to the second question, the participant was considered to show some free-drivership.

Tabulation of the answers to these two questions from the decision-makers survey for this report allows the defining of a qualitative indication of possible free-drivership. A more quantitative estimation of free-drivership effects will be provided in the report for 2005 when the results of a billing analysis are provided. As part of that analysis, a follow-up survey will be made with 2004 and 2005 participants a year or two after their participation in the BE Program to determine whether they have installed any non-rebated energy efficiency measures. This information will allow more definitive identification and measurement for sites with spillover effects.

3.2 RESULTS OF NET SAVINGS ESTIMATION

The procedures described in the preceding section were used to estimate free-ridership rates and net-to-gross ratios for the Building Efficiency Program for 2004 and 2005.

3.2.1 Net Savings Estimation for 2004 BE Program

3.2.1.1 Free-ridership Estimates for 2004

The data used to assign free-ridership scores were collected through a telephone survey of 52 participants in the BE Program during 2004. These 52 respondents represented just over a tenth of the 488 program participants in 2004, but accounted for over a fourth of the expected kWh savings.

The free-ridership scoring procedure was applied to kWh savings projects both to all projects together and to projects by end use categories. Separate free-ridership rates were estimated for four categories of kWh savings projects:

- Lighting (including Custom Lighting, Custom Delamping, and Standard Lighting);
- HVAC (including Custom HVAC and Standard HVAC);
- Motors and VFD (including Custom Motors, Standard Motors, and Custom VFD); and
- Buildings and Other (including Custom Buildings and Custom Other).

The procedure was also applied to all gas-saving projects taken together.

As discussed in Section 3.1.1, the first criteria in determining what proportion of kWh savings from a project should be assigned to free-ridership was whether a participant was financially able to undertake the project without financial assistance from the BE Program. If a respondent to the decision-makers survey answered "No" to the question of "Would you have been financially able to install the equipment or measures without the financial incentive from the Building Efficiency Program?", a free-ridership score of 0 was assigned to the project. That is, if a participant did not require financial assistance from the Building Efficiency Program to undertake a project, then that participant was judged to not be a free-rider.

Under this criterion, the other free-ridership scoring criteria were applied only to projects for participants who answered "Yes" to the question: "Would you have been financially able to install the equipment or measures without the financial incentive from the Building Efficiency Program?" Participants who answered "Don't know" to this question were grouped with those participants who answered "No".

The results when the free-ridership scoring procedure was applied with these assumptions to kWh savings from all projects are presented in Table 3-3. The table shows how the realized gross kWh savings for all projects were distributed across the various combinations of free-ridership indicator variables and the resulting free-ridership percentages. For kWh savings from all projects, the free-ridership percentage is estimated to be 17.1% when the scoring procedure is applied only to projects where the survey

respondents answered that they would have been financially able to undertake the project without financial assistance from the BE Program.

Table 3-3. Estimated Free-ridership for kWh Savings from All Projects in 2004

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	56.9%	0.0%
No	No	Yes	0.00	5.8%	0.0%
No	No	No	0.33	15.6%	5.2%
No	Yes	Yes	0.33	6.4%	2.1%
Yes	No	Yes	0.33	1.5%	0.5%
No	Yes	No	0.67	4.9%	3.3%
Yes	Yes	Yes	0.67	8.7%	5.8%
Yes	Yes	No	1.00	0.1%	0.1%
Overall free-ridership rate:					17.0%

The free-ridership percentage as estimated in Table 3-3 groups together participants who answered "No" and "Don't know" to the question of whether they would have been financially able to install the equipment or measures without the financial incentive from the BE Program. Further analysis was undertaken to examine whether this assumption was warranted. This additional analysis included (1) calculating free-ridership percentages for each group using the experience-plans-influence criteria of the scoring procedure and (2) estimating the expected kWh savings for surveyed sites in the three groups.

The results of this additional analysis are presented in Table 3-4. In terms of both free-ridership percentage and expected kWh savings, sites where survey respondents answered "Don't know" to the financial ability question are more similar to sites where respondents answered "No" than to sites where respondents answered "Yes". Sites where survey respondents answered "No" or "Don't know" to the financial ability questions had lower free-ridership percentages and higher expected kWh savings than for sites where survey respondents answered "Yes" to the financial ability question.

When only respondents answering "Yes" to the financial ability question are considered, the free-ridership rate for all 2004 BE projects is estimated to be 17.0%. However, when respondents answering "Don't know" to the financial ability question are grouped with the "Yes" respondents, the estimated free-ridership rate is 26.5% (i.e., 17.0% + 9.5%).

Table 3-4. Comparison of Estimated Free-ridership for kWh Savings from All Projects in 2004 When Sites Are Categorized by Financial Ability to Install Energy Efficient Equipment/Measures without BE Financial Incentive

"Would have been financially able to install the equipment or measures without the financial incentive from the Building Efficiency Program"	***Percentage of Total Realized Gross kWh Savings***	***Free-ridership Percentage***	***Expected kWh Savings for Surveyed Sites***
Yes	43.1%	17.0%	87,992
No	37.8%	7.0%	309,563
Don't know	19.1%	9.5%	340,242

The results of this analysis should be kept in mind when reviewing the tabulations from the decision-makers survey that are presented in Chapter 4. Those tabulations are presented for the survey respondents as a whole and do not distinguish among respondents according to financial ability to undertake energy efficiency projects without financial assistance from the BE Program.

Based on the analysis reported in Table 3-3 for all projects, the free-ridership scoring procedure was applied to projects categorized by end use on the assumption that the free-ridership score was 0 for projects where survey respondents answered "No" or "Don't know" to the financial ability question. (Appendix E provides alternative estimates of free-ridership when respondents answering "Don't know" to the financial ability question are grouped instead with respondents answering "Yes".)

The results of applying the free-ridership scoring procedure to kWh savings from lighting projects are presented in Table 3-5. The table shows how the realized gross kWh savings for lighting projects were distributed across the various combinations of free-ridership indicator variables and the resulting free-ridership percentages. For lighting kWh savings, the free-ridership percentage is estimated to be 16.7%. The largest contribution to the overall rate (5.83%) comes from facilities that reported that they had previous experience with the measure they also installed through the BE program and that they had plans and intentions to install the measure even without the BE program, but that the BE program did have some influence on their decision.

Table 3-5. Estimated Free-ridership for kWh Savings from Lighting Projects in 2004

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross Lighting kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	64.04%	
No	No	Yes	0.00	0.56%	0.0%
No	No	No	0.33	13.89%	4.6%
No	Yes	Yes	0.33	4.96%	1.6%
Yes	No	Yes	0.33	2.06%	0.7%
No	Yes	No	0.67	2.16%	1.4%
Yes	Yes	Yes	0.67	12.17%	8.2%
Yes	No	No	0.67	0.00%	0.0%
Yes	Yes	No	1.00	0.15%	0.2%
Overall free-ridership rate:					16.7%

The results of applying the free-ridership scoring procedure to kWh savings from HVAC projects are presented in Table 3-6. The table shows how the realized gross kWh savings for HVAC projects were distributed across the various combinations of free-ridership indicator variables and the resulting free-ridership percentages. For HVAC kWh savings, the free-ridership percentage is estimated to be 22.6%. The largest contribution to the overall rate (14.9%) comes from facilities that reported that they had no previous experience with the measure they also installed through the BE program, but that they had plans and intentions to install the measure even without the BE program and the BE program did not have influence on their decision.

Table 3-6. Estimated Free-ridership for kWh Savings from HVAC Projects in 2004

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross HVAC kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	32.11%	0.0%
No	No	Yes	0.00	22.48%	0.0%
No	No	No	0.33	8.87%	3.0%
No	Yes	Yes	0.33	14.33%	4.7%
Yes	No	Yes	0.33	0.00%	0.0%
No	Yes	No	0.67	22.20%	14.9%
Yes	Yes	Yes	0.67	0.00%	0.0%
Yes	No	No	0.67	0.00%	0.0%
Yes	Yes	No	1.00	0.00%	0.0%
Overall free-ridership rate:					22.6%

The results of applying the free-ridership scoring procedure to kWh savings from motors and VFD projects are presented in Table 3-7. For kWh savings from motor and VFD projects, the free-ridership percentage is estimated to be 5.3%.

Table 3-7. Estimated Free-ridership for kWh Savings from Motors/VFD Projects in 2004

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross Motors & VFD kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	82.5%	0.0%
No	No	Yes	0.00	1.6%	0.0%
No	No	No	0.33	12.7%	4.2%
No	Yes	Yes	0.33	3.2%	1.1%
Yes	No	Yes	0.33	0.0%	0.0%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	0.0%	0.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					5.3%

The results of applying the free-ridership scoring procedure to kWh savings from custom building and custom other projects are presented in Table 3-8. For kWh savings from custom building and custom other projects, the free-ridership percentage is estimated to be 8.5%.

Table 3-8. Estimated Free-ridership for kWh Savings from Custom Building and Custom Other Projects in 2004

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross Buildings & Other kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	71.8%	0.0%
No	No	Yes	0.00	2.6%	0.0%
No	No	No	0.33	20.4%	6.8%
No	Yes	Yes	0.33	5.1%	1.7%
Yes	No	Yes	0.33	0.0%	0.0%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	0.0%	0.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					8.5%

The results of applying the free-ridership scoring procedure to projects that saved gas are presented in Table 3-9. For therm savings, the overall free-ridership percentage is estimated to be 35.3%. The largest contribution to the overall rate (16.90%) comes from facilities that reported that they had no previous experience with the measure they also installed through the BE program but that they had plans and intentions to install the measure even without the BE program and that the BE program did not influence their decision.

Table 3-9. Estimated Free-ridership for Therm Savings for Building Efficiency Improvement Projects in 2004

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross Therm Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	0.0%	0.0%
No	No	Yes	0.00	19.7%	0.0%
No	No	No	0.33	39.8%	13.3%
No	Yes	Yes	0.33	15.3%	5.1%
Yes	No	Yes	0.33	0.0%	0.0%
No	Yes	No	0.67	25.2%	16.9%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	0.0%	0.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					35.3%

The estimates of free-ridership developed for the various categories of energy efficiency improvement projects in the BE Program in 2004 are summarized in Table 3-10, along with the implied net-to-gross ratios.

Table 3-10. Summary of Estimated Free-ridership Rates and Implied Net-to-Gross Ratios by Category of Energy Efficiency Improvement Project

Category of Energy Efficiency Improvement Project	***Estimated Free-ridership Rate***	***Implied Net-to-Gross Ratios***
HVAC	22.6%	77.4%
Lighting	16.7%	83.3%
Motors and VFD	5.3%	94.7%
Building and Other	8.5%	91.5%
Gas	35.3%	64.7%

Estimates of the net realized savings for projects in the BE Program during 2004 were estimated by applying the net-to-gross ratios in Table 3-10 to the estimates of achieved gross program-level savings developed in Chapter 2. Estimated program-level achieved net savings are reported in Table 3-12 for kWh savings and in Table 3-13 for therm savings.

The implied overall net-to-gross ratio for kWh savings was 84.1%. Applying this ratio to the estimated achieved gross kW reductions of 6,213 kW implies estimated achieved net kW reductions of 5,226 kW

Table 3-11. Estimated Program-Level Achieved Net kWh Savings for Building Efficiency Projects in 2004

Type of Energy Efficiency Improvement	***Achieved Gross Program-Level kWh Savings***	***Net-to-Gross Ratio***	***Achieved Net Program-level kWh Savings***
HVAC			
Custom HVAC	8,422,338	77.4%	6,518,890
Standard HVAC	241,539	77.4%	186,951
Lighting			
Custom Lighting	8,561,746	83.3%	7,131,934
Custom Delamping	24,174	83.3%	20,137
Standard Lighting	11,350,934	83.3%	9,455,328
Motors			
Custom Motors	1,215,613	94.7%	1,151,186
Standard Motors	716,559	94.7%	678,581
Custom VFD	1,761,628	94.7%	1,668,262
Custom Building	4,231,915	91.5%	3,872,202
Custom Other	554,579	91.5%	507,440
Custom Gas	1,558	64.7%	1,008
Totals	37,082,583	84.1%	31,191,919

Table 3-12. Estimated Program-Level Achieved Net Therm Savings for Building Efficiency Projects in 2004

Type of Energy Efficiency Improvement	***Achieved Gross Program-Level Therm Savings***	***Net-to-Gross Ratio***	***Achieved Net Program-level kWh Savings***
Custom Building	4,705	64.7%	3,044
Custom HVAC	13,082	64.7%	8,464
Custom VFD	1,363	64.7%	882
Custom Other	25,090	64.7%	16,233
Custom Gas	36,581	64.7%	23,668
Totals	80,821	64.7%	52,291

2.2.2.4 Spillover or Free-Drivership Effects for 2004

As discussed in Section 3.1.2, answers to two questions on the survey of decision-makers were used in analyzing whether there were "free driver" effects associated with non-rebated purchases by BE Program participants. These questions were as follows:

- Before you knew about the Energy Trust's energy efficiency incentive programs, had you purchased and installed any energy efficient equipment at this facility?
- Has your experience with the Building Efficiency Program led you to buy any energy efficient equipment for which you did not apply for a rebate?

If a participant answered "no" to the first question, and "yes" to the second question, the participant was considered to show some free-drivership.

Table 3-13 shows how realized kWh savings for the BE Program in 2004 were distributed according to answers for these two questions. As can be seen, respondents who represented about 21.5% of total realized savings gave answers that were indicative of spillover effects (i.e., the no-yes combination).

Table 3-13. Responses from Survey of Decision-Makers for 2004 BE Projects Pertaining to Spillover Effects

Before you knew about the Energy Trust's energy efficiency incentive programs, had you purchased and installed any energy efficient equipment at this facility?	***Has your experience with the BE Program led you to buy any energy efficient equipment for which you did not apply for a rebate?***	***Percent of Population Realized kWh Savings***
Yes	Yes	11.68%
Yes	No	22.50%
Yes	Don't know	0.49%
No	Yes	21.52%
No	No	43.56%
No	Don't know	0.24%
		100.00%

3.2.2 Net Savings Estimation for 2005 BE Program

The procedures described in the preceding section were used to estimate free-ridership rates and net-to-gross ratios for the 2005 Building Efficiency Program. The data used to assign free-ridership scores were collected through a telephone survey of 90 participants in the BE Program during 2005. These 90 respondents represented just over a tenth of the 832 program participants in 2005, but accounted for over a fourth of the expected kWh savings.

The free-ridership scoring procedure was applied to kWh savings projects both to all projects together and to projects by end use categories. Separate free-ridership rates were estimated for four categories of kWh savings projects:

- Lighting (including Custom Lighting, Custom Delamping, and Standard Lighting);
- HVAC (including Custom HVAC and Standard HVAC);
- Motors (including Custom Motors and Standard Motors) and Custom VFD;
- Custom Buildings; and
- Custom Other.

The procedure was also applied to all gas-saving projects taken together.

3.2.3 Free-Ridership Estimates for All Projects Together

As discussed in Section 3.1.1, the first criteria in determining what proportion of kWh savings from a project should be assigned to free-ridership was whether a participant was financially able to undertake the project without financial assistance from the BE Program. If a respondent to the decision-makers survey answered "No" to the question of "Would you have been financially able to install the equipment or measures without the financial incentive from the Building Efficiency Program?", a free-ridership score of 0 was assigned to the project. That is, if a participant did not require financial assistance from the Building Efficiency Program to undertake a project, then that participant was judged to not be a free-rider.

Under this criterion, the other free-ridership scoring criteria were applied only to projects for participants who answered "Yes" to the question: "Would you have been financially able to install the equipment or measures without the financial incentive from the Building Efficiency Program?" Participants who answered "Don't know" to this question were grouped with those participants who answered "No".

The results when the free-ridership scoring procedure was applied with these assumptions to kWh savings from all projects for 2005 are presented in Table 3-14. The table shows how the realized gross kWh savings for all projects were distributed across the various combinations of free-ridership indicator variables and the resulting free-ridership percentages. For kWh savings from all projects, the free-ridership percentage is estimated to be 17.1% when the scoring procedure is applied only to projects where the survey respondents answered that they would have been financially able to undertake the project without financial assistance from the BE Program.

Table 3-14. Estimated Free-ridership for kWh Savings from All Projects in 2005

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	60.95%	0.0%
No	No	Yes	0.00	0.5%	0.0%
No	No	No	0.33	25.0%	8.3%
No	Yes	Yes	0.33	2.1%	0.7%
Yes	No	Yes	0.33	0.00%	0.0%
No	Yes	No	0.67	7.0%	4.7%
Yes	No	No	0.67	2.7%	1.8%
Yes	Yes	Yes	0.67	0.5%	0.4%
Yes	Yes	No	1.00	1.2%	1.2%
Overall free-ridership rate:					17.0%

The free-ridership percentage as estimated in Table 3-14 groups together participants who answered "No" and "Don't know" to the question of whether they would have been financially able to install the equipment or measures without the financial incentive from the BE Program. Further analysis was undertaken to examine whether this assumption was warranted. This additional analysis included (1) calculating free-ridership percentages for each group using the experience-plans-influence criteria of the scoring procedure and (2) estimating the expected kWh savings for surveyed sites in the three groups.

The results of this additional analysis are presented in Table 3-15. In terms of both free-ridership percentage and expected kWh savings, sites where survey respondents answered "Don't know" to the financial ability question are more similar to sites where respondents answered "No" than to sites where respondents answered "Yes". Sites where survey respondents answered "No" or "Don't know" to the financial ability questions had lower free-ridership percentages and higher expected kWh savings than for sites where survey respondents answered "Yes" to the financial ability question.

Table 3-15. Comparison of Estimated Free-ridership for kWh Savings from All Projects in 2005 When Sites Are Categorized by Financial Ability to Install Energy Efficient Equipment/Measures without BE Financial Incentive

"Would have been financially able to install the equipment or measures without the financial incentive from the Building Efficiency Program"	***Percentage of Total Realized Gross kWh Savings***	***Free-ridership Percentage***	***Average Expected kWh Savings for Surveyed Sites***
Yes	39.05%	17.0%	123,978
No	47.56%	10.3%	200,065
Don't know	12.62%	4.6%	170,617

The results of this analysis should be kept in mind when reviewing the tabulations from the decision-makers survey that are presented in Chapter 4. Those tabulations are presented for the survey respondents as a whole and do not distinguish among respondents according to financial ability to undertake energy efficiency projects without financial assistance from the BE Program.

3.2.4 Free-Ridership Estimates for End Use Categories

Based on the analysis reported in Table 3-14 for all projects, the free-ridership scoring procedure was applied to projects categorized by end use on the assumption that the free-ridership score was 0 for projects where survey respondents answered "No" or "Don't know" to the financial ability question.

The results of applying the free-ridership scoring procedure to kWh savings from lighting projects are presented in Table 3-16. The table shows how the realized gross kWh savings for lighting projects were distributed across the various combinations of free-ridership indicator variables and the resulting free-ridership percentages. For lighting kWh savings, the free-ridership percentage is estimated to be 22.0%. The largest contribution to the overall rate (5.61%) comes from facilities that reported that they had no previous experience with the measure they also installed through the BE program, that they had no plans and intentions to install the measure even without the BE program, and that the BE program did not have influence on their decision.

Table 3-16. Estimated Free-ridership for kWh Savings from Lighting Projects in 2005

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross Lighting kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	50.4%	0.0%
No	No	Yes	0.00	0.8%	0.0%
No	No	No	0.33	33.6%	11.2%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	0.0%	0.0%
No	Yes	No	0.67	7.6%	5.1%
Yes	Yes	Yes	0.67	0.9%	0.6%
Yes	No	No	0.67	4.6%	3.1%
Yes	Yes	No	1.00	2.0%	2.0%
Overall free-ridership rate:					22.0%

The results of applying the free-ridership scoring procedure to kWh savings from HVAC projects are presented in Table 3-17. The table shows how the realized gross kWh savings for HVAC projects were distributed across the various combinations of free-ridership indicator variables and the resulting free-ridership percentages. For HVAC kWh savings, the free-ridership percentage is estimated to be 13.1%.

Table 3-17. Estimated Free-ridership for kWh Savings from HVAC Projects in 2005

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross HVAC kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	60.0%	0.0%
No	No	Yes	0.00	2.4%	0.0%
No	No	No	0.167	36.0%	12.0%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	0.0%	0.0%
No	Yes	No	0.67	1.6%	1.1%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	0.0%	0.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					13.1%

The results of applying the free-ridership scoring procedure to kWh savings from motor and VFD projects are presented in Table 3-18. For kWh savings from motor and VFD projects, the free-ridership percentage is estimated to be 27.4%.

Table 3-18. Estimated Free-ridership for kWh Savings from Motor and VFD Projects in 2005

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross Motors & VFD kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	43.6%	0.0%
No	No	Yes	0.00	8.6%	0.0%
No	No	No	0.33	22.9%	7.6%
No	Yes	Yes	0.33	6.3%	2.1%
Yes	No	Yes	0.33	0.0%	0.0%
No	Yes	No	0.67	3.0%	2.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	0.0%	0.0%
Yes	Yes	No	1.00	15.7%	15.7%
Overall free-ridership rate:					27.4%

The results of applying the free-ridership scoring procedure to kWh savings from custom building projects are presented in Table 3-19. For kWh savings from custom building projects, the free-ridership percentage is estimated to be 0.00%.

Table 3-19. Estimated Free-ridership for kWh Savings from Custom Building Projects in 2005

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross Buildings kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	100.0%	0.0%
No	No	Yes	0.00	0.0%	0.0%
No	No	No	0.33	0.0%	0.0%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	0.0%	0.0%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	0.0%	0.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					0.0%

The results of applying the free-ridership scoring procedure to kWh savings from other custom projects are presented in Table 3-20. For kWh savings from other custom projects, the free-ridership percentage is estimated to be 8.86%.

Table 3-20. Estimated Free-ridership for kWh Savings from Other Custom Projects in 2005

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross Other kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	47.7%	0.0%
No	No	Yes	0.00	0.9%	0.0%
No	No	No	0.33	50.8%	16.9%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	0.0%	0.0%
No	Yes	No	0.67	0.6%	0.4%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	0.0%	0.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					17.3%

The results of applying the free-ridership scoring procedure to projects that saved gas are presented in Table 3-21. For therm savings, the overall free-ridership percentage is estimated to be 5.3%

Table 3-21. Estimated Free-ridership for Therm Savings for Building Efficiency Improvement Projects in 2005

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross Therm Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without BE Program?***	***BE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from BE Program			0.00	85.5%	0.0%
No	No	Yes	0.00	0.0%	0.0%
No	No	No	0.33	8.0%	2.7%
No	Yes	Yes	0.33	4.9%	1.6%
Yes	No	Yes	0.33	0.0%	0.0%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	1.5%	1.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					5.3%

The estimates of free-ridership developed for projects in the BE Program in 2005 are summarized for the various categories of energy efficiency improvement projects in Table 3-22, along with the implied net-to-gross ratios.

Table 3-22. Summary of Estimated Free-ridership Rates and Implied Net-to-Gross Ratios for 2005 BE Program by Category of Energy Efficiency Improvement Project

Category of Energy Efficiency Improvement Project	***Estimated Free-ridership Rate***	***Implied Net-to-Gross Ratios***
HVAC	13.1%	86.9%
Lighting	22.0%	78.0%
Motors and VFD	27.4%	72.6%
Building	0.0%	100.0%
Other	17.3%	82.7%
Gas	5.3%	94.7%

Estimates of the net realized savings for projects in the BE Program during 2005 were estimated by applying the net-to-gross ratios in Table 3-22 to the estimates of achieved gross program-level savings developed in Chapter 2. Estimated program-level achieved net savings are reported in Table 3-23 for kWh savings and in Table 3-24 for therm savings.

The implied overall net-to-gross ratio for kWh savings was 79.8%. Applying this ratio to the estimated achieved gross kW reductions of 18,183 kW implies estimated achieved net kW reductions of 14,516 kW

Table 3-23. Estimated Program-Level Achieved Net kWh Savings for Building Efficiency Projects in 2005

Type of Energy Efficiency Improvement	***Achieved Gross Program-Level kWh Savings***	***Net-to-Gross Ratio***	***Achieved Net Program-level kWh Savings***
HVAC			
Custom HVAC	6,130,167	86.9%	5,327,115
Standard HVAC	153,389	86.9%	133,295
Lighting			
Custom Lighting	19,292,755	78.0%	15,048,349
Custom Delamping	254,905	78.0%	198,826
Standard Lighting	10,075,446	78.0%	7,858,848
Motors			
Custom Motors	590,261	72.6%	428,529
Standard Motors	842,170	72.6%	611,415
Custom VFD	11,989,644	72.6%	8,704,482
Custom Building	4,483,509	100.0%	4,483,509
Custom Other	5,048,298	82.7%	4,174,942
Dishwashing	106,671	100.0%	106,671
Insulation	679	100.0%	679
Totals	58,967,894	79.8%	47,076,661

Table 3-24. Estimated Program-Level Achieved Net Therm Savings for Building Efficiency Projects in 2005

Type of Energy Efficiency Improvement	***Achieved Gross Program-Level Therm Savings***	***Net-to-Gross Ratio***	***Achieved Net Program-level Therm Savings***
Custom Gas	49,990	94.7%	47,341
Custom Building	54,108	94.7%	51,240
Custom HVAC	75,529	94.7%	71,526
Custom VFD	17,185	94.7%	16,274
Custom Other	20,924	94.7%	19,815
Boiler	4,243	94.7%	4,018
Dishwashing	12,144	94.7%	11,500
Food Service	10,512	94.7%	9,955
Furnace	1,213	94.7%	1,149
Gas heat	34,490	94.7%	32,662
Insulation	52,873	94.7%	50,071
Tankless	668	94.7%	633
Other	150	94.7%	142
Total	334,028	94.7%	316,325

2.2.2.5 Spillover or Free-Drivership Effects for 2005

As discussed in Section 3.1.2, answers to two questions on the survey of decision-makers were used in analyzing whether there were "free driver" effects associated with non-rebated purchases by BE Program participants. These questions were as follows:

- Before you knew about the Energy Trust's energy efficiency incentive programs, had you purchased and installed any energy efficient equipment at this facility?
- Has your experience with the Building Efficiency Program led you to buy any energy efficient equipment for which you did not apply for a rebate?

If a participant answered "no" to the first question, and "yes" to the second question, the participant was considered to show some free-drivership.

Table 3-25 shows how realized kWh savings for the BE Program were distributed according to answers for these two questions. As can be seen, respondents who represented about 21.4% of total realized savings gave answers that were indicative of spillover effects (i.e., the no-yes combination).

Table 3-25. Responses from Survey of Decision-Makers Pertaining to Spillover Effects for 2005 BE Program Participants

Before you knew about the Energy Trust's energy efficiency incentive programs, had you purchased and installed any energy efficient equipment at this facility?	***Has your experience with the BE Program led you to buy any energy efficient equipment for which you did not apply for a rebate?***	***Percent of Population Realized kWh Savings***
Yes	Yes	5.3%
Yes	No	17.2%
Yes	Don't know	0.0%
No	Yes	21.4%
No	No	50.7%
No	Don't know	5.4%
		100.00%

4. SURVEY OF DECISION-MAKERS

As part of the evaluation work effort, a survey was made of a sample of decision makers for facilities that participated in the Building Efficiency Program. That survey provided the information used in Chapter 3 to estimate free-ridership for projects in the BE Program during 2004 and 2005. However, the survey also provided more general information pertaining to the making of decisions to improve energy efficiency by program participants. An analysis of that information is presented and discussed in this chapter. Detailed tabulations of the data collected through the surveys of decision makers are provided in Appendix C.

4.1 SURVEY METHODOLOGY

The sample of participants to interview were selected through the sample design process discussed in Chapter 2. Table 4-1 reports the numbers of participants actually interviewed according to whether selected for the sample with certainty or non-certainty. Because of this stratification, different weights were assigned to respondents in the two strata to allow representation of the population of BE Program participants from which the respondents came. While the number interviewed represents about 11% of the number of participant sites in the BE Program during 2004, the sites for which interviews were conducted represented about 25% of the expected kWh savings for the program

Table 4-1. Distribution of Customer Interviews by Sample Selection Stratum

Sample Selection Stratum	***2004***		***2005***	
	Number in Population	***Number Interviewed***	***Number in Population***	***Number Interviewed***
Certainty	39	17	43	22
Non-certainty	449	35	715	68
All	488	52	758	90

Each participant was interviewed using the survey instrument provided in Appendix B. For those sites in the sample that received on-site visits, the interviews were conducted during the visits. For sites not visited, the interviews were conducted by telephone. During the interview, a participant was asked questions about (1) his/her general decision making regarding purchasing and installing energy efficient equipment, (2) his/her knowledge of and satisfaction with the Building Efficiency Program, and (3) the influence that the Building Efficiency Program had on his/her decision to install energy efficiency measures (e.g., lighting measures, HVAC measures,).

4.2 SUMMARY OF MAJOR FINDINGS FROM SURVEY OF DECISION MAKERS FOR 2004 BE PROGRAM PROJECTS

This section provides a summary of major findings from the survey of . (Appendix E provides question-by-question tabulations of the survey responses.) Based on a review of the survey tabulations, the following points can be made.

- Overall, respondents indicated a relatively high level of satisfaction with the BE Program. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, respondents representing 85% of participants and nearly 75 of realized kWh savings rated their overall satisfaction with the BE Program at either "4" or "5".
- Equipment vendors or contractors are the primary source by which participants in the program in 2004 learned about the program. Respondents representing 62% of participants and about 55% of realized kWh savings reported learning about the program primarily from equipment vendors or contractors. The second most-cited source for learning about the program was utility company representatives, being cited by respondents representing 16% of participants and about 48% of realized kWh savings.
- Incentive payments from Energy Trust of Oregon were important in decision making on energy efficiency improvements. Respondents representing 62% of participants and nearly 78% of realized kWh savings reported the incentive payments as being "Very Important" in their decision making.
- Survey responses indicate that a majority of participants would have been financially able to install the energy efficiency equipment for which they received a BE financial incentive even without that incentive. Respondents representing 69% of participants and 43% of realized kWh savings indicated that they had this financial ability. Moreover, respondents representing 18% of participants and 25% of realized kWh savings indicated that they "definitely" would have installed the energy efficiency equipment even without the BE financial incentive.
- Most participants are aware of the availability of Business Energy Tax Credits (BETC). Respondents representing about 75% of participants and nearly 96% of realized kWh savings reported being aware of BETC. However, when asked how important the BETC was in their decision making on energy efficiency improvements, a rating of "Very Important" was made only by respondents representing about 36% of participants and 58% of realized kWh savings.
- The Small Scale Energy Loan Program (SELP) appears to have low visibility. Familiarity with SELP was reported by respondents representing 13% of participants and 21% of realized kWh savings. No respondents reported SELP as being "Very Important" in their making decisions on energy efficiency improvements.

- Respondents representing 43% of participants and 77% of realized kWh savings reported having purchased and installed energy efficient equipment at their facility before they knew about the Building Efficiency Program.
- Respondents representing 55% of participants and 58% of realized kWh savings reported having plans to install the energy efficiency equipment for which they received a BE Program financial incentive before participating in the program. Moreover, respondents representing 42% of participants and 36% of realized kWh savings indicated that they would have gone ahead with their plans even if they had not participated in the BE Program.

4.3 SUMMARY OF MAJOR FINDINGS FROM SURVEY OF DECISION MAKERS FOR 2005 BE PROGRAM PROJECTS

This section provides a summary of major findings from the survey of decision makers for sites that participated in the BE Program in 2005. (Question-by-question tabulations of the survey responses are provided in Appendix E.) Based on a review of the survey tabulations, the following points can be made..

- Overall, respondents indicated a relatively high level of satisfaction with the BE Program. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, respondents representing 85% of participants and nearly 89% of realized kWh savings rated their overall satisfaction with the BE Program at either "4" or "5".
- Equipment vendors or contractors were the primary source by which participants in the program in 2005 learned about the program. Respondents representing 64% of participants and about 62% of realized kWh savings reported learning about the program primarily from equipment vendors or contractors. The second most-cited source for learning about the program was being directly approached by a representative of the BE Program, , being cited by respondents representing 15% of participants and about 13% of realized kWh savings.
- Incentive payments from Energy Trust of Oregon were important in decision making on energy efficiency improvements. Respondents representing 84% of participants and nearly 95% of realized kWh savings reported the incentive payments as being "Very Important" in their decision making.
- Survey responses indicate that a significant percentage of participants would have been financially able to install the energy efficiency equipment for which they received a BE financial incentive even without that incentive. Respondents representing 46% of participants and 38% of realized kWh savings indicated that they had this financial ability. Moreover, respondents representing 16% of participants and 7% of realized kWh savings indicated that they "definitely" would have installed the energy efficiency equipment even without the BE financial incentive.
- Most participants are aware of the availability of Business Energy Tax Credits (BETC). Respondents representing about 90% of participants and nearly 95% of

realized kWh savings reported being aware of BETC. When asked how important the BETC was in their decision making on energy efficiency improvements, a rating of "Very Important" was made by respondents representing about 57% of participants and 72% of realized kWh savings.

- The Small Scale Energy Loan Program (SELP) appears to have low visibility. Familiarity with SELP was reported by respondents representing 14% of participants and 3% of realized kWh savings. Respondents representing about 3% of participants and 0.13% of realized kWh savings reported SELP as being "Very Important" in their making decisions on energy efficiency improvements.
- Respondents representing 38% of participants and 51% of realized kWh savings reported having purchased and installed energy efficient equipment at their facility before they knew about the Building Efficiency Program.
- Respondents representing 65% of participants and 79% of realized kWh savings reported having plans to install the energy efficiency equipment for which they received a BE Program financial incentive before participating in the program. Moreover, respondents representing 31% of participants and 15% of realized kWh savings indicated that they would have gone ahead with their plans even if they had not participated in the BE Program.

5. FINDINGS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The major findings and recommendations from the study of the projects in the BE Program in 2004 and 2005 were as follows.

Discrepancies between expected and verified savings were examined on a site-by-site basis for a sample of projects.

- For lighting projects, the examination of individual sites focused on major discrepancies between expected and verified energy savings that could be attributed to (1) differences in the operating hours for the areas where the energy efficiency light fixtures were installed and (2) the use of fixture wattages that can be inconsistent from project to project. Data on operating hours for lighting were verified using monitored data, information obtained by interviewing facility personnel, and some physical evidence (e.g., posted operating hours of the facility). The monitored data revealed that in a majority of cases the difference between monitored and expected operating hours was at or less than 10% of the expected operating hours. Based on these results, it was concluded that the operating hours expected is highly consistent with the actual operating hours at the site.
- For HVAC, Building, and VFD measures, most discrepancies were found where engineering calculations were used to estimate the energy savings in lieu of modeling, especially for those projects where weather data was not used as the basis of calculations. In such instances, very broad assumptions were made, which may not be applicable or consistent year round. However, discrepancies of more than 10% were found only in 16 out 51 sites where HVAC, Building, Motor and VFD projects were implemented, and the majority of these discrepancies fall within the 10-30% range. The source of discrepancies cannot be generalized for these measures. However, it is recommended that all of the measures other than lighting projects be reviewed and analyzed on a case-by-case basis.
- Estimated realization rates for gas-saving 2005 BE projects, realization rates were lower than the realization rates for 2004 gas-saving projects or for electric-saving projects. Most of the gas-saving projects with lower realization rates were projects in which custom measures were installed to save gas. Because the measures were custom, the reasons for the lower realization rates differed case by case and no general reasons provide a complete explanation. However, in several cases it did appear that the heating usage estimated in this study through DOE-2 simulations was somewhat higher than had been used in developing the *ex ante* expected savings for the measures.

In general, the monitoring performed for the 2004 projects resulted in confirmation of the expected energy savings.

- The monitored data for lighting projects revealed that on average, the monitored data is consistent with the claimed hours.
- The monitored data for Building, HVAC and VFD projects confirmed the variation in operating loads introduced by the addition of the energy efficient hardware and/or improved control system.
- Although the monitored data is not used in the savings calculations, which rely more on DOE-2 modeling, it serves as a good confirmation that the system is operating as intended. It is recommended that monitoring be performed whenever possible for all measures as an additional confirmation that the system is functioning properly, especially where an Energy Management System that provides data trending is not available.

Gross savings were estimated using proven techniques, including engineering calculations using industry standards and verification of computer simulations developed by program contractors to determine energy savings. In addition, independent estimates of savings were developed through an analysis of billing data.. The analysis of billing data for a set of participants confirmed the engineering analyses in showing that reductions in electric and gas usage occurred after energy efficiency measures were installed. However, the analysis of electricity billing data showed reductions, particularly for larger users, that were larger than expected, suggesting that other factors were also working to reduce energy use. The analysis of gas billing data showed reductions in gas usage that were consistent with but somewhat lower than the reductions estimated through the engineering analysis.

Survey-based techniques for estimating free-ridership in a program were applied to the data collected through a telephone survey of decision-makers. Data collected through this survey were also used to assess qualitatively the extent of program spillover effects. Participants representing about 21.5% of realized kWh savings provided answers that indicated some spillover was occurring.

5.2 RECOMMENDATIONS

The following are the recommendations for future evaluation(s) of the BE Program:

- Wherever possible, short-term monitoring of HVAC equipment with variable loading conditions is recommended, particularly for equipment with large power draws (chillers, large fans and pumps). Short-term monitoring allows verification of claimed operating trends and setpoints.
- Time-of-use monitoring of the retrofitted lighting systems revealed that the differences between claimed and monitored operating hours were not significant. In

most cases, confirmation from the facility staff regarding operating hours would be sufficient. It is recommended that monitoring be done only for cases with is a significant discrepancy between hours claimed by the contractor and hours provided by the contact person at the time of the site visit.

- A standardized wattage information sheet or a look-up table should be made available to all participating lighting contractors. In many instances, contractors used different wattage values in calculating energy savings for the same type of fixture. Wherever possible, contractors should also be encouraged to indicate the type and characteristics of ballast (e.g. high efficiency, ballast factor, etc) and lamp (e.g. 700-series, 800-series, High Output, etc.) being installed and replaced.
- In most HVAC-related projects involving calculations of electricity savings, the project file included sufficient documentation to review and assess the methods used to arrive at the energy savings. Documentation on gas savings, however, was rather limited. In many of the files reviewed, it was not clear how the contractor arrived at the gas savings. It is recommended that Energy Trust encourage contractors to provide more detailed calculations methodology and assumptions used in the calculations of gas savings.
- In some typical projects involving large amounts of gas savings (installation of a Variable Frequency Drive on supply fans is one example), Energy Trust should consider standardizing the calculations. This requires development of automated calculators or look-up tables for the most common measures.
- In comparison to savings derived from DOE-2 simulations, it appears that the gas savings for VFD installations on supply fans were frequently overestimated. Although fan VFDs are very effective in reducing electricity consumption, they often do not provide as much reduction to heating energy consumption. In many instances, reconciliation with the claimed savings was not possible due to the lack of documentation on calculations methodology and assumptions.
- Due to fewer number of HVAC-related gas measures in comparison to those with electricity savings, it is recommended that the sample design for future program evaluations captures as much gas savings as possible in the Custom HVAC, Custom Building Controls, Custom VFD, Custom Gas and Custom Other measure categories.
- Energy Trust has worked to develop a standardized approach to estimating the net impacts of programs that can be applied across all programs being evaluated. However, there is not yet a standardized approach to estimating the participant and non-participant spillover effects of programs. Accordingly, another area of additional research is to develop and refine an approach to estimation of spillover. For example, a common approach to estimating spillover for nonresidential facilities is being developed by contractors to the California Public Utilities Commission who are conducting evaluations of the 2006-2008 energy efficiency programs that investor-owned utilities in California have implemented.

- To better quantify spillover savings, more effort should be made during site visits to collect spillover data for measures implemented in the program year(s) but not recorded in the project file. The collected information should be confirmed with the decision-maker during the interview to determine if the facility applied for a rebate from Energy Trust for the implemented measures.
- Peak kW savings data were not consistently available in the project files. If data on peak kW savings are of interest to the Energy Trust, it is recommended that Energy Trust develop guidelines for peak kW calculations and begin tracking peak kW savings on a consistent basis.
- In the billing analysis, to account for changes in the overall sales of electricity due to economic fluctuations in Oregon's commercial sector, it is recommended that future evaluation(s) consider analysis of billing data for non-participants.

APPENDIX A: ON-SITE DATA COLLECTION FORM

The form used for collecting data on-site is provided under separate cover.

APPENDIX B: QUESTIONNAIRE FOR DECISION MAKERS SURVEY

The questionnaire used for the survey of decision makers is provided under separate cover.

APPENDIX C: TABULATIONS OF DATA FROM SURVEYS OF DECISION MAKERS

This appendix provides tabulations of the data collected from the surveys of decision makers for projects in the 2004 and 2005 Building Efficiency Program.

C.1 TABULATIONS FOR PROJECTS IN PROGRAM YEAR 2004

Question-by-question tabulations of the survey responses from decision makers for projects in program year 2004 are presented in this section. Each table provides the responses to a question from the survey interview form (see Appendix B.) Each table shows the percentage distributions of respondents across response categories, with responses weighted so that respondents reflect the population in terms of both number of participants in the program and the realized kWh savings of these participants.

Q1. Compared to all other factors, how important is energy efficiency as a factor in planning your operations for this facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	48.17	75.77
	Somewhat important	40.84	19.87
	Only slightly important	10.99	4.36
	Not important at all	0.00	0.00
	Don't know	0.00	0.00
	Totals	100%	100%

Q2. Which of the following policies or procedures does your organization have in place regarding energy efficiency improvements at this facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Energy management plan	60.38	57.55
	Staff member responsible for energy and energy efficiency	35.31	40.67
	Corporate policies that incorporate energy efficiency in operations and procurement	11.18	30.46
	Other	3.57	9.00

Q3. How does your organization decide to make energy efficiency improvements for this facility? Is the decision:	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Made by one or two key people	62.06	58.94
	Based on staff recommendation to a decision maker	14.55	21.88
	Made by a group or committee	20.28	16.45
	Other	3.10	2.73
	Totals	100%	100%

Q4. What are the **primary sources** your organization relies on for **information** about energy efficient equipment, materials and design features?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Building Efficiency Program representative	31.74	45.59
	Utility company representative	30.99	55.60
	Brochure or advertisement	8.36	5.93
	Trade association or journals	16.44	29.90
	Friends and colleagues	10.24	19.36
	Architect, engineer or energy consultant	42.44	58.83
	Equipment vendor or building contractor	47.51	33.97
	Other	5.73	6.10

Q5. How important is **past experience with energy efficient equipment** in making your decision to install energy efficient equipment for this facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	45.54	62.52
	Somewhat important	38.21	35.38
	Only slightly important	8.36	0.87
	Not important at all	5.26	0.97
	Don’t know	2.63	0.25
	Totals	100%	100%

Q6. How important are **your organization's policies** in your decision making regarding energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	35.97	67.00
	Somewhat important	32.02	25.44
	Only slightly important	15.77	3.54
	Not important at all	16.24	4.02
	Totals	100%	100%

Q7. How important is **advice and/or recommendations received from your electric or gas utility** in your decision to purchase and install energy efficient equipment?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	24.79	42.72
	Somewhat important	53.71	48.24
	Only slightly important	13.61	7.35
	Not important at all	7.89	1.69
	Totals	100%	100%

Q8. How important is **advice and/or recommendations received from equipment vendors** in your decision making on energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	25.07	28.30
	Somewhat important	57.75	66.06
	Only slightly important	11.46	5.07
	Not important at all	5.73	0.57
	Totals	100%	100%

Q9. How important are incentive payments from The Energy Trust of Oregon in your decision making on energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	62.26	77.53
	Somewhat important	32.49	20.62
	Only slightly important	5.26	1.85
	Not important at all	0.00	0.00
	Total:	100%	100%

Q10. Are you familiar with the Oregon Business Energy Tax Credit (BETC)?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	75.40	95.93
	No	24.06	4.07
	Totals	100%	100%

If answered "Yes" to Q10, Q10.1. How important are BETC tax credits in your decision making on energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	36.25	57.65
	Somewhat important	27.70	25.53
	Only slightly important	5.26	0.51
	Not important at all	2.63	0.25
	Don't know/no answer	28.17	16.06
	Totals	100%	100%

Q11. Are you familiar with the Oregon Small Scale Energy Loan Program (SELP?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	12.87	21.33
	No	84.51	76.52
	Don't know	2.63	2.15
	Totals	100%	100%

If answered "Yes" to Q11, Q11.1 How important is SELP in your decision making on energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	0.0	0.00
	Somewhat important	2.63	5.19
	Only slightly important	3.10	1.73
	Not important at all	6.67	9.21
	Don't know/no answer	87.60	83.87
	Totals	100%	100%

Q12. Which financial methods does your organization typically use to evaluate energy efficiency improvements for your facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Initial cost	8.83	7.39
	Simple payback	41.03	49.66
	Internal rate of return	10.52	4.01
	Life cycle cost	13.61	10.60
	Other	2.63	0.40
	Don't know/no answer	23.38	27.95
	Totals	100%	100%

Q13. When you have to replace equipment at this facility, **how often** do you try to purchase and install **energy efficient equipment**?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Always	45.07	63.47
	Usually	46.10	26.96
	Sometimes	6.20	9.46
	Occasionally	0.00	0.00
	Never	2.63	0.12
	Totals	100%	100%

Q14. Has your company participated in any **other** energy efficiency incentive programs or received Oregon or federal tax credits for energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	The Energy Trust of Oregon's Production Efficiency Program	34.37	43.19
	Portland General Electric programs	15.49	27.31
	Pacific Power and Light programs	5.73	12.32
	BETC	14.28	34.71
	Small Scale Energy Loan Program (SELP)	2.63	1.35
	Northwest Natural Gas	3.57	11.81
	Other utility (	0.57	3.29
	Northwest Energy Efficiency Alliance	0.94	7.92
	None	49.20	25.58
	Other	3.10	5.66
	Don't Know	2.63	1.62

Q15. Before you knew about the Building Efficiency Program, had you purchased and installed any energy efficient equipment at this facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	43.39	77.23
	No	48.73	26.66
	Don't know	7.89	1.11
	Totals	100%	100%

Q16. Has your organization purchased any energy efficient equipment in the last two years for which you did not apply for a financial incentive through the Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Purchased energy efficient equipment but did not apply for financial incentive	27.42	35.60
	Applied for financial incentive on all of the energy efficient equipment purchased	12.40	20.88
	Applied but did not receive incentive	0.00	0.00
	Don't know	24.13	11.63
	No answer	36.05	31.89
	Totals	100%	100%

If answer to Q16 was "Purchased energy efficient equipment but did not apply for financial incentive", Q16.1.. If you purchased energy efficient equipment but did not apply for financial incentive, why didn't you apply for a financial incentive on that equipment?0	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Didn't know whether equipment qualified for financial incentives	5.73	1.61
	Didn't know about financial incentives until after equipment was purchased	3.10	5.25
	Didn't have time to complete paperwork for financial incentive application	4.04	9.93
	Paperwork for the financial incentive application was too much	2.63	0.39
	Financial incentive wasn't enough to bother with	3.57	10.33
	Other	2.63	0.25
	No answer	78.31	72.24
	Totals	100%	100%

Q17. Before participating in the Building Efficiency Program, had you installed any equipment/measure similar to [Rebated Equipment/Measure] at your facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	18.59	34.68
	No	81.41	65.32
	Totals	100%	100%

Q18. Did you have plans to install [Equipment/Measure] before participating in the program?0	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	55.12	58.46
	No	44.88	41.54
	Totals	100%	100%

If answered "Yes" to Q18, Q18.1 Would you have gone ahead with this planned installation even if you had not participated in the program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	42.25	35.70
	No	6.67	13.80
	Not applicable	51.08	50.51
	Totals	100%	100%

Q19. How important was previous experience with the Building Efficiency Program in making your decision to install [Equipment/Measure]?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	19.06	32.00
	Somewhat important	21.22	43.85
	Only slightly important	10.99	5.60
	Not important at all	24.13	7.59
	Don't know	24.60	10.95
	Totals	100%	100%

Q20. Did a representative of the Building Efficiency Program recommend that you install [Equipment/Measure]?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	71.36	69.26
	No	28.17	28.34
	Don't know	0.47	2.40
	Totals	100%	100%

If answered "Yes" to Q20, Q20.1 If the Building Efficiency Program representative had not recommended installing [Equipment/Measure], how likely is it that you would have installed [Equipment/Measure] anyway?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Definitely would have installed	6.20	13.75
	Probably would have installed	5.26	2.07
	Probably would not have installed	11.46	11.99
	Definitely would not have installed	2.63	0.33
	Don't know/no answer	74.46	71.86
	Totals	100%	100%

Q21. Would you have been financially able to install [Equipment/Measure] without the financial incentive from the Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	69.01	43.10
	No	19.06	37.84
	Don't know	11.93	19.06
	Totals	100%	100%

Q22. If the financial incentive from the Building Efficiency Program had not been available, how likely is it that you would have installed [Equipment/Measure] anyway?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Definitely would have installed	18.12	25.06
	Probably would have installed	29.11	33.48
	Probably would not have installed	36.05	27.52
	Definitely would not have installed	6.20	11.32
	Don't know	10.52	2.62
	Totals	100%	100%

Q23. How did the availability of information and financial incentives through the Building Efficiency Program affect the quantity (number of units) of [Equipment/Measure] that you purchased and installed?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Purchased and installed more equipment/measures than otherwise would have	27.89	36.93
	Did not affect quantity purchased and installed	63.75	49.85
	No answer	8.36	13.22
	Totals	100%	100%

Q24. How did the availability of information and financial incentives through the Building Efficiency Program affect the level of energy efficiency you chose for [Equipment/Measure]?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Efficiency of equipment was better than otherwise would have chosen	21.69	30.18
	Did not affect level of efficiency chosen for equipment	78.31	69.82
	Totals	100%	100%

Q25. How did the availability of information and financial incentives through the Building Efficiency Program affect the timing of your purchase and installation of [Equipment/Measure]?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Purchased and installed equipment/measure earlier than otherwise would have	42.72	47.71
	Did not affect timing of purchase and installation	57.28	52.29
	Totals	100%	100%

Q26. Did you receive an Oregon Business Tax Credit (BETC) for the measure?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	42.72	54.36
	No	32.21	29.37
	Don't know	25.07	16.27
	Totals	100%	100%

Q27. When considering the influence of BETC and the Energy Trust incentive on your decision to install the energy efficient equipment, would you say:	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	BETC had most influence	2.63	0.19
	Energy Trust incentive had most influence	39.82	53.44
	BETC and Energy Trust incentive had equal importance	32.96	37.64
	Combination of the BETC and the incentive had most influence	5.26	2.00
	Other	14.08	1.41
	No answer	5.26	5.31
	Totals	100%	100%

Q28. Did you obtain a SELP to finance the measure?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	0.00	0.00
	No	85.92	93.36
	Don't know	11.46	6.54
	No answer	2.63	0.11
	Totals	100%	100%

Q29. When considering the influence of SELP and the Energy Trust incentive on your decision to install the energy efficient equipment, would you say:	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	SELP had most influence	0.00	0.00
	Energy Trust incentive had most influence	48.17	70.23
	SELP and Energy Trust incentive had equal importance	0.00	0.00
	Combination of the SELP and the incentive had most influence	0.00	0.00
	Other	14.08	2.96
	No answer	37.74	26.81
	Totals	100%	100%

Q30. How did you learn of the Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Approached directly by representative of Building Efficiency Program	2.63	5.19
	Saw information brochure on Building Efficiency Program	1.88	6.56
	Utility company representative mentioned (e.g., PGE, PacifiCorp, NW Natural Gas)	16.44	47.87
	Energy Trust website	1.88	18.67
	Trade association (e.g., BOMA)	2.63	1.21
	Friends and colleagues (i.e., word of mouth)	11.46	9.70
	Architect, engineer or energy consultant	12.40	20.39
	Equipment vendor or building contractor	62.06	54.90
	Other	10.52	2.86

Q31. When did you learn of the Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Had participated in other energy efficiency incentive programs	9.02	35.98
	Before planning for replacing the equipment began	31.27	26.50
	During our planning to replace the equipment	46.10	22.80
	Once equipment had been specified but not yet installed	2.63	0.33
	After equipment was installed	0.00	0.00
	Other or don't know	5.73	10.14
	No answer	5.26	4.25
	Totals	100%	100%

Q32. How helpful were the representatives for the Building Efficiency Program in answering questions and providing professional support?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very helpful	46.76	61.74
	Somewhat helpful	26.95	32.92
	Not very helpful	2.63	0.79
	Not at all helpful	5.26	0.35
	Don't know	15.77	4.09
	No answer	2.63	0.12
	Totals	100%	100%

Q33. Has your experience with the Building Efficiency Program led you to buy any energy efficient equipment for which you did not apply for a financial incentive?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	21.22	33.21
	No	70.89	66.06
	Don't know	7.89	0.73
	Totals	100%	100%

Q34. Given your experience with the Building Efficiency Program, would you buy energy efficient equipment in the future even if financial incentives for such equipment were not being offered through the Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	71.83	82.38
	No	1.41	8.63
	Don't know	26.76	8.99
	Totals	100%	100%

Q35A. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the performance of equipment installed?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	6.67	10.85
	2.	2.63	5.19
	3.	5.26	6.83
	4.	32.49	19.82
	5. Very satisfied	52.96	57.31
	Totals	100%	100%

Q35B. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the savings on monthly bill?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	4.04	10.73
	2.	2.63	0.25
	3.	15.77	11.91
	4.	22.44	17.39
	5. Very satisfied	30.52	45.75
	Don't know or no answer	24.60	13.97
	Totals	100%	100%

Q35C. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the incentive amount?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	6.67	10.85
	2.	0.00	0.00
	3.	16.24	12.21
	4.	32.96	26.60
	5. Very satisfied	41.50	50.09
	Don't know or no answer	2.63	0.24
	Totals	100%	100%

Q35D. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the application process?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	5.73	5.42
	2.	1.41	10.53
	3.	24.60	20.64
	4.	34.37	35.17
	5. Very satisfied	26.01	26.23
	Don't know or no answer	7.89	2.00
	Totals	100%	100%

Q35E. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the information provided by the contractor?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	6.67	10.85
	2.	7.89	6.67
	3.	8.36	6.62
	4.	31.27	31.14
	5. Very satisfied	43.19	44.32
	Don't know or no answer	2.63	0.40
	Totals	100%	100%

Q35F. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the quality of the work conducted by the contractor?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	9.30	11.10
	2.	2.63	5.19
	3.	10.52	8.40
	4.	17.65	22.75
	5. Very satisfied	49.39	47.68
	Don't know or no answer	10.52	0.24
	Totals	100%	100%

Q35G. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the overall program experience?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	6.67	10.85
	2.	0.00	0.00
	3.	8.36	10.87
	4.	43.47	31.59
	5. Very satisfied	41.50	46.69
	Don't know or no answer	0.00	0.00
	Totals	100%	100%

Q37. Did you interact with the Energy Trust or program staff more than once?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	47.70	66.43
	No	41.31	26.91
	Don't know	5.26	0.49
	No answer	5.73	6.18
	Totals	100%	100%

Q38A. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the courtesy of Energy Trust or PMC staff on the phone?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	4.04	10.73
	2.	0.00	0.00
	3.	3.10	9.65
	4.	16.71	13.98
	5. Very satisfied	50.61	53.07
	Don't know or no answer	25.54	12.56
	Totals	100%	100%

Q38B. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the helpfulness of Energy Trust or PMC staff on the phone?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	4.04	10.73
	2.	0.00	0.00
	3.	3.10	9.65
	4.	19.81	19.84
	5. Very satisfied	44.88	45.60
	Don't know or no answer	28.17	14.17
	Totals	100%	100%

Q38C. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the knowledge of Energy Trust or PMC staff of the program service?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	4.04	10.73
	2.	0.00	0.00
	3.	6.20	15.54
	4.	18.87	11.50
	5. Very satisfied	45.35	49.67
	Don't know or no answer	25.54	12.56
	Totals	100%	100%

Q38D. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the ease of transactions with Energy Trust or PMC staff?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	4.04	10.73
	2.	0.47	5.10
	3.	8.83	13.30
	4.	28.17	25.52
	5. Very satisfied	32.96	32.78
	Don't know or no answer	25.54	12.56
	Totals	100%	100%

Q38E. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with Energy Trust or PMC staff on any issue that needed resolution?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	3.10	5.30
	2.	0.00	0.00
	3.	6.67	18.37
	4.	11.46	12.39
	5. Very satisfied	44.41	43.04
	Don't know or no answer	35.36	20.89
	Totals	100%	100%

C.2 TABULATIONS FOR PROJECTS IN PROGRAM YEAR 2005

Question-by-question tabulations of the survey responses from decision makers for projects in program year 2005 are presented in this section. Each table provides the responses to a question from the survey interview form (see Appendix B.) Each table shows the percentage distributions of respondents across response categories, with

responses weighted so that respondents reflect the population in terms of both number of participants in the program and the realized kWh savings of these participants.

Q1. Compared to all other factors, how important is energy efficiency as a factor in planning your operations for this facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	70.97	83.35
	Somewhat important	27.65	15.75
	Only slightly important	1.39	0.89
	Not important at all	0.00	0.00
	Don't know	0.00	0,00
	Totals	100%	100%

Q2. Which of the following policies or procedures does your organization have in place regarding energy efficiency improvements at this facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Energy management plan	28.68	40.64
	Staff member responsible for energy and energy efficiency	43.94	35.76
	Corporate policies that incorporate energy efficiency in operations and procurement	26.77	32.21
	Other	17.42	16.32

Q3. How does your organization decide to make energy efficiency improvements for this facility? Is the decision:	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Made by one or two key people	75.48	69.75
	Based on staff recommendation to a decision maker	6.84	15.95
	Made by a group or committee	5.19	10.83
	Other	11.10	1.14
	No answer	1.39	2.33
	Totals	100%	100%

Q4. What are the **primary sources** your organization relies on for **information** about energy efficient equipment, materials and design features?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Building Efficiency Program representative	26.42	35.18
	Utility company representative	31.97	51.85
	Brochure or advertisement	21.48	28.73
	Trade association or journals	24.00	26.58
	Friends and colleagues	30;16	22.55
	Architect, engineer or energy consultant	29.45	40.94
	Equipment vendor or building contractor	70.81	73.79
	Other	5.55	2.75

Q5. How important is **past experience with energy efficient equipment** in making your decision to install energy efficient equipment for this facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	58.84	60.54
	Somewhat important	35.35	34.81
	Only slightly important	3.03	3.85
	Not important at all	1.39	0.66
	Don’t know/no answer	1.39	0.13
	Totals	100%	100%

Q6. How important are **your organization's policies** in your decision making regarding energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	50.26	63.41
	Somewhat important	35.61	28.96
	Only slightly important	8.32	6.06
	Not important at all	4.42	1.52
	Don't know/no answer	1.39	0.05
	Totals	100%	100%

Q7. How important is **advice and/or recommendations received from your electric or gas utility** in your decision to purchase and install energy efficient equipment?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	44.71	57.81
	Somewhat important	50.87	41.68
	Only slightly important	4.16	0.51
	Not important at all	0.26	0.00
	Totals	100%	100%

Q8. How important is **advice and/or recommendations received from equipment vendors** in your decision making on energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	42.03	45.90
	Somewhat important	57.45	53.38
	Only slightly important	0.52	0.72
	Not important at all	0.00	0.00
	Totals	100%	100%

Q9. How important are incentive payments from The Energy Trust of Oregon in your decision making on energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	83.97	94.69
	Somewhat important	14.39	4.77
	Only slightly important	0.26	0.00
	Not important at all	1.39	0.54
	Total:	100%	100%

Q10. Are you familiar with the Oregon Business Energy Tax Credit (BETC)?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	89.77	94.80
	No	9.97	5.20
	Don't know/no answer	0.26	0.00
	Totals	100%	100%

If answered "Yes" to Q10, Q10.1. How important are BETC tax credits in your decision making on energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	57.45	72.02
	Somewhat important	17.68	10.00
	Only slightly important	0.00	0.00
	Not important at all	5.81	2.58
	Don't know/no answer	19.07	1.74
	Totals	100%	100%

Q11. Are you familiar with the Oregon Small Scale Energy Loan Program (SELP?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	14.39	3.04
	No	85.10	91.44
	Don't know	0.52	5.51
	Totals	100%	100%

If answered "Yes" to Q11, Q11.1 How important is SELP in your decision making on energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	2.77	0.13
	Somewhat important	1.39	0.05
	Only slightly important	1.39	0.22
	Not important at all	7.45	2.15
	Don't know/no answer	87.00	97.45
	Totals	100%	100%

Q12. Which financial methods does your organization typically use to evaluate energy efficiency improvements for your facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Initial cost	43.68	30.60
	Simple payback	60.74	74.59
	Internal rate of return	20.45	27.91
	Life cycle cost	8.84	6.73
	Other	1.39	0.04
	Don't know/no answer	4.16	1.36
	Totals	100%	100%

Q13. When you have to replace equipment at this facility, **how often** do you try to purchase and install **energy efficient equipment**?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Always	40.03	43.33
	Usually	45.58	40.47
	Sometimes	9.97	9.08
	Occasionally	1.39	1.21
	Never	1.65	5.08
	Don't know/no answer	1.39	0.84
	Totals	100%	100%

Q14. Has your company participated in any **other** energy efficiency incentive programs or received Oregon or federal tax credits for energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	The Energy Trust of Oregon's Production Efficiency Program	23.39	33.29
	Portland General Electric programs	12.90	27.86
	Pacific Power and Light programs	9.35	14.26
	BETC	25.39	25.89
	Small Scale Energy Loan Program (SELP)	2.77	0.13
	Northwest Natural Gas	4.94	3.20
	Other utility	0.00	0.00
	Northwest Energy Efficiency Alliance	6.32	4.35
	None	43.78	32.11
	Other	3.29	2.34
	Don't Know	14.65	15.21

Q15. Before you knew about the Building Efficiency Program, had you purchased and installed any energy efficient equipment at this facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	37.52	50.96
	No	60.58	39.40
	Don't know	1.90	9.64
	Totals	100%	100%

Q16. Has your organization purchased any energy efficient equipment in the last two years for which you did not apply for a financial incentive through the Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Purchased energy efficient equipment but did not apply for financial incentive	18.71	20.24
	Applied for financial incentive on all of the energy efficient equipment purchased	19.84	22.02
	Applied but did not receive incentive	0.00	0.00
	Don't know	60.07	57.10
	No answer	1.39	0.64
	Totals	100%	100%

If answer to Q16 was "Purchased energy efficient equipment but did not apply for financial incentive", Q16.1.. If you purchased energy efficient equipment but did not apply for financial incentive, why didn't you apply for a financial incentive on that equipment?0	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Didn't know whether equipment qualified for financial incentives	4.16	0.04
	Didn't know about financial incentives until after equipment was purchased	3.55	6.33
	Didn't have time to complete paperwork for financial incentive application	2.16	4.34
	Paperwork for the financial incentive application was too much	1.39	0.51
	Financial incentive wasn't enough to bother with	1.65	1.44
	Other	1.39	0.12
	No answer	85.71	87.22
	Totals	100%	100%

Q17. Before participating in the Building Efficiency Program, had you installed any equipment/measure similar to [Rebated Equipment/Measure] at your facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	19.84	21.58
	No	76.87	76.12
	Don't know/no answer	3.29	2.30
	Totals	100%	100%

Q18. Did you have plans to install [Equipment/Measure] before participating in the program?0	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	64.65	78.84
	No	33.71	20.33
	Don't know/no answer	1.65	0.84
	Totals	100%	100%

If answered "Yes" to Q18, Q18.1 Would you have gone ahead with this planned installation even if you had not participated in the program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	31.29	14.87
	No	9.87	18.38
	Not applicable	58.84	66.76
	Totals	100%	100%

Q19. How important was previous experience with the Building Efficiency Program in making your decision to install [Equipment/Measure]?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	25.55	41.29
	Somewhat important	26.00	18.34
	Only slightly important	5.55	1.36
	Not important at all	17.42	18.52
	Don't know	18.29	17.42
	No answer	7.19	3.08
	Totals	100%	100%

Q20. Did a representative of the Building Efficiency Program recommend that you install	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***

[Equipment/Measure]?	Yes	77.65	79.39
	No	17.94	17.97
	Don't know/no answer	4.42	2.64
	Totals	100%	100%

If answered "Yes" to Q20, Q20.1 If the Building Efficiency Program representative had not recommended installing [Equipment/Measure], how likely is it that you would have installed [Equipment/Measure] anyway?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Definitely would have installed	2.77	3.82
	Probably would have installed	4.16	0.82
	Probably would not have installed	10.48	11.84
	Definitely would not have installed	1.65	1.46
	Don't know/no answer	80.94	82.05
	Totals	100%	100%

Q21. Would you have been financially able to install [Equipment/Measure] without the financial incentive from the Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	45.94	38.31
	No	37.77	47/87
	Don't know	13.26	12.33
	No answer	3.03	1.48
	Totals	100%	100%

Q22. If the financial incentive from the Building Efficiency Program had not been available, how likely is it that you would have installed [Equipment/Measure] anyway?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Definitely would have installed	15.52	7.32
	Probably would have installed	34.23	41.01
	Probably would not have installed	42.55	45.62
	Definitely would not have installed	4.68	4.57
	Don't know/no answer	3.03	1.48
	Totals	100%	100%

Q23. How did the availability of information and financial incentives through the Building Efficiency Program affect the quantity (number of units) of [Equipment/Measure] that you purchased and installed?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Purchased and installed more equipment/measures than otherwise would have	23.13	33.84
	Did not affect quantity purchased and installed	73.84	64.68
	No answer	3.03	1.48
	Totals	100%	100%

Q24. How did the availability of information and financial incentives through the Building Efficiency Program affect the level of energy efficiency you chose for [Equipment/Measure]?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Efficiency of equipment was better than otherwise would have chosen	20.45	16.71
	Did not affect level of efficiency chosen for equipment	74.61	78.47
	Don't know/no answer	4.94	4.82
	Totals	100%	100%

Q25. How did the availability of information and financial incentives through the Building Efficiency Program affect the timing of your purchase and installation of [Equipment/Measure]?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Purchased and installed equipment/measure earlier than otherwise would have	32.84	34.14
	Did not affect timing of purchase and installation	64.13	65.00
	Don't know/no answer	3.03	0.86
	Totals	100%	100%

Q26. Did you receive an Oregon Business Tax Credit (BETC) for the measure?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	61.10	57.17
	No	20.71	17.73
	Don't know/no answer	18.19	25.10
	Totals	100%	100%

Q27. When considering the influence of BETC and the Energy Trust incentive on your decision to install the energy efficient equipment, would you say:	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	BETC had most influence	2.77	6.94
	Energy Trust incentive had most influence	38.90	37.81
	BETC and Energy Trust incentive had equal importance	31.55	27.96
	Combination of the BETC and the incentive had most influence	19.58	26.43
	Other	4.16	0.02
	No answer	3.03	0.84
	Totals	100%	100%

Q28. Did you obtain a SELP to finance the measure?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	1.39	0.09
	No	68.45	75.48
	Don't know	6.06	7.50
	No answer	24.10	16.93
	Totals	100%	100%

Q29. When considering the influence of SELP and the Energy Trust incentive on your decision to install the energy efficient equipment, would you say:	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	SELP had most influence	1.39	0.09
	Energy Trust incentive had most influence	31.97	36.83
	SELP and Energy Trust incentive had equal importance	2.77	3.96
	Combination of the SELP and the incentive had most influence	1.39	0.03
	Other	1.65	0.14
	No answer	60.84	58.95
	Totals	100%	100%

Q30. How did you learn of the Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Approached directly by representative of Building Efficiency Program	14.90	12.62
	Saw information brochure on Building Efficiency Program	2.68	13.85
	Utility company representative mentioned (e.g., PGE, PacifiCorp, NW Natural Gas)	13.77	29.58
	Energy Trust website	4.68	11.16
	Trade association (e.g., BOMA)	3.29	7.12
	Friends and colleagues (i.e., word of mouth)	12.13	11.16
	Architect, engineer or energy consultant	11.77	21.69
	Equipment vendor or building contractor	64.39	62.10
	Other	5.81	3.28

Q31. When did you learn of the Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Had participated in other energy efficiency incentive programs	19.58	26.30
	Before planning for replacing the equipment began	45.32	42.36
	During our planning to replace the equipment	30.94	29.93
	Once equipment had been specified but not yet installed	0.00	0.00
	After equipment was installed	0.00	0.00
	Other or don't know	2.77	1.36
	No answer	1.39	0.05
	Totals	100%	100%

Q32. How helpful were the representatives for the Building Efficiency Program in answering questions and providing professional support?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very helpful	67.68	77.14
	Somewhat helpful	22.10	18.70
	Not very helpful	0.52	2.60
	Not at all helpful	1.39	0.02
	Don't know	8.32	1.53
	Totals	100%	100%

Q33. Has your experience with the Building Efficiency Program led you to buy any energy efficient equipment for which you did not apply for a financial incentive?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	20.71	26.62
	No	68.19	68.04
	Don't know	8.32	4.48
	No answer	2.77	0.86
	Totals	100%	100%

Q34. Given your experience with the Building Efficiency Program, would you buy energy efficient equipment in the future even if financial incentives for such equipment were not being offered through the Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	65.77	68.76
	No	9.10	5.32
	Don't know	23.74	25.90
	No answer	1.39	0.02
	Totals	100%	100%

Q35A. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the performance of equipment installed?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	1.65	1.90
	2.	5.81	2.19
	3.	3.03	4.65
	4.	12.13	23.77
	5. Very satisfied	73.23	65.32
	Don't know/no answer	4.16	2.17
	Totals	100%	100%

Q35B. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the savings on monthly bill?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	0.00	0.00
	2.	6.32	8.56
	3.	5.81	2.76
	4.	24.36	20.14
	5. Very satisfied	42.19	52.43
	Don't know/no answer	21.33	16.11
	Totals	100%	100%

Q35C. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the incentive amount?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	0.00	0.00
	2.	5.81	2.19
	3.	12.13	11.10
	4.	19.32	9.06
	5. Very satisfied	59.97	75.53
	Don't know/no answer	2.77	2.12
	Totals	100%	100%

Q35D. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the application process?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	0.26	0.72
	2.	3.03	2.03
	3.	19.32	20.55
	4.	23.74	17.19
	5. Very satisfied	49.48	53.05
	Don't know/no answer	4.16	6.45
	Totals	100%	100%

Q35E. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the information provided by the contractor?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	1.39	0.02
	2.	6.06	4.07
	3.	11.87	16.15
	4.	24.52	18.74
	5. Very satisfied	48.97	58.18
	Don't know/no answer	7.20	2.84
	Totals	100%	100%

Q35F. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the quality of the work conducted by the contractor?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	0.00	0.00
	2.	5.81	2.19
	3.	6.06	14.02
	4.	24.87	24.92
	5. Very satisfied	54.94	56.24
	Don't know/no answer	8.32	2.64
	Totals	100%	100%

Q35G. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the overall program experience?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	1.39	0.02
	2.	7.45	4.18
	3.	4.42	4.86
	4.	28.42	35.51
	5. Very satisfied	56.94	53.53
	Don't know or no answer	1.39	1.90
	Totals	100%	100%

Q37. Did you interact with the Energy Trust or program staff more than once?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	50.68	74.03
	No	42.13	22.54
	Don't know	4.16	1.79
	No answer	3.03	1.65
	Totals	100%	100%

Q38A. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the courtesy of Energy Trust or PMC staff on the phone?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	0.00	0.00
	2.	4.42	2.15
	3.	1.90	3.26
	4.	3.81	13.59
	5. Very satisfied	43.58	56.57
	Don't know/no answer	46.29	24.44
	Totals	100%	100%

Q38B. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the helpfulness of Energy Trust or PMC staff on the phone?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	1.39	0.11
	2.	4.68	4.03
	3.	0.26	1.27
	4.	5.71	16.36
	5. Very satisfied	40.29	49.97
	Don't know/no answer	47.67	28.26
	Totals	100%	100%

Q38C. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the knowledge of Energy Trust or PMC staff of the program service?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	0.00	0.00
	2.	4.68	4.03
	3.	0.52	1.99
	4.	8.58	10.34
	5. Very satisfied	39.93	59.20
	Don't know/no answer	46.29	24.44
	Totals	100%	100%

Q38D. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with the ease of transactions with Energy Trust or PMC staff?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	1.39	0.11
	2.	4.94	4.75
	3.	3.55	5.87
	4.	13.77	15.16
	5. Very satisfied	30.06	49.67
	Don't know/no answer	46.29	24.48
	Totals	100%	100%

Q38E. On a scale of 1 to 5, where "5" is very satisfied and "1" is very unsatisfied, how would you rate your satisfaction with Energy Trust or PMC staff on any issue that needed resolution?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	1. Very unsatisfied	1.39	0.11
	2.	4.94	4.75
	3.	3.55	5.92
	4.	10.48	11.65
	5. Very satisfied	33.10	53.13
	Don't know or no answer	46.55	24.44
	Totals	100%	100%

APPENDIX D: COMPARISON OF MONITORED AND EXPECTED HOURS OF USE FOR LIGHTING

This appendix provides a comparison of monitored and expected hours of use for the samples of 2004 and 2005 lighting projects for which monitoring was conducted.

Figure D-1 shows graphically the relationships between monitored and expected hours of use for the 27 lighting projects that were monitored from the 2004 BE program and for the 15 lighting monitoring projects from 2005. Visually, the relationships between monitored and expected hours of use appear similar between the 2004 projects and the 2005 projects.

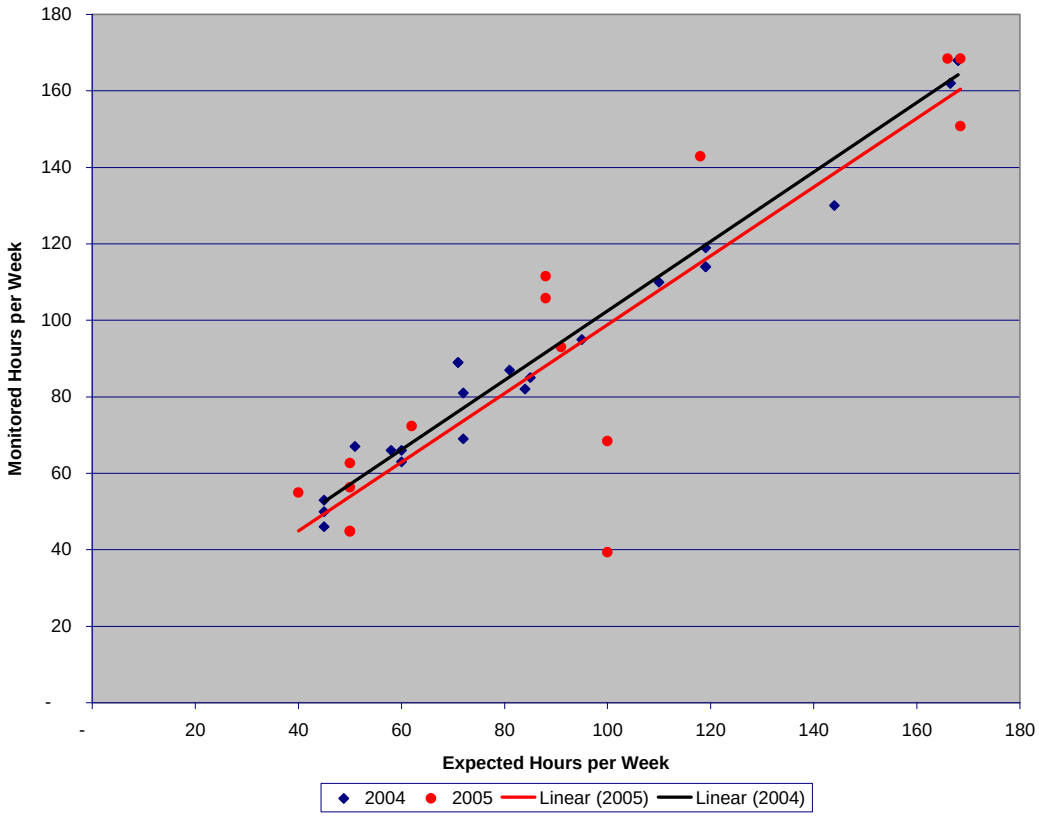

Figure D-1. Comparison of Monitored versus Expected Hours of Use for Lighting Projects Monitored from 2004 and 2005 BE Program with Separate Regression Lines for 2004 and 2005

Regression equations fitted to the two subsets of data provided the following results.

- For the monitored projects from the 2004 BE program, the fitted regression is: monitored hours per week = 11.74 + 0.908 x expected hours per week, with R^2 = 0.98.

- For the monitored projects from the 2005 BE program, the fitted regression is: monitored hours per week = 8.96 + 0.8995 x expected hours per week, with R^2 = 0.77.

To test whether the regression for the two sets of data are different, a regression was run over all data points but with dummy variables used to identify whether the intercept or slope for the regression line for the 2005 data points were different from the intercept and slope for the 2004 data points. The results of this regression, which are shown in Table D-1, indicated that there intercept and slope for the regression line fitted to the 2005 data points are not statistically different from the intercept and slope for the 2004 data points.

Table D-1. Results for Regression Analysis to Test Differences between Regression Lines for 2004 and 2005 Data Points

	Estimated Coefficients	***Standard Error***	***t Stat***	***P-value***
Intercept	11.740	6.800	1.726	0.092
Expected hours per week	0.908	0.060	15.007	0.000
Dummy for 2005 data points	(2.785)	10.975	(0.254)	0.801
Dummy*Expected hours	(0.008)	0.104	(0.077)	0.939
Number of observations: 42		R-squared: 0.901		

Because there was no statistically significant difference between the regression lines for the two sets of data points, a single regression was fitted over the combined set of data points. The results of that regression are reported in Table D-2 and shown graphically in Figure D-2.

Table D-2. Results for Regression Analysis of Combined Set of Monitored Lighting Data Points for 2004 and 2005

	Estimated Coefficients	***Standard Error***	***t Stat***	***P-value***
Intercept	10.341	5.225	1.979	0.055
Expected hours per week	0.909	0.048	18.960	0.000
Number of observations: 42		R-squared: 0.900		

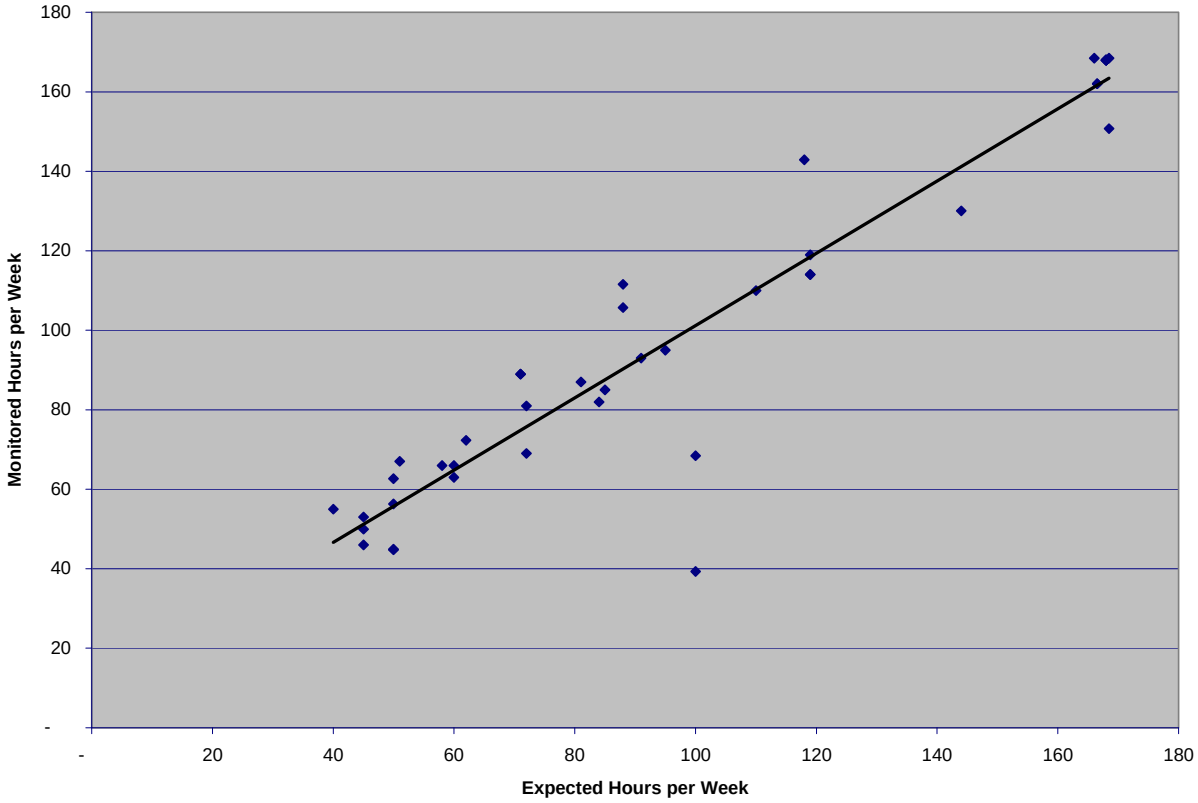

Figure D-2. Comparison of Monitored versus Expected Hours of Use for Lighting Projects Monitored from 2004 and 2005 BE Program with Common Regression Line

APPENDIX E: ALTERNATIVE ESTIMATES OF FREE-RIDERSHIP

This appendix provides alternative estimates of net-to-gross (free-ridership) rates for the evaluations of the 2004 and 2005 Building Efficiency (BE) Program. These modifications apply to the particulars of the scheme used to assign free-ridership scores to survey respondents. There are three sections.

- Section E-1 shows the free-ridership rates when the free-ridership scoring scheme is applied only to those participants who report having the financial capability to undertake an energy efficiency measure even without a financial incentive from Energy Trust.
- Section E-2 shows the free-ridership rates when respondents answering "Don't know" to a financial capability question are grouped with "Yes" respondents rather than with "No" respondents..

E.1 FREE-RIDERSHIP RATES WHEN ONLY RESPONDENTS WITH FINANCIAL CAPABILITY ARE INCLUDED

The scoring scheme for the free-ridership calculations is shown in Table E-1.

Table E-1. Free-ridership Scoring Scheme

Had Financial Capability to Install Measure without Program Incentive?	***Had Previous Experience with Measure?***	***Had Plans and Intentions to Install Measure without Program?***	***Program had influence on Decision to Install Measure?***	***Free-ridership Score***
No/Don't know				0.00
Yes	No	No	Yes	0.00
Yes	No	No	No	0.33
Yes	No	Yes	Yes	0.33
Yes	Yes	No	Yes	0.33
Yes	No	Yes	No	0.67
Yes	Yes	Yes	Yes	0.67
Yes	Yes	No	No	0.67
Yes	Yes	Yes	No	1.00

Table E-2 shows the free-ridership rates when the scoring scheme in Table E-1 is applied to those program participants who reported having the financial capability to install energy efficiency measures even without an Energy Trust financial incentive.

Table E-2. Summary of Estimated Free-ridership Rates When Free-Ridership Scoring Is Applied Only to Program Participants Who Report Having Financial Capability to Install Energy Efficiency Measures Even Without Energy Trust Financial Incentive

Category of Energy Efficiency Improvement Project	***2004 BE***	***2005 BE***
HVAC	22.53%	12.95%
Lighting	16.66%	21.91%
Motors and VFD	5.24%	27.29%
Building and Other	8.43%	
Building		0.00%
Other	-	17.16%
Gas	35.08%	5.29%
All Projects	16.97%	16.98%

E.2 FREE-RIDERSHIP RATES WHEN "DON'T KNOW" RESPONDENTS ARE INCLUDED WITH "YES" RESPONDENTS FOR FINANCIAL CAPABILITY

The scoring schemes in Table E-2 groups respondents who answered "Don't know" with those answering "No" in assigning scores. An alternative scoring scheme groups the "Don't know" respondents with the "Yes" respondents for purposes of assigning scores. The scoring scheme would then be as shown in Table E-3.

Table E-3. Scoring Scheme with "Don't Know" Respondents Grouped with "Yes" Respondents

Had Financial Capability to Install Measure without Program Incentive?	***Had Previous Experience with Measure?***	***Had Plans and Intentions to Install Measure without Program?***	***Program had influence on Decision to Install Measure?***	***Free-ridership Score***
No				0.00
Yes/Don't know	No	No	Yes	0.00
Yes/Don't know	No	No	No	0.33
Yes/Don't know	No	Yes	Yes	0.33
Yes/Don't know	Yes	No	Yes	0.33
Yes/Don't know	No	Yes	No	0.67
Yes/Don't know	Yes	Yes	Yes	0.67
Yes/Don't know	Yes	No	No	0.67
Yes/Don't know	Yes	Yes	No	1.00

Table E-4 shows the free-ridership rates when the free-ridership scores are assigned according to the scheme in Table E-3.

Table E-4. Summary of Estimated Free-ridership Rates with Don't Knows Included with Yeses for Financial Capability Question

Category of Energy Efficiency Improvement Project	***2004 BE***	***2005 BE***
HVAC	22.53%	14.75%
Lighting	29.09%	27.11%
Motors and VFD	32.46%	27.37%
Building and Other (2004)	32.13%	
Building (2005)		0.00%
Other (2005)		28.35%
Gas	25.08%	5.29%
All Projects	26.86%	21.58%