IMPACT EVALUATION
OF NEW BUILDING
EFFICIENCY PROGRAM
FOR 2004 AND 2005

Final Report

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Energy Trust of Oregon

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EXECUTIVE SUMMARY

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

Data for the study were collected through interviews with NBE program staff, review of program materials and processes, on-site inspections, end-use metering, and interviews with participating firms.

- On-site visits were used to collect data for savings impacts calculations. 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.
- Monitoring of lighting, HVAC equipment, or motors/VFDs was conducted to obtain more accurate information on hours of operation.
- Electric and gas billing data for some participants were provided by The Energy Trust.
- Using the on-site, monitored, and billing data, gross savings were estimated using proven techniques, including computer simulations using DOE-2.
- A survey of decision makers for sites in the NBE Program in 2004 and 2005 provided the information for the net-to-gross analysis. Survey-based techniques for estimating free-ridership in a program were applied to the data collected through the survey of decision-makers.
- Data collected through the survey of decision makers were also used to assess qualitatively the extent of program spillover effects. Participants representing about 5.6% of realized kWh savings for 2004 projects and about 4.5% for 2005 projects provided answers that indicated some spillover was occurring at their sites.

Table ES-1 provides summary statistics on the numbers and square footages for sites for which different types of data collection were conducted.

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

- In general, the evaluation of the projects in the NBE Program in 2004 and 2005 resulted in confirmation of the expected energy savings, with realization rates for gross savings being just over 100% for kWh savings in 2004 and 2005 and therm savings in 2004. Therm savings in 2005 showed a lower realization rate of 41.9%.
- Net-to-gross ratios were also similar between the two years.

Table ES-1. Summary of Data Collection Effort

	2004		2005	
	Number of Sites	**Square Footage of Sites**	**Number of Sites**	**Square Footage of Sites**
Program Participants				
	18	999,461	85	3,866,462
Sites where Data Collected On-Site				
	18	999,461	72	3,585,523
Sites Monitored				
Monitored for lighting	4	256,928	27	1,708,912
Monitored for HVAC, VFDs, etc.	0	0	3	48,204
Monitored for both lighting and HVAC	2	76,545	5	432,651
Totals for monitored sites	6	333,473	35	2,189,767
Sites with electric billing data				
	9	495,731	41	2,662,281
Sites Represented in Decision Makers Survey				
	14	818,833	70	3,366,565

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

	Expected Gross	***Realization Rate***	***Achieved Gross***	***Net-to-Gross Ratio***	***Achieved Net***
2004					
kWh savings	3,007,619	108.4%	3,259,592	67.2%	2,190,793
kW reductions	n/a	n/a	1,030	67.2%	692
Therm savings	25,573	100.7%	25,759	67.2%	17,310
2005					
kWh savings	8,719,145	103.6%	9,035,782	68.8%	6,216,949
kW reductions	n/a	n/a	2,401	68.8%	1,652
Therm savings	124,854	41.9%	52,341	69.1%	36,168

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EnergyTrust of Oregon, Inc.

MEMO

Date: February 13, 2008
To: Board of Directors
From: Philipp Degens, Evaluation Manager
Spencer Moersfelder, Business Sector Manager
Subject: Staff Response for the 2004-2005 New Buildings Program Impact Evaluation

The evaluation has shown that the New Buildings (NB) program is running smoothly in the realm of delivering the predicted electric savings. Realization rates above 100% were estimated for electric measures in both 2004 and 2005. For lighting measures assumed hours and wattages tended to be quite similar to those found from the site visit and metering. As a result future evaluations will focus 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 just over 100% in 2004 but only 42% 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. With the small number of gas incentives high year to year variances are not unexpected. Lower gas realization rates were also estimated in the Existing Buildings (EB) program and the Boiler Tune-up portion of the Building Tune-Up and Operations (BTO) program (now part of the EB program). Staff believes that we are still learning how best to calculate gas energy savings. Knowledge of the commercial gas market in the area of sizing of gas furnaces/boilers, their system control parameters, and how systems are actually are operated and maintained is still a growing field. Evaluation expects to focus more on gas projects in the future to firm up many of the operating assumptions and system parameters that are used to estimate savings. For example evaluation of the BTO program indicated that gas boiler systems' hours of operation and loads were much lower than expect.

Participant satisfaction with the program was high in 2004 and decreased in 2005. Comparisons with prior evaluations could not be made due to different wording of the satisfaction question. What the exact reasons for this decrease in reported satisfaction with the overall program will be researched more in the current process evaluation. However, the program did manage to provide incentives to buildings representing nearly 20% of all of Oregon's nonresidential new construction completed in 2005.

The evaluation estimated a free rider rate of 23% and 21% for 2004 and 2005. This falls within the range of other studies of commercial new construction programs around the nation and not that much more than the EB program. Additionally participants representing 5% of the savings reported that the NB program had influenced them to install additional energy efficiency measures. A later review of modeled energy consumption showed that buildings generated an average 9% additional savings from measures that did not receive program incentives. Spillover will receive a greater emphasis in the evaluation of 2006 and 2007 participants.

1. INTRODUCTION

Under contract with Energy Trust of Oregon (Energy Trust), ADM Associates, Inc. (ADM) has conducted an impact evaluation of the New Building Efficiency (NBE) Program that Energy Trust fielded in 2004 and 2005. This report presents and discusses the results of the evaluation.

1.1 DESCRIPTION OF NBE PROGRAM

The New Building Efficiency program offers technical design assistance and financial incentives for the building of new, energy-efficient commercial facilities. The assistance and incentives are offered through three different program tracks.

- The Standard Track provides prescriptive incentives for equipment upgrades and components of lighting and controls, motors, drives, HVAC and gas equipment. No energy calculations are required by the Standard Track. Incentives up to $50,000 per project are offered by the Standard Track.
- The Custom Track is for a project in the concept, schematic or early design stages and allows the program to influence equipment choices and building design using an integrated, whole building design approach. Energy calculations or energy models showing savings above code or standard practice are required. Incentives up to $200,000 per project are offered by the Custom Track.
- The LEED-NC Track is for projects participating in the US Green Building Council's Leadership in Energy and Environmental Design rating system for commercial new construction projects.

The Standard Track may be combined with the Custom Track making available up to $250,000 per project. For all tracks, program approval must be received before the project design is finalized or before equipment is purchased.

There were 18 sites with 18 projects that participated in the NBE Program during 2004 and 85 sites with 87 projects that participated in 2005. Table 1-1 shows the kWh and therm savings expected from these projects.

Table 1-1. Expected kWh and Therm Savings for New Building Efficiency Projects in 2004 and 2005

Program Year	Number of Sites	Number of Projects	Expected kWh Savings	Expected Therm Savings
2004	18	18	3,007,619	25,573
2005	85	87	8,719,145	124,854
Totals	103	105	11,726,778	150,427

1.2 EVALUATION OBJECTIVES

The goals for the impact evaluation included the following:

- Developing reliable estimates of gross and net program savings for the NBE Program for 2004 and 2005;
- Making observations and developing recommendations to help Energy Trust improve the implementation of the NBE Program; and
- Reviewing and making recommendations on Energy Trust and NBE Program energy savings estimation methods.

The following types of estimates were to be determined for gross and net program savings:

- Estimates of total program savings and savings by end-use or measure class (e.g. lighting, HVACs, etc.).
- Estimates of measure and program realization rates
- Estimates of free ridership for each major measure category
- Estimates of participant spillover, i.e. whether participants implemented further measures as a result of participation in the program.
- Gross kWh, kW and therm savings at the program, building and major end-use (HVAC and lighting) levels
- Net kWh, kW, and therm savings at the program, building and major end-use (HVAC and lighting) levels

1.3 OVERVIEW OF EVALUATION APPROACH

The approach used for evaluating the NBE Program had the following features.

- "Baseline" conditions for calculating savings were defined primarily with respect to Oregon building code requirements. A second set of baseline conditions was defined with regard to what customers would have done in the absence of the program. Information was obtained in several ways. This included (1) questioning customers directly, (2) interviewing appropriate NBE program representatives, and (3) reviewing design assistance documentation for each site. As part of this procedure, other non-rebated, non-recommended energy efficiency measures that customers installed and that could be attributed to the influence of the program were identified.
- On-site visits were made to all 2004 participant sites and to a sample of 72 of the 2005 sites to collect data on building and equipment characteristics for program participants. "High resolution" data were collected to allow simulation of energy use with the DOE-2 building energy analysis computer model. The data collection was also used to identify any non-recommended, non-rebated efficiency measures that participants installed that may be attributable to the effects of the NBE Program.
- Monitoring was conducted at a sample of 6 of the 18 sites participating in 2004 and at 35 of the sites participating in 2005 to verify hours of operation for HVAC and lighting.

- Interviews were conducted with decision makers for 14 of 18 sites participating in the 2004 NBE Program and for 70 of the 85 sites participating in 2005 to gather information on their decision making and on the factors determining the net-to-gross savings ratios for the program.
- Gross savings from HVAC measures were assessed through proven energy analysis procedures, which are based on using DOE-2 simulations of HVAC energy use calibrated against monthly billing data.
- Net savings (i.e., net-to-gross ratios) for the program were assessed by applying survey-based techniques to the data collected through the telephone survey to estimate free-ridership.

1.4 ORGANIZATION OF REPORT

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

- Chapter 2 presents and discusses the methods used for and the results obtained from estimating gross savings for measures installed under the New 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 New Building Efficiency Program.
- Chapter 4 presents and discusses the results from a survey of decision making for facilities that participated in the New Building Efficiency Program in 2004 and 2005.
- Chapter 5 presents findings and recommendations.
- 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 a discussion of the procedures used to calibrate building simulation analyses and presents comparisons of EUIs developed from billing data, building simulations, and CBECS data.
- Appendix D provides tabulations of the responses from the survey of decision makers.

2. ESTIMATION OF GROSS SAVINGS

This chapter addresses the estimation of gross kWh and therm savings and kW reductions for facilities that participated in the New 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 estimating gross savings for the sites that participated in the NBE Program in 2004 and 2005. Section 2.3 uses the realization rates presented and discussed in Section 2.2 to estimate program-level savings.

2.1 METHODOLOGY USED TO ESTIMATE GROSS SAVINGS

Table 2-1 provides summary statistics showing the numbers and square footage by building type for sites that participated in the NBE Program in 2004 and 2005.

Table 2-1. Numbers and Square Footages by Building Type for Sites Participating in NBE Program in 2004 and 2005

Building Type	***Number of Sites***	***Square Footage***
	2004	
Assembly/ Light Manufacturing	3	194,928
Auto Service	1	3,600
College	2	103,300
Community Center	1	11,155
Detention Facility	1	62,000
Library	1	82,000
Multiple Use	1	270,347
Office	4	113,867
Retail	1	10,000
School	1	12,545
Warehouse	2	135,719
Totals for 2004	18	999,461
	2005	
Grocery	1	56,000
Hospital	2	797,024
Manufacturing	11	173,412
Multifamily	3	123,700
Office	15	536,185
Other	4	65,800
Retail	27	1,102,533
Restaurant	1	8,000
School	5	276,630
Warehouse	16	727,178
Totals for 2005	85	3,866,462

Data for the estimation and evaluation of gross savings for participating in the NBE Program in 2004 and 2005 were collected through various means, including review of program documentation for the sites, on-site data collection, and monitoring.

An effort was made to collect data on-site for all sites that participated in the NBE Program in 2004 and 2005, but on-site data collection could not be scheduled for all sites. Data were collected on-site for all 18 sites that participated in the NBE Program in 2004 and for 72 of the 85 sites that participated in 2005. Table 2-2 shows the numbers and square footages by building type for the 72 sites in the 2005 NBE Program for which data were collected on-site. (The data for the 2004 sites are shown in Table 2-1.) The 72 sites for which data were collected accounted for nearly 93% of the square footage of sites participating in the NBE program in 2005.

Table 2-2. Numbers and Square Footages by Building Type for 72 Sites in 2005 NBE Program for Which Data Were Collected On-Site

Building Type	***Number of Sites***	***Square Footage***
Grocery	1	56,000
Hospital	1	750,000
Manufacturing	11	173,412
Multifamily	3	123,700
Office	11	470,250
Other	3	30,800
Retail	23	998,313
Restaurant	1	8,000
School	5	276,630
Warehouse	13	698,418
Totals for 2005	72	3,585,523

The type of data collection depended on the types of energy efficiency measures installed at the sites.

- For sites where only lighting measures were installed, data were collected with which to verify the numbers and wattages of the lighting equipment.
- For sites where HVAC measures had been installed, “high resolution” data collection was conducted to collect data on building and equipment characteristics that allowed simulation of building energy use with DOE-2.
- The data collection was also used to identify any non-recommended, non-rebated efficiency measures that participants installed that may be attributable to the effects of the NBE program.

A standardized data collection form was used by field personnel to ensure that the required data were collected. A copy of this form is provided in Appendix B. The form is comprehensive in addressing a facility's characteristics, its modes and schedules of operation, and its electrical and mechanical systems. The form also addresses various energy efficiency measures, including high efficiency lighting (both lamps and ballasts), lighting occupancy sensors, lighting dimmers and controls, air conditioning, high efficiency motors, and refrigeration. As part of the data collection effort, program measures were verified and data collected pertaining to the operation of the measures.

Monitoring was conducted at some sites to verify hours of operation for lighting and HVAC equipment. Various evaluation studies have suggested that self-reported information on hours of lighting use may be inaccurate. Accordingly, lighting loggers were installed at sites to collect data pertaining to hours of operation for lighting equipment. Monitoring was also used to collect data on the operation of HVAC fans, VFDs, and other equipment for which self-reported information on hours of operation may not be accurate.

Monitoring was conducted at 6 sites that participated in the program in 2004 and at 35 sites that participated in 2005. The distribution of the number of monitoring sites by program year, type of building and type of monitoring is shown in Table 2-3. A similar distribution of square footage is shown in Table 2-4. Monitoring was conducted at sites that represented about a third of the total square footage for sites participating in the program in 2004 and about two-thirds of total square footage for sites participating in 2005.

Table 2-3. Distribution of Number of Monitoring Sites by Program Year, Type of Building, and Type of Monitoring

Building Type	***Type of Monitoring***			***Total Number of Sites Monitored***
	Both Lighting and Motors/VFDs Monitored	***Only Lighting Monitored***	***Only Motors or VFDs Monitored***	
		2004		
Assembly/ Light Manufacturing		3		3
Detention Facility		1		1
Office	1			1
School	1			1
Totals for 2004	2	4		6
		2005		
Hospital		1		1
Manufacturing		4		4
Multifamily		2	1	3
Office		4	1	5
Other		2		2
Retail	5	8		13
School		2	1	3
Warehouse		4		4
Totals for 2005	5	27	3	35

Table 2-4. Distribution of Square Footage of Monitoring Sites by Program Year, Type of Building, and Type of Monitoring

Building Type	***Type of Monitoring***			***Total Number of Sites Monitored***
	Both Lighting and Motors/VFDs Monitored	***Only Lighting Monitored***	***Only Motors or VFDs Monitored***	
		2004		
Assembly/ Light Manufacturing		194,928		194,928
Detention Facility		62,000		62,000
Office	64,000			64,000
School	12,545			12,545
Totals for 2004	76,545	256,928		333,473
		2005		
Hospital		750,000		750,000
Manufacturing		53,940		53,940
Multifamily		121,200	2,500	123,700
Office		117,068	41,704	158,772
Other		13,800		13,800
Retail	432,651	265,564		698,215
School		188,340	4,000	192,340
Warehouse		199,000		199,000
Totals for 2005	432,651	1,708,912	48,204	2,189,767

Energy Trust provided electric billing data for some of the sites that participated in the NBE Program in 2004 and 2005. Table 2-5 shows the number and square footage of sites with billing data, classified by program year and type of building.

Using the data collected on-site and through the monitoring, gross savings for the participant sites were estimated through engineering analysis and building simulation modeling. (Where available, the billing data were used to benchmark the simulation analyses.) Estimates of energy savings for participant buildings were prepared for various energy conservation measures, both rebated and recommended. Measures analyzed included those for lighting, for HVAC (including VFDs and high efficiency motors for fans, pumps and blowers on HVAC systems, high efficiency chillers and shell measures), and for other end uses.

Before beginning the simulation analysis, the program documentation for each participant site was reviewed to assess the degree to which the savings calculations were supported and defensible and documentation was adequate. Computer inputs were checked to make sure that the buildings and their systems were properly modeled. The base case run was checked against code requirements and the proposed case runs were compared to the base case to identify any improper inconsistencies between them (such as altered schedules or building configurations).

Table 2-5. Numbers and Square Footages by Building Type for Sites with Electric Billing Data

Building Type	***Number of Sites***	***Square Footage***
2004		
Auto Service	1	3,600
College	1	43,300
Community Center	1	11,155
Detention Facility	1	62,000
Library	1	82,000
Multiple Use	1	270,347
Office	1	784
Retail	1	10,000
School	1	12,545
Totals for 2004	9	495,731
2005		
Grocery	1	56,000
Hospital	1	750,000
Manufacturing	4	49,042
Multifamily	3	123,700
Office	6	259,666
Other	3	30,800
Retail	13	809,861
Restaurant	1	8,000
School	3	141,850
Warehouse	6	433,362
Totals for 2005	41	2,662,281

Following the review of project documentation, energy simulation analyses were prepared for the participant sites. This analysis was accomplished using calibrated building simulation analysis. The calibration procedures are discussed in detail in Appendix C. ADM's *CPA 123,* a software program that automates the analysis of energy use and energy efficiency opportunities in buildings, was used for this analysis. The analytical engine for *CPA 123* is DOE 2.1E, which is the most recent version of DOE-2.

In developing the calibrated buildings simulation models, the focus was on the main factors that determine energy use. The accuracy of a savings estimate developed through engineering calculations depends on the extent to which the analysis is based on correct assumptions regarding such factors as usage patterns and operating hours. Normally, the weakest part of any engineering calculation of savings relates to the characterization of the operational schedules of energy using equipment for the building being analyzed. The review of energy savings calculations in project documentation was used to determine whether the assumptions for usage patterns were within the range of reasonable hours for each end-use application. For sites where monitoring was conducted, the data on operating hours derived through the monitoring was used to develop estimates of savings for lighting efficiency measures and for any non-HVAC VFDs and motors.

Lighting measures examined in this evaluation study included energy efficient fixtures, lamps and/or ballasts. Analyzing the savings from such lighting measures required data for (1) fixture wattage and (2) hours of operation. Information on per-fixture baseline demand, existing demand, and appropriate operating hours was used to calculate peak capacity savings and annual energy savings for sampled fixtures of each usage type.

Savings estimates were derived through a series of building simulation runs. The various simulation runs are identified in Table 2-6. Each simulation produces estimates of energy and demand usage to be expected under different assumptions about equipment and/or construction conditions.

Table 2-6. Parametric Runs for Energy Savings Simulations and Analysis

Run	Name	Rebated Measures	All Other Measures	Operating Schedule	Occupancy Level	Weather Data
Billing Reconciliation						
1.	Model Calibration	As Built	As Built	Actual	Current	Actual
Estimates of Energy Use (for calculating savings)						
2.	As Built	As Built	As Built	Actual	100%	TMY
3.	Expected Meas.	Application	As Built	Actual	100%	TMY
4.	Measure Base	Per Code	As Built	Actual	100%	TMY
5.	Whole Bldg Base	Per Code	Per Code	Actual	100%	TMY

The Model Calibration Run was a base case simulation to ensure that the energy use estimates from the simulations had been reconciled against actual data on the building's energy use. This run was based on the information collected in the on-site visit pertaining to types of equipment, their efficiencies and capacities, and their operating profiles. Current occupancy levels were used for this simulation, as were local weather data from Oregon weather stations covering the study period. (Current occupancy levels might represent less than full occupancy, since some time may be required for a new commercial building to achieve full occupancy.)

Baseline Efficiency Runs were made to determine the energy use for a building under specified baseline conditions. There were two sets of baseline conditions considered. The first, primary baseline was established by the requirements of the version of Oregon's building energy efficiency codes in effect at the time of construction. Commercial buildings in Oregon are built to satisfy Oregon's building code through either a Prescriptive approach, a Simplified Trade-off approach, or a Whole Building approach.

- The Prescriptive Approach, which is the simplest and least time-consuming of the three approaches, requires that an applicant fill out compliance forms to show that each individual building component or system complies with the standards as described by Oregon non-residential Energy Code. For most buildings, it is easier to complete the compliance forms manually. However, many applicants use the state's computer compliance tool. The software allows the user to use the simplified tradeoff approach.

- The Simplified Tradeoff Approach (STA) is an alternative method to show compliance of the building envelope. The STA may allow the applicant to tradeoff between component efficiencies. For example, increased roof insulation may compensate for windows less efficient than perspective levels. The STA is fairly time consuming and requires the use of CodeComp software. The current version of this software CodeComp5.0 must be used for all projects taking advantage of the Simplified Trade-Off Approach for compliance with the building envelope provisions of the Oregon Energy Code.
- The Whole Building Approach allows the applicant to trade off between envelope, mechanical and lighting equipment efficiencies. However, this approach gives the applicant more flexibility in terms of trade off among various building components and equipment efficiencies. The Whole Building Approach is rarely used because it is time-consuming and complex. It requires the applicant to model interaction of all of the proposed building elements using the DOE 2.1E building simulation software.

A second baseline for the simulation analyses was established by determining what would have been installed in the building in the absence of the NBE program. This baseline was based on information gathered regarding customers' intentions absent the program. This information was obtained (1) through direct questioning of the customers, (2) through interviews with NBE representatives, and (3) through detailed review of any design assistance documentation.

The baseline efficiencies were applied twice in the parametric simulation analyses: once to the rebated measures and then to all of the remaining energy-use measures in the building.

For the As-Built Efficiency Run, full occupancy was assumed and average weather data were used. This run provides information with which to gauge the long-term savings impacts.

For the Expected Measure Efficiency Run, it was assumed that the efficiencies of the measures that were recommended and for which a customer received rebates were those designated in the program application. Additionally, measures that were recommended but not rebated were also considered in the Expected Measure Run. The efficiencies may or may not be the same as the efficiencies observed for the equipment in the field. These runs calculated the energy use of a building as it would occur if all the expected measures were installed. The difference between this energy use and the actual energy use reflects any mismatches between the expected efficiency and the actual.

The results of the various simulations are used to develop estimates of energy savings for the individual sites, following the taxonomy defined in Table 2-7.

Table 2-7. Definitions of Savings Calculations

	Savings to be Calculated	***How Calculated***
A	Total Achieved Savings	Difference between results of 2 and 5
B	Non-rebated Measure Savings	Difference between results of 4 and 5
C	Rebated Measure Savings	Difference between results of 2 and 4
D	Expected Measure Savings	Difference between results of 3 and 4

The savings estimates for the individual sites developed through this analysis were compared to the initial estimates of expected savings contained in the tracking database for the program. This comparison provided estimates of realization rates for the sites.

2.2 RESULTS OF ESTIMATING GROSS SAVINGS

For each set of gross savings estimates for a site, measure savings were calculated as the difference between energy use for a building built only to baseline conditions as defined by building code requirements and the building as-built, including the energy efficiency measure. Both kWh and therm savings estimates were developed.

2.2.1 Realized Gross Savings for 2004

2.2.1.1 Realized Gross kWh Savings for 2004

Estimates of realized gross kWh savings and realization rates calculated for all 18 individual sites participating in the NBE Program in 2004 are reported in Table 2-8. The overall realization rate for kWh savings was 108.4% for 2004 participants.

Table 2-8. Realized Gross kWh Savings for Individual Participant Sites in NBE Program in 2004 (Savings in kWh/year)

Site ID	***Expected kWh Savings***	***Realized kWh Savings***	***Realization Rate***
1200500	149,803	62,591	41.8%
1200502	85,229	84,577	99.2%
1200503	131,970	328,672	249.1%
1200505	1,171,773	1,180,504	100.7%
1200506	634,424	479,825	75.6%
1200509	123,540	166,033	134.4%
1200511	18,797	19,066	101.4%
1220011	357,574	347,515	97.2%
1220023	145,623	156,780	107.7%
1220028	498	1,705	342.4%
1220046	12,928	15,950	123.4%
1220048	25,925	255,840	986.8%
1220049	94,943	101,995	107.4%
1220059	34,157	31,987	93.6%
1220066	4,270	(89)	-2.1%
2004054	16,165	26,641	164.8%
Totals	3,007,619	3,259,592	108.4%

As can be seen in Table 2-8, the calculated realization rates varied across sites. Most obvious, Site 1220048 shows a very high realization rate. The data for this site in the tracking system showed only 25,925 kWh savings. However, it was not clear how these savings were calculated, and there was no documentation on savings calculations. During the on-site visit, the field surveyor found a total of 102 fixtures (40 being 6-lamp T8 fixtures and 62 being 8-lamp T8 fixtures). Realized savings were calculated using the number of fixtures found and current operation hours.

Realized gross kWh savings and realization rates for 2004 are reported by major end uses in Table 2-9.

Table 2-9. Realized Gross kWh Savings by End Use for NBE Program in 2004 (Savings in kWh/year)

End Use	Expected kWh Savings	Realized kWh Savings	Realization Rate
Custom	14,880	15,476	104.0%
HVAC	1,151,049	1,050,077	91.2%
HVAC Controls	192,216	271,827	141.4%
Lighting	1,039,996	1,327,155	127.6%
Lighting Controls	116,785	181,422	155.3%
Motor	5,337	7,452	139.6%
Shell	122,087	40,900	33.5%
Domestic Hot Water	326,466	326,466	100.0%
Other	38,817	38,817	100.0%
2004 Totals	3,007,619	3,259,592	108.4%

2.2.1.2 Realized kW Reductions for 2004

The tracking system data maintained by Energy Trust for NBE projects in 2004 and 2005 does not contain estimates of kW reductions for the projects. However, the analysis effort for this evaluation estimated kW reductions for the sites participating in the program in 2004. Thus, the ratio of kW reductions to realized kWh savings was calculated to be 0.000316 kW reduced per kWh saved. Applying this ratio to the total achieved gross kWh savings of 3,259,592 kWh gives an estimated kW reduction of 1,030 kW.

2.2.1.3 Realized Gross Therm Savings for 2004

Estimates of realized gross therm savings and realization rates calculated for individual sites that participated in the NBE Program in 2004 are reported in Table 2-10. The overall realization rate for therm savings for 2004 participants was 100.7%.

Table 2-10. Realized Gross Therm Savings for NBE Program in 2004
(Savings in Therms/year)

Site ID	Expected Therm Savings	Realized Therm Savings	Realization Rate
1179614	24,707	24,781	100.3%
1220058	866	978	112.9%
Totals	25,573	25,759	100.7%

Realized gross therm savings and realization rates for 2004 are reported by major end uses in Table 2-11.

Table 2-11. Realized Gross Therm Savings by End Use for NBE Program in 2004
(Savings in Therms/year)

End Use	Expected Therm Savings	Realized Therm Savings	Realization Rate
Custom Gas	24,707	24,781	100.3%
Radiant Heating	866	978	112.9%
Totals	25,573	25,759	100.7%

2.2.2 Realized Gross Savings for 2005

2.2.2.1 Realized Gross kWh Savings for 2005

Gross realized savings for the sites that participated in the NBE Program in 2005 were estimated using data for 72 sites out of the 85 that participated in the program that year. These 72 sites accounted for nearly 93 percent of the expected kWh savings for the NBE Program in 2005. Realized gross kWh savings and realization rates based on the data for the 72 sites are reported by major end uses in Table 2-12.

Table 2-12. Realized Gross kWh Savings by End Use for Sample of 72 Sites
That Participated in NBE Program in 2005
(Savings in kWh per year)

End Use	Expected kWh Savings	Realized kWh Savings	Realization Rate
Custom	5,261,260	5,395,165	102.7%
HVAC	134,823	208,024	154.3%
Lighting	2,449,218	2,519,408	102.9%
Exterior lighting	79,812	125,929	157.8%
LED exit signs	32,025	57,641	180.0%
Motors	3,012	1,785	59.3%
Shell	140,244	25,086	17.9%
2005 Totals	8,100,394	8,333,038	102.9%

To estimate overall achieved kWh savings for the NBE Program in 2005, the realization rates reported in Table 2-12 for sites that were surveyed were applied through extrapolation to the data on expected kWh savings by end use for the sites that were not surveyed. The results of this extrapolation are reported in Table 2-13.

Table 2-13. Estimated Realized kWh Savings for Sites in NBE Program in 2005 That Were Not Surveyed (Savings in kWh per year)

Site ID	Expected kWh Savings	Estimated Realized kWh Savings	Realization Rate
1179622	9,582	1,738	18.1%
1186529	2,362	1,400	59.3%
1214991	178,356	241,924	135.6%
1220033	28,545	32,545	114.0%
1220042	3,955	4,464	112.9%
1220086	221,804	227,451	102.6%
1220107	30,495	35,574	116.7%
1220108	30,495	35,574	116.7%
1220130	23,524	29,874	127.0%
1222529	89,633	92,202	102.9%
Grand Total	618,751	702,745	113.6%

The results from Table 2-12 and Table 2-13 are brought together in Table 2-14 to estimate the overall realized kWh savings by end use for sites in the NBE Program in 2005. Realized kWh savings for sites in the NBE Program in 2005 were estimated to total 9,035,782 kWh, giving an overall realization rate for kWh savings of 103.6 percent.

Table 2-14. Estimated Realized Gross kWh Savings by End Use for All Sites That Participated in NBE Program in 2005 (Savings in kWh per year)

End Use	Expected kWh Savings	Estimated Realized kWh Savings	Realization Rate
Custom	5,496,789	5,636,688	102.5%
Custom Gas	-1,411	0	0.0%
Ext. Lighting	102,376	161,531	157.8%
HVAC	249,242	384,566	154.3%
LED Exit Sign	36,925	66,460	180.0%
Lighting	2,679,470	2,756,259	102.9%
Motor	5,845	3,464	59.3%
Shell	149,909	26,815	17.9%
Grand Total	8,719,145	9,035,782	103.6%

2.2.2.2 Realized kW Reductions for 2005

The tracking system data maintained by Energy Trust for NBE projects in 2004 and 2005 does not contain estimates of kW reductions for the projects. However, the analysis effort for this evaluation estimated kW reductions for a sample of the sites participating in the program in

2005. Thus, the ratio of kW reductions to realized kWh savings was calculated to be 0.000266 kW reduced per kWh saved. Applying this ratio to the total achieved gross kWh savings of 9,035,782 kWh gives an estimated kW reduction of 2,401 kW.

2.2.2.3 Realized Gross Therm Savings for 2005

There were 16 sites in the NBE Program in 2005 with projects that were expected to provide annual gas savings totaling 124,854 therms.

On-site data collection and analysis was conducted for 10 of the 16 sites with gas-saving projects. Estimates of realized gross therm savings and realization rates calculated for these 10 sites are reported by end use category in Table 2-15. The overall realization rate for therm savings for these sites was 42.6%.

Table 2-15. Realized Gross Therm Savings by End Use for Sample of 10 Sites That Participated in NBE Program in 2005 (Savings in Therms per year)

End Use	Expected Therm Savings	Realized Therm Savings	Realization Rate
Custom	79,733	34,858	43.7%
HVAC/Radiant Heating	5,364	1,387	25.9%
Totals	85,097	36,245	42.6%

To estimate overall achieved therm savings for the NBE Program in 2005, the realization rates reported in Table 2-15 for sites that were surveyed were applied through extrapolation to the data on expected therm savings by end use for the 6 sites that were not surveyed. The results of this extrapolation are reported in Table 2-16.

Table 2-16. Estimated Realized Therm Savings for Sites in NBE Program in 2005 That Were Not Surveyed (Savings in Therms per year)

End Use	Expected Therm Savings	Realization Rate	Estimated Realized Therm Savings
Custom	32,561	43.7%	14,235
HVAC/Radiant Heating	7,196	25.9%	1,861
Totals	39,757	42.6%	16,934

The results from Table 2-15 and Table 2-16 are brought together in Table 2-17 to estimate the overall realized therm savings by end use for sites in the NBE Program in 2005 that had gas-saving projects. Realized therm savings for sites in the NBE Program in 2005 were estimated to total 53,179 therms, giving an overall realization rate for therm savings of 41.9%.

Table 2-17. Realized Gross Therm Savings by End Use for NBE Program in 2005 (Savings in Therms per year)

End Use	Expected Therm Savings	Realized Therm Savings	Realization Rate
Custom	112,294	49,093	43.7%
HVAC/Radiant Heating	12,560	3,248	25.9%
Totals	124,854	52,341	41.9%

2.3 DISCUSSION OF GROSS SAVINGS ANALYSIS

This section provides additional information on EUI and realization rate comparisons to facilitate understanding the results of the gross savings analysis presented in the preceding sections. Section 2.3.1 provides a comparison of EUIs developed for NBE facilities from billing data and from simulations against EUIs for commercial buildings developed using data from the 2003 Commercial Building Energy Consumption Survey (CBECS) that is conducted by the Energy Information Administration of the U. S. Department of Energy. Section 2.3.2 discusses issues associated with savings realization rates for measures installed through NBE projects.

2.3.1 Comparison of EUIs

For NBE facilities that were analyzed through building simulations, it is possible to compare EUIs (1) with EUIs for the facilities developed from the monthly billing data and (2) with EUIs for similar types of buildings developed from data collected by the Energy Information Administration through the Commercial Building Energy Consumption Survey.

Table 2-18 compares EUIs developed for NBE facilities through building simulation analysis to EUIs developed from billing data. Because billing data were missing for some months for some facilities, the EUIs were developed with the billing data by calculating the average monthly kWh usage for the facility in a year and then multiplying the average by 12 to derive an annualized estimate of annual kWh usage. The EUIs developed from the billing data through this procedure are reported in Table 2-18 under the Annualized 2005 and Annualized 2006 columns.

The EUIs for electricity that were developed from annualized kWh data for 2005 and 2006 illustrate that kWh usage for NBE facilities generally increased between the two years. For most types of facilities, the EUIs developed from kWh data for 2006 are higher than for those developed from 2005 data.

The EUIs developed from the simulations of the as-built configurations for the facilities are generally in line with those developed from the billing data.

Table 2-18. Comparison of EUIs Derived from Billing Data and from Simulations (kWh per Year per Square Foot)

Type of Facility	Annualized 2005		Annualized 2006		Simulated As-Built	
	n	EUI	n	EUI	n	EUI
College	1	12.67	1	22.29	1	21.68
Community Center	1	6.42	1	6.19	1	7.15
Detention Facility	1	19.44	1	23.13	1	24.97
Hospital	1	5.27	1	9.86	1	29.60
Library	1	15.49	1	17.53	1	16.77
Manufacturing facility	4	47.93	4	53.84		
Multifamily	3	12.34	3	12.70	2	18.42
Office	8	22.80	8	23.95	9	19.34
Retail	14	15.73	14	17.93	11	18.79
Restaurant	2	54.50	2	56.47	2	46.88
School	4	9.38	4	9.01	5	8.28
Warehouse	6	3.50	4	4.45	1	4.79
Other	3	24.65	3	26.35		

Estimates of EUIs were also developed from data reported in the 2003 CBECS for commercial buildings built between 2000 and 2003 across the county. EUI estimates were calculated from weighted estimates of annual kWh usage and building square footage. These estimates are reported in Table 2-19. The EUIs developed through simulations of the as-built configuration as reported in Table 2-18 are generally in line with the EUIs developed from the CBECS data that are reported in Table 2-19.

- For offices, the EUI of 19.34 for NBE facilities compares to an EUI of 18.34 developed from CBECS data.
- For retail, the EUI of 18.79 for NBE facilities is somewhat lower than the EUIs developed for different types of retail facilities in the CBECS data (i.e., an EUI of 23.64 for strip shopping malls, of 20.30 for enclosed malls, and of 28.28 for retail other than malls).

Table 2-19. EUIs for New Commercial Buildings Derived from 2003 CBECS Data (kWh per Year per Square Foot)

Type of Facility	n	EUI
Office	61	18.34
Laboratory	2	34.84
Nonrefrigerated warehouse	66	4.83
Food sales	7	49.66
Public order and safety	6	16.60
Outpatient health care	16	18.74
Refrigerated warehouse	4	26.66
Religious worship	22	8.49
Public assembly	22	14.27

Type of Facility	***n***	***EUI***
Education	53	13.01
Food service	18	50.20
Inpatient health care	6	28.46
Nursing	5	18.99
Lodging	24	17.06
Strip shopping mall	27	23.64
Enclosed mall	4	20.30
Retail other than mall	30	28.28
Service	22	8.51
Other	6	26.61

2.3.2 Review of Savings Realization Rates

The realization rates for projects in the NBE program in 2004 and 2005 were reviewed to assess whether there were factors that were causing systematic differences in the realization rates. This review focused on 2005 NBE projects, particularly custom and lighting projects, which accounted for most of the expected savings from projects in the 2005 NBE program. (As shown in Table 2-12, the overall realization rates for custom and lighting projects were fairly similar.)

As a first aspect of this review, an analysis was conducted to determine whether realization rates for projects differed systematically by expected kWh savings.

- Using the data for 2005 projects, realization rates were compared to expected kWh savings for custom projects (as shown in Figure 2-1 and for lighting projects (as shown in Figure 2-2). For neither end use is there a strong association between realization rates and expected kWh savings.
- A regression analysis was also performed to determine whether variation in realization rates across projects could be explained by differences in building type. However, the results of the regression analysis showed that differences in building type also are not generally explanatory of the differences in realization rates.
- Reasons for differences between expected and realized kWh savings were examined on a case-by-case basis for ten buildings with the largest differences between expected and realized savings. This case-by-case examination showed that project-specific factors were more likely to cause realized kWh savings to differ from expected savings. Such project-specific factors could include differences in the quantity and efficiency of the equipment actually installed, in occupancy levels, occupancy schedules, and/or activities of occupants, or in building-management practices, such as thermostat set points and equipment maintenance.

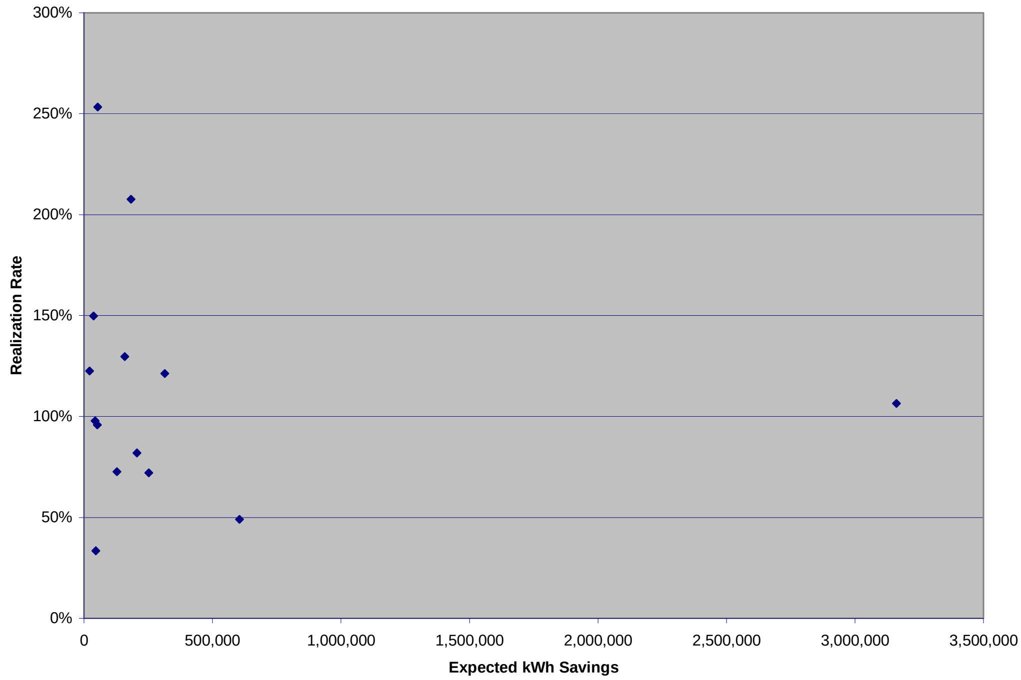

Figure 2-1. Realization Rate versus Expected kWh Savings for 2005 Custom Projects

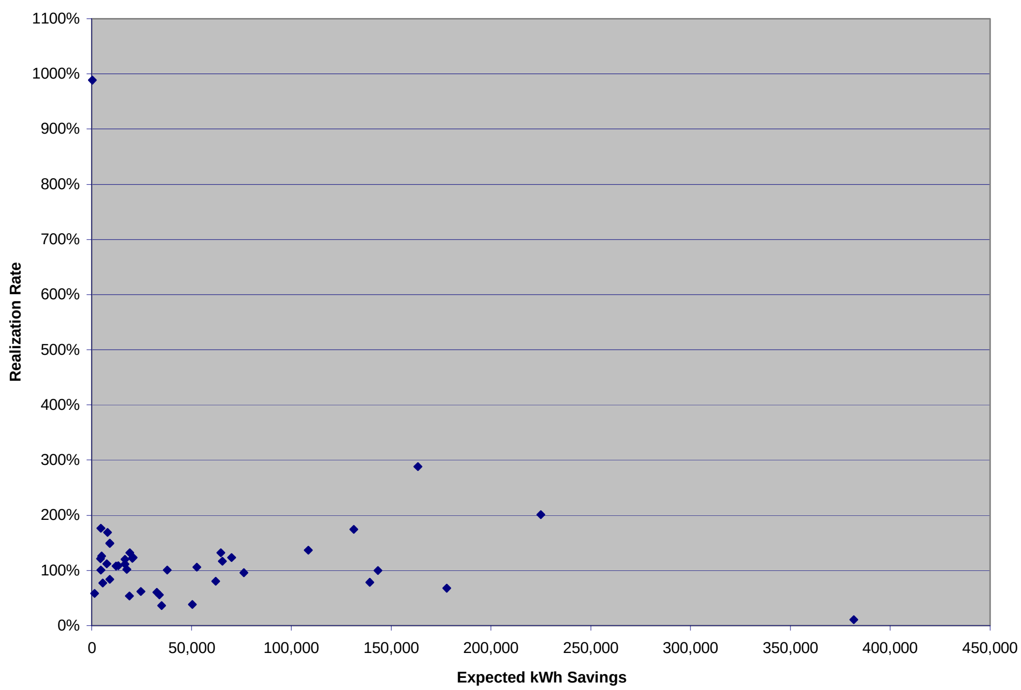

Figure 2-2. Realization Rate versus Expected kWh Savings for 2005 Lighting Projects

As a second aspect of the review, the realization rates for the NBE program in 2004 and 2005 were compared against realization rates found in evaluations of other nonresidential new construction programs.

- For kWh savings, the overall realization rates developed for the NBE program in this study were 108.4% in 2004 (see Table 2-9) and 103.6% in 2005 (see Table 2-14). By comparison, evaluations of the commercial component of the Savings by Design nonresidential new construction programs fielded by investor-owned utilities in California showed an overall realization rate for kWh savings of 84% in 2002 and 97% in 2003.[1]
- Similarly, the realization rates developed in this study for measures categorized by end use also compare to the measure-level realizations developed in the California Building Efficiency Assessment studies, which are shown in Table 2-20. The data reported in Table 2-20 illustrate that realization rates for particular types of measures can vary significantly from year to year even for a given program. This variation reflects changes in the numbers and types of facilities participating in a program from year to year. For example, the numbers of projects with some types of measures (e.g., shell measures) are often small, so that changes in the type of facilities can cause realization rates to change.

Table 2-20. Realization Rates for kWh Savings for Measure Categories as Developed in Building Efficiency Assessment Studies of California's Savings by Design Program

Measure Category	***Program Year 2002***	***Program Year 2003***
Shell	151%	88%
Lighting Power Density	84%	92%
Daylighting controls	70%	95%
HVAC and motors	53%	57%
Refrigeration	136%	57%
Whole building	108%	128%

[1] RLW Analytics, *Building Efficiency Assessment Study*, Final Reports for 2002 and 2003.

3. ESTIMATION OF NET SAVINGS

This chapter reports the results from estimating the net impacts of the NBE Program during 2004, 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 New 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 New 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 New 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 New 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 the NBE Program;
- Plans and intentions of firm to install a measure even without support from NBE Program; and
- Influence that the NBE 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 NBE Program indicated that he/she had previously installed an energy efficiency measure similar to one that they installed under the New 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 New Building Efficiency Program, had you installed any equipment/measure similar to the measure for which you received a financial incentive from the New 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 NBE 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 NBE 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 NBE Program?"

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 NBE Program representative 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 New Building Efficiency Program in making your decision to install [Equipment/Measure]?
- "Did a representative of the New 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, NBE influence was considered to be measurable by a binary Yes/No indicator variable: Yes, NBE Program did influence /No, NBE Program did not have influence. Thus, if a customer answered "Very important" to the question of how important was previous experience, then the NBE 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 NBE recommendation, then that customer is also considered to have been influenced by the program.

With respect to NBE 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 New 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 NBE 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.

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 3-1. 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 Indicator Variable = "N"***
Before participating in the New 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 NBE Program?	0.33	0.00
Did the NBE Program have an influence on customer's decision to install energy efficiency measure?	0.00	0.33

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 NBE Program?***	***NBE 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 NBE Program, and was not influenced in his decision by the NBE 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 NBE 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 New 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 spillover.

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.

3.2 RESULTS OF FREE-RIDERSHIP AND SPILLOVER ESTIMATION

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

3.2.1 Net Savings Analysis for 2004

3.2.1.1 Free-ridership Analysis for 2004

The data used to assign free-ridership scores for 2004 were collected through a telephone survey of 14 participants in the NBE Program during 2004. These 14 respondents represented over three-fourths of the program participants in 2004 and accounted for just over 86% of 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 two categories of kWh savings projects for 2004: lighting (including lighting controls) and HVAC (including HVAC controls). Because there were only 2 sites with gas-saving projects in 2004, the overall free-ridership rate for kWh savings projects was applied to the gas-saving projects.

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 NBE Program. Free-ridership rates for all projects and for particular end uses are calculated under two different assumptions regarding how answers to this financial ability question was answered.

- Under Assumption 1, if a respondent to the decision-makers survey answered “No” or “Don’t know” to the question of “Would you have been financially able to install the equipment or measures without the financial incentive from the New Building Efficiency Program?”, a free-ridership score of 0 was assigned to the project. Thus, 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?”
- Under Assumption 2, the second set of calculation assumes that the free-ridership score is 0 only for projects where survey respondents answered “No” to the financial ability question. That is, free-ridership is calculated for projects where survey respondents answered either “Yes” or “Don’t know” to the financial ability question.

The estimates of free-ridership developed for the various categories of energy efficiency improvement projects for the 2004 NBE Program under these two assumptions are summarized in Table 3-3, along with the implied net-to-gross ratios. Tables showing the calculations are provided in Appendix D.

Table 3-3. Summary of Estimated Free-ridership Rates and Implied Net-to-Gross Ratios by Category of Energy Efficiency Improvement Project for 2004 NBE Program

Category of Energy Efficiency Improvement Project	***Calculated per Assumption 1***		***Calculated per Assumption 2***	
	Estimated Free-ridership Rate	***Implied Net-to-Gross Ratios***	***Estimated Free-ridership Rate***	***Implied Net-to-Gross Ratios***
HVAC	43.7%	56.3%	43.7%	56.3%
Lighting	22.6%	77.4%	22.6%	77.4%
Other	35.0%	65.0%	35.0%	65.0%

Estimates of the net realized savings for projects in the NBE Program during 2004 were estimated by applying the net-to-gross ratios calculated under Assumption 1 in Table 3-3 to the estimates of achieved gross program-level savings developed in Chapter 2. Estimated program-level achieved net savings are reported in Table 3-4 for kWh savings and in Table 3-5 for therm savings.

Table 3-4. Estimated Program-Level Achieved Net kWh Savings for New 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
Custom	15,476	65.0%	10,059
HVAC	1,050,077	56.3%	591,193
HVAC Control	271,827	56.3%	153,039
Lighting	1,327,155	77.4%	1,027,218
Lighting Control	181,422	77.4%	140,421
Motor	7,452	65.0%	4,844
Shell	40,900	65.0%	26,585
DHW	326,466	65.0%	212,203
Other	38,817	65.0%	25,231
Totals	3,259,592	67.2%	2,190,793

Table 3-5. Estimated Program-Level Achieved Net Therm Savings for New Building Efficiency Projects in 2004

Type of Energy Efficiency Improvement	Achieved Gross Program-Level Therm Savings	Net-to-Gross Ratio	Achieved Net Program-level Therm Savings
Custom Gas	24,781	67.2%	16,653
Radiant Heating	978	67.2%	657
Totals	25,759	67.2%	17,310

3.2.1.2 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 NBE 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 New 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 3-6 shows how realized kWh savings for the NBE Program in 2004 were distributed according to answers for these two questions. As can be seen, respondents who represented about 5.6% of total realized savings gave answers that were indicative of spillover effects (i.e., the no-yes combination).

Table 3-6. Responses from Survey of Decision-Makers Pertaining to Spillover Effects for 2004 NBE 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 NBE 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	59.1%
Yes	No	10.2%
No	Yes	5.6%
No	No	25.0%
		100.0%

3.2.2 Net Savings Analysis for 2005

3.2.2.1 Free-ridership Analysis for 2005

The data used to assign free-ridership scores for 2005 were collected through a telephone survey of 70 participants in the NBE Program during 2005. These 70 respondents represented 82% of the program participants in 2005 and accounted for just over 91% of 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 two categories of kWh savings projects for 2005: custom projects and lighting (including lighting controls) projects. A free-ridership analysis was also conducted for gas-saving projects in the 2005 NBE Program.

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 NBE Program. Free-ridership rates for all 2005 projects and for particular end uses for those projects are calculated under the two different assumptions regarding how answers to this financial ability question was answered (see above, Section 3.2.1.1).

The estimates of free-ridership developed for the various categories of energy efficiency improvement projects for the 2004 NBE Program under these two assumptions are summarized in Table 3-7, along with the implied net-to-gross ratios. Tables showing the calculations are provided in Appendix D.

Table 3-7. Summary of Estimated Free-ridership Rates and Implied Net-to-Gross Ratios by Category of Energy Efficiency Improvement Project for 2005 NBE Program

Category of Energy Efficiency Improvement Project	Calculated per Assumption 1		Calculated per Assumption 2	
	Estimated Free-ridership Rate	Implied Net-to-Gross Ratios	Estimated Free-ridership Rate	Implied Net-to-Gross Ratios
Custom electric	28.9%	71.1%	30.1%	69.9%
Lighting	35.7%	64.3%	36.8%	63.2%
Other electric	30.0%	70.0%	30.0%	70.0%
Gas saving	30.9%	69.1%	41.9%	58.1%

Estimates of the net realized savings for projects in the NBE Program during 2005 were estimated by applying the net-to-gross ratios calculated per Assumption 1 in Table 3-7 to the estimates of achieved gross program-level savings developed in Chapter 2. Estimated program-level achieved net savings are reported in Table 3-8 for kWh savings and in Table 3-9 for therm savings.

Table 3-8. Estimated Program-Level Achieved Net kWh Savings for New 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
Custom	5,636,688	71.1%	4,007,685
Ext. Lighting	161,531	64.3%	103,864
HVAC	384,566	70.0%	269,196
LED Exit Sign	66,460	64.3%	42,734
Lighting	2,756,259	64.3%	1,772,275
Motor	3,464	70.0%	2,425
Shell	26,815	70.0%	18,771
Totals	9,035,782	68.8%	6,216,949

Table 3-9. Estimated Program-Level Achieved Net Therm Savings for New 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	49,093	69.1%	33,923
HVAC/Radiant Heating	3,248	69.1%	2,244
Totals	52,341	69.1%	36,168

3.2.2.2 Spillover or Free-Drivership Effects for 2005

Table 3-10 shows how realized kWh and therm savings for the NBE Program in 2005 were distributed according to answers for the two questions used to assess participant spillover. As can be seen, respondents who represented about 4.5% of total realized kWh savings gave answers that were indicative of spillover effects (i.e., the no-yes combination). Survey responses for therm savings showed no spillover effects.

Table 3-10. Responses from Survey of Decision-Makers Pertaining to Spillover Effects for 2005 NBE 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 NBE Program led you to buy any energy efficient equipment for which you did not apply for a rebate?***	***Percent of Population Realized kWh Savings***	***Percent of Population Realized Therm Savings***
No	Yes	4.5%	0.0%

3.3 COMPARISON OF NTG RATIOS ACROSS NRNC PROGRAMS

The foregoing analysis produced overall net-to-gross ratios for kWh savings of 67.2% for NBE projects in 2004 and 68.8% for projects in 2005. These estimates are essentially net-of-free ridership estimates and do not include any spillover effects.

The net-to-gross ratios estimated in this study are within the range shown for net-to-gross ratios for other nonresidential new construction programs, as can be seen by the summary of the net-to-gross estimates for various nonresidential new construction programs shown in Table 3-11.

- The first four programs listed in Table 3-11 were designated as "best practice" nonresidential new construction programs in the National Energy Efficiency Best Practices Study.[1] The NTG ratios for these programs ranged from 67% to 93%.
- The next set of programs listed in Table 3-11 are non-residential new construction programs offered by utilities in California since the mid 1990's. The NTG ratios for these programs ranged from 41% to 80%. Note that these estimates show that there can be significant differences in NTG ratios both for different utilities in a given year and for a given utility in different years. For example, the NTG ratio for PG&E was 80% in 1994 while that for SCE was 50%. In 1996, however, the estimated NTG ratio for PG&E had dropped to 47% while that for SCE had risen to 62%.
- The third set of programs listed in Table 3-11 pertain to the non-residential new construction programs that Portland General Electric offered during the 1990s. While these programs showed relatively high net-to-gross ratios in some years, there were also relatively small numbers of projects in those years. In particular, while there were 75 and 86 projects in 1993

[1] Frontier Associates, LLC under subcontract to Quantum Consulting Inc., *National Energy Efficiency Best Practices Study, Non-Residential New Construction Best Practices Study, Volume NR8,* December 2004.

and 1994 respectively, years when the net to gross ratios were lower, there were only 10 projects in 1992, 5 in 1997, 3 in 1998, and 7 in 1999.

Table 3-11. Summary of Net to Gross Ratios for Nonresidential New Construction Programs

Utility Sponsor	***Program Year***	***NTG Ratio***
Best Practice Programs		
Hawaiian Electric	1999	75%
National Grid	2002	81%
NStar	2001	67%
Northeast Utilities	2002	93%
California Programs		
SCE	1994	50%
PG&E	1994	80%
SDG&E	1995	59%
SCE	1996	62%
PG&E	1996	47%
SCE	1998	62%
PG&E	1998	41%
PG&E	1999	76%
BEA	1999-2001	59%
BEA	2002	69%
BEA	2003	76%
PGE Programs		
Portland General Electric	1992	99%
Portland General Electric	1993	68%
Portland General Electric	1994	78%
Portland General Electric	1997	97%
Portland General Electric	1998	100%
Portland General Electric	1999	98%

4. SURVEY OF DECISION MAKING

As part of the evaluation work effort, a survey was made of a sample of decision makers for facilities that participated in the New Building Efficiency Program in 2004 and 2005. That survey provided the information used in Chapter 3 to estimate free-ridership for projects in the NBE 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.

4.1 SURVEY METHODOLOGY

Interviews were completed with decision makers for 14 of the 18 facilities that participated in the NBE Program in 2004 and for 70 of the 85 facilities that participated in the program in 2005. For 2004, the number interviewed represents just over three-fourths of the number of participant sites and about 86% of the expected kWh savings. For 2005, the number of decision makers interviewed represents about 82% of participant sites and about 91% of the expected kWh savings.

Each participant was interviewed using the survey instrument provided in Appendix B. For those sites 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 New Building Efficiency Program, and (3) the influence that the New 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

This section provides a summary of major findings from the survey. (Appendix C provides question-by-question tabulations of the survey responses.) Based on a review of the survey tabulations, the following points can be made for the program in 2004 and 2005.

4.2.1 Findings from Survey of 2004 Participants

Major findings from the survey of participants in the NBE Program in 2004 were as follows.

- Respondents from the survey of participants in the NBE Program in 2004 indicated a relatively high level of satisfaction with the NBE Program. Respondents representing 86% of participants and nearly 83% of realized kWh savings rated their overall satisfaction with the NBE Program as either “Excellent” or “Very good”.
- Architects, engineers or energy consultants were cited most often as sources of information about energy efficiency. Respondents representing 64% of participants and about 48% of realized kWh savings reported learning about energy efficient equipment, measures and designs from architects, engineers, or energy consultants. The second most-cited source for

learning about energy efficiency was equipment vendors or building contractors, being cited by respondents representing 50% of participants and about 46% of realized kWh savings.

- Incentive payments from Energy Trust of Oregon were important in decision making on energy efficiency improvements. Respondents representing 57% of participants and nearly 77% 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 NBE financial incentive even without that incentive. Respondents representing 93% of participants and 88% of realized kWh savings indicated that they had this financial ability.
- Respondents representing 50% of participants and 69% of realized kWh savings reported having purchased and installed energy efficient equipment at other buildings they had constructed.
- Respondents representing 57% of participants and 31% of realized kWh savings reported having plans to install the energy efficiency equipment for which they received a NBE Program financial incentive before participating in the program.
- Respondents representing 36% of participants and 28% of realized kWh savings reported that there was a commissioning agent involved for the project who performed verification and testing of building systems or who observed the testing.

4.2.2 Findings from Survey of 2005 Participants

Major findings from the survey of participants in the NBE Program in 2005 were as follows.

- Respondents representing 69% of participants and about 45% of realized kWh savings rated their overall satisfaction with the NBE Program as either "Excellent" or "Very good".
- Architects, engineers or energy consultants were cited most often as sources of information about energy efficiency by respondents representing participants in the NBE Program in 2005. Respondents representing 67% of participants and about 86% of realized kWh savings reported learning about energy efficient equipment, measures and designs from architects, engineers, or energy consultants. The second most-cited source for learning about energy efficiency was equipment vendors or building contractors, being cited by respondents representing 61% of participants and about 83% of realized kWh savings.
- Incentive payments from Energy Trust of Oregon were important in decision making on energy efficiency improvements. Respondents representing 56% of participants in the program in 2005 and nearly 61% 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 in the NBE Program in 2005 would have been financially able to install the energy efficiency equipment for which they received a NBE financial incentive even without that incentive. Respondents representing 70% of participants and 83% of realized kWh savings indicated that they had this financial ability.

- Respondents representing 47% of participants and 39% of realized kWh savings reported having purchased and installed energy efficient equipment at other buildings they had constructed.
- Respondents representing 59% of participants and 74% of realized kWh savings reported having plans to install the energy efficiency equipment for which they received a NBE Program financial incentive before participating in the program.
- Respondents representing 27% of participants and nearly 50% of realized kWh savings reported that there was a commissioning agent involved for the project who performed verification and testing of building systems or who observed the testing.

5. FINDINGS AND RECOMMENDATIONS

The major findings and recommendations from the study of the projects participating in the New Building Efficiency Program in 2004 and 2005 are presented in this chapter.

5.1 MAJOR FINDINGS

Gross savings were estimated using proven techniques, including engineering calculations using industry standards and computer simulations. In general, the evaluation performed for the projects in the NBE Program resulted in confirmation of the expected kWh energy savings for NBE projects in both 2004 and 2005. Overall realization rates for kWh savings were 108.4% for 2004 projects and 103.6% for 2005 projects.

For gas savings, the overall realization rate was 100.7% for 2004 projects and 41.9% for 2005 projects. Most the gas savings for 2005 projects were the result of custom projects for which standardized analysis methods were not applicable. Although DOE-2 simulations were made of the gas usage for these projects as part of the evaluation effort, estimation of gas usage in nonresidential buildings in Oregon is sensitive to assumptions about building performance. Different assumptions or data about building performance can significantly affect the estimation of gas usage and savings.

Survey-based techniques for estimating free-ridership in a program were applied to the data collected through a telephone survey of decision-makers. The estimated free-ridership rates are summarized in Table 5-1. In general, roughly a third of program savings are associated with free-ridership.

Table 5-1. Estimated Free-ridership Rates for NBE Program in 2004 and 2005

Category of Energy Efficiency Improvement Project	***Estimated Free-ridership Rates***	
	2004	***2005***
HVAC	43.7%	
Lighting	22.6%	35.7%
Custom electric		28.9%
Other electric	35.0%	30.0%
Gas saving		30.9%

Data collected through the survey of decision makers were also used to assess qualitatively the extent of program spillover effects for participants. These effects were generally small for both 2004 and 2005.

5.2 RECOMMENDATIONS

The evaluation of the impacts of the 2004 and 2005 NBE program identified several areas for which more detailed effort may be appropriate. These include the following:

- *Analysis of Realization Rates.* As shown in this report, realization rates for individual projects in the 2004 and 2005 NBE program showed considerable variation. Such variation is consistent with the variations seen in evaluations of other nonresidential new construction programs. Initial analysis conducted to determine whether there are factors that cause systematic variation in realization rates did not show building type or expected savings to have strong association with realization rates. However, more detailed analysis may be appropriate to determine whether how other factors (e.g., differences in expected and actual operating hours) affect realization rates for particular types of measures. Billing data that reflects the actual operation of a facility is useful for this type of analysis.
- *Analysis of Projects that Save Gas.* Analysis of savings for projects that saved gas showed a relatively low realization rate for such projects in 2005. Because the number of such projects was small, the factors causing the low realization rates were project-specific. However, additional analysis may be appropriate to determine whether there are systematic factors at work to lower realization rates for gas-saving projects.
- *Analysis of Spillover Effects.* 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.

APPENDIX A: ON-SITE DATA COLLECTION FORM

The on-site data collection form is provided under separate cover.

APPENDIX B: QUESTIONNAIRE FOR SURVEY OF DECISION MAKING

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

APPENDIX C: APPROACH TO CALIBRATION

The purpose of this appendix is to provide further detail on the procedures by which the building simulation analyses were calibrated. Section C.1 describes the calibration procedures, while Section C.2 provides data on year-to-year changes in billing data that need to be taken into account for in the calibration effort.

C.1 DESCRIPTION OF CALIBRATION PROCEDURES

The analysis of the savings from measures installed in a newly constructed building was accomplished following Option D of the IPMVP for new construction.[1] This involves using an energy simulation model calibrated to the data for the particular building. ADM's *CPA 123*, a software program that automates the analysis of energy use and energy efficiency opportunities in buildings, was used for this analysis in this project. The analytical engine for *CPA 123* is DOE 2.1E. The DOE-2 energy analysis model is used to develop simulations of end-use energy use and of the savings from the energy efficiency measures installed for a building.

Using a building energy analysis model provides the capability for assessing the effects on energy consumption that result from interactions among a facility's structural and construction characteristics, its equipment and technology characteristics, its occupancy patterns, and weather conditions. However, the accuracy of the analysis depends on the accuracy of the data used as input for the simulation. To ensure the accuracy of the input data, a comprehensive verification and calibration procedure that has several steps is used.

To begin the verification and calibration process, the data collected on-site on a building's structural and equipment characteristics are entered into a computerized database for initial processing and verification. The verification includes both automated and manual checks that are applied to insure good data quality and to minimize the errors attributable to mis-coding, mis-judgments, or incorrect responses. The data are passed through four sets of error checks.

- The first set of error checks is used to detect errors that may have been introduced through the data entry process. Under this procedure, all coded entries are tested by either a range check or a table-lookup check. All data that do not pass these tests are printed into a data entry exception report. Examples of checks made in this first stage include the following:
  - Building use codes not defined
  - Fuel use codes not defined
  - Equipment codes not defined
- The second set of error checks detect errors and/or inconsistencies that may exist within the data for a given facility. Entries for an individual customer are cross-checked against each

[1] Efficiency Valuation Organization, ***IPMVP Volume III, Part I, Concepts and Options for Determining Energy Savings in New Construction, EVO 30000-1: 2006.***

other to ensure that they are correct. Some of the internal consistency checks that are performed include checking the following:

- That the sum of conditioned, unconditioned and refrigerated floor areas is less than or equal to the total floor area of the building
- That total heated floor area less than or equal to total floor area
- That total cooled floor area less than or equal to total floor area
- That unconditioned floor area less than or equal to total floor area

- The third set of error checks is used to detect internal inconsistencies within the database. Buildings are grouped by type, and the data for buildings of each type are processed through a set of statistical analysis routines. Buildings that are classified as "outliers" by this analysis are individually examined for validity. Both tabulations and data plots are used during this stage of the error-checking. Examples of the items checked include:
  - Energy use index by building type
  - Conditioned floor area divided by total building area
  - Total building area divided by number of floors
  - Conditioned floor area divided by number of floors
  - Total building area divided by number of occupants
  - Conditioned floor area divided by number of occupants
- A fourth set of checks are “sanity checks” to make sure that the characteristics and operational data for the building “make sense” and that there are no obvious discrepancies in these data. These sanity checks include the following:
  - Assessing overall electric intensities
  - Assessing lighting power densities
  - Assessing equipment power densities
  - Assessing HVAC equipment densities, including square foot per ton of cooling equipment and kW per CFM for fans

These values are assessed by comparing them to expected values and by determining whether they are consistent with the actual billing data for the building. If the data do not pass the initial checks, any obvious discrepancies are resolved before calibrating against billing data.

The purpose of the calibration against billing data is to ensure that the energy-use estimates from the analysis have been reconciled against actual data on the building's energy use. The goal in calibrating against billing data is twofold. A first goal is to have the pattern of monthly energy use produced through the simulation analysis match against the pattern of monthly energy use seen in the billing data. The second goal of the calibration is to have the estimates of annual energy use developed from the DOE-2 analysis for a facility come within approximately ±10% of the actual energy use as observed in the billing data so that the savings being achieved at a facility from implementing various energy efficiency measures are evaluated against a realistic benchmark.

To begin the calibration process, the verified site data are used to prepare the input files needed for the DOE-2 simulation analysis. *CPA 123* has a pre-processor for transforming on-site data into DOE-2 input files. This pre-processor has been designed to accommodate the level of detail associated with the data collected on-site for the building being analyzed. Moreover, monitored data that ADM has collected for a variety of commercial buildings has been used to refine the way in which the pre-processor generates internal load estimates for non-HVAC equipment.

The pre-processor first applies engineering algorithms to the cleaned data to derive estimates of energy use for non-HVAC end uses. (DOE-2 itself does not calculate internal, non-HVAC loads for a building, so that estimates of such internal loads are needed not only for themselves but also as input to a DOE-2 analysis.) The pre-processor develops these estimates of hourly loads for non-conditioning end uses using information on the inventory of energy-using equipment, the operating schedule of that equipment, total building load data and estimates of end-use energy consumption patterns.

The process of developing estimates of non-HVAC end-use energy use begins with the compiling of the total connected capacity of the equipment at the site by area, adjusting that capacity for known operating characteristics, and adjusting for peak utilization. Operating profiles are then applied, using profiles created using operating schedule information collected on-site and, when available, whole-building load profile data. This general process is modified as appropriate to account for characteristics specific to particular end uses.

As an example to illustrate this procedure, consider the development of profiles for indoor lighting. Lighting loads are estimated as the product of the total connected load and the peak percent on for lighting during the different hours of the day. A complete inventory of lighting equipment in a building is developed from the data collected on-site and used to determine connected load. Conceptually, total lighting capacity or connected load is the lighting load that would occur if all lighting equipment were on simultaneously. It is estimated by summing the rating of all of the lamps in all of the lighting fixtures and adjusting to account for variation in energy consumption due to differences in ballast efficiency. Data are also collected pertaining to the fraction of lighting equipment that is active. Based on examination of lighting controls and discussions with building occupants, estimates are developed for the profile of lighting use during normal operation hours and the fraction of lights that are on outside of normal operating hours.

Similar procedures are used for other non-conditioning end uses: office equipment, cooking, refrigeration, water heating. Seasonal variation is included for thermally-sensitive loads, including water heating and refrigeration, and profiles for outside lighting are computed to vary with hours of daylight.

After the estimates for energy use profiles for internal, non-HVAC end uses have been calculated, the pre-processor then generates a DOE-2 input file for a site. Inputs for a DOE-2 analysis must be in a specified format, and the pre-processor generates the input files in this format. The pre-processor also applies algorithms to the input data to calculate zoning and capacity parameters required for the DOE-2 analysis.

- One set of algorithms is applied to determine the zoning appropriate to the building being simulated. The pre-processor applies criteria to ensure that sufficient zones are defined to represent the building adequately for the analysis.
- Another set of algorithms is applied to determine the appropriate sizing of equipment for each thermal zone. The total capacity of equipment is known from the on-site data. The pre-processor allocates this capacity across thermal zones in proportion to zonal peak loads (as calculated by the LOADS module of DOE-2).

Note that the pre-processor has been explicitly designed to provide realistic inputs for simulations in that it takes full account of the actual configurations of buildings. The actual layout of the building (as shown on the on-site data collection form) is used to determine the proper zoning for the HVAC control system. This ensures that the heating and cooling loads do not cancel each other and that part-load efficiencies of the equipment are properly calculated.

After the DOE-2 input file for a building has been created, DOE-2 simulation runs are made using an actual weather file specific to the building's location.[2] The results of these runs along with monthly billing data for the building are used to calibrate the model for the building. Calibration considers both non-conditioning and conditioning end uses.

Non-conditioned end uses include lighting, equipment, and HVAC fans. In order to calibrate the simulation model for these non-conditioned end uses, the months where very little or no air conditioning seems to be in operation are identified. Typically, the months of April and November are good candidates. This generally gives a good indication as to how much of the total monthly bill can be considered to result from non-conditioning end uses. Since the portion of the bill associated with non-conditioned end uses changes relatively little from one month to another, it makes the non-conditioned calibration process fairly easy.

- First, the results for lighting energy use are examined to make sure that the lighting schedules are reasonable. Lighting schedules are usually easy to obtain during data collection because they have very little variations, if any, during the entire business and non-business periods of the day.
- In commercial buildings, HVAC fans are typically running regardless of the season and hour of the day in order to provide ventilation in the building. Therefore, the operating schedule for the fans may not require any adjustment at all. However, the connected load and CFM used in the simulation are examined to make sure that they are reasonable for the system under consideration.

[2] All of the DOE-2 analyses are made using actual weather data for a time period corresponding to the available billing data for the customer's facility. The basic source for these weather data is the National Climatic Center, operated by the National Oceanic and Atmospheric Administration.

After the process of calibrating non-conditioned end uses is completed, an initial simulation run is made to see how the overall simulation results match against the data on actual energy use (e.g., as measured by monthly billing data). Note that billing data are not used as input to the modeling process, but are used independently to check and calibrate the simulation results. That is, the DOE-2 simulations generate estimates of end-use energy use that are independent of utility billing data. The DOE-2 estimates of energy use can be compared to billing data to determine how closely the energy use of a facility has been replicated.

The estimates of energy use developed through the initial simulations are used in a number of comparisons to gauge the level of consistency between estimated and actual results.

- For energy use, the estimates of energy use are compared on a monthly basis to actual consumption indicated by the billing data. A DOE-2 simulation run provides estimates of energy use on an *hourly* basis (i.e., for 8,760 hours of the year) that are aggregated to provide a set of *monthly* energy use values (both coincident and non-coincident) that are checked against actual monthly energy use data as shown by utility billing data. This seasonality check is important because it provides strong evidence on whether energy use for heating, cooling and non-weather sensitive end uses is being correctly estimated.
- For evaluating the demand estimates, the demands as determined from DOE-2 analysis for particular hours are compared against actual data on demands (either from billing data or from measurements made during the audit).

Based on these comparisons, differences between simulation results and billing data are compensated for by adjusting equipment schedules. Examples of such adjustments include the following.

Plug loads and equipment capacities are adjusted when the comparison shows that there are discrepancies between the two sets of demand values. The characteristics of actual installed technologies are obtained of course during the on-site data collection for the facility. However, the connected load of all equipment in a building generally exceeds the peak demand of equipment actually in use. For this reason, it is important not to accept at face value the connected load implied by the technology inventory. The peak demand estimates for each end use obtained as results of the DOE-2 analysis are used to adjust the connected loads for each end use so that the set of technology characteristics defined for the building is consistent with observed demands.

A major reason for using DOE-2 analysis is to better represent HVAC energy use. By using DOE-2 for simulating the performance of heating and cooling equipment in a facility, account can be taken of such factors as (a) the distribution system type (e.g., single zone, multizone, fan coil, variable air volume, water-loop heat pump, etc.), (b) the presence of terminal reheat coils, (c) the presence of economizer cycles, (d) the types of system controls and thermostat settings, (e) outside air percentages, (f) construction materials and U values for windows, walls, and roof, (g) internal gains from lighting, equipment, and people, and (h) hourly weather conditions including temperature, humidity, and solar radiation. The capability that DOE-2 has for accommodating these factors is important, because both equipment characteristics and scheduling practices can have significant effects on estimates of HVAC energy use.

Examples of equipment/building characteristics that affect the analysis of HVAC energy use that may be adjusted during the calibration process include the following:

- The type of HVAC distribution system and controls has a very dramatic effect on the estimates of HVAC energy use. Considerations that determine the effects of the distribution system include:
  - Are hot and cold deck temperatures kept constant, or are they controlled by zone loads or by outdoor temperature?
  - Are there specific dates for heating/cooling changeovers?
  - Are there economizer controls?
- Ventilation rates (i.e., the percentage of outside air) can significantly affect estimates of conditioning loads and energy use. While building codes generally prescribe outdoor air cfm requirements, ventilation rates can differ among buildings (e.g., depending on the type of damper controls). The outside air CFM used for the simulations may be adjusted to properly reflect both code requirements and actual practice.
- Equipment sizing is an important consideration in analyzing HVAC energy use with DOE-2 or any other energy analysis model. For example, fan sizes, measured in terms of cfm, can significantly affect the results of the analysis, particularly for constant volume distribution systems. Moreover, under-sizing of equipment may result in loads not being met, which essentially means that energy use is underestimated.
- HVAC energy use is also significantly affected by equipment operating schedules. The input file for the DOE-2 analysis is based on self-reported operating schedules (i.e., the customer's conception of how the facility has been operating). However, the billing data reflect how the facility has actually been operating. Hourly operating schedules, utilization rates, and seasonal adjustment factors may need to be adjusted for different end uses to bring the results of the DOE-2 baseline analysis closer to the actual energy-use patterns observed in the billing data.
- Other factors that may be adjusted to calibrate HVAC energy use may include adjusting set point temperatures within a reasonable range (typically between 72° F and 78° F) or adjusting cooling efficiencies of the units (typically 10% -15%).

Data from monitoring of end uses (e.g., lighting, HVAC fans) are used in the calibration process when available. End-use monitored data are helpful in determining the sequence of operation of equipment. The monitored data may also be used to adjust the magnitude of the load that a particular equipment is drawing at a particular time, based on a comparison between hourly loads reported for the end use from the simulation runs and the monitored data.

C.2 ISSUES IN CALIBRATING SIMULATION ANALYSES AGAINST BILLING DATA

Energy Trust was able to provide monthly billing data for 52 facilities that participated in the New Building Efficiency Program in 2004 or 2005. While data were available from 2002 on for a few sites, in practice monthly data were available for most sites only for 2005 and 2006. However, one or more months of data were missing for some sites.

The billing data provided by Energy Trust can be used to illustrate an important point about calibrating energy simulation for new facilities against billing data. In particular, it is important to note that the energy use for a new facility may increase significantly over the first several years (e.g., as occupancy increases). This is illustrated in Figure C-1, which plots average monthly kWh usage in 2006 for 48 NBE facilities against their average monthly kWh usage in 2005. As the estimated trend line illustrates, average monthly kWh usage in 2006 had increased significantly over usage in 2005.

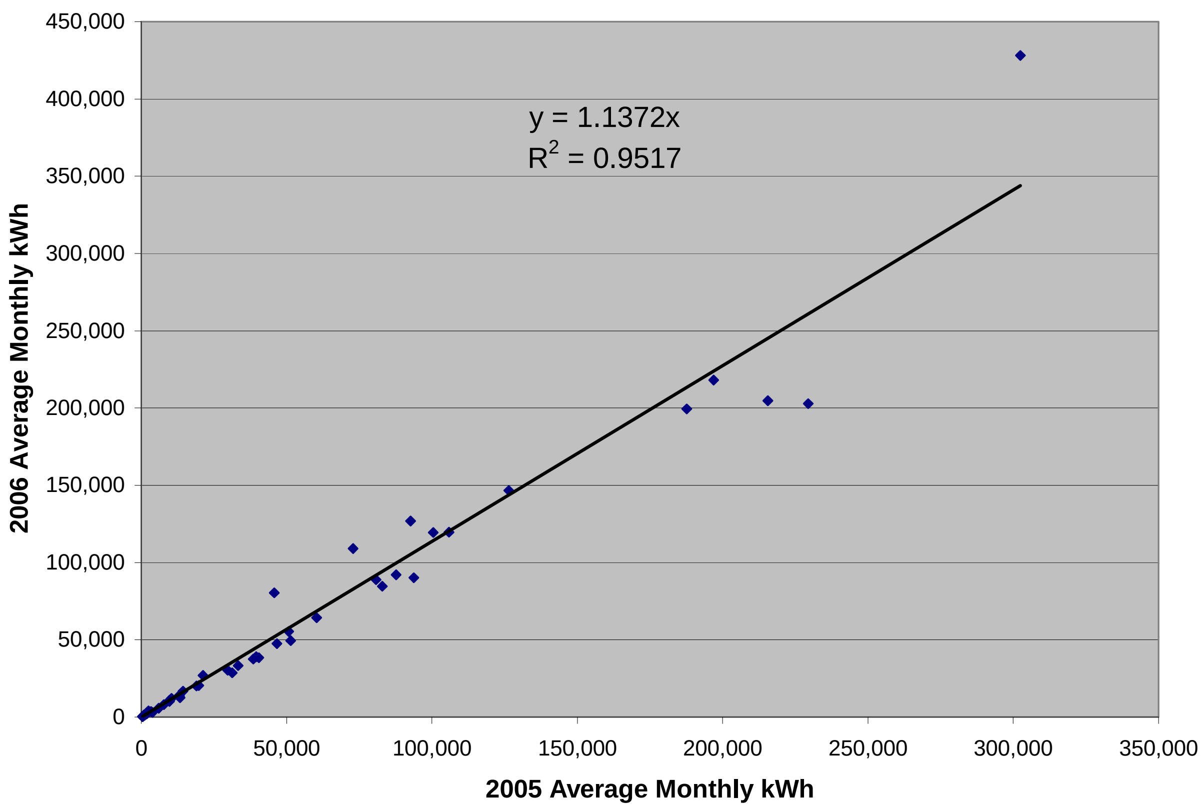

Figure C-1. Comparison of Average Monthly kWh Usage between 2005 and 2006 for 48 NBE Facilities

The implication of the growth in kWh usage in early years of a building's life is that the calibration is more important in accounting for the factors affecting the pattern of energy use than in determining the level of energy use. Indeed, the results of the calibration runs themselves are not necessarily informative about levels of energy use as measured, say, by energy use intensities (EUIs). This is true because the calibration runs are made using data for actual occupancy levels and for weather, and both occupancy and weather can change significantly. Accordingly, the EUIs derived from calibration analysis will likely differ from the EUIs derived when the facility as-built is simulated under the assumption of full occupancy and using TMY weather data.

APPENDIX D: CALCULATION OF FREE-RIDERSHIP RATES

This appendix provides tables showing the calculation of free-ridership rates for NBE projects in 2004 and 2005. For each year, free-ridership rates for all projects and for particular end uses are calculated under two different assumptions.

- Assumption 1: A first set of calculations assumes that the free-ridership score is 0 for projects where survey respondents answered “No” or “Don’t know” to the financial ability question. That is, free-ridership is calculated only for projects where survey respondents answered “Yes” to the financial ability question.
- Assumption 2: A second set of calculation assumes that the free-ridership score is 0 only for projects where survey respondents answered “No” to the financial ability question. That is, free-ridership is calculated for projects where survey respondents answered either “Yes” or “Don’t know”.

D.1 CALCULATION OF FREE-RIDERSHIP RATES FOR 2004

The free-ridership scoring procedure was applied to 2004 kWh savings projects both to all projects together and to projects by end use categories. Separate free-ridership rates were estimated for two categories of kWh savings projects for 2004: custom projects and lighting (including lighting controls) projects.

D.1.1 Calculation of 2004 Free-Ridership Rates per Assumption 1

Results are reported in this section when the free-ridership scoring procedure was applied to 2004 NBE projects under Assumption 1 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 when the free-ridership scoring procedure was applied with Assumption 1 to kWh savings from all NBE projects in 2004 are presented in Table D-1. 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 32.8% 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 NBE Program.

Table D-1. Estimated Free-ridership for kWh Savings from All Projects in NBE Program in 2004: Assumption 1

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 NBE Program?***	***NBE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from NBE Program			0.00	12.4%	0.0%
No	No	Yes	0.00	9.2%	0.0%
No	No	No	0.33	9.2%	3.0%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	49.1%	16.2%
No	Yes	No	0.67	0.0%	0.0%
Yes	No	No	0.67	20.3%	13.6%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					32.8%

The results of applying the free-ridership scoring procedure under Assumption 1 to kWh savings from lighting projects are presented in Table D-2. 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 22.6%.

Table D-2. Estimated Free-ridership for kWh Savings from Lighting Projects in NBE Program in 2004: Assumption 1

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 NBE Program?***	***NBE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from NBE Program			0.00	26.4%	0.0%
No	No	Yes	0.00	19.4%	0.0%
No	No	No	0.33	14.3%	4.7%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	26.0%	8.6%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	13.9%	9.3%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					22.6%

The results of applying the free-ridership scoring procedure under Assumption 1 to kWh savings from HVAC projects are presented in Table D-3. 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 43.7%.

Table D-3. Estimated Free-ridership for kWh Savings from HVAC Projects in NBE Program in 2004: Assumption 1

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 NBE Program?***	***NBE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from NBE Program			0.00	0.0%	0.0%
No	No	Yes	0.00	0.2%	0.0%
No	No	No	0.33	6.4%	2.1%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	61.8%	20.4%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	31.7%	21.2%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					43.7%

D.1.2 Calculation of 2004 Free-Ridership Rates per Assumption 2

The results when the free-ridership scoring procedure was applied to 2004 NBE projects under Assumption 2 are reported here. Assumption 2 is that the free-ridership score was 0 only for projects where survey respondents answered “No” to the financial ability question.

The results when the free-ridership scoring procedure was applied with Assumption 2 to kWh savings from all NBE projects in 2004 are presented in Table D-4. 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 32.8% when the scoring procedure is applied to projects where the survey respondents answered either that they would have been financially able to undertake the project without financial assistance from the NBE Program or that they didn’t know.

Table D-4. Estimated Free-ridership for kWh Savings from All Projects in NBE Program in 2004: Assumption 2

Indicator Variables					
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without NBE Program?***	***NBE Program Had Influence on Decision to Install Measure?***	***Free-ridership Score***	***Percentage of Total Realized Gross kWh Savings***	***Free-ridership Percentage***
Needed financial assistance from NBE Program			0.00	12.4%	0.0%
No	No	Yes	0.00	9.2%	0.0%
No	No	No	0.33	9.2%	3.0%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	49.1%	16.2%
No	Yes	No	0.67	0.0%	0.0%
Yes	No	No	0.67	20.3%	13.6%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					32.8%

The results of applying the free-ridership scoring procedure under Assumption 2 to kWh savings from lighting projects are presented in Table D-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 22.6%.

Table D-5. Estimated Free-ridership for kWh Savings from Lighting Projects in NBE Program in 2004: Assumption 2

Indicator Variables					
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without NBE Program?***	***NBE Program Had Influence on Decision to Install Measure?***	***Free-ridership Score***	***Percentage of Total Realized Gross Lighting kWh Savings***	***Free-ridership Percentage***
Needed financial assistance from NBE Program			0.00	26.4%	0.0%
No	No	Yes	0.00	19.4%	0.0%
No	No	No	0.33	14.3%	4.7%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	26.0%	8.6%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	13.9%	9.3%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					22.6%

The results of applying the free-ridership scoring procedure under Assumption 2 to kWh savings from HVAC projects are presented in Table D-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 43.7%.

Table D-6. Estimated Free-ridership for kWh Savings from HVAC Projects in NBE Program in 2004: Assumption 2

Indicator Variables					
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without NBE Program?***	***NBE Program Had Influence on Decision to Install Measure?***	***Free-ridership Score***	***Percentage of Total Realized Gross HVAC kWh Savings***	***Free-ridership Percentage***
Needed financial assistance from NBE Program			0.00	0.0%	0.0%
No	No	Yes	0.00	0.2%	0.0%
No	No	No	0.33	6.4%	2.1%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	61.8%	20.4%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	31.7%	21.2%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					43.7%

D.2 CALCULATION OF FREE-RIDERSHIP RATES FOR 2005

The free-ridership scoring procedure was applied to 2005 kWh savings projects both to all projects together and to projects by end use categories. Separate free-ridership rates were estimated for two categories of kWh savings projects for 2005: custom projects and lighting (including lighting controls) projects. A free-ridership analysis was also conducted for gas-saving projects in the 2005 NBE Program.

D.2.1 Calculation of 2005 Free-Ridership Rates per Assumption 1

Results are reported in this section when the free-ridership scoring procedure was applied to 2005 NBE projects under Assumption 1 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 when the free-ridership scoring procedure was applied to kWh savings from all projects in 2005 are presented in Table D-7. 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 31.0% when the scoring procedure is applied only to projects in 2005 where the survey respondents answered that they would have been financially able to undertake the project without financial assistance from the NBE Program.

Table D-7. Estimated Free-ridership for kWh Savings from All Projects in NBE Program in 2005: Assumption 1

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 NBE Program?	NBE Program Had Influence on Decision to Install Measure?			
Needed financial assistance from NBE Program			0.00	17.1%	0.0%
No	No	Yes	0.00	3.7%	0.0%
No	No	No	0.33	44.7%	14.7%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	20.2%	6.7%
No	Yes	No	0.67	1.8%	1.2%
Yes	No	No	0.67	12.6%	8.4%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					31.0%

The results of applying the free-ridership scoring procedure to kWh savings from custom projects are presented in Table D-8. The table shows how the realized gross kWh savings for custom 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 28.9%.

Table D-8. Estimated Free-ridership for kWh Savings from Custom Projects in NBE Program in 2005: Assumption 1

Indicator Variables			Free-ridership Score	Percentage of Total Realized Gross Custom kWh Savings	Free-ridership Percentage
Had Previous Experience with Measure?	Had Plans and Intentions to Install Measure without NBE Program?	NBE Program Had Influence on Decision to Install Measure?			
Needed financial assistance from NBE Program			0.00	19.8%	0.0%
No	No	Yes	0.00	0.0%	0.0%
No	No	No	0.33	63.0%	20.8%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	10.3%	3.4%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	7.0%	4.7%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					28.9%

The results of applying the free-ridership scoring procedure to kWh savings from lighting projects are presented in Table D-9. 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 35.7%.

Table D-9. Estimated Free-ridership for kWh Savings from Lighting Projects in NBE Program in 2005: Assumption 1

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 NBE Program?	NBE Program Had Influence on Decision to Install Measure?			
Needed financial assistance from NBE Program			0.00	11.7%	0.0%
No	No	Yes	0.00	12.2%	0.0%
No	No	No	0.33	8.8%	2.9%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	36.1%	11.9%
No	Yes	No	0.67	6.1%	4.1%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	25.1%	16.8%
Yes	Yes	No	1.00		
Overall free-ridership rate:					35.7%

The results of applying the free-ridership scoring procedure under Assumption 1 to therm savings from gas saving projects are presented in Table D-10. The table shows how the realized gross therm savings for gas saving projects were distributed across the various combinations of free-ridership indicator variables and the resulting free-ridership percentages. For therm savings, the free-ridership percentage is estimated to be 30.9%.

Table D-10. Estimated Free-ridership for Therm Savings from Gas Saving Projects in NBE Program in 2005: Assumption 1

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 NBE Program?	NBE Program Had Influence on Decision to Install Measure?			
Needed financial assistance from NBE Program			0.00	50.3%	0.0%
No	No	Yes	0.00	2.4%	0.0%
No	No	No	0.33	2.1%	0.7%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	0.4%	0.1%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	44.8%	30.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					30.9%

D.2.2 Calculation of 2005 Free-Ridership Rates per Assumption 2

The results when the free-ridership scoring procedure was applied to 2005 NBE projects under Assumption 2 are reported here. Assumption 2 is that the free-ridership score was 0 only for projects where survey respondents answered "No" to the financial ability question.

The results when the free-ridership scoring procedure using Assumption 2 was applied to kWh savings from all projects in 2005 are presented in Table D-11. 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 32.3% when the scoring procedure is applied to projects in 2005 where the survey respondents answered either "Yes" or "Don't know" to the question of whether they would have been financially able to undertake the project without financial assistance from the NBE Program.

Table D-11. Estimated Free-ridership for kWh Savings from All Projects in NBE Program in 2005: Assumption 2

Indicator Variables					
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without NBE Program?***	***NBE Program Had Influence on Decision to Install Measure?***	***Free-ridership Score***	***Percentage of Total Realized Gross kWh Savings***	***Free-ridership Percentage***
Needed financial assistance from NBE Program			0.00	6.7%	0.0%
No	No	Yes	0.00	10.1%	0.0%
No	No	No	0.33	48.7%	16.1%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	20.2%	6.7%
No	Yes	No	0.67	1.8%	1.2%
Yes	No	No	0.67	12.5%	8.4%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					32.3%

The results of applying the free-ridership scoring procedure under Assumption 2 to kWh savings from custom projects are presented in Table D-12. The table shows how the realized gross kWh savings for custom 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 under Assumption 2 is estimated to be 30.1%.

Table D-12. Estimated Free-ridership for kWh Savings from Custom Projects in NBE Program in 2005: Assumption 2

Indicator Variables			***Free-ridership Score***	***Percentage of Total Realized Gross Custom kWh Savings***	***Free-ridership Percentage***
Had Previous Experience with Measure?	***Had Plans and Intentions to Install Measure without NBE Program?***	***NBE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from NBE Program			0.00	9.4%	0.0%
No	No	Yes	0.00	6.5%	0.0%
No	No	No	0.33	66.9%	22.1%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	10.3%	3.4%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	7.0%	4.7%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					30.1%

The results of applying the free-ridership scoring procedure under Assumption 2 to kWh savings from lighting projects are presented in Table D-13. 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 under Assumption 2 is estimated to be 36.8%.

Table D-13. Estimated Free-ridership for kWh Savings from Lighting Projects in NBE Program in 2005: Assumption 2

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 NBE Program?***	***NBE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from NBE Program			0.00	1.1%	0.0%
No	No	Yes	0.00	19.3%	0.0%
No	No	No	0.33	12.5%	4.1%
No	Yes	Yes	0.33	0.0%	0.0%
Yes	No	Yes	0.33	36.1%	11.9%
No	Yes	No	0.67	6.1%	4.1%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	24.9%	16.7%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					36.8%

The results of applying the free-ridership scoring procedure under Assumption 2 to therm savings from gas saving projects are presented in Table D-14. The table shows how the realized gross therm savings for gas saving projects were distributed across the various combinations of free-ridership indicator variables and the resulting free-ridership percentages. For therm savings, the free-ridership percentage under Assumption 2 is estimated to be 41.9%.

Table D-14. Estimated Free-ridership for Therm Savings from Gas Saving Projects in NBE Program in 2005: Assumption 2

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 NBE Program?***	***NBE Program Had Influence on Decision to Install Measure?***			
Needed financial assistance from NBE Program			0.00	18.8%	0.0%
No	No	Yes	0.00	0.4%	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	37.1%	12.2%
No	Yes	No	0.67	0.0%	0.0%
Yes	Yes	Yes	0.67	0.0%	0.0%
Yes	No	No	0.67	43.7%	29.6%
Yes	Yes	No	1.00	0.0%	0.0%
Overall free-ridership rate:					41.9%

APPENDIX E: TABULATIONS OF SURVEY RESPONSES

This appendix provides question-by-question tabulations of the survey responses. 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.

E.1 SURVEY RESPONSES: 2004 RESPONDENTS

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	92.9%	100.0%
	Somewhat important	9.1%	0.0%
	Don't know		
	Totals	100%	100%

Q2. 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	42.9%	27.4%
	Based on staff recommendation to a decision maker	7.1%	0.0%
	Made by a group or committee	42.9%	70.4%
	Other	7.1%	2.2%
	Totals	100%	100%

Q3. 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***
	NBE Program representative	14.3%	47.9%
	Utility company representative	21.4%	47.9%
	Brochure or advertisement	0.0%	0.0%
	Trade association or journals	0.0%	0.0%
	Friends and colleagues	7.1%	5.9%
	Architect, engineer or energy consultant	64.3%	47.7%
	Equipment vendor or building contractor	50.0%	45.8%
	Other	14.3%	1.2%

Q4. 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	57.1%	89.9%
	Somewhat important	28.6%	6.5%
	Only slightly important	0.0%	0.0%
	Not important at all	14.3%	3.6%
	Totals	100%	100%

Q5. 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	64.3%	83.7%
	Somewhat important	21.4%	12.4%
	Only slightly important	7.1%	0.9%
	Not important at all	7.1%	3.0%
	Totals	100%	100%

Q6. 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	35.7%	66.7%
	Somewhat important	42.9%	29.2%
	Only slightly important	7.1%	1.1%
	Not important at all	7.1%	3.0%
	Don't know	7.1%	0.0%
	Totals	100%	100%

Q7. 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	50.0%	82.7%
	Somewhat important	42.9%	14.3%
	Only slightly important	0.0%	0.0%
	Not important at all	7.1%	3.0%
	Totals	100%	100%

Q8. How important are incentive payments from The Energy Trust or utilities in your decision making on energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	57.1%	76.5%
	Somewhat important	35.7%	22.4%
	Only slightly important	7.1%	1.1%
	Total:	100%	100%

Q9. 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	14.3%	2.2%
	Simple payback	28.6%	15.3%
	Internal rate of return	0.0%	0.0%
	Life cycle cost	14.3%	43.2%
	Other	28.6%	21.3%
	Don't know/no answer	14.3%	18.0%
	Totals	100%	100%

Q10. Besides the New Building Efficiency Program, has your company participated in any other energy efficiency incentive programs?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes, Other New Construction incentive programs	7.1%	3.0%
	Yes, Retrofit incentive programs	14.3%	13.3%
	Yes, Both types	35.7%	26.4%
	No, no others	35.7%	48.2%
	Don't know	7.1%	9.1%
	Totals	100%	100%

Q11. How many other building projects have you been involved with in the last five years?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	None	28.6%	7.1%
	1-2	35.7%	32.5%
	3-9	21.4%	57.0%
	10 or more	14.3%	3.4%
	Totals	100%	100%

Q11a. How easy has it been for you to comply with Oregon building code standards on other building projects in the past five years?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very easy	35.7%	21.1%
	Somewhat easy	35.7%	65.1%
	Somewhat difficult	7.1%	12.4%
	Very difficult	0.0%	0.0%
	Don't know	21.4%	1.5%
	Totals	100%	100%

Q11b. How easy was it for you to comply with Oregon building code standards on this building?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very easy	71.4%	81.7%
	Somewhat easy	21.4%	18.3%
	Somewhat difficult	7.1%	0.0%
	Very difficult	0.0%	0.0%
	Don't know	0.0%	0.0%
	Totals	100%	100%

Q12. Was there a formal commissioning agent for this building?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	There was a commissioning agent involved who performed verification and testing of building systems or who observed the testing.	35.7%	27.7%
	The equipment start-ups were done by individual contractors.	14.3%	17.6%
	Other	7.1%	42.0%
	No commissioning	35.7%	12.7%
	Don't know	7.1%	0.0%
	Totals	100%	100%

Q13. Before participating in the New Building Efficiency Program, had you installed any similar equipment/measures at other buildings you constructed?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	50.0%	69.3%
	No	50.0%	30.7%
	Totals	100%	100%

Q14. Did you have plans to install [Equipment/Measure] in this facility before participating in the New Building Efficiency Program?0	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	57.1%	30.9%
	No	42.9%	69.1%
	Totals	100%	100%

If answered "Yes" to Q14, Q14.1 Would you have gone ahead with this planned installation even if you had not participated in the NBE Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	50.0%	75.0%
	No	50.0%	25.0%
	Totals	100%	100%

Q15. How important was previous experience with a new construction program in making your decision to install [Equipment/Measure] at this facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	42.9%	64.6%
	Somewhat important	7.1%	17.1%
	Only slightly important	7.1%	0.0%
	Not important at all	28.6%	12.2%
	Don't know	14.3%	6.1%
	Totals	100%	100%

Q16. Did a representative of the New Building Efficiency Program recommend that you install [Equipment/Measure]?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	28.6%	16.1%
	No	71.4%	83.9%
	Totals	100%	100%

If answered "Yes" to Q16, Q16.1 If the New 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	21.4%	13.7%
	Probably would have installed	14.3%	1.5%
	Probably would not have installed	7.1%	12.4%
	Definitely would not have installed	0.0%	0.0%
	Don't know/no answer	57.1%	72.4%
	Totals	100%	100%

Q17. Would you have been financially able to install [Equipment/Measure] without the financial incentive from the New Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	92.9%	87.6%
	No	7.1%	12.4%
	Totals	100%	100%

Q18. If the financial incentive from the New 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	35.7%	12.3%
	Probably would have installed	57.1%	75.3%
	Probably would not have installed	7.1%	12.4%
	Definitely would not have installed	0.0%	0.0%
	Don't know/no answer	0.0%	0.0%
	Totals	100%	100%

Q19. How did the availability of information and financial incentives through the New 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	7.1%	9.1%
	Did not affect quantity purchased and installed	92.9%	90.9%
	Totals	100%	100%

Q20. How did the availability of information and financial incentives through the New 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	21.4%	21.5%
	Did not affect level of efficiency chosen for equipment	71.4%	78.5%
	Don't know/no answer	7.1%	0.0%
	Totals	100%	100%

Q21. How did you learn of the Energy Trust's New Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Approached directly by representative of New Building Efficiency Program	7.1%	5.9%
	Saw information brochure on New Building Efficiency Program	0.0%	0.0%
	Heard from other business owners or developers (word of mouth)	7.1%	0.0%
	Architect, engineer or energy consultant	0.0%	0.0%
	Equipment vendor or building contractor	28.6%	10.8%
	Other	21.4%	10.6%
	Don't know/no answer	35.7%	72.7%

Q22. 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 Trust energy efficiency incentive programs	21.4%	8.0%
	Before planning for the new building began	7.1%	0.1%
	During our planning to construct the building	71.4%	91.9%
	After planning was completed	0.0%	0.0%
	Other or don't know	0.0%	0.0%
	Totals	100%	100%

Q23. How easy was it for you to understand the requirements for participating in the New Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very easy	35.7%	67.5%
	Somewhat easy	57.1%	32.5%
	Somewhat difficult	7.1%	0.1%
	Very difficult	0.0%	0.0%
	Don't know	0.0%	0.0%
	Totals	100%	100%

Q24. How easy was it for you to meet the paperwork requirements of the New Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very easy	28.6%	66.9%
	Somewhat easy	57.1%	23.9%
	Somewhat difficult	14.3%	9.2%
	Very difficult	0.0%	0.0%
	Don't know	0.0%	0.0%
	Totals	100%	100%

Q25. How helpful were staff for the New Building Efficiency Program in answering questions and providing professional support?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very helpful	64.3%	94.1%
	Somewhat helpful	21.4%	3.6%
	Not very helpful	14.3%	2.2%
	Not at all helpful	0.0%	0.0%
	Don’t know	0.0%	0.0%
	Totals	100%	100%

Q26. Has your experience with the New 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	35.7%	64.7%
	No	64.3%	35.3%
	Totals	100%	100%

Q27. Given your experience with the New Building Efficiency Program, would you buy energy	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***

efficient equipment in the future even if the Energy Trust were not offering financial incentives for such equipment?	Yes	71.4%	25.5%
	No	7.1%	3.0%
	Don't know	21.4%	71.5%
	Totals	100%	100%

Q28. Overall, how would you rate your satisfaction with the New Building Efficiency program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Excellent	35.7%	31.0%
	Very good	50.0%	51.9%
	Good	7.1%	17.1%
	Fair	7.1%	0.1%
	Poor	0.0%	0.0%
	Don't know or no answer	0.0%	0.0%
	Totals	100%	100%

E.2 SURVEY RESPONSES: 2005 RESPONDENTS

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	71.4%	54.6%
	Somewhat important	22.9%	44.5%
	Don't know	5.7%	0.9%
	Totals	100%	100%

Q2. 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	57.1%	63.2%
	Based on staff recommendation to a decision maker	11.4%	18.0%
	Made by a group or committee	24.3%	17.8%
	Other	4.3%	0.3%
	Did not answer	2.9%	0.8%
	Totals	100%	100%

Q3. 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***
	NBE Program representative	12.9%	6.0%
	Utility company representative	25.7%	69.5%
	Brochure or advertisement	8.6%	7.4%
	Trade association or journals	17.1%	52.7%
	Friends and colleagues	14.3%	12.9%
	Architect, engineer or energy consultant	67.1%	86.4%
	Equipment vendor or building contractor	61.4%	82.8%
	Other	5.7%	1.2%

Q4. 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	48.6%	47.2%
	Somewhat important	30.0%	48.8%
	Only slightly important	14.3%	2.6%
	Not important at all	2.9%	0.7%
	Don't know	4.3%	0.7%
	Totals	100%	100%

Q5. 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	41.4%	44.7%
	Somewhat important	34.3%	8.7%
	Only slightly important	11.4%	43.2%
	Not important at all	2.9%	0.1%
	Don't know	10.0%	3.3%
	Totals	100%	100%

Q6. 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	31.4%	53.1%
	Somewhat important	32.9%	24.7%
	Only slightly important	10.0%	2.5%
	Not important at all	12.9%	11.8%
	Don't know	12.8%	7.9%
	Totals	100%	100%

Q7. 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	47.1%	55.3%
	Somewhat important	32.9%	31.2%
	Only slightly important	7.1%	5.1%
	Not important at all	11.4%	8.4%
	Don't know	1.4%	0.0%
	Totals	100%	100%

Q8. How important are incentive payments from The Energy Trust or utilities in your decision making on energy efficiency improvements?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	55.7%	60.7%
	Somewhat important	28.6%	26.5%
	Only slightly important	10.0%	5.6%
	Not important at all	5.7%	7.3%
	Total:	100%	100%

Q9. 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	21.4%	6.5%
	Simple payback	25.7%	6.6%
	Internal rate of return	10.0%	7.6%
	Life cycle cost	11.4%	46.4%
	Other	20.0%	29.0%
	Don't know/no answer	11.4%	3.7%
	Totals	100%	100%

Q10. Besides the New Building Efficiency Program, has your company participated in any other energy efficiency incentive programs?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes, Other New Construction incentive programs	18.6%	21.9%
	Yes, Retrofit incentive programs	17.1%	7.3%
	Yes, Both types	18.6%	54.8%
	No, no others	35.7%	11.4%
	Don't know	10.0%	4.6%
	Totals	100%	100%

Q11. How many other building projects have you been involved with in the last five years?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	None	28.6%	5.5%
	1-2	25.7%	52.1%
	3-9	24.3%	14.1%
	10 or more	21.4%	28.3%
	Totals	100%	100%

Q11a. How easy has it been for you to comply with Oregon building code standards on other building projects in the past five years?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very easy	17.1%	9.2%
	Somewhat easy	31.4%	20.0%
	Somewhat difficult	14.3%	56.1%
	Very difficult	1.4%	0.0%
	Don't know	35.7%	37.9%
	Totals	100%	100%

Q11b. How easy was it for you to comply with Oregon building code standards on this building?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very easy	38.6%	23.5%
	Somewhat easy	40.0%	53.6%
	Somewhat difficult	8.6%	14.1%
	Very difficult	2.9%	0.2%
	Don't know	10.0%	8.5%
	Totals	100%	100%

Q12. Was there a formal commissioning agent for this building?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	There was a commissioning agent involved who performed verification and testing of building systems or who observed the testing.	27.1%	49.8%
	The equipment start-ups were done by individual contractors.	24.3%	12.7%
	Other	10.0%	16.0%
	No commissioning	31.4%	16.9%
	Don’t know	7.1%	4.6%
	Totals	100%	100%

Q13. Before participating in the New Building Efficiency Program, had you installed any similar equipment/measures at other buildings you constructed?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	47.1%	38.6%
	No	50.0%	60.7%
	No response	2.8%	0.6%
	Totals	100%	100%

Q14. Did you have plans to install [Equipment/Measure] in this facility before participating in the New Building Efficiency Program?0	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	58.6%	74.4%
	No	40.0%	25.0%
	No response	1.4%	0.6%
	Totals	100%	100%

If answered “Yes” to Q14, Q14.1 Would you have gone ahead with this planned installation even if you had not participated in the NBE Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	48.6%	69.8%
	No	12.9%	6.6%
	No response	38.5%	23.7%
	Totals	100%	100%

Q15. How important was previous experience with a new construction program in making your decision to install [Equipment/Measure] at this facility?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very important	37.1%	20.2%
	Somewhat important	30.0%	24.4%
	Only slightly important	4.3%	0.8%
	Not important at all	15.7%	12.7%
	Don't know	12.9%	41.9%
	Totals	100%	100%

Q16. Did a representative of the New Building Efficiency Program recommend that you install [Equipment/Measure]?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	10.0%	19.4%
	No	85.7%	79.1%
	No response	4.3%	1.5%
	Totals	100%	100%

If answered "Yes" to Q16, Q16.1 If the New 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	2.9%	2.8%
	Probably would have installed	5.7%	6.4%
	Probably would not have installed	1.4%	0.1%
	Definitely would not have installed	4.3%	13.9%
	Don't know/no answer	85.7%	76.9%
	Totals	100%	100%

Q17. Would you have been financially able to install [Equipment/Measure] without the financial incentive from the New Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	70.0%	82.9%
	No	12.9%	6.7%
	Don't know/no answer	17.1%	10.4%
	Totals	100%	100%

Q18. If the financial incentive from the New 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	34.3%	16.2%
	Probably would have installed	42.9%	59.3%
	Probably would not have installed	15.7%	8.2%
	Definitely would not have installed	4.3%	13.9%
	Don't know/no answer	2.9%	2.4%
	Totals	100%	100%

Q19. How did the availability of information and financial incentives through the New 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	15.7%	4.4%
	Did not affect quantity purchased and installed	84.3%	95.6%
	Totals	100%	100%

Q20. How did the availability of information and financial incentives through the New 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	40.0%	26.7%
	Did not affect level of efficiency chosen for equipment	60.0%	73.3%
	Totals	100%	100%

Q21. How did you learn of the Energy Trust's New Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Approached directly by representative of New Building Efficiency Program	7.1%	1.2%
	Saw information brochure on New Building Efficiency Program	1.4%	0.0%
	Heard from other business owners or developers (word of mouth)	5.7%	4.3%
	Equipment vendor or building contractor	47.1%	36.6%
	Other	28.6%	5.7%
	Don't know/no answer	10.0%	52.2%

Q22. 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 Trust energy efficiency incentive programs	10.0%	2.3%
	Before planning for the new building began	22.9%	20.6%
	During our planning to construct the building	42.9%	62.0%
	After planning was completed	15.7%	7.1%
	Other or don't know	8.6%	8.0%
	Totals	100%	100%

Q23. How easy was it for you to understand the requirements for participating in the New Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very easy	32.9%	12.1%
	Somewhat easy	35.7%	27.2%
	Somewhat difficult	15.7%	47.4%
	Very difficult	2.9%	2.8%
	Don't know	12.9%	10.5%
	Totals	100%	100%

Q24. How easy was it for you to meet the paperwork requirements of the New Building Efficiency Program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very easy	34.3%	12.4%
	Somewhat easy	32.9%	23.4%
	Somewhat difficult	12.9%	47.7%
	Very difficult	5.7%	1.3%
	Don't know	14.3%	15.2%
	Totals	100%	100%

Q25. How helpful were staff for the New Building Efficiency Program in answering questions and providing professional support?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Very helpful	54.3%	27.0%
	Somewhat helpful	24.3%	50.5%
	Not very helpful	4.3%	4.3%
	Not at all helpful	1.4%	1.1%
	Don’t know	15.7%	17.0%
	Totals	100%	100%

Q26. Has your experience with the New 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	31.4%	14.4%
	No	55.7%	74.6%
	No response	12.9%	10.9%
	Totals	100%	100%

Q27. Given your experience with the New Building Efficiency Program, would you buy energy efficient equipment in the future even if the Energy Trust were not offering financial incentives for such equipment?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Yes	71.4%	73.5%
	No	11.4%	14.5%
	Don’t know	17.1%	12.0%
	Totals	100%	100%

Q28. Overall, how would you rate your satisfaction with the New Building Efficiency program?	***Response***	***Percent of Population N***	***Percent of Population Realized kWh Savings***
	Excellent	27.1%	16.6%
	Very good	41.4%	28.0%
	Good	21.4%	45.6%
	Fair	1.4%	1.1%
	Poor	4.3%	0.9%
	Don’t know or no answer	4.3%	7.8%
	Totals	100%	100%