Final Report

Preliminary Energy Savings Impact Evaluation: Better Buildings Neighborhood Program

American Recovery and Reinvestment Act of 2009

November 4, 2013

Prepared For:

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy

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Funded By:

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This document presents the findings from the preliminary impact evaluation of the U.S. Department of Energy's (DOE) Better Buildings Neighborhood Program (BBNP). The report was prepared in partial fulfillment of a contract with the Lawrence Berkeley National Laboratory to conduct a comprehensive program assessment of BBNP. Jeff Dowd of DOE's Office of Energy Efficiency & Renewable Energy (EERE) was the DOE Project Manager. Technical oversight of the project was provided by Ed Vine, Staff Scientist, of Lawrence Berkeley National Laboratory. Jeff Dowd, of DOE's Office of Energy Efficiency and Renewable Energy (EERE) was the DOE project manager.

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BBNP grantees are frequently being asked to explain their program activities and to report and document their accomplishments and we know that they are extremely busy. We appreciate their cooperativeness and friendliness regarding our requests and questions. We anticipate that many future discussions will continue to illuminate the accomplishments of the Better Buildings Neighborhood Program and we look forward to conducting the final impact evaluation activities to bring these to light.

We also want to thank the teams at Nexant, Research Into Action and Evergreen for their efforts to develop and produce this report.

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- Bill Miller, Lawrence Berkeley National Laboratory
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Notice

Table of Contents

List of Figures

List of Tables

Executive Summary

This document presents the findings from the preliminary impact evaluation of the U.S. Department of Energy's (DOE) Better Buildings Neighborhood Program (BBNP). The report was prepared in partial fulfillment of a contract with the Lawrence Berkeley National Laboratory to conduct a comprehensive program assessment of BBNP.

BBNP is one of many programs funded through the American Recovery and Reinvestment Act of 2009. Total funding under BBNP is approximately $508 million for energy efficiency upgrade and improvement programs for residential, commercial, multifamily, and agriculture sectors. The state and local governmental entities that were awarded the grants worked with nonprofits, building energy efficiency experts, financial institutions, utilities, and other organizations to develop community-based programs and incentives for building energy upgrades. Each grantee proposed, and is implementing, its own program design to deliver energy efficiency within its designated jurisdiction.

Initially, DOE made 25 awards to local governmental or nonprofit organizations in amounts ranging from $1.2 to $40 million through the competitive Energy Efficiency and Conservation Block Grant (EECBG) program. Nine similar grantees were awarded funding from the Formula EECBG program while seven grantees were awarded funding from the State Energy Program solicitation, resulting in 41 total BBNP grantees.

The three BBNP objectives are:

1. Initiate building energy upgrade programs that promote projects estimated to achieve energy savings in more than 40 communities.
2. Demonstrate more than one sustainable business model for providing energy upgrades to a large percentage of the residential and/or commercial buildings in a specific community.
3. Identify and spread the most effective approaches to completing building energy upgrades that support the development of a robust retrofit industry in the United States.

BBNP seeks to increase the overall energy efficiency of residential and nonresidential facilities through home and building assessments, a trained workforce, and through financing and incentives that lead to energy efficiency upgrades.

Evaluation Objectives

The overall objective of the preliminary impact evaluation was to develop independent, quantitative estimates of BBNP's economic impacts and energy savings for projects completed from the onset of programmatic activities in the fourth quarter of 2010 through the second quarter of 2012. Additionally, through this preliminary evaluation, the team sought to provide lessons learned and recommendations to DOE and the grantees who wish to continue their programs after the grant funding has ended. The team intends to use the preliminary evaluation findings to inform the research plan for the final impact evaluation activities, which will begin immediately after approval of this report.

Methodology

The evaluation of BBNP is unique due to the program's significant scope, size, and reporting methodology. Grantees collected and reported a wide range of information, and the team worked to design a flexible methodology that handled the variety of information that was available. The impact evaluation consisted of three high-level activities to determine verified energy savings of the programs offered by the grantees and also consisted of an economic analysis to determine gross and net economic and fiscal impacts.

The activities to determine gross and net verified energy savings included:

- Measurement and Verification (M&V) of a sample of grantees and projects. M&V activities were conducted to determine gross verified energy savings through a combination of file reviews, telephone surveys, on-site inspections, and engineering analysis of projects. Because it was not cost-effective to complete analysis and site inspections on a census of the programs and the program projects, savings were verified for a representative sample of projects.
- Billing analysis on projects from grantees with sufficient utility bill data. The evaluation team also conducted a billing analysis to estimate realized energy savings[1] at the project level. The scale of this billing analysis depended on the availability of sufficient pre and post-installation utility billing data for a large enough sample of end-use customers to support a regression model.
- Net-to-Gross (NTG) analysis on the M&V sample population.[2] Attribution surveys were conducted on the same sample population that received M&V activities.[3] Surveys were conducted via telephone with the goal of understanding participant behavior and actions due to the program influence.

The preliminary impact evaluation utilized data from multiple sources: grantee databases, DOE databases and utility bills. For the M&V activities and NTG analysis, surveys were conducted with over 300 residential and commercial project participants across a sample of 36 grantee

1 Realized energy savings are the savings calculated through the billing analysis at the participant site.

2 The Net to Gross analysis sought to determine BBNP's level of influence on the project implementation by the participant. The savings verified through the evaluation activities are considered "gross verified savings." These gross verified savings are adjusted by applying a factor (net to gross ratio) to determine the overall net verified savings. This factor was obtained through the use of participant surveys that measured the influence BBNP had on their decision to participate.

3 Attribution surveys were administered on a sample of participants to determine a net-to-gross ratio, which is a measure of how much influence BBNP had on the individual participants to implement the projects.

locations. Billing analysis was completed for four grantees. Ultimately, the results from all the activities were combined and extrapolated to the population in order to determine the overall verified energy savings estimated for BBNP.

Measuring the economic impacts estimated for BBNP is a complex process, as spending by grantees and program participants unfold over time. Due to this complexity, this analysis focused on short-term impacts, which are associated with changes in business activity as a direct result of changes in spending (or final demand) by program administrators, program participants, and institutions that provide funding for energy efficiency programs. The economic modeling framework that best measures these short-term economic impacts is called input-output modeling. Input-output models involve mathematical representations of the economy that describe how different parts (or sectors) are linked to one another. To conduct this modeling, the teams relied on an economic impact model of the US economy constructed using the IMPLAN (for IMpact Analysis for PLANning) modeling software.

Findings

The evaluation team estimated gross verified savings and realization rates[4] for the residential and commercial sectors using both results from M&V activities and the billing analysis regression as well as the energy savings reported by DOE. These reported savings were obtained from a project level database provided by DOE that compiled savings reported from each grantee for projects implemented in their communities. The net verified savings were calculated using customer attribution surveys. Savings are presented as *source* energy savings in million British thermal units (MMBtu) as this is how savings are reported by DOE.[5] Table ES-1 outlines the overall energy savings reported by BBNP and those verified by the evaluation team through the 2nd Quarter of 2012.

Table ES-1: BBNP Reported and Verified Gross and Net Energy Savings thru Q2 2012

Sector	Reported Projects **	Reported Source Savings (MMBtu)**	Realization Rate (%)	Gross Verified Source Savings (MMBtu)	NTG Ratio	Net Verified Source Savings (MMBtu)	Confidence / Precision
Residential	27,743	1,116,160	79%	883,999	83%	733,816	90/7
Commercial	1,333	667,108	106%	706,545	92%	646,888	90/12
Multifamily*	3,119	83,839	—	—	—	—	—

Continued

4 A realization rate represents the ratio of the energy savings verified by the evaluation activities and the savings reported by BBNP.

5 Source energy savings represent the sum of the savings at the facility (often referred to as *site* savings) and the savings from the energy not having to be extracted, converted, and transmitted to the facility due to the energy efficiency or renewable energy project.

Sector	Reported Projects **	Reported Source Savings (MMBtu)**	Realization Rate (%)	Gross Verified Source Savings (MMBtu)	NTG Ratio	Net Verified Source Savings (MMBtu)	Confidence / Precision
Agricultural*	59	9,220	—	—	—	—	—
Total	**32,254**	**1,876,327**	—	**1,590,544**	—	**1,380,704**	**90/7**

* The multifamily and agricultural sectors were not included in the evaluation activities due to a small amount of activity and a lack of data provided by grantees to the evaluation team. Therefore, verified savings totals do not include savings from these two sectors.

** Project Level Databases provided by DOE were used to obtain the reported projects and energy saving values.

One of the goals of this evaluation was to achieve 90% confidence and 10% precision of the results at the overall BBNP level. As shown in Table ES-1, the evaluation activities achieved 90% confidence and 7% precision for BBNP.

Table ES-2 reports the estimated net and gross economic and fiscal impacts, between Q4 2010 and Q2 2012. Since BBNP funds could have been re-directed and used to support other federal government programs, we accounted for this by adjusting gross economic impacts for foregone federal government spending on non-defense programs.[6] This counterfactual is based on the total outlays incurred between Q4 2010 and Q2 2012 and is important to include, since reporting only gross impacts will overstate the economic benefits of any activity approximated for BBNP (i.e., program funds would have been spent on other things if BBNP had not been funded). Consequently, these *net impacts* reflect economic benefits over and above what would have occurred had BBNP not existed, and as such are of particular interest. The total gross and net economic impacts approximated for BBNP are reported in Table ES-2.

Table ES-2: BBNP Total Gross and Net Economic Impacts, Q4 2010 – Q2 2012

Impact Measure	Total Gross Impacts	Total Net Impacts
Output ($ millions)	$1,070.7	$655.6
Personal Income ($ millions)	$376.9	$155.4
Jobs (person-years of employment)	6,681	4,266
State and Local Taxes ($ millions)	$42.2	$24.3
Federal Taxes ($ millions)	$68.4	$30.1

6 An alternative counterfactual scenario would be to assume that the BBNP funding is returned to taxpayers and spent in a way that follows historical purchase patterns. Since the government sector spending has a great multiplier effect on the economy than this alternative, the counterfactual scenario used in this analysis results in a more conservative estimate of net economic impacts due to BBNP spending.

Key Lessons Learned

This preliminary impact evaluation attempted to verify the savings of a $500 million program that allocated resources to varied energy efficiency programs across the country. The challenges associated with this task, including difficulty in acquiring grantee data, lack of quality control/assurance leading to inaccuracies of reported metrics, and the large scale and broad scope of grantee programs affected the team's ability to conduct this evaluation. While navigating these challenges, we learned many lessons that will help shape the future of similar programs that may be offered through a comparable grant process and that will aid in the planning and development of the final impact evaluation activities. The following is a summary of the key lessons learned. A more detailed discussion is presented in the main body of the report.

- Evaluators need to be flexible. Actual evaluation activities diverged from the evaluation plan based on additional and revised information obtained from the grantees. Many grantees provided periodic project updates that adjusted savings and project counts throughout the evaluation activities. The team had to be flexible in our sampling strategy (for both the M&V and billing analysis) and carefully make adjustments based on these updates and revisions in order to maintain a valid data set and evaluation analysis.
- Allow sufficient time to request and gather data from the grantees. Grantees are busy, and unlike most utility-funded efficiency program managers, they are not equipped with the tools and databases to easily extract participant and project level information. In addition, grantees are frequently understaffed, so making clear and concise data requests are necessary to help speed up the response time and alleviate any concerns or questions that they may have regarding data needs. For the final impact evaluation, it will be necessary to give grantees sufficient time and very clear directions when making requests for data.
- Phone verifications had limited value. Phone verifications are standard practice in many utility-funded impact evaluations. While the phone surveys were useful in verifying overall project participation and obtaining attribution information, the team determined that the phone verifications utilized for the M&V activities often proved to have limited value due to factors such as: difficulty for participants to gather key data on measures implemented, confusion regarding the measure funding source (BBNP or local utility program), and uncertainty surrounding baseline and new equipment.
- On-site verifications were valuable. While on-site surveys encounter some of the same issues with reliability as the phone surveys, the on-site surveys were valuable in obtaining a greater level of detail regarding project implementation than could be obtained during phone verifications and file review.

Recommendations

The lessons learned by the evaluation team led to several recommendations for the planning and design of the final impact evaluation. In addition, these lessons informed short-term and long-term recommendations for DOE and the grantees when/if programs of a similar nature are offered in the future. A more detailed discussion is presented in the main body of the report.

Recommendations for the Final Evaluation

Based on the lessons learned during the preliminary impact evaluation activities and the subsequent findings, the team has a number of recommendations for proceeding with the final impact evaluation.

- Reduce participant telephone surveys, conduct more participant on-site visits.
- Ensure the sampling strategy accounts for the end of each grantee's funding cycle by appropriately scheduling necessary data collection activities.
- Overlap billing analysis and M&V sample frames.

Short-Term Recommendations for DOE

As discussed above, the grant funding cycle is coming to a close and many grantees may be ending their programs over the next 3-6 months. However, based on the lessons learned and our interactions with grantees during the preliminary impact evaluation, the team has several recommendations to DOE to aid in more accurate data collection and overall reporting during these last few months.

- Request that grantees match project–level tracking values with overall quarterly tracking values.
- Conduct more investigation into the savings of four unresponsive grantees.
- Investigate opportunities for increasing reported measure accuracy by continuing to provide support to grantees where there appears to be insufficient QA/QC.
- Work with grantees to reduce or eliminate the reporting of zero savings values for projects that indeed achieved energy savings.
- Compile one final dataset to be used for all reporting and analysis in the final evaluation.

Long-Term Recommendations for DOE

The grant cycle for BBNP is coming to a close, and it is uncertain whether future funding will become available to support a program similar to BBNP. If DOE or a similar organization chooses to fund a program like BBNP in the future, the team proposes several recommendations below to help ensure more consistency in program expectations, design, tracking and reporting.

- Plan and develop a comprehensive and easy to use data tracking and reporting system.
- Assess requiring grantees provide timely and accurate progress reports in order to receive funding.
- Require consistent documentation procedures across all grantees and programs.

1 Introduction

Research Into Action, NMR Associates, Nexant Inc., and Evergreen Economics were retained by the Lawrence Berkeley National Laboratory (LBNL) and the U.S. Department of Energy (DOE) to conduct a comprehensive evaluation project (Project) of DOE's Better Buildings Neighborhood Program (BBNP). This Project includes the following components:

- A preliminary process evaluation focusing on the early program period.
- A preliminary impact evaluation focusing on the early grantee projects and including a limited market effects analysis.
- A final process evaluation covering the entire program period.
- A final impact evaluation focusing on all grantee projects, including a limited market effects analysis.

This Preliminary Energy Savings Impact Report (report) details methods used and the estimated quantitative findings for the preliminary impact evaluation period (fourth quarter 2010 through second quarter 2012). The methods used for the evaluation include the use of utility billing regression analysis and measurement & verification in order to quantify energy savings and associated metrics for the residential and commercial sectors. While many grantees also provided services to the multifamily and agricultural sectors, these were not analyzed as part of this report due to a lack of available data.

The report also includes the methodology and the findings from the economic impact analysis, which includes an estimate of jobs (as measured in person-years of employment) as well as estimates of economic output, income (personal and business), and tax revenue that resulted from BBNP program spending.

The report details the evaluation findings from the onset of grantee program delivery in the fourth quarter of 2010 through the second quarter of 2012. The final evaluation will build from the results of this preliminary impact evaluation and detail the overall findings for BBNP through the entire grant period (fourth quarter 2010 through third quarter 2014).

1.1 Program Description

BBNP is a component of the Better Buildings Initiative - a program within DOE's Office of Energy Efficiency and Renewable Energy (EERE). BBNP is one of many programs funded through the American Recovery and Reinvestment Act of 2009 (ARRA).[7]

DOE issued three separate funding opportunities to support BBNP partners. In October 2009, DOE issued the first competitive funding opportunity announcement (FOA), using Energy Efficiency and Conservation Block Grant (EECBG) funds to provide grants to state and local governments for the purpose of testing potential energy upgrade business models and improving building energy efficiency across the country.[8] Additional EECBG funds were allocated through DOE's Formula EECBG program.[9] In June and August 2010, DOE awarded $482 million to 34 grant recipients in amounts ranging from $1.4 million to $40 million.

In April 2010, DOE issued a second competitive FOA under the State Energy Program (SEP) for additional awards, and in November 2010, DOE awarded $26 million to seven SEP award recipients.[10]

Total funding under BBNP is approximately $508 million for energy efficiency upgrade and improvement programs for residential, commercial, multifamily, and agriculture sectors. The state and local governmental entities that were awarded the grants worked with nonprofits, building energy efficiency experts, financial institutions, utilities, and other organizations to develop community-based programs and incentives for building energy upgrades. Each grantee is implementing its own program design to deliver energy efficiency within its designated jurisdiction.

The 41 grantees, as well as multiple sub-grantees, are operating across the United States and its territories (Figure 1-1).

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7 ARRA distributed its funding in three ways: tax benefits; contracts, grants and loans; and entitlements. BBNP is one of the many programs funded by ARRA.

8 *Competitive Solicitation: Retrofit Ramp-up and General Innovation Fund Programs, Funding Opportunity Announcement Number: DE-FOA-0000148*, Announcement Type: Initial CFDA Number: 81.128 Energy Efficiency and Conservation Block Grant Program (EECBG).

9 *Recovery Act – Energy Efficiency and Conservation Block Grants – Formula Grants Funding Opportunity Number : DE-FOA-0000012*, Announcement Type Amendment 000003, CFDA Number: 81.128 Energy Efficiency and Conservation Block Grant Program (EECBG).

10 *State Energy Program (SEP) Strengthening Building Retrofit Markets and Stimulating Energy Efficiency Action DE-FOA-0000251*, Announcement Type: Initial CFDA Number: 81.041.

Figure 1-1: Grantee Locations

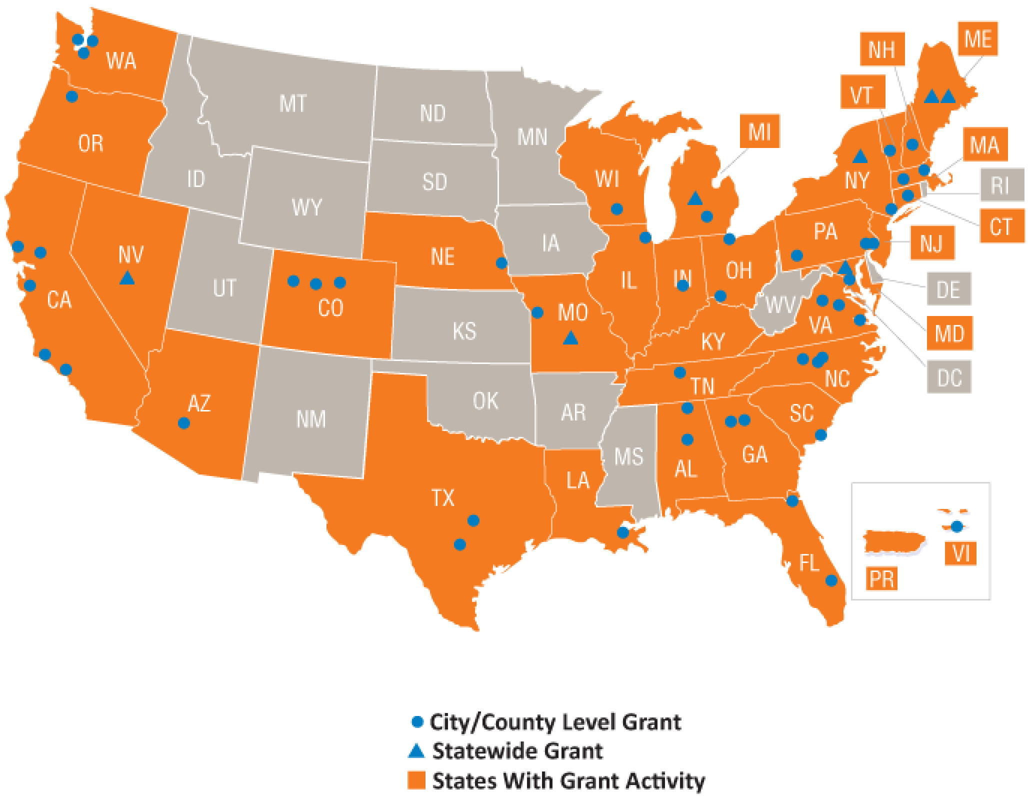


Table 1-1 outlines the original funding amount that each grantee was awarded. This funding was designed to assist grantees with achieving the original goal of over 100,000 projects across all grantees.

Table 1-1: Original Grantee Budgets

GRANTEE LOCATION	TOTAL GRANTED
State of New York	$40,000,000
Los Angeles County, CA	$30,000,000
State of Maine	$30,000,000
State of Michigan	$30,000,000
Boulder County, CO	$25,000,000
Chicago, IL	$25,000,000
Philadelphia, PA	$25,000,000
Phoenix, AZ	$25,000,000

Continued

Grantee Location	Total Granted
Kansas City, MO	$20,000,000
State of Maryland	$20,000,000
Portland, OR	$20,000,000
Seattle, WA	$20,000,000
Southeast Energy Efficiency Alliance (SEEA)	$20,000,000
State of Wisconsin	$20,000,000
Cincinnati, OH	$17,000,000
Toledo, OH	$15,000,000
Austin, TX	$10,000,000
Indianapolis, IN	$10,000,000
State of New Hampshire	$10,000,000
Omaha, NE	$10,000,000
San Antonio, TX	$10,000,000
Camden, NJ	$5,000,000
Greensboro, NC	$5,000,000
Lowell, MA	$5,000,000
State of Missouri	$5,000,000
State of Nevada (SEP)	$5,000,000
State of Michigan (SEP)	$4,994,245
Eagle County, CO	$4,916,126
Bainbridge Island, WA	$4,884,614
State of Maine (SEP)	$4,538,571
Rutland County, VT	$4,487,588
State of Connecticut	$4,171,214
Fayette County, PA	$4,100,018
State of Alabama (SEP)	$3,013,751
St. Lucie County, FL	$2,941,500
State of Virginia (SEP)	$2,886,500
Commonwealth of MA (SEP)	$2,587,976
State of Washington (SEP)	$2,587,500
Santa Barbara County, CA	$2,401,309
Town of University Park, MD	$1,425,000
Town of Bedford, NY	$1,267,874
Total	**$508,203,786**

1.1.1 Program Terminology

In order to effectively communicate key details of the report and ensure consistency with the process and market evaluations, the following terminology will be used throughout. The BBNP will refer to the entire grant program encompassing both EECBG and SEP grants. *Grantees* will refer to the states, counties, cities, and organizations that were awarded the funds while *sub-grantees* are the organizations or local governments that received funding from the grantees. The grantees are operating *programs* with the awarded funding and may have sub-grantees operating programs as well. These programs encompass a variety of activities including contractor training programs, financing programs, rebate programs, energy assessments, etc. *Participants* are the businesses, residents, or contractors who take part in these programs. A collection of one or more energy upgrade measures that are implemented by a participant in a home or building is considered a *project*.

1.1.2 Summary Reported Program Accomplishments

The DOE provided the evaluation team access to databases used by DOE for reporting purposes. These databases detailed the performance of the grantees from the time the grants were awarded in August 2010 through the 2nd Quarter of 2012 and is based on information reported directly by each grantee through DOE's Better Buildings Information System (BBIS). As of 2nd Quarter 2012, all of the grantees had launched programs in an effort to achieve the goals laid out by DOE, with all but one of them having achieved project implementation. Based on these DOE databases, the grantees reported the achievements through Q2 2012 as shown in Table 1-2.

Table 1-2: BBNP Reported Progress through Q2 2012

Metric	Through Q2 2012 Result	Overall Program Budget/Goal	Percent Total Achieved
Spending	$245.7 million	$508 million	48%
Projects	32,254	172,792	19%
Grantees with Projects	40	41	98%
Total Reported Energy Savings (Source)	1,876,327 MMBtu	—	—
$/MMBtu Saved (Source)	$130.9/MMBtu	—	—

The reported energy savings resulted from programs spanning four different sectors served by the grantees: residential, commercial, multifamily, and agriculture. The DOE reports total energy savings as *source* energy savings in million British thermal units (MMBtus). Source energy savings represent the sum of the savings at the facility (often referred to as *site* savings) and the savings from the energy not having to be extracted, converted, and transmitted to the facility due to the energy efficiency or renewable energy project. In this report, source energy savings are used unless otherwise noted. Additionally, grantees reported savings from a number of different fuel types including electricity, natural gas, fuel oil, propane, kerosene, and wood. In order to convert the savings achieved from these different fuel types to site and source MMBtu savings, the team used the conversion factors found in Appendix F.

1.2 Evaluation Goals and Objectives

The overall objective of the preliminary impact evaluation was to develop independent, quantitative estimates of energy and cost savings for projects completed through the second quarter of 2012. Through this preliminary evaluation, the team provided lessons learned and recommendations to DOE and the grantees who wish to continue their programs after the grant funding has ended, and the team intends to use the preliminary evaluation findings to inform the research plan for the final impact evaluation activities. Section 5 outlines these lessons learned and recommendations.

In order to determine the estimated energy and cost savings, the team collected data from a sample of projects across a sample of grantees. These data, along with other information gathered as part of the activities, were utilized to determine gross and net impacts. These activities were not intended to be an evaluation of the individual grantees, which would require a much greater level of sampling, data collection, and overall effort. As a result, this report does not document or present specific findings and impacts attributable to individual grantee programs.

Table 1-3 presents the key metrics measured as part of this evaluation in an effort to gauge results through Q2 2012.

Table 1-3: Key Metrics

Key Metric	Description
Number of Energy Units Saved – by Project, by Program	These units include annual and lifetime kWh, kW, therms, gallons of oil, and MMBtus, and will be weather-normalized.
Costs Saved – by Project, by Program	This includes the value of annual and lifetime energy savings, demand reduction, and renewable energy generation at current customer costs.
Number of Energy Efficiency Measures Installed	Based on tracking data provided from grantees, this includes all measures installed in the building retrofit projects.
Number of Households/ Businesses Retrofitted	These totals are based on the tracking data provided from grantees and verified for a sample of projects.
Number of Renewables Installations	These totals are based on tracking data provided by grantees and verified for a sample of projects.
Number of Renewables MW Installed	This are based on engineering analysis of the total number of installations.
Number of Jobs Created/ Retained	This is measured in person-years of employment and is based on surveys and modeling the impacts against a base case scenario.
Economic Output	This is based on modeling the impacts against a base case scenario.
Personal and Business Income	This is based on modeling the impacts against a base case scenario.
Tax Revenue	This is based on modeling the impacts against a base case scenario.

While the impact evaluation team understands that the goal of the evaluation was to measure and quantify all of the key metrics outlined above, the evaluation had challenges quantifying some of the key metrics due to data and reporting issues. For example, individual measure information for each project was variable within DOE databases, and inaccuracies in data quality were found.

1.3 Summary of Key Evaluation Activities

The Project commenced in February 2012, with a project kick-off meeting followed by the development of the Preliminary Evaluation Plan (Plan). In June 2012, the Plan was submitted for review and comment by DOE and a peer review group consisting of experts in the energy efficiency evaluation field. Based on review comments from DOE and the peer reviewers, the evaluation team decided to conduct a preliminary assessment prior to finalizing the Plan. This allowed the impact team to interview grantees regarding the availability of data, their data collecting and reporting processes, and how each grantee estimated energy and cost savings for their projects and program. The preliminary assessment was conducted in the fall of 2012, and based on the findings of the assessment; the final version of the Plan was submitted to DOE in January 2013.[11] In February 2013, after approval was received on the Plan, the impact evaluation activities commenced with the sampling process, data collection, billing analysis, verification activities and the economic analysis. Table 1-4 provides a summary of the major activities and deliverables associated with the preliminary impact evaluation.

Table 1-4: Summary of Major Preliminary Impact Evaluation Project Deliverables

ACTIVITIES AND DELIVERABLES	COMPLETION DATE
Project Kick-Off	February 2012
Draft Evaluation Plan	June 2012
Presentation of Evaluation Plan to Peer Review Board	July 2012
Grantee Interviews	July - August 2012
2nd Draft Evaluation Plan	December 2012
Final Evaluation Plan	January 2013
Draft Preliminary Impact Evaluation Findings	June 2013
Final Preliminary Evaluation Findings	July 2013

As will be discussed in the Section 3, the evaluation team utilized two major approaches for determining gross savings: utility bill regression analysis, and measurement and verification (M&V) on a sample of grantee projects. Table 1-5 outlines the specific tasks and timelines associated with these approaches.

11 *Final Energy Savings Research Plan, Better Buildings Neighborhood Program*, Research Into Action Team for Lawrence Berkeley National Lab, January 18, 2013.

Table 1-5: Schedule of Major Evaluation Activities

IMPACT EVALUATION ACTIVITIES	COMPLETION DATE
Database and Project File Review	January - March 2013
Billing Data Requests	February 2013
Grantee Data Requests	February - March 2013
Participant Verification Phone Surveys	March - April 2013
On-site Verification Surveys	April 2013
Billing Analysis	March - May 2013
Economic Analysis	March - May 2013
M&V Analysis	May 2013
Report Writing	May - June 2013

Based on the varying level of information available for each grantee, the team utilized either the billing regression analysis or M&V to verify savings for a sample of grantees. Table 1-6 summarizes the final sample results used for the residential and commercial sectors by these evaluation activities. The sampling methodology is discussed later in Section 3.

Table 1-6: Summary of Executed Evaluation Sample and Activities

SECTOR	MEASUREMENT & VERIFICATION		BILLING ANALYSIS	
	Grantees	Number of Sample Projects	Grantees	Number of Sample Projects
Residential	18	217	4	1,145
Commercial	10	102	N/A	N/A
Total	**28**	**319**	**4**	**1,145**

1.4 Evaluation Challenges

This preliminary impact evaluation attempted to verify the savings of a $500 million program that allocated resources to varied programs across the country. The challenges associated with this task were significant and affected the team's ability to conduct this evaluation. Throughout the implementation activities, the team needed to adjust strategies based on cost, availability of data, and feasibility of the timelines. While these challenges presented risks to the validity of the study, the team worked to mitigate these risks through planning and the implementation of a sound sampling methodology. These challenges will be outlined below, while Section 3 will present our methodology that addressed these challenges. The main challenges included:

- Difficulty interpreting grantee data
- Inaccuracies of DOE reported metrics
- Delayed or lack of grantee responsiveness

- Unreliability in participant phone verification surveys
- Large scope and broad scale of the grantee programs

1.4.1 Difficulty Interpreting Grantee Data

The grantees were responsible for submitting metrics associated with project impacts and program operation on a quarterly basis to DOE. However, the grantees were allowed to utilize varying methods for tracking and quantifying savings, which created a number of challenges associated with understanding and interpreting the data. The four main issues that came out of this challenge included:

1. Quantification of Savings. In order to calculate the estimated energy savings reported to DOE, grantees use a deemed approach, modeled approach or a combination of both. The deemed approach involved the use of predetermined energy savings values for measures implemented for each project. The modeled approach involved the use of energy models that are built specifically to the project parameters (i.e., building type, sq. ft., energy using systems, weather, etc.) in order to determine an energy savings estimate. However, the inputs that were used in these calculations were often not available to the evaluation team. Thus, the team often had no insight into the methodology for the calculation of savings and, therefore, could not easily identify potential reasons for discrepancies between verified savings and reported savings.

2. Grantee Reporting. Grantees had two options for reporting savings to DOE. These two reporting options resulted in DOE receiving very different levels of information and, therefore, a separate methodology was implemented by DOE to capture the required information. Additionally, the level of detail provided on DOE reporting forms varied significantly.

3. Project Tracking. All of the grantees tracked project information differently and maintained varying levels of information regarding project implementation activities. Some maintained only tracking databases with a limited level of information, while others kept detailed project records complete with rebate applications or invoices. This variety of information created challenges in verifying measure specific details at all of the project sites for some grantees.

4. Billing Data. As part of the grant specifications, grantees were supposed to collect billing data for all completed projects. However, this proved difficult for many of the grantees due to the challenges associated with obtaining utility bills from the utility provider. Thus, only a few grantees were able to collect utility bills and even fewer had sufficient billing data to allow for the use of billing analysis to verify savings.

1.4.2 Inaccuracies of DOE Reported Metrics

As will be discussed in further detail in Section 2, DOE depends on quarterly reporting from the grantees in order to determine the energy savings, cost savings and number of implemented projects across all the grantees. However, during the course of this evaluation, the team uncovered reporting issues that resulted in inaccuracies in the reported savings and project totals. Specific inconsistencies that were found are outlined in greater detail below.

1.4.2.1 Conflicting Database Totals

The DOE populates their internal database with data submitted by the grantees each quarter and uses this information to *track* program progress. Grantees report total program level data, which populate the "Program Level" database in the Quarterly Summary Reports used by DOE to *report* progress through Salesforce. Grantees also report individual project data, which is uploaded to a "Project Level" database to track and outline every project and the savings associated with each project. Theoretically, the sum of the project level reporting should equal the program level reporting in terms of project savings and project counts; however, during the evaluation activities, we found that they most often do not equal. Currently, the overall reported energy savings differs by 8% between the two datasets, but this difference has been as high as 25% in previous iterations of DOE reporting databases.

There appeared to be a number of reasons for the discrepancy:

1. Grantee reporting errors. There were cases of grantees reporting project details in the wrong fields, projects with missing data, double counting, or projects listed in the wrong sector. These errors often only impacted one database or the other.
2. DOE database upload inconsistencies. DOE uploaded the grantee project data into the Project Level database. However, inconsistencies occurred during the upload process that created differences between what was reported and what was uploaded.
3. Fuel conversion errors. Grantees occasionally did not report fuel savings in the units requested by DOE, which led to conversion and reporting errors in the database.
4. Inconsistencies in reporting of direct install projects. Many of the grantees offered direct install measures that were implemented at a residence during the course of an energy audit. These measures included water saving devices, pipe wrap, programmable thermostats, etc. Some grantees included participants who only received direct install measures as projects in their reporting, while other grantees did not include them as projects, but did include savings from the direct install measures into the total program level savings.

1.4.2.2 Grantee Data Resubmittals

Due to inconsistencies uncovered by DOE through the review of the quarterly submissions or as grantees gathered more project data, grantees would resubmit quarterly reports to update their program reporting. These updates would occur periodically and result in changes in savings amounts and project totals in both the Project Level database and the Program Level data. This created a risk to the validity of the evaluation study because these updates resulted in changes to the reported population and savings values from the original values used to design the evaluation sample.

For purposes of the M&V and billing analysis activities conducted for the preliminary impact evaluation activities, the evaluation team used the information provided in the last update provided in the Project Level database from DOE, dated June 4, 2013. Information provided in the June 4 report allowed the team to determine total project counts, energy savings per project, and energy savings per sector. The economic analysis utilized the Program Level data from the Quarterly Summary Reports due to the specific data captured in these reports needed by the economic analysis. There were also some instances where the most recent data were not used due to time and logistical constraints. These instances are noted in the report as applicable.

1.4.3 Delayed or Lack of Grantee Responsiveness

The evaluation team worked closely with each sampled grantee in attempts to obtain the project-level data needed to conduct the evaluation. During the data request process, grantees were often found to be delayed in their responsiveness, and some grantees simply did not respond to our inquiries. The team learned quickly that the main reason for the hesitation of the grantees to provide the requested information was due to privacy concerns. Grantees were rightly concerned with sharing participant contact information and project-level data to the evaluation team for purposes of the evaluation. After the evaluation team outlined the numerous procedures employed to ensure the confidentiality of the data received, including secure FTP sites and confidentiality agreements, most of the grantees did provide the team with the requested information, but a few grantees did refuse to share any participant or project-level information outside of what they report directly to DOE.

The delay in and/or lack of responsiveness impacted the evaluation team's ability to achieve the goals established in the preliminary impact evaluation plan for both the M&V activities and the billing analysis. While the team selected a significant number of alternate samples, the elimination of those grantees that did not provide the requested information impacted the team's ability to recruit sufficient numbers of projects in the timeframe of the preliminary evaluation. This was especially significant in the commercial sector where unresponsive grantees made it extremely difficult to re-allocate the necessary amount of samples to the remaining grantees due to the much smaller sample frame. Additionally, in the multifamily sector, unresponsive grantees prevented the team from being able to evaluate this sector for the preliminary evaluation.

1.4.4 Limited Value of Participant Phone Verification Surveys

The use of phone surveys of program participants in order to verify the installation of measures is a common evaluation practice. As part of the approach for the M&V activities, the evaluation team implemented phone surveys at approximately 300 residences and businesses. While the phone surveys were useful in verifying overall project participation and obtaining attribution information, the team found that specific measure details installed as part of the project often could not be obtained through the phone surveys. In many cases, there had been a significant time lapse from project implementation to the phone survey (often ~2 years). This impacted the ability of the participants to remember the details of the measures that they implemented, and even more so, of the baseline condition that existed prior to implementation. Additionally, many of the participants had multiple measures installed, some of which included air sealing or insulation, which has specifications that are difficult to remember (i.e., R-values for insulation). Finally, there was often uncertainty in regards to which program funded the measures that they implemented, as many participants may have participated in multiple funding programs or implemented measures at different points over the two-year time period.

1.4.5 Large Scope and Broad Scale of Grantee Programs

Generally, such evaluations of efficiency programs involve analyzing a specified set of measures across the territory of one utility and developing verified savings based on these known conditions. However, BBNP's large scope and broad scale of the programmatic offerings created challenges in establishing a consistent methodology for verifying energy savings. There was a wide variety of measures offered by each of the grantees and the scope of implementation of these measures within each grantee's region was unknown before the analysis. Additionally, grantees utilized different methodologies/algorithms to calculate the savings associated with the measures in a wide range of climatic conditions in the various grantee regions.

1.5 Report Outline

The remainder of this report provides a more detailed overview of BBNP, outlines the methodology utilized for all aspects of the evaluation, presents the findings from the preliminary activities, and discusses the lessons learned by the evaluation team and how these lessons will influence the final evaluation and recommendations for the future. The remainder of this report is divided into the following sections:

- Section 2: Better Buildings Neighborhood Program
- Section 3: Methodology
- Section 4: Findings
- Section 5: Lessons Learned, Recommendations, and Conclusions
- Appendices
  - Appendix A: Residential and Commercial Verification Surveys
  - Appendix B: Residential and Commercial Pre-notification letters
  - Appendix C: Fuel Prices
  - Appendix D: Weather Data
  - Appendix E: Common Measure Savings Sources and Equations
  - Appendix F: Fuel Conversions
  - Appendix G: Detailed Billing Analysis Results

2 Better Buildings Neighborhood Programs

As discussed in Section 1, BBNP granted over $500 million to 41 grantees. According to the FOA:

> "DOE is specifically targeting these funds for high-impact awards that will enable large-scale programs of ongoing energy efficiency retrofits on residential, commercial, industrial, and public buildings in geographically focused areas. These programs should result in high-quality retrofits resulting in significant efficiency improvements to a large fraction of buildings within targeted neighborhoods, technology corridors or communities (i.e. "whole-neighborhood" retrofits)."

The scale of the funding for energy efficiency programs offered by DOE for BBNP was unprecedented. While the federal government has issued periodic funding opportunities for energy efficiency, none have been on the scale of BBNP. Additionally, much of the funding was provided to communities that had limited or no prior experience with offering energy efficiency programs. This combination of significant scale and inexperienced grantees created challenges for DOE to manage and track the results of BBNP which impacted the evaluation efforts.

This section provides more detail on BBNP, the accomplishments through Q2 2012, and the grantee offerings.

2.1 BBNP Goals, Objectives and Expected Program Effects

DOE outlined the four primary objectives for BBNP as:

1. Initiate building energy upgrade programs that promote projects estimated to achieve energy savings in more than 40 communities.
2. Demonstrate more than one sustainable business model for providing energy upgrades to a large percentage of the residential and/or commercial buildings in a specific community.
3. Identify and spread the most effective approaches to completing building energy upgrades that support the development of a robust retrofit industry in the United States.
4. Document lessons learned that can be replicated beyond initial grants and their jurisdictions, in order to expand impacts of BBNP investments.

Based on these objectives, DOE's expected program effects for BBNP include:

- Develop sustainable energy efficiency upgrade programs.
- Upgrade more than 100,000 residential and commercial buildings to be more energy efficient.
- Save consumers approximately $65 million annually on their energy bills.

- Achieve at least 15% energy savings from energy efficiency projects.
- Reduce the cost of energy efficiency program delivery by 20% or more.
- Create or retain approximately 30,000 jobs.
- Leverage more than $3 billion in additional resources.

2.2 Program Requirements

The Better Buildings Neighborhood Program Grant Recipient Management Handbook [12] outlines the program requirements and processes.

The Better Building grants were awarded through three different funding streams over a six-month time period in 2010. The EECBG awards were made in April 2010, June 2010, and September 2010; they end three years later, between May 2013 and September 2013. The SEP awards were made in September and October 2010, with an end date of September 2013. A grant development team from DOE visited each grantee to develop the Statement of Project Objectives (SOPO).

Once the SOPO was completed, the grantee was encouraged to develop an implementation plan. The implementation plan could be developed by the grantee or the grantee could use the template provided by the Better Buildings team. The template was designed to allow reporting for marketing and outreach, financing, workforce development and contractor capacity, and data, reporting, and evaluation that helped frame the details of the implementation plan. The implementation plans were due within three months after signing the SOPO.[13]

The implementation plan is a living document. Since grants are not contracts, there is no set deliverables defined by the implementation plan and success is not measured against the implementation. The plans may be and are being modified and improved throughout the grant period. Thus, grantees are able to adjust savings and project goals as they proceed through the grant period.

In addition to the activities to meet the SOPO and implementation plan, grantees have obligations to follow federal regulations in their reporting. There are a number of specific reporting documents involving different options of program operation, but the key documents utilized for this report include:

- DOE Performance Project Reports – required quarterly of EECBG and SEP grantees. There is a narrative and a spend plan report to capture key progress and planning data,

12 *The Better Buildings Neighborhood Program Grant Recipient Management Handbook* was first published January 2011, v1.0, v1.2 was published April 2011, and v2.0 January 2012.

13 The Implementation Plan template has a due date of October 31, 2011. With some grantees receiving their awards in September, this date was not feasible; for those receiving them in June and April, it was.

including budgeted and actual spend amounts and progress made against project milestones.

- Better Buildings Program Report – required monthly for EECBG and SEP grantees documenting the number of upgrades. The grantee then submits the *Excel* datasets quarterly that provide details on the upgrade, the loans, the energy bills, and other information needed for the program to assess the effectiveness of the upgrades.

2.3 Grantee Program Details

One of the unique aspects of this program is the freedom that the grantees had to design and implement programs that met the needs of their communities. While DOE provided guidance and expectations, the grantees were able to develop programs specific to their communities. This included a variety of programmatic offerings and financial incentives to encourage participation and achieve project implementation.

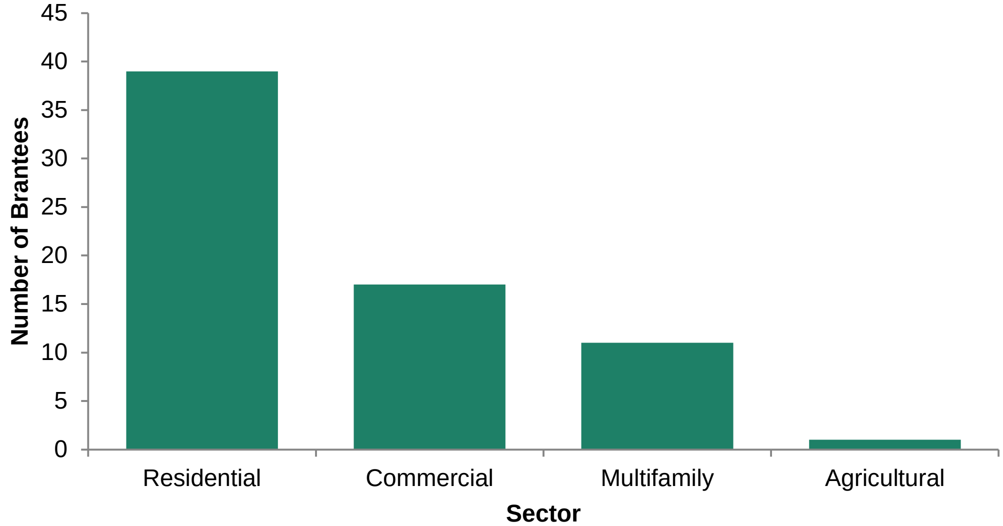
Projects reported by grantees were originally each required to meet a goal of 15% energy use reduction for the building undergoing the energy upgrade. However, in March 2012, DOE allowed grantees the option to meet the 15% energy use reduction goal on their entire portfolio of projects. This optional approach allowed the grantees to accept projects in the program that did not achieve 15% savings, as long as the portfolio of projects implemented through the grantee efforts achieved an overall average of 15% energy savings.

2.3.1 Technologies and Services

In order to achieve the goals established by the grantees in their implementation plan, the grantees utilized their programmatic offerings and financial incentives to improve the energy efficiency of buildings in the markets that they sought to impact. These programs generally focused on providing education and training for residents, business, or contractors, and/or providing financial incentives for the installation of energy upgrades.

Grantees offered programs that focused either on one sector within their community or multiple sectors. Figure 2-1 illustrates the number of grantees offering various sector-based programs.

Figure 2-1: Grantee Sector Offerings



In the residential market, the grantees generally offered two participation options for energy upgrades:

1. Whole-House – Consists of the installation of a specific combination of energy-saving measures that target whole-house energy reduction with incentives based on the overall reduction in the house's energy consumption or on the specific combination of measures.

2. Individual Improvements – includes installation of one or more individual energy savings measures, with incentives provided per measure installed.

The commercial sector programs generally focused on offering incentives on individual measures, with lighting being the most common type of improvement noted in the M&V sample.

Multifamily type programs were categorized in two different ways. Some programs were designed to improve individual units within a multifamily building, while others worked with entire multifamily structures to improve the energy efficiency of the common spaces of the buildings.

During the period of investigation for this preliminary evaluation, only one grantee provided energy efficiency services to agriculture-related industries.

Table 2-1 outlines the various services and measures offered by the grantees.

Table 2-1: Technologies and Services

TECHNOLOGY/SERVICES	RESIDENTIAL	MULTI FAMILY	COMMERCIAL	AGRICULTURE
Energy Audits	X	X	X	X
Energy Efficiency Advisors	X	X	X	
Contractor Training	X	X	X	
Air Sealing	X	X		
Insulation	X	X		
Lighting	X	X	X	X
Programmable Thermostats	X	X		
Water Heater	X	X		
Heating	X	X	X	X
Cooling	X	X	X	X
Washing Machine	X	X		
Refrigerator	X	X		
Freezer	X	X		
Farm Equipment				X
Solar Thermal/Electric	X	X	X	
Equipment Tune Ups	X	X	X	X
Energy Management Systems			X	X
Motor and Drives			X	
Ventilation			X	
Recommissioning			X	

2.3.2 Financial Incentives

The grantees offered a number of different types of financial incentives to promote energy efficiency in their communities. Some of these financial incentives included:

- Rebates
- Loans
- Interest rate buy-downs
- Direct installs

Many of the grantees used one or a combination of these financial incentives, depending on their funding, community interest, previous program offerings in the community, etc.

2.4 Reported Program Accomplishments

As noted in Table 1-2 in Section 1, BBNP reported source energy savings of 1,876,328 MMBtus through the 2nd Quarter of 2012. This section provides greater level of detail on the breakdown of these savings by sector and fuel type.

Table 2-2 outlines results as reported from the Project Level database. Throughout the course of the evaluation activities, there were adjustments made to this database as errors were corrected and grantees submitted updated information.

Table 2-2: Reported BBNP Projects and Energy Savings through Q2 2012

SECTOR	NUMBER OF PROJECTS IMPLEMENTED	PERCENT OF TOTAL PROJECTS	TOTAL SOURCE ENERGY SAVINGS (MMBTU)**	PERCENT OF PORTFOLIO SAVINGS
Residential	27,742	86%	1,116,160	59.5%
Multifamily	3,119	9.7%	83,839	4.5%
Commercial	1,334	4.1%	667,108	35.6%
Agriculture*	59	0.2%	9,220	0.5%
BBNP Total	**32,254**	**100%**	**1,876,327**	**100%**

* Agriculture totals obtained from DOE email dated May 9, 2013, as they are not included in Project Level data.

** The information in this table represents the reported savings as of June 4, 2013.

As the table shows, the residential sector accounted for 86% of the projects, but only 60% of the savings. The commercial sector accounted for only 4% of the projects, but nearly 36% of the savings.

Table 2-3 outlines the average savings achieved per project for each of the four sectors.

Table 2-3: Average Sector Savings per Project

SECTOR	AVERAGE SOURCE SAVINGS PER PROJECT (MMBTU)
Residential	40.23
Multifamily	26.88
Commercial	500.08
Agriculture	156.27

The overall savings reported by the grantees included savings from a variety of fuel types including electricity, natural gas, fuel oil, propane, kerosene, and wood. Natural gas and electricity savings were the most common sources of savings. Table 2-4 presents the reported savings per fuel type for each sector. These are presented as *site* savings in the specific fuel units as this is how they are reported by DOE.

Table 2-4: Reported BBNP Energy Savings through Q2 2012 by Fuel Type per Sector

Sector	Electricity (kWh)	Natural Gas (Therms)	Fuel Oil (Gallons)	Liquid Petroleum (Gallons)	Kerosene (Gallons)
Residential	31,632,968	6,007,011	371,961	132,313	1,444
Commercial	55,021,954	301,989	10,523	5,825	—
Multifamily	2,639,454	490,218	—	—	—
Agriculture*	420,114	1,315	—	857	—
Total	**89,714,490**	**6,800,533**	**382,484**	**138,995**	**1,444**

* Agriculture totals obtained from DOE email dated May 9, 2013, as they are not included in Project Level data.

Figure 2-2 shows the percentage of total MMBtu source savings for each fuel type. This figure illustrates that electricity and natural gas resulted in 96% of the overall source MMBtu savings.

Figure 2-2: Percent of Total MMBtu Savings by Fuel Type

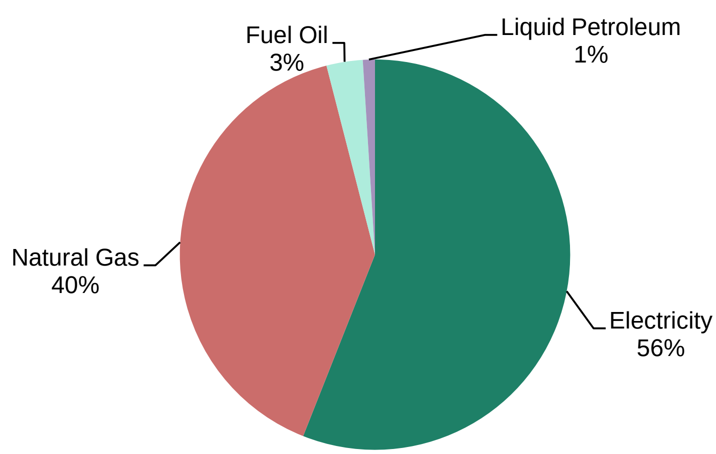


Figure 2-3 and Figure 2-4 illustrate the two major fuel types saved (electricity and natural gas) by sector. As these figures illustrate, the commercial sector was responsible for a majority of the electricity (kWh) savings, while the residential sector was responsible for a majority of the natural gas (therm) savings. This reflects the types of measures seen as most commonly implemented by participants within the sample. The commercial sector consisted of a majority of lighting projects, while the residential sector tended to focus on weatherization type measures that predominantly impacted natural gas savings.

Figure 2-3: Electricity Savings by Sector (kWh)

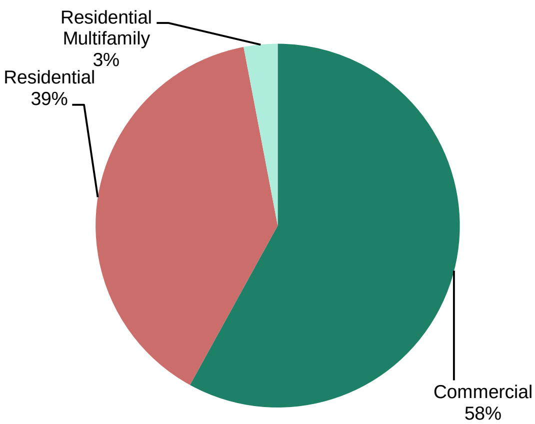
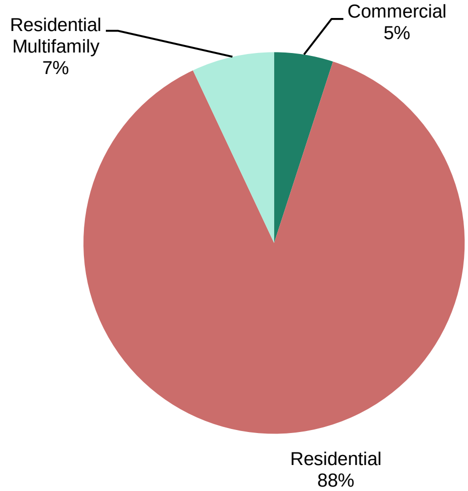


Figure 2-4: Natural Gas Savings by Sector (therms)



2.5 Databases and Data Tracking Processes

In order to produce the reported metrics based on the achievements of the grantees, there are a number of steps taken by both the grantees and DOE. This section outlines the data calculation and tracking processes utilized by both the grantees and DOE to capture and report savings.

2.5.1 Grantee Data

As discussed in Section 1, grantees utilize deemed saving values, modeled savings values, or a combination of both to calculate the energy savings associated with projects implemented in their territories. While the sources and inputs for these savings were often unavailable to the evaluation team, the team was able to determine which modeling software was commonly utilized by the grantees to calculate savings.

For those grantees using modeled savings, the following list shows the software programs employed, based on interviews conducted with the grantees:

- CSG
- TREAT
- Beacon
- REM/Rate
- Energy Performance Score
- PSD Surveyor
- Auto Audit
- EnergyPro
- eQuest
- Weatherization Field Guide
- HEAT
- HERO
- Home Energy Saver pro
- Honeywell
- Optimizer

The evaluation team had hoped to perform reviews on savings methodologies used by grantees in estimating all or part of project energy savings. However, the evaluation team was not provided with sufficient data in order to complete such a review.

Grantees utilize internal databases specifically developed for their programs to track program performance. The information captured within these databases was often more detailed than what was provided to DOE through the quarterly reports, and often included information such as the specific measures implemented for each retrofit project, customer contacts, energy savings assumptions, etc. There is a wide range of internal tracking database systems currently used by the grantees:

- Snughome
- Energy Savvy
- Google Docs
- CSG
- Symbiotic
- PSD
- Longjump
- Neat
- Expression Engine
- Grantee developed

The evaluation team was often offered access to the tracking data systems to capture the necessary information for the analysis.

2.5.2 DOE Reporting Processes

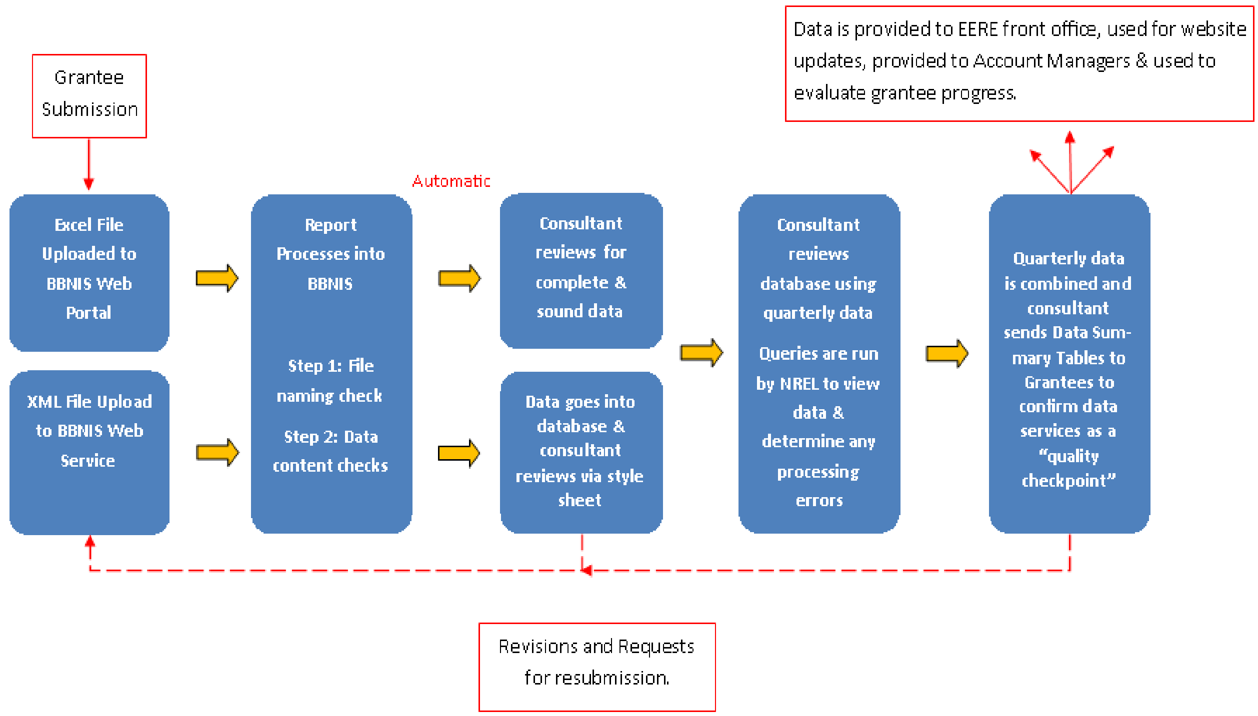
BBNP uses a series of DOE established websites and databases to manage and track the overall BBNP data. These tracking and informational tools are designed to serve specific functions for grantees, program managers, and the public, and include the following:

- Better Building Neighborhood Information Systems (BBIS). This site is used for the grantees to upload program progress reports and is used by DOE to quantify both program and individual project level results.
- Google Site. This site is intended to allow grantees to share program information amongst themselves and DOE to gain an understanding of best practices and relevant program information.
- Public-Facing Better Buildings website. This site allows DOE to share grantee project information with the general public.

Grantees are required to report program results quarterly to DOE through the BBIS, using DOE-provided *Excel* or *XML* templates. This allows DOE to track the performance of the grantees towards the outlined goals and objectives. DOE then summarizes the individual quarterly reports into tracking spreadsheets and dashboards through the *Salesforce* site to use for reporting purposes.

Figure 2-5 outlines the processes used by the grantees and DOE to report accomplishments from BBNP.

Figure 2-5: Grantee and DOE Reporting Process



Source: Figure provided courtesy of Navigant Consulting (2013)

The process outlined above has created a system of checks and balances to address erroneous reporting issues. However, with a program of this scope and scale, issues have occurred that have impacted the reporting of the accomplishments. The DOE and its consultants continue to target areas of concern and work with the grantees to ensure accuracy of their reporting.

3 Methodology

Fundamentally, impact evaluations of efficiency programs seek to quantify the gross and net energy savings that have been realized by projects enrolled in a program. To determine the overall estimated energy savings, the evaluation team utilized an ex-post analysis to estimate the energy saved (actual savings based on post-retrofit conditions) through the use of utility billing analysis and M&V activities on a sample of projects.

As discussed previously, the evaluation team is conducting two impact evaluations as part of this Project: the current preliminary evaluation and a final evaluation. The preliminary impact evaluation focuses on verifying grantee reported activities and quantifying metrics for a sample of projects that have been completed by the end of Quarter 2 (Q2) of 2012. The team utilized a sector based analysis (i.e., residential and commercial) that reviewed savings associated with individual projects, not the individual measures making up each project.

M&V activities were conducted to determine gross verified energy savings through a combination of file reviews, telephone surveys, on-site inspections, and engineering analysis of projects. Because it was not cost-effective to complete analysis and on-site inspections on a census of the programs and the program projects, savings were only verified for a representative sample of projects. The evaluation team also conducted a billing analysis to estimate realized energy savings at the project level. The scale of this billing analysis depended on the availability of sufficient pre- and post-installation utility billing data for a large enough sample of end-use customers to support a regression model. BBNP savings reported by DOE for the sample was adjusted to reflect the findings of the M&V and billing analysis activities.

Finally, the preliminary impact evaluation estimated the economic impacts of BBNP. These impacts include jobs (person-years of employment), as well as estimates of economic output, income (personal and business), and tax revenue that result from the program spending relative to a base case scenario where BBNP does not exist.

The impact evaluation for BBNP encompassed the following activities, each of which is outlined in greater detail throughout this section:

- Obtain DOE Program Records
- Develop Sample Approach
- Design the M&V Sample
- Conduct Measurement & Verification
- Conduct Billing Analysis Regression
- Review of Independent Evaluations

- Net to Gross Analysis
- Extrapolation of results to overall BBNP level
- Calculate Additional Metrics
- Economic Impacts Analysis

The impact evaluation team relied on their collective experiences conducting evaluations, along with information gathered from externally published protocols and guidelines for reference and guidance throughout the evaluation project. Secondary sources included:

- *The 2004 California Evaluation Framework*[14]
- *Model Energy-Efficiency Program Impact Evaluation Guide*[15]
- Uniform Methods Project[16]
- *Impact Evaluation Framework For Technology Deployment Programs*[17]
- Conference papers available through the International Energy Program Evaluation Conference (IEPEC) [18]
- "An Evaluation Approach for Assessing Program Performance from the State Energy Program"[19]
- *International Performance Measurement and Verification Protocol* (IPMVP®)[20]

3.1 Obtain DOE Program Records

The initial step of the evaluation activities involved obtaining DOE program records detailing the reported savings and number of projects for each of the grantees. This involved the following key sources of information:

- Project Level Database

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14 June 2004. *The California Evaluation Framework*; TecMarket Works Team; prepared for California Public Utilities Commission and the Project Advisory Group.

15 November 2007. *Model Energy Efficiency Program Impact Evaluation Guide, A Resource of the National Action Plan for Energy Efficiency,* Schiller Consulting, prepared for U.S. Environmental Protection Agency.

16 For a full copy of the Uniform Methods Project protocols see: *http://www1.eere.energy.gov/deployment/ump.html*

17 Reed, J., Jordan, G., and E. Vine. 2007. *Impact Evaluation Framework for Technology Deployment Programs*; U.S. Department of Energy (DOE) Energy Efficiency and Renewable Energy (EERE).

18 See: *www.iepec.org*.

19 Written in collaboration by TecMarket Works, NYSERDA, Megdal & Associates, Edward Vine, and Marty Kushler.

20 2010. *International Performance Measurement and Verification Protocol*. Efficiency Valuation Organization (EVO®).

- Program Level Database from Quarterly Summary Reports
- Measure Implementation Database
- Billing Data
- Grantee Quarterly Reports

As discussed in Section 1, the evaluation team encountered challenges in determining the quality and accuracy of the data. Due to these challenges, the team often used a triangulation approach to determine sources of inconsistency, areas of concern, and overall quality of the data. The evaluation team worked with representatives from DOE and NREL to correct errors, understand underlying issues, and interact with the grantees to correct issues.

The evaluation team selected the Project Level Database for use in determining the M&V sample and conducting the impact analysis for energy savings for two main reasons:

1. The project data could be sorted into sectors to allow the team to determine savings and project totals for each sector. The Program Level data did not have this option.
2. Interviews with some grantees indicated that the project level data was "more correct" compared to the Program Level data.

The team also worked with DOE and NREL to obtain billing data. The DOE periodically requests billing data from the grantees. Due to the challenges associated with obtaining utility bills from the local utilities, many grantees were unable to collect these data.

Finally, the economic analysis utilized the Program Level Database, as this included specific metrics used in the analysis, such as program expenditures, leveraged costs, and project costs. This information was needed to conduct the economic analysis. The use of two different data sources for the analysis work in this report created some discrepancies in the reporting of the results. These are noted where applicable.

3.2 Develop the Sample Approach

The evaluation of BBNP is unique due to the program's significant scope, size, and reporting methodology. As discussed, grantees collected and reported a wide range of information and the team worked to design a flexible methodology that handled the variety of information that was available. The impact evaluation consisted of two high-level activities to determine gross verified savings:

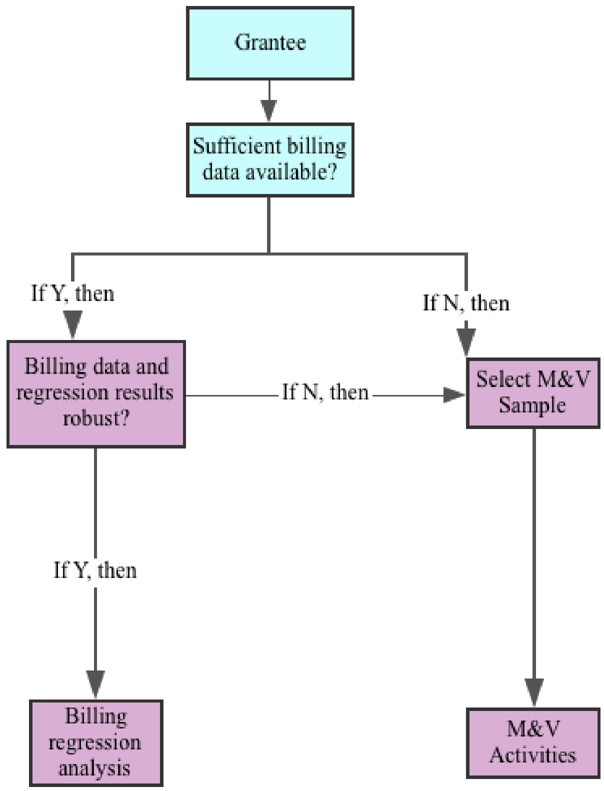
- Measurement and Verification (M&V) of a sample of grantees and projects
- Billing analysis on projects from grantees with sufficient utility bill data

Ultimately, the results from both activities were combined and extrapolated to the population in order to determine the overall estimated energy savings for BBNP. Details regarding the methodology for combining and extrapolating the results are provided later in this section.

3.2.1 Develop Specific Evaluation Activity Sample Frame

Unique sample frames for each evaluation activity were selected based on the level and type of information available for each grantee and, therefore, which activity was best suited to the grantee. Figure 3-1 outlines the decision tree that the evaluation team used to determine the evaluation activity.

Figure 3-1: Evaluation Activity Decision Tree



As Figure 3-1 depicts, if a grantee had sufficient pre- and post-utility billing data available for the projects completed, this grantee was evaluated using a billing regression analysis. Those grantees unable to collect utility billing data were evaluated using the M&V approach.

The evaluation team initially identified 13 grantees with utility billing data for their program participants. However, after conducting an analysis of the data, the team determined that only four grantees had sufficient billing data that would enable a billing analysis approach.

Based on the evaluation activity determined for each grantee, Table 3-1 outlines the sample frame by evaluation activity.

Table 3-1: Grantee Sample Frame by Evaluation Activity

Evaluation Activity	Number of Grantees in Sample Frame	Number of Projects in Sample Frame	Reported Energy Savings in Sample Frame (MMBtus)
M&V	36	25,724	1,658,875
Billing Analysis	4	3,352	124,393
Total	**40***	**29,076****	**1,783,268****

* One grantee had no projects completed through 2nd Quarter 2012.

** Value includes only commercial and residential sectors.

3.3 Design The M&V Sample

The goal for the M&V sampling approach was to achieve a high level of confidence and precision in the verified gross and net savings for the overall BBNP. In order to achieve this, and provide the most cost-effective sample for the M&V activities, the evaluation team employed a Value of Information (VOI) approach. VOI is used to balance cost and rigor, and follows a process to allocate the bulk of the M&V funds to areas with high impact and high uncertainty.

The confidence/precision targets for the M&V activities were selected based on the objectives outlined by DOE for the evaluation. The sampling provided a high level of project verification coupled with an efficient use of on-site activities to achieve an industry-standard level of measurement rigor. Verification of energy savings and attribution surveys were conducted through participant telephone surveys with detailed desk review and analysis of project documentation for the entire sample population. A smaller subset of the sample population of projects was selected for on-site inspections.

3.3.1 Determine the M&V Sample Parameters

Three key parameters were established for an effective sample design of the M&V population:

- Confidence
- Precision
- Coefficient of Variance

3.3.1.1 Confidence and Precision

The industry standard confidence and precision levels for energy efficiency program evaluations is 90% confidence, with 10% precision. The evaluation team's sampling strategy was designed to meet 90/10 confidence and precision at the overall BBNP level.

3.3.1.2 Coefficient of Variance

The greater the deviation of the observed value from the reported value, the greater is the variance in the sample pool. A greater variance in the sample pool indicates poor correlation between ex ante and ex-post savings and the potential need to sample more data points in order to reduce the error ratios in the sample pools. If a greater variance is expected in the reported impacts, the Coefficient of Variance[21] (Cv) is set at a higher value at the beginning of the sampling process, resulting in a larger sample pool.

After discussions with grantees and DOE, the evaluation team determined that there was a strong likelihood for a larger deviation in reported savings. In order to address this issue, the Cv used for setting the sample size was set at 1.2 for the overall BBNP. Utility evaluations generally use a Cv of .5 for the majority of evaluations, as their programs are generally focused on specific measures and have established standardized reporting and measurement procedures. By establishing a higher Cv, we acknowledged the challenges listed below and selected a larger sample size to account for the perceived higher variability in the reported results.

- Grantee's challenges with reporting project savings
- Errors in the reporting documents
- DOE's challenges in capturing data in different formats
- Changes in reporting requirements since the programs began
- Lack of grantee experience managing energy efficiency programs

3.3.2 Establish the Sample Size

The sample size (*n*) was calculated based on the following formula, assuming an infinite population size (which essentially is the case for BBNP):

$$n = \frac{C_v^2 Z^2}{P^2}$$

- Where:

  n = sample size for an infinite program population

  Cv = Coefficient of variance = 1.2 (assumed)

  P = Precision = 10%

  Z = Z-Statistic based on 90% confidence = 1.645

21 The Coefficient of Variance (Cv) is an estimate of the variability of the population in relation to the mean. Populations with assumed higher Cv indicates a larger sample size will be necessary in order to achieve the desired confidence and precision due to variability in the reported findings.

Using the above formula, the team determined that a sample size of 385 projects was desired for BBNP. A subset of 65 projects of this sample population, which was established based on available budget, was selected for on-site verification activities. One of the goals of these on-sites was to determine how the level of verification rigor might impact the findings and to use these results to inform the final evaluation methodology. In order to balance costs, the additional rigor was prescribed for a portion of the sample projects within eight grantees based on resources available and to also minimize travel costs.

3.3.3 Stratification

With the M&V sample frame determined, the evaluation team first stratified BBNP projects into two strata based on the key sectors receiving services from the grantees: residential and commercial. This stratification allowed for the grouping of similar project types that increase the homogeneity within each sector stratum and reduce the expected variation in the verified results. Stratification occurred at the project level as opposed to the measure level due to the lack of detail provided in the reporting databases regarding measures implemented for each project.

The evaluation team had intended to select a sample of projects for the multifamily sector. However, due to a combination of unresponsive grantees and a lack of project level detail for other grantees, the team was unable to conduct any sampling or verification activities for the multifamily sector. As shown earlier, the multifamily sector savings only account for 3% of savings. However, the evaluation team will strive to conduct analysis on the multifamily sector for the final impact evaluation.

An objective in many sampling approaches is to focus on areas with high impact. Therefore, the evaluation team allocated samples to each sector stratum based on the magnitude of the reported savings for each sector in the sampling frame. Table 3-2 outlines the *planned* sampling approach for each of the three-sector stratum based on the data provided to the team in February 2013.

Table 3-2: Planned M&V Sampling First-Level Stratification

				Anticipated Sample Size (Number of Projects)	
Strata	Number of Projects	Source Energy Saved (MMBtus)	Percent of Sample Frame Savings	Desk Analysis w/ Telephone Survey Verification Method	On-Site Analysis Verification Method (Subset-Sample)
Residential	23,461	821,112	61%	237	40
Multifamily	390	31,891	2%	9	—
Commercial	1534	482,864	36%	139	25
Totals	**25,385**	**1,335,867**	**100%**	**385**	**65**

Once program evaluation activities commenced, the final executed sample was not identical to the planned sample, due to difficulties in obtaining project data from grantees, which impacted recruitment and analysis efforts. Table 3-3 summarizes the final *actual* sample and associated M&V activities.

Table 3-3: Actual M&V Sampling First-Level Stratification

Strata	Total Actual Sample (Number of Projects)	Actual Desk Analysis Only (Number of Projects)	Desk Analysis w/ Telephone Survey Verification Method (Number of Projects)	On-Site Analysis Verification Method – Subset of Sample (Number of Projects)
Residential	217	16	154	47
Multifamily	0	0	—	—
Commercial	102	33	51	18
Totals	**319**	**49**	**205**	**65**

The next step was to allocate the sector sample size to the populations within each sector. Due to the differing characteristics between each sector, the team used two different allocation methods. The details below provide the actual allocation of samples achieved by the team as opposed to the planned number of samples. The change from planned sample to the actual sample created risks such as non-coverage (populations not included in sample frame) and non-response (population members refuse participation) to the validity of the findings. However, the team sought to reduce the risks through the methodologies outlined below.

3.3.3.1 Residential Stratification

The team used the Dalenius-Hodges method[22] to create strata boundaries according to the size of the grantee energy savings within the residential stratum. This method created three substrata within the residential stratum: *small*, *medium*, and *large*.

To guide the process of allocating the residential sample among the substrata, the evaluation team's goal was to balance impact with perceived uncertainty to minimize the overall error in our final impact estimate. To accomplish this goal, the Neyman allocation method[23] was used to allocate the sample to each of the three stratum created by the Dalenius-Hodges methodology. The results of this allocation method are outlined in Table 3-4.

[22] Cochran, William G. Third ed. 1997. *Sampling Techniques.* New York, New York: John Wiley & Sons, Inc. The Dalenius-Hodges methodology is used to determine optimal strata boundaries based on the cumulative root frequency method.

[23] Cochran, William. Third ed. 1997. *Sampling Techniques*. Neyman allocation is a sample allocation method that is most often used with Dalenius-Hodges. It allocates sample size to strata based on product of stratum size and uncertainty in order to maximize survey precision, given a fixed sample size.

Table 3-4: Residential M&V Sample Design by Substrata

Grantees within each Residential Sub - Strata	Reported Source Energy Saved (MMBtu)*	Reported Number of Projects*	Actual Sample Size (Number of projects)
Small			
State of Maryland	187	16	65
State of Connecticut	304	243	
Santa Barbara County, CA	433	6	
Camden, NJ	700	20	
Chicago, IL	727	10	
State of Missouri	826	6	
Greensboro, NC	1,327	74	
Phoenix	1,507	63	
Commonwealth of MA (SEP)	2,006	148	
Town of University Park, MD	2,332	92	
Town of Bedford, NY	3,664	81	
State of Virginia (SEP)	3,824	63	
Omaha, NE	4,048	54	
Kansas City, MO	6,557	498	
State of Washington (SEP)	7,741	121	
State of New Hampshire	7,966	172	
State of Alabama	8,101	76	
Eagle County, CO	8,272	295	
Indianapolis, IN	8,924	207	
Seattle, WA	9,219	213	
State of Nevada (SEP)	10,796	104	
San Antonio, TX	11,545	406	
Fayette County, PA	15,167	361	
Wisconsin	18,625	450	
Rutland, VT	19,438	391	
Medium			
Bainbridge Island, WA	35,091	431	72
State of Michigan	35,742	2090	
State of Maine	36,533	1,438	
Cincinnati, OH	43,524	811	
Los Angeles County, CA	63,621	1,695	
Portland	76,413	1,412	

Continued

Grantees within each Residential Sub - Strata	Reported Source Energy Saved (MMBtu)*	Reported Number of Projects*	Actual Sample Size (Number of Projects)
	Large		
Southeast Energy Efficiency Alliance	117,653	2,171	80
State of New York	428,955	10,172	
Total	**991,768**	**24,390**	**217**

* Project and Savings total from Project Level data June 4, 2013.

The samples within each small, medium, and large substratum were then randomly selected from the population of projects within each stratum. Random selection within the stratum allowed for the allocation of samples across the entire sample frame of the grantees within that stratum. Additional projects were then selected from the grantees receiving the initial sample allocation as alternates if the initial sample projects could not be verified due to lack of grantee response, lack of interested participant, or insufficient data. This helped reduce the risk of non-coverage error by not only ensuring enough alternates were selected but also that they would be allocated to similar type grantees within each stratum.

3.3.3.1.1 On-Site Selection

As mentioned above, the additional level of rigor of on-site verification visits were prescribed for a portion of the sample projects within six grantees based on resources available and to minimize travel costs.[24] All samples selected for on-sites also received a desk review and a phone survey.

3.3.3.1.2 Final Residential M&V Sample

Table 3-5 shows the final list of grantees, the sample sizes and level of rigor employed for the residential sector. In a few cases, grantees had to either be removed from the sample due to unresponsiveness or a lack of adequate data. The project samples selected from these grantees were then re-allocated to other grantees within the same stratum using the alternates previously selected.

Additionally, the team conducted only desk analysis on a limited number of projects for two main reasons:

- The grantee did not provide contact data, but did provide project data.
- Unresponsive grantees’ projects were reallocated to other grantees. Due to time constraints, additional phone verifications could not be completed on the reallocated samples. However, when project data were available for these reallocated samples, the team was able to conduct verification through a desk analysis.

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24 Due to potential issues associated with the convenience sampling methodology used to select on-site visits, the team removed the findings from the on-site visits for the calculation of the verified savings.

Table 3-5: Final Residential M&V Sample

Grantees within Residential Substrata	Total Sample	Desk Analysis Only	Desk Analysis with Phone Verification	On-site Visits (Subset of Phone Verifications)
		Small		
State of Connecticut	5	0	5	0
State of Virginia (SEP)	1	0	1	0
Town of Bedford, NY	1	0	1	1
Fayette County, PA	6	0	6	0
Seattle, WA	3	3	0	0
State of Alabama	2	0	2	0
San Antonio, TX	9	0	9	6
State of Nevada (SEP)	4	3	1	0
Rutland, VT	6	0	6	0
Kansas City, MO	4	0	4	0
Wisconsin	24	0	24	0
		Medium		
Cincinnati, OH	12	0	12	7
Portland	17	0	17	6
LA County	1	0	1	0
State of Michigan	39	9	30	11
Bainbridge Island, WA	3	0	3	0
		Large		
Southeast Energy Efficiency Alliance	11	1	10	0
State of New York	69	0	69	16
Total	**217**	**16**	**201**	**47**

3.3.3.2 Commercial Stratification

For the commercial sector, the team used a very similar stratification method to the residential sector. The team used the Dalenius-Hodges method to create strata boundaries according to the size of the grantee energy savings within the commercial stratum. This method created two substrata within the commercial stratum: small and large. Then the Neyman allocation method was used to allocate the sample to each of the two strata. The results of this allocation method are outlined in Table 3-6.

Table 3-6: Commercial M&V Sample Design by Substrata

Grantees within each Commercial Substrata	Reported Source Energy Saved (MMBtu)*	Reported Number of Projects*	Sample Size (Number of Projects)
Small			
Omaha, NE	0	2	50
State of Maryland	0	1	
Eagle County, CO	28	1	
State of Michigan (SEP)	1,189	1	
Chicago, IL	1,323	2	
State of New Hampshire	2,098	9	
Camden, NJ	3,857	15	
Lowell, MA	4,124	23	
Cincinnati, OH	4,894	20	
Southeast Energy Efficiency Alliance	5,097	17	
Los Angeles County, CA	12,305	92	
Seattle, WA	18,433	9	
Greensboro, NC	33,256	8	
San Antonio, TX	39,415	5	
State of Michigan	45,905	18	
Toledo	125,266	8	
Large			
Boulder County	178,093	889	52
Phoenix, AZ	191,826	214	
Total	**667,109**	**1,334**	**102**

* Project and Savings total from Project Level data June 4, 2013.

The samples within each small and large substratum were then randomly selected from the population of projects within each stratum. Random selection allowed for the allocation of samples across the entire sample frame of the grantees within that stratum. Additional projects were then selected from the grantees receiving the initial sample allocation as alternates if the initial sample projects could not be verified due to lack of grantee response, lack of interested participant, or insufficient data.

3.3.3.2.1 On-Site Selection

As mentioned in the residential sector, the additional level of rigor of on-site verification visits were prescribed for a portion of the sample projects within two grantees, based on resources available and to minimize travel costs.[25] All samples selected for on-sites also received a desk review and a phone survey.

3.3.3.2.2 Final Commercial M&V Sample

Table 3-7 shows the final list of grantees, the sample sizes, and level of rigor employed for the commercial sector. In a few cases, grantees had to either be removed from the sample due to unresponsiveness or a lack of adequate data. The project samples selected from these grantees were then re-allocated to other grantees within the same strata using the alternates previously selected.

Additionally, the team conducted only desk analysis on a limited number of projects for two main reasons:

- The grantee did not provide contact data, but did provide project data.
- Unresponsive grantees' projects were reallocated to other grantees. Due to time constraints, additional phone verifications could not be completed on the reallocated samples. However, when project data were available for these reallocated samples, the team was able to conduct verification through a desk analysis.

Table 3-7: Final Commercial M&V Sample

Grantees within Each Commercial Substrata	Total	Desk Analysis Only	Desk Analysis with Phone Verification	On-Site (Subset of Phone Verifications)
		Small		
State of New Hampshire	6	3	3	0
Lowell, MA	13	8	5	5
Cincinnati, OH	4	0	4	1
Southeast Energy Efficiency Alliance	2	1	1	0
Seattle, WA	7	7	0	0
Greensboro, NC	5	1	4	0
San Antonio, TX	2	1	1	0
State of Michigan	7	5	2	1
Toledo	4	0	4	0
		Large		
Boulder County	52	7	45	11
Total	**102**	**33**	**69**	**18**

25 Due to potential issues associated with the convenience sampling methodology used to select on-site visits, the team removed the findings from the on-site visits for the calculation of the verified savings.

3.4 Conduct Measurement and Verification

The M&V activities conducted for the preliminary impact evaluation included engineering review and verification activities to determine the energy savings for a sample of projects. To determine the overall estimated BBNP energy savings, the team used an ex-post analysis (actual savings based on post-retrofit conditions) in order to estimate the energy savings for each project selected in the sample. Gross verified energy savings were determined through information gathered from a combination of file reviews, telephone surveys, and on-site inspections.

Gross verified savings were compared to reported savings to determine a realization rate for each sector.

Steps included in the verification approach, each of which is described in more detail in the following sections, were:

- Obtain Grantee Project Records
- Design Survey and Data Collection Forms
- Conduct Telephone Verification Surveys
- Conduct On-Site Verifications
- Conduct Project File Reviews
- Establish Baseline Scenarios
- Verify Gross Energy Savings

3.4.1 Obtaining Grantee Project Records

After the selection of the sample projects was completed using DOE Project Level database, the team reached out to each grantee for which a sampled project was chosen. Grantees were informed that they had been selected as part of a random sample process for the evaluation activities and project documentation for the sampled projects was requested. The team requested information from each grantee for the selected sample, as well as a number of alternates in order to account for unresponsive participants or grantees. The original data request from the grantees included participant contact information and simple project data as available. Once a participant agreed to partake in the survey activities, the team requested additional project document from the grantee including paper applications, audit reports, invoices, etc.

As discussed under *Evaluation Challenges*, obtaining project records was often difficult, and in some cases, no information was received by the evaluation team.

3.4.2 Designing the Survey and Data Collection Instruments

Information gathered during DOE data collection efforts informed the development of the data collection forms used for the phone surveys and on-site verification activities. Due to governmental policy regarding population surveys, the team needed to undertake a number of steps to obtain approval to conduct phone and on-site verifications.

First, each surveyor needed to complete training from the LBNL Environmental Health, Safety and Security Division on Human Subjects Research. This training ensured that staff understood the policies and procedures related to the surveying of populations.

Next, the team designed the survey for both the residential and commercial sectors, as well as an introduction letter to be sent to all potential participants in the sample. The surveys and introduction letter were then sent to the LBNL Human Subjects Committee for approval.[26] The surveys and approved letter are included in Appendix A and B, respectively.

Phone surveys were programmed into *Qualtrics*,[27] an online survey platform, which allowed for consistency and efficiency in data entry while on the phone with participants. Paper data collection forms were developed and used in the field during the on-site activities. All information gathered during the phone surveys and on-site inspections were entered into an internal Microsoft Access tracking database that was designed to track results for all impact evaluation activities.

3.4.3 Conducting Telephone Verification Surveys

The evaluation team attempted to conduct telephone surveys on the entire sample population of projects, in an effort to collect information used to calculate gross verified savings and to verify that equipment was installed as stated on project applications and/or in the grantee's tracking database. Information about baseline conditions, along with all information needed to feed into the assumptions or stipulated values used in the engineering review and analysis, were also sought during these surveys. Potential sample participants were called at least three times at varying times during the day/evening to obtain participation. As discussed previously, the phone surveys had limited value for the evaluation. While they were useful to verify participation in the respective grantee program, the participants were often only able to provide a limited level of detail on the project information. The team had to then rely on the desk reviews and/or on-site visits to fill in the necessary details.

3.4.4 Conducting On-site Verifications

On-site inspections were conducted on a subset of sample projects in order to verify the accuracy of information reported through telephone surveys and project documentation files, to gather additional project details, and to allow the team to note any discrepancies in reported versus actual project documentation. Typically, on-site inspection activities included:

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26 Federal regulations require that research involving human subjects or human derived data or tissues be reviewed by an Institutional Review Board (IRB). At Lawrence Berkeley National Laboratory, the IRB is the Human Subjects Committee (HSC). See: *http://www.lbl.gov/ehs/health_services/harc/hsc.shtml*

27 See: *http://www.qualtrics.com/*

- Collecting baseline and retrofit equipment information
- Obtaining the operating parameters as applicable
- Conducting a visual inspection
- Gathering equipment nameplate information
- Conducting brief on-site interviews with relevant parties to understand the building operation, equipment operating specifics, and other input parameters needed to calculate energy savings
- Gathering all applicable data necessary for input into an energy model, such as building or home square footage, orientation, etc.

The on-site inspections were designed to verify the accuracy of the telephone surveys, and the findings helped to inform the phone surveys and desk reviews. However, due to potential issues associated with the convenience sampling methodology used to select on-site visits, the team removed the findings from the on-site visits for the calculation of the verified savings.

3.4.5 Conducting Project File Reviews

Traditionally, file reviews are completed before phone surveys are conducted. However, most grantees did not provide the evaluation team with project file review data until the phone survey was completed and was, therefore, considered an "official sample project."

Upon receipt of any documentation and project files for the sampled projects, the evaluation team performed a file review. The project-specific documents requested for the sampled projects included customer applications, savings declarations performed by third party contractors (where applicable), pre- and post-project audits, customer invoices, and other information as available and appropriate.

The evaluation team then conducted a file review to answer the following questions:

- Were the data files of sample projects complete and adequate to calculate and report savings?
- Were the measures installed as described in the program tracking and reporting system?
- Were input assumptions available, such as building size, building type, operating hours, etc.?
- Were the savings accurately reported to DOE?

Finally, depending on the selected project, additional supporting information was requested from the grantee, third party consultants, and implementation contractors when needed.

3.4.6 Establishing the Baseline Scenarios

To provide an accurate and defensible evaluation of baseline characteristics, a triangulation approach was utilized. The evaluation team gathered and reviewed data from a variety of sources and reconciled the results to ensure that an accurate representation of the baseline characteristics was obtained. The following sources were utilized depending on the information available from each grantee:

- Application or Project Documents. Some grantees, through the use of applications for audit reports, gathered pre-installation project information. When available and applicable, the team used actual pre-installation information to calculate the ex-post energy and demand savings.
- End-User Interviews. As part of the verification approach, the team conducted phone interviews with participants or facility staff regarding not only the projects that were implemented as part of the program, but also baseline equipment conditions, operating hours, and/or parameters.
- On-Site Surveys. For a subset of the sample population, the team conducted on-site verification of installed measures. During the on-site activities, questions were asked and observations were made regarding baseline equipment condition, operating hours and parameters.
- Local Codes and Standards Requirements. When information was not available via project documentation, phone interviews, or on-site surveys, or when the installed measure was found to be a replacement on burn-out scenario, the evaluation team used local energy and building code requirements as the basis for determining the baseline condition.

Table 3-8 outlines the baselines used for this analysis for the most common measures analyzed in the sample.

Table 3-8: Baseline Measure Data Used for Analysis

MEASURE	BASELINE
Furnace	80 AFUE
Boiler	80 AFUE
Air Conditioner	13 SEER
Air Source Heat Pump	7.7 HSPF
Water Heater – Gas	0.575 EF
Water Heater – Electric	0.92 EF
Insulation – All locations	Pre-existing conditions or R-5 if unknown
CFL Direct Install	Pre-existing lighting or 60W Incandescent if unknown
T8 Fluorescent Lamp	Pre-existing lighting or T12 Fluorescent Lamp, 34W, 1.15 BF if unknown
Air Sealing	Pre-existing condition or 3600 CFM50 if unknown
Duct Sealing	Pre-existing condition or 60% distribution efficiency if unknown

3.4.7 Verifying Gross Impacts

In order to calculate gross verified savings for each sampled project, the team created grantee-specific analysis tools that used the information gathered during the file review, telephone surveys, and on-site inspections. The team was challenged to create a consistent analysis methodology while dealing with grantees located across the country in varied climate zones that offered a wide range of measures and may have been influenced by regional savings algorithms used by local utilities. We used a three-step process when developing the grantee specific analysis tools in order to maintain a consistent approach, while recognizing the influence of regional aspects on the calculation of savings.

- Step 1: Uniform Methods Project (UMP) has created a number of protocols for energy efficiency measures. Only a few of the measures offered by the grantees currently have protocols developed as part of the UMP. The team used these protocols for the following measures:
    - Residential Furnaces and Boilers
    - Residential and Small Commercial AC Systems
    - Residential Lighting
    - Commercial Lighting and Lighting Controls
- Step 2: If the measure did not have a UMP protocol, the team utilized the closest applicable technical resource manuals (TRM) for savings algorithms or deemed values for input into the tool.
- Step 3: Where no local/regional TRM algorithms existed for measures implemented in a specific grantee territory, the team used TRMs from other locations for savings algorithms.

All algorithms included formulae and procedures for taking local weather conditions into account. Additionally, stipulated values were used for variables that could not be verified or measured through the telephone surveys or on-sites. Table 3-9 lists all of the sources used during the development of the engineering algorithms for the calculation of gross verified savings.

Table 3-9: Reference Documents Used M&V Analysis

Reference Document	Effective/Report Date	Version
Database for Energy Efficient Resources (DEER)	October 14, 2009	
Efficiency Vermont TRM	July 18, 2008	2008-53
Massachusetts TRM	January 1, 2011	
Michigan Efficiency Measures Database 12/21/11	December 21, 2011	
Mid-Atlantic TRM	July 1, 2011	2.0
New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs	December 16, 2009	
NREL Uniform Methods Project	March 27, 2013	Draft Protocols
Pennsylvania PUC TRM	June 1, 2012	
State of Illinois Energy Efficiency TRM	June 1, 2012	
State of Ohio Energy Efficiency TRM	August 6, 2010	
Tennessee Valley Authority Measurement Manual	July 14, 2010	
Texas Deemed Savings Installation and Efficiency Standards	April 1, 2010	
United Illuminating and Connecticut Light and Power Program Savings Documentation	September 21, 2010	
Wisconsin Business Programs: Deemed Savings Manual	March 22, 2010	1.0

Table 3-10 and Table 3-11 outline the measures analyzed in the residential and commercial sectors in the sample population. The calculation tools created by the team needed to account for the specific measures each grantee offered.

Table 3-10: Residential Measures Analyzed

Measure	Category	Number of Measures Analyzed
Air Sealing	Thermal Envelope	134
Insulation – Attic/Ceiling	Thermal Envelope	121
Insulation – Wall	Thermal Envelope	68
Lighting	Lighting	59
Furnace Replacement	HVAC	53
Direct Install	Direct Install	43
Insulation – Rim Joist	Thermal Envelope	42
Duct Sealing	HVAC	30
Water Heater Replacement	DHW	30
Insulation – Crawlspace	Thermal Envelope	29

Continued

Measure	Category	Number of Measures Analyzed
A/C Replacement	HVAC	27
Air Source Heat Pump Replacement	HVAC	21
Other	Other	14
Windows	Thermal Envelope	13
Insulation – Floor	Thermal Envelope	12
Boiler Replacement	HVAC	10
Heat Pump Water Heater	DHW	4
Refrigerator/Freezer	Refrigeration	4
Renewable Energy	Renewables	2
Insulation – Basement Wall	Thermal Envelope	1

Table 3-11: Commercial Measures Analyzed

Measure	Category	Number of Measures Analyzed
Lighting	Lighting	70
Other	Other	12
A/C Replacement	HVAC	10
Air Sealing	Thermal Envelope	10
Boiler Replacement	HVAC	8
Furnace Replacement	HVAC	8
Insulation – Attic/Ceiling	Thermal Envelope	8
Refrigerator/Freezer	Refrigeration	6
Renewable Energy	Renewables	6
Water Heater Replacement	DHW	5
Insulation – Wall	Thermal Envelope	3
Direct Install	Direct Install	2
Duct Sealing	HVAC	2
HVAC Controls	HVAC	2
Insulation – Crawlspace	Thermal Envelope	2
Chiller Replacement	HVAC	1
Heat Pump Water Heater	DHW	1
Insulation - Rim Joist	Thermal Envelope	1
Windows	Thermal Envelope	1

See Appendix E for a description of the specific approaches and formulas used to calculate savings for the specific measures.

Additionally, there were a variety of fuel types that the evaluation team encountered during the review of project savings. The M&V efforts addressed all fuel types including electric, natural gas, fuel oil, propane, and others. All energy savings numbers are ultimately expressed in millions of BTUs (MMBtu) for consistency and for comparison with DOE reporting protocols. The conversion factors are located in Appendix F.

3.5 Conduct Billing Regression Analysis

A billing analysis approach was utilized for those instances when sufficient customer billing data and participant tracking data (e.g., information on when measures were installed) were available. The billing regression model utilizes data on monthly electricity or natural gas consumption before and after program participation. To accomplish this, we reviewed all grantee data to determine which grantees had provided sufficient billing data to support a model. Based on this review, only Boulder, Austin, Philadelphia, and St. Lucie County had adequate billing data for the modeling task.

For our general model, we used a fixed effects billing regression model specification.[28] One of the principal advantages of using the billing regression model is that it theoretically allows for the consideration of confounding factors, such as customer size, geographic location, and changes in the features of the building between the pre- and post-participation months. The measure and household details contained in the grantee data quarterly submissions, however, were inconsistent and lacked the level of detail necessary to develop a more detailed model. The final model specification was necessarily a more simplified version that relied on fewer variables to control for external factors that might affect energy consumption. In addition to weather and measure variables, the billing model specification relied on dummy variables for month (to control for possible seasonal influences beyond weather) and customer-specific dummy variables to control for all other influences that may be affecting energy consumption at the customer level.

As discussed elsewhere in this report, the billing analysis uses a baseline of pre-project existing conditions at the site. This approach is different than the M&V analysis where building code is used as the baseline. As a consequence of this difference in methodology, the savings estimates generated by the two approaches are not fully comparable.

The fixed effects model specification for residential participants with electricity billing data is as follows:

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28 The fixed effects model is a model specification that incorporates non-random, time-invariant explanatory variables in the traditional multi-variate regression framework. These constant terms help control for possible influences relating to individual cohorts and time periods that are not controlled for explicitly in the available data. By controlling for these influences using these additional constant terms, the fixed effects model provides a more robust estimation of changes in energy use over time.

$$kWh_{i,t} = \alpha_i + \varphi_t + \beta_1(Part_{i,t}) + \beta_2(Weather_t) + \sum_{j=3}^{13} \beta_j\,(Month_t) + \varepsilon$$

- Where:

$kWh_{i,t}$	=	Normalized kWh usage in month t for customer i
$Part_{i,t}$	=	Binary variable indicating post-participation month for customer i
$Weather_t$	=	Weather data for month t (heating degree-days [HDD] and cooling degree-days [CDD])
$Month_t$	=	Set of binary variables indicating whether or not billing month t is January, February, March, April, etc.
α	=	Customer-specific constant

Similarly, an analogous model was developed for those program participants with natural gas consumption data:

$$Therms_{i,t} = \alpha_i + \beta_1(Part_{i,t}) + \beta_2(Weather_t) + \sum_{j=3}^{13} \beta_j\,(Month_t) + \varepsilon$$

- Where:

$Therms_{i,t}$	=	Normalized natural gas usage in month t for customer i
$Part_{i,t}$	=	Binary variable indicating post-participation month for customer i
$Weather_t$	=	Weather data for month t (HDD)
$Month_t$	=	Set of binary variables indicating whether or not billing month t is January, February, March, etc.
α	=	Customer-specific constant

Before the data were used in the model, both the electricity and gas data were subjected to a data cleaning process that screened out participants with insufficient pre-retrofit or post-retrofit data, and unusually small or large fuel consumption data. These data screens helped to eliminate outlier values that would have otherwise biased the model results. Additional detail on these screens is provided in the section 3.5.1., below.

Although the team made efforts to model commercial customers, this analysis did not include a commercial billing analysis, as billing data were not available. All model results are discussed in more detail in the Billing Analysis Results section.

3.5.1 Data Cleaning

Once all data were received from the grantees, our team developed data screens to clean the billing data for analysis. It was important to remove any potentially erroneous billing data from the final modeling dataset to avoid biasing the estimation results.

The screens used to produce the final electricity dataset for modeling removed the following:

- Observations with monthly electricity consumption less than or equal to 100 kWh
- Observations with monthly electricity consumption greater than 10,000 kWh
- Observations with a billing period less than 28 days
- Observations with a billing period greater than 35 days
- Households with average pre-retrofit billing period less than 12 months

Similarly, the screening process for the gas dataset removed the following:

- Observations with monthly electricity consumption less than or equal to 5 therms
- Observations with monthly electricity consumption greater than 300 therms
- Observations with a billing period less than 28 days
- Observations with a billing period greater than 35 days
- Households with average pre-retrofit billing period less than 6 months

A summary of these data screens is shown in Table 3-12. Though a variety of data screens were tried on the models as a sensitivity test, none altered the results or statistical significance of the results greatly, so we opted to use the data screens listed above.

Table 3-12: Summary of Electricity and Natural Gas Billing Regression Data Screens

Data Screen	All Data	Data Screened Out	Data Remaining	Screened Data (Percent of Total)
Observations (Electricity)	39,616	5,650	33,966	86%
Observations (Gas)	34,570	4,558	30,012	87%
Households (Electricity)	1,360	197	1,163	86%
Households (Gas)	1,168	105	1,063	91%

3.6 Review of Independent Evaluation

The team was aware of a small number of grantees undertaking impact evaluations for their respective programs. The team planned to compare the results from these independent evaluations to the results from this report. However, no reports were provided to the team in time to analyze and compare. The team will attempt a comparison for the final impact evaluation.

3.7 Net-to-Gross Methodology

The evaluation team conducted attribution surveys on the sample participants that completed a telephone survey as part of the M&V activities. We did not conduct surveys with participants of the grantees included in the billing analysis.

We used the survey method (equivalently, the self-report method) for the same reasons that have made it the most common method supporting net-to-gross (NTG) analyses: there are few other methods available and, as is typical, these methods are not appropriate for the program design or the available evaluation resources.[29] According to Haeri and Khawaja (2002), "self-report remains the most common method for determining free-ridership," in spite of the fact that many researchers engaged in estimating NTG have significant concerns with the methodology.[30]

Our survey questions sought information relating both to attribution (free-ridership) and spillover. For this preliminary impact evaluation, we analyzed and report only the attribution data. Thus, our NTG ratio reflects an adjustment for free-ridership only. We reviewed the answers to our spillover questions to inform our planned methodology for the final impact evaluation.[31]

We compiled the attribution results for each project, and rolled up the results to the stratum level within each sector. For a given stratum, the team calculated the stratum-average free-ridership (FR) score from the participants' responses to a series of FR-related questions. The team multiplied the stratum-average FR score by the stratum verified savings and summed the resulting stratum-net-savings to obtain a sector net savings. The team calculated sector NTG as the ratio of the sector-net-savings divided by the sector-verified-savings.

Free-ridership was first calculated at the record level: each record received a free-ridership score ranging from 0-1 (where 0 means no free-ridership, and 1 means 100% free-ridership; thus, .6 means 60% free-ridership). The 0-1 FR range means someone could be a total free-rider (a value

29 These methods are experimental design and quasi-experimental design.

30 Hossein Haeri and M. Sami Khawaja. March 2012. "The Trouble with Freeriders." Public Utilities Fortnightly: 35-42. The authors cite a TecMarket Works study (*California 2002-2003 Portfolio Energy Efficiency Program Effects and Evaluation Summary Report*, prepared for Southern California Edison and the Project Advisory Group. January 2006, pages 68-69), which states, "the issues of identifying free-riders are complicated and estimating reliable program-specific free-ridership is problematic at best."

31 Although our questions sought information on quantities installed from participants reporting spillover actions, the answers we received from the phone survey sample were insufficient to support an estimation of spillover savings. For the final impact evaluation, we will increase the on-site sample size. We intend to augment the self-report method for spillover with on-site investigation for those participants both included in our on-site sampling plan and reporting spillover. We will estimate energy savings associated with spillover measures. We will employ relevant data from our BBNP M&V activities to estimate savings associated with measures included in the whole-house or whole-building upgrades. We will estimate lighting spillover savings from lighting type, baseline lighting consumption, and extent of retrofit. We will estimate appliance/equipment spillover savings based on average end-use energy use and efficiency reductions reported in the literature. We do not anticipate assigning energy savings to behaviors or other actions.

of 1), a partial free-rider (.01-.99) or not a free-rider (0). FR values consist of two components, *change and influence*, each of equal weight (and thus scored a value ranging from 0-.5).

The *change* component indicates what the participant would have likely done if the program had not incented them to do the upgrades, and assigns a FR change score (ranging from 0-.5), depending on what the respondent indicates they would have done in absence of the program. The following list exhibits the options respondents were able to choose from (regarding FR change) and the corresponding FR change value is listed in parentheses following each option:

1. Would they have done the upgrades anyway and paid the full cost themselves? (.5)
2. Would they have done some or different efficient upgrades, that would ultimately result in less savings than they achieved through the program? (.25)
3. Would they not have done any upgrades at all in absence of the program? (0)

The *influence* component indicates how much influence the program had on a respondent's decision to perform the upgrades through the program. Respondents are asked a series of questions regarding how much influence various components of the program (i.e., an energy audit, the program website, etc.) had on their decision to perform upgrades through the program. Respondents rate how influential each of these items were on their efficient actions, using a scale from 1-10 (where low scores indicate low program influence, an indicator of high free-ridership behavior, and high scores indicate high program influence, an indicator of low free-ridership behavior). The team took the highest influence rating for each respondent (as this indicates if any program influence is present) and assigned the following FR influence scores based on their highest influence rating, as outlined in the Table 3-13.

Table 3-13: Free-Ridership Influence Scoring

HIGH SCORE	FR INFLUENCE VALUE
1-2	.5
3-6	.25
7-10	0

If a survey was missing, the data needed to compute its FR influence or FR change score, the team imputed the missing result with the sector average.[32] After computing *change* and *influence* components for each respondent, the two values are summed for each record (summing to create a single FR total score ranging from 0 to 1). The scores of the individuals in each stratum were then averaged in order to create a stratum-level FR total score. Using the stratum FR total value, the team calculated stratum-net-savings by subtracting the stratum's FR value from 1 (to indicate the program effect, which is the inverse of FR) and multiplying the result by the stratum's total

[32] This approach to missing data reduces the sample variance in comparison with methods that would impute values that differ from the mean. We imputed three missing FR_influence values and 13 missing FR_change values for the residential sample (n=208), and imputed six FR_influence values and nine FR_change values for the commercial sample (n=73).

verified savings (in MMBtu). The sector's NTG value is the sum of all strata net savings (i.e., the sector net savings) divided by the sum of all strata's total verified savings.

3.8 Extrapolation of Results to Overall BBNP

In order to determine the overall verified energy savings associated with BBNP, the team extrapolated the sample findings to the population through the use of case weights and realization rates. Extrapolation was done separately for the M&V sample frame and the billing analysis sample frame, and these results were then combined and extrapolated to the entire BBNP.

3.8.1 M&V Sample Extrapolation

To ensure that each project is given the appropriate amount of weight in the final overall savings calculation, the team created case weights for each project based on the number of sample projects selected from each stratum. Following the California Evaluation Framework, a case weight (w_i) for each M&V sampled project was calculated based on the total number of projects in the stratum population (N_h) divided by the number of sample projects in the same stratum (n_h), where h denotes the stratum that contains $project_i$. A stratum is identified by sector and contribution to savings (large, medium, or small) as discussed above.

$$w_i = \frac{N_h}{n_h}$$

The realization rate was then calculated by dividing the sum of the case weight multiplied by the verified savings by the sum of the case weight multiplied by the reported savings, as outlined in the following formula:

$$b = \frac{\sum_{i=1}^{m} w_i y_i}{\sum_{i=1}^{m} w_i x_i}$$

- Where:

b	=	realization rate
m	=	number of sample projects across all stratums
w_i	=	case weight for stratum i
y_i	=	gross verified savings of each project in stratum i
x_i	=	reported savings of each project in stratum i

M&V realization rates were then calculated for each sector (residential and commercial).

3.8.2 Billing Analysis Extrapolation

The billing regression results were also used to develop realization rates for the residential sector. These realization rates were created for each grantee that provided billing data and where robust billing regression models could be estimated. To develop a realization rate for the billing analysis sample grantees based on the billing regression results, a weighted average was calculated of the grantee-level realization rates that were estimated using the billing regression, with *ex ante* savings used as the weights.

3.8.3 Overall BBNP Extrapolation

In order to calculate the overall BBNP gross verified savings for each sector, the team calculated a BBNP level realization rate for each sector using the methodology from the California Evaluation Framework.[33] According to the Framework, two statistically independent evaluation studies that provide statistically unbiased estimates of the savings of the program may be combined into a single estimate. If the two estimators, in this case the realization rates from the M&V analysis and the billing analysis, are both unbiased estimators of a given parameter, then any weighted average of the two estimators is also an unbiased estimator. The error bound of the result is the square root of the reciprocal of the sum of the weights.

The team recognized that potential issues might exist when combining the results from the billing analysis and the M&V. One of these issues involved the possibility that the independent results were from different populations rather than independent results from the same population. In order to investigate this issue, the team reviewed savings per project and costs per project to determine the population similarities. Table 3-14 outlines these findings and illustrates that the populations were similar.

Table 3-14: Sample Frame Comparisons

STRATA	AVERAGE SOURCE MMBTU SAVINGS PER PROJECT	AVERAGE RETROFIT COST PER PROJECT*
Full Residential Population	40.2	$6,263
M&V Sample Frame	41.9	$6,365
Billing Analysis Sample Frame	37.1	$5,769

* For projects where this data was available.

There are two additional issues that created more difficulty in understanding their impact. First, the two analysis methods used different baselines for some of the measures. The billing analysis inherently uses a baseline of pre-project existing conditions as the baseline. This is due to the regression analysis comparing the energy use prior to the project implementation to the energy use after the project installation. However, the M&V analysis uses either a codes and standards baseline or the pre-project existing conditions baseline depending on the measure installed and the amount of information available for each measure. The second issue involves participant spillover savings, which are energy savings due to measures installed by a program participant, likely due to the influence of the program, but for which no program incentive was paid. The

33 June 2004. *The California Evaluation Framework*, TecMarket Works Team, prepared for California Public Utilities Commission and the Project Advisory Group.

billing analysis would capture from the savings due to participant spillover, while the M&V activities did not.

The team recognizes these two issues create instances where the billing analysis savings is a not a direct comparison to the M&V savings. However, the overall impact to BBNP verified savings is considered small because the billing analysis sample frame accounted for only 7% of overall BBNP source energy savings. Therefore, the team believes that combining the results from the two different methodologies is reasonable. For the final impact evaluation, the team plans to overlap the M&V and billing analysis sample frames in an effort to determine a potential adjustment factor that could account for the issues described here.

Therefore, the overall sector realization rate was calculated by taking a weighted average of the realization rates calculated for the M&V extrapolation and the billing analysis extrapolation. These realization rates were weighted based on the total *ex ante* savings of all the grantees within each respective sampling frame.

This weighted average BBNP sector level realization rate was then calculated according to the following formula:

$$b_z = b_{m,z} * \left(\frac{Savings_{rep,m,z}}{Savings_{rep,t,z}}\right) + b_{b,z} * \left(\frac{Savings_{rep,b,z}}{Savings_{rep,t,z}}\right)$$

- Where:

b_z	=	weighted average realization rate by sector z
$b_{m,z}$	=	M&V calculated realization rate for sector z
$b_{b,z}$	=	billing analysis calculated realization rate for sector z
z	=	residential or commercial
$Savings_{rep,m,z}$	=	reported savings for all grantees within M&V sample frame for sector z
Savingsrep,b,z	=	reported savings for all grantees within Billing analysis sample frame for sector z
Savingsrep,t,z	=	total reported savings for all grantees in sector z

Once the weighted average realization rate was determined, this value was applied to the overall reported savings to determine a gross verified savings by sector.

$$Savings_{gross\ ver,z} = Savings_{rep,z} * b_z$$

- Where:

b_z = weighted average realization rate by sector z

z = residential or commercial

$Savings_{rep,z}$ = total reported savings for sector z

$Savings_{gross\ ver,z}$ = total gross verified savings for sector z

The total gross verified savings for BBNP was calculated as the sum of the sector gross verified savings.

Thus, the overall gross verified savings for BBNP is calculated as:

$$Savings_{gross\ ver,BBNP} = \sum_{z} Savings_{gross\ ver,z}$$

- Where:

$Savings_{gross\ ver,BBNP}$ = total gross verified savings of BBNP

$Savings_{gross\ ver,\ z}$ = total gross verified savings for sector z

Net verified savings for each sector were determined by applying the NTG ratio found in the attribution analysis to the sector level gross verified savings from the verification sample only:

$$Savings_{net\ ver,z} = Savings_{gross\ ver,z} * NTG_z$$

- Where:

NTG_z = net-to-gross ratio for sector z z = residential or commercial

$Savings_{gross\ ver,z}$ = total gross verified savings for sector z

$Savings_{net\ ver,z}$ = total net verified savings for sector z

Finally, net verified savings for BBNP were calculated as the sum of the sector net verified savings, and was calculated as:

$$Savings_{net\ ver,BBNP} = \sum_{z} Savings_{net\ ver,z}$$

- Where,

$Savings_{net\ ver,BBNP}$ = total net verified savings of BBNP

$Savings_{net\ ver,z}$ = total net verified savings for sector z

3.9 Calculation of Additional Metrics

The following section outlines how the additional metrics related to the preliminary impact evaluation findings were calculated and reported.

3.9.1 Lifetime Energy Savings

The effective useful life (EUL) of retrofit equipment is an important consideration in the assessment of program effectiveness because the avoided energy, demand, and cost benefits continue to accrue over the lifetime of the measure. In order to calculate lifetime savings for the sample projects in the preliminary impact evaluation, individual project EULs were assigned based on the retrofit measure types implemented in the project, using values sourced from deemed savings databases, such as DEER,[34] RTF, and regional TRMs. The lifetime energy savings were then calculated as:

$$Lifetime\ Energy\ Savings = EUL * Annual\ Energy\ Savings$$

The DOE did not report lifetime energy savings that would allow the evaluation team to develop a realization rate. Therefore, the evaluation team calculated lifetime savings for the entire sector populations by calculating a lifetime savings factor. This factor was calculated by dividing the sample lifetime savings by sample annual savings. This factor was then multiplied by the total verified annual savings to determine a verified lifetime savings.

Current and upcoming changes to energy efficiency regulations will affect the availability of specific lighting technologies in the future marketplace. Specifically, they will begin to phase out the use of certain incandescent general service lamps and T12 general service fluorescent technology. The evaluation team did address this change in energy efficiency regulations, and, in the engineering analysis, these affected measures did not receive the full credit for achieving the first year annual energy savings over the lifetime of the measure. In these cases, the team reduced the future savings by increasing the assumed efficiency of the baseline technology at a certain point in the measure life, as illustrated in Figure 3-2.

[34] The Database for Energy Efficient Resources (DEER). Database maintained by the California Public Utilities Commission and the California Energy Commission. *http://www.energy.ca.gov/deer/.* Accessed 7/9/2012.

Figure 3-2: Calculation of Lifetime Energy Savings with Future Baseline Adjustment

The length of time a measure received credit for the full first year annual energy savings values depended on the timing of the market baseline shift (not the timing of the regulation implementation). The methodology is commonly used by utilities and the team used the specific methodology outlined in the Illinois TRM.[35]

3.9.2 Greenhouse Gas Emission Savings

Carbon dioxide (CO_2) and CO_2 equivalent reductions were calculated and reported for each year over the effective useful lifetime of the projects evaluated. Our approach was consistent with recommendations contained in the *Model Energy Efficiency Program Impact Evaluation Guide*[36] for the emission factor approach. This methodology employs the use of emission factors as follows:

$$avoided\ emissions = verified\ energy\ savings * emissions\ factor$$

The emission factor is expressed as mass per unit of energy (pounds of CO_2 per MWh), and represents the characteristics of the emission sources displaced by reduced generation from conventional sources of electricity or reduced consumption of fossil fuels.

35 June 2012. *State of Illinois Energy Efficiency Technical Reference Manual*.

36 National Action Plan for Energy Efficiency (2007). *Model Energy Efficiency Program Impact Evaluation Guide*. Prepared by Steven R. Schiller, Schiller Consulting, Inc. *www.epa.gov/eeactionplan*

For the BBNP evaluation, $CO_2(e)$[37] was calculated using the ENERGY STAR Portfolio Manager Methodology for Greenhouse Gas Inventory and Tracking Calculations.[38] The reference provides an avoided $CO_2(e)$ value for a number of fuel types, as well as an average of electric avoided $CO_2(e)$. These values were used in the Avoided $CO_2(e)$ Table along with energy savings by fuel type and sector to determine annual and lifetime avoided $CO_2(e)$.

3.9.3 Cost Savings

There were numerous challenges associated with the calculation of cost savings for BBNP. There is inherently a wide range of fuel rates used throughout the grantee territories, making it difficult to assign accurate fuel costs (and hence accurate cost savings) to each sampled project. In addition, and most importantly, many grantees did not report any cost savings for their projects, so the evaluation team could not check a verified cost savings value to a reported value. Due to these challenges savings, the evaluation team determined overall BBNP cost savings by applying the sector-based, energy realization rates determined through the M&V and billing analysis to the sector-level cost savings reported by DOE.

3.9.4 Demand Savings

The DOE did not report demand savings and thus the evaluation team was unable to extrapolate verified demand savings to the population. This will be investigated further for the final evaluation.

3.10 Economic Impacts Analysis

A separate analysis component of this evaluation is to estimate the economic impacts of BBNP.

3.10.1 Analysis Methods

The goal of an economic impact analysis of energy efficiency programs is to provide useful, action-oriented information to policymakers and program managers, and to inform interested stakeholders and the public. To that end, the economic impact analysis should: 1) rely on program-specific data whenever possible; 2) be based on a reliable and transparent modeling framework; 3) fully document the modeling approach, and the assumptions and limitations of that approach; and 4) report the full range of economic impact results and produce economic impact metrics that policy makers can use to improve program performance or affect program outcomes.

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[37] Carbon Dioxide Equivalence (CO_2e) is a quantity that describes, for a given greenhouse gas (carbon dioxide, methane, hydro fluorocarbons, etc), the amount of CO_2 that would have the same global warming potential, when measured over a specified timescale.

[38] See: *http://www.energystar.gov/*

In contrast to the energy impact analysis, the evaluation team utilized the Program Level information contained in the BBNP Quarterly Summary Reports to conduct the economic impact analysis. These reports were used rather than the Project level data as they contained the information needed for this analysis such as program outlays, energy cost savings, and measure spending. As the energy impact analysis used the Project level data, discrepancies between the energy impact analysis and the economic analysis may exist.

3.10.1.1 Overview

Measuring the economic impacts estimated for BBNP is a complex process, as spending by grantees and program participants unfold over time. From this perspective, the most appropriate analytical framework for estimating the economic impacts is to classify them into short-term and long-term impacts:

- Short-term impacts are associated with changes in business activity as a direct result of changes in spending (or final demand) by program administrators, program participants, and institutions that provide funding for energy efficiency programs.
- Long-term impacts are associated with the potential changes in relative prices, factor costs, and the optimal use of resources among program participants, as well as industries and households linked by competitive, supply-chain, or other factors.

This analysis measures the short-term economic impacts approximated for BBNP. These impacts are driven by changes (both positive and negative) in final demand, and are measured within a static input-output modeling framework that relies on data for an economy at a point in time and assumes that program spending does not affect the evolution of the economy. (This last event is what economists call a change in the "production possibilities frontier" of the economy.) Energy efficiency programs may have longer lasting effects, and this is clearly the case for continued post-installation energy savings. However, long-term, dynamic effects are not measured in this analysis as it is unlikely that BBNP is causing significant structural changes in the economy given the relatively small magnitude of energy savings achieved relative to the overall size of the national economy.

3.10.1.2 Input-Output Modeling Framework

The economic modeling framework that best measures these short-term economic impacts is called input-output modeling. Input-output models involve mathematical representations of the economy that describe how different parts (or sectors) are linked to one another. There are several important points about input-output models that should be noted:

- Input-output models provide a reasonably comprehensive picture of the economic activities within an economy and can be constructed for almost any study area.
- Input-output models use a simple, rectangular accounting framework called double-entry accounting. This results in a model structure that is well ordered, symmetric, and where, by definition, inputs must be equal to outputs.

- Input-output models are static models in that they measure the flow of inputs and outputs in an economy at a point in time. With this information and the balanced accounting structure of an input-output model, an analyst can: 1) describe an economy at one time period; 2) introduce a change to the economy; and then 3) evaluate the economy after it has accommodated that change. This type of analysis is called *partial equilibrium* analysis.
- In order to provide a common unit of measure, all transaction flows in an input-output model are stated in dollars.

3.10.1.3 The IMPLAN Model

This analysis relies on an economic impact model of the US economy constructed using the IMPLAN (for IMpact Analysis for PLANning) modeling software.[39] IMPLAN has several features that make it particularly well suited for this analysis:

- IMPLAN is widely used and well respected. IMPLAN models are constructed with data assembled for national income accounting purposes, thereby providing a tool that has a robust link to widely accepted data development efforts. The United States Department of Agriculture (USDA) recognized the IMPLAN modeling framework as "one of the most credible regional impact models used for regional economic impact analysis" and, following a review by experts from seven USDA agencies, selected IMPLAN as its analysis framework for monitoring job creation (measured in person-years of employment) associated with the ARRA.[40]
- The IMPLAN model's detailed descriptive capabilities provide a full characterization of the U.S. economy, in, this case, 2011. The IMPLAN model has a wide range of economic data for 440 different industry sectors, as well as for households and government institutions.
- The logical input-output modeling framework and detailed economic data within the IMPLAN model provide the structure necessary to adjust economic relationships or to build custom production functions for spending and activities that are linked back to BBNP. This detailed and flexible modeling system permits the most accurate mapping of BBNP program and participant spending, and energy savings, to industry and household sectors in the IMPLAN model.

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39 IMPLAN (for IMpact Analysis for PLANning) was originally developed by the Forest Service of the U.S. Department of Agriculture in cooperation with the Federal Emergency Management Agency and the Bureau of Land Management of the U.S. Department of the Interior in 1993, and is currently licensed and distributed by the Minnesota IMPLAN Group, Inc., (or "MIG, Inc.").

40 See excerpts from an April 9, 2009 letter to MIG, Inc., from John Kort, Acting Administrator of the USDA Economic Research Service, on behalf of Secretary Vilsack, at *www.implan.com*.

3.10.1.4 Terminology and Impact Metrics

Input-output analysis employs specific terminology to identify the different types of economic impacts. BBNP affects the economy *directly*, through the purchases of goods and services. Under our program-centric approach, these direct impacts include jobs (person-years of employment) and income for grantee staff that administer and manage energy efficiency programs, contractors who provide audit and retrofit services, and energy efficiency equipment manufacturers. Direct impacts also include changes in spending or output attributed to the energy savings for participating households and businesses.

These direct changes in economic activity will, in turn, *indirectly* generate purchases of intermediate goods and services from other, related sectors of the economy. Because these indirect purchases represent interactions among businesses, they are often referred to as "supply-chain" impacts. In addition, the direct and indirect increases in employment and income enhance overall economy purchasing power, thereby *inducing* further consumption- and investment-driven stimulus. These induced effects are often referred to as "consumption-driven" impacts. In this report, the indirect and induced impacts are grouped together and reported as "secondary" impacts.

The IMPLAN model reports the following impact measures:

- Output is the value of production for a specified period of time. Output is the broadest measure of economic activity, and includes intermediate goods and services and the components of value added (personal income, other income, and indirect business taxes). As such, output and personal income should not be added together.
- Personal income is the sum of wages and business income.
  - Wages includes workers' wages and salaries, as well as other benefits such as health and life insurance, and retirement payments, and non-cash compensation.
  - Business income is also called proprietary income (or small business income) and represents the payments received by small-business owners or self-employed workers. Business income would include, for example, income received by private business owners, doctors, accountants, lawyers, etc.
- Job impacts include both full- and part-time employment. These job impacts are measured in person-years of employment.[41]

[41] The IMPLAN modeling software reports jobs in "person-years" of employment where one person-year of employment is equivalent to one person being employed for the duration of one year, two people being employed for half a year each, etc. Furthermore, each "person-year" of employment can represent a new job being created, or an existing job from a previous year being sustained for an additional year. It is necessary to employ the use of person-years of employment when measuring jobs to emphasize the temporary nature of program-related employment. In the case of these BBNP programs, the initial employment will last as long as program funding is available to encourage the installation of energy efficient equipment. As discussed subsequently in the report, longer term employment gains also occur due to energy cost savings enjoyed by customers over the life of the equipment.

All of the economic impacts in this analysis are transitory and depend on program spending by BBNP grantees, as well as spending and energy savings for program participants. As discussed previously, economic impacts are estimated for program outcomes over the Q4 2010 through Q2 2012 time period. Because this seven-quarter time period includes partial years in 2010 and 2012, the economic impact modeling was conducted on a quarterly basis. Economic impact modeling on a quarterly basis presents certain complications, and it is important to understand the modeling issues associated with such analyses and how they affect the reporting of modeling results.

There are two main issues with quarterly analyses. First, the economic relationships in the IMPLAN model are based on annual data (e.g., average annual output or income per worker). Second, although the timing of the direct spending effects is known, the secondary spending effects are assumed to take place over a year. That is, it simply takes time for the supply-chain and consumption-driven spending effects to ripple through the economy, and most analyses assume that it takes a year.

In most cases, summing quarterly spending across years can address these issues. In this analysis, partial years of activity in 2010 and 2012 prevent this outcome. Instead, the direct effects are assumed (or, more precisely, known) to occur in each quarter, with the direct <u>job</u> effects multiplied by four (the number of quarters in a year) while the direct monetary effects are not adjusted. For example, $1 million in spending for a labor-only service, where the average annual wage is $100,000, will generate 10 jobs (person-years of employment) over the course of a year (that is, the equivalent of ten positions each lasting one year). Instead, if this $1 million in spending occurred in one quarter, it would support 40 jobs in that quarter (that is, person-quarter-years of employment). It is clear from this example that the average earnings for this quarter-year of work are $25,000, consistent with an average annual wage of $100,000 for a single person working fulltime. Perhaps more importantly, the 40 “jobs” in the quarter are equivalent to 10 person-years of employment, which is consistent with the initial example of 10 direct jobs if this spending occurred over the course of an entire year.

3.10.1.5 Gross and Net Impacts

Simply citing the economic impacts that occur as a result of some program provides an upper bound estimate of impacts. This upper bound estimate is often referred to as a measure of the *gross* economic impacts. Gross economic impacts offer a perspective on the magnitude of overall impacts that can be traced back to the program; however, they do not necessarily reflect or measure the creation of new jobs or income.

An analysis of the *net* economic impacts requires that only economic stimuli that are new or additive to the economy be counted. To address this, the impact analysis first defines a Base Case scenario that describes what would have happened in the absence of the program. In impact analysis, this base case scenario is typically implemented by posting a counterfactual argument that only counts economic activity that “but for” the program would not have occurred. The distinction between gross and net impacts for BBNP is important because federal funding used to support grantee energy efficiency programs will divert spending from other federal government programs.

For energy efficiency programs, the *gross economic impacts* reflect the economic impacts without adjustments for impacts that might have occurred from spending in the base case scenario. Gross impacts include:

- Program outlays as BBNP grantees incur administrative costs, and purchase labor and materials to carry out their energy efficiency programs. (There are three major categories of program outlays, and these are discussed in detail in the next section of the report.)
- Measure spending represents spending on efficiency upgrades. Measure spending is allocated to equipment and labor, mapped to North American Industry Classification System (NAICS) codes, and then mapped to sectors in the economic impact model.
- Reductions in energy consumption and the associated increase in household disposable income and lower operating costs for businesses.[42]
    - For residential program participants, lower energy costs will increase household disposable income. These estimated residential energy cost savings are fed into a modified household consumption function (household spending on goods and services *less* expenditures on energy) to estimate how this additional spending affects the economy.
    - For businesses, energy savings lowers production costs, which, in the short run, leads to changes in output. To estimate the economic impacts associated with these lower energy costs, the project team used an elasticity-based approach to measure the direct change in output, and associated changes in direct employment and income, for industries that comprise the commercial program. These direct impacts then form the inputs into the economic impact model to measure subsequent supply-chain and consumption-driven effects.
- Reductions in utility revenues as households and businesses consume less electricity. To be balanced in our analysis, these revenue decreases are included in the analysis. To be consistent with reductions in energy consumption, these revenue decreases are included in post-installation quarters between Q4 2010 and Q2 2012. They are not, however, included in annual energy savings impacts beyond this seven-quarter period.

The net economic impacts estimated for BBNP include adjustments to reflect the economic activity that occurs in the base case scenario. That is, net impacts are those impacts over and above what would have occurred in the base case scenario. The *net economic impacts* estimated for BBNP are based on:

- Gross program impacts (discussed above).

42 Both a realization rate adjustment and a net-to-gross adjusted will be applied to the energy cost savings in the final evaluation report. For the preliminary evaluation, the gross and net energy impact analysis was not completed in time for either of these adjustments to be incorporated into the economic impact analysis. The net-to-gross adjustment will also be applied to measure spending in the economic analysis conducted for the final evaluation report.

- Less foregone federal spending on non-defense programs as a result of the federal funding that is allocated to BBNP grantees.

3.10.2 Model Input Data

The economic analysis relies on data for BBNP spending and activities between Q4 2010 and Q2 2012, as gathered from DOE Quarterly Summary Reports and, where necessary, detailed quarterly spreadsheets completed by program grantees. There are limitations to these data as they relate to the economic impact analysis. That is, these data were gathered to monitor program performance and potential market transformation effects. In some instances, detailed spending data necessary for economic impact modeling were not explicitly reported. Moreover, these data were gathered from 41 BBNP grantees, each implementing their own energy efficiency program(s). Thus, there was a degree of inconsistency in reporting across grantees.

BBNP tracks grantee spending for three major outlay categories: Marketing and Outreach (M&O), Labor and Materials (L&M), and Other. BBNP also tracks certain data for three major activity categories: audits (assessments), energy upgrades (retrofits), and loans. These outlay and activity categories are discussed in more detail below, as they relate to the economic impact analysis. They have been reorganized somewhat to facilitate the economic impact modeling process.

3.10.2.1 Outlays

BBNP outlays (or program expenditures) are reported, by grantee and quarter, for three major outlay categories in the Quarterly Summary Reports. These outlays are summarized in Table 3-15. Between Q4 2010 and Q2 2012, total program outlays by BBNP grantees amounted to approximately $245.7 million (48.4% of total funds granted).

Table 3-15: BBNP Outlays by Major Outlay Category

Quarter / Year	Marketing & Outreach (M&O)	Labor & Materials (L&M)	Other	Total Outlays
Q4 2010	$1,853,421	$2,116,949	$11,030,135	$15,000,505
Q1 2011	$4,684,800	$2,411,668	$11,099,437	$18,195,905
Q2 2011	$6,132,662	$11,241,729	$26,541,114	$43,915,504
Q3 2011	$6,763,461	$12,915,553	$20,786,606	$40,465,620
Q4 2011	$6,547,350	$5,257,939	$31,279,315	$43,084,603
Q1 2012	$13,534,208	$5,388,965	$24,526,904	$43,450,078
Q2 2012	$6,943,893	$9,406,343	$25,276,135	$41,626,371
Total All Quarters	**$46,459,794**	**$48,739,147**	**$150,539,646**	**$245,738,587**

Source: BBNP Quarterly Summary Reports.

The data and modeling assumptions for each major outlay category are as follows.

- Marketing and Outreach (M&O) outlays totaled $46.5 million between Q4 2010 and Q2 2012. This represents 18.9% of total outlays over the seven quarters. M&O outlays consist of "grant outlays for communications activities designed to identify, reach and motivate potential program participants to take actions to either learn more (e.g., audit or other informational activity) energy efficiency or initiate an energy efficiency retrofit at the PROGRAM level."[43] Total M&O outlays are reported by grantee in the Quarterly Summary Reports. Detailed M&O activities (e.g., business organization outreach, online and traditional advertising, neighborhood meetings, websites and webinars) are also reported, by grantee, in the Quarterly Summary Reports. However, there is no correspondence or conformity between detailed activities and outlays. That is, detailed M&O spending is not reported. As such, this analysis applies a dollar-value-weighting factor (or roughly an average cost per M&O activity) to the reported number of activities taking place each quarter to allocate total M&O spending in that quarter.

- Labor and Materials (L&M) outlays totaled $48.7 million (or 19.8% of total outlays) over the Q4 2010 through Q2 2012 period. According to BBNP reporting instructions, L&M outlays are "Outlays incurred as part of an audit or retrofit directly associated with the installation of more energy efficient equipment, appliances, or building components (e.g. insulation, windows, etc.) at the PROGRAM level."[44] Accordingly, L&M outlays are not explicitly included as inputs into the economic impact model. Rather, they are included as part of audit and efficiency upgrade (retrofits) activities as follows:

  - Audit activity is tracked by number of residential and commercial audits completed, by grantee and quarter, in the Quarterly Summary Reports. Between Q4 2010 and Q2 2012, BBNP grantees accomplished 113,412 residential audits and 3,855 commercial audits. Spending on audits, however, is not explicitly reported and, as discussed previously, audit spending is assumed to be a component of L&M outlays. Using data compiled from the detailed quarterly spreadsheets submitted by BBNP grantees, audit spending was estimated by calculating an average audit cost for residential ($322 per audit) and commercial ($2,893 per audit) audits between Q4 2010 and Q2 2012 and applying those average costs to the number of residential and commercial audits in each quarter.[45] Audit spending was then modeled by developing a custom production function for Building Inspection Services (NAICS 541350) using audit costs and audit hours from the detailed quarterly spreadsheets to estimate the number of audit jobs (person-years) per million in audit spending.

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43 Quarterly Programmatic tab in the detailed quarterly spreadsheets.

44 Ibid.

45 The calculation of average audit costs was conducted using only grantee spreadsheets that reported complete information for: 1) number of audits, 2) total job hours for audits, and 3) total audit invoiced costs. With 41 grantees and seven quarters of activity, there are 287 grantee spreadsheets. Grantees are asked to report at the project level, so there could be thousands of projects over this time period. Only 120 observations were gathered for the residential sector and only 65 observations were obtained for the commercial sector.

- Energy Upgrades (or retrofits) represent participants' spending on energy efficiency upgrades. Although a small, unknown amount of the costs of the energy upgrades is captured under L&M outlays, most of the costs of energy upgrades are borne by the participant in the form of out-of pocket expenses or borrowed funds, or supported through other federal and non-federal incentives and funding. As such, the economic impacts attributed to energy upgrades are, in fact, based on measure spending. Similarly, measure spending also captures the economic impacts associated with the loans initiated by BBNP grantees. (Measure spending is discussed in more detail in the next section.)

- Other outlays totaled $150.5 million (or 61.3% of total outlays) between Q4 2010 and Q2 2012. Other outlays consist of "Other program grant outlays at the PROGRAM level not classified as materials, labor, marketing, or outreach…(they) represent actual grant funds spent on program delivery and any associated incentives or loans issued during the quarter."[46] Other outlays are reported in total, by grantee, in the Quarterly Summary Reports. Those reports, however, do not include additional information to better understand the nature of these other program delivery costs or to distinguish between program delivery costs and program incentives. This analysis, therefore, relies on energy efficiency program cost data from the U.S. Energy Information Administration (EIA).[47] Nationally, in 2011, the EIA reports that 55.2% of total energy efficiency program costs went towards incentives, with the remaining 44.8% of total program costs allocated to direct (37.2% of total program costs) and indirect (7.6%) costs.[48] Incentive spending supports participants' spending on efficiency upgrades, but represents a transfer rather than a change in final demand. Accordingly, incentive spending was not explicitly included in the economic impact model. Other delivery costs were modeled through a custom production function for energy efficiency program activities, after removing potentially duplicate activities such as marketing and outreach, and auditing.

3.10.2.2 Measure Spending

The measure spending associated with efficiency upgrades represents a significant positive stimulus effect that is not explicitly captured by BBNP outlay categories, or program audit and loan activities. Table 3-16 summarizes BBNP efficiency project activities for residential and commercial sectors, as reported in the Quarterly Summary Reports or calculated from those data. The totals in this table were sourced from the Quarterly Summary Reports which had the

46 Quarterly Programmatic tab in the detailed quarterly spreadsheets.

47 U.S. Energy Information Administration's (EIA's) *Annual Electric Power Industry Report*, 2011, Survey Form EIA-861, File 3A. According to the EIA, direct costs are "The cost for implementing energy efficiency programs (in thousand dollars) incurred by the utility." Incentive costs or payment represent a "Payment by the utility to the customer for energy efficiency incentives. Examples of incentives are zero or low-interest loans, rebates, and direct installation of low cost measures, such as water heater wraps or duct work." Lastly, indirect costs are "A utility cost that may not be meaningfully identified with any particular DSM program category. Indirect costs could be attributable to one of several accounting cost categories (i.e., Administrative, Marketing, Monitoring & Evaluation, Utility-Earned Incentives, Other)."

48 Although program incentives do not explicitly enter the economic impact model as a positive stimulus, they are included with program outlays in the counterfactual spending scenario.

information needed to conduct the economic analysis. These totals may differ slightly from those used in the energy impact analysis as that analysis utilized the project level data. As discussed previously, there were discrepancies between these two data sources.

Table 3-16: Summary of BBNP Efficiency Upgrades, by Sector

	Residential Efficiency Upgrades			Commercial Efficiency Upgrades			All Upgrades
Quarter / Year	Number of Upgrades	Average Invoiced Cost[1]	Total Invoiced Costs	Number of Upgrades	Average Invoiced Cost[1]	Total Invoiced Costs	Total Invoiced Costs
Q4 2010	3,115	$6,264	$19,512,360	38	$17,321	$658,198	$20,170,558
Q1 2011	4,083	$6,556	$26,768,148	83	$8,252	$684,916	$27,453,064
Q2 2011	3,451	$6,385	$22,034,635	112	$43,345	$4,854,640	$26,889,275
Q3 2011	3,791	$8,029	$30,437,939	162	$53,560	$8,676,720	$39,114,659
Q4 2011	4,730	$8,801	$41,628,730	310	$45,005	$13,951,550	$55,580,280
Q1 2012	5,066	$7,776	$39,393,216	293	$57,715	$16,910,495	$56,303,711
Q2 2012	6,617	$6,716	$44,439,772	352	$31,177	$10,974,304	$55,414,076
Total All Quarters	**30,853**	**$7,267**	**$224,214,800**	**1,350**	**$42,008**	**$56,710,823**	**$280,925,623**

Source: BBNP Quarterly Summary Reports.

Note: The Quarterly Summary Reports refer to efficiency upgrades as "retrofits" and include the number and average invoiced cost for residential and commercial retrofits, by grantee, for each quarter. This information was used to calculate the weighted average invoice cost and, then, total invoice costs for each quarter. The weighted average invoiced cost for the commercial sector is elevated in both Q3 2011 and Q1 2012 due to several large, multi-million dollars efficiency upgrade projects.

According to calculations made using data from the Quarterly Summary Reports, it is estimated that BBNP supported approximately $224.2 million in residential and $56.7 million in commercial efficiency upgrades between Q4 2010 and Q2 2012.

A wide range of energy efficiency measures were installed as part of these efficiency upgrades, and the mix of measures changes over time. Although it is possible to calculate total spending on efficiency upgrades, by quarter and sector, the Quarterly Summary Reports do not provide a break out of spending across energy efficiency measures. To determine measure spending for each sector, this analysis used the detailed quarterly spreadsheets submitted by BBNP grantees to: 1) extract measure counts and total invoice amounts for each project; 2) estimate average measure costs using total invoice amounts for projects that consisted of a single measure; 3) apply the average measure cost to measure counts to calculate total measure spending for each quarter; 4) normalize total measure spending for each quarter on a "per million dollar" basis; and 5) apply the normalized measure spending functions to the total spending reported, by sector. Measure spending for each quarter was allocated to equipment and labor, and to the relevant industry sector using NAICS codes and IMPLAN industry codes.

3.10.2.3 Energy Savings

The Quarterly Summary Reports include the annual energy savings (both physical units and dollar value) associated with efficiency upgrades in each quarter.[49] Table 3-17 reports the annual energy savings, by fuel type, and the estimated annual energy cost savings estimated for BBNP between Q4 2010 and Q2 2012. It is important to clarify that the annual energy savings and annual costs savings included in the Quarterly Summary Reports and shown in Table 3-17 represent the benefits of the efficiency upgrade over the course of an entire year. The spending and production benefits to residential and commercial participants, respectively, in each quarter will be one-fourth of these reported annual amounts.

Table 3-17: Reported Annual Energy Savings, by Fuel Type, and Estimated Annual Cost Savings

Quarter / Year	Electricity (kWh)	Natural Gas (Therms)	Heating Oil (Gallons)	LPG (Gallons)	Estimated Annual Cost Savings ($)
Q4 2010	3,112,080	278,309	258,217	2,741	$1,735,342
Q1 2011	8,637,708	291,067	448,154	34,397	$4,093,509
Q2 2011	5,656,352	221,700	204,745	24,288	$2,294,353
Q3 2011	8,165,336	2,504,455	268,950	29,073	$3,521,030
Q4 2011	12,560,952	501,885	346,165	43,266	$4,022,707
Q1 2012	12,209,176	602,847	188,253	44,884	$5,496,960
Q2 2012	24,148,843	647,326	257,358	53,251	$6,632,014
Total All Quarters	**74,490,447**	**5,047,589**	**1,971,842**	**231,900**	**$27,795,915**

Source: BBNP Quarterly Summary Reports.

Although the Quarterly Summary Reports include annual energy and cost savings by grantee and quarter, they do not break out the annual costs savings for residential and commercial sectors. Therefore, this analysis uses project-level data reported in grantees' detailed quarterly spreadsheets to allocate total annual energy cost savings to residential (71.4% of total cost savings) and commercial (28.6%) sectors.

Residential energy cost savings will increase the purchasing power of households on non-energy goods and services. Energy cost savings for commercial participants will lower their costs of production and, in the short run, lead to an increase in output. To estimate the changes in output,

49 This analysis uses reported annual energy savings in the Quarterly Summary Reports. This information is self-reported by grantees in the detailed quarterly spreadsheets, and, according to the Quarterly Programmatic tab, grantees are asked to, "*Please enter the total annual cost savings based on the total measures installed during the most recent quarter. *If direct installation was conducted in your program, please include here the estimated savings from those efforts. In the Methodology tab, you can specify what types of measures were undertaken in your direct installation efforts.*" Most grantees did not provide additional information for direct installations.

the distribution of energy cost savings was estimated across business sectors using the "Principle Building Type" variable in the grantees' detailed quarterly spreadsheets.[50]

The efficiency gains shown in Table 3-16 could result in a loss of revenue to utilities and other fuel providers (producers of heating oil and propane), and this loss of revenue is included in the gross economic impacts.[51] If utilities and other fuel providers had similar economic impact multipliers as other sectors in the economy, then the energy cost savings in other sectors would roughly cancel out the loss of revenue in the utility sector. To be consistent with reductions in energy consumption, these revenue decreases are included in post-installation quarters between Q4 2010 and Q2 2012. They are not, however, included in annual energy savings impacts beyond this seven-quarter period.

50 The detailed quarterly spreadsheets provide grantees with a drop down menu for the Principle Building Type variable. Although infrequently populated, this approach likely generated a more consistent set of responses.

51 The economic impacts in future post-BBNP years do not include an adjustment for foregone utility revenues.

4 Findings

Based on the methodology outlined in Section 3, the following sections present the findings for the preliminary impact evaluation on gross and net verified savings realized through Q2 2012. We first present the combined overall findings from both the M&V analysis and billing analysis. We then break out the findings by analysis approach in subsequent sections. All findings are presented by sector (except for the billing analysis which only looked at residential projects), and the sector findings are combined in the final steps to come to total BBNP verified net savings.

4.1 Overall Preliminary Evaluation Findings

Table 4-1 presents the gross verified savings and confidence/precision achieved by the residential and commercial sectors. Based on the analysis, BBNP residential and commercial sectors achieved gross verified savings of 1,590,544 source MMBtus with 90% confidence and 7% precision of the results. Multifamily and agricultural sectors were not included in this analysis and, therefore, verified savings were not calculated.

Table 4-1: Reported vs. Verified Annual Source Savings

Sector	Reported Projects	Reported Source Savings (MMBtu)	Realization Rate (Percent)	Gross Verified Source Savings (MMBtu)	Confidence / Precision
Residential	27,743	1,116,160	79%	883,999	90/7
Commercial	1,333	667,108	106%	706,545	90/12
Multifamily*	3,119	83,839	—	—	—
Agricultural*	59	9,220	—	—	—
Total	**32,254**	**1,876,327**	**—**	**1,590,544**	**90/7**

* The multifamily and agricultural sectors were not included in the evaluation activities due to a small amount of activity and a lack of data provided by grantees to the evaluation team. Therefore, verified savings totals do not include savings from these two sectors.

The team calculated a realization rate of 79% for the residential sector, which suggests reported savings were generally overstated by DOE by about one-fifth. Additionally, the team calculated a realization rate of 106% for the commercial sector indicating an under reporting of savings by DOE. Overall, the results from Table 4-1 indicate the evaluation activities achieved the desired confidence and precision goals of 90% confidence and 10% precision. Further discussion of the statistics related to these savings is presented later in this section.

Table 4-2 below outlines the overall net verified source savings for the residential and commercial sectors. The net verified source savings were calculated by applying the net to gross ratios obtained from surveys administered to participants within the M&V sample frame.

Table 4-2: Annual Net Verified Savings

SECTOR*	GROSS VERIFIED SOURCE SAVINGS (MMBTU)	NET-TO-GROSS RATIO	NET VERIFIED SOURCE SAVINGS (MMBTU)
Residential	883,999	83%	733,816
Commercial	706,545	92%	646,888
Total	**1,590,544**	**—**	**1,380,704**

* As the team did not evaluate the multifamily or agricultural sectors, these totals are not included in this table

Net verified lifetime savings for the preliminary impact evaluation period are presented in Table 4-3. The evaluation team calculated lifetime savings for every project in the sample; however, because lifetime savings were not reported by grantees, a realization rate could not be calculated for the program. Therefore, to estimate lifetime savings, the average ratio of verified lifetime to annual savings for each sample project was calculated. The ratio was calculated by sector and applied across the population of the residential and commercial sectors to estimate lifetime savings. The reliability of this methodology is predicated on the assumption that the measure mix offered by the grantees is fairly consistent.

Table 4-3: Net Verified Lifetime Source Energy Savings

SECTOR*	NET ANNUAL SOURCE SAVINGS (MMBTU)	LIFETIME SAVINGS FACTOR (YEARS)	NET LIFETIME SOURCE SAVINGS (MMBTU)
Residential	733,816	18.6	13,650,626
Commercial	646,888	11.4	7,347,138
Total	**1,380,704**	**—**	**20,997,764**

* As the team did not evaluate the multifamily or agricultural sectors, these totals are not included in this table.

In addition to the analysis conducted on source MMBtu, savings by fuel type was also analyzed. Table 4-4 and Table 4-5 present the reported and verified savings for electricity (kWh), and natural gas (therms) for both sectors. Fuel type reporting varied significantly, especially amongst fuel oil and propane. Consequently, the realization rates calculated for fuel oil and propane varied widely and indicated both underestimation (often zero reported savings) and overestimation of these fuel types resulting in a lack of overall precision. Additionally, as the sampling strategy did not include stratification by fuel type, and sample sizes of projects selected with fuel oil and propane savings were small, the team did not present individual results for realization rates for fuel oil and propane.

This is a potential area for improvement in future reporting. Additionally, because multifamily and agricultural projects were not analyzed as part of the preliminary impact evaluation, fuel type savings for these sectors were not verified.

Table 4-4: Annual Residential Source Energy Savings by Fuel Type

Fuel Type	Fuel Units	Reported Annual Savings (Units by Fuel Type)	Realization Rate (Percent)	Gross Verified Annual Savings (Units by Fuel Type)	Net-to-Gross Ratio*	Net Verified Annual Savings (Units by Fuel Type)	Confidence / Precision
Electricity	kWh	31,632,968	56 %	17,739,610	83%	14,725,828	90/21
Natural Gas	therm	6,007,011	85%	5,106,218	83%	4,238,723	90/9
Fuel Oil	gallon	371,961	—	—	—	—	—
Propane	gallon	132,313	—	—	—	—	—

* NTG ratios were not calculated by fuel-type and therefore the sector-level NTG ratio was used for this analysis.

Table 4-5: Annual Commercial Source Energy Savings by Fuel Type

Fuel Type	Fuel Units	Reported Annual Savings (Units by Fuel Type)	Realization Rate (Percent)	Gross Verified Annual Savings (Units by Fuel Type)	Net-to-Gross Ratio*	Net Verified Annual Savings (Units by Fuel Type)	Confidence / Precision
Electricity	kWh	55,021,954	104%	57,285,832	92%	52,448,960	90/14
Natural Gas	therm	301,989	89%	270,069	92%	247,266	90/25
Fuel Oil	gallon	10,523	—	—	—	—	—
Propane	gallon	5,825	—	—	—	—	—

* NTG ratios were not calculated by fuel-type and therefore the sector-level NTG ratio was used for this analysis.

Due to challenges and inconsistencies in determining the verified program level cost savings, the team applied the sector-level realization rates to the reported cost savings in order to calculate the overall BBNP cost savings, as outlined in Table 4-6.

Table 4-6: Annual Reported vs. Verified Net Cost Savings

Sector	Reported Annual Cost Savings ($)	Realization Rate (Percent)	Net-to-Gross Ratio	Net Annual Cost Savings ($)
Residential	$ 17,415,485	79%	83%	$ 11,449,760
Commercial	$ 7,140,893	106%	92%	$ 6,924,457
Multifamily	$ 512,412	—	—	—
Total	**$ 25,068,790**	**—**	**—**	**$18,374,217**

The evaluation team also calculated avoided greenhouse gas emissions in carbon dioxide equivalent (CO_{2e}), based on the net verified source energy savings (both annual and lifetime)

Table 4-7 and Table 4-8 present the findings for the residential and commercial sectors for electricity and natural gas.

Table 4-7: Net Verified Residential Avoided CO2e

Fuel Type	Annual Net Source Savings (MMBtu)	CO_{2E} Conversion Factor (Metric Tons/ MMBtu)	Estimated Annual CO_{2E} Avoided (Metric Tons)	Lifetime Savings Factor	Estimated Lifetime CO_{2E} Avoided (Metric Tons)
Electricity	168,478	0.1728	29,108	18.6	541,474
Natural Gas	462,869	0.0532	24,625	18.6	458,073
Total	**631,347***	**—**	**53,733**	**—**	**999,547**

* This total does not the equal the total source savings reported in Table 4-1 due to variances in the reported fuel savings versus the verified fuel type savings.

Table 4-8: Net Verified Commercial Avoided CO_2e

Fuel Type	Annual Net Source Savings (MMBtu)	CO_{2E} Conversion Factor (Metric Tons/ MMBtu)	Estimated Annual CO_{2E} Avoided (Metric Tons)	Lifetime Savings Factor	Estimated Lifetime CO_{2E} Avoided (Metric Tons)
Electricity	600,069	0.1728	103,674	11.4	1,177,494
Natural Gas	27,001	0.0532	1,436	11.4	16,315
Total	**627,070***	**—**	**105,110**	**—**	**1,193,809**

* This total does not the equal the total source savings reported in Table 4-1 due to variances in the reported fuel savings versus the verified fuel type savings.

The net source savings values in the avoided CO_2 tables are referenced from the individual fuel savings for each sector. Each of these calculations uses a sector and fuel type specific realization rate that can be seen in Table 4-3 and Table 4-4. As described above, the realization rates were not provided for fuel oil and propane due to the wide variances and therefore totals for these fuel types were not provided. Further investigation into these variances will be conducted for the final evaluation activities.

4.2 Measurement and Verification Findings

The following section presents the findings from the M&V analysis conducted on the sample of commercial and residential projects across the grantees. Table 4-9 presents the number of sampled projects and their respective reported source energy savings, realization rates, gross verified energy saving, and the associated confidence/precision and error ratios[52] as a result of the M&V activities.[53]

Table 4-9: Annual Reported vs. Verified Source Savings by Sector of the Sample

Sector	Number of Projects	Reported Source Savings (MMBtu)	Realization Rate (Percent)	Gross Verified Source Savings (MMBtu)	Confidence / Precision	Error Ratio
Residential	217	10,106	83%	8,371	90/8	.6
Commercial	102	197,883	106%	209,581	90/12	.9
Total	**319**	**207,990**	**—**	**217,953**	**—**	**—**

Across the M&V sample frame, the residential savings were found to be slightly over reported based on the realization rate calculated by the team. In addition, the error ratio indicated a fairly low level of variability between project verified savings and the *ex post* savings estimate. For the commercial sector, savings appear to be under reported based on the calculated realization rates and the error ratio indicates a high level of variability in the project reported savings and the *ex post* savings estimate. Much of this variability appeared to be driven by one grantee's reporting issues.

The evaluation team analyzed the findings of the sample by fuel type for natural gas and electric savings in order to come up with a realization rate by fuel type to be applied to the overall reported savings. Table 4-10 and Table 4-11 present these findings by sector. The team did not report realization rates for the other fuel types (i.e., fuel oil, propane, wood), due to the limited number of projects within the sample. In addition, there appeared to be reporting issues from some of the grantees with these other fuel types that created calculation issues (i.e., no savings reported for projects that actually achieved savings). It should be noted that multiple projects resulted in energy savings of more than one fuel type, therefore, the sum of the number of projects in Table 4-10 and Table 4-11 will not equal the sum of the number of projects by sector in Table 4-9.

52 The error ratio is a measure of the variability between the evaluated savings and the reported estimate of savings adjusted for the realization rate.

53 Due with potential issues associated with the convenience sampling methodology used to select the on-site visits, findings from the on-site visits have been removed in order to calculate overall realization rates for each sector.

Table 4-10: Reported vs. Verified Residential Source Energy Savings of the Sample, by Fuel Type

Fuel Type	Fuel Units	Number of Projects	Reported Source Savings (Units by Fuel Type)	Realization Rate (Percent)	Gross Verified Source Savings (Units by Fuel Type)	Confidence / Precision
Electricity	kWh	193	262,796	56%	147,375	90/25
Natural Gas	therm	168	60,743	85%	51,631	90/10
Fuel Oil	gallon	15	1,414	—	—	—
Propane	gallon	9	1,736	—	—	—
Wood	cord	1	0	—	—	—

Table 4-11: Reported vs. Verified Commercial Source Energy Savings of the Sample, by Fuel Type

Fuel Type	Fuel Units	Number of Projects	Reported Source Savings (Units by Fuel Type)	Realization Rate (Percent)	Gross Verified Source Savings (Units by Fuel Type)	Confidence / Precision
Electricity	kWh	92	16,136,652	104%	16,800,595	90/14
Natural Gas	therm	24	91,078	89%	81,451	90/25
Fuel Oil	gallon	5	5,435	—	—	—
Propane	gallon	2	5,600	—	—	—

4.2.1 M&V Sample Extrapolation

M&V sample results were extrapolated to the population using the sector level realization rates. Following the protocol outlined by the California Evaluation Framework, as described in Section 3, case weights were calculated and applied to sampled projects by strata. The weighted verified savings were divided by the weighted reported savings to determine the sector realization rate. The realization rate was applied to the sector's population of reported savings to determine the verified gross savings for the sector. An error bound at 90% confidence was calculated to generate the relative precision for the verified gross savings value.

4.2.2 Issues that Impacted the M&V Findings

Over the course of the M&V activities, the team uncovered projects with significant differences between the reported values and the gross verified findings. The following describes our understanding of the main reasons for some of the largest discrepancies:

1. No reported savings. Approximately 7% of the projects in our sample achieved savings, but were reported by the respective grantee to have zero savings.

2. Measures installed and not reported. The team encountered many grantee projects with incomplete measure reporting. This reduced the amount of savings below what the grantee should have credited for these projects. One of the grantees in our sample significantly under-reported the savings for 30% of the projects that we analyzed in our sample. For these projects, the grantee only reported the energy savings associated with one measure, but our review of their documentation and our participant surveys revealed that numerous measures were actually implemented.

3. More measures reported than verified. Conversely, there were also cases of measures reported as installed, where the M&V activities verified that they were not installed. This often occurred where *recommended* measures from an audit were counted as *installed.*

4. Overstatement of savings. In a few cases, the team identified issues where the energy savings being reported by the grantee was more energy than was actually consumed by a typical customer. This likely was due to energy modeling issues, but because the models could not be calibrated or the inputs verified, it was difficult to know the exact reasons.

5. Fuel type reporting issues. There were cases where grantees reported fuel type savings incorrectly, either by listing the wrong fuel type or listing the wrong units (i.e., MMBtu instead of gallons).

4.3 Billing Analysis Findings

This section presents the results from the billing regression models and the resulting savings estimates for the four grantees included in the billing analysis. Table 4-12 and Table 4-13 present the detailed model results for both the electric and gas models for all four grantees combined.

In general, the model results are consistent with expectations, with most coefficients having statistically significant estimates and of the expected sign. The variable of interest is *Post*, which represents the change in consumption in the post-installation period and therefore a reflection of energy savings resulting from the program. The point estimate of -136.75 indicates energy savings of almost 137 kWh per month or 12% monthly/annually holding all other terms constant.

Similar results were obtained from the gas model shown in Table 4-13. As in the electric model, the variable *Post* reflects the change in consumption in the post-participation period and, therefore, can be interpreted as an estimate of savings resulting from the program. In this case, the estimate of -5.87 indicates that participants are savings almost 6 therms per month or 11.1% monthly/annually holding all other terms constant.

The model results for the individual grantee regressions are included in *Appendix G: Detailed Billing Analysis Results.*

Table 4-12: Detailed Electricity Billing Regression Model Results

Variable	Coefficient (β)	Standard Error	B/Standard Error	Probability [|Z|>z]	95% Confidence Interval
(β_1) Post	-136.754064	4.91871543	-27.803	0.000	(-146.395, -127.114)
(β_2) HDD	0.48659318	0.01956458	24.871	0.000	(0.44825, 0.52494)
(β_3) CDD	1.4191267	0.0278205	51.01	0.000	(1.36460, 1.47365)
(β_4) January	16.2807166	11.2367509	1.449	0.1474	(-5.7429, 38.3043)
(β_5) February	33.1806842	10.454715	3.174	0.0015	(12.6898, 53.6715)
(β_6) March	-18.3141094	10.6199545	-1.724	0.0846	(-39.1288, 2.5006)
(β_7) April	-13.5355036	12.6467569	-1.07	0.2845	(-38.3227, 11.2517)
(β_8) May	-16.9715928	14.6153938	-1.161	0.2456	(-45.6172, 11.6741)
(β_9) June	71.5940435	18.4426969	3.882	0.0001	(35.4470, 107.7411)
(β_{10}) July	151.466578	22.4258457	6.754	0.000	(107.513, 195.420)
(β_{11}) August	212.58535	23.3590059	9.101	0.000	(166.803, 258.368)
(β_{12}) September	114.978331	21.8512383	5.262	0.000	(72.151, 157.806)
(β_{13}) October	-9.37782095	16.8544978	-0.556	0.5779	(-42.41203, 23.65639)
(β_{14}) November	-33.0870592	12.1898907	-2.714	0.0066	(-56.9788, -9.1953)

Table 4-13: Detailed Natural Gas Billing Regression Model Results

Variable	Coefficient (β)	Standard Error	B/Standard Error	Probability [|Z|>z]	95% Confidence Interval
(β_1) Post	-5.87193176	0.30567941	-19.209	0.000	(-6.47105, -5.27281)
(β_2) HDD	0.11588497	0.00124271	93.252	0.000	(0.11345, 0.11832)
(β_3) CDD	0.01839848	0.00183773	10.011	0.000	(0.01480, 0.02200)
(β_4) January	2.12500676	0.64731003	3.283	0.001	(0.85630, 3.39371)
(β_5) February	15.4064229	0.65300663	23.593	0.000	(14.1266, 16.6863)
(β_6) March	6.5584045	0.6282995	10.438	0.000	(5.32696, 7.78985)
(β_7) April	-4.24012874	0.79488123	-5.334	0.000	(-5.79807, -2.68219)
(β_8) May	-9.08277883	0.93972524	-9.665	0.000	(-10.92461, -7.24095)
(β_9) June	-7.4115604	1.20649211	-6.143	0.000	(-9.77624, -5.04688)
(β_{10}) July	-5.48601959	1.49874313	-3.66	0.0003	(-8.4235, -2.54854)
(β_{11}) August	-5.73229674	1.57252529	-3.645	0.0003	(-8.81439, -2.6502)
(β_{12}) September	-8.26833138	1.45404953	-5.686	0.000	(-11.11822, -5.41845)
(β_{13}) October	-8.40130471	1.08338756	-7.755	0.000	(-10.52471, -6.2779)
(β_{14}) November	-4.17705079	0.76114045	-5.488	0.000	(-5.66886, -2.68524)

Table 4-14 presents a summary of our model statistics and results for the entire sample of projects with available billing data. On average, we found that BBNP participants had:

- Monthly electricity consumption equal to approximately 1,143 kWh
- Monthly gas consumption equal to nearly 53 therms
- Approximately 31 months of billing data

Our billing regression models found that, on average:

- Participants installing electric measures reduced their consumption by 12%
- Natural gas participants reduced consumption by 11.1%

While these results are reasonable estimates of savings, they do fall short of the program goal of achieving a minimum of 15% savings. These two estimates translate to an average annual electricity savings of 1,646 kWh and average annual natural gas savings of 70.2 therms.

Table 4-14: Electricity and Natural Gas Billing Regression Model Summary

Model Summary	Electricity	Natural Gas
Average Monthly Normalized Fuel Usage	1,143.09	52.71
Average Post-Retrofit Billing Months	11.5	11.3
Average Pre-Retrofit Billing Months	20.3	19.9
Adjusted R-Squared Statistic	0.90	0.80
Average Monthly Savings (% of usage)	12.00%	11.10%

Table 4-15 shows the energy savings estimates for each of the four grantees in the billing analysis sample and expresses them as a share of consumption.

Table 4-15: Electricity and Natural Gas Fuel Savings by Grantee

Model Summary	Grantee			
	Grantee 1	Grantee 2	Grantee 3	Grantee 4
Average Monthly Electricity Savings (kWh)	163.96	89.42	93.62	316.51
Average Monthly Electricity Savings (percent of consumption)	14.80%	7.40%	10.90%	18.60%
Average Monthly Natural Gas Savings (Therms)	8.39	5.10	4.08	NA
Average Monthly Natural Gas Savings (percent of consumption)	23.40%	8.00%	6.30%	NA

The billing regression results were used to develop realization rates for those grantees that had adequate data to support the modeling effort. The realization rates were calculated for each grantee by dividing the estimated savings from the billing regression by the original *ex ante* savings values. The standard error, confidence interval, and relative precision were also calculated for each realization rate obtained from a billing regression model. To develop a realization rate for the entire sector based on the billing regression results, a weighted average was calculated using the grantee-level realization rates derived from the billing regression results, with *ex ante* population savings used as the weights.

In order to compute program realization rates, the team utilized a number of data sources to match project *ex ante* savings values and billing data. This procedure worked well in most situations with the overall match rate between the collection of grantee quarterly submissions and billing data being very high (91%). Given this high match rate, it is unlikely that the savings estimates derived from the billing regression are biased due to missing data for these grantees.

It is also important to note that the billing regression uses the pre-installation energy usage as the baseline for estimating savings. For many cases, the pre-installation usage is an appropriate baseline. In other instances, such as replacement on failure or burnout, a more appropriate baseline would be building code, as this is the standard that the new equipment will be required to meet. The team attempted to identify the types of installations that occurred to the extent possible from the available data. The participant level data available, however, did not have adequate detail to identify those measures where using the pre-installation baseline would be inappropriate. Measure data for one grantee, for example, listed the exact same groups of measures installed for all participants. To the extent that these measures were widely prevalent in the data, then the results from the billing regression will overstate the savings that should be attributed to the grantee programs.

Table 4-16 illustrates the realization rates computed from the billing regression model results for the four grantees in the sample. Overall, our analysis finds an energy savings realization rate of 60,.3%, when electric and gas are combined into MMBtu. Reported by fuel type, 54.9% of *ex ante* electricity savings were realized, while the realization rate for natural gas savings was 66.8%.

Table 4-16: Billing Regression Model Realization Rates by Grantee

GRANTEE	REALIZATION RATES		
	Electricity (kWh)	Natural Gas (Therm)	Combined (MMBtu)
Grantee 1	85.1%	23.8%	43.3%
Grantee 2	52.7%	81.0%	58.2%
Grantee 3	38.6%	27.4%	35.9%
Grantee 4	76.0%	NA	76.0%
ALL (Residential)	**54.9%**	**66.8%**	**60.3%**

To explore why the realizations were lower than expected, we did a comparison of the original *ex ante* savings value with the average annual fuel consumption, and these results are shown in Table 4-17. Across all fuel types and grantees, the ratio of *ex ante* savings as percentage of annual energy consumption is relatively high, ranging from 9% to 28% for electric measures and 23% to 29% for gas measures. Given these high initial *ex ante* values relative to the initial program goal of achieving 15% savings, the lower realization rates obtained from the billing regression are not surprising.

Table 4-17: Ex ante Savings and Annual Fuel Consumption by Grantee

FUEL	GRANTEE			
	Grantee 1	Grantee 2	Grantee 3	Grantee 4
Ex ante Electricity Savings (kWh)	3,734	1,255	2,905	4,998
Annual Avg. Electricity Consumption	13,294	14,496	10,307	20,420
Elec. Savings / Consumption	0.28	0.09	0.28	0.24
Ex ante Gas Savings (therms)	124	179	179	NA
Annual Avg. Natural Gas Consumption	430	756	777	NA
Gas Savings / Consumption	0.29	0.24	0.23	NA

In addition to the relatively high initial savings values, there are other possible reasons why the realized savings differed from the original *ex ante* savings values. These factors include:

- Removal of rebated equipment after participation
- Equipment not functioning
- Actual equipment installed being different from that recorded in the program tracking data
- Operating conditions (run hours, temperature settings, etc.) being different from those assumed in the *ex ante* savings calculations.
- Different baseline conditions than those assumed in the *ex ante* savings values. With the billing regression, the baseline is the existing equipment conditions, which may or may not be consistent with the baseline assumptions used in the *ex ante* savings estimates. If the assumed baseline is building code in the *ex ante* savings, then the billing regression will overstate savings.

4.4 Combining the M&V and Billing Analysis Findings and Extrapolating to the Population

The next step in the analysis was to combine the findings from the residential M&V and billing analyses and extrapolate the combined findings to the residential population. As described in Section 3, the individual realization rates from the M&V and billing analyses were weighted based on the proportion of reported savings analyzed by the M&V and billing analyses. Table 4-18 below illustrates these weighted realization rates and the overall combined realization rate for the residential sector.

Table 4-18: Residential Combined Realization Rate

ANALYSIS	REALIZATION RATE	WEIGHT	COMBINED REALIZATION RATE
M&V	83%	83.7%	79%
Billing	60%	16.3%	

The combined residential realization rate of 79% was applied to the population reported savings in order to extrapolate the gross verified savings for the residential sector.

Because billing analysis was not conducted on commercial projects, the realization rate of 106% for the M&V sample was extrapolated to the population with no additional analysis or weighting.

4.5 Risks to Validity of Findings for the Approach Used

As discussed in Section 1, there were a number of challenges that could have impacted the validity of the impact evaluation findings. The team took steps to mitigate these risks and presented below is a discussion of the key risks that arose and the team's mitigation strategy for each:[54]

- Accurate Sample Coverage by Segment. This risk involves the possibility of not including a significant number of population segments in the sample frame. As discussed above, the evaluation team used stratified random sampling to segment the population. Over the course of the evaluation activities, numerous projects were added to the Project Level database as grantees made corrections to their reported information. The team reviewed where these changes occurred and determined that the projects added were evenly spread across the grantees and strata. Therefore, these additions did not impact the grantee sample frame, and the strata boundaries were maintained. The added projects were assumed to be representative of the strata populations. Thus, the risk of inaccurate segmentation was minimized.
- Non-response Bias. The team encountered instances of non-response from both grantees and participants**.** However, the team took careful steps to minimize the non-response risk. Grantees were contacted numerous times for data, and most grantees eventually provided the team with the necessary data. For those grantees that did not provide data, the samples from their location were reallocated to grantees within the same stratum. During the phone verification surveys, potential participants were called at least three times at varying times during the day/evening to obtain participation. In addition, incentives were offered for participants who agreed to participate in the on-site surveys.
- Measurement Error. In order to reduce the possibility of measurement error, the team utilized a triangulation approach to the review of project data. The team used grantee-

[54] Other threats to the validity of findings could include sources of random error (i.e., error occurring by chance). This report does not explicitly outline our response to this type of error.

provided project data, DOE reports, phone surveys and in the applicable cases, on-site surveys to capture project implementation activities. While the inputs and assumptions were not provided to the team to determine issues with grantee calculation of *ex ante* savings, the team developed an approach to the calculation of savings that strived for consistency and clearly factored in regional/state specific data for the calculation of verified savings.

4.6 Confidence & Precision

Confidence and precision statistics were calculated for the sampling error of the M&V and billing analysis studies and are presented in the following tables. After determining final realization rates for each study, error bounds were calculated in accordance with the California Evaluation Framework and as described in Section 3. Confidence was selected at the 90% level. Relative precision values were calculated by dividing the error bound of the verified source MMBtu savings by the verified source MMBtu savings. Additionally, where possible, the error ratios were also calculated.

For the residential analysis, statistics were computed for both the M&V and billing analyses and ultimately combined to reflect a combined realization rate. The M&V analysis did realize a slightly lower precision value. Error bounds were combined using the equation below:

$$Error\ Bound_{RES\_total} = \sqrt{Error\ Bound^2_{RES\_M\&V} + Error\ Bound^2_{RES_{billing}}}$$

Relative precision was then calculated by dividing the combined error bound by the total verified gross savings. The final relative precision for the combined M&V and billing analyses for the residential sector was calculated at 7.3% while the error bound was ±64,746 source MMBtus.

The commercial analysis resulted in a relative precision of 12.3% and an error bound of ±89,114 source MMBtus. In addition, the team calculated an error ratio of 0.9. This indicates a high level of variability in the evaluated savings compared to the *ex post* savings. The commercial results presented did include the exclusion of an outlier identified during the statistical analysis. A single sample member was found to have erroneously reported savings value that was likely due to a unit conversion issue.

Overall the results indicate that at a 90% confidence level, the gross verified savings for the commercial and residential sectors are 1,590,544 source MMBtus ±107,857 source MMBtus. Table 4-19 outlines the overall findings.

Table 4-19: Confidence, Precision, and Error Bound by Sector

Sector	Confidence	Precision	Error Bound (MMBtus)
Residential	90%	7%	68,746
Commercial	90%	12%	89,114
Total	**90%**	**7%**	**107,857**

4.7 Net-to-Gross Analysis Findings

As discussed earlier, the evaluation team conducted attribution surveys on a sample of BBNP participants (the same sample as the M&V analysis) in an attempt to understand how (and how much) BBNP influenced their participation. Using this industry-standard self-report method for free-ridership estimation, we estimate residential NTG to be 0.83 and commercial NTG to be 0.92 (Table 4-20). We applied these net-to-gross ratios to the sector level gross verified savings to determine the sector-level net verified savings.

Table 4-20: Sector Net-To-Gross Estimates

SECTOR	NTG PERCENT
Residential	83%
Commercial	91.5%

We also collected spillover data, yet we determined the data could not support quantification of savings estimates. Thus, our NTG estimate does not include spillover.[55]

The evaluation team queried the samples of surveyed program participants about energy-savings upgrades that they had installed subsequent to program participation but for which they did not receive any incentive (from the specific grantee program or any other source). We followed-up with respondents reporting they had installed such measures and asked them to rate the degree to which the program influenced their actions. Table 4-21 and Table 4-22 outline the spillover actions participants estimated for BBNP, for residential and commercial participants respectively. Fifteen percent of residential participants and 5% of commercial participants reported spillover actions.

Table 4-21: Residential Spillover Measures

MEASURE	NUMBER OF PARTICIPANTS REPORTING ACTION AND ATTRIBUTING TO BBNP
Lighting (CFLs, LEDs) Only	11
Lighting and WH Blanket	1
Lighting, Refrigerator, Dishwasher	2
Lighting, Windows, Doors	1
Lighting, Refrigerator, Clothes Washer & Dryer	1
Lighting, Refrigerator, Windows	1
Lighting, Air Sealing	1

Continued

55 As described in the methodology section, we plan to include spillover savings in the NTG value we calculate for the final impact evaluation.

MEASURE	NUMBER OF PARTICIPANTS REPORTING ACTION AND ATTRIBUTING TO BBNP
Windows Only	3
Central AC & Furnace	1
Whole House Fan	1
Water Heater & Furnace	1
Toilet	1
Insulation	1
Refrigerator, Clothes Washer & Dryer, Skylights, Stove, Toilet, Showerhead, Faucet Aerators	1
Air Sealing	1
Water Pump	1
Air Purifier	1
Clothes Washer & Dryer	1
Refrigerator, Dishwasher, Insulation, Windows, Air Vent	1

Table 4-22: Commercial Spillover Measures

MEASURE	NUMBER OF PARTICIPANTS REPORTING ACTION AND ATTRIBUTING TO BBNP
Lighting (CFLs, LEDs) only	2
Lighting and Ceiling Insulation	1
Windows	1

4.8 Economic Analysis Findings

4.8.1 Gross Economic and Fiscal Impacts

The economic and fiscal impacts approximated for BBNP are based on program outlays, and measure spending on efficiency upgrades and energy savings of program participants. Table 4-23 summarizes the main inputs as they were gathered or calculated from the Quarterly Summary Reports and detailed quarterly spreadsheets submitted by BBNP grantees. Between Q4 2010 and Q2 2012, spending by BBNP grantees or program participants totaled $525.5 million. This figure includes BBNP program funding and customer spending on energy efficiency measures not covered by program incentives. In addition, the energy efficiency measures installed by program participants will generate an estimated $27.8 million in energy cost savings annually.

Table 4-23: Summary of BBNP Spending and Energy Savings Used for Economic Impact Modeling ($ millions)

Quarter / Year	M&O Outlays	Other Outlays		Audit Spending	Measure Spending	Annual Energy Cost Savings
		Incentives	Program Delivery			
Q4 2010	$1.9	$6.1	$4.9	$3.2	$20.2	$1.7
Q1 2011	$4.7	$6.1	$5.0	$5.1	$27.5	$4.1
Q2 2011	$6.1	$14.7	$11.9	$4.6	$26.9	$2.3
Q3 2011	$6.8	$11.5	$9.3	$6.9	$39.1	$3.5
Q4 2011	$6.5	$17.3	$14.0	$7.4	$55.6	$4.0
Q1 2012	$13.5	$13.6	$11.0	$11.0	$56.3	$5.5
Q2 2012	$6.9	$14.0	$11.3	$9.3	$55.4	$6.6
Total All Quarters	**$46.5**	**$83.2**	**$67.4**	**$47.6**	**$280.9**	**$27.8**

Source: As reported or calculated using data provided in BBNP Quarterly Summary Reports and detailed quarterly spreadsheets submitted by BBNP grantees.

BBNP spending and energy savings shown in Table 4-23 will directly support sales, income, and jobs (person-years) in each quarter. Table 4-24 reports the gross direct economic impacts for each quarter (i.e., direct impacts without adjustments for counterfactual spending). (Note that while it makes sense to sum the dollar impacts across the quarters, as shown in the table, it does not make sense to sum the person-year impacts across the quarters, as subsequently discussed.)

Table 4-24: BBNP Gross Direct Economic Impacts, by Quarter

Quarter / Year	Output ($ millions)	Personal Income ($ millions)	Jobs (quarter-year equivalent)
Q4 2010	$27.4	$11.1	656
Q1 2011	$38.7	$15.7	929
Q2 2011	$46.4	$20.7	1,230
Q3 2011	$57.2	$24.0	1,442
Q4 2011	$76.8	$32.0	1,913
Q1 2012	$84.9	$36.2	2,266
Q2 2012	$76.5	$31.9	1,892
Total All Quarters	**$408.0**	**$171.4**	**NA**

The gross direct impacts reported in Table 4-24 highlight the following:

1. The direct economic activity (output) approximated for BBNP is significant ($408.0 million) but modestly lower than total BBNP spending ($525.5 million), primarily due to imports of energy efficiency equipment.

2. In addition to changes in direct output, BBNP is linked to $171.4 million in direct income for BBNP grantee staff, subcontractors, and others, as well as private contractors providing services on audits and efficiency upgrades.

3. BBNP also supports temporary employment. The direct job impacts reported in Table 4-24 reflects full-time equivalent employment lasting the duration of the quarter. Some of the workers employed by BBNP spending have full time BBNP work; others work part-time on work supported by BBNP spending. Some workers may be employed in BBNP activities for multiple quarters, perhaps as long as the duration of the program, while other workers may be employed by BBNP spending for a single quarter. The job effects figures reported in Table 4-24 of 929 in Q1 2011, 1,230 in Q2, 1,442 in Q3 and 1,913 in Q4 are quarterly direct job impacts and need to be averaged over the year to get the 2011-year impact. BBNP spending gets credit for supporting 1,378 person-years of direct employment in 2011.

Table 4-25 reports the gross economic and fiscal impacts, by type, associated BBNP spending and energy savings between Q4 2010 and Q2 2012. To be consistent with the secondary job impacts, the table reports direct job impacts for the period in person-years of employment.

Table 4-25: BBNP Gross Direct Economic and Fiscal Impacts, by Type, Q4 2010–Q2 2012

Impact Measure	Direct	Secondary	Total
Output ($ millions)	$408.0	$662.7	$1,070.7
Personal Income ($ millions)	$171.4	$205.5	$376.9
Jobs (person-years)	2,582	4,099	6,681
State and Local Taxes ($ millions)	$11.2	$31.1	$42.2
Federal Taxes ($ millions)	$25.9	$42.5	$68.4

In total, on a gross basis, BBNP is linked to almost $1.1 billion in economic activity, including $376.9 million in personal income, 6,681 person-years of employment, $42.2 million in state and local tax revenues, and $68.4 million in federal tax revenues between Q4 2010 and Q2 2012. These impacts include:

- Direct impacts of $408.0 million in economic activity, including $171.4 million in personal income and 2,582 person-years of employment (full-time equivalent). In addition, this economic activity directly generated $11.2 million in state and local tax and fee revenues, and $25.9 million in federal tax and fee revenues.

- Secondary impacts associated with supply-chain and consumption-driven spending linked to BBNP consisting of $662.7 million in output, including $205.5 million in personal income and 4,099 person-years of employment. This secondary spending and activity is associated with $31.1 million and $42.5 million in tax and fee revenues for state and local, and federal governments, respectively.

As the preceding discussion indicates, spending associated with BBNP will have secondary impacts that benefit workers and business owners in other sectors of the economy. All of the impact measures described in Table 4-25 can be summarized across direct and secondary impact categories using mathematical formulae to measure and explain what economists refer to as the "multiplier effect." In essence, economic multipliers provide a shorthand way to better understand the linkages between program and other sectors of the economy (i.e., the larger the economic multipliers, the greater the interdependence between a company's operations and the rest of the economy). On a gross basis, BBNP has the following multipliers:[56]

- Output multiplier is 2.6. This means that every million dollars in direct output (BBNP purchases captured by U.S. businesses) is linked to another $1.6 million in output for workers in other sectors of the economy.
- Personal income multiplier is 2.2. Thus, every million dollars in direct personal income approximated for BBNP is linked to another $1.2 million in personal income elsewhere in the U.S. economy.
- Job multiplier is 2.6. This shows that every 10 jobs (person-years of employment) support another 16 jobs (person-years of employment) elsewhere in the economy.

4.8.2 Net Economic Impacts

BBNP is supported by funds through the ARRA. These funds could have been re-directed and used to support other federal government programs. To account for this, the gross economic impacts have been adjusted for foregone federal government spending on non-defense programs based on the total outlays incurred between Q4 2010 and Q2 2012. These *net impacts* reflect economic benefits over and above what would have occurred had BBNP not existed. The total gross and net impacts estimated for BBNP are reported in Table 4-26.

Table 4-26: BBNP Total Economic and Fiscal Impacts, Gross and Net, Q4 2010–Q2 2012 ($ millions)

Impact Measure	Total Gross Impacts	Total Net Impacts
Output	$1,070.7	$655.6
Personal Income	$376.9	$155.4
Jobs (person-years)	6,681	4,266
State and Local Taxes	$42.2	$24.3
Federal Taxes	$68.4	$30.1

As shown in Table 4-26, depending on the impact measure, the net impacts are about 40% to 60% less than the gross impacts, but the net impacts are still strongly positive. This is due to BBNP spending and resulting energy savings having a larger multiplier effect than federal government spending on all other non-defense programs (in aggregate).

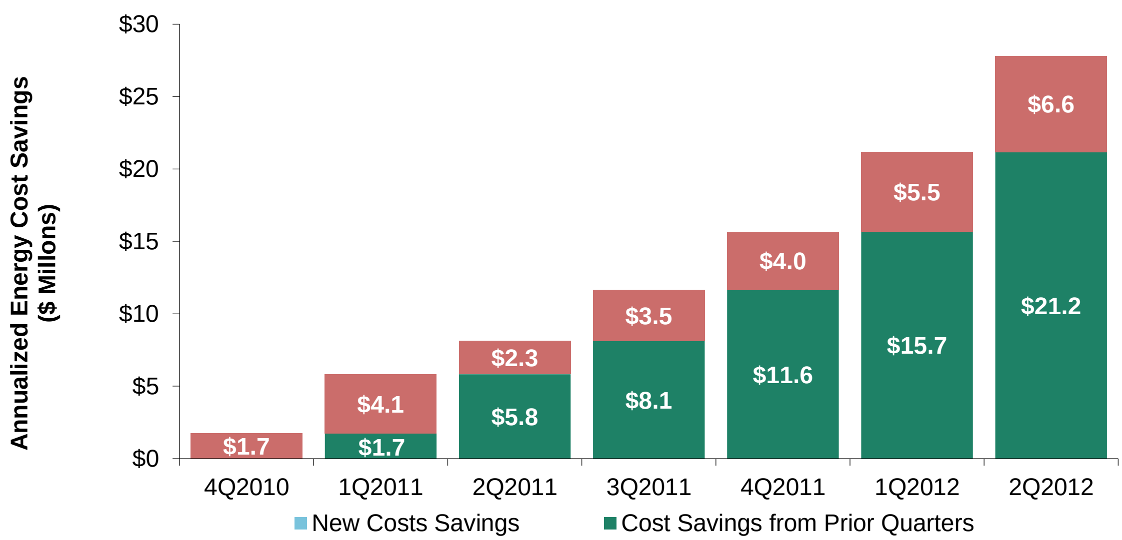
56 This analysis reports Type SAM multipliers. SAM stands for *Social Accounting Matrix*. A Type SAM multiplier is calculated by dividing the sum of direct, indirect, and induced impacts by the direct impacts.

4.8.3 Post-BBNP Energy Savings Impacts

Efficiency upgrades occur over roughly the same time period that equipment and program costs are incurred. The energy savings from these measures, however, extend into future years as most measures have expected useful lives of multiple years. These cost savings continue to benefit the economy as households spend less on electricity and more on other consumer products, and businesses are able to produce goods and services more efficiently. As a consequence, the net effects from a given program quarter or year, when equipment and program spending occurs, only capture a fraction of the overall benefit of these programs.

Figure 4-1 shows the cumulative estimated annualized cost savings, by quarter, for efficiency upgrades completed between Q4 2010 and Q2 2012. By the end of the seven-quarter time period, it is estimated that efficiency upgrades will lower energy costs by $27.8 million annually.

Figure 4-1: Cumulative Estimated Annualized Energy Cost Savings of Efficiency Upgrades, by Quarter



Source: BBNP Quarterly Summary Reports

Table 4-27 shows the net economic and fiscal impacts associated with the estimated energy cost savings from efficiency measures installed between Q4 2010 and Q2 2012. These estimates were calculated using the input-output model to estimate the economic impacts of reduced energy costs while setting all other costs (i.e., equipment purchases and program implementation costs) equal to zero. To truly isolate the impact of the energy cost savings, we also assumed that there was no loss of utility revenues resulting from the measures installed and that utilities (and others) would be able to sell the unused power (fuel) to other customers. This forms the basis of energy efficiency benefits in future post-installation years based solely on the reduced energy costs to the economy and excludes any additional benefits due to the spending on these programs and measures.[57]

Table 4-27: Net Economic and Fiscal Impacts Due to Annualized Energy Savings Alone ($ millions)

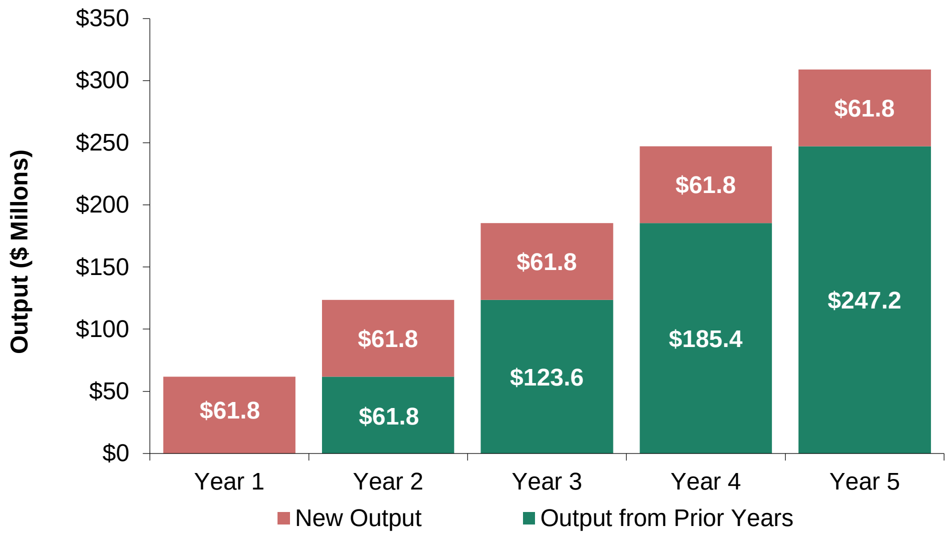
Impact Measure	Annual Net Impacts
Output	$61.8
Personal Income	$19.4
Jobs (person-years)	420
State and Local Taxes	$3.2
Federal Taxes	$4.3

As shown in Table 4-27, the $27.8 million in estimated annual energy savings associated with efficiency upgrades between Q4 2010 and Q2 2012 is linked to $61.8 million in economic output, including $19.4 million in personal income, and 420 jobs (person-years) annually. These estimated annual energy savings and net economic impacts form the basis of annual energy savings and economic impacts in future post-installation years. However, both energy savings and net economic impacts will decline in future years depending on the EULs for measures installed in between Q4 2010 and Q2 2012.

Figure 4-2 shows the cumulative effect for the economic activity (output) in subsequent post-installation years that results from efficiency upgrades accomplished between Q4 2010 and Q2 2012. In the first year, economic output will increase an additional $61.8 million based on energy cost savings achieved in that year. The energy cost savings will continue in future years and generate additional economic impacts. By the end of the fifth year, output will have increased by $309.0 million due to the efficiency upgrades accomplished between Q4 2010 and Q2 2012.

57 Future net energy savings were not adjusted to account for the EULs of installed measures.

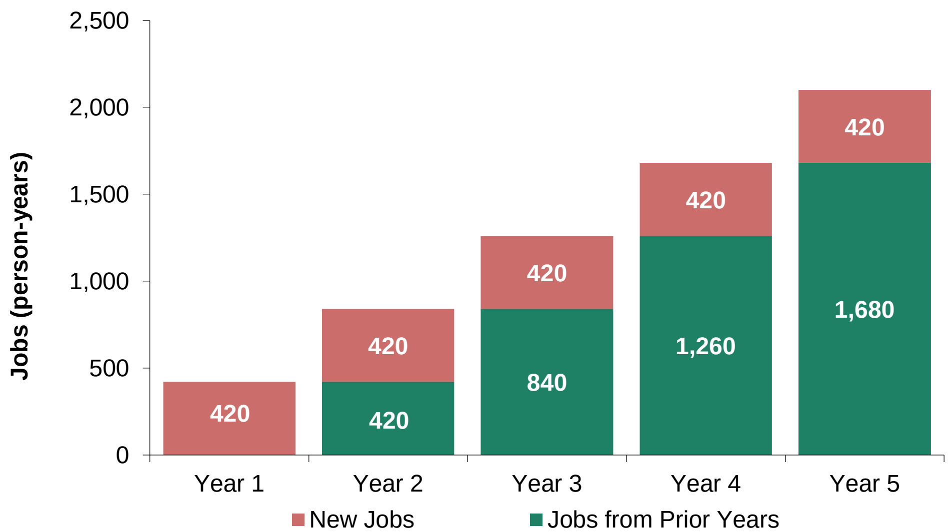
Figure 4-2: Cumulative Output Effects in Post-Installation Years (Five Year Period)



Source: Evergreen and Pinnacle using BBNP data and IMPLAN.

If energy cost savings can be sustained over time, then the employment impacts should persist as well, at least in the short term. The energy savings associated with BBNP efficiency upgrades between Q4 2010 and Q2 2012, will have sustained 2,100 person-years of employment over the following five-year period.

Figure 4-3: Cumulative Job Effects (Measured in Person-Years of Employment) in Post-Installation Years (Five-Year Period)



Source: Evergreen and Pinnacle using BBNP data and IMPLAN.

Together, spending and energy savings associated with BBNP supported, on a net basis, $655.6 million in output, including $155.4 million in personal income, 4,266 person-years of employment, $24.3 million in state and local tax revenue, and $30.1 million in federal tax revenues between Q4 2010 and Q2 2012.

Table 4-28: BBNP Total Economic and Fiscal Impacts, Program and Future Year ($ millions)

IMPACT MEASURE	PROGRAM YEAR NET IMPACTS (Q4 2010 – Q2 2012)	FUTURE YEAR NET IMPACTS (Q3 2012 – Q3 2015)
Output	$655.6	$309.0
Personal Income	$155.4	$97.0
Jobs (person-years)	4,266	2,100
State and Local Taxes	$24.3	$15.9
Federal Taxes	$30.1	$21.4

To these one-time impacts, we can now also include the economic benefits attributed to energy cost savings that persist over time, at least in the short run. Over a five-year, post-installation time period, those impacts amount to $309.0 million in output, including $97.0 million in personal income, 2,100 person-years of employment, $15.9 million in state and local tax revenues, and $21.4 million in federal tax revenues.[58]

This analysis finds that BBNP has supported an increased number of jobs (person-years of employment), economic output, personal income, and tax revenue from in the preliminary evaluation period, Q4 2010 to Q2 2012. While energy efficiency programs should not be primarily seen as an economic development tool, preliminary analysis of BBNP finds evidence of economic benefits that outweigh the direct costs associated with the conservation efforts. Spending on BBNP is also shown to demonstrate positive net economic benefits relative to the most likely alternative use of program funds.

58 In addition to the EULs for installed energy efficiency measures, there are other economic factors that could cause the economic impacts to decline over time, in which case the economic impacts reported above would be overstated. The cumulative impacts do not take into account changes in production and business processes that U.S. businesses make in anticipation of future higher energy prices and/or increased market pressure from international competition to increase production efficiency. To the extent that U.S. businesses are already adjusting in anticipation of higher costs and/or tougher competition, then cumulative impacts presented here are overstated, as the overall market would become more efficient due to factors outside of BBNP influence. Although over 70% of the energy cost savings accrue to households, the cumulative numbers also rely on the critical assumption that each dollar saved will translate into a dollar of increased economic output for those businesses undergoing efficiency upgrades. This assumption is reasonable in the short run, but in the long run it is likely that a dollar of energy savings will translate to less than a dollar of increased economic output as the overall market adopts more efficient production practices in anticipation of increased competition and higher energy costs. Consequently, the cumulative impacts shown here represent an upper bound. Despite these caveats, the ongoing and cumulative effect of energy savings due to the BBNP is nevertheless a continuing benefit to the US economy.

5 Lessons Learned, Recommendations, and Conclusions

The following section outlines the lessons learned as part of the preliminary evaluation activities, the team's recommendations for the final impact evaluation activities and to DOE, along with our conclusions for the preliminary impact evaluation.

5.1 Lessons Learned

As discussed in Section 1, the evaluation team faced multiple challenges during both the planning and implementation of the preliminary impact evaluation. While navigating these challenges, there were many lessons learned that will help shape the future of similar programs and that will aid in the planning and development of the final impact evaluation activities. The lessons learned are outlined below and are characterized based on things learned during interactions with grantees, implementation of the proposed sampling approach, and the overall evaluation activities.

5.1.1 Grantee Interaction

The evaluation team had multiple instances and different facets of interactions with the grantees, through the preliminary assessment interviews, data requests, and program discussions in the effort to learn more about their program offerings and structure. Several lessons learned resulted from these interactions, all of which will be taken into consideration during the final impact evaluation planning.

- Allow sufficient time to request and gather data from the Grantees. Initial data requests were made to the almost 30 grantees in February 2013, shortly after the final approval of the evaluation plan. In some cases, the team did not receive project data from these grantees until May 2013. Grantees are busy and, unlike most utility companies, they are not equipped with the tools and databases to easily extract participant and project-level information. It is necessary to give them sufficient time to gather requested data.
- Give clear and concise data requests. Grantees are busy and frequently understaffed. In addition, many of these grantees have little experience with evaluations. Making clear and concise data requests that include specific information required by the team for analysis (including invoices, audit reports, project applications, etc.) help to speed up the response time and alleviate any concerns or questions that they may have regarding data needs.
- Know when to stop asking. When requesting data from 30 different grantees, many of whom are not already experienced in the area of program evaluation, it is necessary to be

patient yet persuasive regarding the importance of the data requests. It is also necessary to know when to stop asking for more data and just move forward with what has been provided. The team set a “drop-dead” date on data requests as related to the preliminary evaluation. This was necessary in order to allow the team to meet the deadlines related to the preliminary evaluation and to develop an evaluation plan for the final impact evaluation.

5.1.2 Sampling

The design of the sampling strategy was a key factor in the accuracy and usefulness of the preliminary impact evaluation results. The team was reminded of the importance of sampling throughout the evaluation activities and the following lessons learned came out of those experiences.

- Use proper sampling techniques. When seeking to examine savings across multiple and diverse programs such as those offered through BBNP, the team needed to examine the effectiveness of the sampling and the level of rigor employed on the sample. Budget and time constraints put limits on the ability to sample at a high level of rigor across all the grantees. The team designed the sampling strategy with the knowledge that the programs were very diverse and that the reporting procedures were varied and not always consistent. Therefore, the sampling parameters that were used to determine the sample sizes took this known uncertainty and potential range of error into account.
- Be flexible. The evaluation plan was based on preliminary grantee interviews and the review of available data at a certain point in time. After the team fully analyzed the data that were provided by the grantees, changes were made in the sampling design and approach. Additionally, grantees provided periodic project updates which adjusted savings and project counts throughout the evaluation activities. The team had to analyze these adjustments to determine the impact on the validity of the sample.

5.1.3 Evaluation Activities

The impact evaluation team utilized several levels of rigor when determining gross verified savings. The team typically followed standard practices as seen in most utility-funded evaluation activities, but found that approaches that may work for a utility-funded program may not necessarily be as successful for a program with the large scale, scope, and diversity of BBNP.

- Phone verifications had limited value. Phone verifications are standard practice in many utility-funded impact evaluations. While the phone surveys were useful in verifying overall project participation and obtaining attribution information, the team determined that the phone verifications utilized for the M&V activities often proved to have limited value due to factors such as: difficulty for participant to gather key data on measures implemented, confusion regarding the measure funding source (BBNP or local utility program), and uncertainty surrounding baseline/new equipment.

- On-site verifications were valuable. While the phone surveys proved challenging, the on-site surveys were valuable in obtaining a greater level of detail regarding project implementation than could be obtained during phone verifications.
- Reasons for variances in the data were multifaceted. There was no one reason for the discrepancies between the reporting databases used by the grantees and DOE. Both parties were faced with multiple challenges while attempting to develop accurate reports of program progress. The evaluation team had to interact frequently with DOE and the grantees to understand the underlying issues impacting the data.

5.1.4 Department of Energy

BBNP is a program funded entirely through DOE with the objective of creating jobs, saving energy, and setting the foundation for future similar programs. It is difficult for a program of this breadth and depth to create a centralized, consistent, and easy-to-use system for individual program tracking and reporting. However, the key lesson learned as a result of this evaluation is the importance of the design and enforcement of proper reporting processes. The design of proper reporting processes and concise yet all-inclusive data capturing procedures is crucial to the success of any program of this scale and magnitude. In addition, this lesson can be carried into energy efficiency program design, both for utility-funded structures and for non-utility structures, such as those that exist in BBNP. Designing a reporting structure that captures the basic data effectively and accurately is essential to a successful program both in the near term and the long term. Clear reporting procedures lead to a better understanding of the program effects both in the context of energy savings and the proper use of resources. This, in turn, helps lead to better program design in the future and greater program success. Additionally, some level of enforcement regarding the proper reporting would encourage accountability.

5.2 Recommendations

The lessons learned by the evaluation team led to several recommendations for the planning and design of the final impact evaluation. In addition, short-term and long-term recommendations can be made to DOE and the grantees for both near-term changes in BBNP and when/if programs of a similar nature are offered in the future.

5.2.1 Recommendations for the Final Evaluation

Based on the lessons learned during the preliminary impact evaluation activities and the subsequent findings, the team has a number of recommendations for proceeding with the final impact evaluation.

- Limit phone surveys and conduct more on-site visits. As the value of the phone surveys proved limited, the team will try and shift resources to conduct more on-site visits for the final impact evaluation. Phone surveys may not be completely eliminated, but perhaps reduced in number.

- Develop a sampling strategy that accounts for the end of the grant funding cycle. As the grant periods wind down in late 2013 and 2014, grantees will have varying levels of time/availability to provide the team with necessary data, especially once their grant cycle ends. The team will need to develop and implement a sampling strategy that starts before these grants end and continues through collection of final data.
- Investigate overlapping the billing analysis and M&V sample frames. The evaluation team's sampling strategy included the use of two separate sample frames for the M&V analysis and the billing analysis. This approach resulted in two different realization rates that were then combined to come up with a final BBNP realization rate. The team will investigate a sampling strategy for the final impact evaluation that will strive to reduce the isolation of the realization rates and, hopefully, address the discrepancy between the findings. This could be accomplished by overlapping the sample frames and conducting both M&V and billing analysis on a portion of the sample frame so that comparisons can be made between the approaches. However, this would also reduce the overall number of sampled projects that would be independently evaluated.
- Further investigation into savings calculations used by grantees. The team was unable to determine inputs used for both deemed and modeled savings estimates reported by the grantees. This prevented the team from developing an understanding of the potential reasons for discrepancies between the reported and the verified savings. The team will try to coordinate with DOE and the grantees to determine if more information regarding the savings calculations can be provided for the final evaluation activities.

5.2.2 Short -Term Recommendations for DOE

The grant funding cycle is coming to a close and, therefore, many grantees will be shutting their doors over the next 3-6 months. However, based on the lessons learned and our interactions with grantees during the preliminary impact evaluation, the team has several recommendations to DOE to help aid in better and more accurate data collection and overall reporting during these last few months.

- Request that grantees match quarterly report totals. One of the main reasons the Project Level data did not match the Program Level data was that there was no process where grantees matched the individual savings totals from each project to the total savings achieved by the grantee for that quarter. This inherently creates an opportunity for discrepancies.
- Conduct more investigation into the savings of four unresponsive grantees. Four grantees with significant funding and project implementation rates were not included in the sample due to unresponsiveness. While the samples were reallocated to other grantees within their respective stratum, including these grantees in the final evaluation should be a priority; however, assistance from DOE will be necessary in order to collect sufficient data from these grantees.
- Investigate opportunities for increasing reported measure accuracy. The team found a lack of data regarding the reported measures installed at project sites. This is a complex

issue and relies on accurate and comprehensive grantee data collection and reporting. If DOE is interested in understanding measure-specific implementation data, there should be more scrutiny on this level of information received from the grantees.

- Reduce projects with zero savings reported. In the Project Level database, a significant number of projects that achieved energy savings were reported by the grantees to have zero savings. As such, the preliminary impact evaluation sample was impacted, and 7% of our sample had no reported savings, even though the actual project documentation received directly from the grantee had savings outlined for these projects. For the final reporting process, it is recommended that DOE identify the projects with no reported savings and work with the grantees to establish savings values.
- Further investigate issues with fuel savings. Throughout the analysis, the team found inconsistencies with reported fuel savings. In some instances, fuel savings were reported in the wrong units (i.e., instead of gallons, fuel oil may have been reported in MMBtus); and in other cases, savings were simply incorrectly reported (i.e., a grantee reported natural gas savings for a project when the customer actually used propane instead). Further investigation into this issue could improve the accuracy of the reported savings.
- Compile one final dataset to be used for reporting and evaluation purposes. A number of the challenges experienced by the team were a result of being provided multiple different databases with different iterations of reported data. It is recommended that DOE provide one final dataset for all reporting and evaluation purposes to ensure consistency of the results.

5.2.3 Long-Term Recommendations for DOE

The grant cycle for BBNP is coming to a close and it is uncertain whether or not future funding will become available to support a program similar to BBNP. If DOE or a similar organization chooses to fund a program similar to BBNP in the future, several recommendations are made below to help ensure more consistency in program expectations, design, tracking, and reporting.

- Data tracking and reporting systems should be planned to ensure program consistency and evaluation needs. Due to the size of the funding pool and the speed at which it needed to be issued, there was a limited focus on program evaluation and reporting needs when BBNP was designed and launched. One of the lessons learned was that the reporting and tracking processes were cumbersome and inconsistent for both grantees and DOE. Many grantees expressed frustration at the reporting process, and the team uncovered reporting inconsistencies and inaccuracies. While DOE has worked extensively with grantees on reporting procedures, challenges exist because of the system that was initially set up for this program. Therefore, it is critical that for any future programs, consideration be given to the data tracking and reporting needs for both a successful and stream-lined program, but also for the needs of data verification and program evaluation.
- Assess the potential for requiring timely/accurate reporting in order to receive funding. While most grantees have complied with stipulations regarding reporting, there have been

those that have not taken the time to accurately report their savings. For future programs, DOE could assess whether they should consider a potential model for paying out funding as grantees meet certain reporting requirements.

- Require consistent documentation procedures. Grantees had varying information on projects implemented through their programs. Future program design should outline documentation procedures and needs for measure-level, project-level, and program-level reporting.

5.3 Conclusions

In conclusion, the evaluation team believes that the preliminary impact evaluation was an overall success, as many lessons were learned along the way, and these lessons will help shape an even more successful final impact evaluation that will result in precise and accurate impact findings. LBNL staff, DOE staff, their contractors, and NREL staff related to BBNP were all extremely responsive to our team's requests for data and were very helpful during the planning and implementation of the evaluation activities. They understand the realities involved with the program and are constantly working to improve the program and its offerings. In addition, they are constantly balancing the needs for accuracy in reporting without trying to overburden the grantees that are often-times short-staffed and over-worked. BBNP has provided thousands of consumers with the opportunity to make energy, economic, and lifestyle improvements that they may not have otherwise been able to afford or may not have known exist, as well as helping customers reduce energy costs. The team also found throughout the course of conducting the more than 300 surveys, that program participants were generally very satisfied with the programs and grantees.

The realization rates for the residential and commercial sectors are considered reasonable when dealing with a program that spans 41 grantees across the United States who received varying amounts of grant funding and came into the program with large differences in energy efficiency program knowledge and experience. Our team found that grantees are trying their hardest to offer what is best for the residential and commercial customers in their regions and that with DOE's support, these grantees are succeeding in educating and encouraging energy efficiency actions in their communities.

Appendices

A. Residential and Commercial Verification Surveys

A.1. Residential Participant: Better Buildings Neighborhood Programs Telephone Survey

General Information (From Grantee Documentation)

Participant Name:	______________________	Grantee Name:	______________________
Project Ref Number:	______________________	Project Completion Date:	______________________
Contact Address:	______________________	City:	______________________
State:	______________________	Zip:	______________________
Electric Utility:	______________________	Nat. Gas Utility	______________________
Other Fuel Source:	______________________	Nexant Caller:	______________________
Date:	______________________	Time:	______________________

Notes: ____

____

Project Measure Information (From Grantee Documentation)

Circle all that apply

Weatherization Measures:	Air/Duct Sealing, Insulation, Doors, Windows, Programmable Thermostat
Appliance Measures:	Water Heater, Furnace, Boiler, Air Conditioner, Evaporative Cooler, Heat Pump, Refrigerator, Freezer, Dishwasher, Clothes Washer
Lighting Measures:	CFLs, Linear Fluorescents, LEDs
Renewable Energy	Solar Photovoltaic, Solar Thermal
Other Measures:	List:

Hello, my name is *<Your Name>* from Nexant and I'm calling on behalf of the *< Name of grantee/subgrantee and umbrella program >* and the U.S. Department of Energy. We are conducting a national level study to assess the energy savings associated with program participants who implemented energy upgrade projects. May I please speak with *<Contact Name>*?

IF CONTACT NOT AVAILABLE, LEAVE MESSAGE: I am calling because as a participant in *<Name of grantee/subgrantee and umbrella program>*, we would like your feedback as part of a short survey. Your responses will contribute to the national study of the Better Building Neighborhood Program (BBNP), which is the Department of Energy's (DOE) program that funded *<Name of grantee/subgrantee and umbrella program>*. We would greatly appreciate your participation in this voluntary survey. Please give me a call back at your earliest convenience so that we can complete a short telephone survey. *<Give Contact Information including Phone Number>*

IF CONTACT NOT AVAILABLE, LEAVE MESSAGE WITH SOMEONE ELSE: I am calling because as a participant in *<Name of grantee/subgrantee and umbrella program>*, we would like your feedback as part of a short survey. Your responses will contribute to the national study of the Better Building Neighborhood Program (BBNP), which is the Department of Energy's (DOE) program that funded *<Name of grantee/subgrantee and umbrella program>*. Are you familiar with this program and the energy upgrades completed at your house?

a) [If no]: Would you please have *<Contact Name>* call me back at their earliest convenience so that we can set up a time to speak? My phone number is *<Your Phone Number>*.

b) [If yes]: Would you be willing to participate in this voluntary survey? Your feedback will not affect your incentive and is simply used to learn how DOE may improve future programs. All information provided will remain private to the extent permitted by law

i. [If yes] Thank you! Knowing that this is voluntary, we appreciate that you are willing to be interviewed. If you have any additional questions regarding this study, please contact Kevin Afflerbaugh, Project Manager at Nexant at 303-998-2462 or Dr. Edward Vine at the Lawrence Berkeley National Laboratory (LBNL) at 510-486-6047.

ii. [If no]: Would you please have *<Contact Name>* call me back at their earliest convenience so that we can set up a time to speak? My phone number is *<Your Phone Number>*.

IF CONTACT NO LONGER AT SITE: *[Questions will not apply, thank the person for their time and move on to the next participant]*

AFTER LOCATING PROPER CONTACT:

I am calling because as a participant in *<Name of grantee/subgrantee and umbrella program>*, we would like your feedback as part of a short survey. This survey will be used to verify information regarding your project funded by DOE. Your responses will contribute to the national study of the Better Building Neighborhood Program (BBNP), which is the Department of Energy's (DOE) program that funded *<Name of grantee/subgrantee and umbrella program>*. We would greatly appreciate your participation in this voluntary survey. Your feedback will not affect your incentive and is simply used to learn how DOE may improve future programs. All information provided will remain private to the extent permitted by law.

Could I ask you a few questions about the measures you installed through the program? This will take approximately 10 minutes.

a) [If yes] Thank you! Knowing that this is voluntary, we appreciate that you are willing to be interviewed. If you have any additional questions regarding this study, please contact Kevin Afflerbaugh, Project Manager at Nexant at 303-998-2462 or Dr. Edward Vine at the Lawrence Berkeley National Laboratory at 510-486-6047.

b) [If no] *[If they don't agree, ask them if there is another time that would be more convenient for them. If they still say no, thank them for their time, and move on.]*

IF PARTICIPANT IS FROM A GRANTEE SELECTED FOR ON-SITE VISITS:

As an additional part of the study, we will also be conducting on-site visits at a selection of project sites. These on-site visits last an average of thirty minutes, and a trained professional engineer will conduct a walk-through of your residence to gather additional information on the measures you installed. As an incentive for allowing us to conduct an on-site visit, we will provide a $50 Visa gift card at the completion of the site visit. Would you be willing to let one of our engineers come to your home for this purpose?

a) [If yes] Excellent! Before we start the survey, let's schedule the visit. We are currently scheduling visits the week of *<insert week>*. *[Let's give them a few times to work with.]*

[Record Scheduled Time & Date:] ___________________________________

Again, the visit will take approximately ½ hour. We will need access to the areas of your house where you had the work done. The field engineer will provide you with proper identification from Nexant upon arrival. Who will be the contact for this visit?____________________

Is there anything the engineer needs to be aware of before arriving at your home? *[Prompt examples if necessary: Dogs, security code for neighborhood entry, etc.]*

____

If you need to reschedule or cancel, please contact ______ at ____________

b) [If no] That's fine. Let's get started with the survey.

>>> start the survey<<<<

General Energy Upgrade Questions

1. I would now like to verify what energy upgrade measures you had installed. According to program records you had the following measures installed: <*describe measures from project information*>. Is this correct?

2. [If no] What was actually installed? ____________________*[Be sure to ask survey questions appropriate for the measures actually installed]*

General Information

Now I am going to ask a few questions regarding your home.

3. What year was your home built?_____________

4. What is the total conditioned square footage of your home? ______________

5. How many people live in your home? ______ Has there been any change to that number in the last 3 years? ______

6. How many bedrooms? ________

7. How many bathrooms? _______

8. Have there been any modifications to your home in the last 3 years? If so, please describe.____

Heating System Info

The next few questions will focus on your heating system.

9. What is your primary heating fuel---------------------------→	Natural Gas Electricity Propane Fuel Oil Kerosene Wood Geothermal Other:
10. What is your primary heat system type:--------------------→	Gas Furnace Electric Furnace Wood Stove Gas Stove Ground Source Heat Pump Air Source Heat Pump Space Heater Gas boiler--Baseboard Gas boiler—Radiant Gas boiler – other Baseboard--Electric Radiant--Electric Other:

If participant did not receive a new heating system (furnace/boiler/etc) as part of the energy upgrade, ask questions 11-15. Otherwise skip to Question 16. If they received a new heating system, this information will be gathered in the appropriate section detailing their new heating system.

Can you please verify the age, make, model number, and size of the new furnace? This information is often located on a label on the frame of the furnace. *(Make sure they know they may have to take off the panel where all this info is located.)*

11. Age of primary heat system:____________

12. Primary heat system make:_____________

13. Primary heat system model:____________

14. Efficiency (AFUE): _______________

15. Size (btuh): In_______Out_______ *(the unit might only list one)*

16. Do you have a secondary heating system? (Yes/No) [If no, skip to question 21]

17. Secondary Heat System Type:---------------------→

- Fireplace (wood/gas)
- Gas Furnace
- Electric Furnace
- Wood Stove
- Gas Stove
- Ground Source Heat Pump
- Air Source Heat Pump
- Space Heater
- Gas boiler
- Baseboard (electric/hydronic)
- Radiant (electric/hydronic)
- Other:

18. Age of secondary heat system? ________

19. Approximately how often is secondary heat source used? _________

20. Approximately how much square footage is heated by secondary heat source? ________

21. What type of thermostat do you use? (Programmable / non-programmable)

22. Approximate heating-season thermostat settings:

Weekday Daytime	Weekday evening	Weekday Overnight	Weekend Daytime	Weekend evening	Weekend overnight

Cooling System

23. Do you currently have a cooling system? (i.e. central air, room air conditioning, evaporative cooler) *[If no, skip to first section with applicable measure installed by participant that requires verification.]*

24. Primary Cooling System Type:-----------------------------→

- Central Air Conditioner
- Window Air Conditioner
- Evaporative cooler
- Air Source Heat Pump
- Ground Source Heat Pum
- Other:

If participant did not receive a new cooling system as part of their energy upgrade (air conditioner/evap cooler/etc), ask questions 25 – 29. Otherwise skip to Question 30. If they received a new cooling system, this information will be gathered in the appropriate section detailing their new cooling system.

25. What is the approximate age of the primary cooling unit? ________

Can you please verify the make, model number, capacity, and efficiency of the cooling system? This information is often located on a label on the side of the air conditioner

26. Primary cooling unit make? _________

27. Primary cooling unit model: _________

28. Primary cooling unit tonnage: __________

29. Primary cooling unit SEER/CFM: ___________

30. In addition to your primary cooling system, do you have any additional cooling systems? [If no, skip to question 35]

31. Secondary Cooling System Type (if applicable): ------→

- Central Air Conditioner
- Window Air Conditioner
- Evaporative Cooler
- Air Source Heat Pump
- Ground Source Heat Pump
- Other:

32. Age of secondary cooling system: ______

33. Approximately how often is secondary cooling system used? ________

34. Approximately how much square footage is cooled by secondary cooling system? _______

35. Approximate cooling-season thermostat settings:

Weekday Daytime	Weekday evening	Weekday Overnight	Weekend Daytime	Weekend evening	Weekend overnight

Weatherization Measures

Insulation

Wall Insulation

36. What is the total area (sq. ft.) of the walls that were insulated? __________

37. Type of insulation prior to upgrade ----------------→
- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

38. Approximate inches of wall insulation that existed prior to the upgrade ________

39. Value prior to upgrade (if known): ___________

40. Type of insulation added ----------------------------→
- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

41. How many inches of insulation were added? _____________

42. Retrofit R-Value (if known):

Attic Insulation

43. What is the area of the attic floor that was insulated (sq. ft.): _______________________

44. Type of insulation prior to upgrade ------------------------→

- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

45. Inches of attic insulation prior to upgrade: ___________

46. R-Value prior to upgrade (if known): _____________

47. Type of insulation added ----------------------------------→

- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

48. How many inches were added? ____________

49. Retrofit R-Value (if known): ________________

Crawl Space Insulation

50. What is the total area (sq. ft.) of the crawl space wall, floor, and ceiling that were insulated? _________________

51. Type of insulation prior to upgrade ------------------------------→

- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

52. Inches of crawl space insulation prior to upgrade: ______________

53. R-Value prior to upgrade (if known): ________________

54. Type of insulation added --→

None
Rigid Foam
Blanket Batts
Vermiculite
Rockwool
Fiberglass
Cellulose Fiber

55. How many inches were added? _______________

56. Retrofit R-Value (if known): _____________

Rim Joist Insulation

57. What is the total sq. ft. of rim joists insulated? _________

58. Type of insulation prior to upgrade ---------------------→

None
Rigid Foam
Blanket Batts
Vermiculite
Rockwool
Fiberglass
Cellulose Fiber

59. Inches of rim joist insulation prior to upgrade: _________

60. R-Value prior to upgrade (if known): ______________

61. Type of insulation added --------------------------------→

- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber
- ______________

62. How many inches were added? _______________

63. Retrofit R-Value (if known): _________________

Windows

64. Energy ratings of each new type of window installed:

Type 1

U Factor:______

Solar Heat Gain Coefficient: _____

Type 2 (if applicable)

U Factor:______

Solar Heat Gain Coefficient: _____

Type 3 (if applicable)

U Factor:______

Solar Heat Gain Coefficient: _____

65. Quantity of each type of new window installed:
Type 1: _____Type 2:________Type 3:______

66. Total size in sq. ft. of each type of new window:
Type 1: _____Type 2:________Type 3:______

67. # of Panes: (single, dual, etc) Type 1: _____Type 2:________Type 3:______

68. What type of window was replaced?____________________________

69. How many panes did they have? ______________________________

70. What was the framing material?_______________________________

Doors

71. Quantity of new doors installed: _____________________

72. Size of each: _________________

73. Material of each (wood, glass, fiberglass, etc..): _________________

74. What were the old doors? _____________________

Duct and Air Sealing

75. What part of your home was sealed? (Ducts/Windows/Door/Attic)

76. Quantity of each item sealed? (feet of ducts/number of doors or windows/sq. ft. of attic/crawlspace)

   ____

77. What air sealing measures were performed for each area? (ex. Spray foam, caulk, mastic etc): ____

Programmable Thermostat

We discussed your current set points earlier in this survey, now I would like to understand the settings associated with your old thermostat.

78. With your previous thermostat, were the settings the same as the new thermostat?

79. [If no] What were the settings?

Summer

Weekday Daytime	Weekday evening	Weekday Overnight	Weekend Daytime	Weekend evening	Weekend overnight

Winter

Weekday Daytime	Weekday evening	Weekday Overnight	Weekend Daytime	Weekend evening	Weekend overnight

Appliance Measures

Water Heaters

80. What type of water heater did you purchase?-------------------→	Tankless Storage
81. What is the fuel type? --→	Electric Gas Propane Fuel Oil Solar
82. Where is the water heater located?-------------------------------→	Garage Basement Closet Laundry Room

83. Is the water heater in a conditioned space? ____________

84. Is the water heater wrapped with an insulating material? ________

85. Can you please verify the make, model number, capacity, and efficiency of the water heater? This information is often located on a label on the frame of the water heater.

Make:_____________ Model:_________________

Capacity (gallons):_____________ Efficiency (Energy Factor 0 to 1): _______________

ENERGYSTAR Label _______ R-Value of Tank ________

86. What was the temperature set point on your water heater prior to the retrofit? _______

87. What is the temperature set-point on your new water heater? ________________

88. What type of water heater did you replace? (Tankless / Storage)

89. Can you approximate its age? ______________

90. Was it the same fuel type as the new one? ___________

91. [If no] What was the fuel used by the old water heater? __________

92. Was it in good working condition when you replaced it? ___________

93. How did you dispose of the old water heater? (examples: sold / recycled / trashed / contractor removed it)

Furnace

94. Can you please verify the make, model number, and input capacity of the new furnace? This information is often located on a label on the frame of the furnace. *(Make sure they know they will likely have to take off the panel where all this info is located.)*

    Make:_____________ Model:_________________
    Efficiency (AFUE): _______________

    Size (btuh): In_______Out_______ *(the unit might only list one)*

95. What heating system type was replaced by the new furnace? (gas furnace, electric furnace, gas boiler, etc)

96. How old was your previous heating system? _________

97. Was it in good working order when it was replaced? ______

98. What was the efficiency of your old furnace? ______

99. Why was it replaced? ____

100. How was it disposed of? (examples: sold / recycled / trashed)

101. Did the temperature setpoints on your programmable thermostat change after you installed the new furnace? ______

102. [If yes] Please describe how they changed _______________________________

Boiler

103. Can you please verify the make, model number, and efficiency of the boiler? This information is often located on a label on the frame of the boiler.

    Make:_____________ Model:_________________

    Efficiency (AFUE): _______________ Rated heating input (Btu/hr) _______

104. What heating system type was replaced by the new boiler? (examples: gas furnace, electric furnace, gas boiler, etc)

105. How old was your previous heating system? _________

106. Was it in good working order when it was replaced? _______

107. What was the heat output (efficiency) rating of your old boiler? ______

108. Why was it replaced? ____

109. How was it disposed of? (examples: sold / recycled / trashed)

110. Did the temperature setpoints on your thermostat change after you installed the new boiler? _______

111. [If yes] Please describe how they changed ___________________________________

Central Air Conditioner

112. Can you please verify the make, model number, size and efficiency rating of the new air conditioner? This information is often located on a label on the side of the air conditioner.
Make:_____________ Model:_________________
Tonnage: _______________ SEER: _____

113. Did you have a cooling system prior to the installation of your new air conditioner? ____
[If no, this section is complete.]

114. What type of system? (examples: central air conditioner, evaporative cooler, window air conditioner)

115. Was it in good working order when it was replaced? _______

116. How old was your previous cooling unit? _________

117. Why was it replaced? ______

118. How was it disposed of? (examples: sold / recycled / trashed)

119. What was the SEER rating of your old air conditioner? ______

120. Did you have the same thermostat with the old cooling system? _____________

121. Did the temperature setpoints on your thermostat change after you installed the new AC?
____

122. [If yes] Please describe how they changed _____________________________________

Evaporative Cooler

123. Can you please verify the make, model number, size and efficiency of the new evaporative cooler? This information is often located on a label on the frame of the cooler.

Make:_____________ Model:_________________

CFM: _____ Type: Whole house/Room

124. Did you have a cooling system prior to the installation of your new evaporative cooler? _____________ [If no, this section is complete]

125. What type of system? (examples: central air conditioner, evaporative cooler, window air conditioner)

126. Was it in good working order when it was replaced?___________

127. How old was your previous cooling unit? _________

128. Why was it replaced? _______________

129. How was it disposed of? (examples: sold / recycled / trashed)

130. What was the efficiency rating of the prior system (SEER or CFM)? __________

131. Did the temperature setpoints on your thermostat change after you installed the new cooler? ________

132. [If yes] Please describe how they changed _____________________________________

Heat Pump

133. Can you please verify the make, model number, and efficiency of the heat pump?

Make:_____________ Model:_________________

SEER: _______________ Heating Seasonal Performance Factor (HSPF): _______

Tonnage: ______

134. What type of heat pump was installed: Ground Source or Air Source

135. What is the heat pump used for: Heating/Cooling/Both

136. What heating/cooling system did this heat pump replace? (Gas furnace, central air conditioner, lower efficiency heat pump, other)

137. How old was your previous heating/cooling unit? _________

138. Was it in good working order when it was replaced? _________

139. Why was it replaced? __________

140. How was it disposed of? (examples: sold / recycled / trashed)

141. Did the temperature setpoints on the thermostat change after you installed the new heat pump? ______

142. [If yes] Please describe how they changed ____________________________________

Refrigerator

143. First, can you please verify the make and model number of the refrigerator? The model number is often located on a label on the inside wall of the refrigerator.

Make _________________ Model _____________

144. What are the characteristics of your new refrigerator? [Circle applicable features below]

Appliance Characteristics (Choose One in Each Applicable Category Below)					
FRIDG: Configuration	Top Freezer	Side-by-Side	Bottom Freezer	Single Door	
Frost Type	Frost-Free	Manual			
Through Door Features	Water and/or Ice	None			
Location	Kitchen	Garage	Porch/Patio	Basement	Other: ______
Air Conditioning in room?	Central AC	Room AC	None		
Is the refrigerator located in a heated space?	Heated	Unheated			

145. How many cubic feet is the new refrigerator? __________

146. What was the approximate age of the refrigerator that was replaced? __________

147. Was it in good working order when you got rid of it? ______________

148. How did you dispose of it? (examples: sold/ recycled/ trashed/ did not get rid of it) ____________

149. If you still have it, where is it located? ___________

150. What is the make _____________and model ___________of the old refrigerator?

Freezer

151. First, can you please verify the brand and model number of the freezer? The model number is often located on a label on the inside wall of the freezer.

 Make______________ Model ______________

152. What type of freezer is it? (Upright/Chest)

153. How many cubic feet is the freezer? __________

154. Is the freezer located in an air conditioned room? __________

155. What was the approximate age of the freezer that you replaced? __________

156. Was it in good working order when you got rid of it? __________

157. How did you dispose of it? (examples: sold/ recycled/ trashed/did not get rid of it)

158. If you still have it where is it located? __________

159. What is the brand __________ and model __________?

Dishwasher

160. First, can you please verify the brand and model number of the dishwasher that you purchased? The model number is often located on a label on the inside frame of the dishwasher just as you open the door.

 Make __________ Model __________

161. About how many loads per week do you run? __________

162. Do you use heated dry? __________

163. What cycle do you normally set on your dishwasher (light/ normal/ heavy)? __________

164. Has your use of the dishwasher changed since you purchased the new unit? __________

165. [If yes] About how many loads per week did you run the old dishwasher? __________

166. What was the approximate age of the old dishwasher? __________

167. Was it in good working order when you got rid of it? __________

168. How did you dispose of it? (examples: sold/ recycled/ trashed)

Energy efficient dishwashers save both electricity and water, so I'd like to ask a few questions about your water heater. *[If you already asked these questions as the participant replaced their existing water heater as part of the program, skip these questions]*

169. How is your water heater fueled? (Electric/ Natural Gas / Propane/Fuel Oil)

170. How old would you say your water heater is? __________

Clothes Washer

171. First, can you please verify the make and model number of the new clothes washer you purchased? The model number is often located on a label on the inside of the washer just as you open the door.

    Make __________ Model __________

172. Is it front loading or top loading? __________

173. About how many loads per week do you wash? __________

174. How many loads also go through the dryer? All / some / none

175. Has your use of the clothes washer changed since you purchase the new unit? _________

176. [If yes] About how many loads per week did you wash? __________

177. Can you approximate the age of the unit that was replaced? __________

178. Was it in good working order when you got rid of it? __________

179. How did you dispose of it? (Sold/ Recycled/ Trashed)

Energy efficient clothes washers also save energy from clothes drying and water heating, so I'd like to ask a few questions about your water heater and dryer.

180. Was the clothes dryer also replaced? Electric or natural gas?
    ____

181. [If no] What is the approximate age of your current dryer? __________

182. [If yes] What condition was it in when you replaced it? __________

Energy efficient clothes washers save both electricity and water, so I'd like to ask a few questions about your water heater. *[If you already asked these questions as the participant replaced their existing water heater as part of the program, skip these questions]*

183. How is your water heater fueled? (Electric/ Natural Gas / Propane/ Fuel Oil)

184. How old would you say your water heater is? __________

Lighting

CFLs

185. Wattage of new lights ________________________________

186. Quantity of each type: ________________________________

187. Location of new lights: ________________________________

188. What wattage were the replaced lights? ________________________________

Linear Fluorescent

189. Type of new lights (T-8, T-5, etc) ________________________________

190. Wattage of new lights for each type ________________________________

191. Quantity of each type: ________________________________

192. Location of new lights:

193. What wattage were the replace lights? ________________________________

LEDs

194. Wattage of new lights for each type ________________________________

195. Quantity of each type: ________________________________

196. Location of new lights: ________________________________

197. What wattage were the replaced lights? ________________________________

Solar Thermal

198. What is the make __________ and model _______________of your solar thermal system?

199. What is the size of the system? __________

200. What is the system used for? (domestic hot water or space heating)

201. [If hot water for domestic hot water] Can you tell me what type of system was previously in place to heat domestic hot water?_______________

202. [If hot water for domestic hot water] Is the same system in place to serve as a back-up for the solar thermal system or was another type of back-up technology added in its place? ____

203. [If hot water for domestic hot water] Can you please verify the make, model number, capacity, and efficiency of this back up system?

     Make:_____________ Model:_________________

     Capacity (gallons):_____________ Efficiency (Energy Factor 0 to 1): _______________

     ENERGY STAR Label _______ R-Value of Tank ________

204. [If hot water for space heating] I'd like to ask a few questions about your space heating system

     a. What type of heating system did you have before the solar thermal system was installed? ___________________________

     b. Is the same system in place to serve as a back-up for the solar thermal system, or was another type of back-up technology added in its place? ____

     c. Did the temperature setpoints on your thermostat change after you installed the solar thermal system? ________________________

     d. [If yes] Please describe how they changed. __________________

Solar Photovoltaic

205. What is the make___________and model __________ of the panels?

206. What is the make ______________ and model _________________ of the inverters?

207. What is the size (kW) of the system? ______________

208. Has the system ever been off-line? _____________

209. [If yes] How long? ___________

210. Have you cleaned the panels? _________________

211. [If yes] How often?_____________

212. Does the PV system have the ability to log the amount of energy it generates over time?

    a. [If yes] Would you be able to provide us with the data? This might be available digitally or through access to a web portal. ______

    b. [If yes] What duration of energy measurements have been logged by the device? __________________

    c. [If yes] What is the cumulative kWh (energy generated) by the system? ______

Other Measures

Other Measure #1

213. Please describe the other measure:
____
____

214. Did this measure replace existing equipment?_______

215. [If yes] Please describe the measure it replaced:____________________

216. [If yes] Was it in good working order when it was replaced?___________

217. [If yes] Why was it replaced? _______________

Other Measure #2

218. Please describe the other measure:
____
____

219. Did this measure replace existing equipment?_______

220. [If yes] Please describe the measure it replaced:____________________

221. [If yes] Was it in good working order when it was replaced?___________

222. [If yes] Why was it replaced? _______________

Net-to-Gross

Free-Ridership

223. I would like to ask about the role that various things had in your decision to do the upgrade you did. For each thing I mention, please tell me how much of a role it played in your decision, where "1" indicates it played "no role at all" and "5" indicates it played "a major role." Let me know if an item doesn't apply to your situation. [SKIP ITEMS DETERIMED NOT TO BE RELEVANT]

   a. [ASK IF RECEIVED AUDIT] The energy audit (also called an assessment or appraisal) done at your home or business to identify things to include in the upgrade ____

   b. A salesperson or contractor, other than the one who did the audit (or assessment or appraisal) at your home or business _____

   c. [ASK IF RECEIVED LOAN] Any loan that [PROGRAM] provided or arranged for you _____

   d. [ASK IF RECEIVED MONEY FROM PROGRAM] The incentive, rebate, or grant you received from [PROGRAM] ______

   e. [ASK IF RECEIVED MONEY OR TAX CREDIT FROM ANOTHER SOURCE] The incentive, rebate, grant, or tax credit you from a source other than [PROGRAM] _____

   f. [PROGRAM] representative or energy coach or advisor or advocate ____

   g. Information on [PROGRAM]'s website _____

   h. Endorsement or discussion of [PROGRAM] by a trusted source, such as a neighbor, newspaper article, community group, leader in the community___

   i. Advertising and other information from [PROGRAM] _____

224. Which of the following alternatives best describes what you most likely would have done had not participated in [PROGRAM] to complete an energy upgrade? Would you have:

a. Not taken any upgrade action for at least a year

b. Gone ahead a done a remodel to improve your space, but *without any* of the energy savings features you got through [PROGRAM], and paid the full cost yourself

c. Done a remodel with *less extensive* energy-saving upgrades than you did – something that would have cost less but probably would have saved less energy, and paid the full cost yourself

d. Had the *exact same energy-saving upgrades* done anyway, and paid the full cost yourself

e. Done something else (specify) ____________________

f. Don't know

225. Did you replace any equipment through [PROGRAM]?

a. Yes

b. No

226. [IF REPLACED EQUIPMENT; ELSE, SKIP TO NEXT] Which of the following alternatives best describes what you most likely would have done about this equipment not participated in [PROGRAM] to complete an energy upgrade? Would you have:

a. Not replaced any equipment for at least a year

b. Gone ahead replaced the equipment, but not installed the same type as you got through [PROGRAM], and paid the full cost yourself

c. Had the exact same equipment installed, and paid the full cost yourself

d. Done something else (specify) ____________________

e. Don't know

Spillover

227. Since participating in [PROGRAM], have you purchased and installed any energy efficiency items without an incentive from [PROGRAM]? (For example, compact fluorescent lights – or "swirly" lights, energy efficient appliances, insulation, efficient windows, motors, or any other efficiency items)

a. Yes

b. No

c. Don't Know

228. [IF YES, ELSE END SURVEY] What efficiency measures did you install without an incentive – remember, these are things you purchased and installed that were not part of the upgrade that [PROGRAM] provided you an incentive for? For each thing you installed, please estimate the number or amount you installed. (For example, if you installed insulation without an incentive, please estimate how many square feet you had installed.)
[INSTRUCTION FOR PHONE/IN-PERSON SURVEY: IF NEEDED, PROMPT WITH FOLLOWING LIST AND FOLLOW WITH "HOW MANY" WHERE APPROPRIATE. PROBE TO UNTIL RESPONDENT INDICATES NOTHING ELSE.] PROBE: Anything else, such as efficient lighting other than CFLs, high efficiency appliances, windows, or electronics, insulation, or other efficiency items?

Type of item	Number installed	Square feet installed	Other comment
Compact fluorescent ("swirly") lights			
High-efficiency refrigerator			
High-efficiency dishwasher			
High-efficiency clothes washer			
High-efficiency clothes dryer			
Ceiling insulation			
Wall insulation			
Floor insulation			
High-efficiency windows			
Other – please describe: ____________			

229. [IF REPORTED SPILLOVER, ELSE END SURVEY] Even though you installed these items without assistance from [PROGRAM], we'd like to know how much, if at all, [PROGRAM] influenced your decision to install them. Please rate [PROGRAM]'s influence with a five-point scale, where 1 means "no influence," and 5 means "major influence."

a. Record Response: ________

Thank you for participating in this survey!

A.2. Commercial Participant: Better Buildings Neighborhood Programs Telephone Survey

General Information (From Grantee Documentation)

Grantee Name: ______________________________

Business Name: ______________________ Contact Name: ______________________

Project Ref Number: ______________________ Project Completion Date: ______________________

Contact Phone: ______________________ Address: ______________________

City/State: ______________________ Zip: ______________________

Electric Utility: ______________________ Nat. Gas Utility ______________________

Other Fuel Source: ______________________

Nexant Caller: ______________________________

Date: ______________________ Time: ______________________

Notes: ______________________________

____

Project Measure Info (From Grantee Documentation)

Circle all that apply

Weatherization Measures:	Insulation, Cool Roof, Windows, Doors, Air/Duct Sealing, Programmable Thermostat
Office Equipment and Appliance Measures:	Water Heater, Water Cooler, Vending Machine, Commercial Clothes Washer, Refrigerator, Freezer
HVAC Systems	Packaged Systems, Furnace, Boiler, Air Conditioner, Heat Pump, Recommissioning/Tune Up, Economizer
Lighting Measures:	CFLs, Fluorescent Lighting, High-Intensity Discharge System, Exit Signs, LEDs, Lighting Controls
Compressed Air	List:
Motors	List:
Renewable Energy	Solar Photovoltaic, Solar Thermal
Food Service Equipment	Dishwasher, Fryer, Hot Food Holding Cabinet, Steam Cooker, Convection Oven, Low Flow Pre Rinse Spray Valve, Griddle, Ice Machine
Other Measures:	List:

Hello, my name is *<Your Name>* from Nexant and I'm calling on behalf of the *< Name of grantee/subgrantee and umbrella program >* and the U.S. Department of Energy. We are conducting a national level study to assess the energy savings associated with program participants who implemented energy upgrade projects. May I please speak with *<Contact Name>*?

IF CONTACT NOT AVAILABLE, LEAVE MESSAGE: I am calling because as a participant in *<Name of grantee/subgrantee and umbrella program>*, we would like your feedback as part of a short survey. Your responses will contribute to the national study of the Better Building Neighborhood Program (BBNP), which is the Department of Energy's (DOE) program that funded *<Name of grantee/subgrantee and umbrella program>*. We would greatly appreciate your participation in this voluntary survey. Please give me a call back at your earliest convenience so that we can complete a short telephone survey. *<Give Contact Information including Phone Number>*

IF CONTACT NOT AVAILABLE, LEAVE MESSAGE WITH SOMEONE ELSE: I am calling because as a participant in *<Name of grantee/subgrantee and umbrella program>*, we would like your feedback as part of a short survey. Your responses will contribute to the national study of the Better Building Neighborhood Program (BBNP), which is the Department of Energy's

(DOE) program that funded *<Name of grantee/subgrantee and umbrella program>*. Are you familiar with this program and the energy upgrades completed at this business?

a. [If no]: Would you please have *<Contact Name>* call me back at their earliest convenience so that we can set up a time to speak? My phone number is *<Your Phone Number>*.

b. [If yes]: Would you be willing to participate in this voluntary survey? Your feedback will not affect your incentive and is simply used to learn how DOE may improve future programs. All information provided will remain private to the extent permitted by law

    i. [If yes] Thank you! Knowing that this is voluntary, we appreciate that you are willing to be interviewed. If you have any additional questions regarding this study, please contact Kevin Afflerbaugh, Project Manager at Nexant at 303-998-2462 or Dr. Edward Vine at the Lawrence Berkeley National Laboratory (LBNL) at 510-486-6047.

    ii. [If no]: Would you please have *<Contact Name>* call me back at their earliest convenience so that we can set up a time to speak? My phone number is *<Your Phone Number>*.

IF CONTACT OR STAFF WITH KNOWLEDGE NO LONGER AT SITE: *[Questions will not apply, thank the person for their time and move on to the next participant]*

AFTER LOCATING PROPER CONTACT:

I am calling because as a participant in *<Name of grantee/subgrantee and umbrella program>*, we would like your feedback as part of a short survey. This survey will be used to verify information regarding the project at your business funded by DOE. Your responses will contribute to the national study of the Better Building Neighborhood Program (BBNP), which is the Department of Energy's (DOE) program that funded *<Name of grantee/subgrantee and umbrella program>*. We would greatly appreciate your participation in this voluntary survey. Your feedback will not affect your incentive and is simply used to learn how DOE may improve future programs. All information provided will remain private to the extent permitted by law.

Could I ask you a few questions about the measures you installed through the program? This will take approximately 10 minutes.

a. [If yes] Thank you! Knowing that this is voluntary, we appreciate that you are willing to be interviewed. If you have any additional questions regarding this study, please contact Kevin Afflerbaugh, Project Manager at Nexant at 303-998-2462 or Dr. Edward Vine at the Lawrence Berkeley National Laboratory at 510-486-6047.

b. [If no] *[If they don't agree, ask them if there is another time that would be more convenient for them. If they still say no, thank them for their time, and move on.]*

IF PARTICIPANT IS FROM A GRANTEE SELECTED FOR ON-SITE VISITS:

As an additional part of the study, we will also be conducting on-site visits at a selection of project sites. These on-site visits last an average of forty-five minutes, and a trained professional engineer will conduct a walk-through of your business to gather additional information on the measures you installed. Would you be willing to let one of our engineers come to your business for this purpose?

a. [If yes] Thank you! Before we start the survey, let's schedule the visit. We are currently scheduling visits the week of *<insert week>*. *[Let's give them a few times to work with.]*

[Record Scheduled Time & Date:] ________________________________

Again, the visit will take approximately 45 minutes. We will need access to the areas of your business where the energy upgrades were completed. The field engineer will provide you with proper identification from Nexant upon arrival. Who will be the contact for this visit?__________________

Is there anything the engineer needs to be aware of before arriving at your business? *[Prompt examples if necessary: roof access, security code for entry, etc.]*

____

If you need to reschedule or cancel, please contact ______ at ____________

b. [If no] That's fine. Let's get started with the survey.

>>> start the survey<<<<

General Building Information

1. What year was your building built? ______________________

2. What is the total square footage of your building? ______________________

3. Have there been any modifications to the building in the last 3 years? If so, please describe.

____

4. How many people occupy the building during business hours? _____

5. Of the following options, what is the PRIMARY use of your building? [Only check ONE appropriate space]

Education	Grocery	Health	Lodging	Office	Rest-aurant	Retail	Ware-house	Industrial	Multi-family	Other

6. When is this building occupied? [Check appropriate season and corresponding months]

All Year			Summer Only			Winter Only			Other Seasonal		
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

7. What is the weekly occupancy schedule of this building?

Day	Business Hours	Closed All Day?	Open 24 Hours?
Sunday	From: ____ To: ____	□	□
Monday	From: ____ To: ____	□	□
Tuesday	From: ____ To: ____	□	□
Wednesday	From: ____ To: ____	□	□
Thursday	From: ____ To: ____	□	□
Friday	From: ____ To: ____	□	□
Saturday	From: ____ To: ____	□	□

8. What type of temperature controls does your business use?

Programmable Thermostat
Manual Thermostat
Energy Management System
Always On
Time Clock

9. Approximate winter heat settings:

Weekday Daytime	Weekday evening	Weekday Overnight	Weekend Daytime	Weekend evening	Weekend overnight

10. Approximate summer cooling settings:

Weekday Daytime	Weekday evening	Weekday Overnight	Weekend Daytime	Weekend evening	Weekend overnight

Heating, Ventilation, and Air Conditioning (HVAC) System

11. What is your primary heating fuel--------------------------→	Natural Gas Electricity Propane Fuel Oil Kerosene Wood Geothermal Other:

If participant did not receive a new HVAC system (furnace/boiler/packaged/etc) as part of the energy upgrade, ask questions 12-30 for applicable systems. Otherwise skip to Question 31. If they received a new HVAC system, this information will be gathered in the appropriate section detailing their new system.

12. HVAC System Type: -----------------------------→	Packaged Split System Central
13. Is your HVAC system single zone or multi zone?	
14. Age of HVAC equipment	
15. If Packaged, what type: -----------------------------→	Packaged DX Unit-Heating and Cool Packaged DX Unit – Cooling Only PTAC/Window AC PTAC w/ Heating
16. If Packaged, how many systems?	
17. If more than one, are all the systems the same size?	
18. What is the size of the packaged system(s) (if known)	Tons (Cooling): Btu/hr (Heating):
19. What is the efficiency of the packaged system (if known)	SEER/EER (Cooling): AFUE (Heating):

20.	If Split System, what type: ------------------------→	Cooling Unit + Furnace Cooling Unit + Heat Pump Split System Heat Pump Ground Source Heat Pump Other:

21. If Split System, how many heating units (i.e. furnaces?) and cooling units (i.e. condensing units)?____

22.	If Split System, are all the heating and cooling units the same size?	
23.	What is the size of the split system(s) (if known)	Tons (Cooling): Btu/hr (Heating):
24.	What is the efficiency of the split systems(s) (if known)	SEER/EER (Cooling): AFUE (Heating):
25.	If Central System, what type of heating is used?	Steam Boiler – Baseboard Heat Steam Boiler – Air handlers Water Boiler-- Baseboard Heat Water Boiler -- Air handlers Other:
26.	What is the size of the Central Heating system (Btuh)?	
27.	What is the efficiency of the Central Heating system? (AFUE)	
28.	If Central System, what type of cooling is used?	If Chiller, what type: Centrifugal Reciprocating Rotary Scroll Absorption Other:

29. What is the size of the Central Cooling System (Tons)? ________________

30. What is the efficiency of the Central Cooling System (SEER/EER)?-

____

General Energy Upgrade Questions

31. I would now like to verify what energy upgrade measures you had installed. According to program records you had the following measures installed: <*describe measures from project information*>. Is this correct?

32. [If no] What was actually installed? ___________________*[Be sure to ask survey questions appropriate for the measures actually installed]*

Weatherization Measures

Insulation

Wall Insulation

33. What is the total area (sq. ft.) of the walls that were insulated? __________

34. Type of insulation prior to upgrade ----------------→

- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

35. Approximate inches of wall insulation that existed prior to the upgrade ________

36. R-Value prior to upgrade (if known): ___________

37. Type of insulation added --------------------------→

- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

38. How many inches of insulation were added? ____________

39. Retrofit R-Value (if known): _____________

Attic Insulation

What is the area of the attic floor that was insulated (sq. ft.):_________

40. Type of insulation prior to upgrade ------------------------→
- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

41. Inches of attic insulation prior to upgrade: __________

42. R-Value prior to upgrade (if known): ____________

43. Type of insulation added ---------------------------------→
- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

44. How many inches were added? ___________

45. Retrofit R-Value (if known): _______________

Crawl Space Insulation

What is the total area (sq. ft.) of the crawl space wall, floor, and ceiling that were insulated?
____

46. Type of insulation prior to upgrade ------------------------------→

- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

Inches of crawl space insulation prior to upgrade: _______________

47. R-Value prior to upgrade (if known): _________________

48. Type of insulation added --------------------------------------→

- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

49. How many inches were added? ________________

50. Retrofit R-Value (if known): ______________

Rim Joist Insulation

What is the total sq. ft. of rim joists insulated? __________

51. Type of insulation prior to upgrade ---------------------→

- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

Inches of rim joist insulation prior to upgrade: _________

52. R-Value prior to upgrade (if known): ______________

53. Type of insulation added ------------------------------------→

- None
- Rigid Foam
- Blanket Batts
- Vermiculite
- Rockwool
- Fiberglass
- Cellulose Fiber

54. How many inches were added? ______________

55. Retrofit R-Value (if known): ________________

Windows

56. Energy ratings of each new type of window installed:

<u>Type 1</u>
U Factor:______
Solar Heat Gain Coefficient: _____

<u>Type 2 (if applicable)</u>
U Factor:______
Solar Heat Gain Coefficient: _____

<u>Type 3 (if applicable)</u>
U Factor:______
Solar Heat Gain Coefficient: _____

57. Quantity of each type of new window installed:
Type 1: _____Type 2:________Type 3:______

58. Total size in sq. ft. of each type of new window:

Type 1: _____Type 2:________Type 3:______

59. # of Panes: (single, dual, etc)
Type 1: _____Type 2:________Type 3:______

60. Framing Material: (e.g., vinyl, aluminum, etc.)
Type 1: _____Type 2:_______Type 3:_______

61. What type of window was replaced?___________________________

62. How many panes did they have? ______________________________

63. What was the framing material of the replaced windows?_______________________________

Doors

64. Quantity of new doors installed: _____________________

65. Size of each: _________________

66. Material of each (wood, glass, fiberglass, etc..): - __________________________

What were the old doors? _____________________

Duct And Air Sealing

67. What part of the business was sealed? (Ducts/Windows/Door/Attic)

68. Quantity of each item sealed? (feet of ducts/number of doors or windows/sq. ft. of attic/crawlspace)
____

69. What air sealing measures were performed for each area? (ex. Spray foam, caulk, mastic etc):
____

Programmable Thermostat

We discussed your current set points earlier in this survey, now I would like to understand the settings associated with the old thermostat.

70. With the previous thermostat, were the settings the same as the new thermostat?

71. [If no] What were the settings?

Summer

Weekday Daytime	Weekday evening	Weekday Overnight	Weekend Daytime	Weekend evening	Weekend overnight

Winter

Weekday Daytime	Weekday evening	Weekday Overnight	Weekend Daytime	Weekend evening	Weekend overnight

Cool Roofs

72. What type of cool roof was installed?________________________

73. What is the square footage of the new cool roof?______________________

74. What type of roof did the cool roof replace? ________________________

75. How old was the previous roof? ________________________

Office Equipment and Appliance Measures

Water Heater

76. What type of water heater did you purchase?-------------------→	Tankless Storage
77. What is the fuel type? ---→	Electric Gas Propane Fuel Oil Solar
78. Where is the water heater located?--------------------------------→	Garage Basement Storage Closet

79. Is the water heater in a conditioned space? _____________

Is the water heater wrapped with an insulating material? _________

80. If easily accessible, can you please verify the make, model number, capacity, and efficiency of the water heater? This information is often located on a label on the frame of the water heater.

    Make:_____________ Model:_________________

    Capacity (gallons):_____________ Efficiency (Energy Factor 0 to 1): _____________

    ENERGY STAR Label _______ R-Value of Tank ________

81. What is the temperature setpoint on your new water heater? ________________

82. What was the temperature set point on your water heater prior to the retrofit? _______

83. What type of water heater did you replace? (Tankless / Storage)

84. Can you approximate its age? ______________

85. Was it the same fuel type as the new one? ___________

86. [If no] What was the fuel used by the old water heater? __________

87. Was it in good working condition when you replaced it? ___________

Water Cooler

88. What is the make and model of the water cooler?___________

89. Does the water cooler provide cold water only or does it provide hot and cold water? _________

90. Did you have a water cooler prior to the installation of your new water cooler? ____ [If no, this section is complete.]

91. Was it in good working order when it was replaced? _______

92. How old was your previous water cooler? _________

93. Why was it replaced? ______

Vending Machine

94. What is the make and model of the vending machine?

95. Is the machine capable of operating on one of the following low-power modes (Circle all that apply):

a. Lighting low power state — lights off for an extended period of time.
b. Refrigeration low power state — the average beverage temperature is allowed to rise above 40°F for an extended period of time.
c. Whole machine low power state — the lights are off and the refrigeration operates in its low power state.

96. Do you have a vending miser installed on this machine? ___________

97. Did you have a vending machine prior to the installation of your new vending machine? ____ [If no, this section is complete.]

98. What type of vending machine?

99. Was it in good working order when it was replaced? _______

100. How old was your previous vending machine? _________

101. Why was it replaced? ______

102. Did you dispose the previous vending machine? _____

103. [If no] Is the previous machine still in use? __________

Commercial Clothes Washer

104. What is the make and model of the new clothes washer?_______

105. What is the Minimum Modified Energy Factor (MEF) of the new clothes washer?_____

106. What is the Water Factor (WF) of the new clothes washer?_____

107. About how many loads per week do you wash? __________

108. How many loads also go through the dryer? All / some / none

109. Has the use of the clothes washer changed since the new unit was purchased?_________

110. [If yes] About how many loads per week did you wash? __________

111. Can you approximate the age of the unit that was replaced? __________

112. Was it in good working order when you got rid of it? __________

Energy efficient clothes washers also save energy from clothes drying and water heating, so I'd like to ask a few questions about your water heater and dryer.

113. Is the clothes dryer electric or natural gas?________________________

114. Was the clothes dryer also replaced? ____

115. [If no] What is the approximate age of your current dryer? __________

116. [If yes] What condition was it in when you replaced it? __________

Energy efficient clothes washers also save energy on water heating, so I'd like to ask a few questions about your water heater. *[If you already asked these questions because the participant replaced their existing water heater as part of the program, skip these questions]*

117. How is your water heater fueled? (Electric/ Natural Gas / Propane/ Fuel Oil)

118. What type of water heater do you have (tankless or storage)?______________

119. How old would you say your water heater is? __________

Refrigeration

120. First, can you please verify the brand and model number of the refrigeration equipment?

121. What is the type of new refrigeration equipment? [Circle applicable features below]

Appliance Characteristics (Choose One in Each Applicable Category Below)						
Configuration	Top Freezer	Side-by-Side	Bottom Freezer	Single Door	Vertical	Chest
Defrost	Manual	Partial Automatic				
Door Type	Solid Door	Glass Door	Open-Display Case	Display Case w/Doors		
Through Door Features	Water and/or Ice	None				
Heated Space	Heated	Unheated				

122. How many cubic feet is the new refrigeration equipment? __________

123. What was the approximate age of the equipment that was replaced? ____________

124. Was it in good working order when you got rid of it?

125. If you still have it, where is it located?

126. Are anti-sweat heater controls used on display case doors? Y / N

127. What type of lights do the display cases have? (LED / Fluorescent)

HVAC Measures

Packaged System

128. What type of packaged system was installed:

- Packaged DX Unit-Heating and Cooling
- Packaged DX Unit – Cooling Only
- PTAC/Window AC
- PTAC w/ Heating

129. How many packaged systems does your building have?_____________ How many packaged systems did you replace? ___________

130. If possible, can you please verify the make, model number, efficiency, and input capacity of the new system? This information is often located on a label on the unit or on the invoice.

Make:_____________ Model:_________________

Heating Efficiency (AFUE): _______________ Cooling Efficiency (SEER/EER):___

Heating Size (Btu/hr): In_______Out_______ Cooling Size (Tons)____

131. What system type was replaced by the new packaged system? (old packaged system, split system, etc)

132. How old was your previous packaged system? _________

133. Was it in good working order when it was replaced? ______

134. What was the efficiency of your old packaged system? SEER/AFUE:______

135. Why was it replaced? ____

136. Did the temperature setpoints change after you installed the new system? ______

137. [If yes] Please describe how they changed _______________________________

Furnace

138. How many furnaces did you replace? ___________ How many furnaces does your building have?_____________

139. If possible, can you please verify the make, model number, and input capacity of the new furnace? This information is often located on a label on the frame of the furnace or perhaps on an invoice. *(Make sure they know they will likely have to take off the panel where all this info is located.)*

Make:_____________ Model:_________________

Efficiency (AFUE): _______________

Size (Btu/hr): In_______Out_______ *(the unit might only list one)*

140. What heating system type was replaced by the new furnace? (gas furnace, electric furnace, gas boiler, etc)

141. How old was your previous heating system? _________

142. Was it in good working order when it was replaced? ______

143. What was the efficiency of your old furnace? ______

144. Why was it replaced? ____

145. Did the temperature setpoints on your programmable thermostat change after you installed the new furnace? ______

146. [If yes] Please describe how they changed _______________________________

Boiler

147. What type of boiler was installed:----------→

Condensing Hot Water
Condensing Steam
Other:

148. Can you please verify the make, model number, and efficiency of the boiler? This information is often located on a label on the frame of the boiler or on an invoice.

149. Can you please verify the make, model number, and efficiency of the boiler? This information is often located on a label on the frame of the boiler or on an invoice.

Make:_____________ Model:_________________

Efficiency (AFUE): _______________ Rated heating input (Btu/hr) _______

150. What heating system type was replaced by the new boiler? (examples: gas furnace, electric furnace, gas boiler, etc)

151. How old was your previous heating system? _________

152. Was it in good working order when it was replaced? _______

153. What was the heat output (efficiency) rating of your old heating system? ______

154. Why was it replaced? ____

155. Did the temperature setpoints change after you installed the new boiler? _______

156. [If yes] Please describe how they changed ___________________________________

Air Conditioning

157. How many air conditioning units did you replace? ___________

158. How many air conditioning units does your building have? _________________

159. If easily accessible, can you please verify the make, model number, size and efficiency rating of the new air conditioner(s)? This information is often located on a label on the side of the air conditioner or on the invoice.

Make:_____________ Model:_________________

Tonnage: _______________ SEER: _____

160. Did you have a cooling system prior to the installation of your new air conditioner? ____ [If no, this section is complete.]

161. What type of system? (examples: central air conditioner, evaporative cooler, window air conditioner)

162. Was it in good working order when it was replaced? _______

163. How old was your previous cooling unit? _________

164. Why was it replaced? ______

165. What was the efficiency rating of your old air conditioner (SEER/EER/CFM)? ______

166. Did the temperature setpoints change after you installed the new air conditioner? __________

167. [If yes] Please describe how they changed _____________________________________

Evaporative Cooler

168. Can you please verify the make, model number, size and efficiency of the new evaporative cooler? This information is often located on a label on the frame of the cooler.

Make:_____________ Model:_________________

CFM: _____ Type: Direct/Indirect

169. Did you have a cooling system prior to the installation of your new evaporative cooler? _____________ [If no, this section is complete]

170. What type of system? (examples: central air conditioner, evaporative cooler, window air conditioner)

171. Was it in good working order when it was replaced? ___________________

172. How old was your previous cooling unit? ___________________________

173. Why was it replace?_____________________________

174. What was the efficiency rating of the prior system (SEER or CFM)? __________

175. Did the temperature setpoints change after you installed the new cooler? ________

176. [If yes] Please describe how they changed _____________________________________

Chiller

177. What type of chiller was installed?	Centrifugal Reciprocating Rotary Scroll Absorption Other:

178. How many chiller units did you replace? ___________

179. How many chiller units does your building have? _________________

180. If easily accessible, can you please verify the make, model number, size and efficiency rating of the new chiller(s)?

Make:_____________ Model:_________________

Tonnage: _______________ EER: _____

181. How old was your previous chiller? _________

182. Why was it replaced? ______

183. What was the EER rating of your old chiller? ______

184. Did the temperature setpoints change after you installed the new chiller? __________

185. [If yes] Please describe how they changed ____________________________________

Heat Pump

186. Can you please verify the make, model number, and efficiency of the heat pump?
Make:_____________ Model:_________________

SEER: _______________ Heating Seasonal Performance Factor (HSPF): _______
Tonnage: ______

187. What type of heat pump was installed: Ground Source/ Air Source/Water Source

188. What is the heat pump used for: Heating/Cooling/Both

189. What heating/cooling system did this heat pump replace? (Gas furnace, central air conditioner, lower efficiency heat pump, other)

190. How old was your previous heating/cooling system? _________

191. Was it in good working order when it was replaced? _________

192. Why was it replaced? __________

193. Did the temperature setpoints change after you installed the new heat pump? ______

194. [If yes] Please describe how they changed ____________________________________

Recommissioning/HVAC System Tune Ups

195. What type of HVAC system received Rcx/tune up services? ______________

196. What components of the building's HVAC system received Rcx/tune up activities?
____

197. What measures were completed as part of the Rcx/tune up?
____
____

198. Had the buildings HVAC system received a tune up previously?_____________

199. How old was the HVAC system that was tuned up?_______________

Economizer

200. If possible, can you please verify the make, model, and size of the economizer?
Make:______________ Model:__________________ Tons:_____________

201. Did you have an economizer previously? ____________________

202. If so, how old was it?___________________

Compressor

203. Can you please verify the make, model number, and horse power of the new compressor?
Make:______________ Model:__________________

HP: ________________ Efficiency%: ____________

204. What is the compressor used for: ________________

205. What size and efficiency compressor did this new compressor replace? _______________

206. How old was your previous compressor? __________

207. Was it in good working order when it was replaced? __________

208. Why was it replaced? ___________

Motors

209. Can you please verify the make, model number, efficiency and horse power of the new motor(s)?
Make:______________ Model:__________________

HP: ________________ Efficiency % ________________

210. What is the motor used for: _______________

211. What size and efficiency motor did this new motor replace? ______________

212. How old was your previous motor? ____________________

213. Was it in good working order when it was replaced? __________

214. Why was it replaced? ___________

Lighting

CFLs

Location Description	

Characteristics	Baseline	Efficient
# of Fixtures		
# of Lamps/Bulbs Per Fixture		
Lamp/Bulb Wattage		
Lamp Type		
Lighting Controls		

Linear Fluorescent

Location Description	

Characteristics	Baseline	Efficient
Lamp Type (T-8, T-5, etc)		
# of Fixtures		
# of Lamps/Bulbs Per Fixture		
Lamp/Bulb Wattage		
Lamp Length		
Lamp Shape (U or Straight)		
Ballast Type (Magnetic, Electronic)		
Fixture Wattage		
Lighting Controls		

LEDs

Location Description	

Characteristics	Baseline	Efficient
# of Fixtures		

# of Lamps/Bulbs Per Fixture		
Lamp/Bulb Wattage		
Lamp Type		
Lamp Length		
Lamp Shape		
Ballast Type		
Fixture Wattage		
Lighting Controls		

High Intensity Discharge

Location Description	

Characteristics	Baseline	Efficient
# of Fixtures		
# of Lamps/Bulbs Per Fixture		
Lamp/Bulb Wattage		
Lamp Type		
Lamp Length		
Lamp Shape		
Ballast Type		
Fixture Wattage		
Lighting Controls		

Exit Signs

215. How many exit signs did you replace? _______________

216. What type of lighting is used in the new exit signs (LED/CFLs)

217. What type of exit sign was replaced (Incandescent/CFL)

Lighting Controls

218. What types of lighting controls were installed?___________________________

219. Where were the lighting controls installed? __________________________

220. What are the control settings? (i.e. turn off after 10 min)___________________

Solar Thermal

221. What is the make __________ and model _______________of your solar thermal system?

222. What is the size of the system? __________

223. What is the system used for? (domestic hot water or space heating)

224. [If hot water for domestic hot water] Can you tell me what type of system was previously in place to heat domestic hot water?_______________

225. [If hot water for domestic hot water] Is the same system now in place to serve as a back-up for the solar thermal system or was another type of back-up technology added in its place? ____

226. [If another type of back-up technology] Can you please verify the make, model number, capacity, and efficiency of this back up system?

Make:_____________ Model:_________________

Capacity (gallons):_____________ Efficiency (Energy Factor 0 to 1): _____________

ENERGY STAR Label _______ R-Value of Tank ________

227. [If hot water for space heating] I'd like to ask a few questions about your space heating system

a. What type of heating system did you have before the solar thermal system was installed? ___________________________

b. Is the same system now in place to serve as a back-up for the solar thermal system, or was another type of back-up technology added in its place (if so, please describe back up technology)?

   ____

c. Did the temperature setpoints on your thermostat change after you installed the solar thermal system? ________________________

d. [If yes] Please describe how they changed. __________________

Solar Photovoltaics

228. What is the make___________and model __________ of the panels?

229. What is the make ______________ and model _________________ of the inverters?

230. What is the size (kW) of the system? ______________

231. Has the system ever been off-line? _____________

232. [If yes] How long? ___________

233. Have you cleaned the panels? _________________

234. [If yes] How often?_____________

235. Does the PV system have the ability to log the amount of energy it generates over time?

    a. [If yes] Would you be able to provide us with the data? This might be available digitally or through access to a web portal. ______

    b. [If yes] What duration of energy measurements have been logged by the device? __________________

    c. [If yes] What is the cumulative kWh (energy generated) by the system? ______

Food Service Equipment

Fryer

236. What is the type of new fryer?

    a. Standard open deep-fat gas fryer
    b. Large Vat open deep-fat gas fryer
    c. Standard open deep-fat electric fryer
    d. Large Vat open deep-fat electric fryer

237. What is the make and model of the fryer? __________

238. What is the heavy load cooking energy-efficiency of the new fryer (%)? ___________

239. What is the idle energy rate of the new fryer (Btu/hr)? _____________

240. How old was your previous fryer? _________

241. Was it in good working order when it was replaced? _________

242. Why was it replaced? __________

Steam Cooker

243. What is the make and model of the new steam cooker?___________

244. Is the steam cooker a gas cooker or electric cooker?____________

245. What is the cooking energy efficiency rating of the new steamer (%)? ______________

246. What is the idle energy rate of the new steamer (Btu/hr)? ______________

247. How old was your previous steam cooker? _________

248. Was it in good working order when it was replaced? _________

249. Why was it replaced? __________

Hot Food Holding Cabinet

250. What is the make and model of the new hot food holding cabinet?

251. What is the interior volume size of the hot food holding cabinet (cubic feet)? __________

252. Is the holding cabinet fully insulated? ______________

253. What is the idle energy rate of the holding cabinet (in watts) _______________

254. How old was your previous cabinet? _________

255. Was it in good working order when it was replaced? _________

256. Why was it replaced? __________

Convection Oven

257. What is the make and model of the new convection oven?

258. What type is the new convection oven?
    a. Gas full size
    b. Electric half size
    c. Electric full size

259. What is the cooking energy efficiency of the convection oven (%)?

260. What is the idle energy rate of the convection oven (kW)?

261. How old was your previous oven? _________

262. Was it in good working order when it was replaced? _________

263. Why was it replaced? __________

Low-Flow Pre-Rinse Spray Valve

264. Does the spray valve include the following (Circle all that apply):
    a. Spray nozzle
    b. Lever to control water flow
    c. Dish guard pump

265. What is the gallons per minute output of the spray valve?

Griddle

266. Is the griddle single- or double-sided?___________

267. Does the griddle use electric or gas power?________________

268. What is the cooking energy efficiency rating of the griddle (%)?______________

269. What is the normalized Idle Energy Rate of the griddle? ________________

270. How old was your previous griddle? _________

271. Was it in good working order when it was replaced? _________

272. Why was it replaced? __________

Dishwasher

273. What type of dishwasher is the new unit?
    a. Under Counter
    b. Stationary Single Tank Door
    c. Single Tank Conveyor
    d. Multiple Tank Conveyor

274. About how many loads per week do you run? __________

275. Do you use heated dry? __________

276. What cycle do you normally set on your dishwasher (light/ normal/ heavy)? __________

277. Has your use of the dishwasher changed since you purchased the new unit? __________

278. [If yes] About how many loads per week did you run the old dishwasher? __________

279. What was the approximate age of the old dishwasher? __________

280. Was it in good working order when you got rid of it? __________

Energy efficient dishwashers save both electricity and water, so I'd like to ask a few questions about your water heater. *[If you already asked these questions as the participant replaced their existing water heater as part of the program, skip these questions]*

281. How is your water heater fueled? (Electric/ Natural Gas / Propane/Fuel Oil)

282. What type of water heater do you have (tankless or storage)?______________

283. How old would you say your water heater is? __________

Ice Machine

284. What is the type of the new ice machine?
    a. Ice Making Head (IMH)
    b. Remote Condensing Unit (RCU) with remote compressor
    c. Remote Condensing Unit (RCU) without remote compressor
    d. Self-Contained Unit (SCU)

285. What is the harvest rate of the unit (lbs. ice/day)?

286. What is the energy use limit of the unit (kWh/100 lbs. ice)?

287. What is the potable water use limit of the unit (gal/100 lbs. ice)?

288. How old was your previous ice machine? _________

289. Was it in good working order when it was replaced? _________

290. Why was it replaced? __________

Other Measures

Other Measure #1

291. Please describe the other measure:
____
____

292. Did this measure replace existing equipment?_______

293. [If yes] Please describe the measure it replaced:____________________

294. [If yes] Was it in good working order when it was replaced?___________

295. [If yes] Why was it replaced? _______________

Other Measure #2

296. Please describe the other measure:
____
____

297. Did this measure replace existing equipment?_______

298. [If yes] Please describe the measure it replaced:____________________

299. [If yes] Was it in good working order when it was replaced?___________

300. [If yes] Why was it replaced? _______________

Net-to-Gross

Free-Ridership

301. Please think back to the time before you learned about [PROGRAM], and indicate how seriously you had considered doing an energy upgrade for your business similar to what you did through the program. Use a 1 to 5 scale, where 5 means you "had already decided to do a similar energy upgrade within the coming year" and 1 means you "had never considered doing an energy upgrade." ____

302. I would like to ask about the role that various things had in your decision to do the upgrade you did. For each thing I mention, please tell me how much of a role it played in your decision, where "1" indicates it played "no role at all" and "5" indicates it played "a major role." Let me know if an item doesn't apply to your situation. [SKIP ITEMS DETERIMED NOT TO BE RELEVANT]

    a. [ASK IF RECEIVED AUDIT] The energy audit (also called an assessment or appraisal) done at your business to identify things to include in the upgrade ____

    b. A salesperson or contractor, other than the one who did the audit (or assessment or appraisal) at your business _____

    c. [ASK IF RECEIVED LOAN] Any loan that [PROGRAM] provided or arranged for you _____

    d. [ASK IF RECEIVED MONEY FROM PROGRAM] The financial support you received from [PROGRAM] ______

e. [ASK IF RECEIVED MONEY OR TAX CREDIT FROM ANOTHER SOURCE] The financial support (including any tax credit) you from a source other than [PROGRAM] _____

f. Any technical, facilitation, or other support you received from [PROGRAM] ____

g. Information on [PROGRAM]'s website _____

h. Endorsement or discussion of [PROGRAM] by a trusted source, such as a neighbor, newspaper article, community group, leader in the community___

i. Advertising and other information from [PROGRAM] _____

303. Which of the following alternatives best describes what you most likely would have done had you not participated in [PROGRAM] to complete an energy upgrade? Would you have:

a. Not taken any upgrade action for at least a year

b. Gone ahead and done a remodel to improve your space, but *without any* of the energy savings features you got through [PROGRAM], and paid the full cost yourself

c. Done a remodel with *less extensive* energy-saving upgrades than you did – something that would have cost less but probably would have saved less energy, and paid the full cost yourself

d. Had the *exact same energy-saving upgrades* done anyway, and paid the full cost yourself

e. Done something else (specify) ___________________

f. Don't know

304. Did you replace any equipment through [PROGRAM]?

a. Yes

b. No

305. [IF REPLACED EQUIPMENT; ELSE, SKIP TO NEXT] Which of the following alternatives best describes what you most likely would have done about this equipment if you had not participated in [PROGRAM] to complete an energy upgrade? Would you have:

a. Not replaced any equipment for at least a year

b. Gone ahead replaced the equipment, but not installed the same type as you got through [PROGRAM], and paid the full cost yourself

c. Had the exact same equipment installed, and paid the full cost yourself

d. Done something else (specify) ___________________

e. Don't know

Spillover

306. Since participating in [PROGRAM], have you purchased and installed any energy efficiency items without an incentive from [PROGRAM]? (For example, compact fluorescent lights – or "swirly" lights, energy efficient appliances, insulation, efficient windows, motors, or any other efficiency items)

a. Yes

b. No

c. Don't Know

307. [IF YES, ELSE END SURVEY] What efficiency measures did you install without an incentive – remember, these are things you purchased and installed that were not part of the upgrade that [PROGRAM] provided you an incentive for? For each thing you installed, please estimate the number or amount you installed. (For example, if you installed insulation without an incentive, please estimate how many square feet you had installed.)

[INSTRUCTION FOR PHONE/IN-PERSON SURVEY: IF NEEDED, PROMPT WITH FOLLOWING LIST AND FOLLOW WITH "HOW MANY" WHERE APPROPRIATE. PROBE TO UNTIL RESPONDENT INDICATES NOTHING ELSE.] PROBE: Anything else, such as efficient lighting other than CFLs, high efficiency appliances, windows, or electronics, insulation, or other efficiency items?

Type of item	Number installed	Square feet installed	Other comment
Compact fluorescent ("swirly") lights			
High-efficiency refrigerator			
High-efficiency dishwasher			
High-efficiency clothes washer			
High-efficiency clothes dryer			
Ceiling insulation			
Wall insulation			
Floor insulation			
High-efficiency windows			
Other – please describe: ___________			

308. [IF REPORTED SPILLOVER, ELSE END SURVEY] Even though you installed these items without assistance from [PROGRAM], we'd like to know how much, if at all, [PROGRAM] influenced your decision to install them. Please rate [PROGRAM]'s influence with a five-point scale, where 1 means "no influence," and 5 means "major influence."

   a. Record Response: ________

Thank you for participating in this survey!

B. Residential and Commercial Pre-Notification Letters

B.1. Residential Letter

6/14/2013

Participant Name
Address
City, State, Zip

Dear *Participant*

We are reaching out to you today due to your participation in the *Program Name*. As part of this program, you installed measures to improve the energy efficiency of your home.

In the coming weeks, you may be contacted by phone and asked to participate in a 10 minute, voluntary survey that will be used to verify information regarding these energy efficient measures. In addition, you may also be asked to allow researchers from our team to conduct an on-site visual inspection of the energy efficiency measures installed. This visit typically lasts a half an hour and involves researchers verifying and potentially photographing the measure installation.

Your responses will contribute to a national study measuring the energy saving impacts of the Department of Energy's (DOE) Better Buildings Neighborhood Program, which funded the *Program Name*. The DOE has contracted with an independent research firm, Nexant, Inc. to conduct this study. Your feedback will not affect any incentive you may have received and any information provided will be used by the DOE to help improve their programs for future years. No identifiable information specific to your house will be reported to the DOE or stored by Nexant.

We would greatly appreciate your participation in this voluntary survey. If you have any additional questions regarding this study, please contact Kevin Afflerbaugh, Project Manager at Nexant at 303-998-2462 or Dr. Edward Vine at the Lawrence Berkeley National Laboratory at 510-486-6047.

Sincerely,

Kevin Afflerbaugh
Project Manager
Nexant, Inc
303-998-2462
kafflerbaugh@nexant.com

Nexant, Inc.

1401 Walnut St Ste 400
Boulder, CO 80302-5332 USA

tel | +1.303.402.2480
fax | +1.303.440.6644

www.nexant.com

B.2. Commercial Letter

Nexant

6/14/2013

Participant Name
Business Name
Address
Address

Dear Participant Name:

We are reaching out to you today due to your participation in the PROGRAM NAME. As part of this program, you installed measures to improve the energy efficiency of your building.

In the coming weeks, you may be contacted by phone and asked to participate in a short, voluntary survey that will be used to verify information regarding these energy efficient measures. Your responses will contribute to a national study measuring the energy saving impacts of the Department of Energy's (DOE) Better Buildings Neighborhood Program, which funded the PROGRAM NAME. The DOE has contracted with an independent research firm, Nexant, Inc to conduct this study.

Your feedback will not affect any incentive your business may have received and any information provided will be used by the DOE to help improve their programs for future years. No identifiable information specific to your business will be reported to the DOE or stored by Nexant.

We would greatly appreciate your participation in this voluntary survey. If you have any additional questions regarding this study, please contact Kevin Afflerbaugh, Project Manager at Nexant at 303-998-2462 or Dr. Edward Vine at the Lawrence Berkeley National Laboratory at 510-486-6047.

Sincerely,

Kevin Afflerbaugh
Project Manager
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C. Fuel Prices

Table C-1: Commercial Energy Prices

State	Electricity (kWh)*	Natural Gas (therm)**
Colorado	$ 0.09	$ 0.80
Georgia	$ 0.10	$ 1.06
Massachusetts	$ 0.14	$ 1.11
Michigan	$ 0.10	$ 0.92
North Carolina	$ 0.08	$ 0.96
New Hampshire	$ 0.14	$ 1.19
Ohio	$ 0.10	$ 0.81
Texas	$ 0.09	$ 0.71
Virginia	$ 0.08	$ 0.96
Washington	$ 0.07	$ 1.04

* 2011 average price per kWh: *http://www.eia.gov/electricity/sales_revenue_price/pdf/table5_b.pdf*.

** Average Price per therm from January 2011 through June 2012: *http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm*.

Table C-2: Residential Energy Prices

State	Electricity (kWh) *	Natural Gas (therm) **	Fuel Oil – Type 2 (gallon) ***	Propane/LPG (gallon) ***
Alabama	$ 0.11	$ 1.75	$ 3.80	$ 2.65
Arizona	$ 0.11	$ 1.71	$ 3.80	$ 2.65
California	$ 0.15	$ 0.98	$ 3.80	$ 2.65
Colorado	$ 0.11	$ 0.97	$ 3.80	$ 2.65
Connecticut	$ 0.18	$ 1.53	$ 3.80	$ 2.65
Florida	$ 0.12	$ 1.92	$ 3.80	$ 2.65
Georgia	$ 0.11	$ 1.90	$ 3.80	$ 2.65
Illinois	$ 0.12	$ 1.02	$ 3.80	$ 2.65
Indiana	$ 0.10	$ 1.12	$ 3.80	$ 2.65
Massachusetts	$ 0.15	$ 1.38	$ 3.80	$ 2.65
Maine	$ 0.15	$ 1.50	$ 3.80	$ 2.65
Michigan	$ 0.13	$ 1.13	$ 3.80	$ 2.65
Missouri	$ 0.10	$ 1.60	$ 3.80	$ 2.65
North Carolina	$ 0.10	$ 1.56	$ 3.80	$ 2.65

Continued

STATE	ELECTRICITY (KWH) *	NATURAL GAS (THERM) **	FUEL OIL – TYPE 2 (GALLON) ***	PROPANE/LPG (GALLON) ***
New Hampshire	$ 0.17	$ 1.54	$ 3.80	$ 2.65
Nevada	$ 0.12	$ 1.13	$ 3.80	$ 2.65
New York	$ 0.18	$ 1.52	$ 3.80	$ 2.65
Ohio	$ 0.11	$ 1.30	$ 3.80	$ 2.65
Oregon	$ 0.10	$ 1.24	$ 3.80	$ 2.65
Pennsylvania	$ 0.13	$ 1.44	$ 3.80	$ 2.65
Tennessee	$ 0.10	$ 1.25	$ 3.80	$ 2.65
Texas	$ 0.11	$ 1.24	$ 3.80	$ 2.65
Virginia	$ 0.11	$ 1.51	$ 3.80	$ 2.65
Vermont	$ 0.16	$ 1.80	$ 3.80	$ 2.65
Washington	$ 0.08	$ 1.30	$ 3.80	$ 2.65
Wisconsin	$ 0.13	$ 1.04	$ 3.80	$ 2.65

* 2011 Average price per kWh, EIA website: *http://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf*.

** Average Price per therm from January 2011 through June 2012, EIA website: *http://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PRS_DMcf_m.htm* .

***Average US prices per gallon from the end of 2010 through Q2 of 2012 from the EIA website.

D. Weather Data

Table D-1: Degree Days and Full Load Hours

GRANTEE	STATE	DEGREE DAYS		CDH (F)	RESIDENTIAL FULL LOAD HOURS		N-FACTOR
		HDD (F)	CDD (F)		Heating	Cooling	
Hartselle	AL	3445	1609	12961	1606	1464	22.1
Decatur	AL	3445	1609	12961	1606	1464	22.1
Birmingham	AL	2713	1819	14693	1562	1557	22.1
Phoenix	AZ	4822	1009		1116	2141	19.4
Los Angeles County	CA	1198	435	420	1070	1530	22.1
Boulder County	CO	5664	984	9668	2255	628	16.7
Eagle County	CO	7905	167	—	—	—	—
Connecticut	CT	5792	795	5820	2358	942	16.7
St Lucie County	FL	684	3074	—	504	3288	19.4
Jacksonville	FL	1324	2345	19841	1020	2086	19.4
Atlanta	GA	2826	1722	14577	1686	1484	19.4
Chicago	IL	6206	943	—	2459	683	16.7
Indianapolis	IN	5709	1146	—	2152	948	16.7
Lowell	MA	5808	660	1753	2734	453	16.7
Maine	ME	7390	396	—	2728	321	16.7
Detroit	MI	6105	999	4690	2670	642	16.7
Grand Rapids	MI	6828	580	3979	2771	595	16.7
Marquette	MI	7920	354	2421	3130	222	16.7
Kansas City	MO	4210	2046	11533	2149	1032	16.7
Missouri	MO	5176	1287	—	2048	1050	16.7
Greensboro	NC	3780	1427	9968	1978	1203	19.4
New Hampshire	NH	8503	172	4383	2641	385	16.7
Las Vegas	NV	2329	3316	43976	1642	1773	19.4
Reno	NV	5538	769	11111	2631	317	19.4

Continued

Grantee	State	Degree Days		CDH (F)	Residential Full Load Hours		N-Factor
		HDD (F)	CDD (F)		Heating	Cooling	
Bedford	NY	5272	599	—	2337	1089	16.7
Albany	NY	6516	595	3774	2598	515	16.7
Buffalo	NY	6579	479	2449	2765	571	16.7
Rochester	NY	6462	614	4082	2685	554	16.7
Syracuse	NY	6529	542	3652	2586	552	16.7
New York City	NY	4874	1077	6484	2337	1089	16.7
Binghamton	NY	6992	386	2410	2754	440	16.7
Massena	NY	7828	400	2789	—	—	16.7
Cincinnati	OH	4815	1072	—	2134	996	19.4
Toledo	OH	6307	705	—	2464	649	16.7
Portland	OR	4158	370	3080	2681	379	19.4
Fayette County	PA	5668	554	5102	2380	737	16.7
Philadelphia	PA	4710	1260	—	2328	1032	16.7
Nashville	TN	3665	1738	—	1768	1375	19.4
Austin	TX	1699	2946	—	1142	2412	16.7
San Antonio	TX	1479	3051	—	1101	2237	16.7
Virginia	VA	3849	1448	12954	1980	1188	19.4
Charlottesville	VA	3849	1448	12954	1980	1188	19.4
Rutland	VT	7336	570	3550	2651	455	16.7
Bainbridge Island	WA	4257	214	985	2956	282	19.4
Seattle	WA	4257	214	985	2956	282	16.7
Wisconsin	WI	6999	523	—	2547	487	16.7
Madison	WI	7608	639	—	2547	487	16.7
Milwaukee	WI	7281	553	—	2548	513	16.7

*Calculated from TMY data from nearest weather station to grantee site

E. Common Measure Savings Sources and Equations

E.1. List of Sources

Table E-1: Formula Sources

MEASURE	PRIMARY REFERENCE	SECONDARY REFERENCE (IF NEEDED)
Lighting	UMP	PA TRM for commercial HOU and CF
Lighting Controls	UMP	PA TRM for commercial HOU and CF
Boiler Replacement	UMP	Regional reference documents and TMY3 calculations for EFLH
Furnace Replacement	UMP	Regional reference documents and TMY3 calculations for EFLH
Air Conditioner Replacement	UMP	Regional reference documents and TMY3 calculations for EFLH
Air Sealing	Regional reference document	Ohio TRM
Duct Sealing	Regional reference document	Ohio TRM
Insulation	Regional reference document	Ohio TRM
Photovoltaics	PV Watts v.1	—
Water Heater Replacement	Regional reference document	Illinois TRM
Direct Install	Illinois TRM	—
Duct Sealing	Mid-Atlantic TRM, Option 2	—
Windows	Regional reference document	Best fit to other regional references matched by HDD/CDD
Refrigeration	Wisconsin Deemed Savings Manual	—
Chiller	Ohio TRM	—

E.2. Lighting-Residential

$$kWh_{saved} = NUMMEAS * \left(\frac{\Delta W}{1000}\right) * HRS * IRS * INTEF$$

〉 Where:

NUMMEAS	=	Number of measures sold or distributed through the program
ΔW:	=	Baseline wattage minus efficient lighting product wattage
HRS:	=	Annual operating hours
ISR:	=	In-service rate
INTEF:	=	Cooling and heating interactive effects

E.3. Lighting-Commercial

$$kWh_{savings} = \sum_u \left(\frac{W_{base} * qty_{base}}{1000} * HOU_{base}\right)_u - \sum_u \left(\frac{W_{ee} * qty_{ee}}{1000} * HOU_{ee}\right)_u$$

〉 Where:

W	=	Fixture wattage
Qty	=	Fixture quantity
U	=	Usage group, a collection of fixtures sharing the same operating hours. (ex: hallway, office, warehouse, etc)
HOU	=	Annual hours of use
ee	=	Energy-efficient equipment
Base	=	Baseline equipment

E.4. Furnace/Boiler Replacement – Residential

$$Savings_{b-e} = Capicity_{input-e} * EFLH_{e-installed} * \left(\frac{AFUE_e}{AFUE_{base}} - 1\right)$$

〉 Where:

$Capacity_{input-e}$	=	Heating input capacity of both the baseline and installed Unit
$EFLH_{e-installed}$	=	Full Load Equivalent Hours of the installed high-efficiency Unit

E.5. AC, Central – Residential and Small Commercial

For units with a capacity of more than 5.4 tons:

$$kWh_{saved} = S * \left(\frac{1}{EER_b} - \frac{1}{EER_i}\right) * EFLH$$

For units having a capacity fewer than 5.4 tons:

$$kWh_{saved} = S * \left(\frac{1}{SEER_b} - \frac{1}{SEER_i}\right) * EFLH$$

〉 Where:

S	=	Cooling capacity of Unit (kBTU/hr)
EER_b	=	Energy-Efficiency ratio of the baseline unit, as defined by local code
EER_i	=	Energy-Efficiency ratio of the specific high-efficiency unit
$SEER_b$	=	Seasonal energy-efficiency ratio of the baseline unit, as defined by local code
$SEER_i$	=	Seasonal Energy-Efficiency ratio of the specific high-efficiency unit
EFLH	=	Equivalent full-load hours for cooling

E.6. Air Sealing

Cooling Savings (central A/C):

$$kWh_{savings} = \left(\left(\frac{\Delta CFM}{NF}\right) * 60 * CDH * DUA * 0.018\right) / 1000 / SEER$$

$$Peak\ kW = \left(\frac{\Delta kWh}{cFLH}\right) * CF$$

Heating Savings:

Electric Heating

$$kWh_{savings} = (\left(\left(\frac{\Delta CFM}{NF}\right) * 60 * 24 * HDD * 0.018\right) / 1{,}000{,}000 / COP) * 293.1$$

Fossil Fuel Savings

$$MMBTu_{savings} = \left(\left(\frac{\Delta CFM}{NF}\right) * 60 * 24 * HDD * 0.018\right) / (AFUE * 1{,}000{,}000)$$

〉 Where:

ΔCFM	=	The initial and final tested leakage rates at 50 psi
SEER	=	Cooling Equipment Efficiency
COP	=	Electric Heating Equipment Efficiency
AFUE	=	Fossil Fuel Heating Equipment Efficiency
CDH	=	Cooling Degree Hours
HDD	=	Heating Degree-Days
cFLH	=	Cooling Full Load Hours
CF	=	Coincidence Factor

DUA	=	Discretionary Use Adjustment to account for the fact that people do not always operate their air conditioning system when the outside temperature is greater than 75°F
NF	=	N-Factor

E.7. Insulation

Cooling Savings:

$$kWh_{saving} = \left(\left(\frac{1}{R_{exist}} - \frac{1}{R_{new}}\right) * CDH * 0.75 * Area\right) / \ 1000 / \ SEER$$

$$Peak\ kW = \frac{\Delta kWh}{FLHcool} * 0.5$$

Space Heating Savings:

Fossil Fuel Savings

$$MMBTU_{saving} = \left(\left(\frac{1}{R_{exist}} - \frac{1}{R_{new}}\right) * HDD * 24 * Area\right) / 1{,}000{,}000 / \ AFUE$$

Electric Savings

$$kWh_{saving} = (\left(\left(\frac{1}{R_{exist}} - \frac{1}{R_{new}}\right) * HDD * 24 * Area\right) / 1{,}000{,}000 / \ COP) * 293.1$$

- Where:

R_{exist}	=	R-value of existing Insulation (should include total assembly)
R_{new}	=	R-value of new Insulation (should include the total assembly and any existing insulation)
HDD	=	Heating Degree Days
CDH	=	Cooling Degree Hours
Area	=	Total insulated area (square feet)
COP	=	Electric heating equipment efficiency value
SEER	=	Cooling equipment efficiency value
AFUE	=	Fossil Fuel equipment efficiency value
FLHcool	=	Cooling full load hours

F. Fuel Conversions

Table F-1: Fuel Conversions

ESTIMATED & EXPECTED ENERGY SAVINGS REPORTED ARE CONVERTED TO SOURCE MMBTU USING THE FOLLOWING CONVERSION FACTORS		
Electricity	1 kWh	0.0034 (kWh to MMBTU) x 3.365 (site to source)
Natural Gas	1 ccf	0.103 (ccf to MMBTU) x 1.092 (site to source)
Natural Gas	1 therm	0.100 (therms to MMBTU) x 1.092 (site to source)
Fuel Oil (Type 2)	1 gallon	0.139 (gallons to MMBTU) x 1.158 (site to source)
Propane/LPG	1 gallon	0.0917 (gallons to MMBTU) x 1.151 (site to source)
Kerosene	1 gallon	0.135 (gallons to MMBTU) x 1.205 (site to source)
Wood	1 cord	22.0 (cords to MMBTU) x 1 (site to source)

Source Energy and Emission Factors for Energy Use in Buildings *http://www.nrel.gov/docs/fy07osti/38617.pdf*

G. Detailed Billing Analysis Results

Table G-1: Descriptive Statistics – Austin, TX Gas Regression Model Results

MODEL SUMMARY	
Average Monthly Normalized Usage (Therms)	35.85
Average Post-Retrofit Billing Months	12.59
Average Pre-Retrofit Billing Months	17.14
Adjusted R-Squared Statistic	0.75
Average Monthly Savings	23.4%

Table G-2: Standard Gas Model Regression Results – Austin, TX

VARIABLE	COEFFICIENT (β)	STANDARD ERROR	B/STANDARD ERROR	PROBABILITY [|Z|>z]	95% CONFIDENCE INTERVAL
(β_1) Post	-8.37301	0.35235	-23.76	0	(-9.06359, -7.68242)
(β_2) HDD	0.14167	0.00231	61.35	0	(0.13714, 0.14620)
(β_3) CDD	0.0257	0.00284	9.05	0	(0.02013, 0.03126)
(β_4) January	2.36916	0.75351	3.14	0.0017	(0.89232, 3.84601)
(β_5) February	15.626	0.78685	19.86	0	(14.0837, 17.1682)
(β_6) March	10.2721	0.68626	14.97	0	(8.9271, 11.6172)
(β_7) April	9.39592	0.86946	10.81	0	(7.69181, 11.10003)
(β_8) May	7.8569	1.09005	7.21	0	(5.72044, 9.99337)
(β_9) June	4.66986	1.46624	3.18	0.0014	(1.79609, 7.54363)
(β_{10}) July	1.04001	1.72693	0.6	0.547	(-2.34470, 4.42473)
(β_{11}) August	-2.46936	1.91021	-1.29	0.1961	(-6.21330, 1.27459)
(β_{12}) September	-1.48019	1.71056	-0.87	0.3869	(-4.83283, 1.87244)
(β_{13}) October	4.31644	1.11945	3.86	0.0001	(2.12236, 6.51053)
(β_{14}) November	1.45945	0.81567	1.79	0.0736	(-0.13923, 3.05814)

Source: Analysis by Evergreen Economics of data provided by Better Buildings

Table G-3: Descriptive Statistics – Austin, TX Electricity Regression Model Results

Model Summary	
Average Monthly Normalized Usage (sWh)	1,107.85
Average Post-Retrofit Billing Months	13.21
Average Pre-Retrofit Billing Months	17.62
Adjusted R-Squared Statistic	0.82
Average Monthly Electricity Savings	14.8%

Table G-4: Standard Electricity Model Regression Results – Austin, TX

Variable	Coefficient (β)	Standard Error	B/Standard Error	Probability [|Z|>z]	95% Confidence Interval
(β_1) Post	-164.034	7.12906	-23.01	0	(-178.007, -150.061)
(β_2) HDD	0.33537	0.04111	8.16	0	(0.25479, 0.41595)
(β_3) CDD	1.20067	0.04537	26.47	0	(1.11175, 1.28958)
(β_4) January	80.1189	14.71599	5.44	0	(51.2761, 108.9618)
(β_5) February	62.464	13.41075	4.66	0	(36.1794, 88.7486)
(β_6) March	-31.8509	13.55657	-2.35	0.0188	(-58.4213, -5.2805)
(β_7) April	-82.4718	16.23451	-5.08	0	(-114.2909, -50.6527)
(β_8) May	-43.2783	19.70003	-2.2	0.028	(-81.8896, -4.6669)
(β_9) June	132.61	26.44854	5.01	0	(80.772, 184.449)
(β_{10}) July	241.924	30.2427	8	0	(182.649, 301.199)
(β_{11}) August	349.285	33.13764	10.54	0	(284.336, 414.234)
(β_{12}) September	222.457	31.06599	7.16	0	(161.569, 283.345)
(β_{13}) October	-25.9911	22.19146	-1.17	0.2415	(-69.4855, 17.5034)
(β_{14}) November	-91.0634	15.77684	-5.77	0	(-121.9854, -60.1414)

Source: Analysis by Evergreen Economics of data provided by Better Buildings

Table G-5: Descriptive Statistics – Boulder County, CO Gas Regression Model Results

MODEL SUMMARY	
Average Monthly Normalized Usage (Therms)	63.74
Average Post-Retrofit Billing Months	11.45
Average Pre-Retrofit Billing Months	21.24
Adjusted R-Squared Statistic	0.80
Average Monthly Savings	8.0%

Table G-6: Standard Gas Model Regression Results – Boulder County, CO

VARIABLE	COEFFICIENT (β)	STANDARD ERROR	B/STANDARD ERROR	PROBABILITY [|Z|>z]	95% CONFIDENCE INTERVAL
(β_1) Post	-5.12755077	0.45148285	-11.357	0	(-6.01244, -4.24266)
(β_2) HDD	0.12335837	0.00228155	54.068	0	(0.11889, 0.12783)
(β_3) CDD	0.0596533	0.00679608	8.778	0	(0.04633, 0.07297)
(β_4) January	-3.50837273	1.05951923	-3.311	0.0009	(-5.58499, -1.43175)
(β_5) February	11.4436662	0.96528849	11.855	0	(9.5517,13.3356)
(β_6) March	4.35678636	0.98579391	4.42	0	(2.42467, 6.28891)
(β_7) April	-7.75640259	1.34992857	-5.746	0	(-10.40221, -5.11059)
(β_8) May	-13.4935816	1.48570182	-9.082	0	(-16.4055, -10.5817)
(β_9) June	-11.1798239	1.77799634	-6.288	0	(-14.6646, -7.695)
(β_{10}) July	-11.2539455	2.31757801	-4.856	0	(-15.7963, -6.7116)
(β_{11}) August	-9.9979172	2.38856643	-4.186	0	(-14.67942, -5.31641)
(β_{12}) September	-12.8915475	2.19016932	-5.886	0	(-17.1842, -8.5989)
(β_{13}) October	-12.4883938	1.86671997	-6.69	0	(-16.1471, -8.8297)
(β_{14}) November	-2.41595201	1.32799332	-1.819	0.0689	(-5.01877, 0.18687)

Source: Analysis by Evergreen Economics of data provided by Better Buildings

Table G-7: Descriptive Statistics – Boulder County, CO Electricity Regression Model Results

Model Summary	
Average Monthly Normalized Usage (kWh)	1,208.41
Average Post-Retrofit Billing Months	11.26
Average Pre-Retrofit Billing Months	22.37
Adjusted R-Squared Statistic	0.93
Average Monthly Electricity Savings	7.4%

Table G-8: Standard Electricity Model Regression Results – Boulder County, CO

Variable	Coefficient (β)	Standard Error	B/Standard Error	Probability [|Z|>z]	95% Confidence Interval
(β_1) Post	-88.8440495	7.52684727	-11.804	0	(-103.5964, -74.0917)
(β_2) HDD	0.2244823	0.04138783	5.424	0	(0.14336, 0.30560)
(β_3) CDD	1.26383335	0.11456704	11.031	0	(1.03929, 1.48838)
(β_4) January	8.64893263	20.8663184	0.414	0.6785	(-32.24830, 49.54617)
(β_5) February	35.8132349	18.4145277	1.945	0.0518	(-0.2786, 71.9050)
(β_6) March	-27.3959059	18.027562	-1.52	0.1286	(-62.7293, 7.9375)
(β_7) April	-45.8497032	23.8265755	-1.924	0.0543	(-92.5489, 0.8495)
(β_8) May	-98.1805109	26.1242139	-3.758	0.0002	(-149.383, -46.978)
(β_9) June	-89.639306	30.4988542	-2.939	0.0033	(-149.416, -29.8627)
(β_{10}) July	-44.4879752	40.0328364	-1.111	0.2664	(-122.9509, 33.9749)
(β_{11}) August	-34.388747	40.7657422	-0.844	0.3989	(-114.2881, 45.5106)
(β_{12}) September	-116.05774	38.0752401	-3.048	0.0023	(-190.684, -41.432)
(β_{13}) October	-118.353072	32.9387137	-3.593	0.0003	(-182.912, -53.794)
(β_{14}) November	-45.2407567	24.1237686	-1.875	0.0607	(-92.5225, 2.0410)

Source: Analysis by Evergreen Economics of data provided by Better Buildings

Table G-9: Descriptive Statistics – Philadelphia, PA Gas Regression Model Results

MODEL SUMMARY	
Average Monthly Normalized Usage (Therms)	64.73
Average Post-Retrofit Billing Months	8.28
Average Pre-Retrofit Billing Months	24.44
Adjusted R-Squared Statistic	0.71
Average Monthly Savings	6.3%

Table G-10: Standard Gas Model Regression Results – Philadelphia, PA

VARIABLE	COEFFICIENT (β)	STANDARD ERROR	B/STANDARD ERROR	PROBABILITY [|Z|>z]	95% CONFIDENCE INTERVAL
(β_1) Post	-4.08525	3.09197	-1.32	0.1864	(-10.14540, 1.97489)
(β_2) HDD	0.07641	0.01299	5.88	0	(0.05096, 0.10187)
(β_3) CDD	0.00015	0.02629	0.01	0.9955	(-0.05138, 0.05167)
(β_4) January	14.6903	7.47334	1.97	0.0493	(0.0428, 29.3378)
(β_5) February	14.3168	7.01471	2.04	0.0413	(0.5682, 28.0654)
(β_6) March	0.88251	5.76334	0.15	0.8783	(-10.41343, 12.17844)
(β_7) April	-31.4209	6.61069	-4.75	0	(-44.3776, -18.4641)
(β_8) May	-44.4157	7.92432	-5.6	0	(-59.9471, -28.8843)
(β_9) June	-50.3707	10.06862	-5	0	(-70.1048, -30.6365)
(β_{10}) July	-51.4403	12.00669	-4.28	0	(-74.973, -27.9077)
(β_{11}) August	-51.6085	12.7156	-4.06	0	(-76.5306, -26.6864)
(β_{12}) September	-53.5343	10.57065	-5.06	0	(-74.2524, -32.8162)
(β_{13}) October	-51.6117	8.67639	-5.95	0	(-68.6171, -34.6062)
(β_{14}) November	-30.5101	6.7312	-4.53	0	(-43.703, -17.3172)

Source: Analysis by Evergreen Economics of data provided by Better Buildings

Table G-11: Descriptive Statistics – Philadelphia, PA Electricity Regression Model Results

Model Summary	
Average Monthly Normalized Usage (kWh)	858.89
Average Post-Retrofit Billing Months	8.25
Average Pre-Retrofit Billing Months	30.72
Adjusted R-Squared Statistic	0.63
Average Monthly Savings	10.9%

Table G-12: Standard Electricity Model Regression Results – Philadelphia, PA

Variable	Coefficient (β)	Standard Error	B/Standard Error	Probability [|Z|>z]	95% Confidence Interval
(β_1) Post	-93.5395	25.53669	-3.66	0.0002	(-143.5904, -43.4885)
(β_2) HDD	0.47177	0.10763	4.38	0	(0.26081, 0.68273)
(β_3) CDD	1.39422	0.2015	6.92	0	(0.99928, 1.78916)
(β_4) January	32.2473	58.78366	0.55	0.5833	(-82.9666, 147.4611)
(β_5) February	-1.00313	46.30979	-0.02	0.9827	(-91.76865, 89.76239)
(β_6) March	0.00476	41.84515	0	0.9999	(-82.01024, 82.01975)
(β_7) April	-43.9142	58.26315	-0.75	0.451	(-158.1079, 70.2795)
(β_8) May	-74.037	71.57679	-1.03	0.301	(-214.3250, 66.2509)
(β_9) June	-6.13952	89.93592	-0.07	0.9456	(-182.41069, 170.13165)
(β_{10}) July	45.5425	103.7246	0.44	0.6606	(-157.7540, 248.8391)
(β_{11}) August	126.694	103.8598	1.22	0.2225	(-76.867, 330.256)
(β_{12}) September	75.1124	89.1816	0.84	0.3997	(-99.6803, 249.9052)
(β_{13}) October	-24.6096	69.81691	-0.35	0.7245	(-161.4482, 112.2290)
(β_{14}) November	-15.412	52.90028	-0.29	0.7708	(-119.0947, 88.2706)

Source: Analysis by Evergreen Economics of data provided by Better Buildings

Table G-13: Descriptive Statistics – St. Lucie County, FL Electricity Regression Model Results

Model Summary	
Average Monthly Normalized Usage (kWh)	1,701.66
Average Post-Retrofit Billing Months	10.60
Average Pre-Retrofit Billing Months	13.80
Adjusted R-Squared Statistic	0.79
Average Monthly Savings	18.6%

Table G-14: Standard Electricity Model Regression Results – St. Lucie County, FL

Variable	Coefficient (β)	Standard Error	B/Standard Error	Probability [|Z|>z]	95% Confidence Interval
(β_1) Post	-316.585	48.8998	-6.47	0	(-412.427, -220.743)
(β_2) HDD	0.45939	0.5569	0.82	0.4102	(-0.63213, 1.55090)
(β_3) CDD	1.569	0.65477	2.4	0.0172	(0.28567, 2.85233)
(β_4) January	113.452	116.8566	0.97	0.3325	(-115.583, 342.487)
(β_5) February	-81.1444	98.40807	-0.82	0.4103	(-274.0206, 111.7319)
(β_6) March	-163.97	108.3196	-1.51	0.1312	(-376.272, 48.333)
(β_7) April	-224.149	99.53531	-2.25	0.0251	(-419.234, -29.063)
(β_8) May	-98.237	127.9941	-0.77	0.4434	(-349.1008, 152.6267)
(β_9) June	105.656	163.5923	0.65	0.5189	(-214.979, 426.291)
(β_{10}) July	210.374	205.7643	1.02	0.3075	(-192.916, 613.665)
(β_{11}) August	320.098	224.6898	1.42	0.1554	(-120.286, 760.482)
(β_{12}) September	175.125	209.9411	0.83	0.4049	(-236.352, 586.602)
(β_{13}) October	117.228	138.6563	0.85	0.3986	(-154.533, 388.990)
(β_{14}) November	-103.426	98.31764	-1.05	0.2938	(-296.125, 89.273)

Source: Analysis by Evergreen Economics of data provided by Better Buildings