Colorado Governor's Energy Office Final ARRA Evaluation Report

Submitted to The GEO

By Nexant

In partnership with Group 14 and Research Into Action

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1 EXECUTIVE SUMMARY

On Feb. 13, 2009, Congress passed the American Recovery and Reinvestment Act (ARRA) of 2009 with the goal of spurring economic growth and creating or saving jobs. This Act appropriated money to the Department of Energy (DOE) to utilize the funding to encourage the implementation of energy efficiency and renewable energy projects. The Colorado Governor's Energy Office (GEO) was a state agenciy responsible for utilizing and distributing ARRA funds in Colorado. Nexant, Inc. and its subcontractors, Research Into Action and Group 14 Engineering (evaluation team) were retained by the GEO to conduct a program Measurement and Verification impact evaluation (Project) of the ARRA funds. This report documents the results of this Project.

The main purpose of this Project was to evaluate the gross and net impact energy savings associated with three ARRA funding streams: the State Energy Programs grant (SEP), the State Energy Efficient Appliance Rebate Program (SEEARP), and the Energy Efficiency and Conservation Block Grant (EECBG). The GEO used these funding streams in addition to state and program partner funding[1] (hereafter referred to as non-ARRA funding) to deliver programs to the residential, commercial, industrial, and government sectors. These programs included:

- Rebates and grants for energy efficiency improvements
- Rebates and grants for renewable energy sources
- Technical assistance
- Workshops, trainings, studies, and outreach

This project report only includes participation and results for energy-efficiency projects that had been completed by February 1, 2012 or there the evaluation team there was certainty in the results commencing in the calendar year of 2012. Consequently, the project was unable to provide results for all ARRA funding due to these incomplete and/or uncertain projects. Additionally, funds spent for non-direct energy-efficiency saving activities, such as administration, education and education were not included in this evaluation.

1.1 SUMMARY OF PROGRAMS

The GEO applied the ARRA funds to three funding streams based on DOE requirements: the State Energy Programs grant (SEP), the State Energy Efficient Appliance Rebate Program (SEEARP), and the Energy Efficiency and Conservation Block Grant (EECBG). All three funding streams have specific allocation and reporting requirements, but the main goal of each was to encourage the installation of energy efficiency and renewable energy projects while maintaining or adding jobs to the economy.

[1] Additional funding sources were provided by the Colorado Clean Energy Fund and program partners typically represented by local utilities.

The GEO utilized these funding streams to complement existing utility and government programs by offering rebates or advisory services that encouraged Colorado residents and businesses to participate in the existing programs. The GEO also created programs and services that filled market gaps that were underserved by the serving utility or local government infrastructure.

1.1.1 State Energy Programs

The State Energy Program (SEP) is a competitive and formulaic award from the DOE that provided funding for state energy related programs. The GEO allocated this funding to 11 market titles, six of which were included in the evaluation and provided services that included:

- Financial incentives such as:
  - Loans
  - Loan Guarantees
  - Rebates
  - Grants
- Technical assistance

The Market Titles evaluated as part of this project included the following:

- **Capital Investments**: Capital Investments included both grant and financing programs that provided a source of capital, leveraged further investment dollars, and encouraged the deployment of renewable energy and energy efficiency projects.
- **Renewable Energy:** Renewable Energy is composed of three market titles; Education and Outreach, Program Consulting, and Rebates and Grants. These market titles sought to address barriers to broad scale distributed renewable energy generation, decrease the usage of fossil fuels in our electrical, thermal and transportation fuel portfolios and to spur job creation and innovation in the state.
- **Residential Buildings:** The Residential Buildings market title provided education and outreach through workshops and trainings, technical assistance, and financial incentives for Colorado residents in both existing and new homes.
- **Commercial Buildings Existing:** The Commercial Buildings Existing market title provided services to improve the energy efficiency of existing commercial buildings. These services ranged from technical assistance for energy performance contracting to grants for communities to run energy efficiency programs.
- **Commercial High Performance Buildings:** The Commercial High Performance Building Program provided technical assistance to public agency new construction and major renovation projects, workshops and trainings and grants to Colorado communities and agencies to encourage the development of high performance buildings.

- **Greening Government:** This market title sought to meet Greening Government Executive Order goals through a number of services including energy tracking software, grants, refrigerator decommissioning, and computer energy saving software.

1.1.2 Energy Efficiency and Conservation Block Grants

The Energy Efficiency and Conservation Block Grant (EECBG) funding stream worked with cities, counties, and states to develop, promote and implement energy efficiency and conservation projects. The GEO is the administrator for the EECBG funding for Colorado and funds a variety of energy efficiency projects and programs. The GEO split the EECBG funding into seven activities. The evaluation included four of these seven activities.

- **Activity 1: Residential and Commercial Buildings and Audits:** provided funding for the Main Street Efficiency Initiative through subgrants to entitled and non-entitled communities.
- **Activity 2: Subgrants for Energy Efficiency Retrofits:** provided funding for grants and rebates for energy efficiency projects, renewable energy projects, education and outreach, and energy auditor equipment.
- **Activity 5: LED Street Lighting Grants:** provided grants to three Colorado communities for LED street lights.
- **Activity 6: Onsite Renewable Energy Technology:** provided grants for renewable energy projects on public buildings. $1/watt was provided for solar PV to a number of Colorado communities.

1.1.3 State Energy Efficiency Appliance Rebate Program

Under the State Energy Efficiency Appliance Rebate Program (SEEARP), ARRA funding was used to establish a residential ENERGY STAR appliance rebate program. The evaluation team evaluated issued rebates for ENERGY STAR appliances including:

- Clothes Washers
- Dish Washers
- Refrigerators
- Water Heaters (tankless and gas condensing)
- Boilers (gas condensing)
- Furnaces (gas condensing)

1.1.4 Program Participation Summary

The GEO's programs and services encouraged participation from residents, businesses, and public institutions throughout Colorado. Table 1-1 details the participation in the various GEO offerings evaluated as part of this Project in each funding stream as provided by the GEO. As a portion of funding was derived from non-ARRA sources, a portion of the total participation, and consequently total savings, are allocated to sources other than the SEP, EECBG, and SEEARP funding streams.

Table 1-1 Evaluated Program Participation

Funding Stream	Rebates	Grants	Financing	Technical Assistance	Total
State Energy Program	4,645	49	8	565	5,267
Energy Efficiency & Conservation Block Grant(1)	6,143	12	-		6,155
State Energy Efficient Appliance Rebate Program	31,792	-	-	-	31,792
Sub-total ARRA Funding	***42,580***	***61***	***8***	***565***	***43,214***
Non-ARRA Funding	6,185	-	-	-	6,185
Total	**48,765**	**61**	**8**	**565**	**49,399**

1.2 GENERAL METHODOLOGY

The Project followed guidelines established for ARRA funds impact evaluations in the Department of Energy (DOE) SEP[1] and EECGB[2] Program Notices. The evaluation team utilized best practices outlined in DOE specified resources such as the *California Evaluation Protocols* and the *International Performance Measurement and Verification Protocol.* The Project also sought to integrate and develop consistency of activities with the National Evaluation of ARRA funds, including the National ARRA Evaluation for SEP and EECGB funding.

Fundamentally, impact evaluations seek to quantify the net savings that have been realized by the programs under review by determining the gross savings realized by projects enrolled in the programs and the net-to-gross (NTG) ratios. Due to the variety of programs provided within each funding stream, the evaluation team utilized many tactics to evaluate each funding stream.

For the GEO impact evaluation, both ex-ante analysis (expected savings based on baseline conditions) and ex-post analysis (actual savings based on post retrofit conditions) were conducted. Ex-ante analyses were only conducted for large impact projects that were not being completed within the time frame of this evaluation project. The majority of projects received an ex-post analysis. The following activities summarize the major tasks within the project:

1.2.1 Program Data Collection and Analysis

Data for the Project was provided by the GEO including program participation, budgets, and estimated energy savings. Nexant reviewed these data and interacted with the GEO staff to ensure the accuracy of the data and that data were applied correctly in the evaluation activities. Nexant did

[1] DOE; "DOE Recovery Act Reporting Requirements for the State Energy Program (SEP)", attachment 3; SEP Program Notice 10-06; effective date March 1, 2010.
[2] DOE; "Guidance for Energy Efficiency and Conservation Block Grant Recipients on Program Evaluation Guidelines." EECGB Program Notice 10-017, effective date July 21, 2010.

identify some inconsistencies from various tracking databases and worked with the GEO staff to reconcile these issues. This process ultimately resulted in adjustments to the initially reported budget, participation, and savings values provided by the GEO. These adjusted values were utilized for evaluation purposes.

1.2.2 Gross Savings Estimation

The major activity in the impact evaluation was to determine the energy savings that were achieved by the ARRA funded program participants. These gross verified savings were determined through a combination of engineering analysis and site inspections of installed measures. Because it was not cost-effective to complete analysis and site inspection of a census of the participants, savings were verified for a representative sample. The program-reported savings for the sample were adjusted to reflect the review findings. This adjustment was captured in a realization rate, which is the ratio of evaluation review savings to program-reported savings for the sample.

1.2.3 Net Savings

The net energy savings were calculated by applying a net-to-gross (NTG) ratio to the gross verified savings. Net savings are a reflection of the degree to which the gross savings are a result of the program efforts and funds. The NTG ratio was developed by asking participants behavioral questions and determining the program's influence on their decision to install the efficient equipment, as measured by the freeridership rates. Freeridership reflects the percentage of savings that would have occurred without the GEO program. In order to estimate net energy savings, the evaluation team employed telephone and on-site surveys to quantify the actual impact of the GEO programs.

1.3 SUMMARY OF FINDINGS

Net source energy savings associated with the GEO programs are presented here in accordance with DOE SEP evaluation requirements. Source energy savings represents the sum of the savings at the facility 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. Both source and site energy savings are presented in the remaining sections of this report.

The overall net source energy savings for the three funding streams are presented in Table 1-2.

Table 1-2 Overall Net Source Energy Savings

Funding Stream	Net Electricity Savings (kWh)		Net Gas Savings (MMBtus)		Total Net Energy Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
State Energy Program	111,349,243	1,641,356,387	233,645	3,916,441	613,569	9,516,749
Energy Efficiency & Conservation Block Grant	12,134,578	205,797,735	42,221	786,864	83,624	1,489,045
State Energy Efficient Appliance Rebate Program	7,288,450	81,123,312	37,910	744,688	62,778	1,021,481
Total	**130,772,271**	**1,928,277,434**	**313,776**	**5,447,993**	**759,971**	**12,027,276**

This Project also calculated additional metrics associated with the energy savings which include demand savings, greenhouse gas emissions savings and water savings. These metrics associated with the net source energy savings are presented in Table 1-3.

Table 1-3 Overall Net Source Demand, CO2e, and Water Savings

Funding Stream	Net Demand Savings (kW)		Net C02e Savings (tonne)		Net Water Savings (gallons)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
State Energy Program	14,990	14,990	46,383	708,963	40,270,974	593,618,947
Energy Efficiency & Conservation Block Grant	690	690	5,950	104,703	4,388,636	74,429,560
State Energy Efficient Appliance Rebate Program	248	248	4,245	64,498	2,635,967	29,339,353
Total	**15,927**	**15,927**	**56,578**	**878,163**	**47,295,577**	**697,387,860**

Figure 1-1-1 through Figure 1-1-4 illustrate the various reporting metrics for both gross verified savings and net savings for each funding stream.

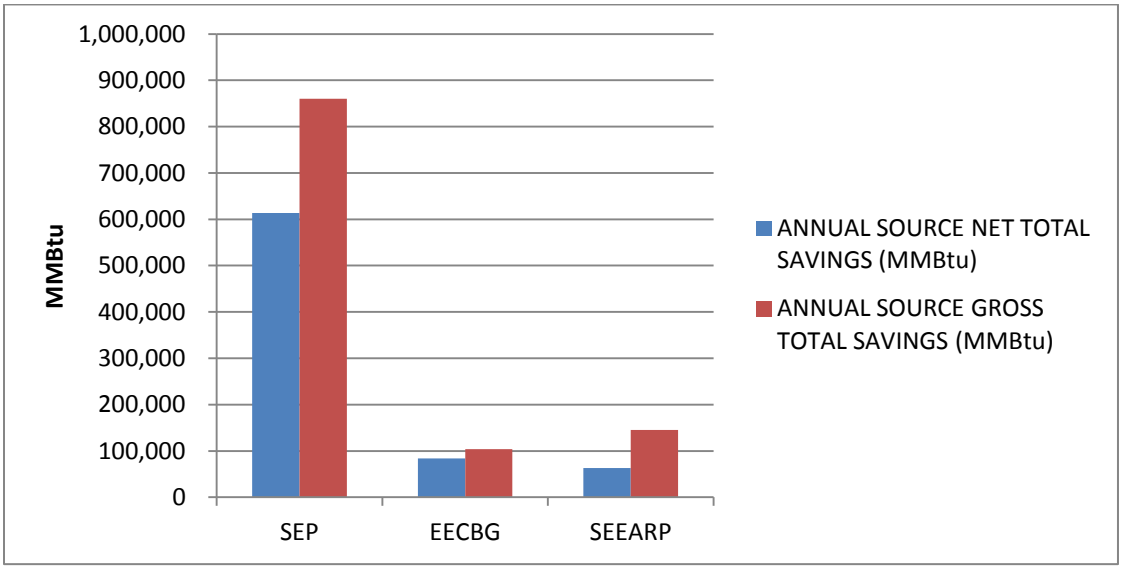


Figure 1-1-1 Comparative Source Savings by Funding Stream

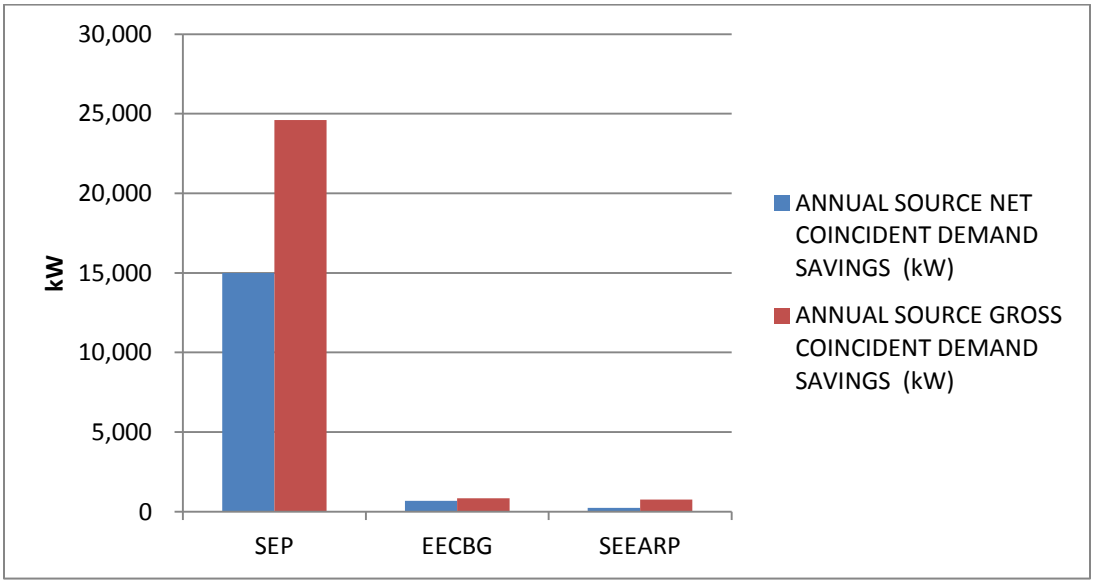


Figure 1-1-2 Comparative Demand Savings by Funding Stream

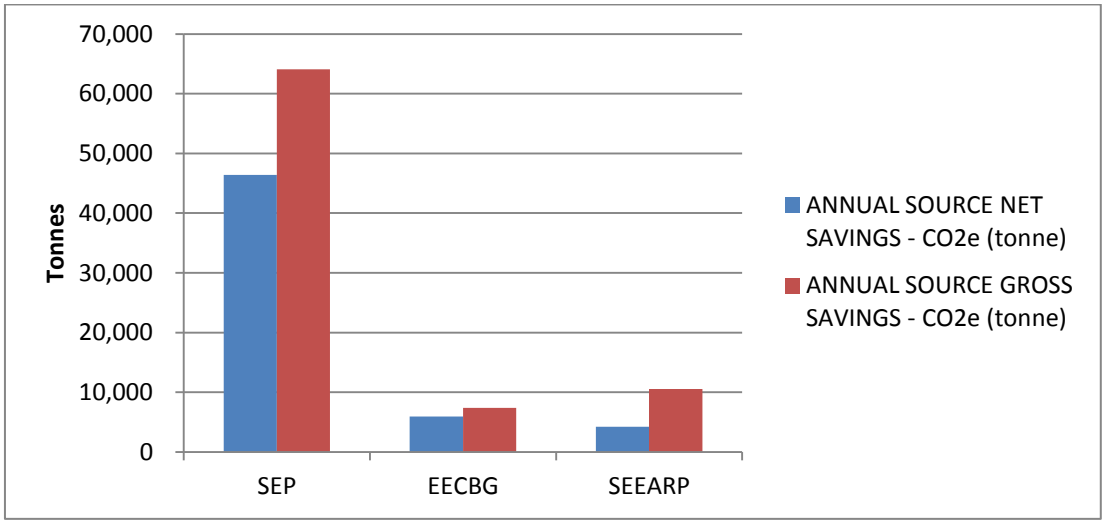


Figure 1-1-3 Comparative CO_2e Savings by Funding Stream

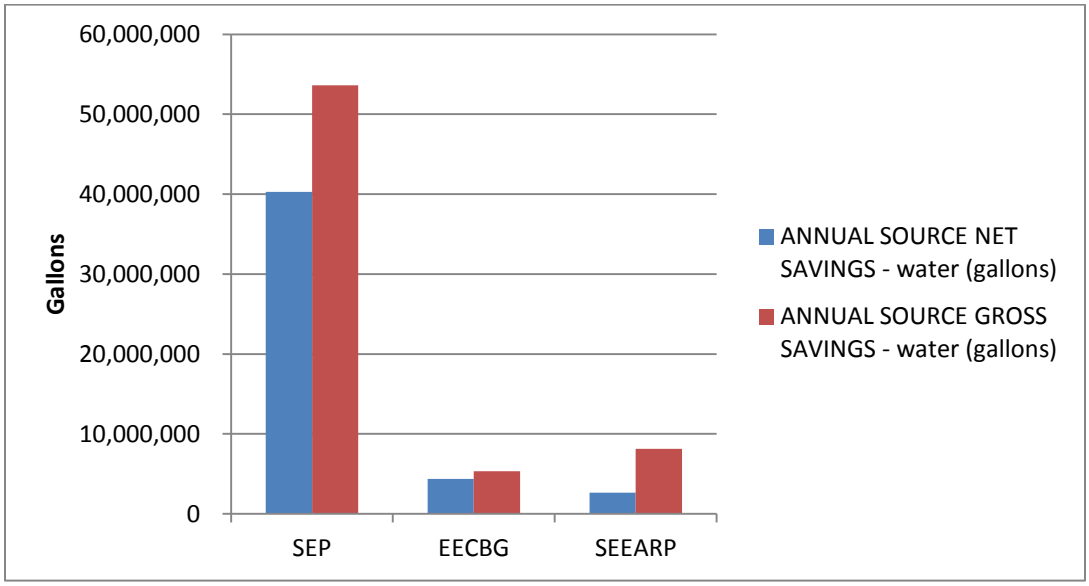


Figure 1-1-4 Comparative Water Savings by Funding Stream

1.3.1 Cost Effectiveness

The evaluation team completed a cost effectiveness test, the SEP Recovery Act Cost Test (SEP-RAC) in accordance with the SEP Program Notice, which requires: "The SEP-RAC test states that the net energy impacts achieved should be no less than 10 million BTUs of source energy per year for every $1,000 invested of SEP Recovery Act funds. Net energy impact benefits at the project site will be converted into source impact benefits." Cost effectiveness tests based on the current findings are provided for each funding stream in Table 1-4.

The tests show that all three funding streams meet the cost effectiveness test requirements. The target is to achieve a score of .01 or higher.

Table 1-4 Cost Effectiveness

Funding Stream	Expenditures of Evaluated Programs (2-1-12)	Net Energy Savings – Source (MMBtus)	DOE Cost Effectiveness Test[1]	$/MMBtu[2]
State Energy Program	$24,715,353	613,569	0.025	$40
Energy Efficiency & Conservation Block Grant	$7,143,885	83,624	0.012	$85
State Energy Efficient Appliance Rebate Program	$4,706,489	62,778	0.013	$75
Total	**$36,565,727**	**759,971**	**0.021**	**$48.11**

[1] Hurdle is .01

[2] Target is ≤ $100/MMBtu

The evaluation team calculated the cost effectiveness based on the programs that were evaluated as a component of this Project and which had verified energy savings attributed to them. Programs that were not evaluated such as the SEP Utilities Market Title, Transmission Market Title, or the Renewable Energy Program Consulting Market Title had their direct costs as well as their proportional share of the administrative costs removed from the cost effectiveness calculations. Additionally, the Revolving Loan Program, which is a program within the SEP Capital Investments Market Title, was evaluated as part of this project, but the evaluation team was only able to provide verifiable energy savings that resulted from this project for a very small percentage of overall program costs (~2%). Savings associated with the other projects within the Revolving Loan Program were not able to be verified at this time, and these programmatic costs were not included in the cost effectiveness calculations.

1.4 ACCOMPLISHMENTS

Based on this evaluation of these verified Colorado GEO ARRA funded energy-efficiency activities, the following accomplishments were realized:

- Annual energy bills were reduced by $16,215,000 and $164,825,000 will be saved across the measure life in present dollar value.
- The average program participant will save $329.04 per year.

- The rebate and grant programs leveraged at least $8 of participant and other program funds for every GEO ARRA dollar spent[1].

[1] Technical assistance programs are not included in this analysis. Due to lack of available data, the evaluation team believes the GEO rebate and grant leverage additional funds, but participant cost documentation for certain program is limited.

2 INTRODUCTION

Nexant, Inc. and its subcontractors, Research Into Action and Group 14 Engineering (evaluation team) were retained by the Colorado Governor's Energy Office (GEO) to conduct a program Measurement and Verification Project (Project) of American Recovery and Reinvestment Act (ARRA) funds. The main purpose of this Project was to evaluate the gross and net impact energy savings associated with three ARRA funding streams: the State Energy Programs grant (SEP), the State Energy Efficient Appliance Rebate Program (SEEARP), and the Energy Efficiency and Conservation Block Grant (EECBG). The GEO used these funding streams in addition to state and program partner funding to deliver programs to the residential, commercial, industrial, and government sectors. These programs included:

- Rebates and grants for energy efficiency improvements
- Rebates and grants for renewable energy sources
- Technical assistance
- Workshops, trainings, studies, and outreach

2.1 EVALUATION GOALS AND OBJECTIVES

The over-arching Project goal was to follow the definition of impact evaluation established in the "Model Energy Efficiency Program Impact Evaluation Guide – A Resource of the National Action Plan for Energy Efficiency," November 2007:

"Evaluation is the process of determining and documenting the results, benefits, and lessons learned from an energy efficiency program. Evaluation results can be used in planning future programs and determining the value and potential of a portfolio of energy efficiency programs in an integrated resource planning process. It can also be used in retrospectively determining the performance (and resulting payments, incentives, or penalties) of contractors and administrators responsible for implementing efficiency programs.

Evaluation has two key objectives:

1. To document and measure the effects of a program and determine whether it met its goals with respect to being a reliable energy resource.

2. To help understand why those effects occurred and identify ways to improve."

Additionally, the Project followed guidelines established for ARRA impact evaluations in the Department of Energy (DOE) SEP[1] and EECGB[2] Program Notices. The Project also sought to integrate and develop consistency of activities with the National Evaluation of ARRA funds.

The Project established a methodology and framework to allow the GEO to measure and report more accurate energy savings for future program years by implementing the following techniques:

- Consistent methodologies for project tracking
- Transparency in the Measurement and Verification (M&V) activities
- Standard worksheet templates for common efficiency measures
- Clear citation of external and secondary sources, both for stipulated parameters and guidelines
- Direction of industry standard databases and resources, such as the California Database of Energy Efficient Resources (DEER) and Northwest Power and Conservation Council (NPCC) Regional Technical Forum (RTF)

Finally, the Project gathered additional information on non-energy benefits of GEO programs, such as:

- Water Savings
- Participant Satisfaction
- Total Influenced Energy Benefits
- Quantity of People and/or Agencies Reached

The majority of the data was collected through participant surveys and interviews. Job benefits were initially calculated for only one program, the Renewable Energy Development Team, per request of the GEO. However, job benefits were also calculated for a subset of the Capital Investments program after it was determined that sufficient data would not be available to calculate energy savings of that program.

[1] DOE; "DOE Recovery Act Reporting Requirements for the State Energy Program (SEP)", attachment 3; SEP Program Notice 10-06; effective date March 1, 2010.
[2] DOE; "Guidance for Energy Efficiency and Conservation Block Grant Recipients on Program Evaluation Guidelines." EECGB Program Notice 10-017, effective date July 21, 2010.

2.2 REPORT ORGANIZATION

This report details the evaluation methodology and findings as well as information about the GEO offerings that were a part of the ARRA funding. The report is organized as follows:

- Section 2 provides an introduction to the Project and the GEO programs and services
- Section 3 provides an overview to the Project methodology
- Section 4 presents the high level findings at the funding stream level
- Sections 5 -7 provide findings and methodology for programs and services within each of these funding streams: SEP, EECBG, and SEEARP
- Section 8 provides general information about the ARRA funded programs and services offered by the GEO

2.3 THE GOVERNOR'S ENERGY OFFICE

The Governor's Energy Office (GEO) was created in 1977 with the purpose of promoting energy conservation in Colorado under the original name "Office of Energy Management and Conservation." It was renamed as the GEO in 2007 by former Governor Bill Ritter. The goal of the GEO is to advance energy efficiency and renewable clean energy resources, while also focusing on increasing business and job creation in Colorado.

2.3.1 GEO ARRA Background

On Feb. 13, 2009, Congress passed the American Recovery and Reinvestment Act (ARRA) of 2009 with the goal of spurring economic growth and creating or saving jobs. This Act appropriated money to the Department of Energy (DOE) to utilize the funding to encourage the implementation of energy efficiency and renewable energy projects. Much of the allocation to the DOE was distributed to state agencies to manage.

The GEO was one of Colorado's state agencies responsible for utilizing and distributing ARRA funds in Colorado. The GEO applied the funds to three funding streams based on DOE requirements: the State Energy Programs grant (SEP), Energy Efficiency and Conservation Block Grant (EECBG), and the State Energy Efficient Appliance Rebate Program (SEEARP). All three funding streams have specific allocation and reporting requirements, but the main goal of each was to encourage the installation of energy efficiency and renewable energy projects while maintaining or adding jobs to the economy.

The GEO utilized these funding streams to complement existing utility and government programs by offering rebates or advisory services that encouraged Colorado residents and businesses to participate in the existing programs. The GEO also created programs and services that filled market gaps that were underserved by the existing utility or government infrastructure across the state.

2.3.1.1 Expenditures and Benefits

In 2009, the GEO submitted detailed information regarding the programs that would be offered under each funding stream to the DOE. This submittal also included budgets and forecasted annual energy savings for each funding stream. Table 2-1 details the budgets and the forecasted annual energy savings originally reported by the GEO that were evaluated in this Project. The budgets and energy savings were calculated by GEO staff in 2009 utilizing DOE provided calculators and estimations. The information contained in this original submittal to the DOE provided the foundation for the planning of this Project.

Table 2-1 GEO 2009 Proposed Budget and Gross Site Energy Savings

Funding Stream	Budget	Forecasted Annual Energy Savings (MMBtus)
State Energy Program	$48,833,151	366,242
Energy Efficiency & Conservation Block Grant	$9,593,500	769,149
State Energy Efficient Appliance Rebate Program	$4,739,000	N/A [(1)]
Total	**$63,165,651**	**1,135,391**

[(1)] Energy savings were not forecasted for the SEEARP by GEO for their original reporting to the DOE

2.3.1.2 Quantifying Impacts

The GEO had a variety of goals for their ARRA program offerings beyond energy savings. These goals included job creation, economic stimulus, and market transformation. In order to meet these varied goals, the GEO created a range of offerings to Colorado residents and businesses. To help organize the data, the evaluation team allocated the ARRA expenditures into cost categories that describe the services provided by the GEO programs. These categories included:

- **Administrative**. This includes the GEO staff, overhead, travel, public information and marketing and other miscellaneous administrative costs.
- **Education and Outreach**. Education and outreach costs include training and workshops offered by program staff and external consultants on a range of technical issues. Also included are outreach efforts to build participation in the various programs.
- **Technical Assistance**. Many of the GEO's programs provide technical assistance from contractors to assist both the residential and commercial sector implementation of energy efficiency and renewable energy projects.
- **Equipment Incentives**. These costs include various financial incentives including grants, rebates, loans, or loan loss reserves for energy efficient or renewable energy equipment.

The GEO attributed energy savings to services included in the cost categories of technical assistance and equipment incentives in their quarterly reports to the DOE. These services were the focus of this impact evaluation. Administrative and education and outreach efforts were not evaluated and any programs associated with these efforts are not discussed in this report. Figure 2.1 depicts the cost categories as a percentage of total budget and shows that 71% of the ARRA funds are allocated to technical assistance and equipment incentives. This breakdown is generally consistent with standard utility offerings.

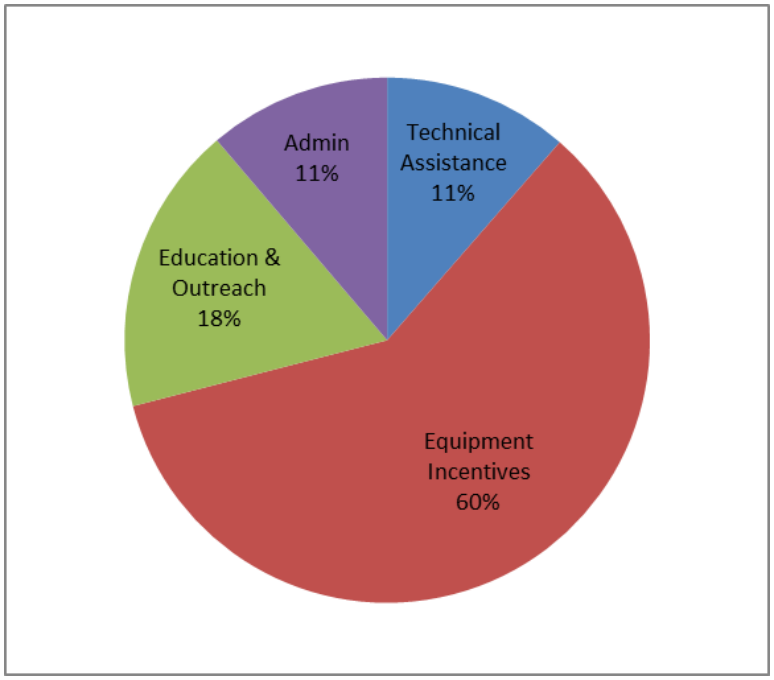


Figure 2-1: Segmentation of All ARRA funds by General Activity

2.4 STATE ENERGY PROGRAMS

The State Energy Program (SEP) is a competitive and formulaic award from the DOE that provides funding for state energy related programs. The GEO allocated this funding to 11 market titles that serve different market sectors with a variety of services. Six of these 11 market titles involved incentives and/or technical assistance and were the focus of the evaluation of SEP programs. These market titles included:

- Capital Investments
- Renewable Energy Programs
- Residential Buildings
- Commercial Buildings Existing
- Commercial High Performance Buildings
- Greening Government

This section provides general information regarding each of these market titles. More detailed information on each of these market titles is provided in Section 8. Table 2-2 provides a summary of the evaluated SEP market titles and the corresponding funding included as of February 1, 2012.

Table 2-2: Summary of Evaluated SEP Market Title

SEP Evaluated Market Titles	Expenditures (2-1-12)
Capital Investments	$5,521,905
Commercial Buildings Existing	$3,295,149
Commercial High Performance Buildings	$2,378,411
Greening Government	$651,730
Renewable Energy Programs	$6,636,978
Residential Buildings	$6,231,180
Evaluated Sub Total	**$24,715,353**
Incomplete Programs Not Evaluated[1]	$16,424,452
Market Titles Not Evaluated[2]	$7,757,183
Total	**$48,896,988**

[1)] Revolving Loan Program (Capital Investments) and Renewable Energy Development Team Program (Renewable Energy Programs) were both not evaluated as no projects had been completed at the time of this evaluation. However, both of these programs are expected to complete projects in 2012.
[2)] Market Titles not evaluated include Administration, Public Information, Transmission and Utilities

The remainder of this section will provide general information regarding each of the SEP market titles.

2.4.1 Capital Investments

Capital Investments included both grant and financing programs that provided a source of capital, leveraged further investment dollars, and encouraged the deployment of renewable energy and energy efficiency projects.

2.4.2 Renewable Energy

The Renewable Energy market title sought to address barriers to broad scale distributed renewable energy generation, decrease the usage of fossil fuels in our electrical, thermal and transportation

fuel portfolios and to spur job creation and innovation in the state. The renewable energy services evaluated by this Project included:

- Technical Assistance
- Rebates
- Grants

2.4.3 Residential Buildings

The Residential Buildings market title provided education and outreach through workshops and trainings, technical assistance, and financial incentives for Colorado residents in both existing and new homes. Evaluated services included:

- Promoting advanced energy codes
- Existing home energy efficiency
    - Expand Insulate Colorado
    - New incentives for duct sealing, furnace replacement, air sealing, and lighting
    - Bundle incentives for whole house tune-up

2.4.4 Commercial Buildings Existing

The Commercial Buildings Existing market title provided services to improve the energy efficiency of existing commercial buildings. These services ranged from technical assistance for energy performance contracting to grants for communities to run energy efficiency programs.

The Commercial Buildings Existing had three ARRA funded components:

- Energy Performance Contracting
- Main Street Efficiency Initiative
- Commercial Building Grants and Contracts

2.4.5 Commercial High Performance Buildings

The Commercial High Performance Building program provided technical assistance to public agency new construction and major renovation projects, workshops and trainings and dissemination/development of tools and best practices. Additionally, grants were offered to Colorado communities and agencies to encourage the development of high performance buildings.

2.4.6 Greening Government

This market title sought to meet Greening Government Executive Order goals through a number of services including energy tracking software, grants, refrigerator decommissioning, and computer energy saving software.

2.5 ENERGY EFFICIENCY AND CONSERVATION BLOCK GRANTS

The Energy Efficiency and Conservation Block Grant (EECBG) funding stream worked with cities, counties, and states to develop, promote and implement energy efficiency and conservation projects. The GEO is the administrator for the EECBG funding for Colorado and used this funding for a variety of energy efficiency projects and programs. The GEO split the EECBG funding into seven activities. These activities were:

- Activity 1: Residential and Commercial Buildings and Audits
- Activity 2: Subgrants for Energy Efficiency Retrofits
- Activity 3: Subgrants to Non-Entitlement Counties
- Activity 4: Material Conservation Program
- Activity 5: Lighting Project
- Activity 6: Onsite Renewable Technology
- Activity 7: Project Oversight

Funding in each of the seven activities assisted communities in developing and implementing energy efficiency projects. Services were developed based on community needs, and funding was allocated differently depending on whether the communities were entitled or non- entitled. Entitled communities received DOE funding based on a formulaic process, while the non-entitled communities received funding through a grant application process or equipment rebate funding.

These activities sought to build an energy efficiency infrastructure across a range of Colorado communities. For communities that had staff resources to manage and run services, the GEO provided technical support and funding. For communities that did not have staff resources or expertise, the GEO would manage and run the services in addition to offering technical assistance and educational support.

As the scope of the Project was to evaluate programs that had verifiable energy savings, only Activities 1, 2, 5, and 6 were included in the evaluation. Table 2-3 provides a summary of the evaluated SEP market titles and the corresponding funding included as of February 1, 2012.

Table 2-3: Summary of Evaluated EECGB Activities

EECBG Evaluated Activities	Expenditures (2-1-12)
#1 Residential & Commercial Buildings	$1,124,156
#2 Subgrants for EE Retrofits	$5,818,272
#5 Lighting Project	$25,000
#6 Onsite Renewable Technology	$176,456
Totals	**$7,143,885**
Activities Not Evaluated[1]	$1,832,514
Total	**$8,976,399**

[1)] These Activities include #3 Subgrants to Non-Entitlement Communities, #4 Material Conservation Program and #7 Project Oversight due to lack of energy savings attributable to these Activities.

2.5.1 Activity 1: Residential and Commercial Buildings and Audits

Activity 1 provided funding for the Main Street Efficiency Initiative through subgrants to entitled and non-entitled communities. The majority of the funding in this activity was managed by the Commercial Buildings Existing Program Manager. The remaining funding was used by Local Programs to provide energy efficiency in public buildings grants.

2.5.2 Activity 2: Subgrants for Energy Efficiency Retrofits

Activity 2 provided funding for grants and rebates for energy efficiency projects, renewable energy projects, education and outreach, and energy auditor equipment. The majority of the funding in this activity was managed in the Residential Buildings and Renewable Energy Programs. The remaining funding was used by Local Programs to provide energy auditor equipment grants and energy efficiency in public buildings grants.

2.5.3 Activity 5: LED Street Lighting Grants

This activity provided grants to three Colorado communities for LED street lights.

2.5.4 Activity 6: Onsite Renewable Energy Technology

This activity provided grants for renewable energy projects on public buildings. $1/watt was provided for solar PV to a number of Colorado communities.

2.6 STATE ENERGY EFFICIENCY APPLIANCE REBATE PROGRAM

ARRA funding contributed to the establishment of a residential ENERGY STAR appliance rebate program. The State Energy Efficiency Appliance Rebate Program (SEEARP) provided rebates for ENERGY STAR appliances including:

- Clothes Washers

- Dish Washers
- Refrigerators
- Water Heaters (tankless and gas condensing)
- Boilers (gas condensing)
- Furnaces (gas condensing)

3 METHODOLOGY

This section provides an overview of core activities central to this impact evaluation. Due to the variety of programs provided within each funding stream, the evaluation team utilized many tactics to evaluate each funding stream. More detail on the specific methodology used within each funding stream is provided in Sections 5, 6 and 7. Section 4 provides the overall findings from the Project.

Fundamentally, impact evaluations seek to quantify the net savings that have been realized by the programs under review by determining the gross savings realized by projects enrolled in the programs and the net-to-gross (NTG) ratios. Gross energy savings for the GEO were determined through a combination of engineering analysis and site inspections of program participants. Because it was not cost-effective to complete analysis and site inspection on a census of the program participants, savings were only verified for a representative sample. The program-reported savings for the sample were adjusted to reflect the review findings. This adjustment was captured in a realization rate, which is the ratio of evaluation review savings to program-reported savings for the sample. In order to estimate net energy savings, the evaluation team employed telephone and on-site surveys to quantify the actual impact of the GEO programs. Net savings were a reflection of the degree to which the savings are a result of the program efforts and funds. The net savings were calculated by applying net-to-gross scaling factors to the gross savings.

For the GEO impact evaluation, both ex-ante analysis (expected savings based on baseline conditions) and ex-post analysis (actual savings based on post retrofit conditions) were conducted. Ex-ante analyses were only conducted for large impact projects that were not being completed within the time frame of this evaluation project. The majority of projects received an ex-post analysis.

This evaluation is composed of the following general steps which are described in further detail in this section:

- Obtaining Program Data Records
- Designing the Sample
- Verifying the Sample
  - Level I Audits (File Reviews)
  - Develop Site-Specific M&V Approach
  - Level II Audits (On-site Inspections)
  - Establish the Baseline

- Calculate Impacts and Load Shape Analysis

- Estimating Net Savings

- Reporting the Results

3.1 OBTAIN RECORDS

The first significant step of the evaluation activities was to obtain comprehensive program records for each of the three funding streams, SEP, EECBG, and SEEARP from the GEO. Three main types of data records were used for a review of the programs:

- Program tracking databases/spreadsheets

- Program project files

- Project documents from external sources, such as documents from customers, program consultants, other government agencies, or implementation contractors

Obtaining each program's tracking database was a critical activity in the evaluation process. The GEO programs utilized different participant data tracking procedures. The evaluation team obtained these databases or spreadsheets and compiled a comprehensive list of program participants and specific project data for the participants, which included name, site address, savings reported, project schedule, incentives paid, etc. This information was utilized by the evaluation team to:

- Attempt to determine the aggregate reported program saving impacts

- Establish and execute program sampling strategy

Project files were documents the program maintained for each project and included the application documents, savings calculations, and any additional supporting documentation on the history of the project.

Finally, depending on the program and the project, additional supporting information was requested from third party consultants, customers, and implementation contractors. This included measurement and verification (M&V) data, trend data, revisions to projects, equipment inventories, and equipment specifications. The information obtained from these other sources was useful as it provided a more accurate and comprehensive understanding of the program and the energy efficiency or renewable energy measures that were implemented.

Project records revealed implementation schedules that extended past the anticipated completion date of this project of February, 2012. These projects could still be selected for M&V and analysis, if the project had sufficient certainty in the reported savings and installation schedule (ex-ante review).

3.2 DESIGNING THE SAMPLE

In order to provide the most cost effective sample, 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 evaluation funds to programs and projects with high impact and high uncertainty. Because of the need for cost-effective yet reliable evaluation methods, coupled with the expectations for rigor, our sampling was guided by VOI algorithms to supplement the deterministic sample sizing that follows from more routine statistical sampling methods. The VOI metric allowed us to focus on the data points or samples with the greatest impact and uncertainty.

A nested sampling metric was designed to meet the following objective:

- 90% confidence interval and 10% precision at the ARRA funding stream level (SEP, EECGB, and SEEARP)

A secondary objective in the sampling approach was to focus on projects in the GEO programs with high impact. However, because of the inconsistency in reporting procedures utilized for the GEO programs (in some cases, savings were reported as zero), program budgets were utilized as a proxy to stratify savings weights within the funding stream. The following steps were taken to generate the sample populations to be used in the impact evaluation.

1. Sample size were be calculated based on the following formulae:

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

where,

C_v = Coefficient of variance = 0.5 (assumed)

P = Precision = 10%, criteria described above

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

2. The sample size for each sub-stratum was calculated using a ratio estimation approach based on the GEO program budget (as a proxy for anticipated saving weight) to the ARRA funding stream.
3. Each project within the sub-stratum was assigned a random number (using a standard statistical random number generation tool).
4. The random numbers were multiplied by each project's reported energy reduction (from program records) to produce a rank for each project in each sub-stratum. In cases, where there was variability in reported savings within singular project, budget was utilized as a proxy for savings.

5. Projects in each sub-stratum were arranged by rank in descending order. Starting from the top, projects were selected per the assigned sample size. Alternate sample projects were also selected for each sub-stratum.

Based on the GEO-created tracking databases, Table 3-1 summarizes the planned and achieved sample populations by funding stream, along with the general M&V methodology employed. Additionally, because funding for the GEO programs was derived from both ARRA and non-ARRA sources, the evaluation team allocated total participation by percent of ARRA funding only.

Table 3-1 Sample Population Sizes Final

Funding Stream	Planned Total Sample Size	Achieved Total Sample Size	C/P Target	High-Rigor Data Collection			Moderate-Rigor Data Collection		
				Method	Planned Sample Size	Achieved	Method	Planned Sample Size	Achieved
SEP	112	152	90%/10%	Site Visits	68	45	Desk Review	44	107
SEEARP	82	82	90%/10%	Site Visits	30	38	Tel Surveys	52	44
EECBG	68	64	90%/10%	Site Visits	34	26	Desk Review	34	38

Oversampling was also included for a few specific programs:

- **SEP, Residential, Code Compliance** – Additional samples were added at the request of the GEO.
- **SEEARP, SEP, EECGB, Residential, Gas Furnaces** – Additional samples were added due to cross-cutting nature of these measures and large participation.

The evaluation team conducted site inspections for a portion of the sampled population, while the balance of the sample population was analyzed through telephone surveys or a desk review of available documents. More specific details on the samples for each funding stream are included below and in Sections 5, 6 and 7.

The samples outlined in Table 3-1 were updated throughout the Project as the evaluation team gathered additional information on the funding streams. When this Project began, many of the programs were at early phases of implementation, and there was incomplete information on program participation, budgets, or savings. As the Project continued, these programs matured or finished allowing the evaluation team to have a better understanding of the programs and a sampling strategy that would address this new information.

3.2.1 State Energy Program (SEP)

One challenge of implementing the evaluation for the SEP was the extensive variety of services provided within the SEP funded program. To deal with this challenge, the impact evaluation of the SEP was conducted through desk reviews, on-site inspections, phone interviews, and utility bill analysis depending on the program.

The evaluation approach implemented by the evaluation team sampled the populations of each market title to ensure that we met the DOE recommended 90/10 confidence/precision for the entire funding stream. The evaluation team stratified the SEP funding stream by market titles and cost categories (technical assistance and incentives) that have energy savings attributed to them based on budget appropriations as a proxy for energy impacts.

A savings weighted approach ensured the high budget projects were selected for review. Additional project samples were included for Residential Buildings at direction of the GEO, and additional project samples were included for Commercial Buildings Existing program due to the large disparity of between the savings impact and budget submitted to the DOE for the Energy Performance Contracting (EPC) Program. Table 3-2 details our sample for the SEP, including ARRA funding sources:

Table 3-2 SEP Sampling Data

Market Title[(1)]	Funding Stream	Program Participants	Sample Size[(2)]
Capital Investments - Revolving Loan Program	SEP	5	5
Capital Investments--Loan Loss Reserve	SEP	3	3
Capital Investments--NEED Grants	SEP	36	14
Commercial Buildings Existing	SEP	229	12
Commercial High Performance Buildings	SEP	83	9
Greening Government	SEP	115	31
Renewable Energy Programs	SEP / EECBG / non-ARRA	604	34
Residential Buildings	SEP / EECBG / SEEARP / non-ARRA	4,192	44
Totals		**5,267**	**152**

(1) Market Title includes participants from technical assistance, grants, and rebates only

(2) Actual sample size achieved

3.2.2 Energy Efficiency and Conservation Block Grant (EECBG)

Similar to the SEP evaluation, the challenge of sampling the EECBG funding stream was the variety of services provided within this funding stream. The approach implemented by the evaluation team

adequately sampled the populations of each market title to ensure that we met the DOE recommended 90/10 confidence/precision for the entire funding stream. The evaluation team stratified the EECBG funding stream by market titles and cost categories (technical assistance and incentives) that have energy savings attributed to them based on budget appropriations as a proxy for energy impacts.

The impact evaluation of the EECBG activities was conducted through desk reviews, on-site inspections, phone interviews, and utility bill analysis. The sample size for the EECBG funding stream is calculated using a ratio estimation approach based on budget weights for those activities with energy savings. A savings weighted approach ensured the high budget projects were selected for review. Table 3-3 below indicates our sample population for the EECBG as well as ARRA funding sources:

Table 3-3 Sample for EECBG

Activity[1]	Funding Stream	Program Participants	Sample Size[2]
1.Residential & Commercial Buildings & Audits	SEP/EECBG	258	29
2. Subgrants for EE Retrofits	SEP/EECBG/SEEARP/non-ARRA	5,893	32
5. Lighting Project	EECBG	2	1
6. Onsite Renewable Technology	EECBG	2	2
Totals		**6,155**	**64**

(1) Activity includes participants from technical assistance, grants, and rebates only
(2) Actual sample size achieved

As discussed in Section 6, a significant portion of EECBG funding is allocated to the GEO programs co-funded by other ARRA funding streams. Consequently, sampling for EECBG funds was combined with certain programs from other funding streams. However, the evaluation team was careful to allocate the energy savings for these combined funds to the EECBG portion of funding.

3.2.3 SEEARP

The impact evaluation of the rebates offered through SEEARP was conducted through phone interviews, site inspections, and utility bill analysis. Phone interviews were used when it was expected that the average homeowner could provide the information accurately. Site inspections were used when the necessary information to be collected was more complex. These evaluation efforts targeted a 90% confidence interval with 10% precision for the SEEARP funding stream as a whole. Confidence and precision at the measure-specific level are outlined in the following table. Measures that were reported to contribute more savings were evaluated at higher precision levels.

Table 3-4 SEEARP Sampling Data

Appliance	Funding Stream	Participants	Sample Size[(1)]
Clothes Washers	SEEARP	10,662	10
Dishwashers	SEEARP	6,951	8
Refrigerators	SEEARP	305	0
Refrigerators (recycling)	SEEARP	8,118	10
Water Heaters - Gas Storage	SEEARP	260	8
Water Heaters - Gas Tankless	SEEARP	163	8
Furnaces - Gas	SEP/EECBG/SEEARP/non-ARRA	4,906	8
Boilers - Gas	SEEARP	427	30
SEEARP Total		**31,792**	**82**

3.3 VERIFYING THE SAMPLE

The next step in the impact evaluation process was the verification of the gross impacts of the sample projects, which are the energy and demand savings that are found at a customer site as the direct result of a program's operation.

The impact evaluation activities resulted in adjustment factors, or realization rates, which were applied to the reported savings documented in the program tracking records. The ratio of the savings determined from the site inspections, M&V activities, or engineering calculations to the program-reported savings is the project realization rate. The program realization rate is the weighted average for all projects in the sample. The adjusted savings obtained by multiplying the program realization rates by the program-reported savings are termed the gross savings, and they reflect the direct energy and demand impact of the program's operations. These savings do not account for customer or market behavior that may have resulted in greater or lesser savings; these market effects are captured through tasks carried out in net impact analysis.

Total program gross savings were adjusted using Equation 1.

Equation 1

Where

kWh_{ver} = kWh verified by the impact team for the program, the gross impact

kWh_{rep} = kWh reported for the program

Realization rate = kWh_{ver}/ kWh_{rep} for the research sample

Demand (kW) savings were treated in a similar manner.

3.3.1 Level I Audits – File Reviews (All Projects)

After participant sample projects were selected, the evaluation team performed a Level I audit. Level I audits consisted of a desk review of the project file requested from each program stream. The project specific documents for the sampled projects included the customer applications, savings declarations performed by third party contractors (where applicable), post project audits, etc.

The evaluation team conducted an engineering file review to answer the following questions:

- Did sample projects meet all process and eligibility requirements, including the applicant, building, measure, and project cost eligibility?
- Were the data files of sample projects complete, well documented, and adequate to calculate and report savings?
- Were the measures properly installed as described in the program tracking and reporting system?
- Were the M&V Plans followed correctly for reporting savings?

The file review concluded with telephone surveys or on-site surveys with the participant. For those projects where no site inspection was conducted, the participant was asked questions to verify measure installation and provide parameter data to be used for analysis. For those projects where site inspections were conducted, the telephone survey had limited questions only necessary to schedule the site inspections, as the more detailed surveys were conducted on-site.

3.3.2 Develop Site-Specific M&V Approach

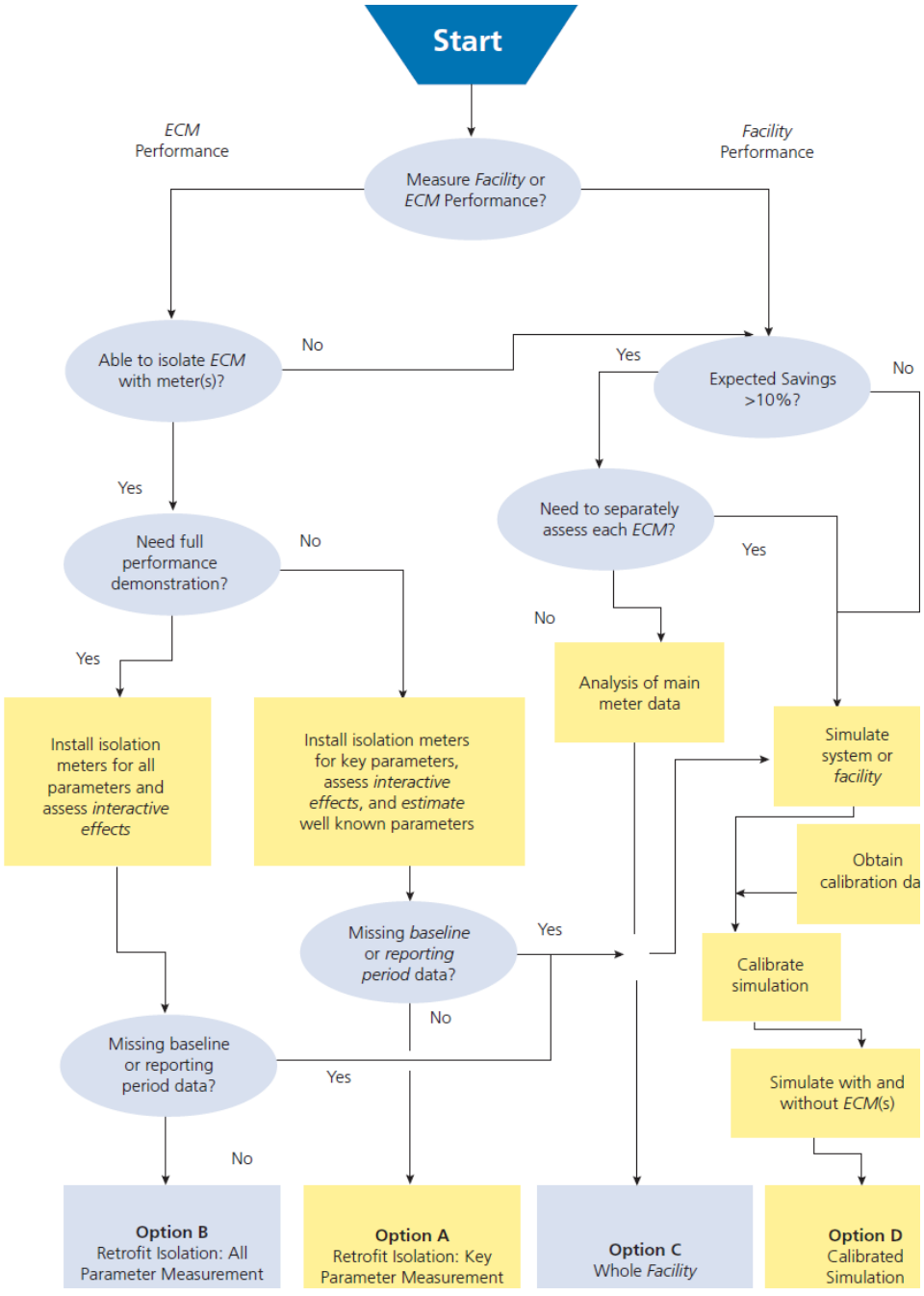
Desk review of projects was conducted in preparation for telephone and site surveys. Upon review of the project documents, a unique M&V plan was developed for each project. M&V methods for each project type were developed with adherence to the International Performance Measurement and Verification Protocol (IPMVP). The broad categories of the IPMVP are as follows:

- ***Option A, Retrofit Isolation: Key Parameter Measurement*** – This method uses engineering calculations, along with partial site measurements, to verify the savings resulting from specific measures.
- ***Option B, Retrofit Isolation: All Parameter Measurement –*** This method uses engineering calculations, along with on-going site measurements, to verify the savings resulting from specific measures.
- ***Option C, Whole Facility –*** This method utilizes whole-facility energy usage information, most often focusing on a utility bill analysis, to evaluate savings.
- ***Option D, Calibrated Simulation –*** Computer energy models are employed to calculate savings as a function of the important independent variables. The models must include

verified inputs that accurately characterize the project and must be calibrated to match actual energy usage.

Figure 3.1 presents a flowchart summarizing the selection of the IPMVP M&V Options.

Figure 3.1 IPMVP Methodoloy Selection Process[1]



[1] From EPA National Model Evaluation Guide

3.3.3 Level II Audits – On Site Inspections (Limited Projects)

On-site audits were built on the information obtained during the Level 1 audits. Site inspections were key to the accurate evaluation of programs and represented a significant portion of the effort. Because of the importance of the task, the team worked to ensure that site inspections were carefully planned and were cost-effectively executed. The team leveraged their efforts in the Level 1 audits to also prepare for the Level 2 audits. Level 2 audit activities included:

- Collecting baseline and retrofit equipment information
- Obtaining the operating parameters
- Conducting a visual inspection
- Gathering equipment nameplate information
- Conducting brief on-site interviews with relevant parties to understand the building operation, load shapes, equipment operating specifics, and other input parameters needed to calculate energy savings.

In some cases unbiased continuous or long-term metered data was available from the customer or in the project files, therefore no additional measured data was collected. Additionally, measurements were not necessary for sites where measure performance had low uncertainty, such as continuous 8,760 operating schedules.

3.3.3.1 Customer Interface Protocols

Customers were contacted by the evaluation team to arrange on-site inspections. After several attempts to reach customers, alternative projects were selected to replace the primary samples. A preliminary telephone survey served as a participant introduction to evaluation M&V activities, confirm that the customer participated in the program and to verify basic information such as building type and building size. On-site recruitments were made during the telephone survey and were scheduled with an evaluation team field engineer.

When interfacing with premise customers, evaluation team members adhered to the following protocols to ensure the GEO's relationship with its customers was protected:

- The inspector attempted to schedule the inspection. Up to three attempts to call were made and no more than two email attempts. Voice messages were considered an attempt.
- Inspectors identified themselves as a contractor hired by the GEO to evaluate the savings of the respective program.

- The inspectors ensured the contact understood that our work had no effect on the incentive they received, they were merely selected as part of a study the GEO was performing on the effectiveness of the program, and their assistance would be greatly appreciated.

- All data was kept confidential. All individual data and survey responses were maintained in strict confidentiality and the evaluation team only provided reports to the GEO at an aggregated level such as by program sector, type of measure, location, etc.

3.4 ESTABLISH THE BASELINE CONDITION

As members of the evaluation team authored the International Performance Measurement and Verification Protocol (IPMVP) and are leaders in the field of energy measurement and verification, the evaluation team has extensive tools and experience in determining project baselines. In many cases, the assessment of an accurate baseline presents more challenges than evaluating installed equipment as the equipment or conditions have been replaced.

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:

- **Application or contract documents.** Efficiency projects receiving rebates or grants often included calculations of energy savings, which generally included a description of the baseline equipment.

- **End-user interviews.** As part of the evaluation process, the evaluation team surveyed staff involved with the project to assess baseline equipment, as well as operating conditions and parameters.

- **Observation of similar locations**. Some projects only involved upgrades to a portion of a building, leaving the remainder of the space untouched. In these scenarios, it was possible to observe the remaining equipment to gain an understanding of conditions and operation.

- **Utility bills**. Where appropriate and available, the evaluation team gathered historical utility bills to assess the feasibility and accuracy of claimed baseline characteristics.

- **Local code requirements**. Where applicable, the evaluation team benchmarked all findings against local energy and building codes to validate results and provide an additional source in the event of non-characterized equipment.

Each of these sources were carefully evaluated and weighed to provide a complete assessment of the baseline conditions. The weight applied to each source depended on the nature of the project, as well as the evaluation team's assessment of the quality of the source.

Several types of baselines were appropriate, depending on the nature of the program:

- **Codes and Standards**. In the case of new building construction, the baseline condition required that the facility was constructed to meet but not exceed local building codes. Similarly, in the case of new appliance purchases, the baseline condition required that the customer purchase a standard efficiency appliance.

- **Pre-project Existing Conditions.** For projects that improve efficiency of existing buildings, the baseline condition is that the building would have continued to operate under its pre-project efficiency.

- **Base Level of Knowledge**. In the case of education programs, the baseline condition is what the customer would have done without having the new information.

- **Zero**. In renewable energy generation projects, the baseline condition will be "zero." Without the project, no energy would have been generated.

The baselines used for each of the funding streams are addressed in more detail in Sections 5, 6 and 7.

3.4.1 Calculate Impacts and Load Shape Analysis

The evaluation team utilized standard, published savings formulas and approaches to calculating energy impacts, including those published by ASHRAE, IESNA, etc. For review of some projects, computer simulation models were constructed to validate and/or simulate energy performance. In order to calculate the demand (kW) benefits of the implemented energy efficiency measures, the evaluation team validated and constructed load shapes. These load shapes included analysis of savings during the summer peak, off peak and shoulder peak periods for each measure reviewed. Load shapes were vital in calculating on-peak demand savings especially when the measures installed had daily and seasonal variations in the operating schedule. Our approach was to calculate and report system coincident on-peak demand savings using the standard on super summer peak period definition used by Xcel Energy[1].

3.4.1.1 Entirely Stipulated and Deemed Savings

In cases where sufficient data was not available or the specific end use technology did not warrant a metering approach, an entirely stipulated or deemed savings approach was used. The IPMVP recognizes that there are instances when measurement and verification of the savings is not justified and the likelihood performance can be demonstrated to the participant in another manner, such as in cases where the cost of measurement is too high as compared to the savings, where the parameters preclude accurate measurements, or where the confidence of the savings projections is

[1] Summer Super Peak Period, June – August; 12:00 through 17:00

high. When utilized in our analysis, stipulated or deemed values and parameters were clearly identified for transparency.

3.5 NET SAVINGS ESTIMATION

Attribution was assessed by adapting and expanding an instrument that Research Into Action has developed with Energy Trust of Oregon. This brief instrument assessed two components of free-ridership: 1) intention to carry out the energy efficient project without program funds; and 2) influence of the program in the decision to carry out the energy efficient project. Intention was assessed through three brief questions:

1. Had the respondent ever considered replacing the measure in question before being contacted by the program representative?
2. Had the respondent planned to replace the measure in question before being contacted by the program representative?
3. How the project likely would have differed if the respondent had not received the program incentive, from no change (would have done the project exactly as it was done) to reduced project scope or size or used less expensive or efficient equipment to cancelled the project altogether.

Program influence was assessed by asking the respondent how much influence – from 1 (no influence) to 5 (great influence) – the program incentive, the assessment, and the respondent's interaction with the contractor had on the decision to do the project the way it was done.

Algorithms were applied to the responses to the two sets of questions to generate a "project change" score and a "program influence" score. Each score ranges from 0, meaning the responses to that set of questions indicate no freeridership, to 50, meaning the responses indicate complete freeridership. The two scores are summed, resulting in a total freeridership score ranging from 0 to 100. The number is interpreted as the percentage likelihood that a given respondent is a freerider.

Each respondent's adjusted gross savings estimate was multiplied by that person's freeridership score to determine the net savings for that participant.

If the respondent indicated that, without program assistance, they would have done a project with lower energy savings, the interviewer asked a follow-up question to determine the level of energy savings relative to that of the project that was done. Recognizing that it may be difficult for the respondent to provide accurate and reliable information about the actual energy savings that would have been achieved, only two or three options were provided that reflected either a low or high or a low, medium, or high level of relative savings.

For commercial programs, if the respondent indicated that, without program assistance, they would have done the same project as was done with program, the interviewer asked if the company (or some other source) would have made the funds available to do the project. The purpose of this question is to serve as a check against a possible "social desirability" influence on the response –

that is, some respondents may give the "socially desirable" response that they would have carried out the energy-saving activity without program support, even though they might not in fact do so. If a respondent indicated the company probably would not have funded the project, the component score is adjusted downward.

Under the above general approach, the intention component score was calculated as outlined in the Table 3-5:

Table 3-5 Intention Scoring Methodology

Response to Main Intention Question	Relative Level of Savings	Would Company Pay?	Intention FR Component
Postpone or cancel	n/a	n/a	0
Done project with lower savings	Much lower savings	n/a	12.5
	Moderately lower savings		25
	Slightly lower savings		37.5
Done same project	n/a	No	25
		Don't Know	37.5
		Yes	50
Don't know	n/a	n/a	25

Note that, if the respondent reported that they would have done the same project without program assistance but that the company would not have allocated the funds to pay for it, the project still received a component score of 25. This was because the respondent gave contradictory answers, and therefore the likely outcome is considered to be unknown. In the case of unknown outcomes, the mid-point score of 25 was given.

We modified the above methodology to handle the GEO's complex set of programs. The particular challenges in adapting the attribution methodology were that a particular the GEO program participant may have received a variety of services – including technical assistance (TA) and education and outreach (E&O) as well as grants and incentives – through multiple programs. Therefore, the attribution instrument explored the influence of all the GEO programs and services that any particular participant took part in on the resulting energy savings. Appropriate questions, as discussed below, were triggered based on the particular programs and services pertaining to each participant.

For participants who took part in more than one program, the intention questions were revised to reflect that fact and determine which program or programs affected participants' intentions, if any did. This was a matter of asking each intention question for each program that the participant took part in. However, after gaining a deeper understanding of the patterns of program participation, we were able to develop a set of questions that achieved the same end in a more streamlined fashion.

The program influence questions also were expanded and/or modified to cover the various program services that any participant might have received, including TA. We worked with the GEO staff to identify the range of services and develop appropriate questions.

Several factors affected the final attribution approach. A principal factor was whether the influence of any TA or E&O was expected to be direct (i.e. services provided directly to the end users) or indirect (services provided to service providers who then influence the end users). In cases where the influence was expected to be direct, our existing attribution battery was adapted. Many commercial programs provide technical assistance, either directly through program sales staff, through program-sponsored technical studies, or indirectly through the network of trade allies, to help customers plan and carry out equipment upgrades. Our attribution battery asked about the influence of program staff as well as any technical studies that were performed. Under this approach, we worked with the GEO staff to ensure that each attribution battery addresses the appropriate program-specific set of TA or E&O activities. The questions addressed the specific channels of influence as well as when the TA or E&O occurred relative to other program-related activities. The set of activities was considered one of several program influences.

Assessing indirect influence was more challenging, but still possible. Appropriate questions included, for example, whether the program participant received an audit and, if so, who performed the audit. Follow up questions addressed the audit's influence on program participation. That influence was counted as program influence only if the professional who did the audit received program TA or E&O.

3.6 COST EFFECTIVENESS

At the completion of the project, the evaluation team completed the SEP Recovery Act Cost Test (SEP-RAC), which is in accordance with the SEP Program Notice[1], which requires: "*The SEP-RAC test states that the net energy impacts achieved should be no less than 10 million BTUs of source energy per year for every $1,000 invested of SEP Recovery Act funds. Net energy impact benefits at the project site will be converted into source impact benefits.*" Source benefits are often larger than site benefits when inefficiencies from transmission, pipelines, energy conversion are considered. For instance, a coal-fired plant operating at 33% efficiency will save 10,340 BTUs for every project site kWh saved[2], without consideration of transmission losses. The evaluation team gathered data for each project site's source energy, based on fuel type and utility source, to calculate source impact benefits. SEP-RAC tests were conducted for each program and funding stream, although only the aggregate funding stream is required to meet the cost-effectiveness test per the Evaluation Guidelines.

[1] DOE; "DOE Recovery Act Reporting Requirements for the State Energy Program (SEP)", attachment 3; SEP Program Notice 10-06; effective date March 1, 2010.

[2] 1 kWh = 3412 Btu / 0.33 efficiency = 10, 340Btus

3.7 QUALITATIVE ANALYSIS

The evaluation team recognized that the GEO was interested in determining if additional metrics could be measured to demonstrate the performance and results of the GEO's ARRA funded programs. Participant surveys and interviews attempted to gather additional information on non-energy benefits of the GEO programs, such as:

- Participant Satisfaction
- Total Influenced Energy Benefits
- Quantity of People and/or Agencies Reached

3.8 GLOSSARY

Within the body of this report, there are several technical terms that require explanation. Additionally, some of the terms may appear to be similar at first review; however, have very different means. Terms such as "site" and "source" can easily be confused by the reader and are thus defined as following:

Attribution The process of determining the percentage of a program's savings that are directly related to the program's influences. Its value is determined through the use of survey techniques, and the Attribution Survey used for this project can be seen in Appendix A.

Baseline The expected energy usage level of a specific measure or project before improvements are implemented. This becomes the comparison value for all energy savings calculations.

Deemed Savings Amount of savings for a particular measure provided by documented and validated sources or reference materials. Often used when confidence is high for a specific measure, databases lack sufficient information, or costs of measurement and verification greatly outweigh the benefits.

Freerider A participant who, on some level, may have participated in the program regardless of GEO influence. Determining freeridership values is a large component in calculating the Net-to-Gross ratio.

Gross Savings Total amount of a parameter of interest (kWh, kW, MMBtu, CO_2e, water) saved by a project/program.

Market Titles Different market sectors that provide a variety of services and are targeted by a program. These include Capital Investments, Renewable Energy, Residential Buildings, and Commercial Buildings among others.

Net-to-Gross Ratio A ratio value determined through the process of surveying decision makers who implemented projects in order to account for freeridership and other attribution effects. The net-to-gross (NTG) ratio is multiplied by gross verified savings to produce net savings. (NTG is typically calculated for a statistically significant sample of projects and then extrapolated to the population as a whole)

Net Savings Total amount of a parameter of interest (kWh, kW, MMBtu, CO_2e, water) saved by a program that is directly related to the program. It takes into account the realization rate, as well as results of the attribution analysis (freeriders), to provide a value of energy savings directly related to the program influence. Net Savings is calculated by multiplying the gross verified savings by the net-to-gross (NTG) ratio.

Project A single activity (lighting retrofit, refrigeration replacement, PV system install, etc.) at a single location.

Program A group of projects with similar technology characteristics that are installed in similar applications.

Realization Rate A measure of the amount of verified saving for a project/program compared to the reported savings. It is defined as the ratio of Gross Verified Savings to Gross Reported Savings.

Reported Savings Savings calculated and reported by the GEO – in some cases these values were recalculated by the evaluation team to accurately reflect true findings.

Site Energy Savings Savings (gross or net) directly calculated at a facility.

Source Energy Savings Savings (gross or net) calculated as the sum of the site energy savings and savings from the energy not having to be extracted, converted and transmitted to the facility due to the energy efficiency or renewable energy project. Conversion factors between site and source are listed below:

Stratify The process of breaking down a population of projects into groups with similar characteristics (technical, financial, size, location, etc.). This is used during population sampling and allows projects with greater uncertainty or higher budgets to be accurately weighted to assess their impact on a program.

Sub-Strata	The individual groups remaining once a population has been stratified.
Stipulated Savings	Same as *Deemed Savings*
Total Savings	Savings of electricity (kWh) and natural gas (MMBtu) combined into a single energy value using the following conversion:
Verified Savings	Savings determined by the evaluation team through the collection of data at on-site inspections, phone surveys, and engineering analysis.

4 SUMMARY OF FINDINGS

This section provides a high level overview of the evaluation team's findings at the funding stream level. Specific findings and methodology for each of the programs and services within the funding streams are detailed in Sections 5, 6 and 7.

Site and source energy savings associated with the GEO programs are presented for both gross verified savings and net savings. The site energy savings are those savings directly calculated at a facility. The source energy savings represents the sum of the savings at the facility 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. Both source and site energy savings are presented in the remaining sections of this report.

The conversion factor for electricity used is 1kWh at site to 3.318 kWh at source[1]. Natural gas also has a source energy ratio to site energy; however, the ratio is significantly lower than that for electricity as natural gas is delivered to end user sites without changing mediums. For natural gas consumption at a national average, 1 MMBtu delivered to a site requires 1.047 MMBtus source energy[11].

Additional metrics related to the energy savings are reported. Both annual and lifetime energy savings are presented. Lifetime energy savings were calculated using the useful lives of the energy efficiency or renewable energy projects installed. A degradation factor was applied to the renewable energy projects as their performance degrades over time. More details regarding these additional metrics are provided in Sections 5, 6 and 7.

Carbon and water savings are also presented. In order to derive the amount of water saved from energy efficiency savings, it was necessary to understand the relationship between water use and energy production. Two types of power plants, thermoelectric and hydroelectric, account for significant water usage. Actual water consumption or evaporation, however, varies for each plant type. Thermoelectric plants draw large quantities of water for cooling purposes but return the majority of this water to its source. Therefore, only a small fraction of the water withdrawn is actually evaporated. Hydroelectric plants have a much higher water consumption rate due to evaporation from reservoir surfaces. The National Renewable Energy Laboratory conducted a study that concluded the rate of water consumption per kWh consumed by end users (i.e., site energy) accounting for evaporation at the power plant and transmission and distribution losses. Based on

[11] ENERGY STAR Performance Ratings: Methodology for Incorporating Source Energy Use, March 2011

Colorado's mix of thermoelectric and hydroelectric power plants, 1 kWh of electricity consumed by an end user consumes 1.2 gallons of fresh water[12].

Equivalent CO2 (CO2e) presented below represents the equivalent concentration of CO2 comprised of greenhouse gases. Based on Colorado's power plant mix, the rate of CO2e emissions is .00101 tonnes per kWh of site energy consumed[13]. The emissions factor for natural gas is 0.05345 tonnes CO2e per MMBtu consumed.

Finally, a discussion of evaluation issues and challenges is presented in this section.

4.1 GROSS REPORTED SAVINGS

The first step in determining the net savings for the three funding streams was to evaluate the savings reported by the GEO to the DOE. Reporting of energy savings and other metrics associated with the programs was required quarterly to the DOE using the Performance and Accounting for Grants in Energy (PAGE) reporting system. Table 4-1 outlines the gross site energy savings reported by the GEO as of December, 2011.

Table 4-1 Gross Annual Reported Savings

Funding Stream	Gross Reported Electricity Savings (kWh)	Gross Reported Gas Savings (MMBtus)	Total Gross Reported Savings (MMBtus)
State Energy Program	40,449,213	282,578	431,194
Energy Efficiency & Conservation Block Grant	4,581,035	65,321	80,952
State Energy Efficient Appliance Rebate Program	2,298,010	55,037	62,878
Total	**47,328,257**	**402,937**	**575,024**

The evaluation team took significant steps to accurately represent the reported energy savings by the GEO. Adjustments were made to some of the savings values reported by the GEO to more accurately reflect the reported value. These adjusted reported values were derived from a number of sources including the GEO's spreadsheet reporting tool, database information from the rebate processing contractor, grant applications and other source documents. For instance, savings derived from educational or marketing efforts were not included in the adjusted reported savings as the savings for such efforts could not be verified in the evaluation process. In other instances, no savings were reported for programs despite the substantial budgets associated with those programs. By

[12] Torcellini, P., et al., Consumptive Water Use for U.S. Power Production Technical Report. National Renewable Energy Laboratory, NREL/TP-550-33905, December 2003.

[13] Deru, M. and Torcellini, P., Source Energy and Emission Factors for Energy Use in Buildings Technical Report. National Renewable Energy Laboratory, NREL/TP-550-38617, Revised June 2007.

adjusting such reported savings allowed the evaluation team to calculate realization rates that more accurately reflected the performance of the GEO's programs. These adjustments are reflected in the Gross Reported Savings outlined above. More detail on any adjustments made is presented in Sections 5, 6 and 7.

4.2 GROSS VERIFIED SAVINGS

The data collected as a result of the on-site inspections, phone surveys and engineering analysis allowed the evaluation team to calculate energy and demand savings for each sampled project—this is termed gross verified savings. The ratio of the gross verified savings to the reported savings by the GEO is the project's "realization rate". The program's realization rate is the weighted average for all the projects within the sample, and the program's gross verified savings are the product of the program reported savings and the program's realization rate. These program level gross verified savings are summed to the market title/activity level if there were multiple programs for evaluation within a market title/activity. The market title/activity totals are then summed to the funding stream level. Due to the variability of the programs within the funding stream, the evaluation team did not calculate realization rates at the funding stream levels. The realization rates used within the funding streams are presented in Sections 5, 6 and 7.

Gross verified savings do not account for customer or market data as that is captured in the attribution analysis for the development of the net to gross ratios. Table 4-2 outlines the gross verified site savings for the funding streams.

Table 4-2 Gross Verified Site Energy Savings

Funding Stream	Gross Verified Electricity Savings (kWh)		Gross Verified Gas Savings (MMBtus)		Total Gross Verified Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
State Energy Program	44,687,742	676,338,199	338,603	5,800,573	491,078	8,108,239
Energy Efficiency & Conservation Block Grant	4,436,504	75,047,902	51,503	963,696	66,641	1,219,759
State Energy Efficient Appliance Rebate Program	6,769,263	75,173,019	65,842	1,275,376	88,939	1,531,866
Total	**55,893,509**	**826,559,120**	**455,948**	**8,039,645**	**646,657**	**10,859,865**

In addition to the site savings, the evaluation team calculated the energy savings and other metrics associated with the source of generation. These savings are detailed in Table 4-3 and Table 4-4.

Table 4-3 Gross Verified Source Energy Savings

Funding Stream	Gross Verified Electricity Savings (kWh)		Gross Verified Gas Savings (MMBtus)		Total Gross Verified Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
State Energy Program	148,273,926	2,244,090,144	354,517	6,073,200	860,428	13,730,036
Energy Efficiency & Conservation Block Grant	14,720,322	249,008,938	53,924	1,008,989	104,150	1,858,608
State Energy Efficient Appliance Rebate Program	22,460,414	249,424,078	68,936	1,335,319	145,571	2,186,354
Total	**185,454,662**	**2,742,523,160**	**477,378**	**8,417,508**	**1,110,149**	**17,774,997**

Table 4-4 Gross Verified Source Demand, CO2e, and Water Savings

Funding Stream	Gross Verified Demand Savings (kW)		Gross Verified C02e Savings (tonnes)		Gross Verified Water Savings (gallons)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
State Energy Program	24,596	n/a	64,084	1,007,714	53,625,290	811,605,839
Energy Efficiency & Conservation Block Grant	836	n/a	7,363	129,729	5,323,805	90,057,482
State Energy Efficient Appliance Rebate Program	762	n/a	10,522	147,298	8,123,116	90,207,623
Total	**26,193**	**-**	**81,968**	**1,284,741**	**67,072,211**	**991,870,944**

4.2.1 Reported Savings versus Verified Savings Discrepancies

The evaluation team examined the programs to determine the main reasons for the discrepancies between the gross reported savings and the gross verified savings values. The primary reasons include:

- **Partner matching funds**: Many communities added matching funds to the equipment rebate dollars provided by the GEO. Thus, the savings from the rebated project needs to be allocated to different rebate sources.
- **Input assumptions:** The GEO used assumptions or deemed value to estimate the savings from some of their programs. Based on findings from the on-site and phone surveys, the evaluation team adjusted the savings associated with some of these programs.

- **GEO reporting tool:** The GEO utilized a spreadsheet tool to track and report the energy savings associated with the programs. The evaluation team adjusted some calculations to more accurately reflect the savings because of inaccuracies within the tool.
- **Unreported savings:** The GEO did not report energy savings for a few programs that had attributable energy savings due to uncertainty in the calculation of the savings or due to the uncertainty in the extent of the project.

Each of these factors could drive the realization rate higher or lower, though on average, the realization rate was shifted downward.

4.3 NET SAVINGS

Net energy saving impacts are calculated by multiplying the gross verified savings by a net-to-gross (NTG) ratio. The development of the NTG ratio is described below. However, NTG ratios are not presented at the funding stream level due to the diversity of programs within the funding streams. The NTG ratios calculated for the individual programs within the funding streams are detailed in Sections 5, 6 and 7.

4.3.1 Freeridership

The first component of the NTG ratio is freeridership. Freeriders involve participants who on some level may have participated in the program regardless of the GEO influence. Freeridership was assessed through attribution surveys delivered to the sample populations.

The evaluation team calculated free-ridership (FR) scores for 277 program participants – 137 residential and 140 nonresidential. For some participants, we calculated FR scores for more than one measure. In total, we calculated FR scores for 285 measures – 159 residential and 126 nonresidential.

The 159 residential FR scores were distributed across 13 sample groups, defined primarily by measure type (e.g., clothes washer, furnace, duct sealing). The 126 nonresidential scores were distributed across 17 groups, defined by market title/program and measure type.

The mean FR score across all residential records was 35.8, and the mean score across all nonresidential records was 26.0. Mean FR scores varied greatly among the individual residential and nonresidential sample groups, however.

Within residential groups, mean FR varied from 5.0 to 70.0. For many groups, the sample size was very small, and therefore the mean score is not a reliable estimate of all program participants within that group. The mean residential FR score of 35.8 was within the range found for other residential programs. For example, a recent evaluation that Research Into Action conducted for Energy Trust of Oregon found residential FR scores ranging from 16 for solar water heaters to 61 for refrigerators. The relative levels of FR in the GEO residential groups roughly correspond with those in the Energy Trust evaluation: in both groups, clothes washers and refrigerators had the highest FR, while water heater, duct sealing, and insulation had lower FR scores. In two of the GEO residential groups with

the largest samples (water heater and insulation), the mean GEO scores were about half those found in the Energy Trust evaluation.

It also is suggestive that the mean FR scores for the solar PV and solar thermal participants were comparable to those found in the Energy Trust evaluation – 11.1 and 16.1, respectively.

Within the nonresidential groups, samples were too small to draw any firm conclusions about differences between the groups. The mean FR score across all nonresidential measures was comparable to that reported in evaluations of other nonresidential programs.

4.3.2 Net to Gross Ratios

Based on the calculated rates of freeridership, the evaluation team was able to assess the NTG ratio for the individual programs within the funding streams. These ratios are presented in Sections 5, 6 and 7 for each program. The ratios were not calculated at the funding stream level due to the variability within the funding stream.

At a portfolio level, including all programs funded wholly or partially by SEP, EECBG, and SEEARP, the evaluation team found a net-to-gross ratio of 67.2%. That is, the GEO's efforts are attributable to approximately two thirds of the total verified gross savings. For comparison, a large utility who offered a similar portfolio of programs realized an estimated portfolio level net-to gross-ratio of 74.8% for one program year of its demand side management program that bridges residential and non-residential customers. The GEO net-to-gross ratio is an aggregate value comprised of heterogeneous programs and therefore does not represent expected net-to-gross ratios for individual Market Titles, Activities, or sub-programs.

4.3.3 Net Savings

The evaluation team then multiplied the NTG ratios by the gross verified savings to determine the overall net energy impacts. Table 4-5 summarizes the evaluation team's findings for the net site energy savings.

Table 4-5 Net Site Energy Savings

Funding Stream	Net Electricity Savings (kWh)		Net Gas Savings (MMBtus)		Total Net Energy Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
State Energy Program	33,559,145	494,682,455	223,157	3,740,632	337,661	5,428,488
Energy Efficiency & Conservation Block Grant	3,657,196	62,024,634	40,325	751,541	52,804	963,169
State Energy Efficient Appliance Rebate Program	2,196,640	24,449,461	36,208	711,259	43,703	794,681
Total	**39,412,981**	**581,156,550**	**299,690**	**5,203,432**	**434,167**	**7,186,338**

In addition to the site savings, the evaluation team calculated the energy savings and other metrics associated with the source of generation. These savings are detailed in Table 4-6 and Table 4-7.

Table 4-6 Net Source Energy Savings

Funding Stream	Net Electricity Savings (kWh)		Net Gas Savings (MMBtus)		Total Net Energy Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
State Energy Program	111,349,243	1,641,356,387	233,645	3,916,441	613,569	9,516,749
Energy Efficiency & Conservation Block Grant	12,134,578	205,797,735	42,221	786,864	83,624	1,489,045
State Energy Efficient Appliance Rebate Program	7,288,450	81,123,312	37,910	744,688	62,778	1,021,481
Total	**130,772,271**	**1,928,277,434**	**313,776**	**5,447,993**	**759,971**	**12,027,276**

Table 4-7 Net Source Demand, CO2e, and Water Savings

Funding Stream	Net Demand Savings (kW)		Net C02e Savings (tonnes)		Net Water Savings (gallons)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
State Energy Program	14,990	n/a	46,383	708,963	40,270,974	593,618,947
Energy Efficiency & Conservation Block Grant	690	n/a	5,950	104,703	4,388,636	74,429,560
State Energy Efficient Appliance Rebate Program	248	n/a	4,245	64,498	2,635,967	29,339,353
Total	**15,927**	-	**56,578**	**878,163**	**47,295,577**	**697,387,860**

4.4 COST EFFECTIVENESS

At the completion of the project, the evaluation team completed a cost effectiveness test, specifically the SEP Recovery Act Cost Test (SEP-RAC), in accordance with the SEP Program Notice[14], which requires: "*The SEP-RAC test states that the net energy impacts achieved should be no less than 10 million BTUs of source energy per year for every $1,000 invested of SEP Recovery Act funds. Net energy impact benefits at the project site will be converted into source impact benefits.*" Cost effectiveness tests based on the net source energy savings are provided for each funding stream in Table 4-8.

[14] DOE; "DOE Recovery Act Reporting Requirements for the State Energy Program (SEP)", attachment 3; SEP Program Notice 10-06; effective date March 1, 2010.

Table 4-8 Cost Effectiveness

Funding Stream	Expenditures of Evaluated Programs (2-1-12)	Net Energy Savings – Source (MMBtus)	DOE Cost Effectiveness Test[(1)]	$/MMBtu[(2)]
State Energy Program	$24,715,353	613,569	0.025	$40
Energy Efficiency & Conservation Block Grant	$7,143,885	83,624	0.012	$85
State Energy Efficient Appliance Rebate Program	$4,706,489	62,778	0.013	$75
Total	**$36,565,727**	**759,971**	**0.021**	**$48.11**

[(1)] Hurdle is .01

[(2)] Target is $100/MMBtu

The evaluation team calculated the cost effectiveness based on the programs that were evaluated as a component of this Project and had verified energy savings attributed to them. Programs that were not evaluated, such as the Utilities Market Title, had their direct costs as well as a share of the overall administrative costs removed from our cost effectiveness calculations. Additionally, the Revolving Loan Program, which is a program within the Capital Investments Market Title was evaluated as part of this project, but the evaluation team was only able to provide verifiable energy savings that resulted from this project for a very small percentage of overall program costs (~2%). Savings associated with the other projects within the Revolving Loan Program were not able to be verified at this time, and these programmatic costs were not included in the cost effectiveness calculations.

The Table below outlines the estimated cost savings for Colorado businesses and residents based on the projected net energy savings.

Table 4-9 Participant Annual Energy Cost Savings

Funding Stream	Net Site Electricity Savings (kWh)	Electricity Cost Savings[1]	Net Site Gas Savings (MMBtus)	Nat Gas Cost Savings[2]	Total Annual Cost Savings
State Energy Program	33,559,145	$3,429,745	223,157	$1,642,774	$5,072,519
Energy Efficiency & Conservation Block Grant	3,657,196	$373,765	40,325	$296,856	$670,622
State Energy Efficient Appliance Rebate Program	2,196,640	$241,630	36,208	$264,257	$505,888
Total	**39,412,981**	**$4,045,140**	**299,690**	**$2,203,888**	**$6,249,028**

[1] Average Colorado commercial and residential kWh rates for November 2011

[2] Average Colorado commercial and residential natural gas rates for November 2011
Source: Energy Information Administration, accessed online on February 9, 2012.

4.5 EVALUATION CHALLENGES

The evaluation team experienced a number of challenges during this Project that required careful consideration during the implementation of the evaluation plan. These challenges are outlined here.

4.5.1 Program Structure and Budget Allocation

While the initial reporting to the DOE outlined specific budgets allocated to each service within the funding streams, the GEO programs were established based on market sectors, market actors, and technologies. In some cases, programs combined funds from multiple ARRA funding streams to establish a more comprehensive program. The ARRA funding was delivered into three distinct groups: SEP, EECBG, and SEEARP, but the distribution of funds inside the funding streams varied greatly. For example, the SEP funding was broken out into eight distinct market titles; however, these market titles did not necessarily comprise of one program or project but may have incorporated several distinct programs, projects and delivery mechanisms (i.e. grants). Additionally, one program type may have received funding from multiple sources (i.e. Main Street Efficiency Initiative received funding from the Commercial Buildings Existing program, a SEP funding source, and from EECBG funds). In addition, some measures offered through the various ARRA funding sources may also have been eligible for other incentives through local utility providers and state funding. Therefore, for purposes of the evaluation, it was challenging to track programs or projects back to one sole funding source.

For programs with multiple sources of funding, the GEO created a series of logic steps and rules for both their outside rebate processing firm and internal accounting to appropriately allocate the funds. However, in addition to correctly allocating funds among each program, a key consideration for the evaluation team was to ensure that the energy savings were also appropriately allocated to the proper funding streams based on the funding source. Moreover, as mentioned above, many of the services offered by the GEO leveraged partner funding from local governments or utilities as well as state funding. These non-ARRA sources of funding and their impact on participation and savings also needed to be considered by the evaluation team.

This challenge impacted the sampling strategy, the determination of gross savings and the calculation of net savings. The main solution to this challenge was through the implementation of detailed interviews with the GEO program staff in order to identify the key program services (rebates, grants, technical assistance, etc.) and how they were delivered. As a result of these interviews, the evaluation team determined how different funding streams were allocated; program participation and ultimately savings were calculated based on these budget allocations. The budget stratification was especially utilized for evaluating rebate programs, for which some programs encompassed up to five funding sources. Table 4-10 illustrates the budget percentages applied to the overall savings for each GEO program that was funded by more than one source. For instance,

program savings for the furnace rebate program were calculated based on the allocation listed. Because the furnace rebate program was funded in part by non-ARRA sources, only a proportion of total evaluated energy savings were allocated to the GEO in this report.

Table 4-10: Rebate Programs Budget Sources by Funding Stream

GEO Program	SEP	EECBG	SEEARP	Non-ARRA Funding[(1)]	Total
Insulation & Air Sealing	23%	40%	0%	37%	100%
Furnaces	10%	12%	59%	19%	100%
Duct Sealing	23%	12%	0%	65%	100%
Main Street	43%	57%	0%	0%	100%
Residential Solar PV	42%	31%	0%	27%	100%
Residential Solar Thermal	62%	23%	0%	15%	100%
Residential Wind	14%	31%	0%	55%	100%
Commercial Solar PV	66%	20%	0%	14%	100%
Commercial Solar Thermal	55%	21%	0%	24%	100%

[(1)]Non-ARRA funding was sourced from Partner funding as well as the Colorado Clean Energy Fund

4.5.2 Quantifying Energy Impacts

Due to the wide range of program types, delivery mechanisms, and measures, along with the aggressive schedule for the release of the ARRA programs, a significant challenge was found through inconsistency in program savings calculation methodology. Several different tools were utilized across the programs for tracking and reporting purposes and, to complicate matters, some of the programs have several levels of implementation contractors and/or administrators.

Another challenge faced when calculating/reporting energy savings was that some programs and projects had zero energy savings associated with them. This may have been due to the timing of the installation in relation to this evaluation (i.e. several projects were still in progress and therefore had limited and untracked savings values).

The evaluation team addressed this challenge both in how the sampling plan was developed and through detailed interviews with program administrators. As noted earlier, because of the inconsistency in reporting procedures and calculation methodology used for the programs (in some cases, savings are reported as zero), the program budget was utilized as a proxy to stratify savings weights within each funding stream.

The evaluation team also addressed this challenge through interviews with program team members who designed and/or were implementing the programs. Because DOE did not have strict guidelines on reporting energy savings for these programs, many program administrators were not reporting

energy savings directly to the GEO. In some cases, energy savings were calculated and tracked and this information was gathered directly through the program staff.

There were a few cases of programs reporting zero energy saving e.g., Energy Monitors, New Homes). For these cases, the evaluation team often used stipulated savings values and then conducted phone surveys or on-site verification to help validate the stipulated values. If validated, the stipulated values were then extrapolated to the program as a whole.

4.5.3 Schedule

The evaluation team's efforts occurred as the programs were simultaneously being offered and as projects were being implemented. This scheduling misalignment created some challenges in understanding anticipated budgets, reported energy savings, and detailed scope of the service and/or project. In addition, the goals of the program were developed quickly due to the aggressive schedule by DOE to utilize the ARRA funding. Program approaches were therefore inconsistent across funding streams and many program designs were evolving and changing even after the initial program roll out. The best solution to overcome this challenge was found in the program research and interview process. Detailed interviews with program staff were necessary to fully understand the history and future of each funding stream, program, and intended delivery mechanism.

A second challenge involved some of the larger projects funded through the GEO. It was found that several of these projects had implementation schedules that extend well beyond the evaluation horizon, therefore the scope and completion dates were not finalized and could not be accurately evaluated before the evaluation deadline. In order to allow these projects to be evaluated and reported through the GEO program, the evaluation team provided the GEO with the tools to conduct their own on-going measurement and verification (M&V) and evaluation of energy savings for these projects. This will allow the GEO to go back after the projects have been implemented and calculate the appropriate energy savings and budget allocation associated with the projects.

4.5.4 Data Collection

One of the keys for effective implementation of the evaluation plan was access to the GEO's programmatic data. Each program utilizes different reporting processes, databases and spreadsheets to track and report energy savings from the services offered within each program. This created challenges in receiving consistent program and project level information. Additionally, outside consultants are often used by the GEO to track and report progress of the programs. In an effort to reduce the challenge associated with data collection, the evaluation team reviewed and quantified as much of the data as was available in the very early stages of the project so that there was a better understanding of available/non-available data early on. However, throughout the project, there was still the need to amend approaches and sample sizes based on what data became available.

4.5.5 Attribution Identification

The evaluation team faced several of the same challenges when assessing attribution and the net-to-gross scaling factors. The largest impact from these challenges was in identifying the counterfactuals – what the customer would have done without the program. This was mainly an issue of identifying the likely range of actions that the participant would have taken.

The variability in the types of services offered by the programs and the variability of the projects themselves made it necessary to tailor the attribution assessment appropriately. The need for comparability of results required a consistent overall approach to assess attribution. The challenge was making the individual assessments meaningful while also maintaining a consistent approach.

An example that arose during the evaluation in assessing attribution was where the GEO provided grant funds to loan makers or rebate providers, so there were two stages of program influence: Would the loan have been made or the rebates provided without the GEO assistance, and would the loan or rebate recipient have done the eventual project without the loan or rebate? Similarly, some programs had more than one funding source both within the ARRA funds and from outside sources such as local utility providers. This introduced a challenge when assessing attribution because customers may not have a clear understanding of the funding source for the energy efficiency measure that was implemented and therefore which funding source had the largest impact on their decision.

4.6 COORDINATION WITH NATIONAL ARRA EVALUATION

The State Energy Program is also being evaluated at the national level by Kema, Inc. and its partners. The structure of this impact evaluation, including sampling, is based on 14 different Broad Programmatic Activity Categories (BPACs). Each BPAC is defined in detail in the evaluation plan[15] In order to promote consistency between the evaluation team's the GEO-specific evaluation and national evaluation, the evaluation team compared the BPAC definitions with each of the GEO's SEP programs and determined the most appropriate match. Table 4-12 is a cross-reference showing how the GEO's SEP programs fall within the national evaluation's BPACs. Based on the cross referencing of the GEO programs with the BPACs outlined in Table 4-12, the following table (Table 4-11) allocates the net energy savings associated with the GEO Programs into the National Evaluation BPAC's.

[15] *Detailed Study Plan: Final. National Evaluation of the United States Department of Energy's State Energy Program.* Prepared by KEMA Inc and its subcontractors. Submitted to Oak Ridge National Laboratory. June 30, 2011.

Table 4-11 SEP Cross Referenced Energy Savings

National Eval BPACs	Net Source Energy Savings (MMBtus)
Loans, Grants, and Incentives	252,590
Building Retrofits	277,294
New Construction & Design	9,358
Government, School, and Institutional Procurement	45,806
Renewable Energy Market Development	-
Building Codes and Standards	28,521
Total	**613,569**

Table 4-12 Cross Reference of the GEO's SEP Programs with the National SEP Eval BPAC

GEO Market Title	GEO Service	National SEP Eval BPAC	Subcategory
Capital Investments	Revolving Loan Program	Loans, Grants, and Incentives	Building Retrofits: Nonresidential
Capital Investments	Loan Loss Reserve	Loans, Grants, and Incentives	Building Retrofits: Non Residential
Capital Investments	NEED Grants	Loans, Grants, and Incentives	Renewable Energy Market Development (Projects)
Commercial Buildings Existing	Energy Performance Contracting	Building Retrofits	Technical Assistance to Building Owners
Commercial Buildings Existing	Main Street Energy	Loans, Grants, and Incentives	Building Retrofits: Nonresidential
Commercial Buildings Existing	Commercial Building Grants and Contracts	Loans, Grants, and Incentives	Building Retrofits: Nonresidential
Commercial High Performance Buildings	Direct Technical Assistance	Building Retrofits	Technical Assistance to Building Owners
Commercial High Performance Buildings	Grants	Loans, Grants, and Incentives	Building Retrofits: Nonresidential
Greening Government	Refrigerator Decommissioning	Government, School, and Institutional Procurement	Technical Assistance to Building Owners
Greening Government	Workstation Power Management Tool (BigFix)	Government, School, and Institutional Procurement	Technical Assistance to Building Owners
Renewable Energy	Technical Assistance	Renewable Energy Market Development	Technical Assistance to Building Owners
Renewable Energy	Grants	Loans, Grants, and Incentives	Renewable Energy Market Development: Projects
Renewable Energy	Residential PV	Loans, Grants, and Incentives	Renewable Energy Market Development: Projects
Renewable Energy	Residential Solar Thermal	Loans, Grants, and Incentives	Renewable Energy Market Development: Projects
GEO Market Title	**GEO Service**	**National SEP Eval BPAC**	**Subcategory**
Renewable Energy	Residential Wind	Loans, Grants, and Incentives	Renewable Energy Market Development: Projects
Renewable Energy	Small Commercial PV	Loans, Grants, and Incentives	Renewable Energy Market Development: Projects

Renewable Energy	Small Commercial Solar Thermal	Loans, Grants, and Incentives	Renewable Energy Market Development: Projects
Residential Buildings	Residential Code Compliance	Building Codes and Standards	Generalized Marketing & Outreach (participants traceable)
Residential Buildings	Insulation & Air Sealing	Loans, Grants, and Incentives	Building Retrofits: Residential
Residential Buildings	Duct Sealing	Loans, Grants, and Incentives	Building Retrofits: Residential
Residential Buildings	Energy Monitors	Loans, Grants, and Incentives	Building Retrofits: Residential
Residential Buildings	Energy Star New Homes	New Construction & Design	New Construction & Design
Residential Buildings	Furnaces	Loans, Grants, and Incentives	Building Retrofits: Residential

5 STATE ENERGY PROGRAM FINDINGS

The challenge of evaluating the SEP funding stream was the variety of programs offered by the GEO. As discussed in Section 3, the impact evaluation of the SEP market titles was conducted through desk reviews, on-site inspections, phone interviews, and utility bill analysis, depending on the projects implemented. This section presents high level findings for the SEP funding stream as well as the specific findings and methodology used for each of the market titles.

Table 5-1 provides the site findings for each of the market titles within the SEP funding stream with attributable energy savings. Market titles with no attributable energy savings were not evaluated as part of this Project.

Table 5-1: SEP Site Findings

Market Title	Gross Reported Energy Savings (MMBtus)[1]	Gross Verified Energy Savings (MMBtus)		Net Energy Savings (MMBtus)	
	Annual	Annual	Lifetime	Annual	Lifetime
Capital Investments	156,246	146,362	2,549,775	98,046	1,704,375
Commercial Buildings Existing	167,073	159,999	2,345,135	128,595	1,884,362
Commercial High Performance Buildings	48,336	42,734	641,005	28,211	423,167
Greening Government	420	13,805	71,511	13,805	71,511
Renewable Energy Programs	22,616	21,762	425,789	17,663	341,849
Residential Buildings	36,503	106,416	2,075,025	51,340	1,003,225
Totals	**431,194**	**491,078**	**8,108,239**	**337,661**	**5,428,488**

[1] The GEO did not report lifetime energy savings

5.1.1 SEP Gross Reported Savings

The first step in determining the net savings for the SEP was to evaluate the savings reported by the GEO to the DOE. Reporting of energy savings and other metrics associated with the programs was required quarterly to the DOE using the Performance and Accounting for Grants in Energy (PAGE) reporting system. Table 5-2 outlines the gross site energy savings reported by the GEO as of December 2011 for each market title. The evaluation team utilized a variety of the GEO databases to determine the reported energy savings. First, the team reviewed the rebate databases provided by the GEO's rebate processing subcontractor to determine the number of participants for the rebates. Then the team used the GEO deemed savings to determine the energy savings associated with those rebates. The team also used the GEO's tracking spreadsheet, which served as its DOE reporting tool, to derive non-rebate program energy saving totals. In some cases the reported savings were adjusted due to database issues identified by the evaluation team. These adjusted savings are presented in the table below. More information regarding the methodology for each market title is provided in the sections below. The GEO did not report lifetime energy savings.

Table 5-2 SEP Gross Reported Site Energy Savings

Market Title	Gross Reported Electricity Savings (kWh)	Gross Reported Gas Savings (MMBtus)	Total Gross Reported Savings (MMBtus)
Capital Investments	11,353,428	117,508	156,246
Commercial Buildings Existing	18,779,000	92,395	167,073
Commercial High Performance Buildings	6,600,038	25,817	48,336
Greening Government	123,163	0	420
Renewable Energy Programs	3,326,335	11,267	22,616
Residential Buildings	267,250	35,592	36,503
Total	**40,449,213**	**282,578**	**431,194**

5.1.2 SEP Gross Verified Savings

The data collected as a result of the on-site inspections, phone surveys and engineering analysis, allowed the evaluation team to recalculate energy and demand savings for each sampled project—this is termed the gross verified savings. The ratio of the gross verified savings to the reported savings by the GEO is the project's "realization rate" while the program's realization rate is the weighted average for all the projects within the sample. Total gross verified savings are the product of the reported savings for that program and the program's realization rate. These program level gross verified savings are totaled up to the market title level. The market title totals are then summed to the funding stream level.

The realization rates were not calculated for most market title levels due to the variability of programs within each market title. Only the Greening Government market title had a reportable realization rate of 0.99. Realization rates were calculated for the sub-market title programs and were used by the evaluation team to calculate the gross verified energy saving s for the SEP market titles. Table 5-3 outlines these gross verified site energy savings.

Table 5-3 SEP Gross Verified Site Energy Savings

Market Title	Gross Verified Electricity Savings (kWh)		Gross Verified Gas Savings (MMBtus)		Total Gross Verified Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Capital Investments	10,615,549	184,153,278	110,142	1,921,444	146,362	2,549,775
Commercial Buildings Existing	18,453,062	268,369,134	97,037	1,429,459	159,999	2,345,135
Commercial High Performance Buildings	5,685,794	85,286,911	23,334	350,006	42,734	641,005
Greening Government	4,046,103	20,958,812	0	0	13,805	71,511
Renewable Energy Programs	3,478,858	77,275,066	9,892	162,126	21,762	425,789
Residential Buildings	2,408,375	40,294,998	98,199	1,937,538	106,416	2,075,025
Total	**44,687,742**	**676,338,199**	**338,603**	**5,800,573**	**491,078**	**8,108,239**

In addition to the site savings, the evaluation team calculated the energy savings and other metrics associated with the source of generation. These savings are detailed in Table 5-4 and Table 5-5.

Table 5-4 SEP Gross Verified Source Energy Savings

Market Title	Gross Verified Electricity Savings (kWh)		Gross Verified Gas Savings (MMBtus)		Total Gross Verified Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Capital Investments	35,222,391	611,020,578	115,319	2,011,752	235,497	4,096,554
Commercial Buildings Existing	61,227,261	890,448,786	101,597	1,496,644	310,505	4,534,855
Commercial High Performance Buildings	18,865,465	282,981,969	24,430	366,456	88,799	1,331,990
Greening Government	13,424,971	69,541,339	0	0	45,806	237,275
Renewable Energy Programs	11,542,849	256,398,668	10,357	169,746	49,741	1,044,578
Residential Buildings	7,990,989	133,698,803	102,814	2,028,602	130,080	2,484,783
Total	**148,273,926**	**2,244,090,144**	**354,517**	**6,073,200**	**860,428**	**13,730,036**

Table 5-5 SEP Gross Verified Source Demand, CO2e, and Water Savings

Market Title	Gross Verified Demand Savings (kW)		Gross Verified CO2e (tonnes)		Total Gross Verified Water Savings	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Capital Investments	9,529	n/a	16,885	293,523	12,738,659	220,983,934
Commercial Buildings Existing	4,122	n/a	24,068	351,048	22,143,675	322,042,961
Commercial High Performance Buildings	2,020	n/a	7,048	105,727	6,822,953	102,344,293
Greening Government	16	n/a	4,087	21,168	4,855,324	25,150,575
Renewable Energy Programs	1,130	n/a	4,067	87,121	4,174,629	92,730,079
Residential Buildings	7,779	n/a	7,928	149,127	2,890,050	48,353,997
Total	**24,596**	**-**	**64,084**	**1,007,714**	**53,625,290**	**811,605,839**

5.1.3 Net Savings

Net energy savings impacts are calculated by multiplying the gross verified savings by a net-to-gross (NTG) ratio. The development of the NTG ratio is described below. However, some NTG ratios are not presented at the market title level due to the diversity of programs within the market title. The NTG ratios for the individual programs within the market titles are detailed in further in this section.

5.1.4 Freeridership

The first component of the NTG ratio is freeridership. Free riders involve participants who on some level may have participated in the program regardless of the GEO influence. Freeridership is assessed through attribution surveys delivered to the sample populations.

The evaluation team conducted surveys with decision makers for the sampled projects.

5.1.5 Net to Gross Ratios

Based on the calculated rates of freeridership, the evaluation team was able to assess the NTG ratio for the individual programs within the market titles. However, some ratios were not calculated at the market title level due to the variability within the market title. Realization rates were calculated for the sub-market title programs and were used by the evaluation team to calculate the net verified energy saving s for the SEP market titles.

5.1.5.1 Net Savings

The evaluation team then multiplied the NTG ratios by the gross verified savings to determine the overall net energy impacts. Table 5-6 summarizes the evaluation team's findings for the net site energy savings.

Table 5-6 SEP Net Site Energy Savings

Market Title	Net Electricity Savings (kWh)		Net Gas Savings (MMBtus)		Total Net Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Capital Investments	7,158,925	124,117,586	73,620	1,280,886	98,046	1,704,375
Commercial Buildings Existing	14,822,480	215,520,270	78,020	1,149,007	128,595	1,884,362
Commercial High Performance Buildings	3,777,449	56,661,742	15,322	229,837	28,211	423,167
Greening Government	4,046,103	20,958,812	0	0	13,805	71,511
Renewable Energy Programs	2,674,439	59,407,934	8,538	139,149	17,663	341,849
Residential Buildings	1,079,748	18,016,111	47,656	941,754	51,340	1,003,225
Total	**33,559,145**	**494,682,455**	**223,157**	**3,740,632**	**337,661**	**5,428,488**

In addition to the site savings, the evaluation team calculated the energy savings and other metrics associated with the source of generation. These savings are detailed in Table 5-7 and Table 5-8.

Table 5-7 SEP Net Source Energy Savings

Market Title	Net Electricity Savings (kWh)		Net Gas Savings (MMBtus)		Total Net Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Capital Investments	23,753,312	411,822,152	77,080	1,341,087	158,126	2,746,224
Commercial Buildings Existing	49,180,988	715,096,257	81,687	1,203,010	249,493	3,642,918
Commercial High Performance Buildings	12,533,577	188,003,659	16,043	240,639	58,807	882,108
Greening Government	13,424,971	69,541,339	0	0	45,806	237,275
Renewable Energy Programs	8,873,789	197,115,526	8,940	145,689	39,217	818,247
Residential Buildings	3,582,605	59,777,455	49,896	986,016	62,120	1,189,977
Total	**111,349,243**	**1,641,356,387**	**233,645**	**3,916,441**	**613,569**	**9,516,749**

Table 5-8 SEP Net Source Demand, CO2e, and Water Savings

Market Title	Net Demand Savings (kW)		Net CO2e (tonnes)		Net Water Savings	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Capital Investments	6,489	n/a	11,350	197,040	8,590,710	148,941,104
Commercial Buildings Existing	3,308	n/a	19,337	281,976	17,786,976	258,624,324
Commercial High Performance Buildings	1,343	n/a	4,673	70,091	4,532,939	67,994,090
Greening Government	16	n/a	4,087	21,168	4,855,324	25,150,575
Renewable Energy Programs	862	n/a	3,179	67,789	3,209,327	71,289,521
Residential Buildings	2,971	n/a	3,757	70,899	1,295,698	21,619,333
Total	**14,990**	**-**	**46,383**	**708,963**	**40,270,974**	**593,618,947**

The remainder of this section will detail the individual findings and methodology for each of these market titles.

5.2 CAPITAL INVESTMENTS

Capital Investments included the following three programs that were evaluated for this Project:

- Green Colorado Credit Reserve
- Revolving Loan Program
- New Energy Economy Development (NEED) Grants

Table 5-9 details the findings from our evaluation activities for the Capital Investments market title.

Table 5-9 Capital Investments Site Findings

Capital Investments	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Revolving Loan Program	0	n/a	3,578	71,566	0.25	895	17,891
Green Colorado Credit Reserve	0	n/a	788	11,032	0.57	453	6,336
NEED Grants	156,246	0.91	141,996	2,467,176	0.68	96,699	1,680,147
Totals	**156,246**	-	**146,362**	**2,549,775**	-	**98,046**	**1,704,375**

5.2.1 Green Colorado Credit Reserve

The Green Colorado Credit Reserve (GCCR) is a $1 million loan loss reserve created to leverage private lenders to make small commercial loans up to $100,000 for capital improvements to promote energy efficient retrofits in buildings and renewable energy installations. The goal of the program is to both improve access to capital for small Colorado businesses interested in making energy efficiency or renewable energy improvements and better equip lenders to provide those loans. The program works by providing participating lenders a 15% loan loss reserve contribution for every loan registered in the program to encourage private sector lending and generate cost savings for businesses.

5.2.1.1 Savings

The GCCR program is still gaining traction in the marketplace. To date, three Colorado banks have registered to participate (with several more banks expressing interest) and three loans were closed in 2011 with two of the banks. The loans provided capital to small businesses in Colorado for energy efficiency and renewable energy projects. Table 5-10 shows the gross and net verified savings associated with the three projects completed to date.

Table 5-10 Green Colorado Credit Reserve Findings

Capital Investments	Gross Reported Energy Savings (MMbtus)	Realization Rate	Gross Verified Energy Savings (MMbtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Green Colorado Credit Reserve	0	n/a	788	11,032	0.57	453	6,336

5.2.1.2 Qualitative Findings

Interviews with participating banks and businesses indicate that the GCCR program is having the desired effect for the loans that have closed to date. Both banks indicated they were able to provide the loans at more favorable terms than they otherwise would have been able to. This reduces loan repayment amounts, making the energy projects more economically attractive to the businesses. The GCCR program is also enabling banks to provide loans in an industry they might not have otherwise. One bank manager stated, "We would not have been able to provide the loan without the existence of the GCCR funds."

5.2.1.3 Methodology

While the program is still gaining traction in the marketplace, an initial desk review of the three participating banks and three businesses that received a loan was performed to provide initial estimates of the investment and energy savings impacts for the program. With only two banks and three businesses participating, a census survey was conducted. As part of the desk review, the evaluation team sought to better understand the terms of each loan and how it supported an energy efficiency retrofit or renewable installation. A review of project documents and communications with the GEO occurred, along with phone interviews of all bank managers and business representatives participating in the loan.

Follow-up interviews with bank managers and business participants were conducted to verify energy savings associated with each project that received a loan. Energy savings were calculated from the performance metrics of the energy retrofit or renewable installation. On-site inspections were not performed. Once energy savings were calculated from the desk review, an Attribution Survey of both the business and bank manager enabled the team to calculate free rider scores and quantify the percentage of energy savings attributable to the GCCR funds. These attribution surveys sought to understand the influence the loan terms had on the viability of the project and provide a proper net to gross discount factor to the savings. Total savings for the program were then weighted by investment per project as compared to total investment.

5.2.2 Revolving Loan Program

The Revolving Loan Program (RLP) is designed to provide essential capital to early-stage companies and commercial projects utilizing innovative energy technologies that are incapable of accessing capital from traditional sources. Loans of at least $100,000 are intended for either large-scale retrofit of buildings or for companies whose products or services directly impact the renewable energy and energy efficiency sector in Colorado from an economic development basis.

5.2.2.1 Savings & Job Impacts

The GEO had not yet closed all of the loans associated with the RLP program at the time of the evaluation. Five loans were closed as of December 31, 2011 representing 64% of the program's funds. The majority of the loans were provided for the net working capital needs of four early-stage

companies; remaining loans were directed to a commercial building retrofit. Three additional loans were approved, but were still within the closing process as of the time of this report.

It was only possible to calculate verified energy savings for the loan provided to the commercial building retrofit. Table 5-11 below shows the gross and net verified energy savings associated with that specific loan. It should be noted that the savings below are not intended to be representative of the entire Revolving Loan Program.

Table 5-11 Revolving Loan Program Findings

Capital Investments	Gross Reported Energy Savings (MMbtus)	Realization Rate	Gross Verified Energy Savings (MMbtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Revolving Loan Program	0	n/a	3,578	71,566	0.25	895	17,891

It was not possible to verify energy savings associated with the remaining four loans. The funds were intended to stimulate economic development of the "green" economy in Colorado and provide working capital for early-stage companies. While the companies' products ultimately provide energy savings in the marketplace, direct and measurable energy savings were not available at the time of this report. However, job impacts are known and are reported in Table 5-12 and Table 5-13 below along with illustrative energy impacts. While energy savings cannot be measured for the companies in Table 5-12 below, the loans clearly had a significant impact on jobs with 119 jobs created in Colorado in 2011.

Table 5-12 Illustrative Energy Savings and Verified Job Impacts

Company	Purpose of Loan	Jobs Created in 2011	Jobs Retained in 2011	NTG Ratio	Illustrative Energy Savings
Company #2	Financing for the acquisition and renovation of a building that will house manufacturing operations.	113	0	1.00	Production of 400 units contributing to 800 MW of installed renewable energy
Company #3	Working capital to pay salaries for sales and marketing expense.	6	13	0.75	N/A

At some point in the future it may be possible to calculate measurable energy savings associated with the loans for company 4 and company 5. The products produced by these companies do have direct energy savings, and therefore could be calculated on a savings per unit sold basis. However, the companies' operations within Colorado are still in the early stage and had not sold any products as of the time of this report. The potential for energy savings are significant in the coming years and on an economic basis the loan created and retained 69 jobs in Colorado.

Table 5-13 Energy Savings per Unit Sold & Job Impacts

Company	Purpose of Loan	Jobs Created in 2011	Jobs Retained in 2011	NTG Ratio	Estimated Annual Energy Savings per unit sold
Company #4	Financing for manufacturing equipment purchases	25	28	0.88	9.6 kW (nameplate capacity)
Company #5	Financing for capital equipment purchases	8	8	1.00	94,640 KWh

5.2.2.2 Qualitative Findings

The loan recipients included four Colorado "cleantech" early-stage companies and one building retrofit project. Of the five loan recipients interviewed to date, the loans have overall had a significant impact on their operations and ability to successfully enter the marketplace. Some of the qualitative impacts of the loans are noted below:

- One CEO noted that the RLP loan "*saved his company*" enabling them to begin manufacturing to fulfill existing orders. 16 jobs were created and retained in Colorado.
- Another CEO noted that without the loan from the RLP, they would have been forced to move their operations from Colorado to Europe preventing the creation of 113 jobs in Colorado.
- Another owner noted that without the RLP loan his company would have had to significantly cut back operations and lay off more than 13 employees and discontinue development of a new product.
- A CEO noted the loan enabled it to purchase 60% of its manufacturing equipment and be first to market with a potentially breakthrough technology.
- The energy efficiency retrofit loan provided a lower interest rate for the building owner to install high-efficiency technologies; however, it was discovered the retrofits would have largely happened without the RLP loan (as is indicated by the high free rider score).

5.2.2.3 Methodology

A desk review of the five businesses that received a loan was performed to provide estimated energy savings, job impacts and qualitative findings on the program. No on-site data collection occurred. As part of the desk review, we sought to better understand the terms of each loan and what the funds supported. A review of project documents and communications with the GEO occurred, along with phone interviews of the business representatives. Attribution surveys were developed to quantify what portion of the energy impacts can be attributed to the RLP funds either now or in the future.

Verified energy savings are only provided for the company that conducted a building retrofit (Table 5-11). The building owner provided billing information, spec sheets, and efficiency information of both the pre and post retrofit equipment. Savings were calculated based on estimated annual energy usage of the lighting and heating equipment before and after the retrofit.

Verified energy savings are not feasible at this time for the companies in Table 5-12 and Table 5-13. These loans were primarily designed to stimulate economic development in the "green" economy in Colorado and provide working capital to early stage companies. Consequently, two significant barriers presented themselves:

1. The loans provided working capital to purchase equipment or pay salaries of early-stage companies whose products do not have direct energy savings (companies in Table 5-12).
2. While the companies that received the loans manufactured products whose energy savings can be estimated, they were still in a very early-stage and had not yet sold any products produced by operations in Colorado (companies in Table 5-13).

It is not possible to calculate verified energy savings now or in the future for a company whose product has no direct energy savings (as is the case for company #2 and #3). That is not to say there aren't potential energy savings associated with the loans, there are simply too many assumptions necessary to calculate an estimated savings. And while it is not possible to verify energy savings for companies #4 and #5 based on existing forecasted sales, it may be possible to verify energy savings in the future. Therefore, our approach for those companies was to estimate projected energy savings based on a per-unit of sales basis. Verified savings could then be calculated in the future once historical sales figures are available. This would be done by calculating the energy savings associated with each unit of sales, multiplied by the listed free rider score, then multiplied again by the historical sales numbers. The simplified equation would be as follows:

*Project Energy Savings (kWh) = Per Unit energy savings * Free Rider Score (%) * number of unit sales*

5.2.3 NEED Grants

New Energy Economy Development (NEED) Grants seek to accelerate deployment of renewable energy and energy efficiency projects by providing grant funding to communities for energy efficiency and renewable energy projects.

5.2.3.1 Savings

The NEED Grant program assisted a wide variety of project types. Moreover, how the NEED Grant was applied to a project was not strictly uniform throughout the program. For the purposes of this evaluation, gross savings represent savings that are attributable to measures directly funded or indirectly supported by the NEED Grant itself. In many cases, the grant did directly fund a portion of each measure installed within a project, and the gross savings are derived from the project as a whole. There were, however, scenarios in which the NEED Grant was allocated to a specific measure that was separate from other measures installed within the project. For example, a NEED Grant may have been applied to fund a specific measure in one building as part of an EPC project that provided upgrades to multiple buildings; it would be misrepresentative to allocate the gross savings of the entire EPC project to the NEED Grant. In these cases, the evaluation team isolated the effects of each measure and has reported gross savings for only those measures that were directly or indirectly supported by the NEED Grant.

Additionally, the evaluation team reviewed the GEO reported energy savings but adjusted these savings to best reflect projects that produced actual energy efficiency measures. Reported savings were provided via Attachment A of the NEED Grant applications. Projects that used the NEED Grant to produce studies or marketing programs were considered Education & Outreach (E&O) projects with no direct energy savings. Therefore, the reported savings for these projects were removed from the sample and population when calculating the verified savings for the program. Table 5-14 below shows the adjustments made by the evaluation team.

The initial sample generated by the evaluation team intended to exclude E&O projects. However, after beginning the program review, the evaluation team found two participants in its sample that it considered as E&O projects. While both these projects reported expected savings in its application to the GEO, the evaluation team judged there to be no direct energy savings from these projects. These projects were not included when calculating the realization rate for the NEED Grant Program.

Table 5-14 NEED Grant Verified Savings

NEED Grant Program	MMBtu
GEO Reported Savings[1]	1,836,345
E&O Reported Savings	1,680,099
Adjusted Reported Savings	156,246
Realization Rate	0.91
Verified Savings	**141,996**

[1]Reported savings derived from NEED Grant application Attachment A.

The net savings attributable to the GEO were determined by the attribution score calculated for the program. Each participant was interviewed by phone using the survey instrument designed for each sample.

Due to the heterogeneity and unique aspects of the NEED Grant projects sampled, each survey was custom designed for each sample. The methodology for the design of the survey instrument involved determining how the NEED Grant was used in the overall scope of the project. For instances in which the NEED Grant directly funded a particular measure(s), the survey instrument inquired specifically on that measure(s). In cases for which the NEED Grant was distributed across the overall scope of the project, the survey instrument inquired on the project as a whole.

5.2.3.2 Qualitative Findings

Satisfaction

NEED Grant recipients showed the greatest satisfaction with the amount of the grant received as well as the performance of the NEED Grant-funded systems and/or measures. Satisfaction was also generally high based on the overall experience, the application, information obtained on website, and the ability to find a contractor. NEED Grant recipients showed very low satisfaction with the time it took to receive the grant installments.

Qualitative Observations

The attribution survey asked by the evaluation team also included questions regarding outside influences on a NEED Grant project. Other forms of assistance such as other grants and internal budgets were reported to play a significant role on the project. Additionally, the role of the project contractor also was rated as playing a strong role in the project.

5.2.3.3 Methodology

Due to the variety of energy efficiency and renewable energy projects funded by this grant program, the evaluation team employed IPMVP Option A, C, or D depending on the projects selected to sample. A total of six samples were selected for on-site inspections and eight were selected for desk review.

Projects selected for desk review underwent inspection of all project documents including communications between the GEO, the participant, and third party contractors, grant application and final reporting, installation documentation, savings calculations, and interviews with participants. Reported energy savings were reviewed and adjusted in cases of identified calculation errors or inconsistencies between reported performance and verified performance of installed equipment. For some projects, such as those that involve wind or solar photovoltaic generation, enough data was available to run simulation models without the need to visit the site.

Projects that underwent an on-site inspection have adjusted gross savings estimated dependent on on-site data collection. While on-site, evaluation team engineers gathered information on the equipment that was installed as a result of the grant such as nameplate data, equipment counts, and fixture counts to verify installation occurred as depicted in design documents. In certain cases, equipment was inspected that was not directly funded by the NEED Grant, yet the NEED grant still influenced the installation of that equipment. Due to the wide variety of projects funded by the

NEED grant program, various spreadsheet models and software tools were used to analyze the projects based on data collected on-site.

5.3 COMMERCIAL BUILDINGS EXISTING

Commercial Buildings Existing included three programs that were evaluated as part of this Project:

- Energy Performance Contracting (EPC)
- Grants
- Main Street Efficiency Initiative (MSEI)

Table 5-15 details the findings from our evaluation activities for the Commercial Buildings Existing market title.

Table 5-15 Commercial Building Existing Site Findings

Commercial Buildings Existing	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Energy Performance Contracting	156,484	0.95	148,026	2,220,394	0.80	118,805	1,782,071
Grants	0	n/a	1,673	21,745	0.88	1,464	19,027
Main Street Efficiency Initiative	10,589	0.94	10,300	102,996	0.81	8,326	83,264
Totals	**167,073**	**-**	**159,999**	**2,345,135**	**-**	**128,595**	**1,884,362**

5.3.1 Energy Performance Contracting

The EPC program provides technical assistance to communities undertaking an energy performance contract. The GEO manages and administers the EPC activities of 14 energy service companies that provide performance contracting services to the communities.

5.3.1.1 Savings

The GEO reported savings for the EPC program was 156,484 MMBtu. Based on the calculated realization rate of 94.6%, the evaluation team determined a verified annual gross savings of 148,026 MMBtus. The vast majority of these savings were derived from natural gas savings. A net-to-gross ratio of 0.80 was determined from results of the attribution surveys. This resulted in a net site energy savings of 118,805 MMBtus.

5.3.1.2 Qualitative Findings

Satisfaction

In general, the participants contacted regarding this project were quite positive regarding the EPC program. However, more than one questioned attribution of the savings realized to the GEO. Some felt that the GEO was mostly a "match making" service, connecting building owners and managers with ESCOs active in the field of performance contracting.

5.3.1.3 Methodology

Due to the large number of building and measures involved in each of the 10 sample projects, the evaluation team used a sampling technique to determine each of the larger project's overall savings. Using the data contained in the Technical Energy Audit (TEA) provided with each EPC project, calculations were developed for a subset of the energy conservation measures representing 77 - 83% of the total project savings, depending on the project. The savings determined from these measures were then extrapolated to the remaining measures' savings to determine the overall project savings rates.

Each measure was evaluated using standard engineering savings calculations and direct measurement of savings was not possible due to the fact that the 10 sample projects were still under construction as of this report date. In addition, pre-construction energy measurements were not available to provide the needed baseline. Most of the projects largest savings were from lighting retrofit measures, therefore the calculations used to determine these savings were straightforward, with little uncertainty. The is contrasted with some measures such as HVAC upgrades, controls changes and direct digital control installations, where pre and post energy measurements are often required to accurately determine savings.

For attribution, the evaluation team surveyed both the building owner and the ESCO, under the theory that, since the GEO worked with both the building owner and the ESCO, neither alone could accurately describe what would have happened without the assistance.

In addition to being asked what would have happened (postpone/cancel, smaller project, same upgrade) without program support, building owners were asked:

- If they've ever worked with an ESCO before (addresses how well they could predict what would have happened without program support).
- How valuable the GEO assistance was (1-5 scale).
- Whether the business would have contacted an ESCO on its own.
- How it would have financed the project.

ESCOs were asked:

- How likely they would have known about the client without GEO assistance.
- What likely would have happened without GEO assistance (same EPC, lower-savings EPC, no EPC).

The intention component score was based on responses by both the building owner and the ESCO. The building owner score is calculated first. If the building owner reports experience with ESCOs and indicates that, without GEO assistance, they would have gotten an EPC, self-financed, or have cancelled or postponed the project, then only the owner response is considered. In other cases, where there may be reason to question the building owner's ability to provide an accurate response (the building owner does not have experience with ESCOs, so they would not know whether they would be able to establish an EPC to do the same project), then the ESCO's response is also considered. If the ESCO's response disagrees with the owner's response, the latter's intention score is adjusted.

5.3.2 Commercial Building Existing Grants

The Commercial Building Existing Grants were used to encourage the completion of energy efficiency and renewable energy projects.

5.3.2.1 Savings

There were no reported savings for this program. Verified savings were only calculated for the two sample projects, not for the population as information for the non-sampled grants was not available.

5.3.2.2 Qualitative Findings

The GEO offered 4 grants through this program. Of these, two projects were randomly selected to undergo measurement and verification. While both projects resulted in energy savings, there were also other "soft" benefits from these projects. For one project, the grant helped enable the restoration of an historic building. At the other, a large public event was held to educate the community about the economic and environmental benefits of energy efficient building technologies.

5.3.2.3 Methodology

A measurement and verification analysis was performed for the two sample projects funded by this program. For the first project, projected energy savings were calculated by the owner and summarized in the grant application to the GEO. The energy savings reported were based on ASHRAE Manual-J calculations, degree day weather data, and included a 60,000 BTU annual domestic hot water load. Because the facility had not been heated during the winter in the last couple of decades, the new energy use profile was compared to a baseline that assumed the use of the propane heating system all year round.

For the second project, the M&V analysis drew upon the data contained in a previously completed energy audit and the grant progress reports provided to the GEO. Since very little facility specific data was provided, the evaluation team calculated savings by making assumptions regarding the energy efficiency measures and historical utility data.

Since no GEO-reported savings exist for this program activity, there is no basis to determine a realization rate.

5.3.3 Main Street Efficiency Initiative

Funding for the MSEI program came from both SEP and EECBG and energy savings were allocated based on budgets from each funding stream. These budget allocations were:

SEP-- 43% of the MSEI budget

EECBG-- 57% of the MSEI budget

Detailed information regarding the MSEI evaluation is discussed in Section 6.2.1 under the EECBG Section.

5.4 COMMERCIAL HIGH PERFORMANCE BUILDINGS

Two programs were evaluated as part of the Commercial High Performance Buildings market title:

- Technical Assistance
- Grants

Table 5-16 details the findings from our evaluation activities for these activities:

Table 5-16 Commercial High Performance Buildings Site Findings

Commercial High Performance Buildings	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Technical Assistance	48,336	0.86	41,521	622,814	0.66	27,605	414,071
Grants	0	n/a	1,213	18,191	0.50	606	9,096
Totals	**48,336**	-	**42,734**	**641,005**	-	**28,211**	**423,167**

5.4.1 Technical Assistance

The High Performance Building Technical Assistance program provided direct assistance to public institutions to encourage the implementation of energy efficient equipment during the construction of new buildings.

5.4.1.1 Savings

Reported annual gross savings were 48,336 MMBtus. The evaluation team's analysis estimated a realization rate of 86% resulting in annual gross site savings of 41,521 MMBtus. Attribution surveys determined a net-to-gross ratio of 67 resulting in annual net site savings of 27,605 MMBtus and annual net source savings of 58,109 MMBtus. The total savings were approximately shared between electricity and natural gas savings.

5.4.1.2 Qualitative Findings

Most sample project participants reported that the GEO played a role in the design phase and provided assistance in advancing efficiency measures. In general, the GEO consultants worked with design teams to identify energy efficiency strategies in schematic design. The GEO consultants then reviewed design development and construction documents for implementation issues relative to the efficiency measures. Many of the clients participated in other design assistance and rebate programs and pursued LEED Certification. The GEO program was complementary to these other efforts.

One client expressed that the GEO High Performance Building Technical Assistance was extremely valuable and constructive. "Our assessment of the support from this the GEO program has been very positive. Some of the ideas were outside what we could afford but there was an excellent dialogue and a lot of exchange of ideas, trade-offs, performance opportunities."

All clients from each of the eight sample projects were contacted over the phone and through email to participate in a simple phone survey intended to provide information regarding their projects. Additionally, two GEO contractors provided key data for the M&V analysis. Select additional

contractors involved with the sample project we contacted for supplementation information requests.

Satisfaction

The role that the GEO played varied amongst the projects, with some remaining very minimal and ending early on in design and others where the GEO remained active throughout the design and construction process. While the experiences of the clients were varied, all seemed to be satisfied with the end result of the program. No dissatisfaction in the GEO program and process was expressed by any of the clients.

5.4.1.3 Methodology

Eight sample projects were chosen to represent participants of the Commercial High Performance Technical Assistance Program. These sample projects were chosen randomly from a total population of 80 High Performance Building Technical Assistance projects (accessed through the GEO database). A questionnaire was developed to collect information considered to be beneficial to the measurement and verification process. This questionnaire was delivered as a phone survey to each client. After all clients had been contacted, a list of documents needed was developed and requested from the GEO consultants. The primary documents requested included: Final project drawings and specifications, final energy model results (LEED EAp2 submittal if pursuing LEED Certification), and commissioning plan, M&V plan, and technical energy audit (if applicable).

After documents were obtained, the measurement and verification process for each sample project began with the following steps:

1. Review 100% construction drawings (CD's) and energy reports and log all energy efficiency measures identified in the reports.
2. Verify that the energy efficiency measures are included in the 100% CD's and note performance criteria. Identify and add any measures that are in the drawings but not in the energy modeling report.
3. Input the energy modeling results, energy and demand, by end use and fuel type.
4. Review validity of energy modeling results by comparing to an industry standard, such as Energy Star Target Finder. Review energy savings by end use predicted by energy model and compare to energy efficiency measures included in the 100% CD's.
5. Determine the operating hours. Compare the annual operating hours estimated with those used in the energy model.
6. Identify those measures that result in the greatest energy savings and require verification of savings estimate. Primary measures to evaluate and verify include:
    a. Review insulation levels of opaque assemblies, (e.g. walls and roof). If insulation levels are verified in drawings and are close or better than the energy code prescriptive requirements, no savings calculations are necessary. Savings associated with these components are typically less than 5% of total savings.
    b. Review fenestration performance and verify that what was modeled reflects what is in the design (U, SHGC and VT). If fenestration area is more than 20%, it may have a

significant influence on energy savings. Savings calculations are only necessary if what is modeled differs by more than 10% from design.

c. Perform interior lighting take-offs for representative spaces and identify extent of lighting controls. Calculate lighting energy savings. Where occupancy sensors and daylighting controls are used, estimate associate savings and document assumptions.
d. If exterior lighting energy savings are significant (10% or more of electricity savings), perform take-off on exterior lighting.
e. If the proposed HVAC design differs from the energy code baseline, identify the relevant efficiency improvements over the baseline. Review energy modeling results for reasonableness and adjust as necessary.
f. Compare pumps and associated controls to determine is savings predictions are reasonable. If estimated electricity savings are more than 10% of electricity savings, verify calculations.
g. Calculate the adjusted energy and demand savings for the project and compare to the GEO reported savings to determine realization rate.

The attribution methodology included asking what would have happened (postpone/cancel, smaller project, same upgrade) without program support. Building owners who said they would have done a project (i.e., all those who did not say they would have postponed or cancelled the project) were asked if they would have found similar assistance elsewhere without program assistance. The theory is that those who would not have found similar assistance would have achieved lower savings, regardless of whether they would have done the same or a smaller project, than if they would have found similar assistance. Therefore, those who reported that they would not have found similar savings elsewhere were assigned lower intention component scores than those who reported that they would have found similar savings elsewhere.

5.4.2 High Performance Buildings Grant Program

The High Performance Buildings Grant Program offered funding for energy efficiency and renewable energy improvements.

5.4.2.1 Savings

There were no reported savings for this grant program. Verified savings were only provided for the one sample, not for the population as information for the non-sampled grants was not available.

5.4.2.2 Qualitative Findings

The GEO awarded eight grants for this program. Three of these had energy savings attributable to the grants. One project was chosen for the evaluation activities.

Staff members of the sampled facility were contacted over the phone and through email to request information regarding their project. The evaluation team also reached out to the project architect to secure needed data.

5.4.2.3 Methodology

A measurement and verification analysis was performed for the single project funded by this program. Using the data contained in the LEED submittal, calculations were developed for each energy conservation measure funded by the grant (high performance windows and wall insulation). The following assumptions were used in the calculations:

- All energy savings related to envelope upgrades are in heating energy.
- A 65F base degree day calculation was used to estimate energy savings.
- Design model used to calculate design envelope properties (Building UA factor).
- GSHP is first stage heat, condensing boiler is 2nd stage heat.
- The rated performance of the geo-exchange heat pump was used to calculate heating energy savings.
- Calibrated spreadsheet model to LEED model by assuming internal heat gain & max heat available from heat pump
- Baseline model used to calculate baseline envelope properties.

Since no GEO-reported savings exist for this program activity, there is no basis to determine a realization rate.

5.5 GREENING GOVERNMENT

The GEO's Greening Government program endeavors to assist Colorado state agencies in achieving the mandated goal of reducing energy consumption in state facilities by 20% below a 2005 baseline by the year 2012. This goal was introduced in a 2007 executive order and reinforced by a 2010 executive order. Other goals contained within these two executive orders include specific reductions in state agency consumption of water, paper, petroleum, associated greenhouse gases, and waste.

The team evaluated both the BigFix program and the refrigerator replacement program. BigFix intends to reduce the energy consumption of computers in State agencies using network-based software to power down, or otherwise reduce the energy consumption of, thousands of PCs. The refrigerator replacement program aims to replace older, inefficient refrigerators with Energy Star units in many State agencies.

Table 5-17 details the findings from our evaluation for these activities:

Table 5-17 Greening Government Site Findings

Greening Government	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Refrigerator Replacement	420	0.99	414	4,556	1.0	414	4,556
BigFix	0	n/a	13,391	66,956	1.0	13,391	66,956
Totals	**420**	**-**	**13,805**	**71,511**	**-**	**13,805**	**71,511**

5.5.1.1 Savings

BigFix

Energy savings calculations utilized to analyze the BigFix program used a stipulated savings value of 299 kWh/PC/year, the derivation of which is described in more detail in section 5.5.1.3. Applying the stipulated value to an estimated total number of PCs with the BigFix software deployed on them, resulted in an overall gross energy savings of 3,925 MWh/year.

Refrigerator Replacement

For the refrigerator replacement program, existing, operational refrigerators of varying ages were replaced by Energy Star compliant models. Energy savings varied substantially for each replacement due to factors like the age and size of the baseline refrigerator. Verified savings estimates for the sample ranged from a minimum of 170 kWh/year to a maximum of over 2,000 kWh/year, with a mean average of approximately 930 kWh/year.

5.5.1.2 Participation

BigFix

Table 5-18 shows the targeted participation in the BigFix program.

Table 5-18 BigFix Estimated Participation by State Department

Department	Goal (# of PCs with BigFix implemented)
Public Safety	1,800
Revenue	1,800
CDOT	1,600
DORA	600
DOLA	100
History Colorado	180
Treasury	100
Energy Office	30
OEDIT	100
Governor's Office	100
Natural Resources	1,500
CDHS	2,452*
CDLE	1,468*
Corrections	705*
CDPHE	1,573*
Estimated Total Participation	**14,108**

* Actual participation numbers after full deployment

Refrigerator Replacement

A total of 115 refrigerators were replaced with Energy Star models in 15 different state agencies. The program called for a maximum replacement of 10 refrigerators for any given department. Eight of the 15 departments that participated took full advantage by replacing 10 refrigerators.

5.5.1.3 Methodology

BigFix

The team developed a stipulated energy savings per PC per year based on ten previously completed studies on networked PC power management software solutions from a variety of locations and agency types. Energy savings estimated in each study, divided by the number of PCs deployed, resulted in a kWh/PC/year value. Those values ended up between about 100 and 550 kWh/PC/year, with a mean average over the ten studies of 299.3 kWh/PC/year. This mean average was used as the stipulated energy savings value. To determine the overall number of PCs that will end up with BigFix being installed, a discount factor was established to reduce the goal amounts for the departments where deployment is still underway. The discount factor of 0.87 is based on the average percentage of PCs deployed with the BigFix software from the goal for each of the four

departments with completed deployments. After adjusting the remaining departments' participation goals, the stipulated value of 299.3 kWh/PC/year was applied to the estimated overall participation of 14,108 PCs to obtain a total estimated annual gross energy savings of 3,924,672 kWh/year.

Refrigerator Replacement

The GEO was able to determine an existing kWh/year value for each refrigerator being replaced using an online tool available on the ENERGY STAR website. Using either the old refrigerator's model number, or by using the age and volume of the unit, this tool is able to generate a typical annual energy consumption for the existing unit. A stipulated value, also supplied via the ENERGY STAR website, was used for the new ENERGY STAR model being installed. The GEO calculated the estimated annual energy savings by subtracting the new kWh/year value, for the ENERGY STAR model, from the kWh/year value for the replacement unit.

To verify the calculations, the evaluation team validated a statistically representative sample of the refrigerator replacement calculations that the GEO performed. This was accomplished by verifying the annual energy consumption estimate for each replacement refrigerator, and then subtracting this consumption value from the stipulated annual consumption for the average ENERGY STAR unit. Due to the fact that ENERGY STAR updates and refines its equipment databases on a regular basis, the results of the evaluation team's findings can be viewed as verified values. The evaluation methodology utilized also serves as a data entry QC process, as well as an update of the original values to the most accurate.

5.6 RENEWABLE ENERGY PROGRAMS

Two programs in the Renewable Energy market title were evaluated as part of this Project:

- Renewable Energy Rebates
- Renewable Energy Grants

Table 5-19 details the findings from our evaluation for these activities:

Table 5-19 Renewable Energy Programs Site Findings

Renewable Energy Programs	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Renewable Energy Rebates	22,616	n/a	19,190	366,242	n/a	15,592	293,886
Renewable Energy Grants	0	n/a	2,572	59,547	0.81	2,071	47,963
Totals	**22,616**	-	**21,762**	**425,789**	-	**17,663**	**341,849**

5.6.1 Renewable Rebates

The Renewable Rebate program provided financial incentives for installing solar photovoltaic, solar thermal, and small wind projects at residential and commercial sites.

5.6.1.1 Savings

Gross savings attributable to these projects were calculated using specific techniques for each measure type, as detailed in the methodology below. Gross savings values for solar thermal and solar photovoltaic projects varied more significantly than the sample points for wind projects. This variation depended primarily on array sizing and solar access at the project site. For example, the solar photovoltaic array sizes for the sample points ranged from a small residential system rated less than 3 kW to a relatively large commercial project rated at roughly 20 kW. Additionally, project sites varied significantly across the state from areas like the front range, where the average annual direct normal insulation can be lower than 5 kWh/sq.m/day, to areas like Alamosa where average annual direct normal insulation reaches above 7 kWh/sq.m/day[16]. Similar variations affected solar thermal projects comparably.

On the other hand, of the five sample points for wind generation projects, each project used the same Southwest Windpower Skystream 3.7 turbine. In fact, over 70% of all wind rebates went to projects that employed that same component. The primary factors affecting variations in gross savings attributed to wind projects included site location and turbine hub height. Hub heights for sampled projects ranged from 10 to 15 meters. Site locations for sampled projects included one mountain site, two sites on the plains just east of Colorado Springs, and two sites in the southeastern-most portion of the state. The latter two sites had scaled average annual wind speeds greater than 8 m/s, while the Colorado Springs sites had averages below 7 m/s. The mountain-region site fell in the middle, just shy of 8 m/s.

[16] NREL's Solar Power Prospector: http://maps.nrel.gov/node/10

The GEO reported numbers were derived from the GEO's rebate processing contractor's database reflecting the status of the renewable rebate programs as of December 2011. The total population value of project sizes were recorded from the database in units of kW for wind and solar PV projects and daily Btu generation for solar thermal projects. The kW values were converted to total annual energy generation using the following multipliers provided by the GEO's spreadsheet reporting tool:

- 1,540 MWh/MW for solar PV
- 1,862 MWh/MW for wind

Solar thermal energy generation was converted to annual energy generation by multiplying the reported number by 365 days. The GEO reported values were adjusted due to errors in the rebate processing database that either significantly overstated or understated the reported savings.

5.6.1.2 Qualitative Findings

Approximately two thirds of implemented renewable measures across both residential and commercial segments were solar photovoltaic projects. Solar thermal projects accounted for almost 30% of the total projects while the remaining evaluated projects were comprised of residential wind projects. Within each measure category, residential rebates widely surpassed the number of rebates given out for commercial projects.

Satisfaction

Generally, across renewable rebate measure categories and market sectors, participants surveyed were very satisfied with most aspects of the program. Participants who installed solar photovoltaic or wind systems were overwhelming satisfied with their overall experience. Results for both residential and commercial solar thermal projects still exhibited very good responses for overall experience.

The most significant variations between responses by the residential and commercial market segments were regarding the rebate amount, information from the GEO, and the ease of finding a contractor. Residential customers across all measure types were generally satisfied with the dollar amount they received, the information they obtain from Recharge Colorado, and were very satisfied with the ease with which they found a contractor to install their project. Commercial customers had mixed satisfaction with these three topics.

Residential wind and commercial solar photovoltaic project participants were very satisfied with rebate application process. Residential solar photovoltaic and solar thermal participants, as well as commercial solar thermal participants, were somewhat less satisfied with the application process.

Residential wind participants surveyed were very satisfied with the GEO website information on rebates, while each other category had mixed satisfaction with the coverage of that topic. Website content regarding energy efficiency was also met with mixed feelings by all participants. Least

satisfied with the website content were residential solar photovoltaic customers and commercial solar thermal customers.

Turnaround time to receive the rebate tended to be a sore subject for residential solar thermal customers and commercial customers in both the solar photovoltaic and solar thermal measure categories. Residential wind and solar photovoltaic participants were very satisfied with the turnaround time.

Finally, residential wind and solar photovoltaic participants across both market segments were very satisfied with the performance of their systems, but customers who had solar thermal systems installed were somewhat less satisfied with their performance. Most participants were very satisfied by the quality of the installation, with the exception of commercial solar photovoltaic customers who had a more mixed response to the installation quality.

Qualitative Observations

The attribution survey asked by the evaluation team also included questions regarding outside influences on the renewable rebates program. Rebate recipients indicated that other funding sources were a large influence on their projects. Specifically, recipients indicated federal tax credits as a significant driver of the project. An additional noted influence was the role of a retailer. The role of the retailer was very influential with residential wind systems but less so with solar thermal and solar PV systems.

5.6.1.3 Methodology

Verified savings calculation methodologies for the Renewable Rebates program were broken down by measure type. For instance, the methodology used to calculate the verified savings of a solar photovoltaic project was the same across the two segments involved in the program: residential and commercial. Savings were weighted by the percent of funding made available through the SEP budget and were extrapolated to lifetime values based on the assumed expected useful lives presented in Table 5-20.

Table 5-20 Renewable Rebates Funding and Useful Life

Renewable Measure Type	SEP Funding Allocation(1)	Useful Life
Solar Photovoltaic	66%	25[3]
Solar Photovoltaic	42%	25[3]
Solar Thermal	55%	15[2]
Solar Thermal	62%	15[2]
Wind	14%	20[2]

(1) Funding percentages provided by THE GEO Rebate Program Manager
(2) DEER, EUL 2006-2007
(3) Lawrence Berkeley National Laboratory

Residential and Commercial Solar Photovoltaic

Residential and small commercial solar photovoltaic projects were evaluated using a software modeling tool from the National Renewable Energy Laboratory called the System Advisor Model (SAM)[17]. The tool is most commonly used for system planning and sensitivity analyses, but lends itself well to evaluation of existing systems. Inputs into the model include specific system component makes and models, layout of the array, site shading characteristics, system derate coefficients for factors such as soiling, panel mismatch, and wiring, as well as weather data such as direct normal solar insulation and average wind speed. The steps involved in verifying the energy generation from the sampled projects were as follows:

1. The customer was contacted and asked whether or not their particular installation had the capability to track its generation over time and whether or not that data was readily available to the evaluation team. If data was readily available, no site visit was scheduled with the customer and a phone survey was conducted to obtain data on the system above and beyond what was supplied by the rebate processing contractor. The survey included questions on panel soiling and factors that affect shading of the array.

2. In cases where no time-series data was available, a site visit was scheduled. During the site visit, the engineer on site gathered data similar to the content of the phone survey. In addition, he or she gathered data on the exact orientation of the array, its current soiling status, as well as shading. Detailed shading data was captured using Solmetric's SunEye 210 Shade Tool[18]. This tool uses a fisheye lens to capture images on-site, from the perspective of the array itself. A solar path is overlaid on the image and the SunEye's associated software calculates 8,760 hourly shading factors for the given array.

[17] Source: https://sam.nrel.gov/
[18] Source: http://www.solmetric.com/buy210.html

3. The customer's project is modeled in SAM based on the array's equipment specifications, location, orientation, shade factors, etc. Models of arrays for which generation data had been obtained were then calibrated to that data. Models for which no time-series data was available were modeled using inputs from the site visit.

4. Lifetime savings were based on 25 year life of equipment.

Residential and Commercial Solar Thermal

Both residential and commercial solar thermal projects were evaluated using the IPMVP Option C approach. Using the Option C approach requires gas and/or electric usage histories for significant periods before and after installation of the energy-saving equipment. Due to the fact that monthly resolution of utility data is required for this approach, customers who supplemented propane-consuming equipment with their solar thermal installation were removed from the sample. The steps involved in verifying the energy savings from the sampled projects were as follows:

1. Sampled projects were qualified for analysis by ensuring the solar thermal system was not associated with any propane-consuming equipment.

2. A phone survey was conducted with each customer, the initial questions of which were geared towards further qualifying the customer. These questions fortified the strength of the analysis by confirming a relatively stable building size, occupancy, and usage pattern over the duration of the analyzed period.

3. The remainder of the phone survey gathered details on the equipment supported by the solar thermal system, other equipment using the same fuel type, and usage patterns for all associated equipment.

4. Data gleaned from the phone survey provided support and guidance in the analysis of the customer's utility data.

5. Lifetime energy savings based on 15 year life span of equipment.

Residential Wind

Residential wind turbine projects were analyzed using a software modeling tool originally put forth by the National Renewable Energy Laboratory (NREL) called *HOMER, The Micropower Optimization Model* (HOMER). The HOMER tool is now owned and maintained by HOMER Energy, LLC[19].

Site visits for these residential wind turbine projects were deemed unnecessary due to the unlikelihood of being able to directly access the equipment. Detailed project data, including equipment specifications and layout, was obtained from the rebate processing contractor. The steps involved in verifying the energy savings from the sampled projects were as follows:

[19] Source: http://homerenergy.com/index.html

1. A brief phone survey was conducted with the customer to verify that the data supplied by the rebate processing contractor was accurate.

2. The customer was also asked whether or not the system tracked energy generation over time. None of the customers surveyed as part of this evaluation had a system with this type of capability.

3. Historical wind data was obtained from Western Wind Dataset for a weather station judged to be both near in proximity and of a similar terrain as the subject site.

4. This wind resource data, as well as the details on the system components, were input into the HOMER software to produce an accurate simulation of the installed system.

5. Lifetime energy savings based on 20 year life span of equipment.

5.6.2 Renewable Energy Grants Program

The Renewable Energy Grants were offered to overcome the financial barriers associated with implementation of renewable energy projects including biomass, solar, wind, compressed natural gas, ground source heat pumps, and anaerobic digestion.

5.6.2.1 **Savings**

There were no reported savings for this grant program. Verified savings were based on the population as a census approach was used to evaluate this program.

5.6.2.2 **Qualitative Findings**

Three of the GEO renewable grant programs funded by ARRA dollars had no energy savings or renewable generation associated with the project. However, these programs did produce useful information that will advance the development of the Colorado renewable industry. The qualitative benefits from these programs are summarized below.

Biomass

The GEO's Biomass grants funded four studies. These studies provided detailed information of the development potential of various biomass energy generation sites. While none of the studies have resulted in actual energy saving/generating projects, they have advanced the regional knowledge base regarding this technology.

CNG

The GEO funded one CNG plant project. Initially, there was scope to capture waste methane for use in the CNG production process, but this element was postponed. As such, there are no energy saving or renewable energy production associated with this grant. However, because of the fuel switching from gas or diesel to CNG, there will most likely be a reduction of greenhouse gas emissions and a reduction in dependence on foreign oil.

Advanced Geothermal Development

The GEO funded five geothermal grants. Only one of them resulted in a project that reduced conventional fossil fuel consumption. While none of the other four studies have resulted in actual energy saving/generating projects, they have advanced the regional knowledge base regarding geothermal technology.

Participants

All institutions that received a renewable grant were contacted over the phone and through email to request information regarding their projects. In some cases, follow up contact was made with an installing contractor.

5.6.2.3 Methodology

A measurement and verification analysis was conducted for all 10 of the awarded the GEO renewable grants. During the course of this analysis, it was discovered that four grants were canceled and one did not release funding as of the time of this Project. Of the remaining five grants, all resulted in multiple projects within each grant.

The biomass grant funds resulted in four projects and the residential solar PV grant funds also resulted in four projects. The advanced geothermal development grant resulted in six projects. After all program changes had been noted, 16 grant projects amongst the five grants were analyzed.

Only the six projects resulted in any energy savings or renewable energy production.

For the PV projects, the evaluation team used the following methodology to verify savings:

1. Contacted site to request Xcel bills (on a PV production Medium Program rate)
2. Tabulated actual production data from bills
3. Ran PVwatts analysis for system
4. Extracted PVwatts hourly data that corresponded to actual period of operation
5. Compared meter data to PVwatts prediction
6. Quantified Variance between meter data and PVwatts
7. Used PVwatts hourly profile to quantify peak and coincident peak kW savings
8. Secured photo documentation of the site when possible.

For the ground source heat pumps, the following methodology was used to verify savings:

1. Secure detailed list of awarded incentives and resulting installations (with installed capacity data and existing heating technology).
2. Perform savings analysis using eQuest to simulate a template home for each size of GSHP in order to estimate annual heating load (in MMBtu)
3. For retrofits:
    a. Calculated an estimate of previous annual fuel use using 0.78 AFUE for NG and Propane appliances

   b. Calculated an estimate of previous annual fuel use using 40% efficiency for Coal appliances
   c. Calculated an estimate of previous annual electrical using an efficiency of 1 for electric resistance appliances.
   d. Calculated an estimate of the new annual electrical using a COP of 4 for the new GSHP.
   e. NG savings are calculated by summing the modeled NG heating consumption for all projects retrofitting NG with GSHP and subtracting the new electrical use (modeled) from the GSHP.
   f. Propane savings are calculated by summing the modeled propane heating consumption for all projects retrofitting propane with GSHP and subtracting the new electrical use (modeled) from the GSHP.
   g. Electric savings are equal to the sum of difference between previous and new electrical usage.
4. For new installations
   a. Calculated similar to the Retrofits, except that all installations are assumed to have electric heat as the modeled base case

For geothermal installations, the following methodology was used to verify savings:

1. Determine previous use of energy to heat the city shop building. All of this energy use has been replaced by geothermal.
   a. Previous energy use is documented through historical utility bills.
2. Convert into MMBTU savings, taking altitude factor into account.

Since no GEO-reported savings existed for any of these projects, there is no basis to determine a realization rate.

5.7 RESIDENTIAL BUILDINGS

The following programs were evaluated in the Residential Buildings market title as part of this Project:

- Residential Codes
- ENERGY STAR for New Homes
- Energy Monitors
- Duct Sealing
- Insulation and Air Sealing
- Furnace

Table 5-21 details the findings for each of these programs.

Table 5-21 Residential Buildings Site Findings

Residential Buildings	Gross Reported Energy Savings[1] (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Residential Codes	0	n/a	67,275	1,345,508	0.38	25,228	504,566
ENERGY STAR New Homes	0	n/a	10,197	152,956	0.43	4,334	65,006
Energy Monitors	0	n/a	126	632	0.84	107	534
Duct Sealing	202	1.04	211	3,790	0.73	153	2,748
Insulation & Air Sealing	28,621	0.69	19,609	392,189	0.85	16,570	331,400
Furnace	7,681	1.17	8,997	179,949	0.55	4,949	98,972
Totals	**36,503**	**-**	**106,416**	**2,075,025**	**-**	**51,340**	**1,003,225**

[1] Reported savings based on GEO rebate processing subcontractor database

SEP funding for duct sealing rebates, insulation & air sealing rebates, and furnace rebates was comingled with other funding streams to offer these rebates. Table 5-22 outlines the percentage of SEP funding used to offer these rebates. The energy savings in Table 5-21 above were based on the percentage of SEP funding for each rebate. Table 5-22 also outlines the life span of the equipment used to calculate the lifetime energy savings.

Table 5-22 SEP Funding Stream % and Useful Lives

Residential Buildings	% SEP Funding Stream[1]	Useful Life
Residential Codes	100%	20
ENERGY STAR New Homes	100%	10
Energy Monitors	100%	5
Duct Sealing	23%	18[(2)]
Insulation & Air Sealing	23%	20[(2)]
Furnace	10%	20[(2)]

[(1)] Funding percentages provided by GEO Rebate Program Manager

[(2)] DEER, EUL 2006-2007

5.7.1 Residential Codes

The Residential Codes program was intended to provide technical assistance to jurisdiction code officials on the process of adopting, implementing, and enforcing the 2009 IECC residential energy code. Funding was provided through the SEP budget and was dispersed by the DOE on condition that the State would achieve state-wide 90% adoption and compliance by 2017. As of November 2011, approximately 33% of the State's jurisdictions had adopted or were likely to adopt the 2009 IECC (these jurisdictions represent approximately 66.5% of the total existing housing units in the State).

5.7.1.1 Savings

There was no reported energy savings associated with the Residential Codes program. Therefore the gross energy savings measured by the evaluation team served as the verified gross savings for the program (no effective realization rate was determined). The evaluation team found an annual gross verified savings of 67,275 MMBtus. The vast majority of savings were derived from natural gas savings. This value is based on deemed savings provided by the DOE's Pacific Northwest National Laboratory and applying the observed code compliance rate of 87%. A net-to-gross factor of 0.38 was derived from surveys conducted with jurisdiction code officials throughout the state. This resulted in an annual net site savings of 25,228 MMBtus. Annual net source savings were 28,520 MMBtus.

5.7.1.2 Qualitative Findings

Colorado Code Consulting (CCC) reached all 339 jurisdictions. Furthermore, the CCC anticipated completing 92 workshops by January 2012. As of November 2011, workshops averaged 14 attendees with a maximum of 70 attendees in some cases. Attendees were comprised of a single or

multiple jurisdictions' building code personnel as well as other stakeholders including contractors, architects, inspectors, realtors, and others.

The evaluation team conducted 30 phone interviews to determine the freeridership score as well as to receive feedback on the workshops and experiences with adopting and implementing the 2009 IECC. 15 of these interviews were dedicated to jurisdictions with a rank of 1-3. 7 interviews were conducted with jurisdictions ranked 0 and the remaining 8 interviews were conducted with jurisdictions ranking from 4-8 (see explanation for ranks in section 5.7.1.3 Methodology below).

Of the 30 jurisdictions surveyed, all were contacted by the CCC and 26 of the 30 jurisdictions attended at least one workshop while some jurisdictions attended up to 5 workshops (of the 4 jurisdictions that did not attend a workshop, 3 had already adopted the 2009 IECC or had developed a custom code stricter than the 2009 IECC). Of the jurisdictions that were currently implementing the 2009 IECC, the evaluation team found that on average these jurisdictions had 8 inspectors on staff and approximately 50% of the surveyed jurisdictions indicated their workload had increased as a result of the 2009 IECC energy codes. Of the jurisdictions interviewed that had not yet adopted the 2009 IECC, approximately 75% indicated that their jurisdiction would adopt the 2009 or 2012 IECC by the end of 2012.

Over 75% of the surveyed jurisdictions indicated the workshops were very helpful for understanding the new provisions of the code. These jurisdictions also found the workshops to be very beneficial in improving the ability to enforce the 2009 IECC for both jurisdictions that were implementing the code and for those that were anticipating its adoption. Very few jurisdictions recalled workshop attendance by other stakeholders. Other stakeholders that did attend were primarily contractors as well as some architects and developers. Almost all jurisdictions believed the workshops should be continued in the future; some jurisdictions suggested adding hands-on or field training as a component of the workshops as well as additional information regarding the 2012 IECC.

Jurisdictions were also asked about how the adoption of the 2009 IECC had impacted builders. There appeared to be a preference for the performance path compliance among builders; however, the majority of jurisdictions stated builders often utilized either the prescriptive or performance compliance paths. Almost all jurisdictions surveyed had not observed any specific section of the code that was difficult for builders to comply. Most jurisdictions felt there had been no impact on builders' practices, although some jurisdictions believed the quality of the construction had increased.

The evaluation team asked jurisdictions that had not yet adopted the 2009 IECC what the primary reasons were for not adopting. Responses were limited; however, a common response was lack of support from the local administration as well as enforcement ability.

5.7.1.3 Methodology

The impacts of the Residential Codes program required understanding the role of the Colorado Code Consulting's (CCC) technical assistance on the decision-making process of jurisdictions that had or planned to adopt the 2009 IECC. This was the target population for the impact evaluation. To segment the jurisdictions, the evaluation team adopted the rating scale developed by the CCC (Table 5-23). Jurisdictions rated 0 were not candidates for the impact evaluation as they were considered freeriders. These jurisdictions adopted the 2009 IECC before the CCC began its efforts and therefore achieved the energy savings associated with the 2009 IECC without the technical assistance of the CCC. Jurisdictions rated 4-8 were considered non-adopters of the new code and therefore had no energy savings to evaluate. Jurisdictions rated 1-3 were candidates for evaluation, as they may have received the technical assistance from the CCC and subsequently been influenced by the program to adopt the 2009 IECC.

Table 5-23 Residential Code Adoption Ratings

Rating	Status
0	No adoption difficulty; currently adopted 2009 IECC or better
1	Currently in adoption process
2	Adoption scheduled by 12/2011
3	Adoption scheduled after 12/2011
4	Jurisdiction has not notified Division of Housing of plans
5	Currently adopted 2006 IECC w/ no adoption plans
6	Currently adopted 2003 IECC w/ no adoption plans
7	Adopted code less than 2003 IECC and no adoption plans
8	No adopted ENERGY codes and no plans to adopt energy code

Energy savings were derived from deemed savings values published by the DOE's Pacific Northwest National Laboratory. Deemed savings were provided for each climate zone within Colorado and represented the average annual percent incremental savings achieved for a residential building that was built to the 2009 IECC relative to the 2006 IECC. The application of these deemed savings are relevant to jurisdictions that adopted the 2009 IECC and the number of new housing units and remodels built after adoption of the code. Additionally, an overall expected level of code compliance for each jurisdiction was determined to realize the total expected number of new homes that achieved the energy savings.

The focus of the evaluation team's site visits was to determine a representative level of compliance. Compliance was determined by using the DOE 2009 IECC Checklist, which is the tool DOE will require to gauge states' energy code performance in 2017. The checklist was used in the field by the evaluation team at construction sites to confirm a building was built to the specifications of the 2009 IECC. Site visit location was determined by deriving a random sample from the population of

jurisdictions that ranked 1-3. The jurisdiction sample was weighted by the 2000 and 2010 US Census records of existing residential units.

In addition to the evaluation team's analysis of jurisdictions that rank 1-3, the team also further investigated the remaining jurisdictions to achieve a qualitative understanding for the effectiveness of the technical assistance provided by the CCC. A random sample of jurisdictions with a rank of 0 or 4-8 were contacted and asked similar survey questions as those asked to jurisdictions ranking 1-3. The purpose of these inquiries was to further understand the impact of the CCC program workshops and feedback on the 2009 IECC energy codes.

The attribution approach in this case is unique as many jurisdictions had not yet made the decision, at the time of the survey, whether or not to adopt the new code. Therefore, the survey asked respondents both what they were planning to do about a building code and what they would have done without the GEO outreach and assistance. In both cases, the options were to retain their current code, abandon any code, and adopt a different code (and, if so, what code?). The survey also asked what their current code was. The intention score was determined by the difference between what they planned to do and what they would have done without the GEO program: a response indicating they would have adopted at least as strict a code without the program as with the program resulted in the maximum intention component score; a response indicating that they planned to adopt the 2009 IECC code but would have maintained their current code or abandoned a code resulted in the minimum intention component score; other combinations of responses resulted in an intermediate intention component score.

Some respondents had already adopted the 2009 IECC code; they were asked if they had adopted the code before the GEO provided the outreach and assistance and how much (on a one-to-five scale) that outreach and assistance improved their ability to enforce code compliance. Those who had adopted the code before the GEO outreach and assistance were assigned the maximum intention component score.

5.7.2 ENERGY STAR New Homes

The ENERGY STAR New Homes program was developed in 2007 by the GEO as part of a multi-year strategy to improve the energy performance of Colorado's homes over both the short term and long term[20]. Beginning in 2009, the GEO began offering ENERGY STAR Homebuilder rebates to assist with the cost of HERS raters to certify a home ENERGY STAR compliant[21]. The GEO reported that ENERGY STAR New Home construction had increased from 5% to 30% of new residential construction from 2004 to 2010 and is estimated to surpass 40% by 2011 thereby showing strong demand for this rebate program.[22]

[20] Governor's Energy Office Transition Book, December 2010.
[21] ibid.
[22] ibid.

5.7.2.1 Savings

There were no reported energy savings associated with the ESNH program. Therefore the average gross energy savings measured by the evaluation team served as the verified gross savings for the sample (no effective realization rate was determined).

5.7.2.2 Qualitative Findings

Satisfaction

Satisfaction with ENERGY STAR New Homes program was highest for participant overall experience, time to receive the rebate, and the ease of finding a HERS rater and the results of the inspection. Participants responded with lower satisfaction with regard to the amount of the rebate received.

Qualitative Observations

Phone survey responses indicated that sampled participants had different motivations to build ENERGY STAR New Homes. In more than one case, participants indicated that it was a requirement of either the local jurisdiction or of the project developer to build to ENERGY STAR certification. In these cases, participants were frustrated with the GEO rebate application process as each home in a development required an individual application. The participant suggested that the ability to apply for the rebate across an entire home division would drastically increase the efficiency of the process. Additionally, participants also voiced frustration to the fact that only contractors could apply for the rebates, as the actual rebate value was passed on to the project developer. In such cases, participants indicated the rebate program should be more flexible.

5.7.2.3 Methodology

Gross energy savings for ENERGY STAR New Homes were calculated using construction information specific to each home in the sample set. The evaluation team acquired the home energy rating certificates for each home. These sheets are generated as part of the ENERGY STAR certification process They show the HERS Index and estimated annual energy usage for the home, based on inputs to an energy modeling software (REM/Rate) about the home's size, construction, internal loads, and infiltration. The HERS Index is defined as the ratio between the estimated energy use of the high efficiency ENERGY STAR home and a similar home built to code minimums:

$$\frac{\text{}}{\text{}}$$

The code minimum energy use was taken as the baseline for each home in the sample set, and was calculated using this relationship. The energy savings associated with the home's ENERGY STAR certification was calculated using:

For attribution, builders are asked if they would have done the HERS inspection without the rebate. If they report they would not have had the HERS inspection, they are asked if they would still have built to Energy Star standard and, if not, what standard they would have built to (current code, 2008 NGBS, different standard).

5.7.3 Energy Monitors

The Energy Monitors program is part of the Residential and Rebate Programs administered by the GEO in coordination with Recharge Colorado. The program offered consumers up to a $100 rebate for the purchase cost of a home energy monitor.

5.7.3.1 Savings

There were no reported energy savings associated with the Energy Monitors program. Therefore the average gross energy savings measured by the evaluation team served as the verified gross savings for the sample (no effective realization rate was determined).

5.7.3.2 Qualitative Findings

Satisfaction

Participants sampled showed greatest satisfaction with the amount of the rebate received and the time to receive the rebate. Satisfaction was generally high for the application process, the Recharge Colorado website with regard to information pertaining to rebates, other information provided by the GEO, and the overall experience. Approximately only half of the respondents replied favorably to general energy efficiency information found on the Recharge Colorado website and in regard to the ease of finding a rebate-eligible energy monitor to purchase.

Qualitative Observations

In addition to determining the estimated energy savings produced by the energy monitors, the evaluation team also further inquired on participants' usage and behavioral reactions to the energy monitor. Energy monitors are often called into question with regard to their persistence, i.e., how are energy savings initially generated by the energy monitor sustained into the future. To gain a qualitative understanding for persistence, the evaluation team asked participants the frequency the energy monitor was viewed in the first month and after six months from the purchase date. The majority of participants reported viewing the energy monitor 10 or more times per day during the first month. This frequency dropped to 1-4 times per day after six months. Furthermore, participants reported that the energy monitor caused the participant to make behavioral changes to reduce energy consumption within the first month. These behavioral changes were still in practice after six months from the purchase date.

5.7.3.3 Methodology

The analysis for Energy Monitors followed a calculated savings approach, using a combination of deemed values published from data sets and information provided by sampled participants. Calculations were applied to these data to arrive at the measured energy savings.

The analysis began with selecting a random sample of 4 participants to conduct phone surveys and derive the estimated energy savings for the program. Additionally, the evaluation team gathered data from published studies on annual residential electricity consumption in Colorado to serve as baseline conditions. The evaluation team assumed 8,148 kWh as the average annual electricity consumption for Colorado residential buildings[23]. A deemed value of 7% was used for expected energy savings resulting from the installation and use of energy monitors.

The phone survey consisted of attribution questions as well as general questions about the participant's HVAC system and behavioral usage of the energy monitor. Specifically, the evaluation team inquired how frequently the energy monitor was used and what behavioral changes, if any, the participant made in reaction to the energy monitor. The purpose of these questions was to develop a qualitative understanding for persistence and efficacy of the energy monitor.

5.7.4 Duct Sealing

The Duct Sealing program is part of the Residential and Rebate Programs administered by the GEO in coordination with Recharge Colorado. The program offered consumers up to a $150 rebate for having a contractor seal the ducts throughout the residence, (the GEO would provide up to $75 of the rebate).[24]

5.7.4.1 Savings

The savings were allocated based on the SEP funding percentage and are shown in Table 5-21.

5.7.4.2 Qualitative Findings

Satisfaction

Participants sampled showed greatest satisfaction with the overall experience and performance of their home HVAC system after the duct sealing work was complete. Satisfaction was generally high for the application process, the ability to find a contractor to perform the work, and the Recharge Colorado website with regard to finding information on the rebate program. Participant satisfaction was lower (about half of the sampled participants were highly satisfied) with the amount of the rebate received, time to receive the rebate, and for general energy efficiency information provided on the Recharge Colorado website.

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[23] Energy Information Agency, "Residential Average Monthly Bill by Census Division, and State", 2009 data. Available online: http://www.eia.gov/cneaf/electricity/esr/table5.html

[24] Duct Sealing program eligibility sheet; provided by the Governor's Energy Office, August 2011.

5.7.4.3 Methodology

The analysis for Duct Sealing followed a calculated savings approach, using a combination of deemed values published from data sets and information provided by sampled participants. Engineering calculations were applied to these data to arrive at the measured energy savings.

The analysis began with selecting a random sample of 5 participants to conduct phone surveys and derive the estimated energy savings for the program. Additionally, the evaluation team gathered data from published studies on annual HVAC energy consumption in Colorado to serve as baseline conditions. The baseline was further tailored to each sampled participant based on responses to survey questions. Homes furnished with natural gas and/or propane furnaces were assumed to consume 494.9 therms annually and 464.7 kWh annually for blower fan consumption[25]. Central air conditioning systems were assigned an annual consumption of 1546.0 kWh[2627]. Deemed values of 5% or 9% for expected energy savings resulting from duct sealing were applied to calculate the incremental energy savings[28]. 5% savings were applied to sampled homes in which duct work was completely located within conditioned space while 9% savings were applied to sampled homes with ducts that were only partially located in conditioned space.

The phone survey consisted of attribution questions as well as general questions about the participant's home. The purpose of these general questions was to understand the configuration of the ducts throughout the home and determine if any portion of the ductwork was located in unconditioned and non-insulated space. The participant's responses determined which deemed value to apply to the energy savings calculations.

As described above, the realization rate for the Duct Sealing was 1.04. The deviation of measured savings from the GEO's reported savings are due, first, to the assumption the GEO applied to its savings that 60% of Colorado home heating systems are fueled with natural gas and 40% fueled with electricity, and second, the exclusion of cooling energy savings. The evaluation team observed 100% of site visits had natural gas- or propane-fueled heating systems; one sampled participant did have a heat pump system in conjunction with a propane furnace. Thus, the amount of electricity savings observed in the field were approximately one third of reported electricity savings. The evaluation team adjusted the population verified savings to reflect heating system conditions observed in the field rather than maintaining the GEO's initial assumed heating system conditions. Additionally, the evaluation team found that cooling savings amounted to approximately 11% of overall savings.

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[25] KEMA, Inc., Colorado DSM Market Potential Assessment, Final Report, March 2010. Table 4-2, Table 4-5; Xcel Energy Billing Data-2008, Xcel Energy Home use Data-2008, KEMA Analysis. Calibrated to 2010 Sales Forecast (from Feb/Mar 2009).

[26] ibid.

[27] Annual consumption for central air conditioner was also used to calculate consumption for one sampled participant that indicated the home was heated in with a heat pump in conjunction with a propane furnace. The weighted annual energy consumption assigned for the heat pump was 1284 kWh based on heating degree days which were used to calculate the estimated utilization of the heat pump.

[28] Oak Ridge National Laboratory, "Field Test of Advanced Duct-Sealing Technologies within the Weatherization Assistance Program", November 2001.

5.7.5 Insulation and Air Sealing

The Insulation and Air Sealing program was developed in 2007 by the GEO as part of a multi-year strategy to improve the energy performance of Colorado's homes over both the short term and long term[29]. Beginning in 2009, the GEO began offering insulation rebates as part of the Insulate Colorado program which offered consumers up to a $300 rebate for improving the insulation of existing homes[30]. This program was expanded with the launch of the GEO's state-wide Rebate Program in coordination with the Recharge Colorado communications initiative and website (RechargeColorado.com)[31] and increased the rebate amount to $600 of which the GEO provided up to $400 (remaining rebate balance offered through program partner). [32]

5.7.5.1 Savings

The savings were based on the percentage of SEP funding for these rebates and is presented in Table 5-21.

5.7.5.2 Qualitative Findings

Satisfaction

In general, satisfaction among sampled insulation participants was good. Satisfaction was highest with the amount of the rebate received by participants. Satisfaction with the overall experience and the Recharge Colorado website also ranked highly. Lower satisfaction was rated for the ease of finding a contractor to perform the work as well as information provided directly from the GEO.

5.7.5.3 Methodology

The data analysis for Insulation and Air Sealing followed a calculated savings approach, using a combination of deemed values published from data sets, on site data collection, and data furnished by the GEO. Engineering calculations were applied to these data to arrive at the measured energy savings.

The analysis began with selecting a random sample of 25 participants to conduct site inspections and derive the estimated energy savings for the program. The evaluation team gathered pertinent data from the GEO, specifically the Insulation and Air Sealing Program worksheets that provided the pre- and post-retrofit conditions of the sample participant. These worksheets were brought into the field during site visits to verify the work stipulated on the worksheet was completed. Additionally, site inspections collected the following information:

- Inspection of envelope upgrades including type and measurement of thickness of insulation and square footage of area improved

[29] Governor's Energy Office Transition Book, December 2010.
[30] ibid.
[31] ibid.
[32] Insulation and Air Sealing program eligibility sheet; provided by the Governor's Energy Office, August 2011.

- Residence HVAC system type and heating fuel type. HVAC system setpoints and occupancy schedules
- Residence fenestration characteristics
- Existing insulation type and thickness, where possible

Having verified the data on the GEO-issued worksheet, the evaluation team used the following equations to calculate the incremental savings resulting from the additional insulation installed[33]:

$$\Delta kWh_{CAC} = \frac{CDD \times 24\frac{hr}{day} \times DUA}{SEER_{CAC} \times 1000\frac{W}{kW}} \times \left[A_{roof}\left(\frac{1}{R_{roof,bl}} - \frac{1}{R_{roof,ee}}\right) + A_{wall}\left(\frac{1}{R_{wall,bl}} - \frac{1}{R_{wall,ee}}\right)\right]$$

$$\Delta kWh_{RAC} = \frac{CDD \times 24\frac{hr}{day} \times DUA \times F_{Room\ AC}}{EER_{RAC} \times 1000\frac{W}{kW}} \times \left[A_{roof}\left(\frac{1}{R_{roof,bl}} - \frac{1}{R_{roof,ee}}\right) + A_{wall}\left(\frac{1}{R_{wall,bl}} - \frac{1}{R_{wall,ee}}\right)\right]$$

$$\Delta kWh_{elec\ heat} = \frac{HDD \times 24\frac{hr}{day}}{3412\frac{Btu}{kWh}} \times \left[A_{roof}\left(\frac{1}{R_{roof,bl}} - \frac{1}{R_{roof,ee}}\right) + A_{wall}\left(\frac{1}{R_{wall,bl}} - \frac{1}{R_{wall,ee}}\right)\right]$$

$$\Delta kWh_{gas\ heat} = \frac{HDD \times 24\frac{hr}{day}}{furnace\ eff.\ rating} \times \left[A_{roof}\left(\frac{1}{R_{roof,bl}} - \frac{1}{R_{roof,ee}}\right) + A_{wall}\left(\frac{1}{R_{wall,bl}} - \frac{1}{R_{wall,ee}}\right)\right]$$

R-values for existing insulation were adopted from the GEO -issued worksheet while R-values for newly installed insulation were calculated based on observed thickness and insulation type as well as R-value conversion factors included on the GEO-issued worksheets. Additionally, furnace efficiencies were assumed to be 80% unless stipulated efficiencies were observed during inspections. Cooling system efficiencies were based on equipment age and deemed SEER and EER ratings[34].

As described above, the realization rate for the Air Sealing and Insulation was .69. The deviation of measured savings from the GEO's reported savings are due, first, to the assumption the GEO applied to its savings that 60% of Colorado home heating systems are fueled with natural gas and 40% fueled with electricity, and second, the exclusion of cooling energy savings. The evaluation team observed 92% of site visits had natural gas-fueled heating systems (electric baseboard and electric furnace comprised the remaining 8% of the sample). Thus, the amount of electricity savings observed in the field were approximately 1/3rd of reported electricity savings. The evaluation team adjusted the population verified savings to reflect heating system conditions observed in the field rather than maintaining the GEO's initial assumed heating system conditions. Additionally, the evaluation team found that cooling savings amounted to approximately 4% of overall savings.

[33] Pennsylvania Public Utility Commission. Technical Reference Manual, June 2011.

[34] US Department of Energy, Energy Efficiency & Renewable Energy. Available online: http://www.energysavers.gov.

5.7.6 Furnace

Information on the savings and methodologies used for Furnaces is presented in Section 7 as a significant portion of the funding for furnace rebates came from the SEEARP funding stream.

6 ENERGY EFFICIENCY AND CONSERVATION BLOCK GRANT FINDINGS

The challenge of evaluating the EECBG funding stream was the variety of programs offered by the GEO and tracking funding allocations to SEP programs. As discussed in Section 3, the impact evaluation of the EECBG activities was conducted through desk reviews, on-site inspections, phone interviews, and utility bill analysis depending on the projects implemented. This section presents high level findings for the EECBG funding stream as well as the specific findings and methodology used for each of the activities.

Table 6-1 provides the site findings for each of the activities within the EECBG funding stream with attributable energy savings:

Table 6-1 EECBG Site Findings

Activity	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
1.Residential & Commercial Buildings & Audits	10,589	0.94	10,300	102,996	0.81	8,326	83,264
2. Subgrants for EE Retrofits	69,005	n/a	55,348	1,095,725	n/a	43,484	858,867
5. Lighting Project	157	0.51	80	879	1.00	80	879
6. Onsite Renewable Technology	1,202	0.76	913	20,159	1.00	913	20,159
Totals	**80,952**	-	**66,641**	**1,219,759**	-	**52,804**	**963,169**

As discussed in Section 2, a significant portion of EECBG funding is allocated to the GEO programs co-funded by other ARRA funding streams. Consequently, the allocation of energy savings for programs with combined funding streams was based on the percentage of budget from each funding stream.

6.1.1.1 Additional EECGB Reporting

As part of this evaluation, the evaluation team collected information consistent with the DOE's Energy Efficiency and Conservation Block Grant Notice 10-019 (Notice) dated October 26, 2010. The subject of the Notice is "Guidance for Energy Efficiency and Conservation Block Grants Grantees on Sub-Recipient Monitoring." The evaluation team collected information that will allow the GEO to answer the following questions from Appendix 1: Sub-recipient Monitoring Checklist Example of the Notice:

Project Administration

2. Is the sub-recipient completing the project described in the statement of work (scope)?

a. Are there any discrepancies between the two?

3. Is the sub-recipient on schedule to meet the project's milestones within the period of availability of funds?

4. Has the sub-recipient developed a process that generates timely and accurate cost, schedule, and work completion information?

Project Performance

6. Is the sub-recipient collecting the correct metrics from the project?

7. What provisions has the sub-recipient put in place for evaluation, including performance measurement and verification?

6.1.2 Gross Reported Savings

The first step in determining the net savings for the EECBG funding stream was to evaluate the savings reported by the GEO to the DOE. Reporting of energy savings and other metrics associated with the programs was required quarterly to the DOE using the Performance and Accounting for Grants in Energy (PAGE) reporting system. Table 6-2 outlines the gross site energy savings reported by the GEO as of December, 2011. First, the team reviewed the rebate databases provided by the GEO's rebate processing subcontractor to determine the number of participants for the rebates. Then the team used GEO provided deemed savings to determine the energy savings associated with those rebates. The team also used the GEO's spreadsheet tool, which was used for DOE reporting, to derive non-rebate program energy saving totals. In some cases the reported amounts had to be adjusted due to minor database issues to determine an appropriate reported total. More information regarding the methodology for each market title is provided in the sections below. The GEO does not report lifetime energy savings.

Table 6-2 EECBG Gross Reported Site Savings

Activity	Gross Reported Electricity Savings (kWh)	Gross Reported Gas Savings (MMBtus)	Total Gross Reported Savings (MMBtus)
1.Residential & Commercial Buildings & Audits	1,756,506	4,595	10,589
2. Subgrants for EE Retrofits	2,426,418	60,726	69,005
5. Lighting Project	45,907	0	157
6. Onsite Renewable Technology	352,204	0	1,202
Total	**4,581,035**	**65,321**	**80,952**

6.1.3 EECBG Gross Verified Savings

The data collected as a result of the on-site inspections, phone surveys and engineering analysis, allowed the evaluation team to recalculate energy and demand savings for each sampled project—this is termed the gross verified savings. The ratio of the gross verified savings to the reported savings by the GEO is the project's "realization rate" while the program's realization rate is the weighted average for all the projects within the sample. Total gross verified savings are the product of the reported savings for that program and the program's realization rate. These program level gross verified savings are totaled up to the activity level. The activity totals are then summed to the EECBG funding stream level.

The realization rates for each of the activities are presented in Table 6-3.

Table 6-3 EECBG Realization Rates

Activities	Realization Rate
1.Residential & Commercial Buildings & Audits	.91
2. Subgrants for EE Retrofits	N/A
5. Lighting Project	0.51
6. Onsite Renewable Technology	0.76

Using these realization rates, the evaluation team calculated the gross verified energy savings for the EECBG activities. Table 6-4 outlines these gross verified site energy savings.

Table 6-4 EECBG Gross Verified Site Energy Savings by Activity

Activity	Gross Verified Electricity Savings (kWh)		Gross Verified Gas Savings (MMBtus)		Total Gross Verified Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
1.Residential & Commercial Buildings & Audits	1,671,835	16,718,348	4,595	45,953	10,300	102,996
2. Subgrants for EE Retrofits	2,473,529	52,163,666	46,908	917,743	55,348	1,095,725
5. Lighting Project	23,432	257,750	0	0	80	879
6. Onsite Renewable Technology	267,709	5,908,139	0	0	913	20,159
Total	**4,436,504**	**75,047,902**	**51,503**	**963,696**	**66,641**	**1,219,759**

In addition to the site savings, the evaluation team calculated the energy savings and other metrics associated with the source of generation. These savings are detailed in Table 6-5 and Table 6-6.

Table 6-5 EECBG Gross Verified Source Energy Savings by Activity

Activity	Gross Verified Electricity Savings (kWh)		Gross Verified Gas Savings (MMBtus)		Total Gross Verified Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
1.Residential & Commercial Buildings & Audits	5,547,148	55,471,478	4,811	48,113	23,738	237,382
2. Subgrants for EE Retrofits	8,207,170	173,079,043	49,113	960,877	77,115	1,551,422
5. Lighting Project	77,747	855,213	0	0	265	2,918
6. Onsite Renewable Technology	888,257	19,603,204	0	0	3,031	66,886
Total	**14,720,322**	**249,008,938**	**53,924**	**1,008,989**	**104,150**	**1,858,608**

Table 6-6 EECBG Gross Verified Source Demand, CO2e, and Water Savings by Activity

Activity	Gross Verified Demand Savings (kW)		Gross Verified CO2e (tonnes)		Total Gross Verified Water Savings (gallons)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
1.Residential/Commercial Buildings & Audits	0	n/a	1,946	19,457	2,006,202	20,062,017
2. Subgrants for EE Retrofits	758	n/a	5,123	104,044	2,968,235	62,596,399
5. Lighting Project	0	n/a	24	260	28,118	309,299
6. Onsite Renewable Technology	78	n/a	270	5,967	321,250	7,089,766
Total	**836**	-	**7,363**	**129,729**	**5,323,805**	**90,057,482**

6.1.4 Net Savings

Net energy saving impacts are calculated by multiplying the gross verified savings by a net-to-gross (NTG) ratio. The development of the NTG ratio is described below. However, some NTG ratios are not presented at the activity level due to the diversity of programs within the activity. The NTG ratios for the individual programs within the activities are detailed in further in this section.

6.1.4.1 Freeridership

The first component of the NTG ratio is freeridership. Free riders involve participants who on some level may have participated in the program regardless of GEO influence. Freeridership is assessed through attribution surveys delivered to the sample populations. The evaluation team conducted surveys with decision makers for the sampled projects.

6.1.4.2 Net to Gross Ratios

Based on the calculated rates of freeridership, the evaluation team was able to assess the NTG ratio for the individual programs within the activities. These ratios are provided in Table 6-7.

Table 6-7 EECBG Net to Gross Ratios by Activity

Activity	Net to Gross Ratio
1.Residential & Commercial Buildings & Audits	0.82
2. Subgrants for EE Retrofits	n/a
5. Lighting Project	1.00
6. Onsite Renewable Technology	1.00

6.1.4.3 Net Savings

The evaluation team then multiplied the NTG ratios by the gross verified savings to determine the overall net energy impacts. Table 6-8 summarizes the evaluation team's findings for the net site energy savings.

Table 6-8 EECBG Net Site Energy Savings by Activity

Activity	Net Electricity Savings (kWh)		Net Gas Savings (MMBtus)		Total Net Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
1.Residential & Commercial Buildings & Audits	1,351,551	13,515,507	3,715	37,150	8,326	83,264
2. Subgrants for EE Retrofits	2,014,505	42,343,239	36,610	714,392	43,484	858,867
5. Lighting Project	23,432	257,750	0	0	80	879
6. Onsite Renewable Technology	267,709	5,908,139	0	0	913	20,159
Total	**3,657,196**	**62,024,634**	**40,325**	**751,541**	**52,804**	**963,169**

In addition to the site savings, the evaluation team calculated the energy savings and other metrics associated with the source of generation. These savings are detailed in Table 6-9 and Table 6-10.

Table 6-9 EECBG Net Source Energy Savings by Activity

Activity	Net Electricity Savings (kWh)		Net Gas Savings (MMBtus)		Total Net Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
1.Residential & Commercial Buildings & Audits	4,484,445	44,844,452	3,890	38,896	19,190	191,905
2. Subgrants for EE Retrofits	6,684,129	140,494,866	38,331	747,968	61,137	1,227,337
5. Lighting Project	77,747	855,213	0	0	265	2,918
6. Onsite Renewable Technology	888,257	19,603,204	0	0	3,031	66,886
Total	**12,134,578**	**205,797,735**	**42,221**	**786,864**	**83,624**	**1,489,045**

Table 6-10 EECBG Net Source Demand, CO2e, and Water Savings by Activity

Activity	Net Demand Savings (kW)		Net CO2e (tonnes)		Net Water Savings (gallons)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
1.Residential & Commercial Buildings & Audits	0	n/a	1,573	15,730	1,621,861	16,218,608
2. Subgrants for EE Retrofits	612	n/a	4,083	82,746	2,417,407	50,811,886
5. Lighting Project	0	n/a	24	260	28,118	309,299
6. Onsite Renewable Technology	78	n/a	270	5,967	321,250	7,089,766
Total	**690**	-	**5,950**	**104,703**	**4,388,636**	**74,429,560**

6.2 ACTIVITY 1: RESIDENTIAL & COMMERCIAL BUILDINGS AND AUDITS

Only the Main Street Efficiency Initiative program from Activity 1 was selected for evaluation as part of this project. Table 6-11 presents the evaluation findings for this activity.

Table 6-11 EECBG Activity 1 Site Findings

Activity 1	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
MSEI	10,589	0.94	10,300	102,996	0.81	8,326	83,264

[1] Saving values in Table 6-11 represent EECBG MSEI savings based on a 50% funding allocation.

6.2.1 Main Street Efficiency Initiative

The Main Street Efficiency Initiative (MSEI) began in early 2010 with the launch of five programs to serve the small business community. These programs were designed to reduce energy costs for local businesses, create local jobs, and reduce carbon emissions. The small business community is a difficult sector to reach with energy efficiency programs for a variety of reasons including landlord/tenant issues and program costs vs. energy benefits. It is also generally underserved by utility based demand side management programs. The GEO programs sought to both fill market gaps where small businesses were not being served, and also use existing utility rebates/programs where available to further encourage businesses to implement energy efficiency projects.

6.2.1.1 Savings

Each of the MSEI Grant Programs was managed by a different party, which resulted in a wide variety of tracking and reporting types. Gross reported energy savings were acquired from various

documentation including program estimates, energy assessments, audit reports, invoices, and rebate awards. The team ended up sampling a total of 29 MSEI businesses. The samples were split up among the different grant types and communities by a weighted distribution based on budget. The communities provided a variety of services to their businesses, including education and outreach, facility assessments, and rebates for energy efficiency measures. The samples were taken only from the businesses that had implemented an energy efficiency measure, such as a lighting retrofit, re-commissioning service, set-back thermostats, or a tune-up of HVAC systems.

The evaluation team acquired enough information from the businesses to calculate energy savings for each of the energy conservation measures, and compared those with the gross reported energy savings to come up with a realization rate for each business. These were then averaged, to come up with realization rates for each MSEI grant program type. Additionally, NTG ratios were developed through surveys with participating businesses. Table 6-12 presents the results for the MSEI Grant Programs that were evaluated.

6-12 Main Street Site Energy Savings

MSEI Grant Programs	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)	NTG Ratio	Net Verified Energy Savings (MMBtus)[1]
Self-Managed	8,118	1.03	8,362	0.73	6,402
GEO-Managed	2,364	0.81	1,915	1.00	1,915
Competitive	7,740	0.86	6,656	0.91	6,046
Small Scale	2,885	0.95	2,741	0.56	1,542
Total	**21,108**	**-**	**19,674**	**-**	**15,905**

[1]Net verified values vary from aggregate program analysis due to aggregated realization rate and NTG ratio

Some of the communities did not have energy savings from their programs included in the evaluation for two main reasons:

1. There was no direct energy savings associated with the community's activities.

2. The community had not yet implemented the energy conservation measures, and thus had no data to share. Or they did not provide the necessary information.

All of the communities participating in the GEO-Managed Grant Program and the Small Scale Grant Program had energy savings included in the evaluation of the MSEI. The tables below outline the status of the communities within the Competitive and Self-Managed Grant Programs. Overall, the MSEI program will likely see an increase in the energy savings associated with this program when all the grants are completed and final reports are compiled by the participating communities.

6-13 Self Managed Grant Evaluation Status

Self Managed Grant	Energy Savings Included In Evaluation (Y/N)	If Not, Why?
City of Grand Junction	Y	
City of Fort Collins	N	No direct energy savings
CLEER	N	No direct energy savings
City of Aurora	N	Information not provided
City & County of Denver	Y	
Boulder County	Y	

6-14 Competitive Grant Evaluation Status

Competitive Grant	Included In Evaluation Activities (Y/N)	If Not, Why?
CLEER: Tri-County Main Street Efficiency Program	N	ECM's have not yet been installed
Platte River: Efficiency Express Program	Y	
EOC: Nonprofit Energy Efficiency Program	Y	
ORE: Energy Wise Business Program	Y	
Colfax Green Partnership	N	No direct energy savings
Woodland Park: Mainstreet Makeover II	Y	

6.2.1.2 Methodology

MSEI is a fairly complex grant program providing assistance to 29 communities through four different types of grants. Based on the requirements of the different grants, the communities create programs to assist businesses to implement energy efficiency projects. There is a high level of variability within the program regarding services, reporting, energy savings calculations, and rebates.

The initial plan was to sample 11 MSEI businesses. The team would then evaluate the energy savings associated with these businesses through site visits and desk reviews. However, after the evaluation team conducted interviews with the GEO staff, the GEO consultants managing this

program, and the individual communities participating in the various MSEI grant programs, the team changed the sampling approach to 29 MSEI businesses to achieve a 90/15 confidence/precision.

Challenges associated with evaluating the MSEI grant programs are listed below.

1. Varying program end dates. Each of the 29 communities has different contract end dates, which results in incomplete data collection.

2. Variety of energy savings calculations. Due to the different structure within each grant program, energy savings for the various implementation projects may be calculated by the GEO consultants, Xcel Energy on-site assessment providers, community program managers, or implementation contractors. This lack of consistency leads to uncertainty in the energy savings reported by the program.

3. Incomplete reporting of energy savings. According to the GEO consultant managing the MSEI, the Self-Managed and the Competitive Grant communities are not technically required to record energy savings for the businesses participating in the programs. This means that only some of the communities reported energy savings for these two programs with budgets of approximately $1.5 million (approximately 80% of the total MSEI budget).

The 29 MSEI businesses chosen for the sample implemented varying energy conservation measures. Verified savings calculation methodologies are broken down by measure type, and general assumptions used for each are listed below.

Lighting

Xcel Energy lighting assessments, equipment bids and invoices are reviewed, and the program documentation are reviewed to acquire the quantities of bulbs or fixtures installed, the wattages of both the new bulbs, as well as the operating hours of each business. $/kWh is estimated based on building audits for businesses in the same area.

Programmable Thermostats

Savings based on data provided through ENERGY STAR's programmable thermostat calculator. Setback settings were acquired from the business, otherwise default values were used.

HVAC

HVAC savings were calculated by using an eQuest model simulation methodology. All end load percentages for heating and cooling come from 2003 CBECS data.

Solar Shades

The end loads are taken from CBEC's data for service. The evaluation team used conservative estimates of 3% savings based on the GEO contractor's energy experience.

6.3 ACTIVITY 2: SUBGRANTS FOR ENERGY EFFICIENCY RETROFITS

Activity 2 provided funding for grants and rebates for energy efficiency projects, renewable energy projects, education and outreach, and energy auditor equipment. The majority of the funding in this activity was managed in the Residential Buildings and Renewable Energy Programs. The remaining funding was used by Local Programs to provide energy auditor equipment grants and energy efficiency in public buildings grants.

The programs included in this Activity that were evaluated include:

- Residential energy efficiency rebates
- Renewable energy rebates
- Energy Efficiency in Public Buildings grants

As mentioned earlier, EECBG funding was comingled with other funding streams to provide the residential and renewable energy rebates. The evaluation team allocated the energy savings attributable to those rebates to Activity 2 based on the percentage of Activity 2 funding used. Table 6-15 presents the evaluation findings for this activity.

Table 6-15 EECBG Activity 2 Site Findings

Activity 2	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Residential Rebates	58,057	n/a	44,214	884,060	n/a	34,222	684,283
Renewable Energy Rebates	10,948	n/a	9,874	195,291	n/a	8,166	160,338
EE in Public Buildings Grants	0	n/a	1,260	16,375	0.87	1,096	14,246
Totals	**69,005**	-	**55,348**	**1,095,725**	-	**43,484**	**858,867**

6.3.1 Residential Energy Efficiency Rebates

The findings for the Residential Energy Efficiency Rebates are presented in Table 6-16.

Table 6-16 EECBG Activity 2 Residential EE Rebate Site Findings

Activity 2: Residential Rebates	Gross Reported Energy Savings[1] (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Duct Sealing	110	1.04	115	2,062	0.73	83	1,495
Insulation & Air Sealing	48,904	0.69	33,507	670,133	0.85	28,313	566,262
Furnace	9,043	1.17	10,593	211,865	0.55	5,826	116,526
Totals	**58,057**	**-**	**44,214**	**884,060**	**-**	**34,222**	**684,283**

[1] Reported savings based on the GEO rebate processing subcontractor database

EECBG funding for duct sealing rebates, insulation & air sealing rebates, and furnace rebates was comingled with other funding streams. Table 6-17 outlines the percentage of EECBG funding used to offer these rebates. Table 6-17 also presents the useful life of the equipment used to calculate the lifetime energy savings. The energy savings in Table 6-16 above were based on the percentage of EECBG funding for each rebate.

Table 6-17 EECBG % Funding and Useful Lives

Residential EE Rebates	% EECBG Funding Stream[1]	Useful Life
Duct Sealing	12%	18[(2)]
Insulation & Air Sealing	40%	20[(2)]
Furnace	12%	20[(2)]

[(1)] Funding percentages provided by the GEO Rebate Program Manager

[(2)] DEER, EUL 2006-2007

6.3.1.1 Savings

Savings are outlined in Table 6-16.

6.3.1.2 Qualitative Findings

For detailed qualitative findings, see Section 5.7.4.2 for Duct Sealing, Section 5.7.5.2 for Insulation and Air Sealing, and Section 7 for Furnaces.

6.3.1.3 Methodology

For detailed methodology, see Section 5.7.4.3 for Duct Sealing, Section 5.7.5.3 for Insulation and Air Sealing, and Section 7 for Furnaces.

6.3.2 Renewable Energy Rebates

The findings for the Renewable Energy Rebates are presented in Table 6-18.

Table 6-18 EECBG Activity 2 Renewable Energy Rebate Site Findings

Activity 2: Renewable Energy Rebates	Gross Reported Energy Savings[1] (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Residential PV	5,126	1.02	5,234	115,510	0.83	4,334	95,657
Residential Solar Thermal	3,490	0.44	1,528	22,925	0.90	1,372	20,581
Residential Wind	354	1.26	446	8,927	0.95	424	8,481
Commercial PV	1,242	0.91	1,125	24,835	0.64	720	15,895
Commercial Solar Thermal	736	2.09	1,540	23,093	0.85	1,315	19,725
Totals	**10,948**	**-**	**9,874**	**195,291**	**-**	**8,166**	**160,338**

[1] Reported savings based on the GEO rebate processing subcontractor database

EECBG funding for the Renewable Energy Rebates was comingled with other funding streams to offer these rebates. Table 6-19 outlines the percentage of EECBG funding used to offer these rebates as well as the useful life of the equipment used to calculate the lifetime energy savings. The energy savings in Table 6-18 above were based on the percentage of EECBG funding for each rebate.

Table 6-19 EECBG % Funding and Useful Lives

Renewable Energy Rebates	% EECBG Funding Stream[1]	Useful Life
Residential PV	31%	25[(3)]
Residential Solar Thermal	23%	15[(2)]
Residential Wind	31%	20[(2)]
Commercial PV	20%	25[(3)]
Commercial Solar Thermal	21%	15[(2)]

[(1)] Funding percentages provided by the GEO Rebate Program Manager

[(2)] DEER, EUL 2006-2007

[(3)] Lawrence Berkeley National Laboratory

6.3.2.1 Savings

Savings are outlined in Table 6-18.

6.3.2.2 Methodology

For detailed methodology for each of the rebates, see Section 5.6.1.

6.3.3 Energy Efficiency in Public Buildings Grants

This grant program provided funding for local government and school district energy efficiency projects.

6.3.3.1 Savings

There were no savings reported for this program. Verified and net savings are outlined in Table 6-18.

6.3.3.2 Qualitative Findings

A total of eleven grants were awarded to eight state departments, municipal governments, and state universities. Table 6-20 displays the total grant amounts awarded to each participating agency.

Table 6-20: Energy Efficiency in Public Buildings Participants

Participant	Total Grant Amount
CU	$40,080
CSU	$84,260
CDHS	$23,400
DPA	$14,650
Freemont County	$50,000
City of Florence	$40,000
Town of Mancos	$31,780
DMVA	$37,610

6.3.3.3 Methodology

The types of measures associated with the Energy Efficiency in Public Buildings Grants program varied rather widely, similar to the NEED grant program. Due to the small sample size for this program (2 projects) a customized approach was developed for each selected sample. Since the NEED grants required this same type of customized approach, but on a larger scale, care was taken to draw from, and keep consistent with, the methodologies used for those sample points.

The first project of the two sample points for the EE Retrofits program took an IPMVP Option C approach. The project involved retrofitting an existing, over-sized chiller with a newer, smaller unit. Analysis involved review of historical utility bills for the facility. Regression analysis was used to relate cooling degree days to energy use during the cooling season. Due to a change in use for this particular facility, the newer chiller served a much smaller load than the original use of the building would have required. When the agency applied for the grant, the existing chiller had recently failed. Therefore, analysis required that a code-level chiller of a similar size be used as the baseline. This significantly reduced the amount of savings that could be claimed for the project from a case in which the baseline was the original, over-sized chiller. In the regression model, the energy consumption of the new chiller was compared to the estimated energy consumption of a same-sized chiller with code-level efficiency. Since the kW/ton rating of the new chiller was only a small fraction below the code maximum, verified savings for this sample point was fairly insignificant.

Analysis of the second sample also used an IPMVP Option C approach. The sample point involved a variety of measures that reduced both electric and natural gas consumption in two municipal government buildings. Measures included insulation and air sealing, lighting retrofits, occupancy sensors, and programmable thermostats. Utility bills were obtained for both electric and natural gas consumption for both buildings. Each building's electricity and natural gas consumption were

analyzed for several months leading up to the retrofits and then compared to several months of data following the retrofit date. Natural gas consumption reflected a close relationship to heating degree days, so a regression analysis was performed to determine savings from that fuel source. Due to the region and associated low impact of cooling in these two buildings, electricity consumption did not vary significantly with variations in cooling degree days. Therefore, analysis of electricity savings was based on an average daily electricity savings, and was then extrapolated to an annual value.

6.4 ACTIVITY 5: LIGHTING PROJECT

Two municipalities received EECGB funding to install LED street light fixtures. Table 6-21 presents the evaluation findings for this activity.

Table 6-21 EECBG Activity 5 Site Findings

Activity 5	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Lighting Project	157	0.51	80	879	1.00	80	879

6.4.1 Savings

Energy savings are realized by replacing energy intensive mercury vapor street lights, with energy efficient light emitting diode (LED) lamps.

6.4.2 Qualitative Findings

Satisfaction

Based on responses to the attribution survey, the participant expressed highest satisfaction with the amount of the grant received and the performance of the equipment. Satisfaction was generally lower with the overall project experience, the application process, the time to receive the rebate, and information obtained from the GEO website and the GEO staff.

6.4.3 Methodology

Energy savings for this grant were realized by replacing high intensity discharge (HID) street lights with energy efficient light emitting diode (LED) lamps. Therefore, energy savings were calculated by determining the difference in power usage between the HID baseline fixtures and the LED fixtures.

Project 1

To perform the analysis, the evaluation team collected data from the this project, including: number of fixtures replaced, wattage of the fixtures installed and the annual operating hours of the fixtures. This data is presented in Table 6-22. The equation below was used to calculate energy savings:

The total program savings is the sum of the individual project savings.

The lighting contractor used the following data in their calculations:

Table 6-22 LED Project 1 Details

Existing Street Light	Existing Street Light Wattage	Installed Street Lights Type	Installed Street Lights Wattage	Annual Operating Hours
Mercury Vapor Lamps	(53) lamps at 175-watts	LED	(42) fixtures at 40-watts and (11) fixtures at 100-watts	5,580 Hours

The evaluation team calculated the program energy savings using 100-watt high pressure sodium (HPS) lamps as the baseline, and the annual operating hours provided by the lighting contractor. The LED fixtures actually replaced 175-watt mercury vapor lamps. However, the Energy Security and Independence Act regulations, which are currently taking effect, have banned the use of mercury vapor lamps. Therefore, mercury vapor lamps would not have been available to replace the currently installed lamps. For this reason, the evaluation team chose to use 100-watt, HPS lamps as the baseline.

Project 2

The follow information was provided for Project 2:

Table 6-23 LED Project 2 Details

Existing Street Light	Existing Street Light Wattage	Installed Street Lights Type	Installed Street Lights Wattage	Annual Operating Hours
High Pressure Sodium Lamps	(16) lamps at 400-watts	LED	(16) 150-watt LED fixtures	5,580 Hours

For this project, evaluation team calculated the program energy savings using 400-watt high pressure sodium (HPS) lamps as the baseline, and the annual operating hours provided by the lighting contractor. It was assumed in this calculation that Project 2's street lights operate for the same number of hours as the street lights in Project 1.

There were no formally reported energy savings for the LED Lighting Project Program. Based on provided project documentation from the GEO, only Project 1 provided expected savings in its application; this value was adjusted by the Evaluation team to reflect a baseline of HPS lamps. The Evaluation team calculated expected energy savings for Project 2 based on supporting project documents.

The sum of both projects' expected savings served as the reported energy savings for the program. The Evaluation team subsequently performed its energy savings analysis on Project 1 to arrive at a measured savings value to calculate a realization rate and also administered an attribution survey to determine the net to gross factor.

6.5 ACTIVITY 6: ONSITE RENEWABLE ENERGY TECHNOLOGY

The program evaluated in Activity 6 was the Renewable Energy in Public Buildings grant program. In the case of Renewable Energy in Public Buildings, the Local Program offered grants at $1/watt for solar PV projects. Table 6-24 presents the evaluation findings for this activity.

Table 6-24 EECBG Activity 6 Site Findings

Activity 6	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
RE in Public Buildings	1,202	0.76	913	20,159	1.00	913	20,159

6.5.1 Savings

Reported savings for the Renewable Energy in Public Buildings were derived from project narratives and email correspondence between the grantee and the GEO. From these sources, a reported annual savings of 1,202 MMBtu were estimated. Measured savings were estimated at 913 MMbtus annually.

6.5.2 Qualitative Findings

There were originally three grant projects. However, one of the three projects nullified its contract with the GEO. Of the remaining two projects, one was completed in October 2011. The second project was pending NEPA approval as of December 2011 but is expected to be completed in July 2012.

6.5.3 Methodology

Data analysis followed IPMVP Option B (Retrofit Isolation), which involved direct measurement of the energy benefit of the PV panels for the first sample via a site inspection and IPMVP Option D (Model Simulation) for the second sample. For the first sample, the evaluation team conducted a site inspection focused on the following tasks:

- Verification of installation and operation of the PV system
- Inspection of PV system condition
- Collection of system data

The evaluation team utilized the SunEye 2000 to measure potential solar energy available at the site adjusting for shading effects and the angle of sunlight throughout the year. These measurements were used in the analysis due to the fact that the system was not yet operational at time of inspection and therefore had no meter data available. Based on the measurements taken from the system, a simulation of annual energy generation was generated. Energy generation for the second sample was produced by generating a simulation model using information provided through a phone interview with the grantee including anticipated location, system size and design, and

technology employed. The baseline for both analyses is zero, as no energy would have been generated in the absence of the PV system.

7 STATE ENERGY EFFICIENCY APPLIANCE REBATE PROGRAM

The impact evaluation of the rebates offered through SEEARP was conducted through phone interviews, site inspections, and utility bill analysis. Phone interviews were used when it was expected that the average homeowner could provide the information accurately. Site inspections were used when the necessary information to be collected was more complex.

Table 7-1 outlines the findings from the evaluation of the SEEARP funding stream.

Table 7-1 SEEARP Site Findings

Appliance	Gross Reported Energy Savings (MMBtus)	Realization Rate	Gross Verified Energy Savings (MMBtus)		NTG Ratio	Net Energy Savings (MMBtus)	
	Annual		Annual	Lifetime		Annual	Lifetime
Clothes Washers	8,968	0.79	7,087	77,953	0.30	2,126	23,386
Dishwashers	2,030	0.77	1,554	21,749	0.40	626	8,760
Refrigerators	3,018	6.40	19,312	212,428	0.33	6,276	69,039
Water Heaters - Gas Storage	960	0.44	421	8,411	0.75	315	6,308
Water Heaters - Gas Tankless	1,269	0.73	927	18,544	0.74	686	13,730
Furnaces - Gas	44,960	1.17	52,668	1,053,357	0.55	28,967	579,347
Boilers - Gas	1,673	4.17	6,971	139,423	0.68	4,706	94,111
Totals	**62,878**	**-**	**88,939**	**1,531,866**	**-**	**43,703**	**794,681**

7.1.1 SEEARP Gross Reported Savings

The first step in determining the net savings for the SEEARP was to evaluate the savings reported by the GEO to the DOE. Reporting of energy savings and other metrics associated with the programs was required quarterly to the DOE using the Performance and Accounting for Grants in Energy (PAGE) reporting system. Table 7-2 outlines the gross energy and demand savings reported by the GEO as of December, 2011. The evaluation team utilized the GEO's rebate processing contractor's databases to determine the gross reported savings:

Table 7-2 SEEARP Gross Reported Site Energy Savings

Appliance	Gross Reported Electricity Savings (kWh)	Gross Reported Gas Savings (MMBtus)	Total Gross Reported Savings (MMBtus)
Clothes Washers	1,103,858	5,201	8,968
Dishwashers	309,737	973	2,030
Refrigerators	884,415	0	3,018
Water Heaters - Gas Storage	0	960	960
Water Heaters - Gas Tankless	0	1,269	1,269
Furnaces - Gas	0	44,960	44,960
Boilers - Gas	0	1,673	1,673
Total	**2,298,010**	**55,037**	**62,878**

7.1.2 SEEARP Gross Verified Savings

The data collected as a result of the on-site inspections, phone surveys and engineering analysis, allowed the evaluation team to recalculate energy savings for each sampled project—this is termed the gross verified savings. The ratio of the gross verified savings to the reported savings by the GEO is the project's "realization rate" while the program's realization rate is the weighted average for all the projects within the sample. Total gross verified savings are the product of the reported savings for that program and the program's realization rate. These program level gross verified savings are summed to the funding stream level.

The realization rates for each of the SEEARP appliances are presented in Table 7-3.

Table 7-3 SEEARP Realization Rates

Appliance	Realization Rate
Clothes Washers	0.79
Dishwashers	0.77
Refrigerators (recycling)	6.40
Water Heaters - Gas Storage	0.44
Water Heaters - Gas Tankless	0.73
Furnaces – Gas	1.17
Boilers – Gas	4.17

Using these realization rates, the evaluation team calculated the gross verified energy savings for the SEEARP program. Table 7-4 outlines the gross verified site energy savings for the SEEARP appliances.

Table 7-4 SEEARP Gross Verified Site Energy Savings

Appliance	Gross Verified Electricity Savings (kWh)		Gross Verified Gas Savings (MMBtus)		Total Gross Verified Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Clothes Washers	872,302	9,595,317	4,110	45,214	7,087	77,953
Dishwashers	237,042	3,318,592	745	10,426	1,554	21,749
Refrigerators	5,659,919	62,259,110	0	0	19,312	212,428
Water Heaters - Gas Storage	0	0	421	8,411	421	8,411
Water Heaters - Gas Tankless	0	0	927	18,544	927	18,544
Furnaces - Gas	0	0	52,668	1,053,357	52,668	1,053,357
Boilers - Gas	0	0	6,971	139,423	6,971	139,423
Total	**6,769,263**	**75,173,019**	**65,842**	**1,275,376**	**88,939**	**1,531,866**

In addition to the site savings, the evaluation team calculated the energy savings and other metrics associated with the source of generation. These savings are detailed in Table 7-5 and Table 7-6.

Table 7-5 SEEARP Gross Verified Source Energy Savings

Appliance	Gross Verified Electricity Savings (kWh)		Gross Verified Gas Savings (MMBtus)		Total Gross Verified Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Clothes Washers	2,894,297	31,837,263	4,304	47,339	14,179	155,968
Dishwashers	786,506	11,011,089	780	10,917	3,463	48,486
Refrigerators	18,779,612	206,575,727	0	0	64,076	704,836
Water Heaters - Gas Storage	0	0	440	8,806	440	8,806
Water Heaters - Gas Tankless	0	0	971	19,416	971	19,416
Furnaces - Gas	0	0	55,143	1,102,865	55,143	1,102,865
Boilers - Gas	0	0	7,299	145,976	7,299	145,976
Total	**22,460,414**	**249,424,078**	**68,936**	**1,335,319**	**145,571**	**2,186,354**

Table 7-6 SEEARP Gross Verified Source Demand, CO2e, and Water Savings

Appliance	Gross Verified Demand Savings (kW)		Gross Verified CO2e (tonnes)		Total Gross Verified Water Savings (gallons)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Clothes Washers	0	n/a	1,111	12,222	1,046,762	11,514,381
Dishwashers	0	n/a	281	3,935	284,451	3,982,311
Refrigerators	762	n/a	5,717	62,882	6,791,903	74,710,932
Water Heaters - Gas Storage	0	n/a	24	471	0	0
Water Heaters - Gas Tankless	0	n/a	52	1,038	0	0
Furnaces - Gas	0	n/a	2,947	58,948	0	0
Boilers - Gas	0	n/a	390	7,802	0	0
Total	**762**	**-**	**10,522**	**147,298**	**8,123,116**	**90,207,623**

7.1.3 Net Savings

Net impacts are calculated by multiplying the gross verified savings by a NTG ratio. The development of the NTG ratio is described below.

7.1.3.1 Freeridership

The main component of the NTG ratio is freeridership. Freeriders involve participants who on some level may have participated in the program regardless of the GEO influence. Freeridership is assessed through attribution surveys delivered to the sample population.

7.1.3.2 Net to Gross Ratios

Based on the calculated rates of freeridership, the evaluation team was able to assess the NTG ratio for the appliances within the SEEARP. These ratios are provided in Table 7-7.

Table 7-7 SEEARP NTG Ratios

Appliance	Net to Gross Ratio
Clothes Washers	0.30
Dishwashers	0.40
Refrigerators (recycling)	0.33
Water Heaters - Gas Storage	0.75
Water Heaters - Gas Tankless	0.74
Furnaces – Gas	0.55
Boilers – Gas	0.68

7.1.3.3 Net Savings

The evaluation team then applied the NTG ratio to the gross verified savings to determine the overall net impacts. Table 7-8 summarizes the evaluation team's findings for the net site savings.

Table 7-8 SEEARP Net Site Energy Savings

Appliance	Net Electricity Savings (kWh)		Net Gas Savings (MMBtus)		Total Net Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Clothes Washers	261,690	2,878,595	1,233	13,564	2,126	23,386
Dishwashers	95,475	1,336,655	300	4,200	626	8,760
Refrigerators	1,839,474	20,234,211	0	0	6,276	69,039
Water Heaters - Gas Storage	0	0	315	6,308	315	6,308
Water Heaters - Gas Tankless	0	0	686	13,730	686	13,730
Furnaces - Gas	0	0	28,967	579,347	28,967	579,347
Boilers - Gas	0	0	4,706	94,111	4,706	94,111
Total	**2,196,640**	**24,449,461**	**36,208**	**711,259**	**43,703**	**794,681**

In addition to the site savings, the evaluation team calculated the energy savings and other metrics associated with the source of generation. These savings are detailed in Table 7-9 and Table 7-10.

Table 7-9 SEEARP Net Source Energy Savings

Appliance	Net Electricity Savings (kWh)		Net Gas Savings (MMBtus)		Total Net Savings (MMBtus)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Clothes Washers	868,289	9,551,179	1,291	14,202	4,254	46,790
Dishwashers	316,787	4,435,022	314	4,397	1,395	19,529
Refrigerators	6,103,374	67,137,111	0	0	20,825	229,072
Water Heaters - Gas Storage	0	0	330	6,604	330	6,604
Water Heaters - Gas Tankless	0	0	719	14,375	719	14,375
Furnaces - Gas	0	0	30,329	606,576	30,329	606,576
Boilers - Gas	0	0	4,927	98,534	4,927	98,534
Total	**7,288,450**	**81,123,312**	**37,910**	**744,688**	**62,778**	**1,021,481**

Table 7-10 SEEARP Net Source Demand, CO2e, and Water Savings

Appliance	Net Demand Savings (kW)		Net CO2e (tonnes)		Net Water Savings	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Clothes Washers	0	n/a	333	3,666	314,029	3,454,314
Dishwashers	0	n/a	113	1,585	114,570	1,603,986
Refrigerators	248	n/a	1,858	20,437	2,207,368	24,281,053
Water Heaters - Gas Storage	0	n/a	18	353	0	0
Water Heaters - Gas Tankless	0	n/a	38	768	0	0
Furnaces - Gas	0	n/a	1,621	32,421	0	0
Boilers - Gas	0	n/a	263	5,267	0	0
Total	**248**	**-**	**4,245**	**64,498**	**2,635,967**	**29,339,353**

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Table 7-12 outlines the average annual energy savings per appliance participants can expect through the purchase of a high efficiency appliance.

Table 7-11 SEEARP Energy Savings per Appliance

Appliance	Net Savings - Electricity/Appliance (kWh)	Net Savings - Natural Gas/Appliance (MMBtu)	Net Savings - Total Energy/ Appliance (MMBtu)
Clothes Washers	82	0	1
Dishwasher	34	0	0
Refrigerators	672	0	2
Water Heater - Storage	0	2	2
Water Heater - Tankless	0	6	6
Furnaces	0	11	11
Boilers	0	16	16

7.2 CLOTHES WASHERS

The Clothes Washers program provided an incentive of $75 for the purchase of a new ENERGY STAR rated clothes washer.

7.2.1 Qualitative Findings

Satisfaction

Participants reported very high satisfaction with all aspects of this program. The area with the least satisfaction reported was related to the lack of information present on the website related to the rebate details.

In addition, participants in this program reported that they were highly influenced by the retailer or salesperson regarding the selection of the more efficient appliance.

7.2.2 Methodology

The methodology for calculating gross savings from purchasing a new ENERGY STAR rated clothes washer was based on deemed savings values published by ENERGY STAR and self-reported information collected from each sampled participant via phone survey.

Because ENERGY STAR clothes washer reduce hot water usage and required drying time, deemed savings depend on the fuel type of the hot water heater and the dryer. The following shows the

ENERGY STAR deemed savings values[35] for specific water heater and dryer fuel types, assuming an annual usage of 392 loads.

Table 7-12 Water Heater/Dryer Deemed Energy Savings

Water Heater Fuel	Dryer Fuel	Electric Savings (kWh)	Gas Savings (MMBtu)
Electric	Electric	224	0
Natural Gas	Electric	97	0.61

The evaluation team collected estimated usage values as well as appliance fuel types from each participant. The self-reported annual usage was used to scale the ENERGY STAR deemed savings values for both electric and gas fuels, as shown in the following equations:

Peak demand savings were assumed to be negligible, which is consistent with other similar evaluation findings[36].

7.3 DISHWASHERS

This program provided an incentive of $50 for the purchase of a new ENERGY STAR rated dishwasher.

7.3.1 Qualitative Findings

Satisfaction

Participants generally reported high satisfaction with this program. The area with the least satisfaction reported was related to the application process.

Participants in this program reported that they were highly influenced by the retailer or salesperson regarding the selection of the more efficient appliance.

7.3.2 Methodology

The methodology for calculating gross savings from purchasing a new ENERGY STAR rated dishwasher was based on the Energy Factor (EF) of each appliance in the sample and self-reported information collected from each sampled participant via phone survey. The dishwasher EF is defined to include energy used by the dishwasher and energy used by the hot water heater to support dish washing.

Because ENERGY STAR dishwashers reduce hot water usage, the calculated savings depend on the fuel type of the hot water heater. The evaluation team collected the water heater fuel source from

[35] http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerClothesWasher.xls

[36] Residential Retrofit High Impact Measure Evaluation Report for CPUC. The Cadmus Group. February 8, 2010.

each participant, as well was the self-reported annual usage of the dishwasher. The annual energy usage for sampled dishwashers was calculated using the following equations. The savings for each fuel type is calculated as the difference between annual energy usage of the installed ENERGY STAR appliance and a conventional appliance.

For electric water heating:

For gas water heating:

Values used in these equations are summarized in the following table. Deemed values are taken from ENERGY STAR publications[37].

Table 7-13 Deemed Energy Savings Calculations

Metric	Value
Energy Factor (EF)	ENERGY STAR =Model-specific Conventional = 0.5984
Cycles per Week	Self-reported
% of DW Energy used for WH	56%
Annual Standby Energy	8.765 kWh
kWh to Therm conversion	0.003412
Avg Efficiency of Gas WH	75%

Peak demand savings were assumed to be negligible, which is consistent with other similar evaluation findings[38].

7.4 REFRIGERATORS

This program provided an incentive of $50 for the purchase of a new ENERGY STAR rated refrigerator. An additional $50 incentive was offered for recycling the original refrigerator.

[37] http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls

[38] Residential Retrofit High Impact Measure Evaluation Report for CPUC. The Cadmus Group. February 8, 2010.

However, in practice almost all participants (~90%) received the full $100 incentive regardless of participation in the recycling portion of the program.

The determination of whether a participant received the $50 incentive or the $100 incentive was intended to be based on participation in recycling of the original appliance. However, the program was executed such that $100 was incented for anyone who bought an appliance from a list of approved vendors. The evaluation team determined that purchasing the appliance from the approved vendor list did not affect whether the participant relinquished their appliance to the vendor or not. Additionally, the evaluation team determined that some participants who received the $50 incentive did recycle their original appliance. Therefore, the evaluation team has pooled the participants in both categories and evaluated them as one population.

7.4.1 Savings

The GEO Reported Savings values for this program are calculated as the number of participants multiplied times the per-unit energy savings for this appliance as listed in the GEO's spreadsheet tool, which is used for the reporting to DOE. This tool does not include any savings for refrigerators that were recycled (i.e. removed from the grid) as opposed to refrigerators that were sold or given away (i.e. remained on the grid). The high realization rate for this program is because the evaluation team has assigned additional energy savings for refrigerator recycling where appropriate.

7.4.2 Qualitative Findings

Satisfaction

Participants reported very high satisfaction with all aspects of this program. The area with the least satisfaction reported was related to the lack of information present on the website related to the rebate details.

Participants in this program reported that they were highly influenced by the retailer or salesperson regarding the selection of the more efficient appliance.

7.4.3 Methodology

The methodology for calculating gross savings from purchasing a new ENERGY STAR rated refrigerator was based on the annual Unit Energy Consumption (UEC) as published by ENERGY STAR for each specific refrigerator in the sample. Baseline UECs were also calculated using configuration-specific equations published by ENERGY STAR [39], summarized in Table 7-14.

Table 7-14 Refrigerator Baseline UEC Methodology

Configuration	Baseline UEC (kWh)

[39] http://energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Consumer_Residential_Refrig_Sav_Calc.xls

Manual Defrost	8.82*AV+248.4
Partial Auto Defrost	8.82*AV+248.4
Top Mount Freezer w/o thru the door ice	9.8*AV+276
Side Mount Freezer w/o thru the door ice	4.91*AV+507.5
Bottom Mount Freezer w/o thru the door ice	4.6*AV+459
Top Mount Freezer w/ thru the door ice	10.2*AV+356
Side Mount Freezer w/ thru the door ice	10.1*AV+406

The evaluation team collected the configuration, adjusted volume (AV), and the annual UEC for each refrigerator in the sample. Refrigerator model numbers were verified via phone survey. The electricity savings for each refrigerator were calculated as

The evaluation team also collected information about the condition and status of each participant's old refrigerator. For participants who recycled their original appliance, an additional electric energy savings was attributed for removing the old appliance from the grid.

Peak demand savings was calculated using:

where:

Hours = average annual run-time hours of refrigerator = 5000 hours[40]

CF_{demand} = summer coincident factor for demand = 0.62[41]

7.5 WATER HEATERS (STORAGE)

This program provided an incentive of $200 for the purchase of a new ENERGY STAR rated gas storage water heater.

7.5.1 Qualitative Findings

Satisfaction

Participants reported generally high satisfaction with all aspects of this program.

[40] Efficiency Vermont; Technical Reference User Manual (TRM). 2008. TRM User Manual No. 2008-53. Burlignton, VT 05401. July 18, 2008.

[41] Mid Atlantic TRM Version 1.0. May 2010. Prepared by Vermont Energy Investment Corporation. Facilitated and managed by Northeast Energy Efficiency Partnerships.

Participants in this program reported that they were highly influenced by the retailer or salesperson regarding the selection of the more efficient appliance.

7.5.2 Methodology

The methodology for calculating gross savings from purchasing a new ENERGY STAR rated storage hot water heater was based on the Energy Factor (EF) for each specific appliance in the sample. The fuel consumption of each hot water heater was calculated using:

Table 7-15 summarizes the values used.

Table 7-15 Water Heating Energy Savings Methodology

Metric	Value
Baseline EF	0.67-0.0019*capacity in gallons[42]
ENERGY STAR EF	Model-specific
HW = hot water used per day in gallons	64.3[43]
T_{hot} = temperature of hot water discharge	120°F
T_{cold} = temperature of cold water supply	55°F

The evaluation team verified the EF and capacity of each appliance in the sample set via phone survey.

7.6 WATER HEATERS (TANKLESS)

This program provided an incentive of $300 for the purchase of a new ENERGY STAR rated gas tankless water heater.

7.6.1 Qualitative Findings

Satisfaction

Generally, participants reported high satisfaction with the program. The lowest satisfaction reported was with the application process.

Participants in this program reported that they were highly influenced by the retailer or salesperson regarding the selection of the more efficient appliance.

42 "Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters" US Dept of Energy Docket Number: EE–2006–BT-STD–0129, p. 30

43 "Energy Conservation Program for Consumer Products: Test Procedure for Water Heaters", Federal Register / Vol. 63, No. 90, p. 25996

7.6.2 Methodology

The methodology for calculating gross savings from purchasing a new ENERGY STAR rated tankless hot water heater was based on the Energy Factor (EF) for each specific water heater in the sample. The energy savings of each hot water heater was calculated using the following equation:

Table 7-16 summarizes the values used. The baseline was considered to be a standard 50-gallon storage water heater.

Table 7-16 Tankless Water Heater Energy Savings Methodology

Metric	Value
Baseline EF (50-gal storage unit)	0.575
ENERGY STAR EF	Model-specific
Deg Factor (accounts for disparity between nominal EF and actual efficiency of tankless water heaters)	91.2%[44]
HW = hot water used per day in gallons	64.3[45]
T_{hot} = temperature of hot water discharge	120°F
T_{cold} = temperature of cold water supply	55°F

The evaluation team verified the EF of each water heater in the sample set via phone survey.

7.7 GAS FURNACES

This program provided a $500 incentive for the purchase of a new ENERGY STAR rated gas furnace.

7.7.1 Qualitative Findings

Satisfaction

Participants reported high satisfaction with almost all aspects of this program. One exception is the website's information on energy efficiency, which most participants were not aware of.

Participants in this program reported that they were highly influenced by the retailer or salesperson regarding the selection of the more efficient appliance. Most participants in this program were also influenced by the availability of the Federal tax credit for installing this appliance.

[44] A 2006 recommendation to the California Energy Commission. Davis Energy Group, Measure Information Template: Tankless Gas Water Heaters, April 2008
http://www.energy.ca.gov/title24/2008standards/prerulemaking/documents/2006-05-18_workshop/2006-05-11_GAS_WATER.PDF

[45] "Energy Conservation Program for Consumer Products: Test Procedure for Water Heaters", Federal Register / Vol. 63, No. 90, p. 25996

7.7.2 Methodology

The methodology for calculating gross savings for ENERGY STAR furnace replacements was conducted using utility bill analysis. Gas bills were collected for each sampled participant for at least 24 months, one year before and one year after the retrofit. In the case of failed furnaces, the baseline condition was considered to be a new standard efficiency furnace (AFUE=80%). This baseline was applied to almost all sampled participants. In a few cases where the furnace was replaced before the end of its useful life, the baseline condition was considered to be the pre-retrofit gas usage.

The evaluation team also performed an on-site verification of each furnace in the sample. In order to inform the utility analysis for each residence, information collected on-site included:

- Actual efficiency (AFUE) of the installed furnace
- Condition and age of the replaced furnace
- Information about all other gas end-uses in the residence

The method used to analyze each participant's utility data was:

1. Collect gas usage and meter read dates.
2. Determine location specific heating degree days (HDDs) applicable to each utility bill.
3. Use linear regression of gas usage vs. HDDs to determine the heating load of each residence.
4. Calculated baseline gas consumption:
    a. For failed furnaces, apply a ratio of standard efficiency (80%) to installed furnace efficiency (~95%).
    b. For furnaces not at end of life, use pre-retrofit heating load as baseline.
5. Verified savings = Baseline gas consumption – Post-retrofit gas consumption.

Final savings value allocated among the multiple funding streams included in the Furnace rebate program. SEEARP comprised 59% of the total Furnace program budget and therefore the savings allocated to SEEARP was weighted by this percentage.

7.8 GAS BOILERS

This program provided a $400 incentive for the purchase of a new ENERGY STAR rated hot water boiler.

7.8.1 Savings

The GEO reported savings value for this program was calculated as the number of participants multiplied times the per-unit energy savings for this appliance, which was listed in the GEO

spreadsheet reporting tool. The high realization rate for this program indicates that the GEO spreadsheet reporting tool savings value for this program was probably too low.

7.8.2 Qualitative Findings

Satisfaction

Participants reported high satisfaction with all aspects of this program.

Participants in this program reported that they were highly influenced by the retailer or salesperson regarding the selection of the more efficient appliance. Most participants in this program were also influenced by the availability of the Federal tax credit for installing this appliance.

7.8.3 Methodology

The methodology for calculating gross savings for ENERGY STAR hot water boiler replacements was conducted using utility bill analysis. Gas bills were collected for each sampled participant for at least 24 months, one year before and one year after the retrofit. In the case of failed boilers, the baseline condition was considered to be a new standard efficiency boiler (AFUE=80%). This baseline was applied to almost all sampled participants. In a few cases where the boiler was replaced before the end of its useful life, the baseline condition was considered to be the pre-retrofit gas usage.

The evaluation team also performed an on-site verification of each boiler in the sample. In order to inform the utility analysis for each residence, information collected on-site included:

- Actual efficiency of the installed boiler
- Condition and age of the replaced boiler
- Information about all other gas end-uses in the residence

The method used to analyze each participant's utility data was:

1. Collect gas usage and meter read dates.
2. Determine location specific heating degree days (HDDs) applicable to each utility bill.
3. Use linear regression of gas usage vs. HDDs to determine the heating load of each residence.
4. Calculated baseline gas consumption:
    a. For failed boilers, apply a ratio of standard efficiency (80%) to installed furnace efficiency (~95%).
    b. For boilers not at end of life, use pre-retrofit heating load as baseline.
    c. Verified savings = Baseline gas consumption – Post-retrofit gas consumption.

8 DETAILED PROGRAM DESCRIPTIONS

The Governors' Energy Office was one of Colorado's state agencies responsible for use and distributing ARRA funds in Colorado. The GEO applied the funds to three funding streams based on DOE requirements: the State Energy Programs grant (SEP), the State Energy Efficient Appliance Rebate Program (SEEARP), and the Energy Efficiency and Conservation Block Grant (EECBG). All three funding streams have specific allocation and reporting requirements, but the main goal of each was to encourage the installation of energy efficiency and renewable energy projects while maintaining or adding jobs to the economy.

The GEO utilized these funding streams to complement existing utility and governmental programs by offering rebates or advisory services that encouraged Colorado residents and businesses to participate in the existing programs. The GEO also created programs and services that filled market gaps that were underserved by the existing utility or government infrastructure across the state.

This section provides detailed information on the programs and services offered by the GEO for each of the three funding streams. This information includes

- Program Background
- Markets served
- Barriers addressed
- Program administration
- Program operation

8.1 GEO ARRA PROGRAM OVERVIEW

8.1.1 Segmentation of funding streams and activities

While the original filing to the DOE outlined the budgets based on funding streams, the GEO programs were developed to efficiently use the funding and streamline services run by the program managers. Program managers often managed funding from two or three of the ARRA funding streams.

The mixing of funds created evaluation issues as the Project required appropriate attribution of the energy savings associated with each funding stream. Using the logic steps outlined by the GEO for the use of the funds as well as accounting and tracking reports, the evaluation team was able to accurately track the funds.

8.2 STATE ENERGY PROGRAM

The sections below provided details on the market titles evaluated as part of this Project.

8.2.1 Capital Investments

8.2.1.1 Green Colorado Credit Reserve Program

One of the biggest challenges for businesses when considering energy efficiency investments is the large up-front costs associated with these capital improvements. Furthermore, finding access to capital for these purposes can be difficult to secure. The Green Colorado Credit Reserve (GCCR) is a loan loss reserve designed to address these challenges. The program was created in November 2010 to leverage private lenders to make small commercial loans up to $100,000 for capital improvements to promote energy efficient retrofits in buildings and renewable energy installations. The program exists to serve both small Colorado businesses and private lenders in Colorado.

This program builds on the Colorado Credit Reserve program administered by the Colorado Housing Finance Authority (CHFA). The CHFA has been contracted to administer the GCCR program. The goal of the program is to both improve access to capital for small Colorado businesses wanting to finance energy efficiency or renewable projects and better equip lenders to provide those loans. The program works by providing participating lenders a 15% loan loss reserve contribution for every loan registered in the program to encourage private sector lending and generate cost savings for businesses.

It does this by providing lenders with partial risk coverage in the event of a loan default, thereby spreading the risk and enabling financial institutions to provide lower-interest loans to businesses. Lower interest rates result in lower interest payments, making energy efficiency or renewable energy projects more economically attractive as utility savings approach or exceed debt payments.

The GEO has made $1 million available to banks interested in participating in the GCCR program. With the program just getting underway, there are three participating banks in Colorado that have made two loans. One loan helped finance a commercial solar photovoltaic installation, with another provided to a commercial lighting retrofit company.

8.2.1.2 Direct Lending Revolving Loan Program

The Direct Lending Revolving Loan Program (RLP) was created in November 2010 to provide businesses access to capital where the GEO identifies finance gaps in the market. According to the GEO, the RLP is designed to provide essential capital to early-stage companies and commercial projects utilizing innovative energy technologies that are incapable of accessing capital from traditional sources. The idea is to provide these companies and projects the funding required to deploy and commercialize innovative energy technologies in an effort to create jobs and spur traditional lenders to fill these gaps in the future. Loans under the RLP will be larger than the loans under the GCCR program, with a minimum $100,000. the GEO.Specifically, the loans are intended for either large-scale retrofit of buildings or for companies whose products or services directly impact the renewable energy and energy efficiency sector from an economic development basis, or any other unique opportunity to promote energy efficiency and renewable energy. To date, five loans have been closed - four with Colorado cleantech companies and one for a building retrofit. Four more loans are slated to be closed by March 2012.

An added benefit of the RLP is that, according to the GEO, it will provide the opportunity to earn revenue (between 4-5% on interest) as it effectively makes loans and payments from outstanding loans are received. This will create an opportunity to grow the fund over time and provide a revenue source for the GEO in the long run and "revolve" them and lend to new applicants.

8.2.1.3 NEED Grant Program

The New Energy Economy Development (NEED) grant program was initiated under the auspices of the GEO's Capital Investment Program. Developed in partnership with the Governor's Office of Economic Development and International Trade (OEDIT), the primary aim for the program was to further bolster existing funding for energy efficiency or renewable energy projects being undertaken by Colorado businesses and communities. In most cases, the intention was for the NEED grant to provide enough funding to save a project that may have otherwise been canceled or to enhance or expand a project that may have had a restricted scope due to financial limitations. For example, several NEED grantees had undergone the initial stages of an Energy Performance Contract (EPC) only to find that one of the more desirable measures had to be removed from the scope due to the strict project payback requirements of the EPC process. The NEED grant, in these cases, provided enough funding to wrap that measure back into the EPC or to fund the individual measure outside the scope of the EPC. Other grantees were in the process of funding single-measure projects and the NEED grant assisted in the decision to move forward with the project. Overall, the goal of the program has been to further Colorado's New Energy Economy by saving energy and energy costs, as well as creating jobs.

The types of projects and measures assisted by NEED grants have varied quite extensively. Measures have included typical HVAC, lighting, and other energy efficiency retrofits, solar photovoltaic, solar thermal, wind, and other renewable energy systems, and other less tangible measures that aim to engage citizens, deliver education and outreach, or provide actionable tools for municipalities to advance their energy programs.

8.2.2 Commercial Buildings Existing

The Commercial Buildings Existing market title offers three programs that were a focus of this Project: Energy Performance Contracting (EPC), Grants and the Main Street Efficiency Initiative (MSEI). This section will outline the EPC and the Grants programs while the MSEI program is discussed in more detail in the EECBG program descriptions in Section 8.3.1.

The EPC program provides comprehensive technical assistance to help communities through the performance contracting process. One of the challenges for communities seeking to improve the energy efficiency of their buildings is the overall project cost. Additionally, there is often a lack of strategy for the improvement of energy efficiency in buildings and equipment is simply replaced when it fails. Energy Service Companies (ESCOs) provide a service that can overcome these barriers through an energy performance contract. A typical project is delivered by the ESCOs consist of the following elements:

- **Turnkey Service** – The ESCO provides all of the services required to design and implement a comprehensive project at the customer facility, from the initial energy audit through long-term Monitoring and Verification (M&V) of project savings.
- **Comprehensive Measures** – The ESCO tailors a comprehensive set of measures to fit the needs of a particular facility, and can include energy efficiency, renewables, distributed generation, water conservation and sustainable materials and operations.
- **Project financing** – The ESCO arranges for long-term project financing that is provided by a third-party financing company. Financing is typically in the form of an operating lease or municipal lease.
- **Project Savings Guarantee** – The ESCO provides a guarantee that the savings produced by the project will be sufficient to cover the cost of project financing for the life of the project.

However, this service can be daunting for communities due to the time involved as well as understanding the engineering and financial analysis provided by the ESCOS.

The EPC program helped communities overcome these barriers by providing a number of services to ensure the communities understood the process and trusted the ESCOS. These services included:

- Evaluating and pre-qualifying 14 ESCOS to participate in the program
- Administering and managing the activities of these ESCOS
- Assisting the communities with the selection of an ESCO
- Assisting communities with review of the ESCOS assumptions, financial and engineering analysis, and other data
- Presentation to community boards, commissions and councils regarding the potential project

Through the EPC program, many state and local governments have been able to improve the condition and energy efficiency of their buildings while improving occupant comfort and productivity. To date, the GEO's EPC program has worked with hundreds of communities interested in improving the energy efficiency of their building stock and has 31 communities that are currently in various stages of construction of energy efficiency upgrades.

The CBE program also issued four grants to communities to help improve the efficiency of existing buildings. These grants helped these communities overcome the financial barrier to energy efficiency improvements.

8.2.3 Commercial High Performance Buildings

The Commercial High Performance Building (HPB) program provides technical assistance to public agency new construction and major renovation projects, workshops and trainings, and grants to help finance the installation of energy efficient equipment in new buildings. HPB program goals include institutionalizing high performance building statewide, supporting state policies, and

creating positive local economic impact. The program seeks to accomplish these goals by providing training opportunities, tools, and technical assistance along with targeted grants.

The HPB technical assistance program provided technical support to owners and project teams to ensure achievement of aggressive levels of energy efficiency as well as compliance with the state's third-party certification requirements. This service provides not only the technical assistance for construction design teams but also included tracking of program results and program marketing. The technical assistance involved working with construction design teams to incorporate energy efficiency and renewable energy equipment and strategies into the design of the new buildings. Oftentimes, construction design teams are either unfamiliar with high efficient equipment or concerned about its potential cost, and therefore do not spec it into the design of a new building. The technical assistance team provided education and modeling to showcase how high efficient equipment is often cost effective in the short and long terms when included in the design stage. This assistance has encouraged the installation of numerous high efficient strategies and equipment into 80 public buildings throughout Colorado.

Grants targeting high performance design encouraged the development of a high performance design culture in Colorado. The grants have been issued to 10 communities for either the installation of energy efficient equipment or for services to help promote energy efficient design in new construction.

8.2.4 Renewable Energy Programs

The sections below detail the programs evaluated as part of the Renewable Energy Programs market title.

8.2.4.1 Renewable Rebates Program

Several items of legislation in the state of Colorado in the past several years have been aimed at advancing the penetration of renewable energy technology deployment. Distributed renewable energy has been specifically called out as a major driver of this advancement. In fact, in 2010 House Bill 10-1001 was passed increasing Colorado's Renewable Energy Standard to 30% of retail sales by 2020 and requiring that 3% of electricity sales come from distributed renewable generation. To help meet these goals, the Governor's Energy Office implemented a rebate program for renewable energy projects for commercial and residential customers. The measures eligible for rebates included solar photovoltaic systems, solar hot water systems, and small wind generation. By providing funding for these types of projects the Governor's Energy Office aimed to mitigate the financial obstacles often associated with renewable energy. The goal of the program was to spur growth in the industry, thereby creating jobs, sustaining continued innovation, and raising awareness of distributed renewable generation throughout the state.

Funding for the program comes from both the GEO's Renewable Energy Program and Residential Program budgets. Proposed energy savings was not spelled out specifically for the Renewable Rebate program.

Due to the high volume of applicants and participants receiving rebates, the GEO has hired a third-party rebate processing administrator. They administer the rebates and reports total rebate amounts and system sizes, as well as other project details, to the GEO. The GEO calculates energy savings for these measures using the following techniques:

1. Solar Photovoltaic: Multiply the system size in kW by a stipulated kWh/kW value deemed an appropriate average for photovoltaic systems in Colorado.

2. Solar Thermal: Use the stipulated Btu/day rating for the solar thermal array

3. Wind: Multiply the system size in kW by a stipulated kWh/kW value deemed an appropriate average for wind systems in Colorado.

8.2.4.2 Renewable Energy Development Team

The Renewable Energy Development Team program provided technical assistance for renewable energy projects throughout Colorado. This service is geared towards communities looking to increase renewable energy within their boundaries and is provided by a consultant to the GEO.

The technical assistance provided by the GEO consultant falls into two main categories: Federal Energy Regulatory Commission (FERC) projects and the Technical & Business Development Assistance Program (TBDA). FERC projects are all small hydroelectric projects. The technical assistance program helps Colorado communities overcome the regulatory and permitting barriers that often prevent the installation of small hydroelectric projects. The REDT streamlined the process to obtain the required FERC approval by providing assistance in reviewing project details and reporting to the state resource agencies that need to approve the project before obtaining FERC approval. Once a project is approved by FERC, the community can move ahead with financing and building the project.

The TBDA program involved communities looking to install a variety of renewable projects including solar, wind, biomass, small hydro, geothermal, and wind. The services provided by the GEO consultant include working with the communities to ensure that their projects have the necessary cost/benefit details to attract investors to fund the projects. The GEO consultant will also present the projects to potential investors in hopes of obtaining project funding.

The program is available to Colorado local governments, non-profits, utilities, and land owners. Those interested must provide a basic scope of the project as well as a completed application for the program. Eligible technologies include the following distributed renewable electrical generation sectors, with a nameplate rating of 30 megawatts (MW) or less except where noted:

- Biomass (non-toxic plant matter, animal waste and waste products, and methane from landfills or wastewater residuals only).

- Small hydro (less than 10 MW).

- Solar photovoltaic and solar thermal.
- Distributed Generation (under 30 MW) wind.
- Geothermal (direct-use applications and power generation, excludes heat pumps).
- Federal Energy Regulatory Commission (FERC) small hydro streamlined permitting pilot (low-impact projects only).

The GEO and the consultant reviewed the applications and scored them based on a number of factors including market viability, financial costs/benefits etc. Those who achieved the requisite score were then entered into the program and received the technical assistance. Those that score too low to participate could resubmit their application after addressing the GEO's concerns.

The evaluation team intended to sample six REDT projects. However, after a review of program materials and discussions with program staff, the team determined that an evaluation of the REDT would not be effective at this time. There are three main reasons for this conclusion:

1. No renewable energy projects would be constructed before the either the original evaluation deadline or the potential extended deadline.
2. Few of either the FERC or TBDA projects will actually complete the technical assistance process provided by this program before the evaluation deadline. Thus, the evaluation team will not be able to quantify estimated energy savings associated with a complete REDT program.
3. Even if a project completes the REDT program, there is no guarantee when, over even if, the project will be constructed.

For these reasons, the evaluation team determined that it would be not be effective to formally evaluate the REDT program. A methodology for evaluation this program in the future is outlined here.

Future Methodology

1. Depending on the number of projects eventually installed, the GEO could either conduct a census approach and evaluate all of the completed projects, or select a sample of the population.
2. Projects selected for sample should undergo inspection of all project documents including the GEO consultant final reports, application documentation, communications between the GEO, the participant, and the GEO consultant, modeling review, construction documentation, and interviews with participants. Engineering activities will include installation verification and savings calculations.

3. Projects which undergo an on-site inspection will have adjusted gross savings estimated through on-site data collection. These activities should commence when projects are completed. While on-site, staff should gather information on the equipment that was installed as a result of the technical assistance program. Actual energy produced by these systems should be collected where possible. This collected data will be compared to construction documents and other project reports.

The baseline for these measures is zero, i.e. no energy would have been generated in the absence of the renewable energy system.

Participation in the program as of Dec 2011 is outlined in Table 8-1 and Table 8-2.

Table 8-1 FERC Participation

FERC	Initial Applications	Full Application	Sent to Resource Agencies	Sent to FERC	Approved by FERC
Participants	25	10	5	1	1
Size (kW)	4,828	1,699	865	23	23

Table 8-2 TBDA Participation

TBDA	Initial Applications	Phase 1 Completion	Phase 2 Completion	Phase 3 Completion	Funded by Investors
Participants	31	16	0	0	0
Size (kW)	53,334	42,214	0	0	0

8.2.5 Residential Buildings

8.2.5.1 Duct Sealing

The Duct Sealing program is part of the Residential and Rebate Programs administered by the GEO in coordination with Recharge Colorado. The program offered consumers up to a $150 rebate for having a contractor seal the ducts throughout the residence, (the GEO would provide up to $75 of the rebate).[46]

Eligible participants were residents of Colorado including home owners or renters and landlords. Participants were instructed to reserve a rebate via the Recharge Colorado website and were instructed to hire a licensed Colorado building contractor to perform the work. The GEO would not provide rebates for do-it-yourself installations. Based on review of invoices collected by the evaluation team as part of its analysis, participants generally had duct sealing performed in conjunction with a larger home retrofit such as the installation of a new furnace. After duct sealing

[46] Duct Sealing program eligibility sheet; provided by the Governor's Energy Office, August 2011.

was completed, the participant included the invoice with the application and submitted it to the GEO for processing. the GEO's subcontractor processed and approved applications and the rebate check was mailed to the consumer within 4-6 weeks[47].

8.2.5.2 Energy Monitors

The Energy Monitors program is part of the Residential and Rebate Programs administered by the GEO in coordination with Recharge Colorado. The program offered consumers up to a $100 rebate for the purchase of a home energy monitor.

Eligible participants were residents of Colorado including home owners or renters. Participants were instructed to reserve a rebate via the Recharge Colorado website and submitted a rebate application with proof of purchase to the GEO.

8.2.5.3 ENERGY STAR New Homes

The ENERGY STAR New Homes program was developed in 2007 by the GEO as part of a multi-year strategy to improve the energy performance of Colorado's homes over both the short term and long term[48]. Beginning in 2009, the GEO began offering ENERGY STAR Homebuilder rebates to assist with the cost of HERS raters to certify a home ENERGY STAR compliant[49]. The GEO reported that ENERGY STAR New Home construction had increased from 5% to 30% of new residential construction from 2004 to 2010 and is estimated to surpass 40% by 2011 thereby showing strong demand for this rebate program.[50]

The ENERGY STAR New Homes rebate program functioned similarly to other Recharge Colorado rebate programs; however, rebates were awarded to contractors rather than end-users/homeowners. Thus, eligible participants were home builders building within Colorado. Participants were instructed to reserve a rebate via the Recharge Colorado website and submitted a HERS certificate with the rebate application indicating the home had achieved ENERGY STAR rating.

8.2.5.4 Insulation and Air Sealing

The Insulation and Air Sealing program was developed in 2007 by the GEO as part of a multi-year strategy to improve the energy performance of Colorado's homes over both the short term and long term[51]. Beginning in 2009, the GEO began offering insulation rebates as part of the Insulate Colorado program which offered consumers up to a $300 rebate for improving the insulation of existing homes[52]. This program was expanded with the launch of the GEO's state-wide Rebate Program in coordination with the Recharge Colorado communications initiative and website

[47] Duct Sealing program eligibility sheet; provided by the Governor's Energy Office, August 2011.
[48] Governor's Energy Office Transition Book, December 2010.
[49] ibid.
[50] ibid.
[51] Governor's Energy Office Transition Book, December 2010.
[52] ibid.

(RechargeColorado.com)[53] and increased the rebate amount to $600 of which the GEO provided up to $400 (remaining rebate balance offered through program partner). [54]

The Insulation and Air Sealing rebate program functioned similarly to other Recharge Colorado rebate programs. Eligible participants were residents of Colorado including home owners or renters and landlords. Participants were instructed to reserve a rebate via the Recharge Colorado website and were subsequently directed to a list of eligible contractors from which to choose for the installation. The GEO would not provide rebates for do-it-yourself installations. Upon installation, the contractor provided detailed information about the existing and newly installed insulation including insulation thickness, R-value, square footage of area insulated, and installation cost on a the GEO-issued worksheet that was remitted to the GEO as part of the rebate application process. Total R-value of existing and new insulation was required to meet or exceed the 2009 IECC recommended R-values. Upon approval, which was processed by the GEO's subcontractor, HEI, the rebate check was mailed to the consumer within 4-6 weeks[55].

8.2.5.5 Residential Codes

The Residential Codes program was intended to provide technical assistance to jurisdiction code officials on the process of adopting, implementing, and enforcing the 2009 IECC residential energy code. Funding was provided through the SEP budget and was dispersed by the DOE on the condition that the State would achieve state-wide 90% adoption and compliance by 2018. Approximately 40% of the State will have adopted the 2009 IECC or 2012 IECC by 2012.

The State of Colorado is a home-rule state which grants each individual jurisdiction a level of autonomy including the adoption of building codes. Thus, it is very difficult for the state government to establish state-wide building energy code minimums. In 2008, the GEO expanded its Residential Codes program through establishing an interagency agreement between the GEO and the Department of Local Affairs (DOLA). DOLA currently administers code programs throughout the state for manufactured homes and provides support to jurisdictions that do not have building codes in place.[56] To administer the Residential Codes program, DOLA contracted Colorado Code Consulting (CCC) to implement the technical assistance efforts of the program.

CCC's contract required the CCC to identify all Colorado jurisdictions, determine the current energy code for each jurisdiction and future adoption plans, and offer workshops to jurisdictions focused on different aspects of the 2009 IECC. The CCC identified 339 jurisdictions and successfully determined the current energy code status for each jurisdiction. The CCC administered questionnaires to each jurisdiction, and based on the responses to the questionnaire, developed multiple custom workshops targeted toward jurisdiction building code officials as well as other stakeholders on components of the 2009 energy code. The intention of the workshops was to provide technical training for new requirements introduced by the 2009 energy code, provide clarification for

[53] ibid.

[54] Insulation and Air Sealing program eligibility sheet; provided by the Governor's Energy Office, August 2011.

[55] Insulation and Air Sealing program eligibility sheet; provided by the Governor's Energy Office, August 2011.

[56] Governor's Energy Office Transition Book, 2010.

compliance paths, and provide education for what it means to adopt the 2009 energy code. To supplement the workshop offerings, the CCC developed in collaboration with DOLA a website that provides additional information on code adoption.

Because this program's intention was to provide technical assistance, there were no preexisting metrics by which to measure energy savings. To address this, the evaluation team defined a measure of 2009 code compliance as a key metric to determine energy savings. As described in the Residential Code Methodology, an overall state-wide rate of compliance for the 2011 calendar year was determined through randomly sampled site visits. The site visits, however, proved challenging, as each visit required the cooperation of multiple stakeholders. For instance, scheduling was dependent on builder availability and timing of building construction, (e.g., inspections for insulation must be completed in a 2-3 day window). Additionally, documents such as building plans with energy performance path requirements were not always available publically and had to be obtained through the building permit office or builder. Lastly, there was a paucity of available sites to visit for the 2011 calendar year, as jurisdictions that adopted the 2009 code in 2011 did so typically in the third or fourth quarter of the year.

The evaluation team expects some of these challenges to diminish in coming years as more jurisdictions adopt the 2009 code and thereby create a larger pool of candidates for site visits. Additionally, improved access to building plans such as online public access will facilitate sampling procedures.

8.2.6 Greening Government Program

The GEO's Greening Government program endeavors to assist Colorado state agencies in achieving the mandated goal of reducing energy consumption in state facilities by 20% below a 2005 baseline by the year 2012. This goal was introduced in a 2007 executive order and reinforced by a 2010 executive order. Other goals contained within these two executive orders include specific reductions in state agency consumption of water, paper, petroleum, associated greenhouse gases, and waste.

A wide variety of efforts, small and large, take place under the leadership of the Greening Government Program. These include education and outreach workshops, financing to supplement energy performance contracts, promoting environmentally preferable purchasing procedures, promoting videoconferencing and telecommuting, among others. The four primary equipment incentive programs implemented under the guidance of Greening Government are outlined below:

8.2.6.1 EnergyCAP Utility Tracking Tool

EnergyCAP is a software tool for tracking utility bill data. The Greening Government program has distributed the software to state agencies and provided assistance to take full advantage of its capabilities. EnergyCAP allows each agency to track its various energy consumption and cost over time and provides recommendations to improve on equipment and operational efficiencies.

8.2.6.2 Refrigerator Decommissioning

The Greening Government program has a refrigerator decommissioning program that assists state agencies with the removal of old, inefficient refrigerators from their facilities and the replacement of those units with Energy Star models.

8.2.6.3 BigFix

The BigFix is the name of an IBM software package chosen as the state-wide computer workstation power management tool. It should be noted that IBM recently acquired the BigFix product and is currently in the process of re-branding it the IBM Tivoli Endpoint Manager.

The Greening Government program has partnered with the state's Office of Information Technology (OIT) to select this software package, install it on computer workstations throughout each state agency, and train and support agency staff on its appropriate use. The purpose of the software is to intelligently manage energy consumption on each workstation by powering down or similarly reducing the device's power draw during times when it's not in use. IBM's website notes that the BigFix software will help "control energy costs with a centralized, scalable, policy-driven management system for endpoints running Windows and Mac," and will "help save as much as $50 per endpoint user per year."[57]

8.3 ENERGY EFFICIENCY AND CONSERVATION BLOCK GRANTS

This section outlines program details within the evaluated Activities of the EECBG Program.

8.3.1 Activity 1: Residential & Commercial Buildings and Audits

8.3.1.1 Main Street Efficiency Initiative

The Main Street Efficiency Initiative (MSEI) began in early 2010 with the launch of five programs to serve the small business community. These programs were designed to reduce energy costs for local businesses, create local jobs, and reduce carbon emissions. The small business community is a difficult sector to reach with energy efficiency programs for a variety of reasons including landlord/tenant issues and program costs vs. energy benefits. It is also generally underserved by utility based demand side management programs. The GEO programs sought to both fill market gaps where small businesses were not being served, and also use existing utility rebates/programs where available to further encourage businesses to implement energy efficiency projects. The programs are outlined below:

Main Street Efficiency in a Box: This program included training business owners and the GEO Community Energy Coordinators on energy management, a web-based Energy Data Management tool to encourage energy tracking, and step-by-step guide for local communities demonstrating best practices for creating efficiency programs for small businesses. There were no energy savings attributed to this program area.

[57] Source: http://www-01.ibm.com/software/tivoli/solutions/endpoint/?s_pkg=bfwm

Competitive Grant for Communities: This grant was intended to assist communities in developing new or strengthening existing local programs that assist businesses in achieving the goals of MSEI. The awarded communities used funds to support outreach efforts and provided funding to local businesses who participated in the program. Recipients included:

- CLEER: Tri-County Main Street Efficiency Program
- Platte River: Efficiency Express Program
- EOC: Nonprofit Energy Efficiency Program
- ORE: Energy Wise Business Program
- Colfax Green Partnership
- Woodland Park: Mainstreet Makeover II

Self-Managed: This program was specifically for 'Entitled' communities and leveraged federal, state and local funding. These communities were awarded funding from which they partnered with the GEO to develop new or strengthen existing programs that assisted businesses in achieving the goals of MSEI. Recipients included:

- City of Grand Junction
- City of Fort. Collins
- CLEER (Garfield County)
- City of Aurora
- City and County of Denver
- Boulder County

GEO -Managed: Through this program, small- and medium-sized businesses received energy efficiency rebates for facility audits, lighting retrofits, re-commissioning services, and setback thermostats. The GEO developed this program with input from each participating city and local utility companies and administered and managed the program on each city's behalf. Recipients included:

- City of Arvada
- City of Lakewood
- City of Littleton
- City of Pueblo
- City of Westminster

Small Scale Grant: This program was the same as the GEO -Managed except that communities received direct funding for outreach efforts. The communities then shared a rebate funding pool that businesses within the communities had access to for energy efficiency improvements. Recipients included:

- City and County of Broomfield
- City of Lamar
- Grand County BEDA
- La Plata Electric Assoc.
- Painted Sky RC&D
- Southern CO Council of Governments (SCCOG) (Walsenburg)
- Sustainable Technology Trust
- The New Community Coalition (TNCC)
- Town of Fairplay (HCCC)
- Town of Frisco
- Town of Leadville and Lake County (HCCC)
- City of Steamboat Springs

The GEO selected a contractor to provide project management and technical support for all programs.

8.3.2 Activity 2: Subgrants for Energy Efficiency Retrofits

Activity 2 provided funding for grants and rebates for energy efficiency projects, renewable energy projects, education and outreach, and energy auditor equipment. The majority of the funding in this activity was managed in the Residential Buildings and Renewable Energy Programs. The remaining funding was used by Local Programs to provide energy auditor equipment grants and energy efficiency in public buildings grants.

The programs included in this Activity that were evaluated as a component of this Project include:

- Residential energy efficiency rebates
- Renewable energy rebates
- Energy Efficiency in Public Buildings grants

8.3.3 Activity 5: LED Lighting Project

The LED street lighting grant was created to increase the installation of LED street lights in rural municipalities. LED street lights are more efficient than the more common high intensity discharge fixtures. However, the higher initial fixture prices make the installation of LED cost prohibitive. This grant provided the funding need to install the LED fixtures and start saving energy.

8.3.4 Activity 6 Onsite Renewable Projects

8.3.4.1 Renewable Energy in Public Buildings

The Renewable Energy in Public Buildings grant program is part of the GEO's larger Local Program. The Local Program implements the New Energy Economy local capacity as well as energy efficiency, renewable energy, and resource conservation programs at the community level[58]. Hence, the Local Program serves multiple participants for a range of project types. In the case of Renewable Energy in Public Buildings, the Local Program offered grants at $1/watt for solar PV projects.

[58] Governor's Energy Office Transition Book, December 2010.

The initial budget for the Renewable Energy in Public Building was to be allocated across three projects. However, one of the three projects nullified its contract with the GEO. Of the remaining two projects, one was completed in October 2011. The second project is pending NEPA approval as of December 2011 but is expected to be completed in July 2012. State Energy Efficiency Appliance Rebate Program

SEEARP was a residential ENERGY STAR appliance rebate program. The program had the following objectives:

- Save energy by encouraging appliance replacement through consumer rebates.
- Make rebates available to consumers.
- Enhance existing rebate programs by leveraging ENERGY STAR national partner relationships and local program infrastructure.
- Keep administrative costs low while adhering to monitoring and evaluation requirements.
- Promote tracking and accountability.
- Use existing ENERGY STAR consumer education and outreach materials.

The offerings of SEEARP were marketed to the public under the brand "Recharge Colorado", primarily through the website (http://www.rechargecolorado.org). The Recharge Colorado website contained extensive information about all SEEARP incentives, including all eligibility requirements. Rebate applications were also submitted through the website. An outside consultant managed rebate applications, verification of eligibility, and mailing rebate checks.

Eligibility requirements varied based on appliance type. General requirements for all SEEARP incentives included:

- New appliance must be ENERGY STAR rated.
- Applicant must be a Colorado resident.
- Applicant must be a residential consumer. (Landlords were not eligible to purchase for rental properties.)
- New appliance must be purchased from a Colorado dealer or online dealer with a Colorado location.
- New appliance must be a replacement unit, not new construction.
- Old appliance must be recycled.

No major issues were encountered in evaluating SEEARP programs. Forming a representative sample of the population was not challenging given the homogeneous nature of each program's participants. The rebate application process included lots of useful data collection which was readily available. Some difficulty in scheduling phone interviews or site visits was noted. However, this is typical for residential programs due to inherent variability in schedules and unwillingness of

participants to allow outsiders into their residences. Some difficulty was also noted in collection of utility data. Although a streamlined process was put into place for data collection from Xcel Energy, the primary electric and gas utility in Colorado, obtaining bills from other utilities was more challenging.

Appendix A ATTRIBUTION SURVEY

CO ARRA Attribution Survey (Non-Residential: Local Programs)
Q1
Organization:
Phone:
Address:
Measures Installed: PV Solar System
Type of assistance: EECBG Grant
Program: Renewable Energy in Public Buildings (Local Program)

Q2-Q4 (Introduction Qs) are removed.

Q5 In addition to this grant, what other funding or other assistance did you get, if any, from Governor's Energy Office or any other sources for the PV solar project?

	Received?	Name	Source		Specify
	Yes	(if known)	GEO	Non-GEO Source	(if known)
Rebate	❑		❑	❑	
Another Grant	❑		❑	❑	
Loan	❑		❑	❑	
Tax Credit	❑		❑	❑	
Technical Assistance	❑		❑	❑	
Training	❑		❑	❑	
Other	❑		❑	❑	

Q6 Renewable Energy in Public Buildings program carries out certain education and outreach activities to inform the public about grants for renewable energy projects. Can you tell me all the sources where you heard about this program or the grant that it offers?

_____

Q7 Intention Questions

I'd like to ask a couple of questions to get at what your organization most likely would have done if you had not received a grant from Renewable Energy in Public Buildings program or other assistance from Governor's Energy Office to install the PV solar system. *[Modify wording as appropriate and necessary]*

Q8 First, if your organization had not received this grant, which of the following is most likely: Your organization would have... [READ 1st THREE CHOICES]

- ...put off installing a PV solar system for at least one year or cancelled it altogether.
- ...installed a smaller PV system.
- ...installed exactly the same PV system.
- ...done something else. If so, what _____
- Don' Know or no answer

Display Q9 if " ...installed a smaller PV system." is selected in Q8.

Q9 You said your organization would have installed a smaller system. Do you think it is more likely that your organization would have installed a system that would have produced... [READ 1st THREE CHOICES]

- At least two-thirds of the energy of the one you installed
- Somewhere from one-third to two-thirds of the energy of the one you installed
- Less than one-third of the energy of the one you installed
- Don't know or no answer

Display Q10 if "...installed exactly the same PV system." Is selected in Q8.

Q10 If your organization had not received this grant, would it have made available the funds needed to cover the entire cost of the project?

- Yes
- No
- Don't Know

Q11 Influence Questions

Now I would like to ask about the role that the program played in your decision to install the PV solar system. *[Modify wording as appropriate and necessary]*

Q12 I'm going to read a list of program activities or services that could have influenced your organization to install the PV solar system. For each one, please indicate how much of a role it played in the decision to install the system. Please answer with a number from 1 to 5, where 1 means it played no role at all and 5 means it played a great role.

[INTERVIEWER – >>If someone says 'no role at all', you should clarify whether it is because the person had no exposure to that program element (e.g. did not visit the website) or because the exposure had no role (e.g. visited website but it had no role at all on the purchase). If the former, it should be coded as 'N/A'. >>If someone says 'don't know', find out if it's, again, because they had no exposure to that program element or they simply have no opinion (e.g. visited website but said 'don't know' about its role on the purchase). If the former, it should be coded as 'N/A'.]

	1=No Role at all	2	3	4	5=Great Role	Don't Know	Not applicable
1. The grant you received from Renewable Energy in Public Bldg(s) program	❍	❍	❍	❍	❍	❍	❍
2. Information about grants, renewable energy, or anything else from Governor's Energy Office	❍	❍	❍	❍	❍	❍	❍
3. Solar contractor	❍	❍	❍	❍	❍	❍	❍
4. Anything else (please specify)	❍	❍	❍	❍	❍	❍	❍

Answer If In addition to this grant, rebate was selected in Q5.

Q13 You told me earlier that you received a rebate. Please indicate how much of a role it played in the decision to install the PV solar system. Please answer with a number from 1 to 5, where 1 means it played no role at all and 5 means it played a great role.

	1=No Role at all	2	3	4	5=Great Role	Don't Know (6)	Not applicable (7)
Rebate	❍	❍	❍	❍	❍	❍	❍

Answer If In addition to this grant, another grant was selected in Q5.

Q14 You told me earlier that you received another grant. Please indicate how much of a role it played in the decision to install the PV solar system. Please answer with a number from 1 to 5, where 1 means it played no role at all and 5 means it played a great role.

	1=No Role at all	2	3	4	5=Great Role	Don't Know (6)	Not applicable (7)
Another Grant	❍	❍	❍	❍	❍	❍	❍

Answer If In addition to this grant, loan was selected in Q5.

Q15 You told me earlier that you received a loan. Please indicate how much of a role it played in the decision to install the PV solar system. Please answer with a number from 1 to 5, where 1 means it played no role at all and 5 means it played a great role.

	1=No Role at all	2	3	4	5=Great Role	Don't Know (6)	Not applicable (7)
Loan	❍	❍	❍	❍	❍	❍	❍

Answer If In addition to this grant, tax credit was selected in Q5.

Q16 You told me earlier that you received a tax credit. Please indicate how much of a role it played in the decision to install the PV solar system. Please answer with a number from 1 to 5, where 1 means it played no role at all and 5 means it played a great role.

	1=No Role at all	2	3	4	5=Great Role	Don't Know (6)	Not applicable (7)
Tax Credit	❍	❍	❍	❍	❍	❍	❍

Answer If In addition to this grant, technical assistance was selected in Q5.

Q17 You told me earlier that you received technical assistance. Please indicate how much of a role it played in the decision to install the PV solar system. Please answer with a number from 1 to 5, where 1 means it played no role at all and 5 means it played a great role.

	1=No Role at all	2	3	4	5=Great Role	Don't Know (6)	Not applicable (7)
Technical Assistance	❍	❍	❍	❍	❍	❍	❍

Answer If In addition to this grant, training was selected in Q5.

Q18 You told me earlier that you received training. Please indicate how much of a role it played in the decision to install the PV solar system. Please answer with a number from 1 to 5, where 1 means it played no role at all and 5 means it played a great role.

	1=No Role at all	2	3	4	5=Great Role	Don't Know (6)	Not applicable (7)
Training	❍	❍	❍	❍	❍	❍	❍

Answer If In addition to this grant, other assistance was selected in Q5.

Q19 You told me earlier that you received other assistance. Please indicate how much of a role it played in the decision to install the PV solar system. Please answer with a number from 1 to 5, where 1 means it played no role at all and 5 means it played a great role.

	1=No Role at all	2	3	4	5=Great Role	Don't Know (6)	Not applicable (7)
Other Assistance	❍	❍	❍	❍	❍	❍	❍

Q20 Satisfaction Questions
Finally, please tell me how satisfied you are with the various types of assistance you received from the program. Again, please answer with a number from 1 to 5, where 1 means you are not at all satisfied and 5 means you are extremely satisfied.

	1= Not at all satisfied	2	3	4	5= Extremely Satisfied	Don't Know	Not applicable
1. Overall experience	❍	❍	❍	❍	❍	❍	❍
2. Information from the GEO about grants, renewable energy, or anything else	❍	❍	❍	❍	❍	❍	❍
3. The grant amount you received	❍	❍	❍	❍	❍	❍	❍
4. The grant application process	❍	❍	❍	❍	❍	❍	❍
5. The amount of time it took to receive the grant	❍	❍	❍	❍	❍	❍	❍
6 .The ease of finding a contractor to install the PV solar system	❍	❍	❍	❍	❍	❍	❍
7. The quality of the installation	❍	❍	❍	❍	❍	❍	❍
8. The performance of the PV solar system	❍	❍	❍	❍	❍	❍	❍

Q21 Do you have any additional comments about the program, staff, or any other assistance you received from the program? _____
Q22 Those are all the questions I have. Thank you for your cooperation, and have a very nice day/evening.
END OF SURVEY– INTERVIEWER CLICK "SUBMIT" IF SURVEY IS COMPLETE.IF WAITING FOR ADDITIONAL INFORMATION, DO NOT CLICK "SUBMIT", INSTEAD JUST CLOSE BROWSER.

GEO ARRA Renewables Rebate Program

M&V Plan & Inspection Form

SOLAR THERMAL SYSTEM

Project Name	
Project Owner	
Address	
Lat and Long	
Project Description	
Project Summary	

M&V Equipment Reqd.	Site lat and longitude Clipboard, paper, Solar M&V plan sheet Camera Solmetric SunEye for measuring shading and other metrics Ladder for roof access SunEye instruction manual for reference
M&V Instructions	Measure the panel azimuth using the SunEye's orientation tool. Place the two front legs of the device lined up with the back edge of a panel in the array. Measure the panel angle with the SunEye's orientation tool. Place the device on the surface of a panel and record the angle. Use the SunEye device to capture shade data (4 corners - it is affected by the magnetic field of the panels) Record nameplate data on all equipment Record system configuration, identifying all equipment Note level of soiling on the panels (mild, moderate, heavy), and whether or not the system is succeptible to high soiling (dusty, etc.) Photo: Overall array, nameplates, positions on

roof shading, module data, etc. Record and data readouts (Temperature of storage tank, temp of fluid from array, etc.) Verify building occupancy, size, and usage patterns have not changed over the past 2 years Have customer provide copies of utility bills (best) or sign release form (good); provide res customers g.c.

General Questions

Do you have a tracking system? _____

When was the system installed? _____

How often is the system taken off-line for maintenance, etc.? _____

How often are the panels cleaned? _____

In the space below, identify equipment for which the solar thermal system displaces energy consumption. Provide details on each equipment's specifications (size, efficiency, etc.), as well as typical usage patterns for connected loads

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