NYSERDA American Reinvestment and Recovery Act 2012 Impact Evaluation Report: Energy Efficiency and Conservation Block Grant

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Prepared For

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NOTICE

ABSTRACT

This report contains the findings of the evaluation of the Energy Efficiency and Conservation Block Grant portions of the American Recovery and Reinvestment Act-funded Program Areas operated in the State of New York by NYSERDA from 2009 through early 2012. The evaluation was conducted by The Cadmus Group, Inc., Beacon Consultants Network, Inc., NMR Group, Inc., Navigant Consulting, Inc., Population Research Systems (PRS), Abt SRBI Inc., and Discovery Research Group (DRG), collectively known as the Cadmus Team, from 2010 through September 2012. The purpose of the evaluation was to document the gross and net electricity, electric demand, fuel, and water savings and clean energy generation achieved by the Program Areas; to estimate the greenhouse gas emissions displacement and macroeconomic impacts (including jobs creation) generated by the Program Areas; and to calculate the cost-effectiveness of the Program Areas.

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EXECUTIVE SUMMARY

BACKGROUND

On February 13, 2009, in response to a deepening recession in the United States economy, the U.S. Congress passed the American Reinvestment and Recovery Act (ARRA). The legislation was signed into law by President Obama on February 17, 2009. ARRA expressed three immediate goals:

1. To create new jobs, as well as save existing ones
2. To spur economic activity and invest in long-term economic growth
3. To foster unprecedented levels of accountability and transparency in government spending

A key provision of ARRA was to fund shovel-ready projects that could go to construction sooner rather than later.

Components of this law made funding available to states through two separate Department of Energy (DOE)-managed programs, State Energy Program (SEP) and Energy Efficiency and Conservation Block Grant (EECBG). The New York State Energy Research and Development Authority (NYSERDA) received a total of $152.9 million in funding through these two programs ($123.1 million from SEP and $29.8 million from EECBG), which it combined with $18.7 million in State Energy Efficiency Appliance Rebate Program (SEEARP) funding to offer the residents of the State of New York a series of energy-efficiency and renewable generation programs and opportunities. The Program Opportunity Notices (PONs), Requests for Proposals (RFPs), and other activities that were issued or undertaken with these funds are summarized in Table ES-1.

Table ES-1. ARRA-Funded Program Areas

Funding	Program Areas/Technologies
All	RFP 1656 ARRA Evaluation
EECBG	Energy Efficiency, Transportation, and Renewable Energy for Small Municipalities (RFP 10), Material Conservation, and Energy Management Personnel*
	Energy Code - Locally Based Circuit Riders (RFP 1621)
SEEARP	Appliance Rebates
SEP	Energy Conservation Studies (PON 4)
	Transportation Clean Fleets and Energy Efficiency and Renewable Energy for Municipalities, Schools, Hospitals, Public Colleges and Universities, and Non-Profits (RFP 1613)
	Energy Code Trainings (RFP 1621)
	Energy Code Baseline Compliance
	Renewable Energy (PON 1686)

* Material Conservation and Energy Management Personnel were not included in this evaluation.

These ARRA-funded Program Areas were designed to be unique from, but complement, NYSERDA's existing robust and diversified portfolio of energy-efficiency and renewable energy programs, which are aimed at complying with the statewide goal of meeting 45% of the State's electricity needs through improved energy efficiency and clean renewable energy by the year 2015. Funds received through SEP and EECBG complement the programs and public policies that support achieving that aggressive goal, and also contribute to the targeted reduction in energy use.

The State's Public Service Commission (PSC), through its System Benefits Charge, Energy Efficiency Portfolio Standard (EEPS), Renewable Portfolio Standard, and utility rate proceedings, put forth a comprehensive set of ratepayer-funded programs that are administered by NYSERDA and the State's investor-owned utilities. In addition, NYSERDA has and continues to administer energy-efficiency and renewable energy programs intended to reduce emissions of greenhouse gases (GHGs) that are funded by the proceeds from auctions of carbon dioxide (CO_2) allowances under the Regional Greenhouse Gas Initiative.

NYSERDA also has and continues to receive appropriations of State funds, and has been the recipient of federal funding through the U.S. DOE, U.S. Environmental Protection Agency (EPA), and the Federal Highway Administration. This additional State and federal funding was designed to support energy research, development, and deployment programs in the buildings, industrial, transportation, and clean energy sectors. The Long Island Power Authority (LIPA) also offers substantial energy-efficiency and renewable energy programs and the New York Power Authority offers financing with no up-front costs for efficiency projects to public schools and other government facilities through its Energy Services Program.

In 2009, NYSERDA also issued RFP 1656 for evaluation services to determine the impacts of these programs. This contract was awarded to a team led by Cadmus. The first task the Cadmus Team completed was developing an Action Plan with a full description of the evaluation activities to be performed. This Action Plan is included as Appendix B. Subsequent to the completion and acceptance of the Action Plan, the Program Areas funded by SEP and other ARRA dollars continued to evolve. The majority of these changes—which resulted in project cancellations, delays, and additional rounds of financing from some Program Areas—were the result of economic factors associated with the recession. These macroeconomic factors resulted in facilities not being able to contribute the funding anticipated, laying off key staff, or other impacts that caused many of these project changes. The changes in projects necessitated changes in the evaluation, which are described in the relevant sections of this report. All of these changes are not reflected in the Action Plan included as Appendix B.

Excepting the impacts of the project changes noted above, this report contains the findings of the EECBG-funded Program Areas' evaluation as described in the Action Plan. The Cadmus Team addressed findings from the SEP and SEEARP-funded Program Areas' evaluation in a separate report finalized in April 2012, with the exception of the Energy Code Program Area. Energy Code is an integrated Program Area in which benefits and costs are not well defined between funding streams. Because of this, the Energy Code Program Area incorporates SEP and EECBG funding into the cost-effectiveness analysis. The full evaluation results are outlined in the Early Building Energy Code Adoption Report, included as Appendix F.

EVALUATION OBJECTIVES AND RESEARCH APPROACH

This section identifies key research objectives, along with evaluation metrics necessary for assessing each objective. For this evaluation, the Cadmus Team assessed customer satisfaction, where possible, through already-planned survey efforts. The primary objectives and metrics included:

- Determining attributable energy and demand savings by Program Area
- Quantifying renewable energy capacity and generation attributable to the Renewable Program Area
- Computing the GHG emissions displacement and environmental impacts of each Program Area[1]
- Evaluating the economic impacts (including job creation and retention)
- Determining the cost-effectiveness of ARRA-funded Program Areas

The Cadmus Team ensured that the work undertaken for this evaluation was pursuant, to the maximum extent possible, to evaluation guidelines[2] put forth by the DOE for ARRA-funded programs and with evaluation guidelines for ratepayer-funded energy-efficiency programs designed to help meet New York's energy-efficiency policy goals.[3]

The Cadmus Team created sample designs for each technology grouping—or Program Area (Energy Code, Energy-Efficiency, Renewable Energy, and Transportation)—under the funding streams, with a maximum 10% margin of error at the 90% confidence level for the overall funding source. In addition to evaluating each Program Area, the Cadmus Team examined the portfolio of Program Areas as a whole, as well as the activities funded through each of the major ARRA-funding streams (SEP, EECBG, and SEEARP). The Team performed geographic analysis for all Program Areas in the gross and net impact portion of the evaluation for New York State as a whole, which the Team further divided by Upstate and Downstate territories.[4] Similarly, the Cadmus Team investigated the relative impacts of Program Area marketing efforts in the Upstate versus Downstate regions.[5]

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[1] The environmental impacts that the Team measured vary by Program Area. In addition to GHG emissions, the Transportation Program Area includes Nitrous Oxides (NOx) and particulates reductions.

[2] Guidance for EECBG grant recipients: http://www1.eere.energy.gov/wip/pdfs/eecbg_evaluation_guidelines_10_017.pdf; Guidance for SEP recipients: http://www.tecmarket.net/documents/Final%20SEP%20Evaluation%20White%20Paper%2010-18.pdf

[3] On June 28, 2008, the New York State PSC adopted an Order approving the EEPS to reduce energy consumption in New York State by a total of 15% below the 2006 forecast for the year 2015; referred to as the 15x15 goal.

[4] For this evaluation, the Downstate region included the utility service territories of Consolidated Edison (New York City and parts of Westchester County) and LIPA (Long Island, which is Nassau and Suffolk Counties). The Upstate region included the balance of the State.

[5] For this analysis, the Team relied on marketing questions included as part of the surveys conducted in support of the evaluation efforts as described throughout the Action Plan. Inclusion of these questions was contingent upon survey length time constraints, and consequently, the final inclusion of this analysis was contingent on the Cadmus Team obtaining sufficient confidence and precision in the findings in both the Upstate and Downstate regions.

FINDINGS

At the time this report was written, many of NYSERDA's EECBG-funded Program Areas were continuing to operate, and many of the planned projects to which funds had been committed had not yet been completed. Due to DOE requirements and the contract between the Cadmus Team and NYSERDA, the evaluation report for these Program Areas is due before the end of September 2012. Evaluating programs before they are complete has benefits and drawbacks.

One of the greatest benefits of conducting evaluations while programs are actively operating is that evaluators are able to speak with customers while they are in the middle of, or have recently gone through the decision-making process. This proximity of evaluation to the decision making timeframe yields the greatest reliability in customer responses regarding the activities they would have been likely to undertake in the absence of a program. When evaluating completed programs, evaluators are sometimes asking participants about decisions they made months or years earlier, and it is very difficult for customers to remember exactly how much influence a program may have had on their decision-making process. As a result, questions about freeridership or program attribution are best asked in close proximity to the decision. For purposes of this report, freeridership is defined as a Program Area participant who would have implemented the Program Area measure or practice in the absence of the Program Area. Freeriders can be total, partial, or deferred.[6]

In contrast to freeridership, one of the greatest challenges to evaluating programs before they are complete is calculating the spillover impacts. For purposes of this report, spillover is defined as reductions in energy consumption and/or demand caused by the presence of the energy-efficiency Program Area, beyond the Program Area-related gross savings of the participants. There can be participant and/or non-participant spillover.[7] Spillover may take months or years to occur depending on the technology, cost, and experience a customer has with program measures. In most cases for this evaluation effort, the Team was not able to measure spillover because customers did not have sufficient time to pursue other actions or purchase equipment they may have become aware of through their participation in the Program Area.

Because freeridership is measured for each Program Area and spillover is not, the evaluated savings for each effort are limited to evaluated gross savings and savings net of freeridership. Furthermore, these evaluated savings are limited to the projects or portions of projects that were installed and operational as of June 30, 2012.

The Cadmus Team conducted 60 phone or online surveys and 61 site visits in support of this evaluation effort.[8] Surveys included questions designed to estimate Program Area-induced installations of energy-efficiency measures and renewable energy capacity (through a form of spillover tied to the diversion of funds as described below). The Cadmus Team used respondents' answers to these questions to calculate freeridership based on an algorithm the Team developed in coordination with NYSERDA prior to fielding the survey. As directed by NYSERDA, this algorithm is an adapted version of one used in recent evaluations of NYSERDA's ratepayer-funded energy-efficiency programs, and was vetted with New

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[6] National Action Plan for Energy Efficiency (NAPEE). *Model Energy Efficiency Program Impact Evaluation Guide.* Available at: http://www.epa.gov/cleanenergy/documents/suca/evaluation_guide.pdf. Downloaded on April 9, 2012.

[7] Ibid.

[8] The Cadmus Team conducted additional surveys (included in Appendix D) as part of a code compliance training and plan review services study.

York regulators and other third-party evaluation contractors for prior evaluations, then updated by NYSERDA and the Cadmus Team to align more closely with the design of the NYSERDA ARRA Program Areas.

Table ES-2 summarizes the evaluated energy savings achieved by each Program Area and in total for all EECBG-funded projects.

Table ES-2. Summary of Realization Rate, Evaluated Gross, and Evaluated Net-of-Freeridership Findings by Program Area

Program Area	Total Claimed Electricity Savings/ Generation from Installed Projects (MWh)	Savings-Weighted Realization Rate	Total Evaluated Gross Electricity Savings/ Generation (MWh)	Freeridership	Evaluated Electricity Savings/ Generation Net of Freeridership (MWh)
Renewable Energy	2,067	1.09	2,253	0.05	2,140
Energy-Efficiency	6,232	0.99	6,170	0.19	4,998
Transportation	Fuel Savings Only				
Energy Code*	24,906	N/A	9,176**	N/A	9,176
Total	**33,205**	**N/M*** **	**17,599**	**N/M*** **	**16,314**
Program Area	**Total Claimed Fuel Savings from Installed Projects (MMBtu)**	**Savings-Weighted Realization Rate**	**Total Evaluated Gross Fuel Savings/ Generation (MMBtu)**	**Freeridership**	**Evaluated Fuel Savings/ Generation Net of Freeridership (MMBtu)**
Renewable Energy	3,586	0.53	1,901	0.06	1,787
Energy-Efficiency	47,022	1.01	47,492	0.19	38,469
Transportation	22,955	0.64	14,691	0.00	14,691
Energy Code*	236,222	N/A	85,146**	N/A	85,146
Total	**309,785**	**N/M*** **	**149,230**	**N/M*** **	**140,093**

Note: This table summarizes the savings as detailed in each of the Program Area evaluation chapters in the Results section of this report. Confidence and precision values for the overall evaluation are equal to or better than 90/10. Please reference the specific Program Area chapters in Section 3: for additional detail on confidence and precision.

* Energy Code savings were estimated as part of an independent evaluation effort, as described in the Energy Code Program Area chapter of Section 3: and presented in the Early Building Energy Code Adoption Report, attached as Appendix F.

** This number represents the applied weighted-average compliance rate, assumed to be 64% for the residential sector and 36% for the commercial sector.

*** Weighted overall realization rates and freeridership results are not meaningful and were therefore replaced with N/M.

The Cadmus Team has conducted numerous net-to-gross (NTG) studies throughout the country, and has provided testimony to commissions on methods of measuring freeridership and spillover. In many cases, the Cadmus Team has recommended using a deemed NTG value of close to 1.0. Through many evaluations, the Cadmus Team has frequently determined that the impacts of spillover nearly offset the impacts of freeridership. Appendix C presents a study Cadmus conducted on behalf of another client that summarizes an investigation into common evaluated NTG findings and recommends accepting a deemed NTG value of 1.0. For the purposes of this report, NTG is defined as a factor representing net Program

Area savings divided by gross Program Area savings, applied to gross Program Area impacts to convert them into net Program Area load impacts (NAPEE 2012). Furthermore, NYSERDA and the New York Department of Public Service have a precedent of accepting a deemed NTG of 0.9 for planning purposes.[9]

Given the requirements from the U.S. DOE that ARRA-funded projects be evaluated to determine net energy impacts, as well as the additional requirement that the evaluation work be completed prior to the conclusion of the programs themselves, the actual measurement of Program Area impacts necessarily understates the likely impacts of the Program Areas. This is because freeridership was much more clearly measurable than spillover, which, although likely to occur in the future, was not currently present at a level that could be evaluated. Hence, this report presents the evaluated freeridership values for each Program Area, a second projected net savings value that includes an estimate of savings from projects that are not yet complete but are contracted and nearly complete, and an approximation of the likely impacts of spillover in addition to freeridership through the use of a deemed NTG value of 0.90.

Based upon this understanding regarding the likely overall net impacts of the EECBG-funded projects, for this evaluation effort the Cadmus Team reviewed the level of savings that are expected to be achieved, in addition to the savings that have been evaluated to date. The Team applied the realization rate that was derived by evaluating projects completed as of June 30, 2012 to the total expected savings, and then adjusted the resulting projected gross savings for the deemed NTG. This resulted in a projection of the total savings that will occur from the Program Areas. These projections are presented in Table ES-3.

[9] New York Evaluation Advisory Contractor Team and TecMarket Works. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Residential, Multi-Family, and Commercial/Industrial Measures.* October 15, 2010. Available online: http://www.dps.ny.gov/TechManualNYRevised10-15-10.pdf.

Table ES-3. Summary of Projected Net Savings Findings by Program Area

Program Area	Total Expected Electricity Savings/ Generation from Installed and Planned Projects (MWh)	Savings-Weighted Realization Rate	Total Projected Gross Electricity Savings/ Generation (MWh)	Net-to-Gross	Projected Net Electricity Savings/ Generation (MWh)
Renewable Energy	2,209	1.10	2,430	0.90	2,187
Energy-Efficiency	7,078	0.99	7,007	0.90	6,306
Transportation	Fuel Savings Only				
Energy Code*	24,906	N/A	9,176**	N/A	9,176
Total	**34,193**	**N/M*** **	**18,613**	**N/M*** **	**17,669**
Program Area	**Total Expected Fuel Savings from Installed and Planned Projects (MMBtu)**	**Savings-Weighted Realization Rate**	**Total Projected Gross Fuel Savings/ Generation (MMBtu)**	**Net-to-Gross**	**Projected Net Fuel Savings/ Generation (MMBtu)**
Renewable Energy	7,320	0.47	3,440	0.90	3,096
Energy-Efficiency	50,444	1.01	50,948	0.90	45,853
Transportation	22,955	0.64	14,691	0.90	13,222
Energy Code*	236,222	N/A	85,146**	N/A	85,146
Total	**316,941**	**N/M*** **	**154,225**	**N/M*** **	**147,317**

* Energy Code savings were estimated as part of a independent evaluation effort, as described in the Energy Code Program Area chapter of Section 3: and presented in the Early Building Energy Code Adoption Report, attached as Appendix F.

** This number represents the applied weighted-average compliance rate, assumed to be 64% for the residential sector and 36% for the commercial sector.

*** Weighted overall realization rate and freeridership results are not meaningful and were therefore replaced with N/M.

HIGH-LEVEL EVALUATION CONCLUSIONS

Based on the findings from the evaluation of all EECBG-funded Program Areas, these funds cost-effectively returned net benefits to the residents of New York in the form of job growth, energy savings, and emissions displacement.

Greenhouse Gas Displacement

In order to calculate both annual and lifetime emissions displaced from each Program Area, the Cadmus Team applied the EPA *State Inventory Tool* emissions factors from NYSERDA to the net annual and net lifetime savings values (by fuel type) determined during the Program Area evaluation.

The Cadmus Team needed to rely on several factors and principals when reviewing the displaced GHG emissions. First, the amount of GHG displaced is an estimation based on available best-practice tools. As there is no singular mandated New York State or federal method for calculating GHG emissions displaced from energy-efficiency programs at this time, the calculations could come out slightly different if another tool were used. Each calculation method has its own set of variables—such as temperature, measures, and fuel types included, as well as emissions factors—thus outputs could vary. In the future, depending on legislation and the progression of study in this area, emissions factors are likely to be updated, possibly altering the amount of GHG displaced over the lifetime of each project.

Table ES-4 lists the lifetime evaluated and projected displaced GHG emissions. Please see the GHG Displaced Emissions by Program Area chapter for additional details on displaced emissions calculations.

Table ES-4. Summary of Displaced Emissions (Metric Tons of CO_2e)

Program Area	Evaluated Lifetime Displaced Emissions	Projected Lifetime Displaced Emissions
Renewable Energy	26,400	28,300
Energy-Efficiency	59,000	72,900
Transportation	10,800	9,660
Subtotal	**96,200**	**111,000**
Energy Code	239,000	239,000
Overall Total	**335,000**	**350,000**

Economic Impacts

The Cadmus Team analyzed the net employment impacts of the EECBG Program Areas by modeling Program Area-induced changes in spending within New York State. This was accomplished using a commercially available economic forecasting model from Regional Economic Models Inc. (REMI). Money entering or leaving New York were modeled as net gains or losses to the economy, while changes in spending within the State were modeled such that the total spending remained constant; increasing spending in one sector is offset by a decrease elsewhere.

The Team modeled two scenarios: one encompassing all evaluated projects and another encompassing all evaluated and planned projects (referred to as projected). In addition, we used two sets of electricity prices: wholesale and retail. The wholesale price approach is consistent with NYSERDA's standard methodology for assessing economic impacts from DSM programs, while the retail prices reflect the national evaluation's approach to monetizing energy savings.

In all scenarios modeled, the EECBG Program Areas created a net positive employment impact on the New York economy, as shown in Table ES-5.

Table ES-5. First and 30 Year Cumulative Employment Impacts in New York State (job–years)

Scenario	First Year Net Job-Years		30 Year Cumulative Net Job-Years	
	Wholesale Prices	Retail Prices	Wholesale Prices	Retail Prices
Evaluated Impacts	107	119	298	387
Projected Impacts	135	155	325	471

Table ES-6 shows the first year and 30-year (cumulative) impacts by Program Area for both scenarios (evaluated and projected) using wholesale prices, based on the analysis performed using REMI. All Program Areas result in net positive employment impacts, except for the Transportation Program Area in the 30-year projected scenario. Please see Figure 4-5 and its accompanying text for an explanation of the negative impacts observed in the Transportation Program Area in the 30-year projected scenario.

The administration and price suppression category is the largest contributor to the employment impacts. The Energy-Efficiency Program Area is the greatest contributor over 30 years.

Table ES-6. First and 30-Year Employment Impacts by Program Area (with wholesale prices)

Program Area	Evaluated Scenario (Job-Years)	Projected Scenario (Job-Years)
First Year Impacts		
Energy-Efficiency	23	24
Renewable Energy	26	32
Transportation	11	10
Administration and Price Suppression (for all Program Areas)	46	68
Total	**107**	**135**
30-Year Impacts (cumulative)		
Energy-Efficiency	119	135
Renewable Energy	25	53
Transportation	19	-11
Administration and Price Suppression (for all Program Areas)	135	147
Total	**298**	**325**

Note: Columns may not sum due to rounding.

In addition, the Early Code adoption, which is described in Appendix F, also resulted in increased employment. Table ES-7 shows the first and 30-year cumulative employment impacts of the EECBG and Early Code adoption combined for the evaluated scenario.

Table ES-7. Employment Impacts of EECBG and Early Code Adoption

Program	Net Job-Years (Wholesale Prices, Evaluated Scenario)	
	First Year	**30 Year**
EECBG	107	298
Early Code Adoption	93	1,485
EECBG and Early Code Adoption	200	1,783

Cost-Effectiveness Analysis

In assessing cost-effectiveness, the Cadmus Team analyzed each Program Areas' costs and benefits from four different perspectives, using Cadmus' DSM Portfolio Pro[10] model. The Team based the benefit-to-cost ratios conducted for these tests on methods described in the California Standard Practice Manual[11] for assessing demand-side management program cost-effectiveness. In addition to the California tests, the Team used the DOE Recovery Act Reporting Requirements for the SEP to determine the SEP Recovery Act Cost (SEP-RAC) test ratio. Although the SEP-RAC test is not part of the DOE reporting requirements for EECBG, it is included here for consistency with other Recovery Act reports. The SEP-RAC test is the ratio of each 10 MMBtu saved per year per $1,000 of Recovery Act funds spent. Detailed results by Program Area and a discussion of the assumptions behind those results are presented in the Portfolio-Level Results section, Cost-Effectiveness Analysis chapter. As a basic definition, any Program Area is deemed to be cost-effective per the requirements of a given test if the benefit-cost ratio is greater than 1.0.

Overall, the EECBG portfolio is cost-effective, with the SEP-RAC test ratio at 1.4 for activities completed by June 30, 2012 (evaluated; Table ES-8) and at 1.2 for all projects (projected; Table ES-9). Individually, the Renewable Energy Program Area has the lowest benefit-cost ratio, while Energy Code Program Area has the highest.

Table ES-8. EECBG SEP-RAC Cost-Effectiveness Test Findings – Evaluated Scenario

Program Area	ARRA Investment in Source MMBtu	Source MMBtu Averted*	Benefit-Cost Ratio
Energy-Efficiency	$6,902,000	88,100	1.3
Renewable Energy	$12,225,000	23,230	0.2
Transportation	$1,369,000	14,790	1.1
Energy Code	$990,000	176,440	17.8
Portfolio	**$21,486,000**	**302,560**	**1.4**

Note: Differences between savings reported here and savings reported in other executive summary tables are due to differences in rounding from source documents, and do not affect the result ratios.

* Plug savings were multiplied by the fossil fuel power factor of 9,949.2 Btu/kWh to calculate source savings.

[10] DSM Portfolio Pro has been independently reviewed by various utilities, their consultants, and a number of regulatory bodies, including the Iowa Utility Board, the New York PSC, the Colorado Public Utilities Commission, and the Nevada Public Utilities Commission.

[11] California Public Utilities Commission. *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.* October 2001.

Table ES-9. EECBG SEP-RAC Cost-Effectiveness Test Findings – Projected Scenario

Program Area	ARRA Investment in Source MMBtu	Source MMBtu Averted	Benefit-Cost Ratio
Energy-Efficiency	$8,235,000	108,810	1.3
Renewable Energy	$13,691,000	25,080	0.2
Transportation	$1,407,000	13,310	0.9
Energy Code	$2,623,000	176,440	6.7
Portfolio	**$25,956,000**	**323,640**	**1.2**

Note: Differences between savings reported here and savings reported in other executive summary tables are due to differences in rounding from source documents and do not affect the result ratios.

* Plug savings were multiplied by the fossil fuel power factor of 9,949.2 Btu/kWh to calculate source savings.

Section 1:

INTRODUCTION

On February 13, 2009, in response to a deepening recession in the United States economy, the U.S Congress passed the American Reinvestment and Recovery Act (ARRA). The legislation was signed into law by President Obama on February 17, 2009. ARRA expressed three immediate goals:

1. To create new jobs, as well as save existing ones
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Funding	Program Areas/Technologies
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NYSERDA also has and continues to receive appropriations of State funds, and has been the recipient of federal funding through the U.S. DOE, U.S. Environmental Protection Agency (EPA), and the Federal Highway Administration. This additional State and federal funding was designed to support energy research, development, and deployment programs in the buildings, industrial, transportation, and clean energy sectors. The Long Island Power Authority (LIPA) also offers substantial energy-efficiency and renewable energy programs and the New York Power Authority offers financing with no up-front costs for efficiency projects to public schools and other government facilities through its Energy Services Program.

In 2009, NYSERDA also issued RFP 1656 for evaluation services to determine the impacts of these programs. This contract was awarded to a team led by Cadmus. The first task of the Cadmus Team was to develop an Action Plan with a full description of the evaluation activities to be performed. This Action Plan is included as Appendix B. Subsequent to the completion and acceptance of the Action Plan, the Program Areas funded by SEP and other ARRA dollars continued to evolve. The majority of these changes—which resulted in project cancellations, delays, and additional rounds of financing from some Program Areas—were the result of economic factors associated with the recession. These macroeconomic factors resulted in facilities not being able to contribute the funding anticipated, laying off key staff, or other impacts, which caused many of these project changes. The changes in projects necessitated changes in the evaluation, which are described in the relevant sections of this report. All of these changes are not reflected in the Action Plan included as Appendix B.

Excepting the impacts of the project changes noted above, this report contains the findings of the EECBG-funded Program Areas' evaluation as described in the Action Plan. The Cadmus Team addressed findings from the SEP and SEEARP-funded Program Areas' evaluation in a separate report finalized in April 2012, with the exception of the Energy Code Program Area. Energy Code is an integrated Program Area in which benefits and costs are not well defined between funding streams. Because of this, the Energy Code Program Area incorporates SEP and EECBG into the cost-effectiveness analysis. The full evaluation results are outlined in the Early Building Energy Code Adoption Report, included as Appendix F.

The Program Areas discussed in this report were administered by NYSERDA, in conjunction with contractors and implementers that were selected through competitive bidding processes. The key implementers for these Program Areas include TRC and ARCADIS.

1.1 PROGRAM DESCRIPTIONS AND PARTICIPATION

For the purposes of this evaluation, the EECBG-funded activities are summarized into four Program Areas:

1. Energy Code
2. Energy Efficiency

3. Renewable Energy
4. Transportation

The budgets, spending, energy savings goals, participation goals, and economic and environmental impact targets for each of these Program Areas are summarized in Table 1-2 and Table 1-3.

Table 1-2. Summary of EECBG-Funded Program Area Budgets and Expenditures

Program Area and Metric	DOE Application Budget	Actual Program Area Expenditures (June 30, 2012)	Projected Program Area Expenditures
Renewable Energy			
Total Program Area Cost (EECBG)	N/A	$12,225,000	$13,691,000
Incentive Cost		$10,110,000	$11,130,000
Energy-Efficiency			
Total Program Area Cost	N/A	$6,902,000	$8,235,000
Incentive Cost		$5,005,000	$5,938,000
Transportation			
Total Program Area Cost	N/A	$1,369,000	$1,407,000
Incentive Cost		$1,189,000	$1,189,000
Energy Code			
Total Program Area Cost	N/A	$990,000	$2,623,000
Incentive Cost		$0	$0
Total			
Budget	$29,760,600	$21,486,000	$25,956,000
Incentive Cost	N/A	$16,304,000	$18,257,000

Table 1-3. Summary of EECBG-Funded Program Area *Ex Ante* Claimed (pre-evaluation) Gross Impacts

Program Area and Metric	Claimed (*Ex Ante*) Gross Installed (June 30, 2012)	Claimed (*Ex Ante*) Gross Projected (Under Contract)
Renewable Energy		
Annual Electricity Generation/Savings (MWh)	2,067	2,209
Annual Generation/Savings (MMBtu)	3,586	7,320
Energy-Efficiency		
Annual Electricity Savings (MWh)	6,232	7,078
Annual Fuel Savings (MMBtu)	47,022	50,444
Transportation		
Annual Electricity Savings (MWh)	0	0
Annual Fuel Savings (MMBtu)	22,955	22,955
Energy Code*		
Annual Electricity Savings (MWh)	N/A	N/A
Annual Fuel Savings (MMBtu)		
Total		
Annual Electricity Savings (MWh)	8,299	9,287
Annual Fuel Savings (MMBtu)	73,563	80,719

* The Team included savings for the Energy Code Program Area in the *Early Building Energy Code Adoption Report* in May 2012; this is attached as Appendix F.

Table 1-4 presents the Program Areas' goals as included in the original DOE applications for EECBG funding.

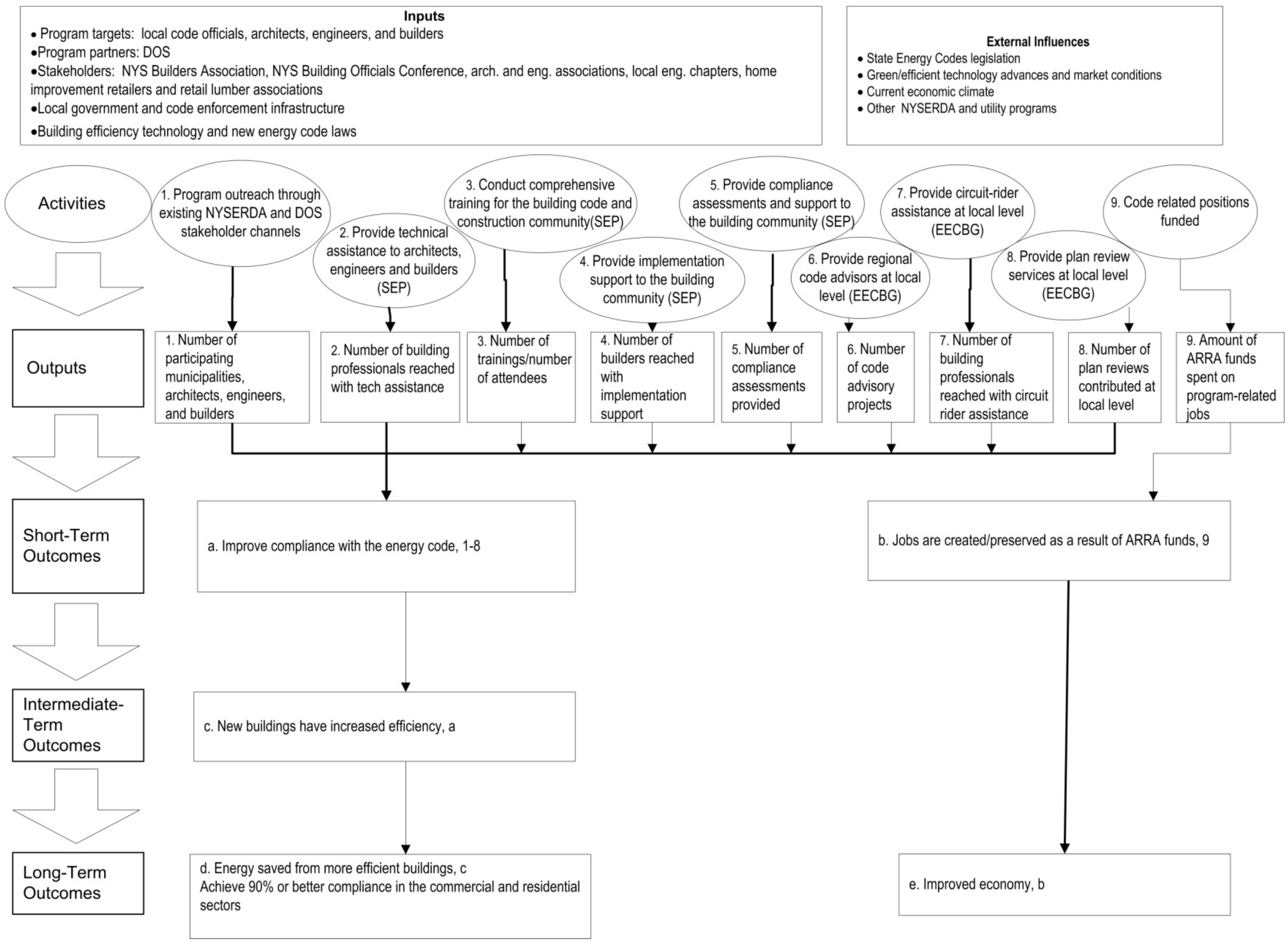
Table 1-4. Program Area Goals from DOE Applications

Program Area	Annual Fuel and Source Electric Savings (MMBtu)	GHG Emissions Reduced (metric tons CO2e)	Jobs Created
Total	5,298,682	348,655	386

1.1.1 Energy Code Program Area

The Energy Code Program Area, supported by ARRA EECBG funding, provides technical assistance to the building community and local energy conservation code enforcement officials (CEOs). The Program Area goal was to achieve the highest practical levels of compliance with provisions set forth in the new Energy Conservation Construction Code of New York State (ECCCNYS, or Energy Code). This effort was closely coordinated between NYSERDA and the New York Department of State (DOS), an agency that promulgates and provides training to code officials on the Energy Code. Figure 1-1 presents the Program Area logic model, indicating the logical linkages between activities, outputs, and outcomes. The figure shows all Program Area activities supported by either EECBG or SEP funds, or a combination of funding. The inputs for the Program Area are funding and other support from NYSERDA, and the expertise of any Program Area implementers and subcontractors. The logic model is based on staff interviews conducted in January 2011. Due to multiple changes in EECBG projects since that time, some of the specifics in the logic model may no longer apply.

Figure 1-1. Energy Code Program Area Logic Model



ARRA required that states update their Energy Code to be at least equivalent to the 2009 International Energy Conservation Code (IECC) for residential buildings, and to the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 90.1-2007 for commercial buildings, in order to receive additional state energy SEP grants. In a 2009 letter to the DOE secretary, the governor at the time, David Paterson, stated that New York would move to adopt the residential and commercial building code required by ARRA, and indicated that he expected it to be implemented by December 2010. On April 1, 2010, the State Fire Prevention and Building Code Council voted to update the ECCCNYS to the 2009 IECC and ASHRAE 90.1-2007, along with several New York State-specific enhancements. All buildings that are heated or cooled for human occupancy are covered by the Energy Code. All measures that affect heating, cooling, electric energy use, and building process operations are included within the Energy Code. This updated Energy Code became mandatory for buildings permitted after December 28, 2010. The adoption of the updated Energy Code was linked directly to New York's receipt of ARRA SEP funding. The early code adoption is also expected to result in significant energy savings to support New York State's 15x15 goal as part of the EEPS.[12] The intent of that goal is to reduce the statewide energy use by 15% below forecast levels by the year 2015.

The New York DOS is responsible for promulgating and providing technical support for the Energy Code. NYSERDA has a long-standing relationship with DOS, having previously provided technical and training support through several Energy Code grants funded by DOE. NYSERDA developed the ARRA-funded code training, support, and compliance assessment Program Area in close cooperation with DOS. These initiatives support the Governor's effort to adopt a more stringent Energy Code and provide various implementation and support services to the entire building community, and they seek to achieve no less than 90% compliance in the commercial and residential sectors by 2017. The primary audiences included CEOs in the 1,600 jurisdictions that are charged with local code enforcement, as well as architectural and engineering professionals. Secondary audiences included builders and contractors, real estate brokers, design/build construction firms, and vendors.

Energy Code activities funded through the SEP broadly provide implementation support, training services, and compliance assessments to the building community across the State. EECBG and SEP funding jointly support training efforts, and EECBG funding supports plan review assistance.

Program Area services were provided by NYSERDA contractors who were selected through a competitive bid process.

Evaluation Goals

The Cadmus Team focused this evaluation on the training activities funded jointly by EECBG and SEP and the plan review support funded by EECBG. The objectives of the evaluation of EECBG activities were to estimate the following Energy Code Program Area impacts:

- Jobs created by the Energy Code Program Area
- Areas where the Energy Code Program Area could be improved as some activities continue during 2012
- Cost of the Energy Code Program Area activities

[12] New York PSC. *07-M-0548: Energy Efficiency Portfolio Standard*. 2008. Available online: http://www3.dps.ny.gov/W/PSCWeb.nsf/All/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument.

In addition to assessing the impacts of the activities funded by EECBG, the Cadmus Team examined the impacts of the early adoption of the residential and commercial building energy codes associated with the ARRA requirements. These impacts did not result from EECBG-funded activities, but constitute an important energy savings contribution of ARRA. The analysis of these impacts, presented in Appendix F, was conducted as an independent evaluation effort using non-ARRA funding.

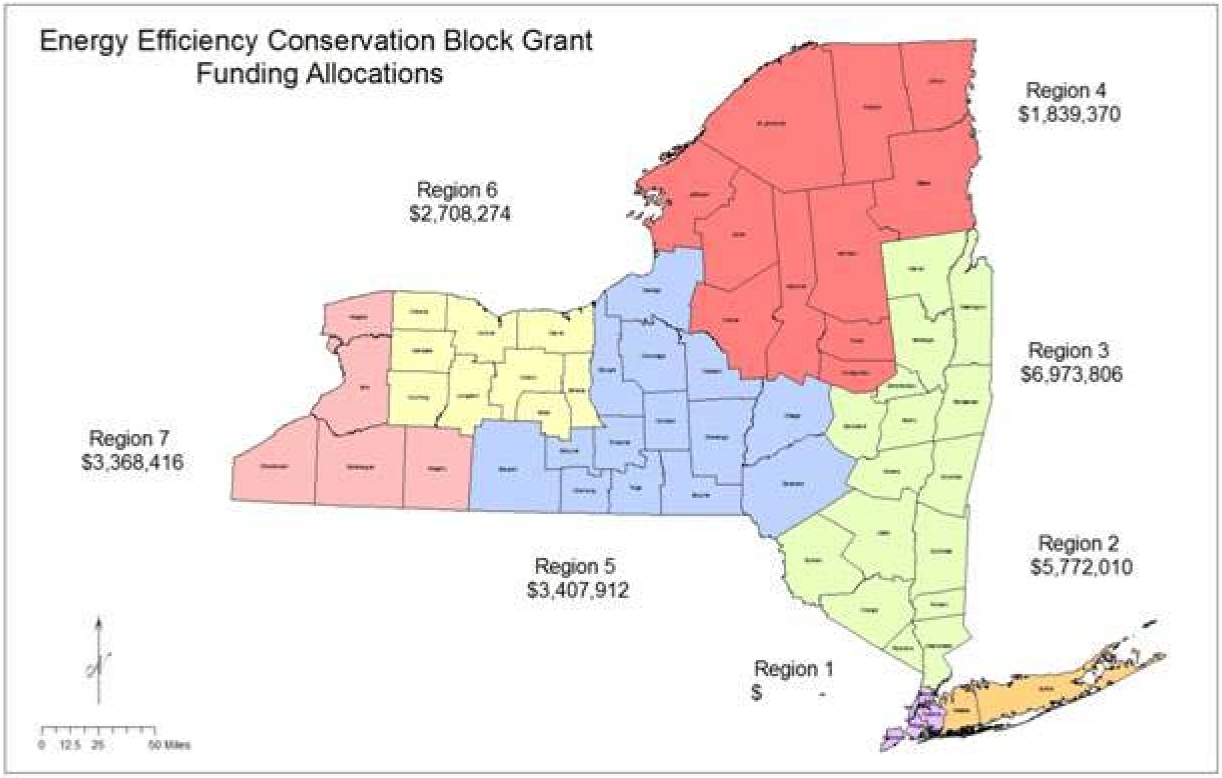
1.1.2 RFP 10 Energy-Efficiency Program Area, Renewable Energy Program Area, and Transportation Program Area

ARRA included funding for the EECBG via RFP 10. Through RFP 10, $20.9 million of New York's allocation of ARRA EECBG funds were distributed to eligible energy conservation projects on a competitive basis. NYSERDA administered the EECBG funds in New York State pursuant to a program plan approved by the U.S. DOE. Energy efficiency, renewable energy, efficient transportation system implementation, material conservation, and energy management personnel measures were all eligible.[13] Eligible proposers were small municipal governments of New York State that did not receive a direct EECBG allocation from the DOE. Eligible proposers agreed to comply with all required federal and State requirements for use of the funds.

In RFP 10's award design, NYSERDA sought to ensure a geographically equitable distribution of the funds through allocations to seven regions across the State of New York (Figure 1-2).

[13] Material conservation and energy management personnel were not included in this evaluation.

Figure 1-2. Funding Allocations for EECBG

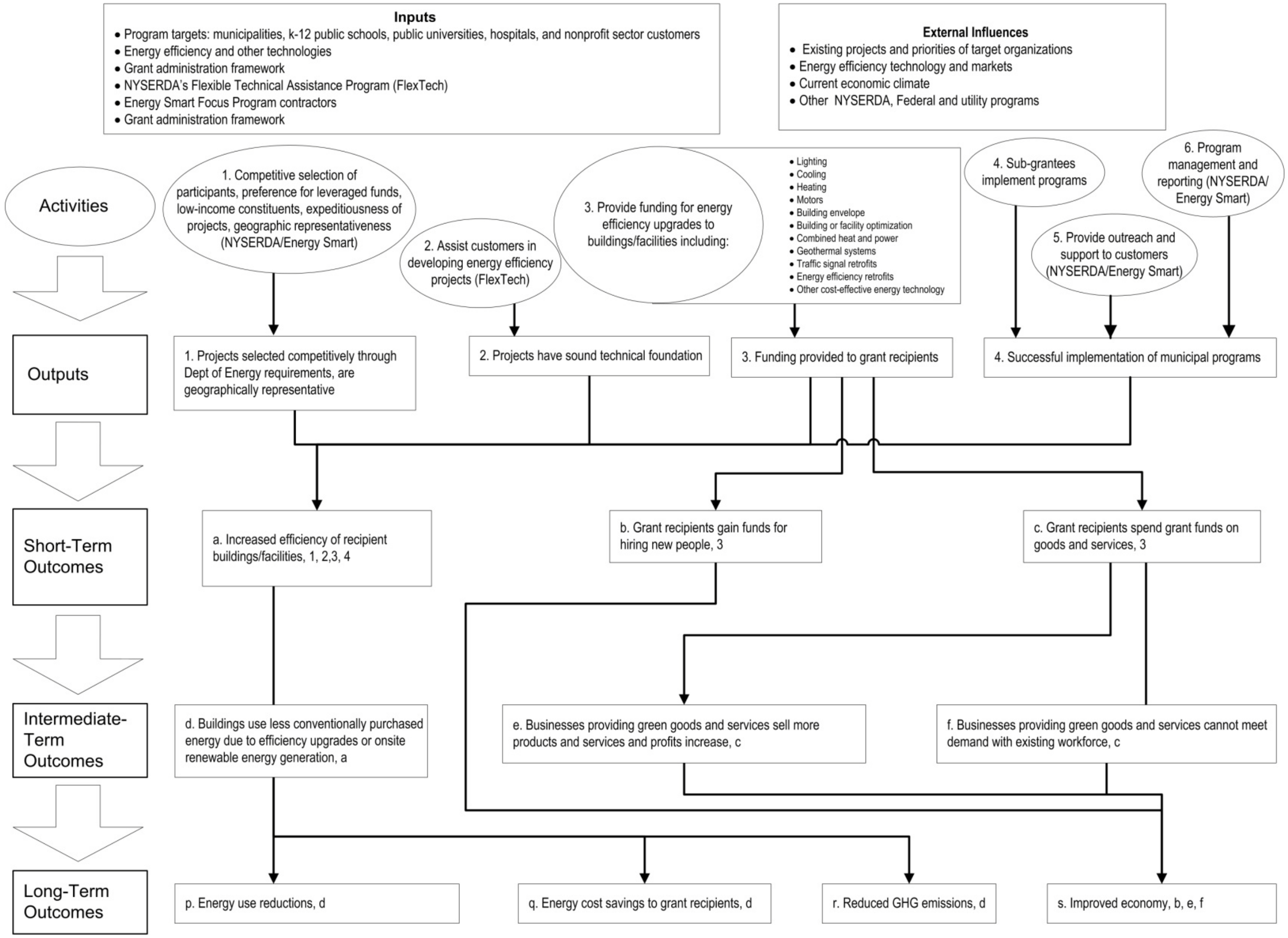


Energy-Efficiency Program Area

An energy-efficiency project is defined as a project that achieves a cost-per-annual-energy-saved threshold of less than $2,000 of total project cost per 10 million Btu of source energy savings, and must have a simple payback equal to or less than the expected life of the measure. Both facility and non-facility integrate measures are eligible. Technologies may include, but are not limited to: lighting; cooling; heating; combined heat and power systems; ground source heat pumps with less than 10 tons of cooling capacity; motors; building envelope, building, or facility optimization; district heating and cooling systems; traffic signal lighting; street lighting; retro-commissioning for energy efficiency; and other energy-efficiency technologies.

Figure 1-3 summarizes the logic for this Program Area, highlighting the key features of the Program Area and indicating the logical linkages between activities, outputs, and outcomes. The figure shows all Program Area activities supported by EECBG or SEP funds or a combination of funding. The inputs for the Program Area are funding and other support from NYSERDA, and the expertise of any Program Area implementers and subcontractors. The logic model is based on staff interviews conducted in January 2011. Due to multiple changes in EECBG projects since that time, some of the specifics in the logic model may no longer apply, for example, material conservation and energy management personnel were not included in this evaluation.

Figure 1-3. Energy-Efficiency Program Areas Logic Model



Evaluation Objectives

The objectives of this evaluation were to estimate the following Energy-Efficiency Program Area impacts:

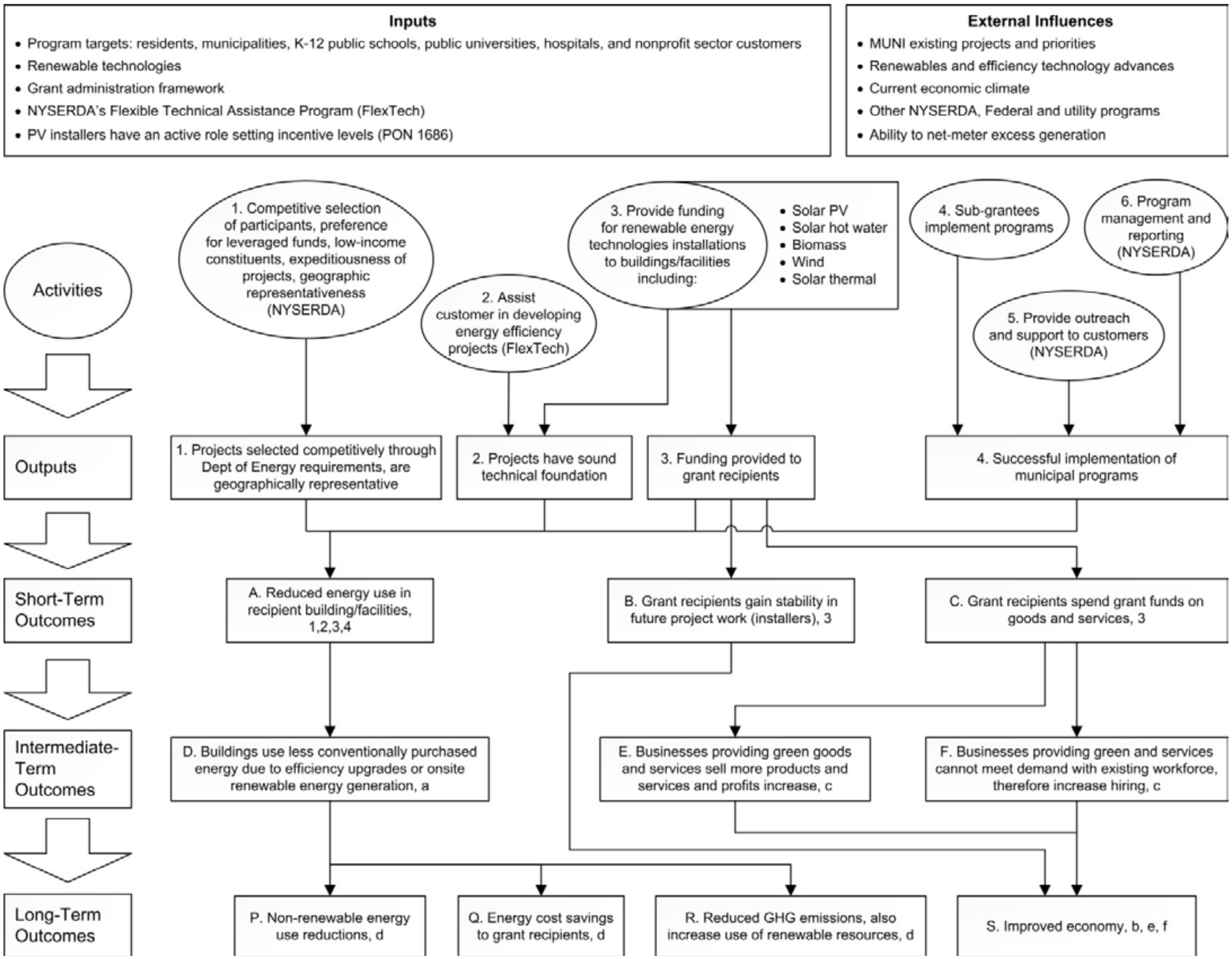
- Gross energy savings
- Net energy savings (the amount of gross savings attributable to the Energy-Efficiency Program Area)
- Avoided GHG emissions
- Jobs created by the Energy-Efficiency Program Area
- Areas where the Energy-Efficiency Program Area could be improved
- Cost-effectiveness

Renewable Energy Program Area

The renewable energy projects that were part of this evaluation fell under NYSERDA Program Area offering RFP 10. This Program Area offering had its own unique characteristics, requirements, and evaluation challenges. A renewable energy project is defined as a project that: 1) achieves a cost-per-annual-energy-generated of less than $8,000 of total project cost per 10 MMBtu generated or saved; 2) is sited at the electric customer's location; 3) is used primarily to serve the electric customer's load (not primarily exported to the utility grid); and 4) has a system that, as designed, cannot generate more electricity than is consumed on-site annually. The installation of eligible renewable energy technologies includes solar photovoltaic (PV), solar thermal (water and space conditioning), biomass, fuel cells, and wind.

The logic model, shown in Figure 1-4, highlights the key features of the Program Area, indicating the logical linkages between activities, outputs, and outcomes. The figure shows all Program Area activities supported by either EECBG or SEP funds or a combination of funding. The inputs for the Program Area are funding and other support from NYSERDA, and the expertise of any Program Area implementers and subcontractors. The logic model is based on staff interviews conducted in January 2011. Due to multiple changes in EECBG projects since that time, some of the specifics in the logic model may no longer apply.

Figure 1-4. Renewable Energy Program Area Logic Model



Evaluation Objectives

The objective of this evaluation was to estimate the following Renewable Energy Program Area impacts:

- Gross energy generation[14]
- Net energy generation (the amount of gross generation attributable to the Renewable Energy Program Area)
- Avoided GHG emissions
- Jobs created by the Renewable Energy Program Area
- Areas where the Renewable Energy Program Area could be improved
- Cost-effectiveness

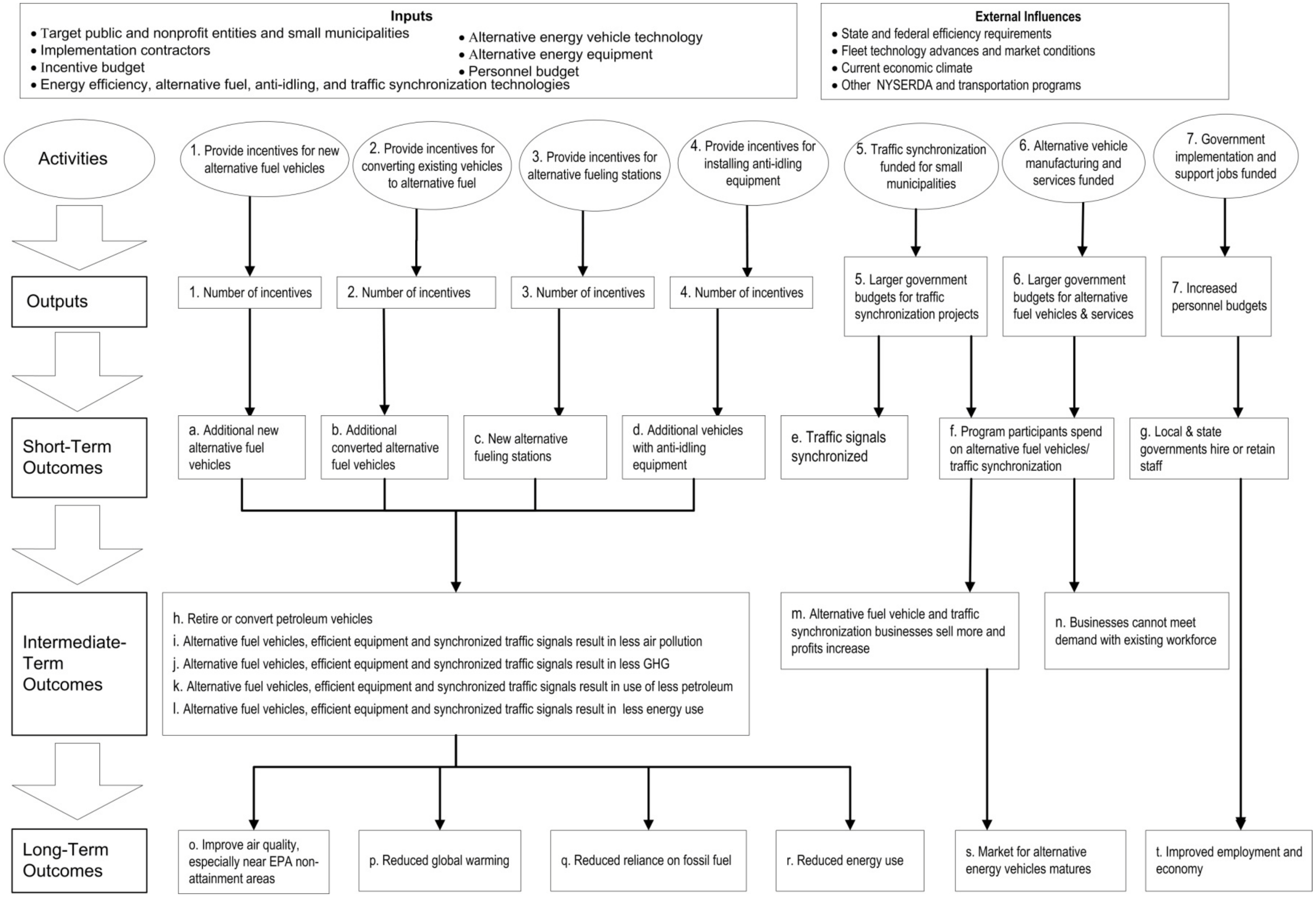
Transportation Program Area

Transportation projects were funded within the NYSERDA ARRA Efficient Transportation System Implementation Projects, under the EECBG. The national EECBG program awards grants to municipalities throughout the states for projects that change driving behaviors, improve air quality, stimulate job creation in the community, and reduce energy use and GHG emissions. An EECBG project must be initiated and overseen by a small municipality and receive no more than $500,000 of NYSERDA funds to complete.

The Program Area logic model, shown in Figure 1-5, highlights the key features of the Program Area, indicating the logical linkages between activities, outputs, and outcomes. The figure shows all Program Area activities supported by EECBG or SEP funds or a combination of funding. The inputs for the Program Area are funding and other support from NYSERDA, and the expertise of any Program Area implementers and subcontractors. The logic model is based on staff interviews conducted in January 2011. Due to multiple changes in EECBG projects since that time, some of the specifics in the logic model may no longer apply.

[14] For purposes of this report, the energy benefits of renewable energy systems will be referred to as generation. This term distinguishes the benefits of renewable energy technology from the benefits derived from energy-efficiency and conservation measures.

Figure 1-5. Transportation Program Area Logic Model



Evaluation Objectives

The objective of this evaluation was to estimate the following Transportation Program Area impacts:

- Gross energy savings
- Net energy savings (the amount of gross savings attributable to the Transportation Program Area)
- Avoided GHG emissions
- Jobs created by the Transportation Program Area
- Areas where the Transportation Program Area could be improved
- Cost-effectiveness

Section 2:

EVALUATION METHODOLOGY

The previous section provided background on NYSERDA's ARRA-funded Program Areas as implemented since 2010. Prior to beginning any fieldwork to determine energy use and savings from measures promoted and installed through the Program Areas, the Cadmus Team interviewed staff at NYSERDA, as well as staff at the Department of Public Service (DPS), DOE, and implementation contractors' companies, in order to understand the development and operations of the Program Areas. In conjunction with this effort, the Cadmus Team developed the Action Plan that defined the evaluation approaches used over the subsequent months that led to the findings contained in this report. The remaining sections describe the evaluated savings, gross and net, achieved by the Program Areas, and estimated or project savings that will continue to occur as a result of Program Area activities.

To evaluate the EECBG-funded Program Areas, the Cadmus Team administered 60 surveys and conducted 61 site visits. These efforts are summarized in Table 2-1.

Table 2-1. Data Collection Summary

Program Area	Total Projects Funded	Surveys	Site Visits	Document Review
Energy Code	N/A	19	0	98
Energy-Efficiency	69	14	25	45
Renewable Energy	65	23	36	42
Transportation	4	4	0	4
Total	**138**	**60**	**61**	**189**

Each of the evaluation efforts yielded information on the activities that were undertaken by Program Area participants. In particular, the evaluation sought to obtain information in several areas:

1. Gross savings
    a. Whether the equipment is installed and will remain installed
    b. Whether the equipment is operating to specifications
    c. Whether the equipment usage is consistent with expectations and with previous operation

    Where possible and appropriate, the Team conducted measurement and verification (M&V) of gross savings in accordance with the International Performance Measurement and Verification Protocol (IPMVP), as shown in Table 2-2.

Table 2-2. Evaluation Approaches Used

Program Area	IPMVP Option	Explanation
Energy-Efficiency	B	Retrofit Isolation
Energy Code	N/A	No site visits
Renewable Energy	B	Retrofit Isolation
Transportation	N/A	No site visits

2. Attribution

The Cadmus Team assessed attribution to determine what would have happened in the absence of the Program Areas. In essence, the Team measured a counterfactual: something that never actually happened. The nature of ARRA funding added another layer of complexity to attribution analysis. The federal government provided strong directives to award money to projects that were ready to move forward—known as being shovel ready—but that had difficulty securing financing due to the recession. The Cadmus Team took such directives into account when assessing attribution, adjusting the definition of freeridership to account for the degree to which ARRA funds allowed projects to continue that might have been delayed or would have been scaled back without ARRA funds. Hence, the Cadmus Team sought to determine:

a. Whether the energy savings would have occurred in the absence of the Program Area efforts and funding

b. Whether the same level of energy savings would have occurred in the absence of the Program Area efforts and funding

c. Whether the savings would have occurred at the same time and to the same level in the absence of the Program Area efforts and funding

In order to best compare Program Area attribution results with those of other NYSERDA programs, the Cadmus Team attempted to follow the long-standing approaches for measuring attribution that have been used in other NYSERDA evaluations, as well as those considered best practices in the industry. While additional detail on the approaches used during the evaluation of each Program Area is provided in Section 3, there is a significant amount of historical information regarding these previous evaluations available on the NYSERDA Website.[15]

3. Process

a. Whether the Program Area is operating as intended when it was designed

b. Whether there are any lessons that should be learned in order to increase the effectiveness of the Program Area, or of any other Program Areas being offered by NYSERDA

The findings from these evaluation activities are detailed in the remaining sections of this report.

One common challenge across most of the evaluation efforts was the changing population of participants in each Program Area, and the numerous changes to the specific projects that were planned at individual participant sites. These changes were particularly visible to the Cadmus Team during this evaluation

[15] http://www.nyserda.ny.gov/Page-Sections/Program-Evaluation/NYE$-Evaluation-Contractor-Reports.aspx. Accessed on April 27, 2012.

because of the timing of the study. Because of the need to complete the evaluation in accordance with the DOE established requirements, the Team conducted this evaluation concurrently with many of the implementation activities. While this both brings benefits and creates challenges, the challenge of project cancellations is noted in several locations throughout this report. These cancellations do not appear to be related to any challenge with NYSERDA's management of the Program Areas. Rather, the primary factors resulting in the cancellations appear to be related to economic conditions, and to a lesser degree to the administrative burden that was involved in complying with federal regulations when accepting and spending the federal ARRA monies.

Section 3:

RESULTS

3.1 ENERGY CODE PROGRAM AREA

NYSERDA funded several Energy Code activities with EECBG and SEP funding, including implementation support, training services, and compliance assessments to the building community across the State. Program Area activities focused on in-person and online training, general technical assistance, plan review support, publications, compliance assessment, and pilot programs that explored means of providing direct project support through regional code advisors.

Program Area services were provided by nine NYSERDA contractors, who were selected through a competitive bid process. These contractors provided the following specific services:

- Training and instructional courses across the State on a first-come, first-served basis.
- Technical assistance services to selected communities across the State at locations determined by NYSERDA and DOS.
- Plan review compliance assessments, conducted statewide.
- Outreach through existing NYSERDA and DOS stakeholder channels, including but not limited to the New York State Builders Association, New York State Building Officials Conference, architectural and engineering associations, local engineering chapters, home improvement retailers, and retail lumber associations.

The Cadmus Team evaluated the effects of a subset of activities funded by EECBG, which included the training and instructional courses and the provision of plan review services to CEOs. Since the training and instructional courses were funded jointly with SEP funds, the training results were evaluated and presented in the SEP evaluation report[16] and are only summarized here. The remainder of the EECBG study results presented address the CEO plan review services.

The Team focused the evaluation of the CEO plan review services on the effectiveness of the services; no energy savings results are presented for the plan review services, as the evaluation scope and timing did not permit quantifying the savings associated with these services. In addition to assessing the impacts of the activities funded by EECBG, the Cadmus Team examined the impacts of the early adoption of the residential and commercial building energy codes associated with the ARRA requirements. These impacts did not result from EECBG-funded activities, but constitute an important energy savings contribution of ARRA. The analysis of these impacts, presented in Appendix F, was conducted as an independent evaluation effort using non-ARRA funding.

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[16] The Cadmus Group. *NYSERDA American Reinvestment and Recovery Act 2012 Impact Evaluation Report: State Energy Programs.* April 30, 2012.

3.1.1 Data Sources

In addition to the sources the Cadmus Team used to conduct the SEP evaluation, the Team used the following data sources for the EECBG Energy Code Program Area evaluation:[17]

- 2010 ECCCNYS document and supporting information
- 2009 IECC document and supporting information
- ASHRAE Standard 90.1-2007 document and supporting information
- McGraw Hill/FW Dodge commercial construction forecast data
- Hanley Wood residential construction forecast data
- DOE EnergyPlus prototypical models
- Vermont Energy Investment Corporation. *New York Energy Code Compliance Study*. 2011.
- Interviews with CEOs who received plan review services
- Interview with the provider of plan review services
- Plan review services documentation and spreadsheet from services provider

3.1.2 Approach: Surveys and Sample Design

For the SEP evaluation, the Cadmus Team interviewed a variety of stakeholders and NYSERDA and DOS staff to determine the status of the Energy Code in New York State, how ARRA funding affected the code adoption and implementation process, and contextual issues related to new code adoption. The Team surveyed several hundred participants who received the training services provided by the NYSERDA contractors, including CEOs, architects, engineers, and builders.[18] The information from these interviews and surveys provided a foundation for the Cadmus Team's data collection and evaluation of the EECBG Program Area activities.

For this EECBG evaluation, the Team obtained a list of all jurisdictions that received the plan review services provided by T.Y. Lin International Group; the documentation on each project that T.Y. Lin provided to the jurisdictions; and a spreadsheet from T.Y. Lin summarizing findings for each project reviewed. The Cadmus Team conducted interviews with 19 CEOs who received the plan review services, as well as with T.Y. Lin.

<u>T.Y. Lin Staff Interview</u>

The Cadmus Team prepared and forwarded a T.Y Lin interview instrument for NYSERDA staff comment. After incorporating comments from the NYSERDA review, the Team interviewed Mr. Copp from T.Y. Lin, who was in charge of the effort to provide CEOs with plan review services. Mr. Copp provided a wide range of insights and information about the plan review services process. He also shared a spreadsheet documenting their findings and copies of the plan review documents they provided to the participating CEOs.

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[17] The Cadmus Team used some of the data sources listed for the early code adoption savings analysis, which is presented in Appendix F.

[18] The exact number of individuals surveyed is unknown, because individuals were not required to answer all questions for each survey and responses were provided in a total frequency format. Not enough information was provided to extrapolate the total number of surveyed participants.

The Cadmus Team reviewed and categorized those documents based on the type of buildings they were for and whether the project had a single or multiple submittals. The Team extracted information from these documents to help guide the CEO interviews, and used the documents to identify common compliance issues.

CEO Interviews

After reviewing the documents provided by Mr. Copp, the Cadmus Team determined that plan review services were provided once for some projects and multiple times for others. In all cases, the first review identified one or more issues that needed to be addressed. However, CEOs did not always request a review of revised submittals, so there were numerous projects with only a single review available.

The Cadmus Team separated out the submittals for projects with only one submittal from those with resubmittals, and then created a basic interview instrument with these two variants. NYSERDA staff provided comments on these draft interview instruments and the Cadmus Team revised them accordingly.

The Team set a target of completing 10 interviews each for one-time submittal and resubmittal projects. The Team also intended to interview CEOs representing a mix of commercial and residential building projects. The amount of time available to schedule and complete these interviews was limited, so the Team's goal was to complete as many interviews as possible, up to the target number, within the time available.

Table 3-1 shows the distribution of completed CEO interviews. The Cadmus Team conducted 19 interviews with CEOs about their experiences with the plan review services; nine for one-time submittal projects and 10 for resubmitted projects.

Table 3-1. Completed CEO Interviews, Energy Code Program Area

Project Submittal	Commercial Building Projects	Residential Building Projects	Total
One-time	5	4	9
Resubmittal	4	4	10*
Total	**9**	**8**	**19**

* Two of the CEOs interviewed had resubmitted both residential and commercial projects for review.

3.1.3 Process Findings

The following subsections detail the training and plan review services provided by NYSERDA and supported with EECBG funding. As noted earlier, EECBG and SEP funding covered other activities that were not evaluated within the scope of this study.

Training Participant Results[19]

As part of the code adoption process, DOS and NYSERDA developed training for relevant stakeholders, primarily CEOs but also including architects, engineers, builders, contractors, realtors, and vendors. ARRA's requirement for 90% compliance by the year 2017 was a significant motivation for the increased

[19] The results presented in this section are the same as those presented in the SEP evaluation, since the training activity was co-funded by both SEP and EECBG.

level of training services. Because SEP co-funded the training with EECBG, the training results are presented in the SEP evaluation as well as in this evaluation of the EECBG Program Areas. Two waves of training participants were surveyed at different times regarding their experiences with the NYSERDA-sponsored trainings.

These trainings met a variety of participants' needs. DOS requires CEOs to attend code training annually. Architects and engineers often need to receive continuing education credits, and these trainings were approved for credit. Table 3-2 shows reasons provided by all training participants indicating that receiving continuing education credits was one of the main reasons participants attended. Table 3-3 shows that CEOs and industry professionals shared similar motivations for attending the training.

The survey results suggest that NYSERDA and DOS efforts are utilized as an educational source to increase knowledge of the Energy Code in the building trades community, with industry professionals using the trainings to improve their professional understanding of code issues.

Table 3-2. Training Motivation for Wave 1 and Wave 2* Participants, Energy Code Program Area (multiple responses)

Motivation	Wave 1		Wave 2	
	Frequency	Portion of Total	Frequency	Portion of Total
Required by my professional organization	40	6%	28	9%
Required by my employer/job	37	6%	30	9%
To improve my professional knowledge	361	55%	156	48%
For the continuing education credits	188	29%	111	34%
Other	31	5%	3	1%
Total	**657**		**328**	

Note: Columns may not sum to 100% due to rounding and multiple responses.

* The NYSERDA contractor responsible for the Program Area Website and online registration initially offered to incorporate the Cadmus Team's online surveys as a requirement to register for the first wave of training in spring 2011, referred to as Wave 1. For the second wave of trainings, Wave 2, the contractor asked participants to complete paper surveys at the appropriate time during the training session.

Table 3-3. Training Motivation for Wave 2 Code Enforcement Officials vs. Industry Professionals, Energy Code Program Area

Motivation	Code Enforcement Officials		Industry Professionals	
	Frequency	Portion of Total	Frequency	Portion of Total
Required by my professional organization	18	10%	10	7%
Required by my employer/job	15	8%	15	11%
To improve my professional knowledge	83	44%	73	52%
For the continuing education credits	69	37%	42	30%
Other	2	1%	1	1%
Total	**187**		**141**	

Note: Columns may not sum to 100% due to rounding.

The Cadmus Team asked participants to rate their overall level of satisfaction with the training. Table 3-4 shows the results. Participants rated their satisfaction on a 0 to 10 point scale, with 0 indicating high dissatisfaction and 10 indicating high satisfaction. Wave 1 post-training survey participants, who were surveyed at least six months after the training, reported slightly positive satisfaction (6.9). Wave 2 participants, who were surveyed immediately after the training, reported very high satisfaction (8.4). Since the Cadmus Team did not have satisfaction data collected immediately after training from the Wave 1 participants, it is uncertain whether the lower ratings by the Wave 1 participants was due to the passage of time since the training or some inherent differences in their satisfaction with the training.

Table 3-4. Participant Satisfaction with Code Training, Energy Code Program Area

Wave	Code Enforcement Officials	Industry Professionals	Overall
1	6.9 (n=90)	6.9 (n=89)	6.9
2	8.3 (n=167)	8.6 (n=137)	8.4

One Program Area training and support service goal was to provide participants with an overview of the plan review process for implementing or complying with the ECCCNYS 2010. The implementation contractors who provided training on plan reviews indicated that this training generated less than the expected interest among CEOs and industry professionals. Training staff reported that although they performed good outreach, they were only able to enlist enough participants to conduct a class in one location. Staff said they thought the CEOs and industry professionals might be uncomfortable with the thought of someone "*looking over their shoulder*" during the plan review process. As discussed below, a third-party later provided plan review assistance.

The Cadmus Team identified six participants who reported taking the plan review overview training (included in the Green Building Residential Examiner Certification course), and asked them to rate it on a scale of 0 to 10, where 0 indicated that it was not at all helpful and 10 indicated that it was extremely helpful (Table 3-5). On average, participants considered the plan review overview to be relatively helpful (6.8).

Table 3-5. Participant Rating of Plan Review Overview Training Helpfulness, Energy Code Program Area

Course	Code Enforcement Officials (n=6)
Green Building Residential Examiner Certification	6.8

NYSERDA staff emphasized that the trainings to date were early efforts, which will be evaluated internally by NYSERDA Energy Code staff. Updated in-person and online trainings will be delivered throughout 2012.

Plan Review Assistance Results

The following subsections present findings from the Cadmus Team's assessment of the plan review services provided by NYSERDA. NYSERDA utilized EECBG funding to provide free, individualized plan review services for CEOs. Their primary goal in providing these services was to inform CEOs of the new codes through project-specific assistance with building permit review and approval. Services were offered starting in 2010 and continued through mid-2012.

This subsection begins with a presentation of the information the Cadmus Team gathered during an extensive interview with the plan review service provider. This is followed by a summary of the Team findings from the plan review documentation. The subsection concludes with information from interviews the Team conducted with a sample of CEOs who received plan review services.

NYSERDA contracted with Newport Ventures, who utilized T.Y. Lin's services to implement CEO plan review services. T.Y. Lin is a global, multidisciplinary engineering services firm with extensive experience in all facets of code compliance, including plan review. The T.Y. Lin team that provided review services consisted of four New York certified CEOs: a former CEO of 20 years and current member of the NYS technical subcommittee for the Energy Code, a previous construction inspector, an architect, and an engineer.

T.Y. Lin reviewed plans submitted by CEOs in order to assist with code compliance assessments. T.Y. Lin would send reviewed plans back to CEOs with a checklist and comments on code compliance, specifically where compliance was deficient or documentation was missing. Residential and commercial projects had their own respective checklists outlining Energy Code standards applicable to their sectors. It was a standard method for T.Y. Lin to use those checklists as a format for plan review, and they modified each checklist to incorporate content and formatting influences from previous checklists, in addition to incorporating the newest building Energy Code. The checklists outlined individual requirements, and T.Y. Lin noted if plans were compliant or non-compliant, or if requirements were not applicable to a specific project. For residential projects only, T.Y. Lin also sent a blank inspection checklist to assist CEOs with collecting the necessary data during on-site inspections.

In addition to the checklist, T.Y. Lin provided CEOs with a narrative of the plan review along with recommendations on how to comply. Occasionally, the recommendations included code references not considered to be Energy Code standards, but which had a tangent relationship to the Energy Code (e.g., mechanical references). Additionally, T.Y. Lin provided a recommendation to CEOs to grant a permit, grant a conditional permit hinged on certain compliance enhancements, or to request a resubmittal for further plan review. After T.Y. Lin sent plan reviews to a CEO, it was up to the CEO to decide how to move forward.

The Cadmus Team interviewed the T.Y. Lin team lead about the status of the Energy Code and the impact of the plan review services. The Team also reviewed the feedback that T.Y. Lin provided to CEOs through the plan review documents and by interviewing participating CEOs. The Team's goal in reviewing feedback was to understand areas where code compliance is deficient, determine how helpful plan review services were to enhancing compliance, and to gain feedback from CEOs on their experiences with the new Energy Code.

Observations from Plan Review Service Provider

During the plan review services interview with the T.Y. Lin team lead, the Cadmus Team addressed a range of topics, including marketing and outreach, Program Area design and implementation, residential and commercial project submissions, and effectiveness of the service.

T.Y. Lin marketed the plan review services in a variety of ways throughout New York. It found that the marketing approach that resulted in the greatest participation of CEOs was word-of-mouth. Utilizing industry contacts collected through years of being involved in New York State code enforcement activities, T.Y. Lin staff directly contacted approximately 250 CEOs through personal phone calls. CEOs tended to be more receptive to Program Area services when they were recommended by a familiar source. After CEOs started utilizing the services offered, T.Y. Lin noted that participants began recommending the Program Area to other CEOs.

An additional tool T.Y. Lin used to spread Program Area information throughout the CEO community was a NYSERDA-approved flyer. They dispersed this flyer, which included a description of plan review services and pertinent contact information, via paper handouts and Websites. The following are avenues through which they provided the flyer:

- New York State Building Officials Conference Newsletter
- New York State Building Officials Websites (for each chapter)
- Four educational conferences for CEOs
  - Included tabling, flyer handouts, and 5-minute announcement with Program Area description
  - Conferences located in Central, Northern, Western, and Eastern New York
  - Estimated number of attendees at each training were 125, 250, 250, and 350
- New York State Division of Code Enforcement Website

The T.Y. Lin team lead reported the flyer to be a useful tool that was easily dispersed to CEOs throughout the State.

Information regarding plan review services was also available through the NYSERDA and Newport Ventures Websites. As CEOs do not typically seek out the types of services provided by the Energy Code Program Area, T.Y. Lin found that active recruitment was necessary. For this reason, proactive contact was critical to getting CEOs interested in the Program Area. The flyers were beneficial in this way, because they could be sent through multiple avenues to reach CEOs in most, if not all, of the jurisdictions.

One particular issue noted by T.Y. Lin regarding recruitment was that participation in plan review services dropped after the initial launch of the Program Area. Once the Program Area was no longer novel, CEO interest in plan review services declined, along with accompanying word-of-mouth advertising. At the same time, the depressed economy limited the amount of construction activity, which directly impacted the number of CEOs seeking plan review assistance. Throughout the effort to provide plan review services, T.Y. Lin struggled to overcome these obstacles to recruiting participants. Regular outreach through personal phone calls and a rebounding economy are factors that facilitated regular Program Area participation.

To participate in plan review services, a CEO must have first registered and enrolled with T.Y. Lin. By request, a T.Y. Lin representative would then send the CEO a registration form. The CEO would complete the form and send it back via e-mail and/or fax. T.Y. Lin then followed up with an acknowledgement letter, spelling out what was needed for the plan review services along with a pre-paid UPS envelope for the CEO to send plans for review. Once they received plans, T.Y. Lin would send an acknowledgement letter to the CEO, informing them that their materials were received and were in the queue for plan review services. The only limit regarding plan review services for CEOs was that each jurisdiction could submit a maximum of 10 different projects for review. Although there was a limit on the number of different projects that could be submitted, each project could be submitted as many times as needed.

Several months after the plan review services started, NYSERDA implemented an online registration process for CEOs. However, T.Y. Lin discovered that many CEOs had difficulty accessing and using the registration Website. To resolve this issue, T.Y. Lin sent registration forms to CEOs via e-mail, collected all the necessary registration information, and completed the online NYSERDA registration for them.

CEOs had the opportunity to resubmit project-specific plans as many times as necessary. The Cadmus Team asked T.Y Lin whether there were any factors (such as size of the jurisdiction, type of project, or CEO knowledge level) that affected whether a CEO resubmitted plans to T.Y. Lin after the first review. However, the plan review services were completely voluntary, so T.Y. Lin did not follow up with projects after providing plan review assistance, and could not comment whether any particular factors affected projects being resubmitted for additional review. One observation T.Y. Lin provided was that some communities that resubmitted a project may have learned from that experience and did not need to resubmit subsequent projects.

For projects that were submitted multiple times, T.Y. Lin generally saw improvements between each submission. Although they did not quantify this improvement, they noted increased communication between CEOs, building planners, builders, and their own company as a positive outcome. If requested, T.Y. Lin included design professionals and builders in communications. This communication assisted in decreasing friction when designers/builders pushed back on CEO comments. T.Y. Lin said the CEOs sometimes used this service to add a neutral third-party voice to help defray some of the push-back they got from designers/builders.

In one situation, T.Y. Lin encountered friction between a builder and a CEO that created an obstacle for the plan review services: T.Y. Lin performed a plan review of a submitted residential project and found significant code deficiencies. The builder complained about having to meet all the deficiencies and, in the end, the jurisdiction decided to not use the review services.

Also according to T.Y. Lin, plan review services for residential and commercial projects had their own sector-specific issues. However, both types of projects were lacking in the documentation and information provided. T.Y. Lin mentioned that this was not likely a result of the new code, since the old code required a similar level of documentation. Instead, they said it was more likely that the lack of information resulted from poor coordination between builders, designers, and HVAC contractors.

For residential projects, T.Y. Lin said that even simple notes that would suffice for code compliance were left out of plans, leaving T.Y. Lin unable to provide adequate plan reviews. One example is related to the requirement that 50% of lighting be high efficacy, which if shown on the plans would have sufficed for plan review, but that information was rarely noted.

For commercial projects, T.Y. Lin usually did not receive a full set of specification documents, which made plan review difficult. One commercial sector-specific problem was that a majority of plans used COMcheck,[20] and the inputs shown often did not match the information on the plans. T.Y. Lin said it is possible that individuals who submitted plans to CEOs sometimes used COMcheck to find a route to code compliance, but the resulting changes were not reflected in the plans. Sometimes CEOs only submitted pieces of approved COMcheck documentation (e.g., building envelope), while not addressing other parts of buildings at all.

Unlike residential projects, commercial projects had two standards that could be used for compliance: the ECCCNYS and ASHRAE 90.1. T.Y. Lin pointed out that ASHRAE 90.1 provides more flexibility for compliance, particularly in space conditioning and allowances for different performance metrics, whereas the ECCCNYS states certain building requirements that need to be met in all buildings. One observation was that ASHRAE 90.1 is better understood by national companies, like Wal-Mart and Target, because it is acceptable across multiple states. During plan review services, T.Y. Lin would occasionally sit down with the CEO, builder, and design professional to walk through ASHRAE 90.1, if all parties were not familiar with the code requirements.

T.Y. Lin indicated that several CEOs provided feedback on the plan review services. These CEOs said they used the services as a learning tool and found them to be very useful and effective. Although the

[20] COMcheck is a software package the DOE developed to makes it easier for architects, builders, designers, and contractors to determine whether new commercial or high-rise residential buildings, additions, and alterations meet the requirements of the IECC and ASHRAE Standard 90.1, as well as several state-specific codes.

amount of participation in the Program Area was disappointing, T.Y. Lin said that the services they offered did help CEOs with code compliance enforcement, and not just those CEOs who submitted plans for review: T.Y. Lin learned that CEOs share this information with other local jurisdictions. They also noted that local code chapters had monthly meetings to discuss the new code for up to six months after it went into effect.

The plan review services reached other professionals as well. Through providing the plan review services and helping CEOs gain permit approval, T.Y. Lin fielded many questions from design professionals. Additionally, the Rochester Home Builders Association recommended that homebuilders reach out to CEOs for copies of the plan review feedback, for their own education.

Plan Review Services Document Review

Throughout the course of two years, T.Y. Lin reviewed 78 residential plans for 50 unique projects and 74 commercial plans for 47 unique projects. Fifty-five CEOs in 36 jurisdictions used the services. Table 3-6 details the number of unique projects by sector and submission type.

Table 3-6. Number of Unique Projects Submitted for Plan Review Services, Energy Code Program Area

Projects	Residential	Commercial	Total
Resubmission	21	20	41
One-time Submission	29	27	56
Total	**50**	**47**	**97**

Residential Projects

At the time of the interview, T.Y. Lin had provided plan review services for single family and multifamily residential projects that included new construction, existing home renovations, and additions to existing homes. As Table 3-6 shows, there were 21 unique projects that were resubmitted at least once, with most projects taking either two or three submittals to substantially comply with the Energy Code. Table 3-7 summarizes the number of residential projects submitted and reviewed and shows the final outcome for each. There were 20 projects that T.Y. Lin recommended for re-submittal after one or more reviews and the CEO did not re-submit to T.Y. Lin for additional review.

Table 3-7. Final Outcomes for Residential Projects (n=50 total projects), Energy Code Program Area

Structure Type	Number of Unique Projects Reviewed	Number of Projects Recommended for Approval	Number of Projects Recommended for Conditional Permit	Number of Projects Recommended for Re-Submittal
Multifamily	10	3	3	4
Single Family	40	11	13	16
Total	**50**	**14**	**16**	**20**

Residential project compliance could be demonstrated in a variety of ways. Common ways included using 1) a software method such as DOE's REScheck[21] or REM/Design, 2) a trade-off method, 3) a prescriptive method, or 4) a performance method. The most common way used to demonstrate residential compliance in plans submitted for review was through REScheck Version 4.4.1.

Table 3-8 summarizes the deficiencies found in the residential building submittals. The most common problems T.Y. Lin identified during plan review services involved a lack of project documentation about fireplace compliance and issues related to REScheck documentation. For 15 projects, the necessary certificates and documentation to determine compliance with a portion of code were not provided. Often only the building envelope certificate was provided. In 11 instances, the project documents and drawings provided in plans were different than what was reflected in either the REScheck or REM/Design software.

Residential projects lacked other forms of documentation as well, such as construction drawings and documentation demonstrating Energy Code compliance (code section 103.2). As a general problem, the path for compliance was not always indicated (nine instances), and projects did not always have a signed statement from a design professional verifying that specifications included in the documents were correct (six instances). Many builders failed to provide documentation and specifications for fireplaces to show that they complied (20 instances; code section 303.1.5). All of these issues indicate a lack of builder awareness about the code compliance requirements.

Aside from not documenting compliance, residential builders also failed to meet certain code requirements. T.Y. Lin identified 14 projects as having inadequately designed slab and under-slab insulation or a lack of detailing of the slab-on-grade insulation. With regards to slab-on-grade insulation, T.Y. Lin recognized that this may be an area where the building community lacks awareness of what is specifically required by code, so they provided additional explanation in their review to help builders understand code sections 402.1.1 and 402.2.8.

Another code requirement that builders had a difficult time complying with was related to air sealing (code section 402.4.1), for which the builders did not show their methods of testing air sealing to prevent significant air leakages or did not provide air leakage test data (seven instances). T.Y. Lin was also concerned about the failure of builders to comply with ducts and air handler requirements (code section 403.2.2); in six instances, submissions showed either no insulation or no tightness test results for ductwork and air handlers. Some submissions failed to provide documentation showing that segments of the home (such as the pool and garage) also comply with code (four instances).

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[21] REScheck is a software package that the DOE developed to make it easier for CEOs, builders, and inspectors to determine code compliance. One of the features of REScheck software that is attractive to builders and CEOs is that it can quickly calculate the total heat loss of a building to determine compliance.

Table 3-8. Common Deficiencies for Residential Projects (n= 48 total projects), Energy Code Program Area

Most Common Problem Reviewed	Number of Projects with Deficiencies	Total Number of Applicable Projects
No documentation for fireplace compliance	20	N/A
Issues with REScheck documentation	15	48
Inadequate slab or under-slab insulation design	14	N/A
Compliance path not indicated	9	48
Lack of air leakage test data	7	47
No signed verification from design professional	6	48
Failure to comply with duct and air handler requirements	6	47
No documents showing compliance for home segments (i.e. pool, garage)	4	N/A

Note: Data were incomplete for two of the 50 projects. N/A indicates that it was not possible to determine how many buildings the measure with a common problem applied to.

There were 21 residential projects that included resubmittals. For 16 of those projects, the CEOs submitted documents exactly twice, and for the other five, they submitted documentation for plan review services three or more times. For the 21 projects that were submitted two or more times, seven resulted in a full permit and eleven resulted in a conditional permit recommendation. The remaining three were not provided with a permit. In some cases, projects that were recommended for a conditional permit were resubmitted, along with projects for which resubmittal was recommended. All but one of the five projects submitted more than twice resulted in a request for a resubmittal. The resubmittals followed a pattern of increased compliance from the first to subsequent submittals. The most resubmittal improvement occurred for projects where a builder or CEO lacked awareness about the Energy Code and the plan review service indicated a method for compliance. This was particularly true with regard to the specifications for fireplaces (code section 303.1.5). Table 3-9 shows these results.

Table 3-9. Resubmittals for Residential Projects (n=50 total projects), Energy Code Program Area

# of Times Submitted	Number of Projects	Projects Recommended for Approval	Projects Recommended for Conditional Permit	Projects Recommended for Resubmittal
1 or More	50	5	5	40
2 or More	21	7	11	3
3 or More	5	3	1	1

Commercial Projects

At the time of the interview, T.Y. Lin had provided plan review services for commercial projects that included new construction, existing building renovations, and additions to existing buildings. Out of the 74 commercial plans they reviewed covering 47 projects, 11 projects were approved for a permit, 10 were approved for a conditional permit, and 26 were recommended for resubmittal (Table 3-10). Overall, there were 20 unique projects with one or more resubmittals, with most of those projects taking three submittals to substantially comply with the Energy Code.

Table 3-10. Outcomes for Commercial Projects (n=47 total submittals), Energy Code Program Area

Structure Type	Number of Unique Projects Reviewed	Number of Projects Recommended for Approval	Number of Projects Recommended for Conditional Permit	Number of Projects Recommended For Re-Submittal
Existing Building	20	5	6	9
New Building	26	6	4	16
Unknown	1	0	0	1
Total	**47**	**11**	**10**	**26**

Compliance with the commercial code could be demonstrated in a variety of ways. Common ways included using 1) a software method such as DOE's COMcheck, 2) a trade-off method, 3) a prescriptive method, and 4) a performance method. The most common way commercial code compliance was demonstrated was through COMcheck, using version 3.8.1.

The most common problems T.Y. Lin identified for commercial projects during plan review were similar to those encountered with residential projects; the plan construction drawings and documentation did not demonstrate compliance (code section 103.2). There were 31 instances in which projects did not conform with this portion of code, either because not all of the information provided on COMcheck matched drawings or because the COMcheck information was incomplete or did not demonstrate compliance with the code. There were also 10 instances in which a design professional's verification of specifications for the building was not submitted. As with residential compliance, these deficiencies indicated a lack of awareness by builders about code compliance requirements.

In addition to the inadequate compliance documentation, there were a number of code deficiencies that related directly to building practices. The most common of these related to air seal testing and ensuring that there was a continuous air barrier in the building (19 instances; code section 502.4.3). Another common deficiency was missing vapor retarders (14 instances; code section 502.5). Other common deficiencies included inadequate duct insulation/sealing and/or missing related documentation (13 instances; code section 503.2.7) and missing documentation for exit signage/lights (12 instances; code section 505.4).

Table 3-11 shows how often various deficiencies were identified. There were also submittals with missing values for lighting controls and occupancy sensors (nine instances; code section 505.2), missing values for HVAC pipe insulation (11 instances; code section 503.2.8), and missing information or drawings for tandem wiring (nine instances; code section 505.3). Many of these deficiencies indicate that either designers or builders are not aware of the requirements of these portions of code, or that the building community has not changed practices to meet the requirements of the 2010 ECCCNYS. In either case, future training efforts should inform the building community about these requirements and the energy benefits associated with their implementation.

Table 3-11. Frequencies of Project Deficiencies for Commercial Building Projects (n=46 total projects), Energy Code Program Area

Most Common Problem Reviewed	Number of Projects with Deficiencies	Total Number of Applicable Projects
Issues with COMcheck documentation/verifying a compliance path	31	46
Air leakage documentation missing continuous air barrier/sealing methods	19	46
Missing vapor retarders	14	46
Inadequate duct insulation/sealing and/or missing related documentation	13	46
Missing documentation for exit signage/lights	12	46
Missing value for HVAC piping insulation	11	46
No signed verification from design professional	10	46
Missing lighting controls/occupancy sensors and related documentation	9	46
Missing information/drawings for tandem wiring	9	46

Note: Data were incomplete for one of the 47 projects.

CEOs resubmitted materials for plan review services for 20 commercial projects, with seven of those projects being submitted three or more times. Ten of the 20 projects submitted two or more times resulted in a full permit, and four resulted in a conditional permit recommendation. The remaining six were not provided with a permit. In some cases, projects that were recommended for a conditional permit were resubmitted, along with projects for which resubmittal was recommended.

For the seven projects submitted more than twice, all but one of the submissions resulted in a full permit (four) or conditional permit (two) being issued. The resubmittals demonstrated improvements from one submittal to the next. Improvements in resubmittals were most frequently related to compliance with HVAC piping requirements and inclusion of a vapor barrier. These improvements suggest that the building community may require technical trainings on the more complex aspects of the commercial code.

Table 3-12. Resubmittals for Commercial Project (n=47), Energy Code Program Area

# of Times Submitted	Number of Projects	Projects Recommended for Approval	Projects Recommended for Conditional permit	Projects Recommended for Resubmittal
1 or More	47	5	7	35
2 or More	20	10	4	6
3 or More	7	4	2	1

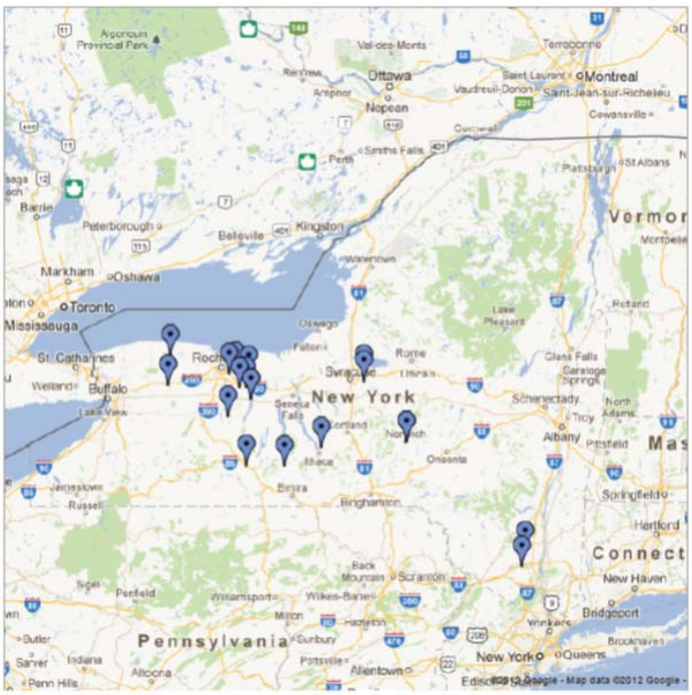
CEO Feedback on Plan Review Services

The Cadmus Team interviewed 19 CEOs representing 19 municipalities who received plan review services from T.Y. Lin. These interviews were conducted by phone between July 31 and August 6, 2012. The Team worked from a list of 19 CEOs that provided one-time submissions only and 18 CEOs that provided resubmissions for the plan review services offered by T. Y. Lin. The Cadmus Team contacted all 37 listed CEOs multiple times, unless they were going to be out of the office throughout the entire calling period. Table 3-13 shows the distribution of the interviewed CEOs by category. Figure 3-1 is a map showing the geographic distribution of the CEOs in New York that the Team interviewed. As shown, the majority are located in municipalities close to Rochester, where T.Y. Lin is headquartered.

Table 3-13. Number of CEOs Interviewed by Submission and Project Type, Energy Code Program Area

Projects	Residential Only	Commercial Only	Residential and Commercial
One-time Submissions	4	5	0
Resubmissions	4	4	2
Total	**8**	**9**	**2**

Figure 3-1. Distribution of Interviewed CEOs, Energy Code Program Area



The Cadmus Team initially thought that there might be some interesting differences in responses between CEOs who had single submissions for plan review assistance and those who made multiple submissions for the same project. Instead, there were few differences of note between these groups. For that reason, the following text concentrates mostly on results for CEOs as a group.

Background Information

As shown in Table 3-14, 16 of the 19 CEOs the Cadmus Team interviewed said they conduct both plan reviews and field inspections. The remaining three were managers who oversee plan reviews.

Table 3-14. CEO Roles, Energy Code Program Area

Do you conduct both plan review and field inspections?	Number of Responses
Yes	16
Not applicable (manager)	3
Total	**19**

The types of projects the CEOs we interviewed review tend to be residential. On average, CEOs reported that 88 residential projects and 25 commercial projects go through plan review in a typical year. There was a high degree of variability in the project counts among CEOs, ranging from one or two per office to as many as 300 residential projects and 57 commercial projects.

Participation and Awareness

When asked to indicate how they heard about the plan review services, the two ways most commonly mentioned by CEOs were through a building codes class (indicated by six of 19 CEOs) and an e-mail from NYSERDA (five of 19). Other ways mentioned were postcards from T.Y. Lin (three), the local building association (three), and miscellaneous other responses (three).

The reasons people decided to use the services are shown in Table 3-15. Most often, CEOs said the plan review service's availability and zero cost were the main reasons, but learning more about the Energy Code and T.Y. Lin's reputation and quality of work were also frequently mentioned.

Table 3-15. Why CEOs Used Plan Review Services, Energy Code Program Area (multiple responses)

Why did you decide to use these services?	Number of Responses
It was available/Free is good	6
Code complexities/To learn more about the Energy Code	4
T.Y. Lin's reputation/T.Y. Lin does excellent work	4
Like not adding to permit costs	1
Good opportunity	1
Second opinion is always good to get	1
Very busy, wear a lot of hats	1
Curiosity	1
Recommendation from another CEO	1

When asked if they were reluctant to use these services, 100% of CEOs (all 19) said no. This reflects the general high level of enthusiasm the participating CEOs had for the Program Area and its value to them in the plan review process.

Residential and Commercial Project Feedback

The Cadmus Team asked CEOs a set of questions specifically about their residential projects and another very similar set of questions about their commercial projects. When asked why they selected the projects they did for plan review assistance, CEOs with residential projects tended to mention curiosity about the Program Area or that they just wanted to try it (five of nine responses). CEOs with commercial projects tended to choose projects that were big, complex, or had technical difficulties that made the plan review assistance quite valuable to them. One CEO said he could not have accomplished his commercial project plan review without the plan review assistance. These responses are summarized in Table 3-16.

Table 3-16. Why CEOs Selected Projects for Plan Review Assistance, Energy Code Program Area (multiple responses)

Commercial Projects	Number of Responses	Residential Projects	Number of Responses
Big complex project/could not accomplish project without this help	5	Only house/first new home this year and was curious	2
Wanted to learn more	2	Thought would try it based on recommendation/meeting; curious	2
Would select every project if I could	1	Coincidental to timing of when Program Area was brought to my attention (curious)	1
TY Lin makes it easier/helps with work load	1	Gave us more time to assess other aspects	1
Free assistance	1	I would like to put all new buildings through it, but limited to 10 so have to pick and choose	1
Usually pick the larger projects for plan review assistance	1	So we would know it meets the current Energy Code	1
Technical difficulties with the project	1	To get familiar with what to look for on new codes	1

There was very little negative feedback about plan review assistance services. However, one CEO mentioned that it took three weeks to get documents back from the reviewers, which he felt was one week too long. One other CEO mentioned a similar concern about the time it took for the review.

CEOs mentioned a variety of significant issues that were identified by the plan reviewer. Heating vents and building envelope issues were identified on both residential and commercial projects. Unique to residential projects were four of the CEOs who made specific comments that the designer's plans and/or designer's knowledge indicated a lack of understanding of the Energy Code. One CEO said that *"most residential projects were like pulling teeth, the architect was not towing the line."* On the commercial side, the most significant issue found was an instance where the contractor had oversized the HVAC system. T.Y. Lin caught the error in their review. This would have had significant consequences for the client, and the CEO was clearly impressed that T.Y. Lin had found the error. Comments from CEOs who submitted a commercial and/or residential project are shown in Table 3-17.

Table 3-17. CEO Comments on Most Significant Issues Found by Reviewer, Energy Code Program Area (multiple responses)

Commercial Projects	Number of Responses	Residential Projects	Number of Responses
Heating vents	2	Architect conflicts/architects plans were insufficient	2
Insulation, air exchanges, HVAC, and/or taping around fenestrations	2	Building envelope	1
Building envelope	1	Lack of duct work or lack of drawing details	1
Energy related (not specific)	1	Small design changes such as infiltration	1
Fan motors	1	Overall tightness of homes	1
Load test (contractor had oversized the system)	1	Wrong REScheck for home	1
Nothing specific, they checked all alterations	1	Do not recall	2
They found that documents were not representative of actual drawings or not on COMCheck	1		
Do not recall	1		

CEOs made uniformly positive comments about the text portions of the plan review and the compliance checklists. There were no big differences between residential and commercial projects. CEOs tended to appreciate the easy-to-understand layman's terms used in the text portion of the review, and also found the checklists very helpful. One CEO was so enthusiastic that he discussed passing the checklist along to colleagues.

As shown in Table 3-18, CEO self-reported awareness of the residential and commercial energy codes did improve, on average, before and after using the plan review services. Two interviewees who categorized themselves as very knowledgeable said their awareness was about the same before and after, but all the other CEOs reported an increase in awareness, to varying degrees.

Table 3-18. Changes in Rating of Knowledge About Energy Code, Energy Code Program Area

On a scale of 1 to 10, where 1 is lowest and 10 highest, how would you rate your knowledge of the Energy Codes:	Residential Energy Code Awareness (average; n=9)	Commercial Energy Code Awareness (average; n=8)
Before plan review services	6.2	6.4
After plan review services	8.1	7.6

The Cadmus Team asked CEOs what the most useful things were they learned from residential and commercial plan review services. Responses were varied. Duct sealing and proper insulation techniques were mentioned for both residential and commercial projects. One CEO mentioned the failure of the contractor to properly insulate non-conditioned space on a residential project. He guessed that 50% of CEOs do not know about that requirement. On the commercial side, CEOs mentioned learning how to check for an oversized HVAC system. Three CEOs simply described it as a good overall learning experience.

Overall Feedback

All CEOs, except one who was not sure, said they had returned the plans to the project applicant after receiving plan review services. Nine of 19 specifically mentioned sending a letter out requesting that the project applicant make the necessary changes. CEOs generally reported that the requested changes or information needs were addressed. Several were clear in separate comments that the project applicant did not have a choice if they wanted a permit. There was consensus among CEOs that designers took the information more seriously than building owners, who may or may not build again.

When asked if there was anything T.Y. Lin or NYSERDA could do to improve plan review service communications, 15 of 19 said no. E-mails were mentioned as a great tool by one CEO. Another mentioned that T.Y. Lin or NYSERDA could offer continuing education classes. One CEO who was especially enthusiastic said NYSERDA should have a seminar or training class specifically about the plan review services. He had been trying to spread the word to other municipalities who were asking about the Program Area. This CEO thought a seminar or class could help other CEOs understand the value the Program Area offers.

Seventeen of 19 CEOs said they were very satisfied with the way plan review services were provided, with two others not responding to this question. This result reflects the high regard CEOs expressed for the service and the talents of T.Y. Lin.

Results were mixed when the Cadmus Team asked whether a similar service for inspections would be helpful. Six said yes, one said no, four said maybe, and five said they didn't know. Two CEOs thought NYSERDA was already funding such a service. One mentioned that T.Y. Lin had offered such a service, but he did not take them up on it. Two CEOs went on to provide additional comments, one saying, "*Instead of reviewing the plans, they should be teaching us how to review the plans*." The other said he already uses a third-party inspection service.

CEOs were pretty evenly divided when asked if they used the plan review service more as a learning tool or as a workload support tool. The largest group, seven of 17 who responded, said it was split 50-50 between being a learning tool and a support tool. Six said it was more of a support tool, while four of 17 said it was more of a learning tool for them. All CEOs said they would use the service if it was offered again.

CEOs made several miscellaneous comments at the end of the interview, all centering on their positive reaction to the Program Area. Typical comments were "*Can't say enough good things about it; I am very happy with T.Y. Lin*" and *"It's an asset to any code official, they would be foolish not to utilize it."*

Finally, we received one additional comment by phone two weeks after the interviews ended. One of the CEOs called back to say, "*If I could tell you anything that would help us (CEOs) the most, it would be to educate the design professionals. We can educate the contractor in the course of permit review and then later in the field, but if we have to educate the design professionals as well, it makes our job much harder."* This comment echoes extemporaneous comments made by other CEOs during the interviews, such as "*NYSERDA should be targeting the architects and engineers for code training*," and "*The designers are the ones with the advanced degrees, they should be keeping up with the code changes*." It is important to note that NYSERDA did offer the services to designers and builders and was unable to get any to sign up.

3.1.4 Program Area Savings Assumptions

Further Information can be found in the *Early Building Energy Code Adoption Report* included as Appendix F.

3.1.5 Gross Savings Calculations and Findings

In addition to estimating the savings from increased compliance due to the Energy Code Program Area, the Cadmus Team recommended calculating the energy savings that could be attributed to the adoption of the Energy Code in response to ARRA. The Pacific Northwest National Laboratory (PNNL) developed state and national energy-savings estimates for the residential and commercial building codes, indicating that NYSERDA could submit a request to DOE for PNNL to perform specific analyses for New York. The Cadmus Team worked with NYSERDA to request that PNNL perform a portion of the gross energy saving analysis. However, due to federal budget constraints, the request was denied and the analysis could not be completed. Thus, the Cadmus Team calculated gross energy savings values using DOE prototypical models, in conjunction with residential and commercial construction forecast data. The analysis of the gross energy savings from early code adoption is reported in Appendix F. This effort was supported with non-ARRA funds.

Table 3-19 summarizes the energy savings results the Cadmus Team estimated are due to early adoption of the residential and commercial building energy codes. These estimates are annual savings for all the structures built, including commercial additions, during the period when the ARRA requirement to adopt energy codes affected which code was in effect in New York.

Table 3-19. Annual Energy Savings Due to Early Code Adoption, Energy Code Program Area

Building Type	Count	Assuming 100% Compliance		Applying Assumed Compliance*		
		Therm Savings	MWh Savings	Compliance Adjustment	Therm Savings	MWh Savings
Residential	11,038 Homes	3,784	748	64%	2,422	479
Commercial, New	49,813,000 Square Feet	1,808,114	19,088	36%	650,921	6,872
Commercial, Additions	10,115,000 Square Feet	550,321	5,069	36%	198,116	1,825
Totals		**2,362,219**	**24,905**	N/A	**851,459**	**9,176**

* Assumed compliance is based on results of a 2011 study conducted for NYSERDA by VEIC. The compliance estimates are subject to considerable uncertainty, given the scope of the study, and should be considered only indicative of the likely compliance rate.

3.1.6 Net Savings Calculations and Findings

There is no net-to-gross (NTG) component of the Energy Code Program Area evaluation. Further information can be found in the *Early Building Energy Code Adoption Report* included as Appendix F.

3.2 ENERGY-EFFICIENCY PROGRAM AREA

3.2.1 Data Sources

The Cadmus Team used the following data sources to evaluate the Energy-Efficiency Program Area:

- NYSERDA Program Area staff interviews to understand Program Area design, targets, and goals
- Participant surveys to measure Program Area attribution and participation satisfaction
- Participant project data to calculate the realization rate and estimated energy savings
- Site visits and engineering estimates to collect measurements to determine actual energy savings

There were a total of 69 energy-efficiency RFP 10 projects. The Cadmus Team divided those projects into three sub-groups, those for which the Team reviewed savings calculations (file review), those for which the Team conducted a file review and site visit, and those for which no action would be taken.

In total, the Cadmus Team provided some form of review for 45 of the 69 projects, or approximately 65% of available projects. Table 3-20 summarizes the status of the original 69 projects.

Table 3-20. Quantity of Evaluations by Evaluation Type, Energy-Efficiency Program Area

Project Status	Number of Projects
RFP 10 Projects	**69**
Projects Receiving Evaluation File Review Only	20
Projects Receiving Evaluation File Review and Site Visit*	25
Total Projects Evaulated	**45**
Percentage of Projects Evaluated	**65%**

* The Team conducted attribution surveys with key personnel at 14 of the site-visited projects.

3.2.1 Approach: Surveys and Sample Design

Participant Surveys

The original attribution sample design called for surveying every site visited (n=25) for the evaluation, measurement, and verification (EM&V) study. However, the Cadmus Team's prior experience with the SEP evaluation (for RFP 1613) made clear that the best person to answer the survey was not usually present during the site visit. Therefore, for this EECBG evaluation, the Cadmus Team fielded an electronic survey, and key personnel from the site completed the survey online after the site visit occurred. At the time of this report, the Cadmus Team had secured surveys for 14 of the 25 site-visited projects. The total expected energy savings from these 14 projects is 15,554 MMBtu, or approximately 21% of the total Program Area savings. Due to the relatively small number of random surveys included in this sample, the data are not weighted.

NYSERDA Program Area Staff Interviews

The Cadmus Team interviewed four NYSERDA Program Area management staff to understand the Energy-Efficiency Program Area design and implementation, as well as Program Area difficulties and successes. The interviews focused on the Program Area implementation: timing, problems encountered, the application process, what worked well, suggestions for improvements, how the ARRA requirements affected the Program Area design, Program Area marketing, and stakeholder feedback received.

Site Visits and Engineering Estimates

The Cadmus Team conducted site visits at a representative sample of completed projects to determine the accuracy of Program Area information, in particular the estimated annual energy savings. To develop the sample, the Cadmus Team developed a stratified distribution of projects based on the savings of each project. The Team automatically selected the 10 projects with the largest savings, then selected 15 more sites at random. The Team assigned field inspectors with technical backgrounds in energy efficiency to each site, where they investigated factors such as the:

- Inventory of equipment installed
- Inventory of equipment replaced
- Physical system characteristics (size, load, capacity, etc.)
- System operational history and downtime, if applicable

Field inspectors conducted interviews with the project system owners to gather data on these factors. They generally assessed system characteristics visually. They collected other characteristics on-site, such as nameplate values and instantaneous measurements (voltage, amperage, etc.), through spot metering and measurement.

System Performance Monitoring

The Cadmus Team supplemented site visit data with M&V efforts. Specifically, the Team installed data acquisition systems (DASs) on select systems in order to estimate energy savings. This additional step was an important element of the evaluation process, as some systems do not have stand-alone metering capability. Where sufficient metering capability existed, the Cadmus Team requested trend data from the system owner.

3.2.2 Process Findings

Program Area Implementation and Process

NYSERDA began developing the Program Area plan about a month in advance of the March 2009 submission deadline with the DOE, and they shaped some of the specifics in the Program Area plan based on suggestions contained in DOE guidance documents. The plan was approved in June 2009.

Program Area participants are required to register for a project number and then complete their registration on the Central Contractor Registry (CCR) Website. Participants can submit their project proposals to receive funding for up to 100% of the project costs. NYSERDA staff reported that 70% to 80% of the proposals that are not ultimately awarded EECBG funding are viable projects that they refer to another existing NYSERDA program. At any given time, Program Area staff estimated that each project manager oversees around one-third of the 20 projects being managed by the Program Area implementation contractors.

Upon receiving a proposal, staff enter basic information in a tracking system, such as customer name, region, and project cost, before electronically sending the proposal to the Program Area implementer for Level 1 and Level 2 engineering reviews. The Level 1 review consists of a junior engineer conducting a preliminary verification of completion and a check of reasonableness. This is followed by a Level 2 review, during which a senior engineer performs a 30 minute to two hour review of technical documentation. On average, the engineering reviews are completed within 20 days of the proposal being received.

Once the review process is complete, NYSERDA Program Area staff begin the technical evaluation panel (TEP) process. They rank proposals on a point system using scoring criteria outlined in the original RFP. They use a limit of $2,000 for every 10 MMBtu as a guide for allocating the NYSERDA Program Area portfolio. They encourage and reward cost sharing and dedicating a project manager to oversee the project, but these are not required. Staff give preference to shovel-ready projects that are poised to begin immediate construction. They exclude proposals receiving funding from another utility, another NYSERDA program, SBC, or LIPA.

If alternative funding sources are not clear from the original proposal, Program Area staff explicitly request that information on the award contract, which asks participants to list other sources of funding. Projects can leverage other ARRA dollars, but are then not eligible for cost-sharing points in the proposal scoring system. Furthermore, projects that already began construction or are already completed are ineligible for funding. On average, the TEP takes between one and two weeks.

Although the engineering review processes are fairly thorough, all proposals that are awarded funding are required to complete a project design review. The NYSERDA Program Area staff ask participants to submit preliminary detailed estimates, depending on the project, which are reviewed by one of the Program Area implementers. As the projects begin the bidding processes, the Program Area implementer conducts a second review to verify that the project scope remained the same as proposed.

These design review processes sometimes lead to contract changes being initiated by the Program Area implementers, who then forward the change information to NYSERDA project managers for review. Further due diligence occurs with pre-, post-, and in-construction site visits, when implementers take photographs to track progress and ensure that measures were not pre-installed.

The Program Area implementers are required to complete at least one site visit for smaller projects, and multiple site visits for projects with larger funding amounts. Additionally, DOE project officers inspect 10% of the projects for performance monitoring. Once a project is complete, the Program Area implementer performs a final review for Buy American,[22] which includes a final on-site inspection, a review of product serial numbers and operating hours, and a post-inspection report.

Interviewed Program Area staff reported that nearly all the participants are taking advantage of the progress payment plans. These payment plans are intended to accelerate the dispersal of ARRA funds to more rapidly spur economic growth. Instead of waiting until project completion to make a lump-sum payment, whenever the construction reaches one of several milestones, Program Area staff issue a payment in proportion to the amount of work that has been completed. According to Program Area staff, they provide 20% to 30% of the funding when the vendor contract is signed. They provide another 20% to 30% when the equipment is delivered on the site. They make subsequent payments when 50% of the installation is complete, and again when 100% of the installation is complete.

Program Area staff mentioned that this process may be changing due to participants and vendors agreeing to streams of payments during the initial bid that were incompatible with the milestone payment plans, ultimately making some projects unviable. Program Area staff reported that the progress payment plans are, at times, a source of delay or participant frustration. However, they also reported that participants usually appreciate the flexibility of the payment plan and understand the merits of having a staggered process. As several of the projects in this Program Area were very small, for example, less than $10,000, some projects received only one payment.

[22] The following Website provides detail on the Buy American legislation: http://www.opencongress.org/bill/112-h2722/text (accessed April 18, 2012). In short, the legislation sought to ensure that purchases of goods funded by ARRA monies were manufactured in the United States, in order to maximize the domestic jobs impact of those dollars.

Program Area Challenges

The Cadmus Team asked NYSERDA staff what aspects of the Program Area do not work well. They speculated that an open enrollment process may increase the speed of project deployment compared to the competitive selection process. Other staff conceded that it would have been difficult for NYSERDA to enter into any substantial renovation projects prior to DOE finalizing the massive changes they issued through April 2011, even if there had been an open enrollment process.

Staff also mentioned the CCR registration process as being a Program Area challenge. Since this system is entirely new, every participant across the nation has to register, resulting in the CCR Website being overwhelmed and crashing on multiple occasions. Since the Program Area staff have no jurisdiction over the CCR Website, they are unable to assist participants through any difficulties during this step of the process. Staff reported that this technological hurdle does not cause anyone to not participate, but it does cause a lot of frustration.

A third Program Area challenge staff mentioned was that the paperwork is significant and tedious. They estimated that ARRA has three to five times the amount of paperwork of a normal SBC program. For example, the Buy American requirements[23] for New York State are that New York projects have a letter from the manufacturer that includes a serial number and signature.

Program Area Strengths

The Cadmus Team asked NYSERDA Program Area staff what aspects of the Program Area work well. The staff agreed that it is extremely helpful to have everything electronic, which makes the administrative aspects of the Program Area very efficient. The staff also reported that the streamlined and standardized engineering review and TEP processes (that were used in both the SEP and EECBG-funded Program Areas) are very efficient and effective: "*Having the math laid out in a pre-set format, always presented in a similar manner, allowed the TEP process to run a lot faster*."

Program Area staff are also pleased with their decision to add selection criteria to the competitive bid process, such as environmental justice, climate registry, climate smart communities, and portfolio managers. They stated that these added measures spurred a noticeable amount of activity and instigated more participation.

Participant Survey Findings

The main purpose of the attribution survey was to collect data necessary for the Cadmus Team to estimate freeridership and net savings resulting from the NYSERDA ARRA Energy-Efficiency Program Area. However, the Team also used the survey to explore key process questions, such as sources of information about the Program Area, the application process, and ease of participation, each of which are summarized below. The remainder of the attribution survey is outlined in Appendix H, which summarizes the awareness, motivation, economic factors, alternative funding, and spillover characteristics of participants in the Energy-Efficiency Program Area.

Program Area Awareness and Motivation to Participate

As shown in Table 3-21, respondents learned about the Energy-Efficiency Program Area in a variety of ways. A large proportion heard about it through NYSERDA sources, with two respondents (14%) having seen the Program Area on the NYSERDA Website, two (14%) having learned of the Program Area through marketing materials, and one (7%) citing Program Area outreach sessions as their source of

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[23] Page 28 of RFP 1613: http://www.nyserda.ny.gov/~/media/Files/FO/Closed%20Opportunities/2009/1613rfp.ashx?sc_database=web.

awareness. In addition, two respondents (14%) cited hearing about NYSERDA ARRA through NYSERDA's FlexTech Program, and two others (14%) noted participating in an unspecified NYSERDA program. Word-of-mouth (n=3; 21%), as well as contractors and installers (n=2; 14%), were also important sources of awareness. These findings support a strategy of maintaining multiple channels of marketing for future NYSERDA programs, as the NYSERDA ARRA Program Area funding is no longer available.

Table 3-21. How Participants Heard about Energy-Efficiency Program Area (multiple responses)

Sources of Awareness	Responses
Sample size	*14*
Word-of-mouth (colleague, friend, family member)	21% (3)
Contractor/installer	14% (2)
NYSERDA Website	14% (2)
Through NYSERDA's FlexTech Program	14% (2)
Participation in another NYSERDA program	14% (2)
Program Area marketing materials	14% (2)
Program Area outreach sessions	7% (1)
Story in the media	7% (1)
Grant consultant	7% (1)
Town grant writer	7% (1)
Consulting architect	7% (1)
Online (unspecified)	7% (1)
Seminar	7% (1)
Don't know/refused	14% (2)

Note: Total may not equal 100% due to rounding and multiple responses. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

The Cadmus Team asked respondents why they decided to apply for NYSERDA funds to implement the project. As shown in Table 3-22, a substantial proportion of respondents (n=5; 36%) indicated that their budgets could not accommodate the work without the ARRA funding. Other reasons for applying for the funds included the need for more efficient equipment (n=2; 14%), to save energy (n=2; 14%), and to reduce the burden on local taxpayers of paying for such projects (n=2; 14%).

Additional reasons, each cited by one respondent (7%), were to implement the first efficiency project for county buildings, to reduce energy costs for the facility, because they always seek grants, and because a consultant architect suggested applying. These findings suggest that, as the Program Area theory anticipated, many participants turned to NYSERDA ARRA to fund projects that may not have otherwise moved forward without the Program Area. However, other participants voiced reasons for applying to the Program Area that provide less clarity regarding whether the project would have moved forward without NYSERDA ARRA funds.

Table 3-22. Why Applied for NYSERDA Funds (multiple responses), Energy-Efficiency Program Area

Reason	Responses
Sample size	*14*
Could not afford the project without funding	36% (5)
Need for more efficient equipment	14% (2)
To save energy	14% (2)
Didn't want to burden local taxpayers	14% (2)
To implement the first efficiency project for all county buildings	7% (1)
Consulting architect who performed efficiency study suggested applying	7% (1)
Always seeking grants (in general)	7% (1)
To reduce energy costs	7% (1)

Note: Total may not equal 100% due to rounding and multiple responses. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

When planning this evaluation, NYSERDA Program Area staff wanted to know if the source of the funds—the national ARRA legislation—enticed people to apply to the Program Area. The ARRA legislation had received a great deal of media coverage, being presented as a way to create jobs and end the recession. NYSERDA thought that the media attention and support for the goals of the broader ARRA legislation may increase interest in the Program Area. Therefore, the Cadmus Team asked respondents whether the fact that the funds were provided by ARRA affected their decision to apply for NYSERDA funds, using a scale from 1 (indicating that it was a critical negative factor) to 5 (indicating it was a critical positive factor). Table 3-23 shows that 43% (n=6) of the respondents said that the fact that AARA provided the funds was not a factor at all in applying, while the remaining respondents said it was either somewhat of a positive factor (n=4; 29%) or a critical positive factor (n=4; 29%) in applying. The results indicate that the source of the funds was of moderate importance to some participants, and none viewed the fact that the funds came from ARRA as a negative factor.

Table 3-23. Influence of ARRA Funding on Decision to Apply for NYSERDA Funds, Energy-Efficiency Program Area

Influence	Responses
Sample size	*14*
Mean	3.9
1 Critical negative factor	0% (0)
2 Somewhat of a negative factor	0% (0)
3 Not a factor at all	43% (6)
4 Somewhat of a positive factor	29% (4)
5 Critical positive factor	29% (4)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

The NYSERDA ARRA funds were meant to be distributed quickly, and NYSERDA said that some participants may have applied for the funds because they offered a way to implement planned energy-efficiency projects on a shorter timeframe than waiting for other sources of funding to manifest.

The Cadmus Team gauged the effect of the NYSERDA fund timing on the decision to apply for funds by asking respondents, "*To what extent was your decision to apply for funds from NYSERDA affected by* *when the funds would become available?*" (Table 3-24). Respondents rated the influence of the fund timing on the same 1 to 5 scale as in the previous question. Half of the respondents (n=7; 50%) said that the timing was not at all a factor in their decision to apply, while 43% (n=6) said the timing was a positive factor. None of the respondents indicated that the timing was a negative factor in applying for the funds. These findings suggest the timing of the funds was of only moderate importance in respondents' decisions to apply for NYSERDA ARRA funds.

Table 3-24. Influence of NYSERDA Funds Timing on Decision to Apply, Energy-Efficiency Program Area

Influence	**Responses**
Sample size	*14*
Mean	3.5
1 Critical negative factor	0% (0)
2 Somewhat of a negative factor	0% (0)
3 Not at all a factor	50% (7)
4 Somewhat of a positive factor	36% (5)
5 Critical positive factor	7% (1)
Don't know/refused	7% (1)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

In an effort to understand whether prior participation in other NYSERDA programs influenced participation in the Energy-Efficiency Program Area, the Cadmus Team asked the respondents a series of questions about their prior experiences with NYSERDA programs. The first question in this series asked respondents to relate whether they had previously participated in any other NYSERDA energy efficiency, energy conservation, or renewable energy programs. As shown in Table 3-25, over one-quarter of respondents (29%) reported that they had.

Table 3-25. Previous Participation in Other NYSERDA Energy Efficiency, Energy Conservation, or Renewable Energy Programs, Energy-Efficiency Program Area

Participation in Another NYSERDA Program	**Responses**
Sample size	*14*
Yes	29% (4)
No	50% (7)
Don't know/refused	21% (3)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

The Cadmus Team then asked the four respondents who reported having previously taken part in other programs to describe the type of prior program in which they had participated. Table 3-26 shows that some of these respondents had participated in multiple programs of various types. Three respondents had participated in an energy audit, while one each had participated in programs involving incentives for replacing equipment, new construction, and renewable energy. Therefore, although only four of the 14 respondents had taken part in prior NYSERDA programs, these four respondents appeared to be committed to making energy efficiency and renewable energy improvements with NYSERDA support.

Table 3-26. Types of NYSERDA Programs in Which Respondents Had Participated (multiple responses), Energy-Efficiency Program Area

Influence	Responses
Sample size	*4*
Energy audit	75% (3)
Equipment replacement incentive	25% (1)
New construction	25% (1)
Renewable energy	25% (1)

Note: Base is respondents who had previously participated in other NYSERDA programs.

Note: Total may not equal 100% due to rounding and multiple responses. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

Using a scale from 1 (indicating a negative influence) to 5 (indicating a positive influence), the four respondents who had participated in other NYSERDA programs indicated the type and extent of influence their experience with those programs had on their decision to apply for NYSERDA ARRA funding. As shown in Table 3-27, two of these respondents indicated that the prior programs positively influenced their decision to apply for NYSERDA funds (i.e., gave a rating of 5), while two respondents said that their past experience with NYSERDA programs had no influence on their decision. These findings indicate that other NYSERDA programs induced at least some informal spillover to the NYSERDA ARRA Program Area, but the sample size of only four respondents is too small to reflect conclusive evidence of spillover.

Table 3-27. Influence of Past NYSERDA Program Experience on Decision to Apply for ARRA Funds, Energy-Efficiency Program Area

Influence	Responses
Sample size	*4*
Mean influence rating	4.0
1 Negatively influential	0% (0)
2 Somewhat negatively influential	0% (0)
3 Not at all influential	50% (2)
4 Somewhat positively influential	0% (0)
5 Positively influential	50% (2)

Note: Base is respondents who had previously participated in other NYSERDA programs.

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

NYSERDA also wanted to understand if the measures installed through NYSERDA ARRA had been recommended in prior programs, especially the FlexTech and Technical Assistance programs or the NYSERDA ARRA-funded Energy Conservation Studies (ECS) Program Area. Therefore, the final question the Cadmus Team asked about prior participation was whether the measures installed through the current Program Area had been recommended in a previous NYSERDA energy-efficiency audit or study (Table 3-28). One of the four respondents who had previously participated in prior NYSERDA programs responded affirmatively, specifying that the measures were recommended by the PON 4 Program. While the Program Area theory predicted that NYSERDA ARRA would provide a source of funds for participants to implement measures recommended in prior studies, it appears that this has not generally been the case.

Table 3-28. Whether Installed Measures Were Recommended in Previous NYSERDA Audit or Study, Energy-Efficiency Program Area

Whether Installed Measures Through Current Program Area were Recommended in Previous NYSERDA Study or Audit	Responses
Sample size	*4*
Yes	25% (1)
No	75% (3)

Note: Base is respondents who had previously participated in other NYSERDA programs.

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

3.2.3 Program Area Savings Assumptions

The Cadmus Team completed an engineering analysis of gross energy savings for the energy-efficient technologies included in this evaluation, as described below. The Team monitored systems receiving performance measurement according to IPMVP Option A or Option B-Retrofit Isolation methodologies, as outlined in IPMVP's *Guidelines for Development and Approval of Custom Measure Protocols*, depending on the variability of the measures installed for the project. For measures such as lighting, where the power draw was readily observable, the Team measured variable parameter (e.g., hours-of-use).

For more variable measures such as HVAC, the Team measured all parameters impacting energy consumption.

Lighting

IPMVP Option and Measurement Boundary

Table 3-29 shows the measure description and planned assessment protocol for lighting retrofit measures.

Table 3-29. Energy Conservation Measures and Selected Protocols for Lighting Retrofit Measures, Energy-Efficiency Program Area

Protocol	Collected Data	Explanation
IPMVP Option B	Occupancy rates and hours of operation via light logger deployment and engineering/statistical methods; fixture and lamp counts via participant surveys, on-site verification, and statistical methods; and lamp power data via engineering/statistical methods (no power logger deployment).	Energy and demand savings were calculated from known and measured wattages and measured hours-of-use. Impacts beyond boundary (i.e., cooling savings) were estimated using standard factors.

Baseline and Reporting Periods

The baseline is the time period prior to installing the energy conservation measure (ECM), within reasonable limits for the purposes of analysis. It represents the period in which the existing measures were in place. For example, for a project in which ECM lighting replaces existing lighting measures, the Cadmus Team would use the existing energy consumption when the existing lighting measures were in place as the baseline. The reporting period is the time after ECM installation when project/site conditions are observed and/or measured (as outlined in Table 3-30).

Table 3-30. Baseline and Reporting Schedule for Lighting Retrofit Measures, Energy-Efficiency Program Area

Baseline Period	Reporting Period
Collect all available data from project files, customer interviews, and site verifications	Lasted four to 12 weeks (summer/fall 2011) where available

Calculations and Adjustments: Savings Analysis Procedure

The Cadmus Team calculated the electrical energy savings resulting from the implemented ECMs according to Equation 3-1.

Equation 3-1. Lighting Energy Savings, Energy-Efficiency Program Area

$$\textit{Energy Savings} = \sum \left[\left(\left(\frac{Demand}{fixture} \times \textit{Fixture Quantity} \right)_{baseline} - \left(\frac{Demand}{fixture} \times \textit{Fixture Quantity} \right)_{reporting} \right) \times \textit{Fixture Operating Time} \right]$$

In Equation 3-1, energy savings are expressed in kWh, demand is expressed in kW, and operating time is defined as the number of hours.

The Team calculated the electrical demand savings resulting from the implemented ECMs according to Equation 3-2.

Equation 3-2. Lighting Demand Savings, Energy-Efficiency Program Area

$$\textit{Demand Savings} = \sum \left[\left(\left(\frac{Demand}{fixture} \times \textit{Fixture Quantity} \right)_{baseline} - \left(\frac{Demand}{fixture} \times \textit{Fixture Quantity} \right)_{reporting} \right) \right]$$

For projects where the necessary information was available, the Team applied a seasonal operational characteristics demand savings adjustment. Since the reporting period does not encompass an entire year, the Team calibrated data based on seasonal business hours or other information advised during the customer interview.

The Cadmus Team also used billing analysis to calculate savings or to supplement engineering calculations. This was considered for every project and used at the discretion of the verification engineer.

Measurement Specifications, Responsibilities, and Accuracy

Spot Measurements

The Team collected data for various parameters on an intermittent (spot) basis. The Team used these data to confirm baseline or reporting conditions if presumed static (meaning that the measured value remained constant and did not require data logging), to check data from alternative sources, or to diagnose equipment status and configuration. Table 3-31 outlines the parameters of interest and their corresponding measurement tools.

Where equipment operation was automatically controlled according to a fixed and readily verifiable schedule, no measurements were required to determine the annual operating hours. In other cases, the Team monitored the operating hours.

Table 3-31. Measurement Equipment and Configuration, Energy-Efficiency Program Area

Parameter	Data Source	Sensor	Measurement Range
Fixture Count	Manual	N/A	N/A
Light Level Output	Extech model #HD450	Light sensor	1 to 4,000 Fc; ± 5% of reading

Note: All tools, loggers, and sensors listed in the table are examples and may have been changed to an equivalent alternative.

Metering

To collect data for various parameters of interest, the Team spot-metered, metered on the day of a site visit, or installed and left meters in place. This collection often coincided with the baseline and/or reporting periods, and was continuously sampled at regular intervals to facilitate modeling complex measure data. The Team used these data to monitor baseline or reporting conditions (if presumed dynamic) and to check data from alternative sources.

The variables the Team measured for each site were generally the same, but the following various methods were used to obtain the metered data:

- Data loggers and appropriate measurement device (e.g., current transducer, temperature probe, light status)
- Energy management system (EMS) trending
- Lighting panel spot measurements or metering

The Cadmus Team performed a file review of each project in the selected sample and determined the data gathering method based on collecting data to specify the assumptions made in the original savings estimates. For example, if hours-of-use was a primary assumption of the original savings calculations, the Team would seek to collect data to better define the true usage. Table 3-32 shows parameters of interest and the associated metering equipment.

Table 3-32. Metering Equipment and Configuration, Energy-Efficiency Program Area

Parameter	Data Source	Interval
Light Level Output (runtime)	Dent Light Logger	1 second
Occupancy Sensor	WattStopper	constant

The Cadmus Team thoroughly reviewed modeling and baseline calculations for accuracy and to ensure that standard engineering practices were followed. The Team adjusted the models, as needed, to account for any recorded discrepancies between the model and actual system installed.

Metering Accuracy

The lighting logger accuracy is detailed in Table 3-26 above (± 5% of reading). The overall accuracy of the calculated data was driven by the measured variable with the widest range of accuracy.

HVAC

IPMVP Option and Measurement Boundary

Table 3-33 shows the description and implemented assessment protocol for HVAC measures.

Table 3-33. Energy Conservation Measures and Selected Protocols for HVAC Measures, Energy-Efficiency Program Area

Protocol	Collected Data	Explanation
IPMVP Option B	Example for pre- and post-ECM. System size, nameplate data, hours of operation, cooling load, setpoints, kW, and TMY2 weather data for bin analysis.	Energy and demand savings were calculated from verified measured usage data. Other pertinent factors, such as refrigerant charge and airflow, were confirmed.

Baseline and Reporting Periods

The baseline is the time period prior to installing the ECM, within reasonable limits for the purposes of analysis. The reporting period is the time after ECM installation when project/site conditions are observed and/or measured (as outlined in Table 3-34).

Table 3-34. Baseline and Reporting Schedule for HVAC Measures, Energy-Efficiency Program Area

Baseline Period*	Reporting Period**
Collect all available data from project files, EMS trend data, customer interviews, and/or site verification	Lasted four to 12 weeks (summer/fall 2011), depending on data availability

* The measurements taken during the baseline period were subject to availability. For projects implemented during the winter months, the Team may not have recorded valid metering data due to the absences of an adequate cooling load and runtime over a representative sample of temperature bins.

** For all sites evaluated, the Team made efforts to obtain a valid sample of metered data during the peak and swing temperature bins.

Calculations and Adjustments: Savings Analysis Procedure

The Cadmus Team calculated the electrical energy savings resulting from the implemented ECMs according to Equation 3-3.

Equation 3-3. HVAC Energy Savings Calculation, Energy-Efficiency Program Area

$$\text{Energy Saved (kWh)} = (\text{kWh}_{base}) - (\text{kWh}_{post})$$

Where:

kW_{base} = Metered or calculated baseline kW

kW_{post} = Metered reporting period kW

The Team compared the baseline energy consumption and efficient system energy consumption over the same conditions. The methods for adjusting this are discussed in the next section.

The Team used Equation 3-4 to estimate savings based on the energy-efficiency rating (EER) of the HVAC system, which is temperature dependent. For these calculations, the Cadmus Team used measured data to estimate energy consumption for each hour of the entire year using the average temperature from that hour.

Equation 3-4. EER-Based Energy Savings Calculation, Energy-Efficiency Program Area

$$\Delta kWh_i = Energy\ use_i \times \frac{EER_{ee}(T)}{(EER_{base}(T))} - Energy\ use_i$$

Where:

ΔkWh_i	=	Energy saved at each hour
$Energy\ use_i$	=	Energy consumption (either metered or modeled)
$EER_{ee}(T)$	=	EER of the new, high-efficiency equipment as a function of outdoor dry bulb temperature
$EER_{base}(T)$	=	EER of the baseline equipment as a function of outdoor dry bulb temperature

The Team used Equation 3-5 to calculate demand savings.

Equation 3-5. HVAC Demand Savings Calculation, Energy-Efficiency Program Area

$$\text{Demand Saved (kW)} = kW_{base} - kW_{post}$$

Basis for Adjustment

Two types of adjustments were required for HVAC measures:

1. Extrapolation of meter data to estimate yearly energy use
2. Normalization of energy savings to adjust for year-to-year differences in weather

When EMS data were not available, the Team metered systems over a period that included a full range of ambient conditions (outdoor temperature and relative humidity). The Cadmus Team used a sufficient metering period that covered the range of ambient conditions in order to develop a model. The Team used cooling degree days (CDDs), heating degree days (HDDs), or enthalpy (a function of temperature and relative humidity) to develop the relationship between energy consumption and ambient conditions.

Since outdoor conditions often have a buildup effect, the Team used an enthalpy buildup to model energy consumption. Enthalpy buildup is similar to the weighted temperature humidity index (WTHI) used by many utilities. Enthalpy is preferred over WTHI because the model is calibrated to match the metered data for each site (and different facilities have different heating and cooling characteristic). The Team used these methods to estimate the yearly energy use of the efficient measure and baseline measure.

When the Team calculated energy savings from metered data, the savings were normalized to account for year-to-year weather differences. This was accomplished by multiplying the savings by the ratio of CDDs or HDDs for the year by the CDDs or HDDs of an average typical meteorological year (TMY).

Where HVAC measures were installed on a process-based system, such as a data center or industrial process, the Team extrapolated savings by following the process requirements.

Measurement Specifications, Responsibilities, and Accuracy

Spot Measurements

The Team collected data for various parameters on an intermittent (spot) basis. The Cadmus Team used these data to confirm baseline or reporting conditions if presumed static, to check data from alternative sources, and to diagnose equipment status and configuration. Table 3-35 outlines the parameters of interest and their corresponding measurement tools.

Where equipment operation was automatically controlled according to a fixed and readily verifiable schedule, no measurements were required to determine the annual operating hours. In other cases, the Team performed monitoring of the operating hours as shown in Table 3-35.

Table 3-35. Measurement Equipment and Configuration, Energy-Efficiency Program Area

Parameter	Data Source	Sensor	Measurement Range
Unit Count	Manual	N/A	N/A
Unit Power (kW)	Amprobe ACD-31P or Fluke 41b	Clamp meter and test leads	Range/accuracy: 0 kW to 600.0 kW; ± (2.0% of reading + 6 LSD) @ Harmonics Fund to 10th and PF > 0.7
System Setpoints	Site inspection/interview	EMS data	N/A
Hours of Operation	Site inspection/interview	EMS trend data	Data were verified with a spot measurement
Air Flow	Spot measurement	a) True flow grid b) DG 700 manometer c) Anemometer traverse (where flow grid was not appropriate)	Accuracy: ± 7%

Metering

To collect data for various parameters of interest, the Team spot-metered, metered on the day of a site visit, or installed and left meters in place. This collection often coincided with the baseline and/or reporting periods, and was continuously sampled at regular intervals to facilitate modeling complex measure data. The Team used these data to monitor baseline or reporting conditions (if presumed dynamic) and to check data from alternative sources.

The variables the Team measured for each site were generally the same, but the following various methods were used to obtain the metered data:

- Data loggers and appropriate measurement device (e.g., current transducer, temperature/relative humidity sensor, anemometer)
- EMS trending (when available)
- Variable frequency drive (VFD) panel readings (when available)
- Appropriate independent variable measurement including airflow and hours of operation

The Cadmus Team performed a file review of each project in the selected sample and determined the data gathering method. Table 3-36 shows parameters of interest and the associated metering equipment.

Table 3-36. Metering Equipment and Configuration, Energy-Efficiency Program Area

Parameter	Data Source	Interval	Measurement Range
Chiller, Air Conditioner or Heat Pump, or Packaged Terminal Air Conditioner Power (kW)	Wattnode WNB-3D-XXX-P with a) Magnelab MAG-SCT-XXX current transformer(s) and b) Onset HOBO H22-001 or H-21	2 minutes	EMS trending data were used if available. Range/accuracy: a) 80% to 115% of nominal voltage (240 V); ± 0.5% of reading from 5% to 100% of rated current b) 0% to 5% thru 0 A to 600 A; ± 1.0% from 10% to 130% of rated voltage
Chilled Water Supply Temp	a) Onset Hobo U12 b) TMCx-HD or similar	2 minutes	EMS trending data were used if available. Range/accuracy: -40° to 122°; ± 0.38° from 32° to 122°
Chilled Water Supply Temp	a) Onset Hobo U12 b) TMCx-HD or similar	2 minutes	EMS trending data were used if available. Range/accuracy: -40° to 122°; ± 0.38° from 32° to 122°
Chilled Water Flow	GE PT878 Portable Flow Meter	2 minutes	EMS trending data were used if available. Range/accuracy: –40 ft/s to 40 ft/s (–12.2 m/s to 12.2 m/s); Pipe ID > 6 in (150 mm): ± 1% to 2% of reading typical Pipe ID < 6 in (150 mm): ± 2% to 5% of reading typical
Supply, Return, and Mixed Air Temperatures	a) Onset Hobo U12 b) TMCx-HD or similar	2 minutes	EMS trending data were used if available. Range/accuracy: -40° to 212°; ± 0.38° from 32° to 122°
Pump Power (if applicable)	Wattnode WNB-3D-XXX-P with a) Magnelab MAG-SCT-XXX current transformer(s) and b) Onset HOBO H22-001	2 minutes	EMS trending or VFD data were used if available. Range/accuracy: a) 80% to 115% of nominal voltage (240 V); ± 0.5% of reading from 5% to 100% of rated current b) 0% to 5% thru 0 A to 600 A; ± 1.0% from 10% to 130% of rated voltage
Hours of Operation	EMS	Unknown	The power metering also determines the hours of operation
Outside Air Temperature	a) Onset Hobo H22-001 b) S-THB-M00X c) TMY Temperature Data	a) 2 minutes for logger b) Bin or hourly for TMY	EMS trending data were used if available. Range/accuracy: -40° to 167°; ± 0.36° from 32° to 122°

Note: All tools, loggers, and sensors listed in this table are examples and may have been changed to an equivalent alternative.

When baseline or reporting period data could not be collected, the Team used equipment model numbers to determine the size, efficiency, kW, and other information needed to calculate or model the system energy usage. Additionally, the Team thoroughly reviewed any modeling or baseline calculations performed by the participant for accuracy and to ensure that standard engineering practices were followed. The Team then adjusted the models, as needed, to account for any recorded discrepancies between the model and actual system installed.

Metering Accuracy

The individual meter accuracies are detailed in Table 3-36. The overall accuracy of the calculated data was driven by the measured variable with the widest range of accuracy. Savings calculations based on power metering alone produced more accurate results than calculations involving other measured variables, such as air and water flow.

Sampling and Accuracy

The Team used a sampling method to extend sample population attributes to the larger population. This method provided satisfactory data with sufficient accuracy and reliability, while still efficiently managing cost and project schedule time.

3.2.4 Gross Savings Findings

Appendix E presents the total projected and evaluated savings for each of the evaluated energy-efficiency projects. For all measures, the analyses show a total Program Area gross savings realization rate of 99.6%.

3.2.5 Confidence and Precision

The Cadmus Team calculated the realization rate for the 24[24] energy-efficiency projects completed before June 30, 2012 that received an on-site visit, data collection and engineering review, or only an engineering review. The Team based the confidence and precision on the variance of the realization rate weighted for the total energy savings of each project. Calculating a ratio of claimed to evaluated savings of 0.9926, the standard error of this ratio, based on a sample of 24, is 0.015, for a precision of ±2.54%, at a confidence level of 90%.

Table 3-37. Energy-Efficiency Program Area Confidence and Precision

Confidence	Precision
90%	± 2.5%

3.2.6 Net Savings Calculations

The Cadmus Team relied on participant surveys fielded electronically and over the phone to determine the attribution of Energy-Efficiency Program Area impacts. The Cadmus Team visited 25 sites and requested attrition surveys from the same 25 projects. The Cadmus Team was able to collect completed surveys for 14 of the 25 sites. The data collection and reporting schedule did not allow the Cadmus Team to perform the follow-up surveys described in Task 5 of the Action Plan. Specifically, projects were not far enough along in the implementation process for participants to answer the anticipated follow-up questions that were to be the focus of these interviews.

The survey included questions designed to estimate Program Area-induced installations of energy-efficiency measures and renewable energy capacity (through a form of spillover tied to the diversion of funds as described below). The Cadmus Team used respondents’ answers to these questions to calculate freeridership based on an algorithm that was developed in coordination with NYSERDA prior to fielding the survey. As directed by NYSERDA, this algorithm is an adapted version of one used in recent evaluations of NYSERDA’s ratepayer-funded energy-efficiency programs, which was vetted with New York regulators and other third-party evaluation contractors for prior evaluations, then updated by

[24] Out of the 25 site visits conducted, only 24 resulted in energy savings, and were therefore included in this analysis.

NYSERDA and the Cadmus Team to align more closely with the design of the NYSERDA ARRA Program Area.[25]

Estimating freeridership for energy efficiency involves four steps:

1. Determining direct freeridership
2. Calculating the Program Area influence score
3. Adjusting direct freeridership based on the Program Area influence score[26]
4. Weighting by the energy savings

The survey questions used in the algorithm are as follows, and the survey instrument can be found in Appendix D:

- FR6A, likelihood of installing the same measure without ARRA funds (direct freeridership score)[27]
- FR6B, percentage of energy-efficiency measures that would have been installed without ARRA funds (direct freeridership score)[28]
- FR2, stage of project planning process before participating in the Program Area (Program Area influence score)
- FR4, influence of Program Area funding (Program Area influence score)

[25] The Cadmus Team also developed two alternative estimates in an attempt to account for a directive from the DOE to adjust net savings estimates by the proportion of the project funded by NYSERDA or by other funding agencies. However, while the Cadmus Team had information from the surveys and Program Area tracking databases on the portion of the project funded by NYSERDA, the Team was not able to determine the sources of those other funds. The DOE directive mandates that the adjustment be made only when other *outside* funding was used (e.g., other grants, non-profit organization); lacking this information—and verifying that taking the adjustment had little effect on freeridership estimates—led the Cadmus Team to recommend not using the adjusted freeridership rate in final calculations of net savings. See: United States Department of Energy. *DOE Recovery Act Reporting Requirements for the State Energy Program (SEP)*. Effective date: March 1, 2010.

[26] The Cadmus Team compared the Program Area influence score to the direct freeridership score in order to examine the consistency of respondents' assessments of the Program Area influence. NYSERDA's Market Characterization, Assessment, and Causality (MCAC) evaluation team had previously assigned a range of reasonable freeridership values for each Program Area influence score. For example, a maximum Program Area influence score of 5 is assumed to have a lower bound of 0% freeridership and an upper bound of 25% freeridership, with the assumption that a freeridership value higher than 25% would be inconsistent with the maximum Program Area influence score. For more details, see: Summit Blue. *Commercial/Industrial Performance Program Market Characterization, Market Assessment and Causality Evaluation*. 2007.

[27] Each respondent may have answered one or both of questions FR6A and FR6B based on the nature of the project.

[28] Ibid.

- FR5, importance of Program Area (Program Area influence score)[29]
- AF1, portion of the project paid by NYSERDA ARRA funds (however, the Cadmus Team ultimately recommends an estimate of NTG that does not use this adjustment, for reasons discussed in footnote 25).

Freeridership results are detailed in Appendix E. This assessment does not account for spillover, because the energy-efficiency projects had been completed too recently to allow spillover to have occurred.[30] Although the exact timing of spillover is uncertain, the Cadmus Team has been advised by individuals familiar with budget planning cycles for public agencies and non-profit organizations that two years is a good estimate of when Program Area-induced spillover can be expected to materialize.

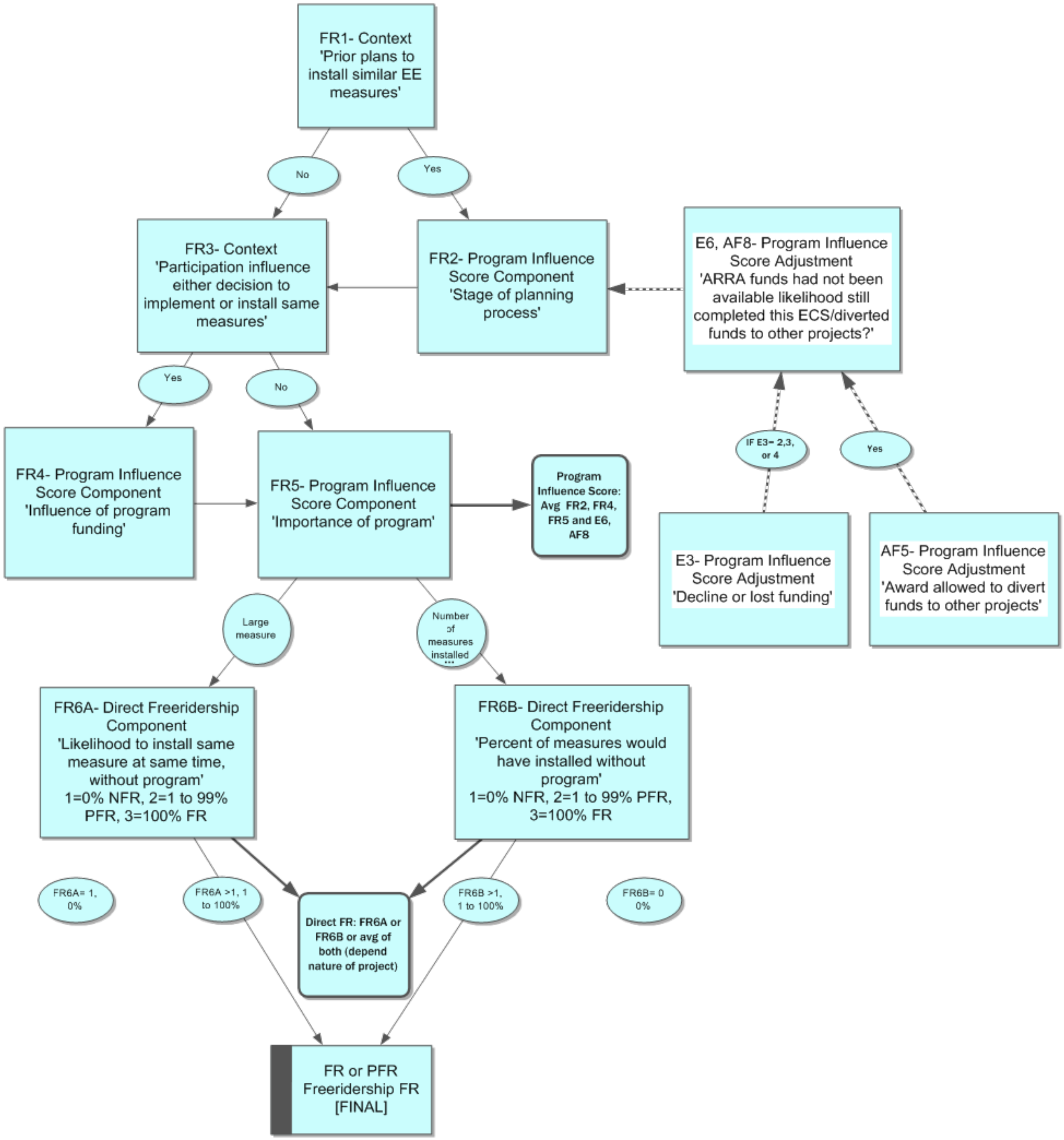
The Cadmus Team did explore qualitatively whether the respondents indicated that NYSERDA ARRA funding induced them to adopt additional energy-efficiency or renewable energy measures, largely through the ability to divert funds formerly set aside for the NYSERDA ARRA project to other energy efficiency or renewable energy projects. However, none of the RFP 10 respondents had diverted funds to other energy efficiency or renewable energy programs.

Figure 3-2 presents the freeridership algorithm graphically. The FR, AF, and E letters in the figure refer to questions from the survey, presented in Appendix D. The full algorithm and detailed calculations are presented in Appendix E.

[29] Two additional criteria—questions E6 (likelihood of completing the project without ARRA funds, limited to respondents that had lost or declined other funds) and AF8 (likelihood of completing additional energy efficiency or renewable energy projects with funds diverted due to NYSERDA ARRA funding)—did not apply to any of the RFP 10 respondents.

[30] Peters, Jane and R. Bliss. *Fast Feedback Pilot: Existing Buildings and Production Efficiency Programs*. Prepared for the Energy Trust of Oregon. 2010.

Figure 3-2. Freeridership Decision Tree, Energy-Efficiency Program Area



3.2.7 Net Savings Findings

This section presents estimates of freeridership and NTG ratios, and summarizes the results of the attribution survey the Team administered with respondents associated with 14 of the Energy-Efficiency Program Area projects. The sampling errors for both types of estimates reflect the small sample size.

The four steps involved in estimating freeridership are illustrated in Table 3-38. The calculations used in each step are described in Appendix E. The final freeridership, without adjusting for the percentage of each project funded by NYSERDA rate, is 19%. Although the sample drawn was not truly random, it did represent a significant portion of the total population (20%). If we assume that no important bias entered into the sample as a result of non-response, and we apply classical sampling theory, we estimate freeridership at the 90% confidence level with precision of 13% to 25%. The range of precision reflects the small sample size.

The adjustment for the percentage of each project funded by NYSERDA decreases freeridership slightly, to 16% (based either on survey responses or on tracking data). Given concerns about the lack of reliable information regarding the source of additional funding (described below), and the small change in the freeridership rate using the adjustment, the Cadmus Team recommends using 19% as the freeridership rate, yielding a NTG ratio of 81%.

The 19% freeridership for EECBG-funded projects is lower than that the rate of 27% estimated for the SEP-funded Energy-Efficiency Program Area projects, likely because the smaller municipalities that were the target of the RFP 10 funds relied on the assistance to a greater extent than the larger organizations and municipalities funded by SEP.

Table 3-38. Freeridership Scores, Energy-Efficiency Program Area

Freeridership Estimation Steps	No Adjustment for % of NYSERDA Funding	Adjusted for % of NYSERDA Funded, Based on Survey Responses	Adjusted for % NYSERDA Funded, Based on Tracking Database
Sample size	*14*	*14*	*14*
(1) Mean direct freeridership; FR6A, FR6B, or their average, depending on the nature of the project	26%	26%	26%
(2) Mean Program Area influence score; average score of FR2,* FR4, FR5, and, if applicable, E6** and AF8 (with a score of 1 meaning weak Program Area influence and 5 meaning strong Program Area influence)	4.53	4.53	4.53
(3) Freeridership, adjusted by Program Area influence score (the Program Area influence score is associated with lower and upper bounds of freeridership, as defined by the FlexTech algorithm. See Appendix E for more detail)	19%	19%	19%
(4) Freeridership, weighted by energy savings	19%	16%	16%
90% confidence interval	13% to 25%	9% to 23%	9% to 23%

* FR2 was reverse-scored such that the response indicating the greatest influence of NYSERDA ARRA funding also received the highest score, and the answers were adjusted to a 5-point scale by multiplying the outcome by 5/6.

** E6 and AF8 are a part of the approved algorithm but they did not apply to any of the 14 respondents to the current survey.

The Cadmus Team benchmarked NYSERDA's Energy-Efficiency Program Area freeridership results with values from similar programs and technical guidance documents.[31] In these other studies, freeridership averaged between 13% and 30%. One example is Questar Gas' business energy-efficiency program, which had a freeridership rate of 26%.[32] Another example is NYSERDA's previous commercial and industrial energy-efficiency program, FlexTech, which had a freeridership rate between 9% and 36%.[33] NYSERDA's Energy-Efficiency Program Area's freeridership of 19% falls within the range of the other programs' freeridership rates. None of the comparison evaluations were of an economic stimulus program, so they are not necessarily comparable to the NYSERDA ARRA Program Area.

The remainder of this section summarizes responses to the survey questions that factored into the freeridership calculation, as well as responses to questions that provided important context or explanations to support the freeridership calculation.

Alternative and Additional Funding

The attribution survey included a number of questions about the funding sources for respondents' energy-efficiency projects. The inclusion of these questions reflects the fact that NYSERDA ARRA funding—and ARRA funding more generally—was intended to allow projects to move forward that may not have otherwise due to the recession. They clarify the importance of NYSERDA ARRA funding on the completion of the projects.

The Cadmus Team used a survey question to determine the percentage of the total project budget covered by the NYSERDA ARRA funds, as projects could have received funding from multiple sources, including other funding agencies (Table 3-39). Six of the 14 projects (43%) were fully funded by ARRA, while NYSERDA ARRA funded between 75% and 99% of the cost for another six (43%) of the projects. The remaining two projects were funded between 25% and 75% of the total project cost. The average proportion of project costs covered by the ARRA funds was 85%.

The Cadmus Team calculated a freeridership rate that adjusted for this question, and the adjustment changed the rate by only a small amount. However, the other funding sources most often included the sub-grantees' own operating budgets. Such projects are not subject to the DOE directive to portion out savings by funding source. Therefore, the Cadmus Team recommends use of the 19% freeridership rate that does not adjust for answers to this question.

[31] The Cadmus Group, Inc. *Evaluation of DEER 2011 Non-Residential Energy-Efficiency NTG*. and The Cadmus Group, Inc. *Avista 2010 Multi-Sector Gas Impact Evaluation Report*, 2011.

[32] Questar Gas. *Utah Energy Efficiency Results.* 2010. Available online: http://www.psc.state.ut.us/utilities/gas/gasindx/1105706indx.html.

[33] NYSERDA. *New York Energy $mart Program Evaluation and Status Report Volume 2*. May 2004.

Table 3-39. Percentage of Total Project Budget Covered by NYSERDA Funds, Energy-Efficiency Program Area

Percentage of Budget	Responses
Sample size	*14*
Mean percent of budget	85%
1% to 24%	0% (0)
25% to 49%	7% (1)
50% to 74%	7% (1)
75% to 99%	43% (6)
100%	43% (6)

Note: Columns may not sum to 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

NYSERDA ARRA funds were intended to allow projects to move forward that may not otherwise have happened due to the recession. Non-profit agencies and local governments often receive grants that require them to match funds, and NYSERDA anticipated that ARRA would serve as a source of these matching funds. Moreover, NYSERDA expected that at least some participants had previously secured funding then lost it due to the financial crisis. The survey included a series of questions designed to clarify how other funding sources—or the lack of them—may have influenced participation in NYSERDA ARRA. However, none of the 14 respondents indicated that they were required to have matching funds for the project supported by NYSERDA ARRA. Also, none of the 14 projects had tried to secure funds prior to applying for NYSERDA ARRA.

Respondents also indicated whether the NYSERDA ARRA funding allowed them to divert money that had been budgeted for the energy-efficiency project to other projects (Table 3-40), which would indicate a form of Program Area spillover (both energy and non-energy related). Four participants (29%) reported that they had been able to divert funds to other projects. However, none reported using diverted funds to finance other renewable energy or energy-efficiency projects. Thus, diversion-related spillover has not resulted in additional energy and demand savings or renewable energy generation.

Table 3-40. Whether Other Financing Sources Required Matching Funds, Energy-Efficiency Program Area

Response	Able to Divert Funds to Other Projects
Sample size	*14*
Yes	29% (4)
No	71% (10)

Note: The base for requiring matching funds includes all projects not fully funded by NYSERDA.

Note: Columns may not sum to 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

Direct Freeridership Questions

The Cadmus Team relied on two survey questions to assess the likelihood that the energy-efficiency project would have moved forward without NYSERDA ARRA funding. These questions served as the basis for the direct freeridership estimate used in the freeridership algorithm.

The first question asked respondents to estimate the likelihood that they would have installed the same efficiency of equipment or measures, at the same time, if they had not participated in the Energy-Efficiency Program Area. They indicated their likelihood using a scale of 0% (indicating that they definitely would not have installed the measures with the same level of efficiency or capacity/rating) to 100% (indicating that they definitely would have installed the measure with the same level of efficiency or capacity/rating). A second, related question asked respondents to estimate the percent of efficiency measures that they would have installed without the NYSERDA funds. The Cadmus Team interviewers asked this question for projects that involved the installation of several individual measures (e.g., lighting measures).

Table 3-41 shows the results of these two questions. When asked about the likelihood of installing the same exact measure (the first column of results), nine respondents (64%) indicated that there was less than a 10% chance that they would have installed the same equipment at the same time without the Energy-Efficiency Program Area. Another four respondents (28%) thought the probability of installing the same equipment was between 20% and 39%. The remaining respondent indicated that there was between 80% and 89% chance that they would have installed the same equipment. On average, respondents estimated that the likelihood of installing the same equipment at the same time was 13%.

The second column in Table 3-41 shows respondents' estimates of the percent of efficiency measures that they would have installed without the NYSERDA funds. Compared with the results from the previous question, these findings indicate a somewhat weaker influence from the Energy-Efficiency Program Area on the scope of the projects than on the type of equipment and timing of installation. Although the majority of respondents (n=9; 64%) said they would have installed less than 30% of the measures without the Program Area, 35% (n=5) of respondents would have installed at least 50% of the measures without the Program Area, with 21% (n=3) saying they would have installed at least 80% of the measures without the funding. The average estimated share of measures that would have been installed is 32%.

Table 3-41. Likelihood of Installing Same Efficiency Measures in Absence of Energy-Efficiency Program Area

	Percent Likelihood	Percent of Measures
Sample size	*14*	*14*
Mean percent likelihood	13%	32%
0-9%	64% (9)	43% (6)
10-19%	0% (0)	0% (0)
20-29%	21% (3)	21% (3)
30-39%	7% (1)	0% (0)
40-49%	0% (0)	0% (0)
50-59%	0% (0)	14% (2)
60-69%	0% (0)	0% (0)
70-79%	0% (0)	0% (0)
80-89%	7% (1)	7% (1)
90-100%	0% (0)	14% (2)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

Influence of the NYSERDA ARRA Program Area on the Projects

While the questions summarized above provided information that the Cadmus Team ultimately used to adjust estimates of freeridership, this section summarizes the series of questions that the Cadmus Team primarily used to estimate the Program Area influence, which factored into the calculation of freeridership. These questions addressed respondents' likely actions if they had not participated in the Energy-Efficiency Program Area, their plans prior to participating, and the influence of the Program Area on their decision to install the measures they incorporated through the Program Area.

The Cadmus Team asked respondents whether they had planned to install similar measures before they applied for the NYSERDA ARRA funds. As shown in Table 3-42, less than half (n=6; 43%) said they had such plans.

Table 3-42. Prior Plans to Install Similar Measures, Energy-Efficiency Program Area

Whether Respondents Planned to Install Similar Energy-Efficiency Measures Before Participating	Responses
Sample size	*14*
Yes	43% (6)
No	57% (8)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

The Cadmus Team then presented the six respondents who said they had been planning to install similar measures before participating in the Program Area with a list of statements describing the process of planning the energy-efficiency project. The Team asked respondents to indicate which statement best described their plans before they participated in the Energy-Efficiency Program Area.[34] Table 3-43 shows that the projects were in relatively early stages in the planning process. Two of these six respondents (33%) had taken initial steps toward considering the equipment or measures, including discussing options with a vendor, contractor, or installer; the other four respondents (67%) were in the earliest phase of planning, having had preliminary internal discussions about a possible project but no contact with a vendor, installer, or contractor.

Table 3-43. Point in Project Planning Process Before Participating in Energy-Efficiency Program Area

Planning Process	Responses
Sample size	*6*
Had preliminary, internal discussions but no plans and no contact with a vendor, contractor, or installer.	67% (4)
Had taken initial steps toward considering the equipment/measures, such as requesting information from or discussing options with a vendor, contractor, or installer.	33% (2)
Had in-depth discussions of specific types of equipment, including positive and negative attributes and costs.	0% (0)
Had identified specific equipment, manufacturers, and models but had not begun the budgeting process.	0% (0)
Had identified specific equipment, manufacturers, and models but budget did not allow completion of project.	0% (0)
Had identified specific equipment, manufacturers, and models and incorporated project into budget.	0% (0)

Note: Base is respondents who indicated they had been planning to install similar measures before participating in the Program Area.

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

The Team used an additional question to assess whether participation in the Energy-Efficiency Program Area influenced the nature of the projects carried out by decision makers: "*Did your participation in the NYSERDA Recovery Act program influence either the decision to implement the project or to install the exact type, size, or amount of high-efficiency measures included in the project?*"[35] Table 3-44 shows that a large majority of respondents (n=12; 86%) said that the Program Area had indeed influenced their project decision making.

[34] This question mirrors that in the FlexTech/Technical Assistance programs' approach, although NYSERDA asked for the additional option, "*Had identified specific equipment, manufacturers, and the models but budget didn't allow completion of project.*" The Cadmus Team adjusted the algorithm accordingly, as described later in the text.

[35] The original FlexTech/Technical Assistance programs' version of this question asked about type and amount of measures influenced by ARRA; NYSERDA also directed the Cadmus Team to ask about the affected measures' size because of the nature of the ARRA projects. The wording of the questions allowed for the influence of the project to effect any or all of these characteristics.

Table 3-44. Whether Participation Influenced Project, Energy-Efficiency Program Area

Whether Program Area Participation Influenced Either the Decision to Implement Project or to Install the Exact Type, Size, or Amount of Project Measures	Responses
Sample size	*14*
Yes	86% (12)
No	14% (2)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

The Cadmus Team then asked the 12 respondents who indicated that their Energy-Efficiency Program Area participation influenced their project about the nature and extent of that influence. Presented with a list of statements describing various levels of influence, the Team asked respondents to choose the statement that best indicated the effect of the Program Area on their decision process. As shown in Table 3-45, seven of these 12 respondents (58%) said that the Energy-Efficiency Program Area funding was the *primary reason* the project was implemented, with another three respondents (25%) saying it was a major driver in increasing the scope of the project or the efficiency of the equipment. One respondent (8%) indicated that the funding lent credibility to the decision to invest in high efficiency, and another (8%) said that the funding allowed them to implement a project that had previously been considered.

Table 3-45. Influence of Energy-Efficiency Program Area on Decision to Install Equipment

Description of Influence	Responses
Sample size	*12*
No influence; all the measures would have been installed at the same efficiencies and in the same amounts without the Energy-Efficiency Program Area.	0% (0)
The Energy-Efficiency Program Area funding helped in making the final decision on measures that had already been thoroughly considered.	8% (1)
The Energy-Efficiency Program Area funding lent credibility to the decision to invest in high efficiency.	8% (1)
The Energy-Efficiency Program Area funding was a major driver in expanding the quantity, scope, or efficiency of the equipment installed.	25% (3)
The Energy-Efficiency Program Area funding was the primary reason that the measures were installed.	58% (7)

Note: Base is respondents who reported that the Energy-Efficiency Program Area influenced the project type, size, or amount of measures installed.

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

The final question intended to assess Program Area influence asked respondents how important the Program Area was in their decision to incorporate high-efficiency measures at the site, on a scale from 1 (indicating it was not at all important) to 5 (indicating it was very important). As shown in Table 3-46, 93% (n=13) of the respondents indicated that it was somewhat or very important, whereas the remaining respondent (7%) said it was not at all important. The average importance rating was 4.6.

Table 3-46. Importance of Energy-Efficiency Program Area in Decision to Incorporate High Efficiency Measures

Importance	Responses
Sample size	*14*
Mean (Scale 1-5)	4.6
1 Not at all important	7% (1)
2 Somewhat unimportant	0% (0)
3 Neither important nor unimportant	0% (0)
4 Somewhat important	14% (2)
5 Very important	79% (11)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

Although the freeridership and NTG estimates presented above (and described in more detail in Appendix E) provide a quantitative assessment of the net impact of NYSERDA ARRA funding on the energy-efficiency projects, the Cadmus Team also asked respondents to describe in their own words "*what the project would have been like*" without the NYSERDA ARRA funds. This question allowed for a qualitative assessment of the importance of the funds to the participants.

As shown in Table 3-47, the most common response (n=7; 50%) was that the project would not have been implemented at all. Other predictions included that the project would have been delayed or taken longer to complete (n=3; 21%) or that it would have been reduced in scope (n=2; 14%). One respondent (7%) said that the project would have been implemented in stages, rather than all at once, and one respondent (7%) said that the project would have been the same, but that the organization would have had to pay the full cost of the project. These responses indicate that overall, the funds made these projects possible, expanded the scope of the projects, or accelerated the timeline of implementation, thus achieving the goals set forth not just by NYSERDA, but also by the federal government for use of ARRA funds. These results are also consistent with the freeridership results, again demonstrating the importance of the ARRA funds.

Table 3-47. Likely Nature of Project in Absence of NYSERDA Funds, Energy-Efficiency Program Area

Nature of Project	Responses
Sample size	*14*
Project would not have been implemented at all	50% (7)
Project would have happened later or taken longer to complete	21% (3)
Project would have been reduced in scope	14% (2)
Project would have been implemented in stages	7% (1)
Project would have been the same, but would have had to pay full amount	7% (1)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses show the percentage of results, while the numbers inside the parentheses reflect frequencies.

Evaluated Savings Net of Freeridership

Accounting for all of the above factors, the evaluated savings net of freeridership are 81% of the gross savings, or 4,998 MWh and 38,469 MMBtu.

Table 3-48 summarizes the evaluated annual net impact of the Energy Efficiency Program Area as of June 30, 2012.

Table 3-48. Savings Impact Evaluated Net of Freeridership through June 30, 2012, Energy-Efficiency Program Area

	Total Claimed Electricity Savings from Installed Projects	Savings Weighted Realization Rate	Total Evaluated Gross Electricity Savings	Freeridership	Evaluated Net of Freeridership
Electricity (MWh)	6,232	0.99	6,170	0.19	4,998
Fuel (MMBtu)	47,022	1.01	47,492	0.19	38,469

3.2.8 Spillover Methodology

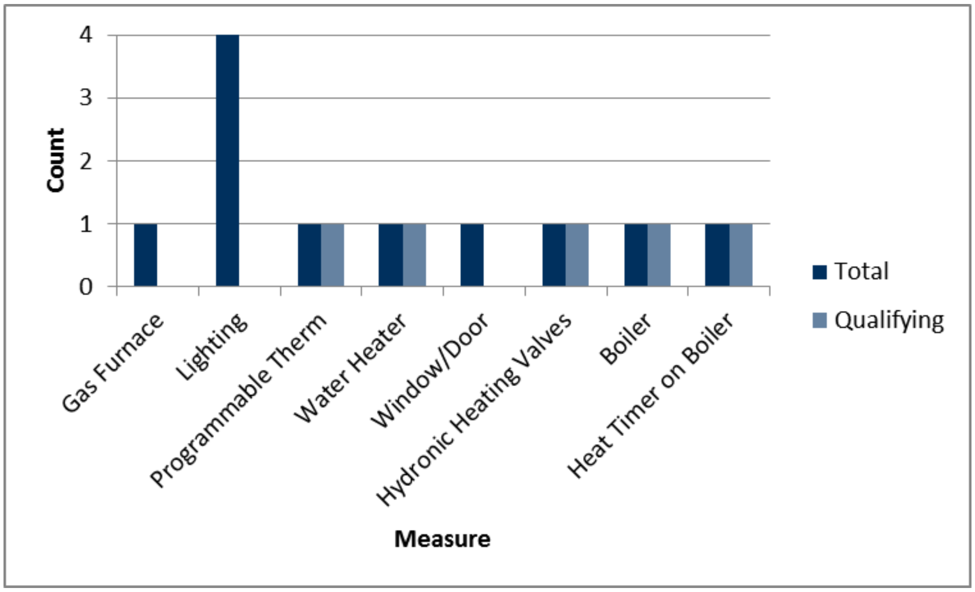
The Energy-Efficiency Program Area under EECBG had 69 projects completed; representatives from 18 of those projects completed a battery of spillover questions in July 2012. Some spillover can occur soon after a project completes, but it is not uncommon for it to take up to two years for additional projects to be budgeted and completed (especially in the nonresidential sector).

The spillover survey inquired about any additional measures installed or energy-saving behaviors undertaken since the approval of the NYSERDA-funded project. Any self-reported equipment spillover measures only qualify as NYSERDA ARRA spillover if they were not funded by any outside entity, and the respondent had to give the NYSERDA Energy-Efficiency Program Area credit for influencing their spillover action. Failure to meet both of those conditions results in a nonspillover measure, and is thus not attributable to the Program Area. Behavior changes only qualified if the respondent attributed their behavior to participating in the Program Area.

Results

The 18 respondents reported a total of 11 spillover measures, five of which were qualifying measures. To qualify, measures must not have received outside funding, and the respondent had to give credit for the action to their participation in NYSERDA's Program Area. Figure 3-3 shows the results of these reported measures.

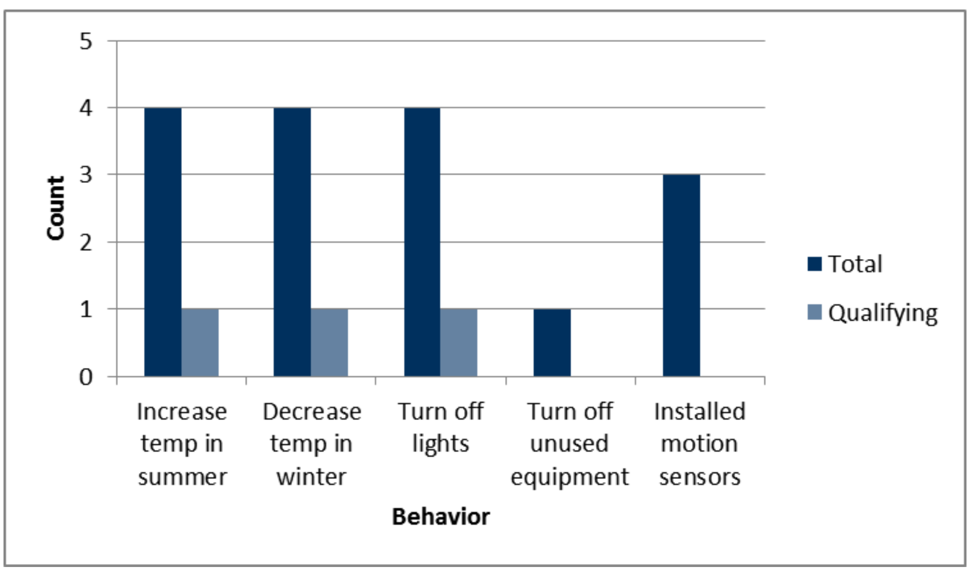
Figure 3-3. Energy-Efficiency Program Area Equipment Spillover Measures



On average, about one out of every four Program Area projects resulted in spillover. Extrapolation to the population yields just over 19 projects from which NYSERDA could claim spillover attribution. The Cadmus Team did not seek to quantify the spillover projects in this analysis because of the small number and the lack of sufficient pre- and post-condition and efficiency data of equipment functionality.

The spillover survey also inquired about behavior changes since participation in NYSERDA's Program Area. The 18 respondents reported 16 energy-savings behavior changes; however, only three were because of participating in the Program Area (Figure 3-4).

Figure 3-4. Energy-Efficiency Program Area Behavior Spillover Measures



3.3 RENEWABLE ENERGY PROGRAM AREA

3.3.1 Data Sources

The Cadmus Team used the following data sources to evaluate the Renewable Energy Program Area:

- NYSERDA Program Area staff interviews to understand Program Area design, targets, and goals
- Participant online surveys to measure Program Area attribution and participation satisfaction
- Weather data to normalize energy generation or savings to an average year
- Site visits and engineering estimates to collect measurements to determine actual energy savings
- System performance monitoring to obtain equipment specific details and energy generation or usage information over time

There were a total of 65 renewable energy RFP 10 projects. The Cadmus Team divided those projects into three sub-groups: 1) those for which the Team would review savings calculations (file review), 2) those for which the Team would conduct a file review and site visit, and 3) those for which the Team would conduct a file review and a monitoring visit.

In total, the Cadmus Team provided some form of review for 41 of the 65 projects, or approximately 63% of available projects. Table 3-49 summarizes the status of these original 65 projects.

Table 3-49. Quantity of Projects by Evaluation Type, Renewable Energy Program Area

Project Status	Number of Projects
RFP 10 Projects	**65**
Projects Receiving Evaluation File Review	12
Projects Receiving Evaluation File Review and Site Visit	23
Projects Receiving Evaluation File Review and Monitoring Visit	6
Total Projects Evaulated	**41**
Percentage of Projects Evaluated	**63%**
Attribution Surveys Completed	23*

* The Cadmus Team administered surveys randomly, and therefore included projects with and without an on-site visit.

3.3.2 Approach: Surveys and Sample Design

<u>Participant Online Surveys</u>

To estimate freeridership for the Renewable Energy Program Area, the Cadmus Team relied on an online participant survey. A total of 23 online surveys were conducted with RFP 10 project participants. Responses were received between September 12, 2011 and June 28, 2012.

The survey sought to ascertain the following:

- How participants first heard about the Program Area
- Why participants chose to apply for NYSERDA ARRA funds

- Prior participation in other NYSERDA Program Areas and the influence of that participation on the decision to apply for NYSERDA ARRA funds
- The role that alternative funding—or the lack thereof—played in the decision to apply for NYSERDA ARRA funds
- Characteristics of the organization receiving the funds

The survey also included a number of questions designed to estimate the Program Area-induced portion of the total installation of renewable energy capacity and energy generation (i.e., the Program Area effect net of freeridership). Methods for this estimation are described in more detail in Appendix E.

The implemented sample design stratified participants from Upstate (all of New York State except New York City (NYC) and Westchester, Nassau, and Suffolk counties) and Downstate (NYC and Westchester, Nassau, and Suffolk counties) into categories based on the technology installed, as shown in Table 3-50. The associated error margins were estimated at the 90% confidence level, assuming a 50/50 proportion of responses for each of the strata.

Table 3-50. Participant Survey Sample Design (population), Renewable Energy Program Area

RFP 10	Population (projects)	Sample Size (completed surveys)	Sampling Error at 90% Confidence Level
PV Upstate	44	14	18.8%
PV Downstate	11	3	49.6%
Non-PV	10	6	23.3%
Overall	**65**	**23**	**15.7%**

<u>NYSERDA Program Area Staff Interviews</u>

The Cadmus Team interviewed NYSERDA and implementation contractor staff to understand the Renewable Energy Program Area design and implementation, as well as Program Area difficulties and successes.

<u>Weather Data</u>

To calibrate each site's performance model to actual weather data, the Cadmus Team used actual total horizontal solar radiation data. This actual radiation data for 11 applicable sites was downloaded from the Solar Data Warehouse Website.[36] The Cadmus Team developed an algorithm to select the appropriate actual weather data for each site based on the nearest linear distance between the site and the data station.

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[36] Solar Data Warehouse: http://www.solardatawarehouse.com/.

Site Visits and Engineering Estimates

The Cadmus Team conducted site visits at 36 completed solar PV projects to determine the accuracy of Renewable Energy Program Area information, in particular the estimated annual energy output/generation. The Cadmus Team's field inspectors, who have technical backgrounds in renewable energy, were assigned to each site and investigated factors such as:

- Inventory of equipment installed
- Physical system characteristics (tilt, orientation, etc.)
- Factors affecting system performance (shading, obstructions to wind, soiling of solar collectors, etc.)
- System operational history and downtime, if applicable

Field inspectors conducted informal interviews with system owners to gather data on some of these factors. System characteristics were generally assessed visually. Other characteristics—such as system tilt, orientation, and shading—were measured at the site. In addition to measuring shading with the Solmetric SunEye and Solar Pathfinder tools, Cadmus Team inspectors reviewed instantaneous shading at the time of the site visit and calculated the annual reduction in energy output due to shading.

One of the most important aspects of the field inspection process was to verify reasonable system operation. The Cadmus Team determined the operational period energy output from the on-site meter reading and confirmation of system interconnection date, then compared it with a weather-adjusted estimate using System Advisor Model (SAM). Using this approach, the Cadmus Team adjusted the theoretical model, which relies on assumptions for system losses and component efficiencies, to match real-world conditions for the location, application, and operational period of evaluated projects.

In cases where more detailed monitoring was not feasible, the Cadmus Team used data from the field inspections at completed non-solar PV projects to predict the energy impact of non-solar PV projects. These inspections followed the same general format as the solar PV inspections, with data collection focused on the relevant technology and resource, such as measuring the tower and obstruction height for wind projects.

The Cadmus Team field inspectors collected and reported site visit results in real-time via a proprietary online field data collection system. Inspectors, using hand-held tablet computers, collected, verified, and uploaded data to a central database, where it was reviewed by project analysts who verified the data quality and identified potential missing or incomplete data. Where necessary, field inspectors followed up with on-site representatives, Renewable Energy Program Area implementers, and other key stakeholders to obtain complete site visit records for each project.

System Performance Monitoring

Site visit data for non-PV systems were supplemented through M&V efforts. Specifically, the Cadmus Team installed DASs on select projects to estimate energy generation. This was an important element of the evaluation process, as some types of renewable energy systems do not have simple generation meters (e.g., biomass boilers, solar walls) or are reliant on a highly variable resource (e.g., wind turbines).[37] In these cases, monitoring is the only reliable way to ensure that systems are performing as expected. For example, a low energy output from a wind turbine with a year or less of operational history may be a poor predictor of long-term electricity generation if the wind speeds during the turbine's first few months of

[37] The Cadmus Team intended to monitor the wind turbines installed under RFP 1613, but was unable to collect meaningful monitoring data on the systems installed due to delays in project implementation.

operation were unusually low. Not including this variability in the analysis could lead to drastically under (or over) predicting the Program Area impacts of these technologies.

The Cadmus Team determined the feasibility for project monitoring based on several factors, such as the reliability of pre-installation estimation methods, system complexity, and the operational time available for data collection. For example, thermal technologies used for space heating were only monitored if the system was operational for a significant portion of the heating season. Due to delays in completing funded projects, it was only feasible to monitor the performance of four systems.

The Cadmus Team's evaluation activities, by technology and region, are summarized in Table 3-51.

Table 3-51. Impact Evaluation Activities by Technology and Region, Renewable Energy Program Area

	Population	Field Inspections Only*	Monitoring Only	Sampling Precision (at 90% Confidence)**
PV Upstate	44	(23) 30	0	4.4%***
PV Downstate	11	(2) 6	0	
Wind Upstate	3	1	1	**
Wind Downstate	0	0	0	**
Solar Thermal Upstate	2	0	1	**
Solar Thermal Downstate	1	0	0	**
SHW Upstate	2	0	2	**
SHW Downstate	0	0	0	**
Biomass Upstate	1	0	1	**
Biomass Downstate	0	0	0	**
Tracking Solar PV Upstate	1	0	1	**
Tracking Solar PV Downstate	0	0	0	**
TOTAL	65	26	6	

* Numbers in parentheses indicate site visits that provided valid data for analysis. For PV Upstate, we visited 30 sites, but only 23 produced usable data. Sample precision was calculated using only the valid data points.

** Sampling precision was not calculated due to the small population size or was not applicable due to a census effort (i.e., no sampling was conducted).

*** The calculated coefficient of variation on the PV projects is 0.21.

As shown in Table 3-51, some site visits did not result in useable results. This was primarily due to:

- No on-site meter being present to confirm actual electricity generation
- An inability to obtain the accurate system startup date from project proponents or documents provided during file review process
- Inability to access relevant system components during site visits
- Systems found not operating and not including a totalizing electricity generation meter
- Insufficient operational history (less than 30 days)

Prior to conducting site visits, the Cadmus Team attempted to obtain complete project information through a technical review of project files and other documentation, but in some cases this information did not match information from on-site personnel. Where this occurred, the Cadmus Team attempted to clarify apparently inaccurate or obtain missing information. Sites with insufficient operational history/generation data were excluded from the final sample, despite efforts to obtain additional data needed to run the modified SAM models..

The sampling precision, 4.4%, was calculated for both the PV Upstate and Downstate categories combined.

3.3.3 Process Findings

An important goal of this evaluation was to determine whether the source of the funds (i.e., ARRA) was instrumental in the decision of participants to apply for them. The ARRA legislation had received a great deal of media coverage, being presented as a way to get the United States out of the recession and back to work again. NYSERDA staff members thought that this broader support for ARRA and its goals increased interest in the Program Area. Therefore, the Cadmus Team asked respondents how the fact that the NYSERDA funds were provided by ARRA affected their decision to apply, on a scale from being a critical negative factor (i.e., a major barrier to applying) to being a critical positive factor (e.g., a major driver of applying; Table 3-52). While the majority (n=15; 70%) said this was not a factor in their decision at all, a substantial proportion (n=6; 23%) said it was either somewhat of a positive factor or was a critical positive factor. The fact that the funds were provided by ARRA was a somewhat negative factor for two of the respondents (7%).

Appendix H summarizes interview findings for a variety of factors related to decision-making, including Program Area awareness, motivation, economic factors, alternative funding, and spillover characteristics for participants of the Renewable Energy Program Area.

Table 3-52. Influence of ARRA Funding on Decision to Apply for NYSERDA Funds, Renewable Energy Program Area

Influence	Overall*	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Critical negative factor	0% (0)	0% (0)	0% (0)	0% (0)
Somewhat of a negative factor	7% (2)	14% (2)	0% (0)	0% (0)
Not at all a factor	70% (15)	64% (9)	67% (2)	67% (4)
Somewhat of a positive factor	13% (3)	7% (1)	33% (1)	17% (1)
Critical positive factor	10% (3)	14% (2)	0% (0)	17% (1)

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Because the ARRA funds were to be distributed quickly, NYSERDA was interested in learning whether some participants applied for the funds because they offered a way to implement renewable energy projects on a shorter timeframe than waiting for other sources of funding. The effect of the NYSERDA funds timing on respondents' decision to apply was gauged by asking: "*To what extent was your decision to apply for funds from NYSERDA affected by* <u>*when*</u> *the funds became available?*" (Table 3-53). For 50% of respondents (n=11), the timing was a positive factor. Timing was not a factor at all in most of the remaining respondents' decision to apply for the funds (n=10; 45%). Timing was somewhat of a negative factor for two of the respondents (6%). These findings support the Program Area theory that the short time frame in which the NYSERDA ARRA funds were distributed was generally a positive factor in inducing participation.

Table 3-53. Influence of Timing of NYSERDA Funds on Decision to Apply, Renewable Energy Program Area

Influence	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Critical negative factor	0% (0)	0% (0)	0% (0)	0% (0)
Somewhat of a negative factor	6% (2)	7% (1)	0% (0)	17% (1)
Not at all a factor	45% (10)	43% (6)	67% (2)	33% (2)
Somewhat of a positive factor	32% (7)	36% (5)	33% (1)	17% (1)
Critical positive factor	18% (4)	14% (2)	0% (0)	33% (2)

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

In an effort to understand whether prior participation in other NYSERDA programs influenced participation in this Program Area, the Cadmus Team asked respondents a series of questions about their prior experiences with NYSERDA programs. The first question in this series focused on respondents' previous experiences with other renewable energy or energy-efficiency programs. First, respondents reported whether they had participated in any other NYSERDA programs before participating in the Renewable Energy Program Area. Table 3-54 shows that one-third of respondents (n=7; 33%) had participated in a previous program(s); all of these respondents were from the Upstate PV population.

Table 3-54. Past Participation in Other NYSERDA Programs, Renewable Energy Program Area

Response	Overall*	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Yes	33% (7)	50% (7)	0% (0)	0% (0)
No	67% (16)	50% (7)	100% (3)	100% (6)

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Respondents who had participated in other NYSERDA programs were asked about the type(s) of program(s) in which they had participated (Table 3-55). Close to one-half (n=3; 45%) had undergone an energy audit, while over one third (n=3, 35%) had participated in an equipment replacement incentive program and nearly one-third (n=2; 30%) had participated in a new construction program. One respondent reported participating in a renewable energy program (RFP 1613), one had participated in an energy conservation program, one reported participating in a lighting and motors program and one reported participating in a lighting program.

Table 3-55. Types of NYSERDA Programs in Which Respondents Have Participated, Renewable Energy Program Area (multiple responses)

Type of NYSERDA Program	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*7*	*7*	*0*	*0*
Energy audit**	40% (3)	43% (3)	N/A	N/A
Equipment replacement incentive	35% (3)	43% (3)	N/A	N/A
New construction	30% (2)	29% (2)	N/A	N/A
Renewable energy	3% (1)	7% (1)	N/A	N/A
Energy conservation	4% (1)	7% (1)	N/A	N/A
Lighting and motors	4% (1)	7% (1)	N/A	N/A
Lighting	4% (1)	7% (1)	N/A	N/A

Note: Base is respondents who had participated in another NYSERDA program(s).

Note: Columns may not sum to 100% due to rounding and multiple responses. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

* It is unclear whether respondents understood the differences between technical studies and energy audits, as the Cadmus Team did not probe respondents to clarify what their responses meant.

These respondents were then asked how their participation in the other NYSERDA program(s) affected their decision to apply for the Renewable Energy Program Area (Table 3-56). A critical negative influence indicates that previous participation in another program was a major barrier to deciding to apply to the Renewable Energy Program Area. A critical positive influence indicates that previous participation was a major driver towards deciding to apply.

All of these respondents indicated that their previous experience with a NYSERDA program(s) was a positive influence. The findings indicate that other NYSERDA programs induced at least some informal spillover to the NYSERDA ARRA Program Area, in that a positive prior experience contributed to respondents applying for the Renewable Energy Program Area.

Table 3-56. Influence of Participation in Other NYSERDA Programs on Decision to Apply for Renewable Energy Program Area

Influence	Overall*	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*7*	*7*	*0*	*0*
Critical negative influence	0% (0)	0% (0)	N/A	N/A
Somewhat of a negative influence	0% (0)	0% (0)	N/A	N/A
Not at all a influence	0% (0)	0% (0)	N/A	N/A
Somewhat of a positive influence	65% (5)	71% (5)	N/A	N/A
Critical positive influence	35% (2)	29% (2)	N/A	N/A

Note: Base is respondents who had participated in another NYSERDA program(s).

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The final question the Cadmus Team asked about prior participation was whether having the measures installed through the current Program Area had been recommended in a previous NYSERDA energy-efficiency audit or study. Out of the seven respondents who had participated in another NYSERDA program(s), one (8%) said that the equipment they installed through the Renewable Energy Program Area had been recommended to them through an audit or conservation study completed through a NYSERDA program (Table 3-57). Therefore, NYSERDA ARRA provided a source of funds for at least some participants in other programs to implement measures recommended in prior studies, although not to the extent desired based on the Program Area theory.

Table 3-57. Whether Equipment was Recommended by Previous NYSERDA Audit or Study, Renewable Energy Program Area

Response	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*7*	*7*	*0*	*0*
Yes*	8% (1)	14% (1)	N/A	N/A
No	92% (6)	86% (6)	N/A	N/A

Note: Base is respondents who had participated in another NYSERDA program(s).

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

* Respondents were asked to specify which NYSERDA program recommended the measures installed for this Program Area, to which the one respondent specified PON 4.

Staff Interview Findings

Interviews conducted with Renewable Energy Program Area staff and implementation contractors yielded several relevant findings:

- The inclusion of technologies in RFP 10 was partially driven by stakeholder input. For example, fuel cells were included for this reason, yet none were ultimately funded under the Renewable Energy Program Area.
- Some communities were resistant to wind and biomass projects, based on the perceived visual and air quality impacts.
- There is expected overlap in interest between RFP 10 and existing RPS programs for small wind and solar PV projects. Applicants under RPS programs were allowed to reapply if they did not have an existing contract in place under RFP 10, thereby foregoing RPS funding in favor of ARRA funds.[38]

3.3.4 Program Area Generation Assumptions and Engineering Analysis

The Cadmus Team completed an engineering analysis of gross energy generation for the renewable energy technologies included in this evaluation. Systems receiving performance monitoring followed the

[38] Based on informal interviews with RPS program staff, RPS programs were fully subscribed during this period and were able to shift applicants to the ARRA-funded programs.

IPMVP Option B-Retrofit Isolation methodology, as outlined in IPMVP's *Guidelines for Development and Approval of Custom Measure Protocols.*[39]

Biomass

One biomass boiler project was funded under RFP 10. The general purpose of biomass boilers is to provide space and/or hot water heating to facilities by burning woody biomass, such as wood chips or pellets. This project was intended to supplement propane usage. The biomass project was installed too late to be included as a site visit or for monitoring. Because biomass boiler projects are unique and, as a fuel switching measure, generally offset fossil fuel usage in favor of a renewable fuel (e.g., wood pellets), the Cadmus Team used a 100% realization rate, and therefore credited the project for 100% of the reported savings. The Team verified that the embodied energy in both fuels were consistent, which ensures that the fuel conversion and therefore retention of the 100% realization rate was reasonable.

Solar Hot Water

A solar thermal hot water system collects solar energy to heat domestic water. In some cases, these systems are used for space heating, supplementing or replacing the use of other fuels. A typical system consists of one or more solar collectors, through which a heat transfer fluid circulates (water or a water/glycol mix) in a thermally insulated absorber plate. The plate collects and transfers solar radiation to the working fluid as heat. From the roof, the working fluid is circulated through a heat exchanger to pre-heat domestic hot water in an insulated hot water tank.

Two solar hot water (SHW) systems were funded under RFP 10. The Cadmus Team was not able to conduct performance monitoring at either site. One site was not completed in time to collect representative system performance data. The Cadmus Team did visit this site to confirm equipment and installation details. The second system was not complete within the timeframe of this evaluation report, and did not receive a site visit or performance monitoring.

Solar Photovoltaics

The Cadmus Team used the data gathered during the site visits as inputs to the National Renewable Energy Laboratory's (NREL's) SAM.[40] SAM was developed by NREL and provides a variety of economic and performance calculations for solar PV, small wind, and other renewable energy technologies. SAM uses TMY2 solar radiation data from weather stations around the U.S., combined with system characteristics such as tilt, orientation, and shading, to generate an 8,760 hour annual profile of generation.

For solar PV, SAM is similar to the commonly available tool, PVWatts.[41] PVWatts was also developed by NREL and uses the same TMY2[42] data and general calculation methods employed in SAM. The Cadmus Team elected to use SAM, however, because of SAM's more flexible interface and data export capabilities.

[39] Available from the Efficiency Valuation Organization at: http://www.evo-world.org.

[40] Accessible online at: https://sam.nrel.gov/.

[41] Accessible online at: http://www.nrel.gov/rredc/pvwatts/.

[42] For this evaluation, Cadmus used TMY3 data, which is more recent and geographically representative than TMY2 data.

A total of 55 solar PV systems were funded under RFP 10. The Cadmus Team conducted 36 on-site inspections of installed solar PV systems. Figure 3-5 shows the locations of projects that received an on-site inspection.

Figure 3-5. Solar PV Site Visit Locations, Renewable Energy Program Area

Using historical data from the weather stations indicated in Figure 3-5, the Cadmus Team compared operational period energy output with irradiance over the same period. The Cadmus Team used Equation 3-6 to identify possible sources of modeling bias in SAM and to adjust the raw annual estimate. SAM uses a variety of derate and adjustment factors, and R_{model} is useful for determining whether these values match real world conditions.

Equation 3-6. Calculation to Identify Modeling Bias, Renewable Energy Program Area

$$R_{model} = \frac{E_{actual}}{PEP_{SAM}\left(\frac{I_{act}}{I_{TMY3}}\right)}$$

Where:

E_{actual} = Cumulative electricity production meter reading, taken during on-site visit at least nine months after system commissioning date

PEP_{SAM} = Estimated operational period electricity generation, determined using SAM

I_{act} = Average global horizontal radiation (W/m^2) for the period beginning on the PV system commissioning date and ending on the date of the meter reading for E_{actual}

I_{TMY3} = Average global horizontal radiation (W/m^2) taken from the relevant TMY3 data file, covering the same period as I_{act}

Once an adjustment factor was calculated for each site, the Cadmus Team used Equation 3-7 to determine the gross generation for each site.

Equation 3-7. Gross Generation Determination, Renewable Energy Program Area

$$AEP_{eval} = AEP_{SAM} * R_{model}$$

Where:

AEP_{SAM} = Predicted annual electricity production as calculated using SAM

R_{model} = Adjustment factor accounting for weather and performance variability between observed system performance and model predictions

Solar Wall

Three solar wall projects were funded under RFP 10. The Cadmus Team monitored the performance of two of these projects as part of the evaluation. Figure 3-6 and Figure 3-7 show photographs of these projects.

Figure 3-6. Monitored Solar Wall Project, Renewable Energy Program Area

Figure 3-7. Solar Wall Collectors (exterior view) at Monitored Project, Renewable Energy Program Area

The following calculation steps were used to determine energy generation and other key metrics for the solar wall system during the monitoring period.

Collector Performance

The daily thermal energy contribution of the solar wall was calculated using Equation 3-8.

Equation 3-8. Daily Thermal Energy Contribution of Solar Wall, Renewable Energy Program Area

$$Q_{sav} = \sum_{i=0}^{i=1,440/t_{int}} flow_{fl} \times t_{int} \times \rho \times c_p \times (T_{sw} - T_o)$$

Where:

$flow_{fl}$	=	Air flow from solar wall (in cubic feet per minute)
t_{int}	=	The 10-minute sampling period (integrated to 1,440 minutes, or 24 hours)
ρ	=	Air density (pounds per cubic foot)
c_p	=	Specific heat of air
T_{sw}	=	Air temperature leaving the collector (^{o}F)
T_o	=	Air temperature entering the collector (^{o}F)

Energy Consumption of the Solar Wall System Fan Units

The energy savings of the solar wall system is the two fan units' electricity consumption, calculated using Equation 3-9 (note that the equation results in a negative number), then added to the energy produced by the solar wall system.

Equation 3-9. Fan Unit Electricity Consumption, Renewable Energy Program Area

$$Q_{electric} = \sum_{i=0}^{i=1{,}440/t_{int}} -P_{int} \times t_{int} \times \frac{1\ hr}{60\ min}$$

Where:

P_{int} = Average power ($Q_{electric1}$ + $Q_{electric2}$) recorded over the sampling interval (Btu/hour)

t_{int} = Logging interval in minutes

Next, the Cadmus Team calculated the average energy consumption per day for all days with metered data. This outcome was scaled to an annual value.

Extrapolation to Typical Year Generation

The solar wall's thermal energy contribution is primarily driven by the available solar radiation and the outdoor temperature. The Cadmus Team correlated the daily thermal energy of the solar wall (Q_{sav}) with daily HDDs and incident solar radiation. Once this correlation was established for the monitoring period, the correlation terms were applied to TMY, daily average irradiance, and HDD values. In cases where the regression method resulted in a poor fit with observed data (i.e., with an R^2 less than 0.8), a ratio-based method[43] was used to adjust monitored data to typical HDD and irradiance conditions.

Tracking Solar Photovoltaics

Maximum output from PV panels occurs when the collector surface is nearly perpendicular to the sun's beam radiation, a condition that occurs a relatively small percentage of the time with fixed tilt collectors. As the angle of solar radiation incidence departs from perpendicular, the apparent area of the collector is reduced and reflection increases, diminishing the output from the PV panel. A mounting system that tracks the movement of the sun can be used to maximize output from solar collectors, by keeping the collectors nearly perpendicular to the sun for a high percentage of the year.

Two tracking solar PV systems were funded under RFP 10. The Cadmus Team monitored the performance of one tracking solar PV system as part of this evaluation effort. This monitoring included tracking the position and energy output of the tracking PV array, as well as solar irradiance and ambient outdoor temperature.

[43] The ratio-based method compares the average solar irradiance and total HDDs during the monitoring period with typical values for the solar wall operating period, and applies this ratio to the observed savings number.

Figure 3-8. Tracking PV Array, Renewable Energy Program Area

Wind

Three distributed wind energy systems were funded under RFP 10, one of which is shown in Figure 3-9. The Cadmus Team monitored one distributed wind system as part of this evaluation.

Figure 3-9. Small Wind Turbine at Monitored Project, Renewable Energy Program Area

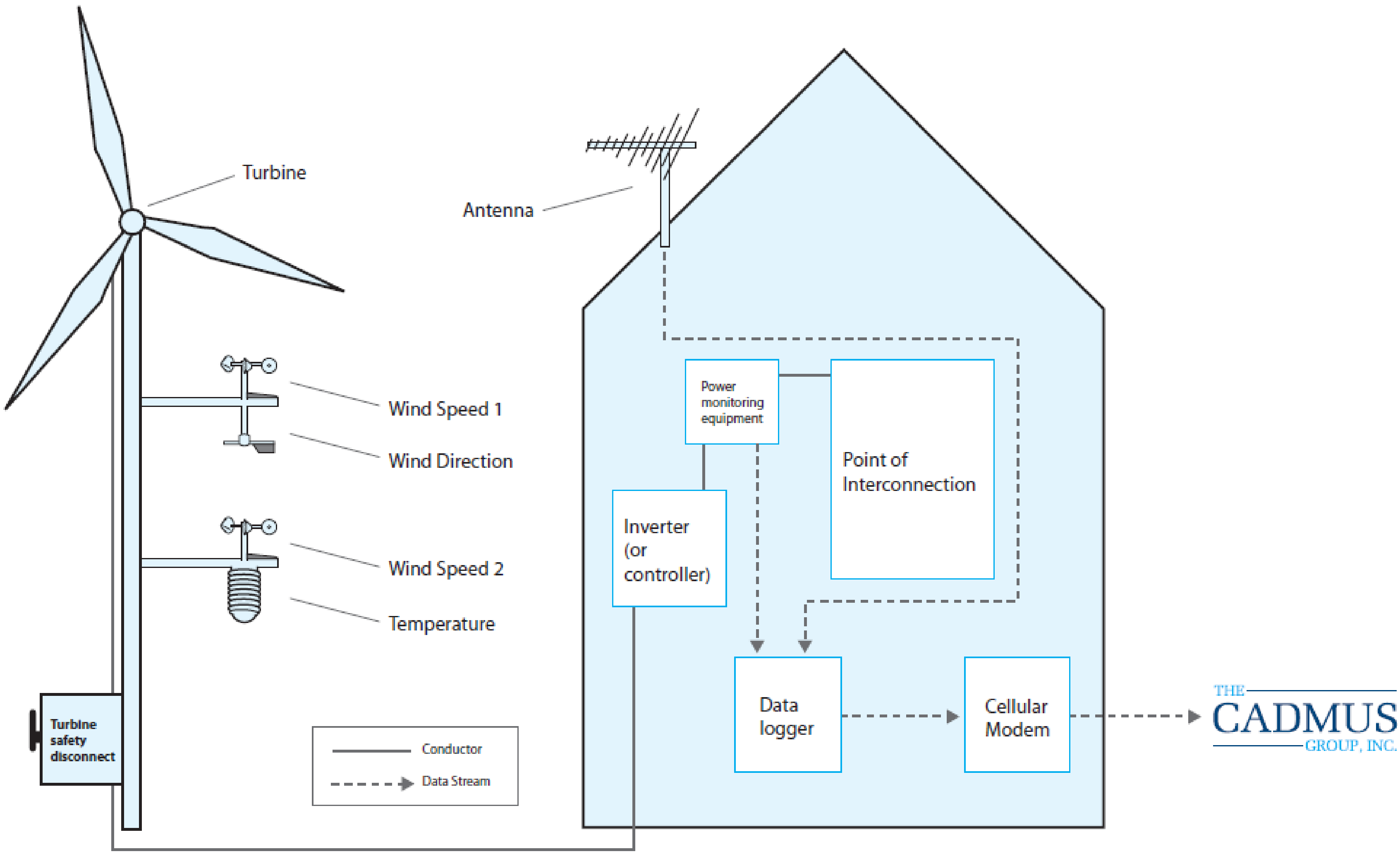
The Cadmus Team installed monitoring equipment on the wind turbine tower, as well as in proximity to the point of interconnection, to collect data necessary for determining key metrics associated with the system performance (shown in Table 3-58). Monitoring occurred for six months.

Table 3-58. M&V Measurements Taken

Identifier	Measurement	Purpose
WS1	Wind speed at 32 meters high	Wind speed determination
WS2	Wind speed at 25 meters high	Wind speed determination
T	Ambient temperature at 25 meters high	Estimation of air density; indicator of icing events
WD	Wind direction at 32 meters high	Directional frequency; power density
P	Power	Turbine output power; power curve resolution

The general locations of the monitoring equipment (anemometer, wind vane, temperature sensor, and power transducer) are shown in Figure 3-10.

Figure 3-10. Generic Small Wind Turbine DAS Configuration Diagram Showing Sensor Locations, Renewable Energy Program Area



Data Acquisition System

The Cadmus Team installed a DAS; components are specified in Table 3-59.

Table 3-59. DAS Components, Renewable Energy Program Area

Identifier	Sensor	Location
WS1	Breeze Wireless combined wind vane and anemometer	On tower, 32 meters high (approximate)
WS2	Breeze Wireless combined temperature sensor and anemometer	On tower, 25 meters high (approximate)
WD	Breeze Wireless combined wind vane and anemometer	On tower, 32 meters high (approximate)
T	Breeze Wireless combined temperature sensor and anemometer	On tower, 25 meters high (approximate)
P	Ohio Semitronics power transducer	On junction box near turbine interconnection point

The following is a general explanation of the set-up, sampling rate, and averaging intervals used for the wind monitoring:

- All data were averaged over 10-minute intervals.
- The sensor setup was wireless (deemed more cost-effective than wired solutions).
- Statistics were collected on measurements, such as standard deviation; the maximum, minimum, and mean wind speeds; wind direction; temperature; and power.

Calculations

The Cadmus Team applied the following data reduction procedures to the raw files from the data logger in order to measure the power curve:

Step 1: Remove Invalid Data from Database

The Team considered data invalid and flagged it for removal for the following reasons:

- Apparent sensor failure or malfunction.
- Turbine shut down, faulted, or any other condition requiring manual intervention.

Step 2: Calculate Wind Shear Coefficient

The Cadmus Team used the relationship between wind speeds at the two measurement heights to derive the wind shear coefficient using the wind profile power law shown in Equation 3-10.

Equation 3-10. Wind Shear Coefficient Calculation, Renewable Energy Program Area

$$\alpha = \ln (WS_1 / WS_2) / \ln (H_1 / H_2)$$

where:

α = The dimensionless wind shear coefficient for the measurement range

WS_1 = The wind speed measured at approximately 80 feet (meters/second)

WS_2 = The wind speed measured at approximately 60 feet (meters/second)

H_1 = The height of wind speed measurement WS_1 (meters)

H_2 = The height of wind speed measurement WS_2 (meters)

Step 3: Extrapolate Hub Height Wind Speed Using Calculated Wind Shear Coefficient

Wind shear can be used to extrapolate wind speeds from anemometer height to the turbine hub height, in order to accurately estimate the wind speeds experienced by the turbine (Equation 3-11).

Equation 3-11. Wind Speed Calculation, Renewable Energy Program Area

$$WS_h = WS_1 (H_h / H_1)^{\alpha}$$

where:

WS_h = Extrapolated wind speed at hub height (meters/second)

H_h = The hub height of the wind turbine (meters)

Step 4: Calculate 10-Minute Average and Site Average Air Densities

The Cadmus Team calculated the site average air density for the monitoring period based on the 10-minute average air densities (ρ_{avg}) using Equation 3-12.

Equation 3-12. Average Air Density Calculation, Renewable Energy Program Area

$$\rho_{\boldsymbol{min}} = \frac{\boldsymbol{p}}{\boldsymbol{RT}}$$

where:

ρ_{min} = The 10-minute average air density (kilograms/cubic meter)

p = The standard atmospheric pressure (101,325 Pa)

R = The specific gas constant for dry air [287.058 J/(kilograms·* temperature in Kelvin)]

T = The measured temperature (Kelvin).

The Team then determined the site average air density by time-averaging the 10-minute average air density.

Step 5: Calculate Normalized Wind Speed

The Cadmus Team normalized hub height wind speed based on estimated air density using Equation 3-13.

Equation 3-13. Normalized Wind Speed at Hub Height Calculation, Renewable Energy Program Area

$$WS_n = WS_h * \left(\frac{\rho}{\rho_{avg}}\right)^{1/3}$$

where:

WS_n = The normalized wind speed at hub height (meters/second)

ρ = The 10-minute average air density (kilograms/cubic meter)

ρ_{avg} = The site average air density (kilograms/cubic meter)

The Evaluation Team then repeated step 5, replacing ρ_{avg} with 1.225 kilograms/cubic meter to calculate the standard normalized wind speed (WS_{ns}) at sea level.

Step 6: Develop Bins for Normalized Standard Wind Speed

The Team then grouped wind speed data according to the Method of Bins.[44] The Team divided the wind speed range into 1.0 meter/second contiguous bins centered on integer wind speeds (e.g., 2 meters/second, 3 meter/second).

Step 7: Bin Analysis

The Cadmus Team analyzed each bin to derive:

- Mean wind speed (meter/second)
- Mean output power of turbine (kilowatts)
- Count of valid data points in bin

Step 8: Formulate Key Results of Power Curve

The Team then converted binned data into key results for further study and inclusion in the final report. These key results include:

- Power curve (output power vs. wind speed), normalized to sea level
- Power coefficient (system efficiency vs. wind speed), normalized to sea level
- AEP (projected annual energy output)
  - Based on site average wind speeds (Rayleigh distribution)
  - Site turbulence intensity scatter plot
  - Analysis of uncertainty

Extrapolation of Weather Data for Full Meteorological Dataset

Using logarithmic regression, the Cadmus Team developed a correlation between the monthly estimated hub height wind speeds, found in step 3 above, to monthly weather data provided by the National Oceanic

[44] The method of bins involves sorting data records into wind speed segments, generally of half integer sizes (i.e., 0.5-1 m/s, 1-1.5 m/s, 1.5-2 m/s).

and Atmospheric Administration (NOAA) for the Buffalo Niagara International Airport. The Team used this log correlation to predict monthly mean wind speeds for months of the year outside the measurement period.

Annual Energy Production Determination

Using the estimated monthly wind speeds found above, the Team estimated the monthly energy production using the Bergey WindCAD production estimation tool. The Cadmus Team utilized the following site specific data in estimating annual production:

- Mean wind speeds
- System power curve
- Weibull k (shape factor)
- Site altitude
- Turbulence factor

The WindCAD model was designed to generate annual production estimates. The Team utilized monthly mean wind speeds, along with site average Weibull shape and turbulence factors during the monitoring period, to estimate 12 annual energy production figures. The Cadmus Team then converted the 12 figures into monthly production estimates by normalizing for the number of days in each month using Equation 3-14.

Equation 3-14. Annual Energy Production Equation, Renewable Energy Program Area

$$P_i = P\frac{n_i}{365}$$

where:

P = The estimated annual energy production calculated by the WindCAD model (kilowatt hours/year)

n_i = The number of days in month 'i'

Long-Term Annual Energy Production Determination

Step 1: Normalize AEP to Long-Term Weather Data

First, the Team normalized the measured annual mean wind speed to the nearest available weather station long-term data (e.g., airport or other weather station).

Second, the Team calculated the ratio between the annual mean of the weather station data for the most recent year containing the measurement period, and for the long-term (10-year) mean of the weather station data using Equation 3-15.

Equation 3-15. Ratio of Short- to Long-Term Weather Station Wind Speed Data Calculation, Renewable Energy Program Area

$$R = \frac{U}{U_{LT}}$$

where:

R = The ratio of the weather station annual mean wind speed for the measurement period to the weather station long-term mean wind speed

U = The weather station annual wind speed for the measurement period (meters/second)

U_{LT} = The long-term predicted annual mean wind speed, accounting for seasonal variation in wind speeds (meters/second)

Third, the Cadmus Team adjusted the measured wind speed by the ratio in Equation 3-16 to account for annual variation.

Equation 3-16. Long-Term Predicted Annual Wind Speed Calculation with Seasonal Variation Calculation, Renewable Energy Program Area

$$U_{LT} = U_M \times R$$

where:

U_{LT} = The long-term predicted annual mean wind speed, accounting for seasonal variation in wind speeds (meters/second)

U_M = The measured mean wind speed for the measurement period (meters/second)

R = The ratio of the weather station annual mean wind speed for the measurement period to the weather station long-term mean wind speed

Finally, the Team used the long-term normalized wind speed values described above to estimate the 10-year estimated AEP.

Step 2: Comparison of Measured and Predicted AEP Values

The Cadmus Team compared the following measured and predicted AEP values:

- Measured AEP
- Measured AEP normalized to long-term weather station data
- Installer-generated AEP estimate

Variation between these estimates are reported as a percent.

3.3.5 Net Generation/Savings Calculations

In order to estimate freeridership for renewable energy technologies, the Cadmus Team examined the degree to which Renewable Energy Program Area activities led to the installation of renewable energy capacity that would not have occurred without the influence of the Program Area. The determination of Renewable Energy Program Area freeridership relied solely on the online participant survey described in Appendix E.

The survey included a number of questions designed to estimate Program Area-induced installation of renewable energy capacity and energy generation.

The Cadmus Team used respondents' answers to these questions to calculate freeridership based on an algorithm developed in coordination with NYSERDA prior to fielding the survey. As directed by NYSERDA, this algorithm is an adapted version of one used in recent evaluations of the FlexTech Program, which NYSERDA and the Cadmus Team updated to align more closely with the Renewable Energy Program Area.

The algorithm is based on several sets of questions and calculations: direct freeridership questions (FR5 and FR6), Program Area influence freeridership questions (FR2, FR3, and FR4), Program Area influence questions based on the impacts of lost funding (E8), turning down other funds after securing NYSERDA ARRA funds (AF8), and diverting funds to other projects after securing NYSERDA ARRA funds (AF10). Following a directive from the DOE, the estimate credits NYSERDA with generation proportionate to its contribution to the overall funding for the project (AF1 and AF2).[45] Finally, freeridership was weighted by the energy generation for each participant. The survey questions used in the algorithm are as follows:

- FR5, the likelihood of installing same system without ARRA funds (direct freeridership score)
- FR6, the capacity of system that would have been installed without ARRA funds (direct freeridership score)
- FR2, the stage of the project planning process before participating in the Program Area (Program Area influence score)
- FR3, the influence of Program Area funding (Program Area influence score)
- FR4, the importance of Program Area (Program Area influence score)
- E8, the likelihood of completing the project without ARRA funds (Program Area influence score, only asked if ARRA funds replaced previously secured funds that were lost)
- AF8, the likelihood of completing the project without ARRA funds (Program Area influence score, only asked if respondent turned down other funds after securing ARRA funds)
- AF10, the likelihood of diverting funds to other projects without ARRA funds (Program Area influence score, only asked if respondent diverted funds to another project after securing ARRA funds)
- AF1 and AF2, the portion of the project paid for with NYSERDA ARRA funds

In summary, estimating freeridership involved five steps:

1. Determining direct freeridership
2. Calculating Program Area influence score

[45] United States Department of Energy. *DOE Recovery Act Reporting Requirements for the State Energy Program (SEP).* Effective date: March 1, 2010. The directive to allocate Program Area effects in proportion to the amount of the project funded through ARRA recognizes that many projects receive funding from multiple sources, such as ARRA, other funding agencies, or their own operating budgets. Each of these entities has a legitimate claim on the energy saved, jobs created, and GHGs reduced as a result of the Program Area projects. To avoid double counting savings, the DOE concluded that the best approach is to have ARRA-funded Program Areas claim effects only in proportion to their savings.

3. Adjusting direct freeridership based on the Program Area influence score[46]
4. Adjusting freeridership by the percent of the project funded by NYSERDA ARRA
5. Weighting by the energy generation

Freeridership results are presented in the Net Savings Findings subsection, and the calculations are detailed in Appendix E.

The assessment does not take spillover[47] into account, because the renewable energy projects had been completed too recently to allow for spillover to have occurred (Peters and Bliss 2010). However, the Cadmus Team did note qualitatively whether the respondents indicated that NYSERDA ARRA funding induced them to adopt additional renewable energy or energy-efficiency measures.

The Cadmus Team developed freeridership estimates for three segments of RFP 10 participants: PV systems installed Upstate, PV systems installed Downstate, and non-PV systems.[48] The Team estimated freeridership for each segment by summing the generation across all the projects within each segment and dividing this number by the sum of anticipated generation across all projects within the same segment. Next, the Team developed an overall freeridership rate for RFP 10. The Cadmus Team developed weights based on anticipated *ex ante* generation from all active RFP 10 renewable energy projects (Table 3-60).

For the overall freeridership rates, the Team weighted each stratum proportionate to the anticipated *ex ante* savings. The Cadmus Team applied these weights to the project-specific estimates of generation net of freeriders to yield weighted generation net of freeriders for the projects. The final step involved summing the weighted generation net of freeriders across all the projects and dividing this number by the sum of anticipated generation across all projects, providing the final weighted freeridership. Freeridership is reported for all RFP 10 renewable energy projects in the Net Savings Findings subsection.

[46] The Cadmus Team compared the Program Area influence score to the direct freeridership score in order to examine the consistency of respondents' assessments of the Program Area's influence. NYSERDA's MCAC evaluation team had previously assigned a range of reasonable freeridership values for each Program Area influence score. For example, a maximum Program Area influence score of 5 is assumed to have a lower bound of 0% freeridership and an upper bound of 25% freeridership, with the assumption that a freeridership value higher than 25% would be inconsistent with the maximum Program Area influence score. For more details see: Summit Blue. *Commercial/Industrial Performance Program Market Characterization, Market Assessment and Causality Evaluation*. 2007.

[47] Spillover is the reduction in energy consumption and/or demand caused by the presence of an energy-efficiency program, beyond the program-related gross savings of the participants and without financial or technical assistance from the program. There can be participant and/or non-participant spillover. (Horowitz, Paul. *Glossary of Terms, Version 2.1*. 2011. Available online: http://neep.org/uploads/EMV%20Forum/EMV%20Products/EMV_Glossary_Version_2.1.pdf).

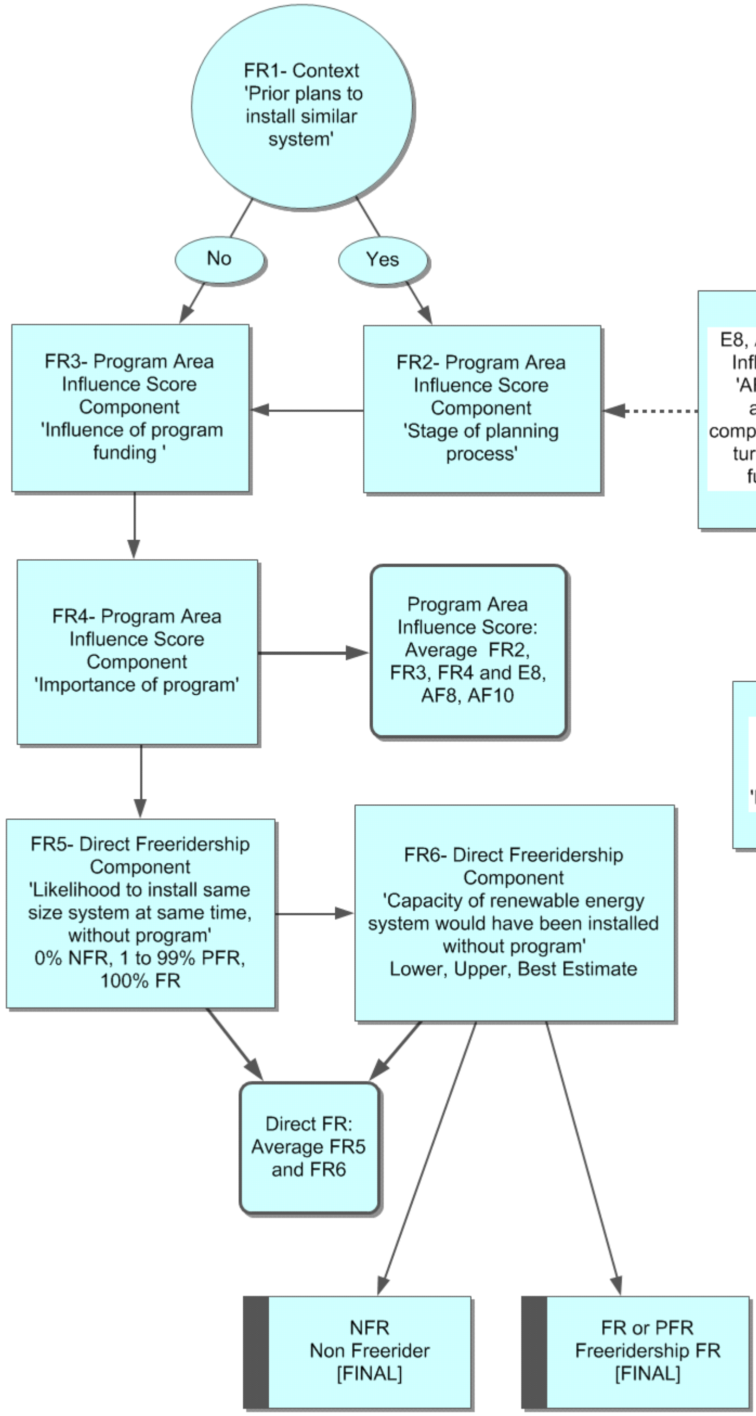
[48] The non-PV projects included wind turbines, biomass boilers, solar water heaters, solar thermal systems, and tracking PV systems.

Table 3-60. Population, Sample Sizes, and Weights for Projects, Renewable Energy Program Area

	Population (projects)	Sample Size (projects)	Population (generation; MMBtu)	Sample (generation; MMBtu)	Weight
PV Upstate	44	14	5,462	1,679	1.25
PV Downstate	11	3	1,571	297	2.03
Non-PV	10	6	7,034	3,429	0.79
Overall	**65**	**23**	**14,067**	**5,405**	

Figure 3-11 presents the algorithm graphically. The FR, AF, and E letters in the figure refer to questions from the survey, which is presented in Appendix D. The full algorithm and detailed calculations from the survey are presented in Appendix E, while the responses to the questions and the calculation of the final freeridership estimate are presented in the Net Savings Findings subsection (described on page 3-82).

Figure 3-11. Freeridership Algorithm Flow Chart, Renewable Energy Program Area



3.3.6 Gross Generation/ Savings Findings

The Cadmus Team conducted a variety of performance monitoring, site visits, and engineering analyses on systems funded under RFP 10, as was shown in Table 3-51. As summarized in Table 3-61, solar PV projects dominated the overall attributable generation/savings for the Renewable Energy Program Area, with significant contributions also made by solar thermal technologies. Comparison to *ex ante* savings/generation estimates is discussed in the following sections.

Table 3-61. Evaluated Gross Generation/Savings by Technology for All Projects, Renewable Energy Program Area

	Annual Gross Population Generation/Savings: All Funded Projects							
	Number of Projects	**Electric (MWh)**	**Electric (MMBtu)***	**Gas (MMBtu)**	**Oil (MMBtu)**	**Propane (MMBtu)**	**Other Fuels (MMBtu)**	**Total (MMBtu)**
PV Upstate	44	1,736	5,923	N/A	N/A	N/A	N/A	5,923
PV Downstate	11	546	1,862	N/A	N/A	N/A	N/A	1,862
Wind Upstate	3	90	307	N/A	N/A	N/A	N/A	307
Wind Downstate	0	N/A	N/A	N/A	N/A	N/A	N/A	0
Solar Thermal Upstate	2	-12	-41	2,826	N/A	N/A	N/A	2,785
Solar Thermal Downstate	1	N/A	N/A	N/A	414	N/A	N/A	414
SHW Upstate	2	4	14	121	N/A	N/A	N/A	136
SHW Downstate	0	N/A	N/A	N/A	N/A	N/A	N/A	0
Biomass Upstate	1	N/A	N/A	N/A	N/A	695	-604	91
Biomass Downstate	0	N/A	N/A	N/A	N/A	N/A	N/A	0
Tracking Solar PV Upstate	1	62	213	N/A	N/A	N/A	N/A	213
Tracking Solar PV Downstate	0	N/A	N/A	N/A	N/A	N/A	N/A	0
Total	**65**	**2,426**	**8,278**	**2,947**	**414**	**695**	**-604**	**11,731**

Note: Columns and rows may not sum correctly due to rounding.

* Electricity conversion is done at the project site, and uses a conversion of 3.412×10^{-3} MMBtu/MWh.

Further details on technology-specific results are outlined in the following sections.

<u>Biomass</u>

As noted above, the biomass project was not eligible for site visit or monitoring, and the reported savings were maintained. The single funded biomass boiler project is expected to reduce propane consumption by 7,609 gallons/year, while increasing the consumption of wood chips by approximately 60.4 tons per year. A small reduction in overall fuel consumption is expected due to a small increase in combustion efficiency associated with the new boiler.

Solar Hot Water

Two SHW systems were installed under RFP 10. As discussed previously, neither site was eligible for performance monitoring as part of this evaluation. The Cadmus Team obtained the most relevant and recent evaluation results for SHW systems in New York from our evaluation of NYSERDA's SEP funded programs.[49] The SEP evaluation, through performance monitoring and analysis, yielded a realization rate of 0.7,[50] which the Team applied to the *ex ante* savings provided by NYSERDA. The annual energy savings due to the two funded SHW projects are expected to be 136 MMBtu, primarily offsetting the use of natural gas. Figure 3-12 shows a picture of roof-mounted solar collectors.

Figure 3-12. Roof-Mounted Solar Collectors at SHW System, Renewable Energy Program Area

Solar Photovoltaic

A total of 55 solar PV systems were funded and completed under RFP 10. Of these, the Cadmus Team conducted site visits and engineering analyses at 36 sites, obtaining valid results for 23 projects. The Cadmus Team was forced to discard site visit results for three projects. These three projects either did not have cumulative energy metering data available and/or the Cadmus Team was not able to confirm a startup date for the system.

Based on site visits and engineering analyses of 23 funded solar PV systems, the overall population of energy generation was determined to be higher than *ex ante* estimates, as shown in Table 3-62, yielding an overall realization rate of 107% for solar PV systems.

[49] The Cadmus Group, Inc., Abt SRBI, Beacon Consultants, et al. *NYSERDA America Reinvestment and Recovery Act 2012 Impact Evaluation Report: State Energy Programs.* April 2012.

[50] The SHW realization rate was reduced primarily due to a mistaken assumption of baseline energy conversion.

Table 3-62. Solar PV Sample Realization Rate, Renewable Energy Program Area

	Annual Energy Generation
Sample Size	*23*
Ex Ante Generation (kWh)	737,074
Ex Post Generation (kWh)	790,533
Realization Rate	1.07

In calculating the sample generation and realization rate, the Cadmus Team used a combination of TMY3 and historical irradiance data to correlate the measured electrical generation with actual weather conditions during each project's operational period. The Team obtained these data from the Solar Data Warehouse, a private company that sells ground-based solar radiation data.

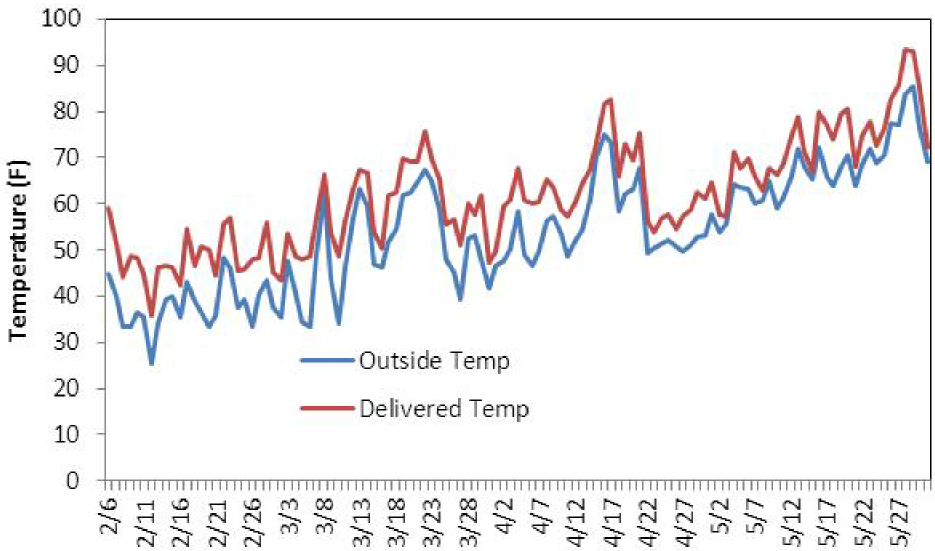
Applying the sample realization rate from Table 3-62 to the entire population of 55 solar PV systems funded under RFP 10 yields a total population generation of 2,282 MWh/year.

Solar Wall

Three solar wall projects were funded under RFP 10. The Cadmus Team monitored the performance of two of the funded solar walls, including relevant balance of system components, such as fan units and controllers. The two solar walls monitored reflect two common configurations. First, some solar walls are installed with distribution ductwork and fans to supply fresh air to buildings that do not already include mechanical outside air distribution systems. The second type of system examined is similar but uses heated air from the solar wall system to preheat the fresh air intake of an existing HVAC system. In this case, the solar wall does not have a dedicated fan and distribution ducting, but rather relies on the fan and ducting of the existing HVAC system.

Figure 3-13 depicts the daily operation of one of the RFP 10 funded solar walls. As sunlight heats up the collector surface, ambient outdoor air is pulled through the solar wall and then ducted into the conditioned space as pre-heated air. The solar wall air temperature is consistently five to 15 degrees higher, as a daily average, than ambient outdoor temperature.

Figure 3-13. Example Daily Temperature Profile of Solar Wall Heated Air and Ambient Outdoor Air, Renewable Energy Program Area



The solar walls funded under RFP 10 achieved an overall realization rate of 46%, for an expected annual savings of 3,203 MMBtu. The lower than expected savings were largely driven by the control scheme for one of the solar walls monitored, as discussed below.

As part of the evaluation of NYSERDA RFP 1613, the Cadmus Team monitored the performance of a solar wall installed in Plattsburg, New York. Three other solar walls were installed at the same site under RFP 10, one of which was monitored as part of this evaluation. The monitored solar wall has the same general configuration (collector area, orientation, equipment specifications) as the solar wall monitored for the RFP 1613 evaluation, and it would be reasonable to expect similar energy savings. However, over the course of this evaluation, the Cadmus Team identified several key differences between the two projects' (funded by RFP 10 vs. RFP 1613) operational patterns, as shown in Table 3-63.

Table 3-63. Key Parameters and Performance Metrics for Similar Solar Walls Funded Under RFP 10 and RFP 1613, Renewable Energy Program Area

Specification	Solar Wall A (RFP 1613)	Solar Wall B (RFP 10)
Collector Area (square feet)	6,000	6,000
Expected Energy Savings (MMBtu/year)	937	937
Observed Energy Savings (MMBtu/year)	828	420
Average Indoor Air Temperature (Fahrenheit)	61.4	56.1

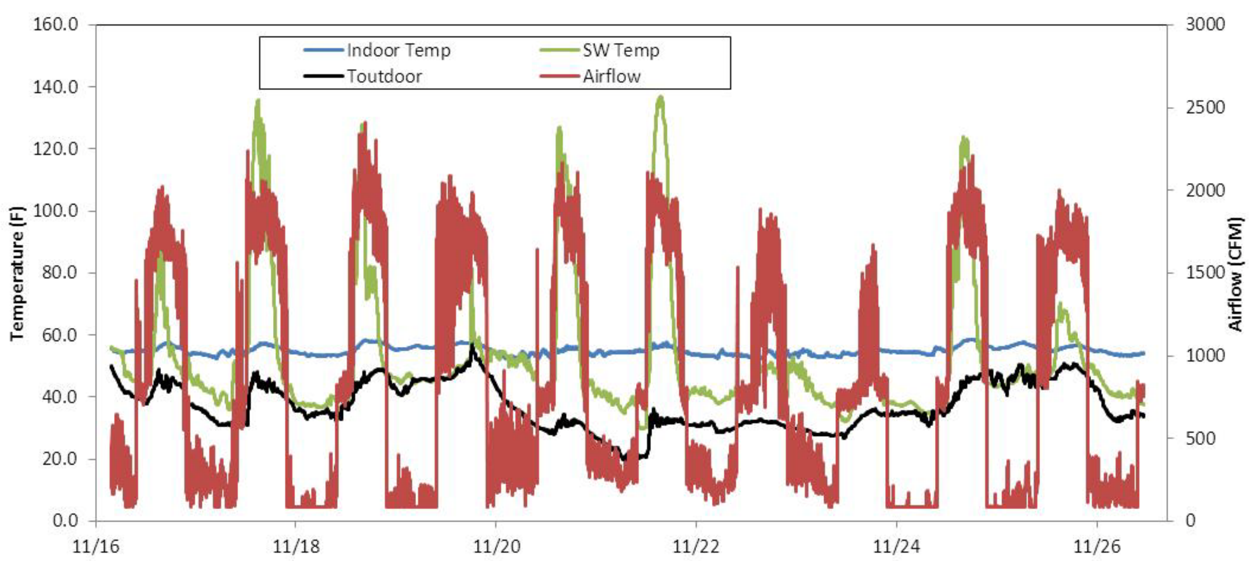
As shown in Table 3-63, despite identical physical characteristics and being located at the same site, the energy savings from the two solar walls are markedly different. The cause of this difference is likely the differing control schemes for the two systems, in particular:

- The RFP 10 funded wall operates from 5:00 a.m. to 5:00 p.m. (Eastern Standard Time), with the solar wall air damper defaulted to 50% open. When the solar wall air temperature reaches 45 °F, the damper opens further to allow more preheated air into the building. During off-hours, from 5:00 p.m. to 5:00 a.m., the solar wall air damper is closed.
- By contrast, the solar wall funded under RFP 1613 operates continuously. This results in the air being pre-heated by the solar wall even when the resulting delivered air temperature is below 45 °F.

For example, if the outdoor air temperature at the site were 30 °F and both solar walls were able to deliver air at 40 °F, the RFP 1613 funded solar wall would deliver the 40 °F air, while the RFP 10 funded wall would not. In terms of delivered energy, the RFP 1613 funded wall would supply enough heat to raise the delivered air temperature by 10 °F, but the preheated air would still require the baseline heating system to supply the remainder of the energy to raise the air from 40 °F to the indoor air temperature. As neither facility had pre-existing mechanical ventilation prior to the installation of the solar walls, the energy savings are calculated on the basis that all of the fresh air delivered by the solar wall would have otherwise been delivered by a standard ventilation system without the solar wall preheat. As a result, the measured energy delivered by the RFP 1613 funded solar wall exceeds that provided by the RFP 10 funded solar wall. This difference may also be partly driven by over-ventilation, albeit with pre-heated air, of the RFP 1613 funded solar wall. In this case, the site owners should evaluate the ventilation requirements of both buildings.

Since performing the RFP 10 evaluation, the Cadmus Team has contacted the solar wall site's building manager to help rectify the inefficient equipment controls. Figure 3-14 show the change in temperature and airflow over 10 days in November.

Figure 3-14. RFP 10-Funded Solar Wall Installation, Renewable Energy Program Area



Tracking Solar Photovoltaic

Two tracking solar PV systems were funded under RFP 10. Tracking solar PV systems can often generate up to 50% more energy than traditional fixed axis systems. The Cadmus Team monitored the energy output and relevant environmental parameters of one of the two tracking PV systems. The monitored system achieved a realization rate of 119% and is expected to generate 9.7 MWh annually.[51]

Figure 3-15 shows a tracking solar PV system at one of the program sites.

Figure 3-15. Tracking Solar PV Array, Renewable Energy Program Area

Wind Turbine

Three wind turbine projects, comprising six turbines, were funded under RFP 10. The Cadmus Team conducted a site visit at one of these project and detailed performance monitoring at another one of the projects. Figure 3-16 depicts a small wind project site.

Figure 3-16. Small Wind Project (two turbines), Renewable Energy Program Area

[51] The NYSERDA SEP evaluation included monitored data on a similar tracking PV project that yielded a realization rate of 119%.

Our performance monitoring findings include the following metrics:

- Data recovery rate
- Measured mean wind speed at 25 meters and 32 meters
- Estimated (extrapolated) mean wind speed at hub-height (36.6 meters)
- Wind speed probability distribution
- Shear coefficient
- Directional wind frequency distribution
- Directional wind power distribution
- SWT system power curve (output power vs. wind speed)
- SWT normalized to sea level and site average air density
- Estimated AEP
- Turbulence intensity

Meteorological Data

The Cadmus Team sampled meteorological data in 10-minute intervals between November 29, 2011 and June 30, 2012. Table 3-64 lists the raw meteorological data recovery statistics for the wind project monitored as part of this evaluation.

Table 3-64. Raw Data Recovery Statistics at Royalton Town Hall Site, Renewable Energy Program Area

Data Column	Possible	Valid	% Recovery
25-meter Wind Speed	30,759	25,432	83%
32-meter Wind Speed	30,759	17,203	56%
Wind Direction	30,759	28,845	94%
Temperature	30,759	25,451	83%

Table 3-65 lists the key meteorological data statistics for the monitored wind project.

Table 3-65. Meteorological Statistics for Royalton Town Hall Site, Renewable Energy Program Area

Measurement Height	25 meters	32 meters
Mean Wind Speed (meters/second)	5.0	5.7
Maximum 10-minute Average Wind Speed (meters/second)	44	39
Turbulence Intensity*	0.17	0.16
Mean Power Density	90	163
Weibull k	2.17	2.13

* The Team calculated turbulence intensity according to the third edition of International Electrotechnical Commission standard 61400-1.

Figure 3-17 illustrates the monthly mean wind speeds at the monitored site during the monitoring period. The Team estimated values for June 2011 through October 2011, as well as for May 2012, according to the methodology described in Program Area Generation Assumptions and Engineering Analysis.

Figure 3-17. Monthly Mean Wind Speeds at Royalton Town Hall Site, Renewable Energy Project Area

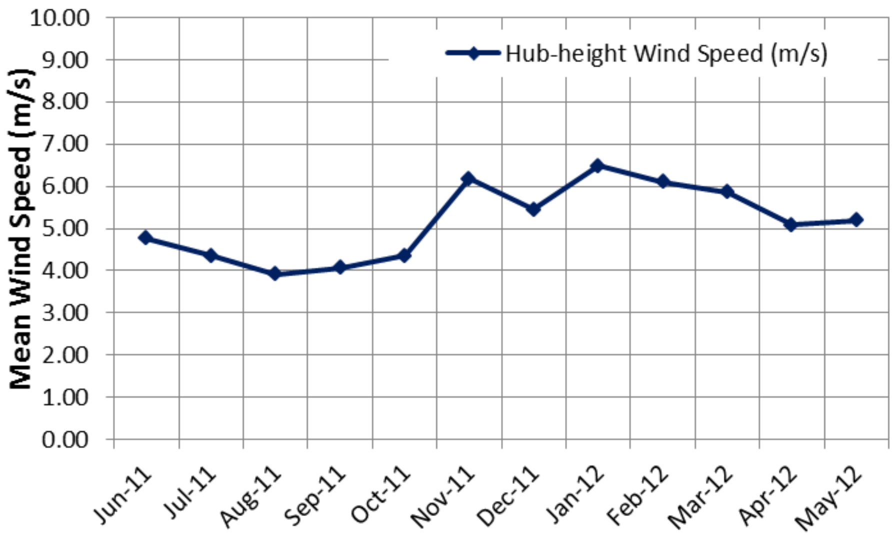


Figure 3-18 illustrates the wind directional frequency at the site for the meteorological monitoring period.

Figure 3-18. Hall Site Wind Rose, Renewable Energy Program Area

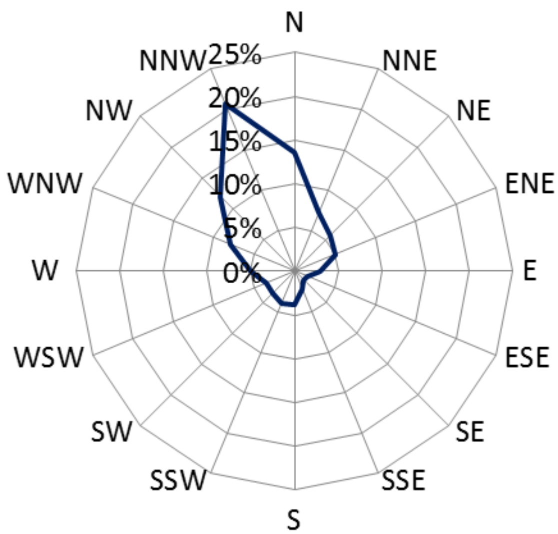
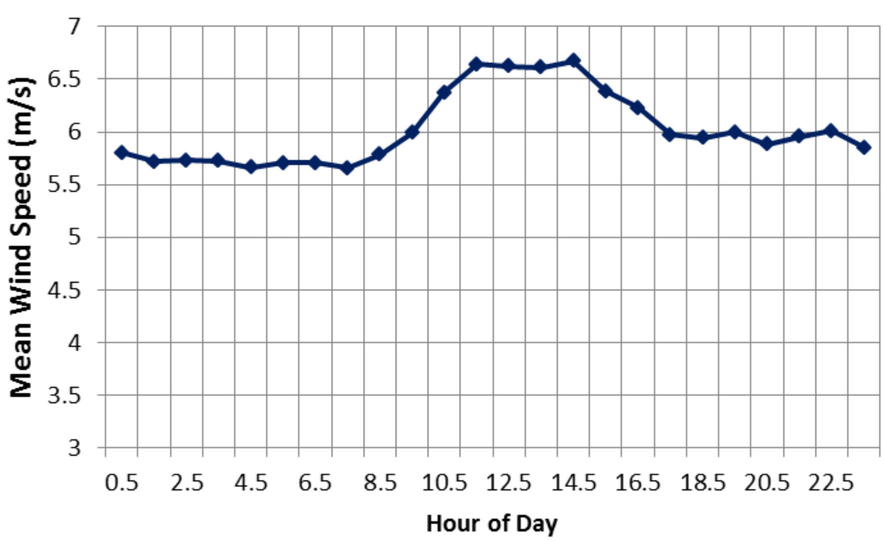


Figure 3-19 illustrates the diurnal wind speed profile for the monitored site. Daily radiation cycles cause differential heating of the earth's surface throughout the course of a day. During the nighttime, as the ground radiates heat into the night sky, cold air settles below the warm air, creating a stable atmospheric condition. During the daytime, as the ground heats up due to the sun's radiation, this heat is transferred to the air which, being buoyant, rises as it travels to regions of lower pressure.

Figure 3-19. Diurnal Wind Speed Profile for Monitored Site, Renewable Energy Program Area



System Events

As can be seen in Table 3-66, two storm events caused downtime for the wind turbines. High winds shut down the inverters on both turbines. The second event damaged one of the inverters, which was replaced after approximately nine days of downtime.

Table 3-66. Wind System Event Log for Royalton Town Hall Site, Renewable Energy Program Area

Date	Description
March 2012	Extremely high winds at the site caused both inverters to trip. The system's host became aware of this on March 10, 2012 and reset the systems at that time.
May/June 2012	System owner reported that both turbines tripped during a storm on May 29, 2012. The east turbine was manually restarted on June 4; however, the west inverter was damaged and subsequently replaced on June 8, 2012.

During the monitoring period, there were three events when components of the wind data failed or were replaced as detailed in Table 3-67.

Table 3-67. Data System Event Log for Royalton Town Hall Site, Renewable Energy Program Area

Date	Description
December 2011	Current transducer for west turbine failed
March 2012	Data loggers were replaced with updated units
April 2012	Wind speed and direction sensor at 32-meter height failed

Power Performance

Table 3-68 lists the data recovery statistics for power production at the site. The Cadmus Team screened the data extensively for their applicability to power performance assessment. Power performance data recovery statistics appear in Table 3-69.

Table 3-68. Raw Power Performance Data Recovery Statistics for the Monitored Site, Renewable Energy Program Area

Data Column	Possible	Valid	% Recovery
Power (East)	30,759	30,515	99%
Power (West)	30,759	27,612	90%

Table 3-69. Screened Power Performance Data Recovery Statistics for Royalton Town Hall Site, Renewable Energy Program Area

Data Column	Possible	Valid	% Recovery
Power Data	30,759	7,589	25%
36.6 Meter Extrapolated Wind Speed	30,759	7,655	25%

Figure 3-20 and Figure 3-21 illustrate the measured power curve for each turbine. Insufficient data were available above 13 meters/second in the wind speed bins to characterize turbine performance. The Team calculated uncertainties for the wind speed range of 4 meters/second through 13 meters/second; these tables are included in Appendix J.

Figure 3-20. Measured Power Curve (west turbine), Royalton Town Hall Site, Renewable Energy Program Area

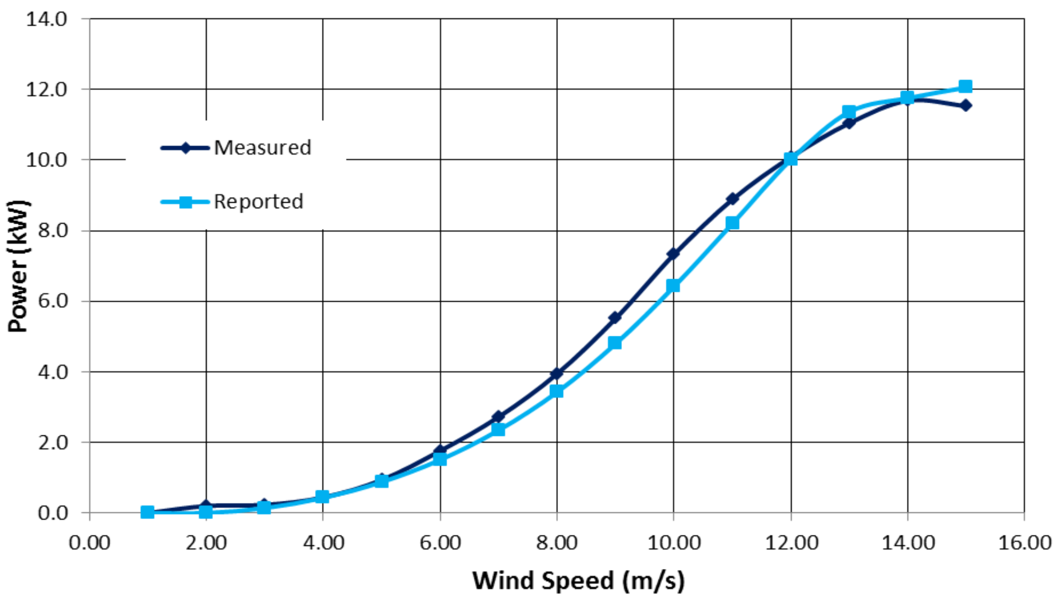
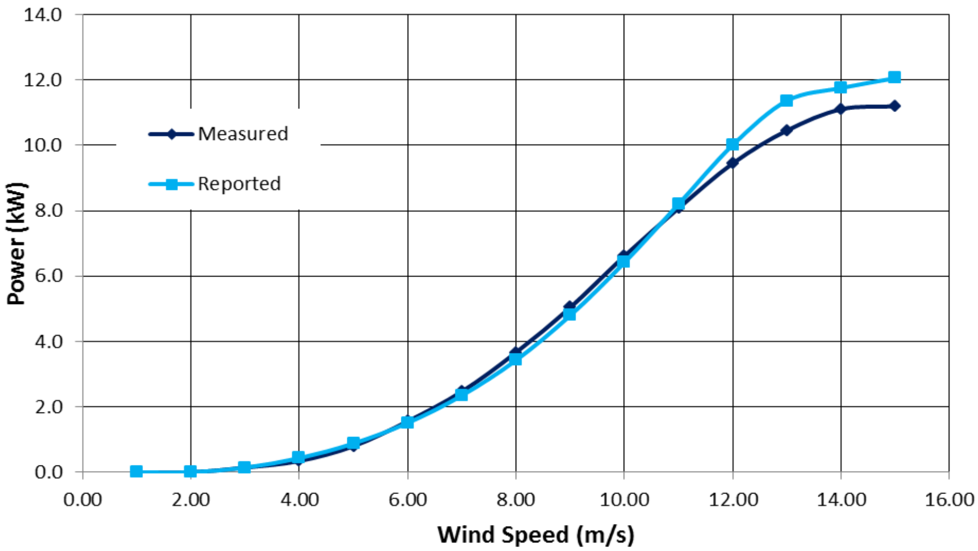


Figure 3-21. Measured Power Curve (east turbine), Royalton Town Hall Site, Renewable Energy Program Area



AEP Estimates

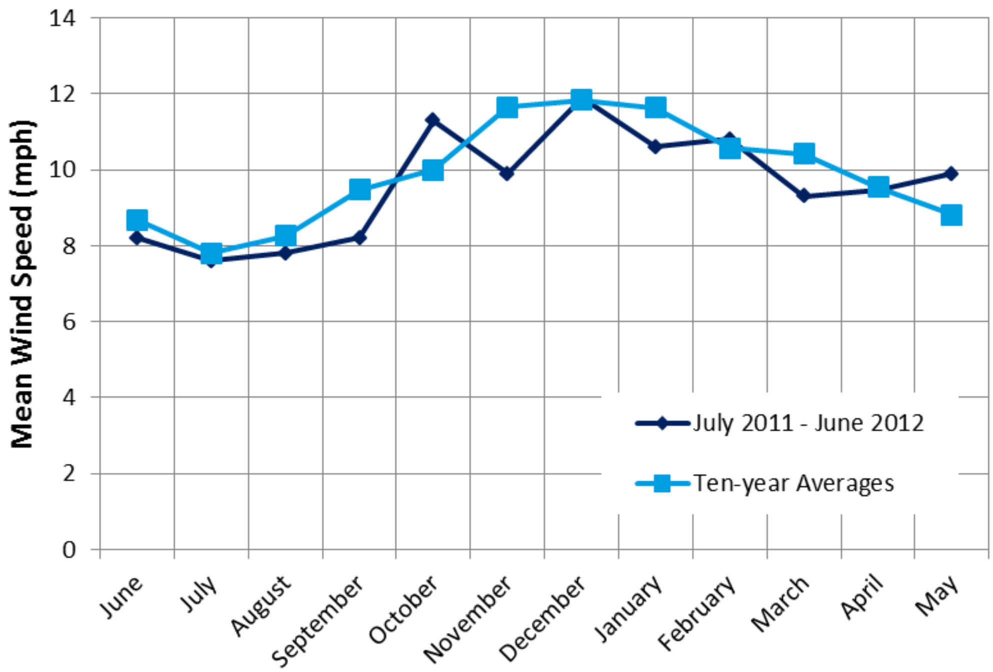
Table 3-70 lists the estimated AEP and long-term estimated AEP for each turbine at the monitored site. The single year value closely approximates the installer's per-turbine estimate of 14,464 kWh/yr.

Table 3-70. AEP Estimates for Each Wind Turbine at Monitored Site, Renewable Energy Program Area

Estimate	East	West	Total
Estimated AEP (kWh/yr)	13,797	15,573	29,370
Estimated Long-term AEP (kWh/yr)	14,156	17,209	31,365

Figure 3-22 shows the comparison of the monthly mean wind speeds during the monitoring period to the monthly mean wind speeds of the previous 10 years using data from the Buffalo Niagara Airport.

Figure 3-22. Monthly Mean Wind Speeds During Monitoring Period and Previous 10 Years at Buffalo Niagara Airport, Renewable Energy Program Area



Source: NOAA Climatological Database, 2002-2012

3.3.7 Net Savings Findings

This section summarizes the results of the freeridership-related survey questions. As described previously in the Net Generation/Savings Calculations subsection, following an algorithm previously developed by NYSERDA and modified for this Program Area, the Cadmus Team estimated freeridership for the renewable energy projects through several sets of questions: direct freeridership questions (FR5 and FR6), Program Area influence freeridership questions (FR2, FR3, and FR4), and Program Area influence questions based on the impacts of lost funding (E8), turning down other funds after securing NYSERDA ARRA funds (AF8), and diverting funds to other projects after securing NYSERDA ARRA funds (AF10). Following a directive from the DOE, the estimate credits NYSERDA with generation proportionate to its contribution to the overall funding for the project (AF1 and AF2; U.S. DOE 2010).

In summary, estimating freeridership involved five steps:

1. Determining direct freeridership
2. Calculating the Program Area influence score
3. Adjusting direct freeridership based on the Program Area influence score (Summit Blue 2007)
4. Adjusting freeridership by the percent of the project funded by NYSERDA ARRA
5. Weighting by the energy generation

The five steps involved in estimating freeridership are illustrated below in Table 3-71. The calculations the Team used in each step are described in detail in Appendix E.

The results suggest that freeridership was approximately 5% for the Renewable Energy Program Area RFP 10 as a whole. The Cadmus Team determined the final freerider rate for the Program Area at a 90% confidence level with a precision of 7 percentage points, or an approximate range from >0% to 13%.[52][53]

Among the individual technology groups, freeridership is estimated to be 0% for PV Downstate, 6% for non-PV projects, and 7% for PV Upstate.[54] Freeridership and net-of-freeridership estimates with 90% confidence intervals are presented in Table 3-71. However, due to the small sample sizes for all three technology groups (and especially for PV Downstate and non-PV projects), the estimates of freeridership and net-of-freeridership values should be interpreted with caution (as illustrated by the larger confidence intervals). Further, the estimates of freeridership and net-of-freeridership do not take spillover into account, because the projects had been completed too recently to allow for spillover to have occurred. Finally, there is little evidence of takeback (i.e., increased energy use as a result of installing the renewable energy system).

[52] We calculated precision on the ratio of ex ante *net* to ex ante *gross* savings. This is a more appropriate and more efficient way of estimation than estimating precision around a proportion. That is why the precision noted here is greater than was reported in Table 3-44. We denote the lower bound of the confidence interval ">0" because the confidence interval includes the value 0% but we know there is at least a small amount of freeridership in the program given the answers to the survey.

[53] Other renewable energy programs' report similar low levels of freeridership, although comparisons are difficult because the other programs' evaluations focused on residential and commercial renewable energy programs. The 2005 *End Use Renewable Energy Market Characterization, Market Assessment and Causality Evaluation* (SERA and Summit Blue) estimated a freeridership value of 0% and spillover value of 0% for NYSERDA's New York Energy $mart SM End-use Renewable Energy Program.

[54] None of the freeridership values for the technology groups are statistically significantly different from each other.

Table 3-71. Freeridership Scores, Renewable Energy Program Area

	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
(1) Mean direct freeridership; average response to FR5 and FR6	5%	5%	0%	14%
(2) Mean Program Area influence score; average score of FR2,* FR3, FR4, and, if applicable, E8, AF8, and AF10 (with 1 indicating weak Program Area influence and 5 indicating strong Program Area influence)	4.7	4.7	4.8	4.4
(3) Freeridership, adjusted by Program Area influence score (the Program Area influence score is associated with lower and upper bounds of freeridership, as defined by the FlexTech algorithm. See Appendix E for more details)	5%	5%	0%	14%
(4) & (5) Freeridership, weighted by generation attributable to NYSERDA ARRA funding (90% confidence interval)**	5% (>0%, 13%)	7% (0%, 15%)	0% (0%, 0%)	6% (>0%, 20%)

* Question FR2 was reverse scored such that the response indicating the greatest influence of NYSERDA ARRA funding also received the highest score, and the answers were adjusted to a 5-point scale by multiplying the outcome by 5/6.

** This row shows the lower and upper bounds of the 90% confidence interval, with 0% as the lower bound for each.

The Cadmus Team benchmarked this Program Area's freeridership results with results from other studies that evaluated similar programs. In these other studies,[55] freeridership rates averaged approximately 0.22. One report calculated freeridership as less than 5%, with a NTG close to 1.0 for solar PV measures.[56] A recent evaluation of a commercial solar PV program in Oregon estimated freeridership rates of 11%.[57] A recent evaluation of a solar PV program in Wisconsin estimated freeridership rates of 19% for residential participants and 21% for commercial participants.[58] The Renewable Energy Program Area freeridership rate of 4% for RFP 10 is low relative to these other programs.

The remainder of this section summarizes the responses to the survey questions that factored into this freeridership calculation, as well as questions that provided important context or explanations in support of the freeridership calculation. The Cadmus Team reports the responses to individual questions in the order they were incorporated into the calculations of freeridership, as presented in Table 3-71 (direct freeridership questions first, followed by Program Area influence questions, and finally the percentage of the projects funded by NYSERDA ARRA).

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[55] The Cadmus Group, Inc. *WI Focus on Energy Renewables Impact Evaluation Report for Jan-Sep 2009*. 2010. and The Cadmus Group, Inc. *WI Focus on Energy Renewables Impact Evaluation Report*. 2010.

[56] NYSERDA. *End-Use Renewables Market Characterization, Market Assessment and Causality Evaluation.* 2005.

[57] Research Into Action. *Final Report Fast Feedback Program Rollout: Nonresidential & Residential Program Portfolio.* 2010. Available online: http://energytrust.org/library/reports/101231_Fast_Feedback_Rollout.pdf.

[58] TetraTech. *Renewables: Impact Evaluation CY10 September 2009 through June 2010.* 2011.

<u>Direct Measures of Freeridership (FR5 and FR6)</u>

The Cadmus Team based the first step in estimating freeridership on responses to two questions that measured freeridership directly. Specifically, the Team asked respondents: 1) to estimate the percent likelihood that they would have installed the same size system, at the same time, if the Renewable Energy Program Area had not been available (FR5), and 2) to estimate the capacity of the renewable energy system that they would have installed if the NYSERDA ARRA funds had not been available (FR6). The Cadmus Team estimated direct freeridership by calculating the average response to these two questions.

First, respondents estimated the percent likelihood that they would have installed the same size renewable energy system, at the same time, if the Renewable Energy Program Area had not been available. The indicated their likelihood using an open-ended scale of 0% (indicating that they definitely would not have installed a renewable energy system) to 100% (indicating that they definitely would have installed the same renewable energy system at the same time).

Table 3-72 shows that nearly all respondents indicated that it was very unlikely that they would have installed the same efficiency and same size system at the same time: 93% reported a likelihood between 1% and 25%, while one respondent reported a likelihood between 26% and 50% and another reported a likelihood of between 51% and 75%. The average likelihood reported was 5.4%.

Table 3-72. FR5, Likelihood of Installing Same Size System at Same Time in Absence of Renewable Energy Program Area

Percent Likelihood	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Mean percent likelihood	5.4%	4.3%	0%	16.7%
1-25%	93% (21)	93% (13)	100% (3)	83% (5)
26-50%	4% (1)	7% (1)	0% (0)	0% (0)
51-75%	3% (1)	0% (0)	0% (0)	17% (1)
76-100%	0% (0)	0% (0)	0% (0)	0% (0)

Note: This question was open-ended.

Note: Totals may not sum 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Next, the Cadmus Team asked respondents to estimate the capacity of the renewable energy system that they would have installed if the NYSERDA ARRA funds had not been available (Table 3-73). Overall, the systems that would have been installed without ARRA funds would have had 3% of the capacity of the installed systems. Considering the populations separately, without ARRA funds, the Upstate PV respondents on average would have installed systems representing a larger percentage of the installed capacity than Downstate PV systems or non-PV systems.

Table 3-73. FR6, Capacity of Renewable Energy System That Would Have Been Installed in Absence of Renewable Energy Program Area

Capacity of System as a Percent of Installed System	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*20*	*13*	*3*	*4*
Mean percent	3%	6%	0%	0%
0-25%	95% (19)	92% (12)	100% (3)	100% (4)
26-50%	0% (0)	0% (0)	0% (0)	0% (0)
51-75%	0% (0)	0% (0)	0% (0)	0% (0)
76-100%	5% (1)	8% (1)	0% (0)	0% (0)

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Note: Three respondents did not answer the question.

The Cadmus Team estimated the direct freeridership by first calculating the average of responses reported in Table 3-72 and Table 3-73 for each respondent. Overall, more than 90% of respondents have a direct freeridership value between 0.0 and 0.25. The overall direct freeridership is very low, at 5% (Table 3-74). Considering the populations separately, direct freeridership is highest for the non-PV respondents (14%), followed by Upstate PV respondents (5%) and Downstate PV respondents (0%).

Table 3-74. Direct Freeridership (average of FR5 and FR6), Renewable Energy Program Area

Direct Freeridership Score	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Mean direct freeridership score	5%	5%	0%	14%
0.00-0.25	91% (21)	93% (13)	100% (3)	83% (5)
0.26-0.50	0% (0)	0% (0)	0% (0)	0% (0)
0.51-0.75	9% (2)	7% (1)	0% (0)	17% (1)
0.76-1.00	0% (0)	0% (0)	0% (0)	0% (0)

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Program Area Influence Score

Estimating freeridership required calculating a Program Area influence score, which the Cadmus Team estimated by calculating the average score of three individual Program Area influence questions, FR2, FR3, and FR4. Additional Program Area influence questions were included if a project lost funding (E8), if a project turned down other funds after securing NYSERDA ARRA funds (AF8), or if a project diverted funds to other projects after securing NYSERDA ARRA funds (AF10).

First, respondents reported whether they were planning to install a similar system prior to participating in the Renewable Energy Program Area. Table 3-75 shows that 16% of respondents were planning to install a similar system.

Table 3-75. FR1, Prior Plans to Install Similar System, Renewable Energy Program Area

Response	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Yes	16% (4)	21% (3)	0% (0)	17% (1)
No	84% (19)	79% (11)	100% (3)	83% (5)

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The Team then presented the four respondents who indicated that they had been planning to install a similar system with a list of statements describing various stages in the planning process, and asked them to indicate which statement best described the project before they participated in the Renewable Energy Program Area. A response of 1 indicated preliminary planning and strong Program Area influence on the decision to install the renewable energy system (Table 3-76).

One out of these four respondents chose the statement indicating that they had taken initial steps toward considering the equipment, but had not considered specific types of equipment or the costs involved. One respondent was at an earlier phase of planning, having had preliminary internal discussions about installing such a system, but had not contacted any vendors or contractors about the idea. One responded had in-depth discussions of specific types of renewable equipment, including positive and negative attributes, as well as costs. The remaining respondent (for non-solar PV) was in an advanced stage of planning, having chosen specific equipment models, and had accounted for the cost of the project in the organization’s budget.

Table 3-76. FR2, Point in Project Planning Process Before Participation in Renewable Energy Program Area

Statements of Planning Stage	Overall*	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*4*	*3*	*0*	*1*
Had preliminary internal discussions, but no plans and no contact with a vendor, contractor, or installer.	28% (1)	33% (1)	0% (0)	0% (0)
Had taken initial steps toward considering the equipment, such as requesting information from or discussing options with a vendor, contractor, or installer.	28% (1)	33% (1)	0% (0)	0% (0)
Had in-depth discussions of specific types of renewable equipment, including positive and negative attributes and costs.	28% (1)	33% (1)	0% (0)	0% (0)
Had identified specific equipment and models but had not begun the budgeting process.	0% (0)	0% (0)	0% (0)	0% (0)
Had identified specific equipment and models but the budget did not allow completion of project.	0% (0)	0% (0)	0% (0)	0% (0)
Had identified specific equipment and models and incorporated project into budget.	17% (1)	0% (0)	0% (0)	100% (1)

Note: Base is respondents who had plans to install a renewable energy system prior to learning about the ARRA funding.

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The Team used responses to the next question to gauge the influence of the NYSERDA funding on respondents' decision to install their system. The Cadmus Team presented respondents with a list of statements describing various levels of influence, and asked them to choose the statement that best indicates the effect of the Renewable Energy Program Area on their decision process. As shown in Table 3-77, a large majority (93%) said that the funding was either a major driver in the decision or the primary reason that the system was installed. One respondent (4%) said that the funding "*helped in choosing to install a system that had been discussed but not thoroughly considered,*" and another said that the funding "*helped in making the final decision*" to install a system that had already been considered.

Table 3-77. FR3, Influence of Renewable Energy Program Area on Decision to Install Equipment

Description of Influence	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
No influence; same type and capacity system would have been installed without the Renewable Energy Program Area.	0% (0)	0% (0)	0% (0)	0% (0)
The Renewable Energy Program Area funding helped in making the final decision on the system that had already been thoroughly considered.	3% (1)	0% (0)	0% (0)	17% (1)
The Renewable Energy Program Area and funding helped in choosing to install a system that had been discussed but not thoroughly considered.	4% (1)	7% (1)	0% (0)	0% (0)
The Renewable Energy Program Area funding was a major driver in the decision to install the system.	33% (8)	29% (4)	33% (1)	50% (3)
The Renewable Energy Program Area funding was the primary reason that the system was installed.	60% (13)	64% (9)	67% (2)	33% (2)

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

When asked how important the Renewable Energy Program Area was in the decision to install the system, on a scale from 1 (indicating that it was not at all important) to 5 (indicating that it was very important), most respondents (93%) indicated that it was very important, while the remaining 7% said it was somewhat important to their decision (Table 3-78).

Table 3-78. FR4, Importance of Renewable Energy Program Area on Decision to Install System

Importance	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Mean (Scale 1-5)	4.9	4.9	5.0	4.8
1 Not at all important	0% (0)	0% (0)	0% (0)	0% (0)
2 Somewhat unimportant	0% (0)	0% (0)	0% (0)	0% (0)
3 Neither important nor unimportant	0% (0)	0% (0)	0% (0)	0% (0)
4 Somewhat important	7% (2)	7% (1)	0% (0)	14% (1)
5 Very important	93% (21)	93% (13)	100% (3)	86% (5)

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The Team included additional Program Area influence questions in the average Program Area influence score if a project lost funding (E8), turned down other funds after securing NYSERDA ARRA funds (AF8), or diverted funds to other projects after securing NYSERDA ARRA funds (AF10).

The Team asked respondents whose projects were not fully covered by NYSERDA funds whether any of the other funding sources they used had required that they obtain matching funds from additional funding sources. No respondents indicated that this was the case, so the need to secure matching funds was not a major driver to participation in the NYSERDA ARRA Program Area.

For the next few survey questions, the Cadmus Team asked respondents about any attempts they might have made to secure financing for the project they completed through the Renewable Energy Program Area before they applied for NYSERDA funds, as well as whether those attempts were successful and how they used previously secured funds. Table 3-79 shows that three respondents (13%) had tried to obtain funding for the project before applying for NYSERDA funds.

Table 3-79. Whether Respondents had Previously Attempted to Secure Financing for Project, Renewable Energy Program Area

Response	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Yes	13% (3)	7% (1)	33% (1)	17% (1)
No	87% (20)	93% (13)	67% (2)	83% (5)

Note: Columns may not sum to 100% due to rounding.The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The results of two follow-up questions indicate that only one respondent was successful in securing additional funding before applying for NYSERDA funds, and that they declined these funds before receiving NYSERDA ARRA funds because the original funding was not enough to complete the project. This respondent said that it was not at all likely that, if the NYSERDA funds had not been available, the project would have been completed.

No respondents reported losing funds, and no respondents reported securing other financing that they turned down after receiving the NYSERDA funds, suggesting that, in general, NYSERDA ARRA funds did not make up for lost funds. Further, because only 13% of respondents had tried to secure financing before applying to NYSERDA for funding, it is not clear if the NYSERDA ARRA funds provided financing when alternative funds were difficult to obtain.

The Cadmus Team then asked respondents whether the NYSERDA funds allowed them to divert monies that had been budgeted for the renewable energy project to other projects, which would indicate a form of Program Area spillover (both energy and non-energy related). Just over one-tenth (12%) responded in the affirmative (Table 3-80).

Table 3-80. Whether NYSERDA Funds Allowed Respondent to Divert Budget to Other Projects, Renewable Energy Program Area

Response	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Yes	12% (3)	14% (2)	0% (0)	17% (1)
No	88% (20)	86% (12)	100% (3)	83% (5)

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The three respondents who said NYSERDA funds allowed them to divert budget to other projects rated the likelihood that they would have diverted those funds if the NYSERDA funds had not been available. Two of the three said that it is not at all likely they would have diverted these funds to other projects (indicating strong Program Area influence), while the third said it was somewhat likely that they would have done so (Table 3-81).

Table 3-81. AF10, Likelihood of Diverting Internal Funds to Other Projects in Absence of NYSERDA Funds, Renewable Energy Program Area

Likelihood	Overall*	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*3*	*2*	*0*	*1*
Mean (scale of 1 to 5)	1.7	1.0	N/A	4.0
1 Not at all likely	76% (2)	100% (2)	0% (0)	0% (0)
2 Somewhat unlikely	0% (0)	0% (0)	0% (0)	0% (0)
3 Neither likely nor unlikely	0% (0)	0% (0)	0% (0)	0% (0)
4 Somewhat likely	24% (1)	0% (0)	0% (0)	100% (1)
5 Very likely	0% (0)	0% (0)	0% (0)	0% (0)

Note: Base is respondents who said NYSERDA funds allowed them to divert budget to other projects.

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The Cadmus Team asked a follow-up question of whether the projects for which the diverted funds were spent were related to renewable energy or energy efficiency. All three of the participants who used diverted funds for other projects reported that it was for an additional renewable energy project. One reported that the diverted funds were used for PV panels, energy-efficient lighting, and SHW. The second used the diverted funds for electric vehicle charging stations, and the third used the funds for energy-efficient lighting.

The Program Area influence score is the average of the three individual Program Area influence questions (FR2, FR3, and FR4), plus AF10 for the respondents who diverted funds to other projects after securing ARRA funds. Because none of the respondents lost funds that had previously been secured, nor had any participants turned down other funds after securing the ARRA funds, questions E8 and AF8 were not included in the Program Area influence score. The full algorithm is described in Appendix E, and is summarized here.

The Cadmus Team reverse-scored[59] questions FR2 and AF10, such that the response indicating the greatest influence of NYSERDA ARRA funding on the project also received the highest score. The Team then converted answers to question FR2 to a 5-point scale by multiplying the outcome by 5/6. Overall, RFP 10 was very influential on respondents' decisions to install a renewable energy system (a 4.7 on a scale from 1 to 5; Table 3-82).

[59] The Cadmus Team obtained the reverse score of FR2 by subtracting the number value associated with each statement from 7. For example, the statement "*Had preliminary internal discussions, but no plans and no contact with a vendor, contractor, or installer*" has a reverse score value of 6, while the statement "*Had identified specific equipment and models and incorporated project into budget*" has a reverse score of 1.

Table 3-82. Renewable Energy Program Area Influence Score

Average Program Area Influence	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Mean (Scale 1-5)	4.7	4.7	4.8	4.4

<u>Adjusting Direct Freeridership Based on the Program Area Influence Score</u>

Following the approved algorithm, which is presented in Appendix E, the Cadmus Team adjusted direct freeridership scores based on the Program Area influence score. The Program Area influence score provides lower and upper bounds of freeridership, as defined in Table 3-83 and in the algorithm in Appendix E (Summit Blue 2007). The Cadmus Team compared a direct freeridership score to the upper and lower bounds of the Program Area influence score (Table 3-83). Wherever the direct freeridership fell outside the bounds of the Program Area influence score, the Team changed the preliminary estimate of freeridership to either the lower or upper bound value (whichever was closest).

Table 3-83. Renewable Energy Program Area Influence Scores and Corresponding Lower and Upper Bounds of Freeridership

Average Program Area Influence Score	1.00	1.33	1.67	2.00	2.33	2.67	3.00	3.33	3.67	4.00	4.33	4.67	5.00
Lower Bound Freeridership Value	75%	70%	60%	50%	40%	30%	25%	20%	10%	0%	0%	0%	0%
Upper Bound Freeridership Value	100%	100%	100%	100%	90%	80%	75%	70%	60%	50%	40%	30%	25%

Adjusted freeridership scores for the Renewable Energy Program Area were low, with an overall freeridership score of 5% (Table 3-84). Comparing the individual populations, Downstate PV respondents had the lowest adjusted freeridership (0%), followed by Upstate PV participants (5%) and non-PV respondents (14%).

Table 3-84. Adjusted Freeridership Score, Renewable Energy Program Area

	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Average preliminary freeridership score	5%	5%	0%	14%

<u>Adjusting Freeridership by the Percent of the Project Funded by NYSERDA ARRA (AF1 and AF2) and Weighting by the Energy Generation</u>

The Cadmus Team then applied freeridership values to the estimated portion of generation attributable to NYSERDA ARRA, and weighted by the expected generation.

The Team asked respondents to report on the funding sources for their renewable energy projects. The inclusion of these questions reflects the fact that NYSERDA ARRA funding—and ARRA funding more generally—was intended to allow projects to move forward that may not have otherwise due to the recession. They elucidate the importance of NYSERDA ARRA funding for the completion of the projects.

First, respondents reported the percentage of their project budget that was covered by NYSERDA funds. As shown in Table 3-85, the vast majority of respondents (91%) said that NYSERDA funds covered more than one-half of the project budget, with 30% of projects being fully covered by the funds. Two respondents reported that the NYSERDA funds covered 10% or less of their total budget. The average percentage covered by NYSERDA funds was 83%. Based on direction from DOE, the Cadmus Team accounted for these percentages when determining the portion of Renewable Energy Program Area impacts attributable to NYSERDA ARRA funding.

Table 3-85. AF1 and AF2, Percentage of Project Budget Covered by NYSERDA Funds, Renewable Energy Program Area

Percentage	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Mean Percent of Budget	83%	75%	98%	95%
0-10%	9% (2)	14% (2)	0% (0)	0% (0)
11-20%	0% (0)	0% (0)	0% (0)	0% (0)
21-30%	0% (0)	0% (0)	0% (0)	0% (0)
31-40%	0% (0)	0% (0)	0% (0)	0% (0)
41-50%	0% (0)	0% (0)	0% (0)	0% (0)
51-60%	0% (0)	0% (0)	0% (0)	0% (0)
61-70%	0% (0)	0% (0)	0% (0)	0% (0)
71-80%	25% (6)	36% (5)	0% (0)	17% (1)
81-90%	22% (5)	36% (5)	0% (0)	0% (0)
91-99%	14% (3)	7% (1)	33% (1)	17% (1)
100%	30% (7)	7% (1)	66% (2)	67% (4)

Note: Totals may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Respondents who reported that their project budget was *not* fully covered by NYSERDA funds were then asked to specify what types of other funding sources they used to complete the project. As shown in Table 3-86, 41% of this sample of respondents used funds from their organization's operating budget, and a similar proportion (43%) used funds from their organization's capital improvement budget. Respondents also partially-funded individual projects with municipal bonds and loans.

Table 3-86. Non-Renewable Energy Program Area Funding Sources (multiple responses)

Funding Sources	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*16*	*14*	*0*	*2*
Operating budget	46% (7)	50% (7)	0% (0)	0% (0)
Capital improvement budget	41% (7)	36% (5)	0% (0)	100% (2)
Municipal bonds	6% (1)	7% (1)	0% (0)	0% (0)
Loans	6% (1)	7% (1)	0% (0)	0% (0)

Note: Base is respondents whose projects were not entirely funded by NYSERDA/ARRA funds.

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Note: One Solar-PV, Downstate respondent could not specify the other funding source so the respondent is not included in the table.

The final freeridership score, weighted by generation attributable to NYSERDA ARRA funding, was approximately 5% for RFP 10 as a whole, with a 90% confidence interval of being between 0% to 13%, and a net-of-freeridership value of 95%, with a 90% confidence interval of being between 87% to 100% (Table 3-87). The Cadmus Team estimated freeridership for each technology group: 0% for PV Downstate, 6% for non-PV projects, and 7% for PV Upstate.[60]

Freeridership and net-of-freeridership estimates with 90% confidence intervals are also presented in Table 3-87. However, due to the small sample sizes for all three technology groups (and especially for PV Downstate and non-PV projects), the estimates of freeridership and net-of-freeridership values should be interpreted with caution (as illustrated by the larger confidence intervals).

Table 3-87. Final Freeridership Scores, Renewable Energy Program Area

	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
(4) & (5) Freeridership, weighted by generation attributable to NYSERDA ARRA funding*	5% (>0%, 13%)	7% (0%, 15%)	0% (0%, 0%)	6% (>0%, 20%)

* This row shows the lower and upper bounds of the 90% confidence interval, with 0% as the lower bound for each.

Takeback

The Cadmus Team asked respondents two questions designed to gauge whether their energy consumption had increased since installing the renewable energy system (a phenomenon known as takeback*)*. Examples of takeback might include leaving lights on longer, taking longer showers, or other activities that could reduce the net benefit of the installed renewable energy system. There is little evidence of widespread takeback.

[60] None of the freeridership values for the technology groups are statistically significantly different from each other.

The first question assessed whether there was any change in energy use at the facilities where the systems were installed. As shown in Table 3-88, 53% of respondent reported that their energy usage had decreased since installing the system, whereas 48% said it had stayed the same. No respondents said their energy use had increased.

Table 3-88. Change in Energy Usage Since Installation, Renewable Energy Program Area

Response	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*14*	*3*	*6*
Increased	0% (0)	0% (0)	0% (0)	0% (0)
Decreased	53% (12)	50% (7)	33% (1)	67% (4)
Stayed the same	48% (11)	50% (7)	67% (2)	33% (2)

Note: Columns may not sum to 100% due to rounding. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The Team presented respondents whose energy use at the facility had stayed the same or increased with a list of possible energy-related actions and asked which, if any, had been taken in their building since the system was installed (Table 3-89). Two non-PV respondents reported that they had increased the temperature setting in the winter, and one non-solar PV respondent reported having decreased temperature settings during the summer. In addition, one Upstate solar PV respondent reported adding a few printers. However, the majority of respondents (81%) said there had been no change in their energy-using behavior or that the renewable energy project had been installed too recently to gauge whether their energy usage had changed.

Table 3-89. Change in Energy-Related Actions Since Installation (multiple responses), Renewable Energy Program Area

Action	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*11*	*7*	*2*	*2*
Increased temperature settings during winter	19% (2)	0% (0)	0% (0)	100% (2)
Decreased temperature settings during summer	6% (1)	14% (1)	0% (0)	0% (0)
Added a few printers	6% (1)	14% (1)	0% (0)	0% (0)
Other responses/No change in behavior	81% (8)	86% (6)	100% (2)	0% (0)

Note: Base is respondents whose energy use has increased or stayed the same.

Note: Columns may not sum to 100% due to rounding and multiple responses. The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Table 3-90 summarizes the evaluated annual net impact of the Renewable Energy Program Area as of June 30, 2012.

Table 3-90. Savings Impact Evaluated Net of Freeridership through June 30, 2012, Renewable Energy Program Area

	Total Claimed Energy Generation/Savings from Installed Projects	Savings Weighted Realization Rate	Total Evaluated Gross Electricity Savings/Generation	Freeridership	Evaluated Net-of-Freeridership
Electricity (MWh)	2,067	1.09	2,253	0.05	2,140
Fuel (MMBtu)	3,586	0.53	1,901	0.06	1,787

3.3.8 Spillover Methodology

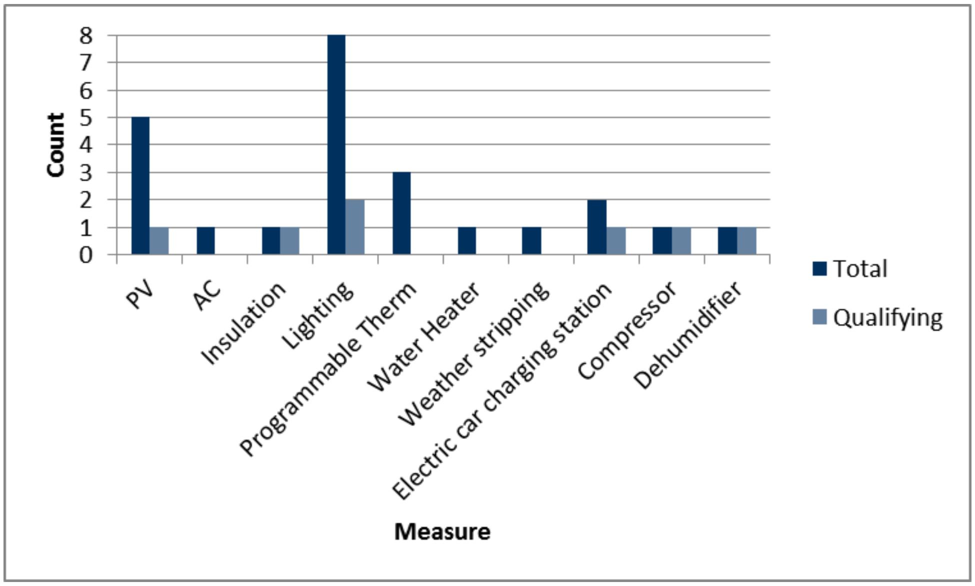
The Renewable Energy Program Area under EECBG had 65 projects completed; representatives from 31 of those projects completed a battery of spillover questions in July 2012. Some spillover can occur soon after a project completes, but it is not uncommon for it to take up to two years for additional projects to be budgeted and completed (especially in the nonresidential sector).

The spillover survey inquired about any additional renewable or energy-efficient measures installed or energy-saving behaviors undertaken since the approval of the NYSERDA-funded project. Any self-reported equipment spillover measures only qualify as NYSERDA ARRA spillover if they were not funded by any outside entity, and the respondent had to give the NYSERDA Renewable Energy Program Area credit for influencing their spillover action. Failure to meet both of those conditions resulted in a non-spillover measure, and is thus not attributable to the Program Area. Behavior changes only qualified if the respondent attributed their behavior to participating in the Program Area.

<u>Results</u>

The 31 respondents reported a total of 24 spillover measures, seven of which were qualifying measures. To qualify, measures must not have received outside funding, and the respondent had to give credit for the action to participation in NYSERDA's program. Figure 3-23 shows the results of these reported measures.

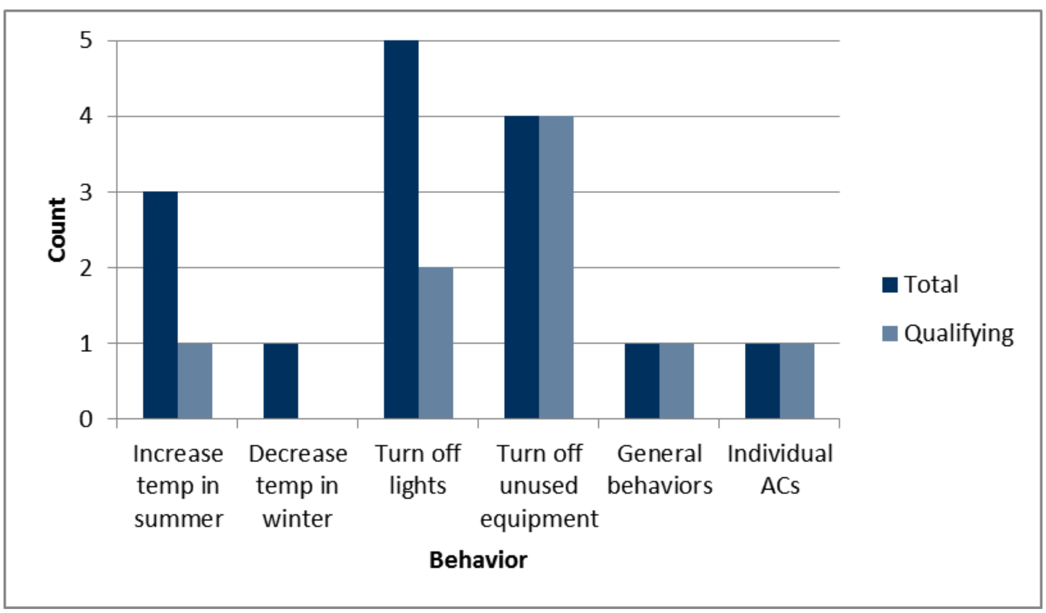
Figure 3-23. Renewable Energy Program Area Equipment Spillover Measures



On average, one out of every five Program Area projects resulted in spillover. Extrapolation to the population yields just over an expected total of 13 projects from which NYSERDA could claim spillover attribution. The Cadmus Team did not seek to quantify the spillover projects in this analysis because of the small number and the lack of sufficient pre- and post-condition and efficiency data of equipment functionality.

The spillover survey also inquired about behavior changes since participation in NYSERDA's Program Area. The 31 respondents reported 15 energy-savings behavior changes; however, only nine were because of participating in the Program Area (Figure 3-24).

Figure 3-24. Renewable Energy Program Area Behavior Spillover Measures



3.4 TRANSPORTATION PROGRAM AREA

3.4.1 Data Sources

The Cadmus Team used the following data sources to evaluate the Transportation Program Area:

- NYSERDA Program Area staff interviews to understand Program Area design, targets, and goals
- Participant phone interviews to calculate the costs, challenges, and estimated fuel savings
- Participant supplied data to determine reductions and costs associated with the projects.

This section presents results from measuring the energy impacts from the Transportation Program Area participation. The following four transportation projects were funded via RFP 10:

1. Three projects reflected by the synchronization of three traffic signal systems with the aide of Synchro software along highly trafficked corridors, with the goals of decreasing idling, emissions, and fuel consumption.
2. The purchase and data integration/conversion of RouteSmart software into the City of Watertown's GIS system, intended to determine the optimal route for refuse and recycling trucks. This fleet consisted of eight trucks, seven of which are in use at any point in time, with one remaining as a backup in case of breakdown.

Program Area-supplied Data

The Cadmus Team reviewed all original project applications and corresponding documentation. The Team also reviewed all changes made to projects subsequent to the original applications being submitted. The Team collected this information from the main project contacts and the project case managers.

Telephone Interviews

The Cadmus Team developed a questionnaire and conducted telephone interviews with all four RFP 10 transportation participants to determine and attribute respondents' actions taken concurrent or subsequent to implementing the transportation projects. The interview guide included questions on the following:

- How respondents heard of the Transportation Program Area
- Funding overlap with other programs and related financing
- Questions pertaining to respondents' motivations to solicit ARRA funding
- Economic factors affecting participation
- Freeridership

3.4.2 Approach: Interviews and Sample Design

The evaluation builds on methods and tools that adhere to DOE ARRA evaluation guidelines, as well as to those of the New York DPS and Evaluation Advisory Group.

The Team designed the sample as a census, to complete telephone interviews with all four transportation participants in RFP 10 who received awards. The Team conducted telephone interviews in June and July 2012 with project contacts once projects were completed and data were available. The interview goals were to: discuss the process and procedures involved in the application and implementation of the projects, determine final costs, better understand issues related to costs and construction that arose during the project, and determine emission and fuel savings.

Appendix H summarizes the awareness, motivation, economic factors, alternative funding, and spillover characteristics of the Transportation Program Area recipients.

3.4.3 Program Area Savings Assumptions

For transportation projects, savings stem from the net reduction in fuel usage before and after project implementation (Table 3-91).

Table 3-91. Sources of Fuel Reduction for Transportation Program Area Projects

Project	Source of Fuel Reduction
#258 City of North Tonawanda, traffic signal synchronization	Coordination of seven traffic signals along 1.3 miles of Nash Road, and four traffic signals along 0.7 miles of Meadow Drive. Nash Road is a principal arterial street, and Meadow Drive is a minor arterial street. This coordination was implemented with the objectives of reducing fuel consumption due to idling and delays, and increasing the ease and flow of traffic through the intersections. Emission reductions as a result of decreases in idling will be recognized.
#69 City of Lackawanna, traffic signal synchronization	Coordination of 11 traffic signals along 2.6 miles. This coordination allows for increased fuel efficiency as a result of reduced idling, as well as a reduction of accidents related to traffic flow.
#234 City of Jamestown, traffic signal synchronization	Coordination of seven traffic signals along 0.6 miles of Main Street, which is a four-lane urban minor arterial street, with the goals of reducing congestion, fuel waste as a result of idling, and emissions as a result of idling.
#151 City of Watertown, purchase of integration/conversion into the City of Watertown GIS system with the RouteSmart software to determine the optimal route for refuse and recycling trucks	The original project was for the implementation of GPS units on seven refuse and recycling trucks to determine the most efficient routes for collection. The scope was revised, and the City of Watertown purchased and were trained on RouteSmart software, which they then integrated into the City's GIS system, allowing them to track and map the most efficient routes for the vehicles. These adjustment reduce fuel consumption and the doubling back of pickups, which reduces traffic and emissions.

3.4.4 Gross Savings Calculations

Due to the relatively small number of Transportation Program Area projects, it would not be possible to share Program Area-specific data without revealing the identities of the participants. For that reason, the Cadmus Team combined the Program Area results for the evaluated scenario, which are presented in Table 3-92. The four projects together yield an overall reduction in the use of gasoline and diesel, and an overall increase in the use of compressed natural gas and electricity.

Table 3-92. Evaluated Annual Savings, Transportation Program Area

	Gasoline Use Reduced Annually	Diesel Use Reduced Annually
Gallons	85,601	37,284
MMBtu Equivalent	9,844	4,847
MMBtu Saved	14,691	
MMBtu Used	N/A	
Net MMBtu Saved	14,691	

3.4.5 Gross Savings Findings

As laid out in the Action Plan, one of the evaluation objectives for the RFP 10 Transportation Program Area was to evaluate the gross savings impacts. Table 3-93 summarizes these findings.

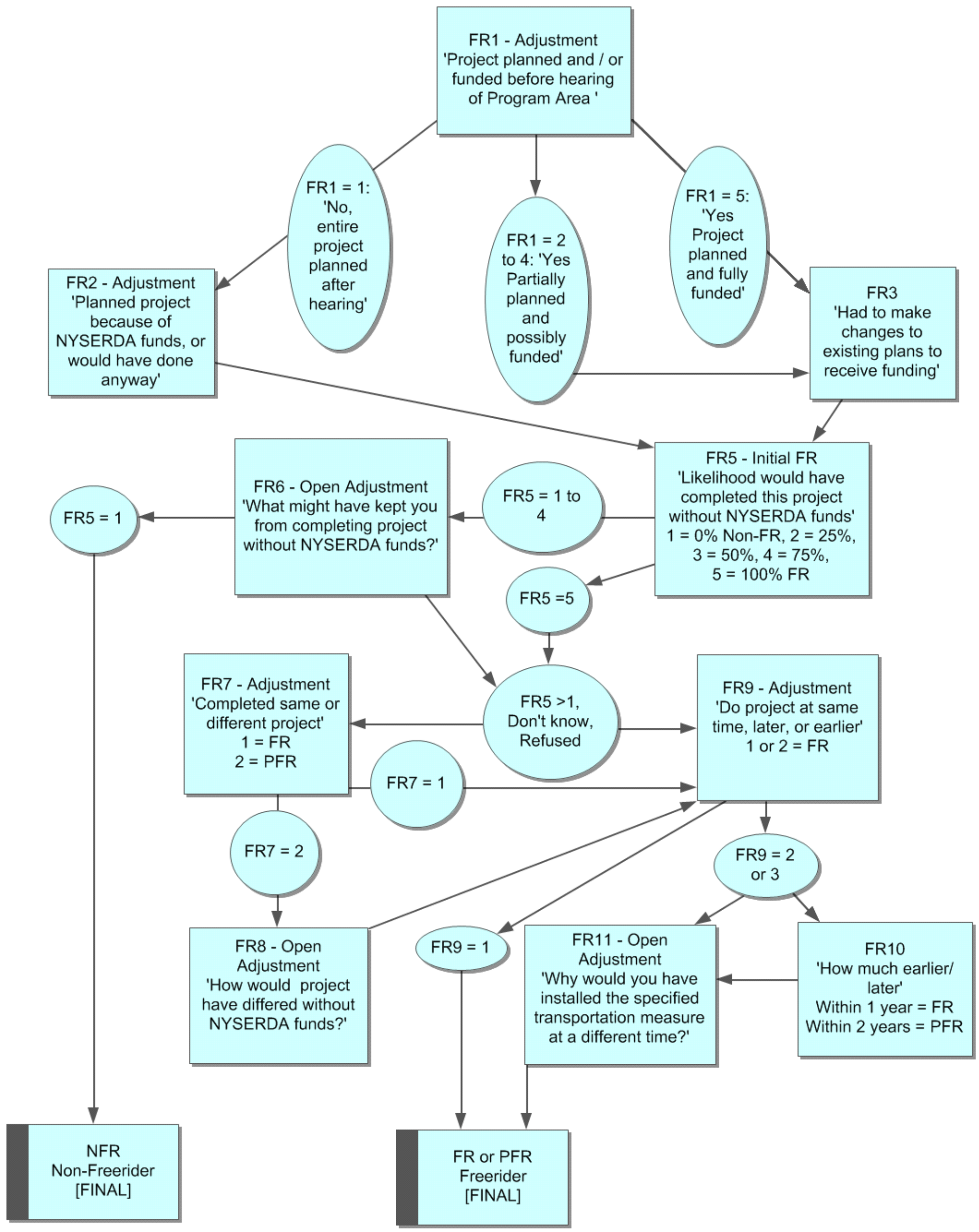
Table 3-93. Evaluated Gross Impacts for the Transportation Program Area

Fuel	MMBtu
Gasoline Savings	9,844
Diesel Savings	4,847
Total Savings	**14,691**

3.4.6 Net Savings Calculations

The determination of freeridership is based on the degree to which the NYSERDA ARRA-funded Transportation Program Area influenced the completion of projects, resulting in energy savings that would not have happened without the Program Area. Figure 3-25 illustrates the questions that led to determining an individual respondent's freeridership status. Responses to some of the questions provided a definitive nonfreerider (NFR) designation (e.g., respondent had no prior plans to implement a transportation project), while other questions used in combination determined a full freerider (FR = 100%) or partial freerider (PFR = 1-99%) designation.

Figure 3-25. Freeridership Algorithm Pathway, Transportation Program Area



To determine Program Area freeridership, the Team relied on participant self-reported information through June 2012. The Team interviewed each organization's main contact for the ARRA-funded Program Area.

The interviews included the following questions:

- **Freeridership.** Would the project have been completed without NYSERDA ARRA funds? Would it have occurred on the same timeline? Why or why not? Would the project scope have been the same? Why or why not? Did NYSERDA ARRA funding allow or require the respondent to change their project-related plans? If so, how?
- **Spillover.** What other actions, if any, have participants taken to save energy or adopt efficient or alternative transportation measures as a result of adopting transportation measures through NYSERDA ARRA?
- **Awareness and motivation**. Why did the participant decide to apply for funding through NYSERDA ARRA? What made them decide on this project rather than something else? Did the timing of the funding affect their plans to implement a project?
- **Economic factors.** Did the participants have funding secured for the project before applying for NYSERDA ARRA funds? Did any of the project funding they had planned on fall through because of the recession?
- **Alternative and additional funding.** Did the participants fund these projects solely with NYSERDA ARRA funds, or did they leverage other funds? If so, what were their other sources of funding? What percentage of the project did ARRA fund? If they did not leverage alternative funding with NYSERDA, what happened to the funds? Did they use other funding for another project, decline them, or did something else happen? Did other funding for the project require that they leverage resources? Did such requirements influence their decision to apply for NYSERDA ARRA funds?

The telephone interviews allowed the Cadmus Team to ascertain the net impact of the ARRA-funded activities by determining whether participants who implemented measures or planned to do so could be classified as freeriders, with further distinctions between full FRs and PFRs. The survey asked a series of questions designed to characterize the following:

- Whether respondents had planned to implement the measures prior to participating in the Transportation Program Area.
- Whether respondents changed their existing plans in order to participate in the Program Area and receive NYSERDA ARRA funds.
- The likelihood that the respondent would have completed the project without the NYSERDA ARRA funds.
- Whether the respondent would have completed the same project without ARRA funding, or would have completed the project differently in some way (e.g., different scale, efficiency level, or scope).
- Whether the respondent would have installed the specified transportation measure(s) at the same time if they had not received NYSERDA ARRA funds.

For the Transportation Program Area, a full freerider (FR=100%) is defined as someone who had planned to complete the project at the same time or earlier without any Program Area assistance.

In ascertaining freeridership, all respondents who completed (or were in the stages of completing) a project were asked the battery of freerider questions. Applying the freeridership algorithm involved dividing respondents into three groups: NFRs, PFRs, and FRs. The Cadmus Team used the freeridership estimate to calculate the net-of-freeridership ratio using Equation 3-17.

Equation 3-17. Net-of-Freeridership

$$Evaluated\ Net - of - Freeridership\ ratio\ =\ 1 - FR$$

As noted above, not enough time had elapsed since transportation projects were conducted to allow for adequate spillover to have occurred, so spillover is not incorporated into the algorithm. However, the Cadmus Team asked a battery of spillover questions, and qualitative responses are noted in Appendix E. It is anticipated that as time progresses, quantifiable spillover savings may result, which could be measured and reported in future follow-up evaluations.

3.4.7 Net Savings Findings

The Cadmus Team used the freeridership questions to assess respondents' actions in relation to the NYSERDA ARRA-funded Transportation Program Area, including their plans prior to participating and the influence of the Program Area on their decision to implement the project. Note that confidence and precision is not relevant since the Team conducted a census of surveys.

The interview included a series of questions to assess respondents' likely actions if they had not participated in the NYSERDA Transportation Program Area, including their plans prior to participating and the influence of the Program Area on these projects.

With the survey, the Cadmus Team attempted to determine how far along respondents were with their project planning when they first heard of the NYSERDA ARRA Transportation Program Area. The Team asked respondents to indicate which statement from the list shown in Table 3-94 best described their plans before they participated.

The table shows that three of the four respondents indicated that they planned the entire project *after* hearing about the NYSERDA ARRA-funded Program Area. One respondent reported that the project was being planned prior to hearing about the NYSERDA Program Area, but the plans had yet to be finalized.

Table 3-94. Point in Planning Process When First Heard About Transportation Program Area

Planning Process	Overall
Sample size	*4*
Planned entire project after hearing about the NYSERDA Program Area	3
Project was being planned, but plans were not finalized	1
Project was planned but had no funding	0
Project was planned but only partially funded	0
Project was planned and fully funded	0
Other	0
Don't know/refused	0

The three respondents who planned the entire project after hearing about the NYSERDA Program Area did so *because* of the NYSERDA Program Area funding (Table 3-95).

Table 3-95. Why Project was Planned After Learning of NYSERDA ARRA Funds, Transportation Program Area

Response	Overall
Sample size	*3*
Planned the project because of the NYSERDA Program Area	3
Would have planned the project without the Program Area	0
Don't know/refused	0

Note: Base is respondents who planned the entire project after hearing about the Transportation Program Area.

The Cadmus Team asked the one respondent who indicated that the project was being planned at the time they heard about the NYSERDA ARRA Transportation Program Area if they had to make changes to their project in order to qualify for Program Area funds: they reported no change was necessary.

The Team then asked all four respondents to estimate the likelihood that they would have completed the same project if they had not received the Transportation Program Area funding. Likelihood was rated on a scale of 1 (indicating that it was not at all likely) to 5 (indicating that it was very likely). Table 3-96 shows that two respondents were somewhat unlikely to have completed the same project without the funds. The other two respondents were not at all likely to have completed the same project without the NYSERDA ARRA funds.

Table 3-96. Likelihood of Completing Same Project in Absence of NYSERDA ARRA Transportation Program Area Funds

Likelihood	Overall
Sample size	*4*
Mean (Scale 1-5)	1.50
1 Not at all likely	2
2 Somewhat unlikely	2
3 Neither likely nor unlikely	0
4 Somewhat likely	0
5 Very likely	0

The Cadmus Team asked respondents what barriers might have prevented them from completing the project without the NYSERDA ARRA funds (Table 3-97). Three out of four mentioned that lack of funding was the greatest barrier. The fourth respondent said if they had not received the funding, the project may have been smaller in scope and possibly delayed.

Table 3-97. Barriers to Completing Project Without NYSERDA ARRA Funds, Transportation Program Area

Barriers	Overall
Sample size	*4*
Lack of funding	3
Smaller in scope/possibly delayed	1
Don't know/refused	0

The Team asked the two respondents who indicated that they were somewhat unlikely to complete the project without the Transportation Program Area whether they would they have completed the same project if the funds had not been available, or if it would have differed in some way (e.g., scale, efficiency level, scope). Both indicated that they would have changed the project in some way (Table 3-98).

Table 3-98. Whether Project Would be Different Absent NYSERDA ARRA Funds, Transportation Program Area

Response	Overall
Sample size	*2*
Same	0
Different	2
Don't know/refused	0

Note: Base is respondents who were somewhat unlikely to complete the same project without NYSERDA ARRA funds.

One of the two respondents who indicated that the project would have been different if the funds were not available would have completed a smaller-scale project, and the other would have pursued a project with an in-house developed software solution (Table 3-99). To summarize the four Program Area participants, two would have completed a different project in size, scope, or scale than the one they funded through NYSERDA ARRA.

Table 3-99. How Project Would Have Been Different, Transportation Program Area

Barriers	Overall
Sample size	*2*
Smaller in scale	1
Transportation routing with internal software product	1
Don't know/refused	0

Note: Base is respondents who said their project would have been different absent Program Area funds.

The Team used the next question to assess the Program Area's effect on the timing of the projects. The Cadmus Team asked the two respondents who were somewhat unlikely to have completed the project in the absence of the NYSERDA ARRA funds whether they would complete the transportation project earlier, later, or at the same time if the funds had not been available (Table 3-100). Both indicated that they would have conducted the project later if they had not received the funds. Both respondents estimated the delay as between three to five years.

Table 3-100. Influence of NYSERDA ARRA Funds on Timing of Completion of the Project, Transportation Program Area

Response	Overall
Sample size	*2*
Same time	0
Earlier	0
Later	2
Don’t know/Refused	0
If yes, how much earlier or later (years/months; average response)	4.0

Note: Base is respondents who were somewhat unlikely to complete the same project without NYSERDA ARRA funds.

Table 3-101 shows why the projects would have occurred later. The reason cited by both respondents involved a lack of funds. Specifically, one respondent commented that, in absence of the NYSERDA funds, less money overall would have required the project to be completed at some future date. The second respondent replied that with a limited availability of funds for efficiency projects, this specific project may not have been approved as a stand-alone budgetary item by the municipality.

Table 3-101. Why Projects Would Have Been Completed Later, Transportation Program Area

Barriers	Overall
Sample size	*2*
Cost required project to be completed in the future	1
Funding not approved as a stand-alone budgetary submittal	1
Don’t know/refused	0

Note: Base is respondents who said their project would have been completed later without Transportation Program Area funds.

Table 3-102 shows the freeridership calculation for the four participants in the NYSERDA ARRA-funded Transportation Program Area. The Cadmus Team adjusted freeridership according to the freeridership algorithm illustrated in Figure 3-25 and the responses given to the freeridership battery of questions outlined above. The overall freeridership rate for all four respondents was 0%: none demonstrated any form of freeridership.

Table 3-102. Transportation Freeridership Calculation, Transportation Program Area

Q#	Purpose	Impact on FR	Number of Respondents	Range of Responses
FR5	First-cut FR question	Initial FR	4	0% to 25%
		Running FR; GO TO	*0% to 25%*	*FR1*
FR1	Sets Context	Adjustment	4	-20% to 0%
		Running FR; GO TO	*-20% to 25%*	*FR2 or FR6*
FR2	Sets Context	Adjustment	3	-20%
		Running FR; GO TO	*-40% to -15%*	*FR6*
FR6	Explanation for FR5	Response; Adjustment	4, "*Lack of funding*" and "*Lower quality project if any/delayed*"	-20%
		Running FR; GO TO	*-35% to 5%*	*FR7 or Final*
FR7	Probing for PFR	Response; Adjustment	2	Depends on FR8
		Running FR; GO TO	*-35 to 5%*	*FR8*
FR8	Probing for PFR	Response; Adjustment	2, "*Smaller in scale*" and "*Implement a different technology*"	-10% to 0%
		Running FR; GO TO	*-35 to -5%*	*FR9*
FR9	Probing for PFR	Adjustment	2	Depends on FR10 and FR11
		Running FR; GO TO	*-35 to -5%*	*FR10*
FR10	Probing for PFR	Response; Adjustment	2, "*3 to 5 years*"	-20%
		Running FR; GO TO	*-55% to -25%*	*FR11*
FR11	Probing for PFR	Response; Adjustment	2, "*Cost*"	-20%
		Running FR	*-75% to -45%*	*Final*
Total Adjustments			**2 Neutral, 1 Neutral/Down, 14 Down**	
Final FR Value			**0%**	

Freeridership rates for the Program Area are summarized in Table 3-103. There were no freeriders among the four Program Area participants. Evaluated savings are equal to the total savings of 14,691 MMBtu, as shown in Table 3-104.

Table 3-103. Freeridership Rates, Transportation Program Area

	Overall	
	n	**Freeridership**
FR (freeriders 100%)	0	0%
PFRs	0	0% - 100%
NFRs	4	100%
Average (unweighted) FR rate	**4**	**0%**

Table 3-104 summarizes the evaluated annual net impact of the Transportation Program Area as of June 30, 2012.

Table 3-104. Savings Impact Evaluated Net of Freeridership through June 30, 2012, Transportation Program Area

	Total Claimed Savings from Installed Projects	Savings Weighted Realization Rate	Total Evaluated Gross Savings	Freeridership (weighted)	Evaluated Net of Freeridership
Electricity (MWh)	N/A	N/A	N/A	N/A	N/A
Fuel (MMBtu)	22,955	0.64	14,691	0.00	14,691

Section 4:

PORTFOLIO-LEVEL RESULTS

4.1 OVERALL NET SAVINGS

At the time this report was written, many of NYSERDA's EECBG-funded Program Areas were continuing to operate, and many of the planned projects to which funds had been committed had not yet been completed. Due to DOE requirements and the contract between the Cadmus Team and NYSERDA, the evaluation report for these Program Areas is due before the end of September 2012. Evaluating programs before they are complete has benefits and drawbacks.

One of the greatest benefits of conducting evaluations while programs are actively operating is that evaluators are able to speak with customers while they are in the middle of, or have recently gone through the decision-making process. This proximity of evaluation to the decision-making timeframe yields the greatest reliability in customer responses regarding the activities they would have been likely to undertake in the absence of a program. When evaluating completed programs, evaluators are sometimes asking participants about decisions they made months or years earlier, and it is very difficult for customers to remember exactly how much influence a program may have had on their decision-making process. As a result, questions about freeridership or program attribution are best asked in close proximity to the decision. For purposes of this report, freeridership is defined as a Program Area participant who would have implemented the Program Area measure or practice in the absence of the Program Area. Freeriders can be total, partial, or deferred.[61]

In contrast to freeridership, one of the greatest challenges to evaluating programs before they are complete is calculating the spillover impacts. For purposes of this report, spillover is defined as reductions in energy consumption and/or demand caused by the presence of the energy-efficiency Program Area, beyond the Program Area-related gross savings of the participants. There can be participant and/or nonparticipant spillover. Spillover may take months or years to occur depending on the technology, cost, and experience a customer has with the Program Area measures. In most cases of this evaluation effort, the Team was not able to measure spillover because customers did not have sufficient time to pursue other actions or purchase equipment they may have become aware of through their participation in the Program Area.

The Cadmus Team has conducted numerous NTG studies throughout the country, and has provided testimony to commissions on methods of measuring freeridership and spillover. In many cases, the Cadmus Team has recommended using a deemed NTG value of close to 1.0. Through many evaluations, the Cadmus Team has frequently determined that the impacts of spillover nearly offset the impacts of freeridership. Appendix C presents a study Cadmus conducted on behalf of another client that summarizes an investigation into common evaluated NTG findings and recommends accepting a deemed NTG value of 1.0. For the purposes of this report, NTG is defined as a factor representing net Program Area savings divided by gross Program Area savings, applied to gross Program Area impacts to convert

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[61] NAPEE. *Model Energy Efficiency Program Impact Evaluation Guide.* November 2007. Available online: http://www.epa.gov/cleanenergy/documents/suca/evaluation_guide.pdf. Downloaded on April 9, 2012.

them into net Program Area load impacts.[62] Furthermore, NYSERDA and the New York DPS have a precedent of accepting a deemed NTG of 0.9 for planning purposes.[63]

Given the requirements from the U.S. DOE that ARRA-funded projects be evaluated to determine net energy impacts, as well as the additional requirement that the evaluation work be completed prior to the conclusion of the programs themselves, the actual measurement of Program Area impacts necessarily understates the likely impacts of the Program Areas. This is because freeridership was much more clearly measurable than spillover, which, although likely to occur in the future, was not currently present at a level that could be evaluated. Hence, this report presents the evaluated freeridership values for each Program Area, a second projected net savings value that includes an estimate of savings from projects that are not yet complete but are contracted and nearly complete, and an approximation of the likely impacts of spillover in addition to freeridership through the use of a deemed NTG value of 0.90.

Based on this understanding regarding the likely overall net impacts of the EECBG-funded projects, for this evaluation effort the Cadmus Team reviewed the level of savings that are expected to be achieved, in addition to the savings that have already been evaluated to date. The Team applied the realization rate that was derived by evaluating projects completed as of June, 30 2012 to the total expected savings, and then adjusted the resulting projected gross savings for the deemed NTG. This resulted in a projection of the total savings that will occur from the Program Areas.

See Table 4-1 for a summary of the projected net savings findings for each NYSERDA ARRA Program Area.

[62] Ibid.

[63] New York Evaluation Advisory Contractor Team and TecMarket Works. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Residential, Multi-Family, and Commercial/Industrial Measures.* October 15, 2010. Available online: http://www.dps.ny.gov/TechManualNYRevised10-15-10.pdf.

Table 4-1. Summary of Projected Net Savings Findings by Program Area

Program Area	Total Expected Electricity Savings/ Generation from Installed and Planned Projects (MWh)	Savings-Weighted Realization Rate	Total Projected Gross Electricity Savings/ Generation (MWh)	Net-to-Gross	Projected Net Electricity Savings/ Generation (MWh)
Renewable Energy	2,209	1.10	2,430	0.90	2,187
Energy-Efficiency	7,078	0.99	7,007	0.90	6,306
Transportation	Fuel Savings Only				
Energy Code*	24,906	N/A	9,176**	N/A	9,176
Total	**34,193**	**N/M*** **	**18,613**	**N/M*** **	**17,669**
Program Area	**Total Expected Fuel Savings from Installed and Planned Projects (MMBtu)**	**Savings-Weighted Realization Rate**	**Total Projected Gross Fuel Savings/ Generation (MMBtu)**	**Net-to-Gross**	**Projected Net Fuel Savings/ Generation (MMBtu)**
Renewable Energy	7,320	0.47	3,440	0.90	3,096
Energy-Efficiency	50,444	1.01	50,948	0.90	45,853
Transportation	22,955	0.64	14,691	0.90	13,222
Energy Code*	236,222	N/A	85,146**	N/A	85,146
Total	**316,941**	**N/M*** **	**154,225**	**N/M*** **	**147,317**

* Energy Code savings were estimated as part of a independent evaluation effort, as described in the Energy Code Program Area chapter of Section 3: and presented in the Early Building Energy Code Adoption Report, attached as Appendix F.

** This number represents the applied weighted-average compliance rate, assumed to be 64% for the residential sector and 36% for the commercial sector.

*** Weighted overall realization rate and freeridership results are not meaningful and were therefore replaced with N/M.

4.2 DISPLACED GHG EMISSIONS

4.2.1 GHG Evaluation Approach

In order to determine the amount of GHG emissions displaced by each NYSERDA ARRA-funded Program Area, the Cadmus Team developed and applied an overarching approach to each Program Area's net annual and net lifetime savings for projects completed by June 30, 2012. The Team then created a set of tables that include all projects that are assumed will be complete by the end of that Program Area. The Cadmus Team refined this overarching approach for each specific Program Area, as needed. The approach[64] is based on the World Resource Institute's (WRI) *Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects* (Guidelines), WRI's Climate Analysis Indicator Tool, EPA's *State Climate Energy Program State Inventory Tool* (SIT), interviews with technical staff at both WRI and EPA, and a literature review.

4.2.2 Review of NYSERDA Emission Factors

The emissions factors provided by NYSERDA were derived from the EPA's SIT and the EPA *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2006* (April 2008). The emissions factors assume CO_2 equivalent conversions that were derived from global warming potential (GWP) numbers in the Intergovernmental Panel on Climate Change's (IPCC's) *Second Assessment Report (1995)*.

NYSERDA developed its own electricity emissions factor based on *Patterns & Trends: New York State Energy Profiles: 1994-2008* (NYSERDA, January 2010) and methodology from the *GHG Inventory and Forecast for the 2009 NYS State Energy Plan* (NYSERDA, August 2009; this electric emissions factor includes the electricity imported into New York State and accounts for transmission and distribution (T&D) losses; thus no line loss factor was applied).

NYSERDA provided the Cadmus Team with the electricity emission factors shown in Table 4-2 for this analysis.

Table 4-2. New York State Electric Grid Average Plug Load Efficiency Emissions Factor

	Electric (lb CO_2e/MWh)	Transport (lb CO_2e/MWh)	Residential (lb CO_2e/MWh)	Commercial (lb CO_2e/MWh)	Industrial (lb CO_2e/MWh)
Electricity	826.00	826.00	826.00	826.00	826.00

Note: These numbers were provided by NYSERDA. Source: Mas, Carl. *NYS Grid Emission Intensity*. 2010. The workbook was based on data from: NYSERDA. *Patterns & Trends: New York State Energy Profiles: 1994-2008.* January 2010. and methodology from: NYSERDA. *GHG Inventory and Forecast for the 2009 NYS State Energy Plan.* August 2009.

The fuel combustion emissions factors that NYSERDA provided came from the EPA's SIT, released on January 3, 2011, and EPA, April 2008 (Annexes 2 and 3). For transportation projects, the CO_2e emissions factors did not vary by vehicle type, as they are on a per-fuel basis. NYSERDA provided the Cadmus Team with the fuel combustion emissions factors shown in Table 4-3 for this analysis.

[64] These emission displacements are associated with both electric and fossil fuel saving measures. Under a cap-and-trade system, the total number of emission allowances is determined by regulation. Regulated entities can purchase allowances and collectively emit up to the cap that is currently in place. Therefore, in the near term, electric efficiency projects may not decrease the overall amount of emissions being released into the atmosphere. Nevertheless, electric efficiency projects will reduce end-users' responsibility or environmental footprint associated with emissions from electricity production. Beginning in Q1 2010, NYSERDA estimates displacements in emissions of CO_2, nitrous oxide, and sulfur dioxide associated with electric efficiency projects based on average emission rates that include emissions associated with imports of electricity. NYSERDA had previously reported emissions displacements using marginal emission factors; they made this transition to average emission factors to be consistent with a footprint displacement framework (per NYSERDA on April 10, 2012).

Table 4-3. Fuel Combustion Emissions Factors by Sector (lb CO_2 equivalent/MMBtu)

Fuel Type	Electric	Transport	Residential	Commercial	Industrial
Coal	204.95	N/A	224.89	211.43	207.58
Natural Gas	116.96	117.25	117.14	117.14	113.38
#2/ Distillate	163.78	163.22	163.78	163.78	161.80
#6/ Residual	166.28	N/A	N/A	166.28	174.20
Kerosene	N/A	N/A	162.10	162.10	159.89
Propane / Liquefied Petroleum Gas	N/A	140.51	136.94	136.94	139.45
Coking Coal	N/A	N/A	N/A	N/A	186.12
Asphalt	N/A	N/A	N/A	N/A	166.64
Lube	N/A	163.57	N/A	N/A	146.71
Other Petroleum Products	N/A	N/A	N/A	N/A	143.31
Gasoline	N/A	159.09	N/A	N/A	N/A
Aviation Fuel	N/A	160.88	N/A	N/A	N/A
Landfill Gas	0.26	N/A	N/A	N/A	N/A
Wood	4.34	N/A	15.79	15.79	3.92

Note: The values in this table represent aggregate CO_2, CH4, and N2O emissions. Provided by NYSERDA. Sources: White cells are from the EPA *State Climate Energy Program's State Inventory Tools* released on January 3, 2011 (http://www.epa.gov/statelocalclimate/resources/tool.html). Grey cells are from EPA, April 2008 (Annexes 2 and 3).

4.2.3 Recommended Emissions Factors

The Cadmus Team supports NYSERDA's decision to reference their own emissions factor for electricity and the EPA SIT for the fuel combustion emissions factors. The EPA SIT tool was specifically designed to help states develop GHG emissions inventories, and is considered best practice by both the EPA and WRI. The state inventory component of the tool provides users with the option of entering their own state-specific data or using default data specific to each state. Default data have been collected by "*federal agencies and other sources covering fossil fuels, agriculture, forestry, waste management, and industry*"[65] and are the basis for this tool. GWPs in the SIT were derived from the IPCC's *Second Assessment Report (1995).*[66]

[65] EPA. *State Inventory Tool*. Available online: http://www.epa.gov/statelocalclimate/resources/tool.html.

[66] The main activity of the IPCC is to provide regular Assessment Reports about the status of climate change knowledge.

4.2.4 Calculation Methods

To calculate both annual and lifetime emissions displaced from each Program Area, the Cadmus Team applied the EPA SIT emissions factors from NYSERDA to the net annual and net lifetime savings values (by fuel type) determined during the Program Area evaluation.

In completing these calculations, the Cadmus Team relied on several assumptions. The first is that the amount of GHG displaced is an estimation based on available best-practice tools. As neither New York nor DOE have a singular method for calculating displaced GHG emissions at this time, the calculations could come out slightly different if another tool were used. Each calculation method also has its own set of variables—such as temperature, measures and fuel types included, emissions factors, and methods—thus outputs could vary. In the future, depending on legislation and the progression of study in this area, emissions factors are likely to be updated, possibly altering the amount of GHG displaced over the lifetime of each project.

4.2.5 Recommendations for Estimating Emissions Displaced from the ARRA-funded Program Areas

Based on the assessments described above, the Cadmus Team recommends that NYSERDA use a hybrid approach for calculating emissions displaced across its portfolio of Program Areas. The Team's recommended approach leverages the emissions factors from the EPA SIT for fuel combustion and from NYSERDA's developed electricity emissions factor, and combines these in a simple spreadsheet format that is consistent with the WRI's GHG Protocol Guidelines.[67] The basis for this recommendation is:

- To ensure consistency of reporting across the organization
- To maximize the ability to compare savings across the Program Areas and Program Area years
- To ensure transparency in the approach and replicability

4.2.6 Measurement and Verification of Displaced GHG from NYSERDA's ARRA-Funded Program Areas

The Cadmus Team calculated the displaced GHG emissions associated with NYSERDA's ARRA-funded Program Areas. To conduct this analysis, the Team used the verified net energy impacts, in terms of net metric tons of GHG emissions avoided over the effective useful life (EUL) of the projects, and also calculated the amount of emissions displaced by each Program Area annually. In this analysis, the Cadmus Team referred to the WRI's *Greenhouse Gas Protocol* and the EPA SIT.

Using the fuel type, the amount of fuel, and the appropriate emissions factor, the Cadmus Team calculated aggregate GHG emissions in CO_2e. The emissions factors provided by NYSERDA relied on the GWPs from the IPCC *Second Assessment Report*, which the EPA SIT defaults to. However, because these GWPs are inherent in the emissions factors, the Cadmus Team was not able to determine savings by each gas type (CO_2, methane, and nitrous oxide).

4.2.7 GHG Displaced Emissions by Program Area

NYSERDA offered ARRA-funded incentives for the following Program Areas: Energy-Efficiency, Renewable Energy, Transportation, and Energy Code. This subsection presents how the Cadmus Team calculated the emissions displaced from projects that received funding from these Program Areas.

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[67] WRI. *Greenhouse Gas Protocol.* Available online: http://www.ghgprotocol.org/calculation-tools/all-tools.

The Cadmus Team calculated the displaced annual and lifetime GHG emissions for each Program Area using the inputs specified in Table 4-3, above. The Team multiplied the net verified savings for each Program Area by the NYSERDA-provided appropriate emissions factor to determine annual displaced emissions. For lifetime displaced emissions, the Cadmus Team first multiplied the net verified savings by the EUL of each measure, by fuel type and then by the appropriate emissions factors. The Team then summed and reported all displaced emissions as aggregate displaced GHG emissions in CO_2e, both annually and for the projects' lifetimes.

GHG Emissions Displaced for the Energy-Efficiency Program Area

The Energy-Efficiency Program Area projects that were included in this evaluation came in the form of grants that NYSERDA awarded on a competitive basis for energy-related projects associated with energy-efficiency retrofits, traffic signal and street lighting efficiency, renewable energy installation for government buildings, and technical consultant services. NYSERDA provides these grants to municipalities.

The Energy-Efficiency Program Area achieved the majority of its savings from displaced electric, natural gas, and fuel oil use. These savings and the associated GHGs displaced are detailed in the following four tables.

Table 4-4. Displaced Net Annual GHG Emissions for Evaluated Projects in the Energy-Efficiency Program Area

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO_2e/MWh)	Emissions Factor (lbs CO_2e/MMBtu)	Metric Tons (CO_2e)
Electric	4,990	MWh	826.00	N/A	1,870
Natural Gas	37,600	MMBtu	N/A	117.14	2,000
#2 / Distillate	891	MMBtu	N/A	163.78	66.2
Propane	(57.5)	MMBtu	N/A	136.94	(3.57)
Total					**3,930**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

Table 4-5. Displaced Net Annual GHG Emissions for All Projects in the Energy-Efficiency Program Area

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO_2e/MWh)	Emissions Factor (lbs CO_2e/MMBtu)	Metric Tons (CO_2e)
Electric	6,330	MWh	826.00	N/A	2,370
Natural Gas	43,500	MMBtu	N/A	117.14	2,310
#2 / Distillate	2,360	MMBtu	N/A	163.78	175
Propane	(63.8)	MMBtu	N/A	136.94	(3.97)
Total					**4,850**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

Table 4-6. Displaced Net Lifetime GHG Emissions for Evaluated Projects in the Energy-Efficiency Program Area

<u>Commercial</u> Sector Fuel Type	**Amount Displaced**	**Units**	**Emissions Factor (lbs CO_2e/MWh)**	**Emissions Factor (lbs CO_2e/MMBtu)**	**Metric Tons (CO_2e)**
Electric	74,900	MWh	826.00	N/A	28,100
Natural Gas	564,000	MMBtu	N/A	117.14	30,000
#2 / Distillate	13,400	MMBtu	N/A	163.78	993
Propane	(862)	MMBtu	N/A	136.94	(53.5)
Total					**59,000**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

Table 4-7. Displaced Net Lifetime GHG Emissions for All Projects in the Energy-Efficiency Program Area

<u>Commercial</u> Sector Fuel Type	**Amount Displaced**	**Units**	**Emissions Factor (lbs CO_2e/MWh)**	**Emissions Factor (lbs CO_2e/MMBtu)**	**Metric Tons (CO_2e)**
Electric	94,900	MWh	826.00	N/A	35,600
Natural Gas	653,000	MMBtu	N/A	117.14	34,700
#2 / Distillate	35,400	MMBtu	N/A	163.78	2,630
Propane	(958)	MMBtu	N/A	136.94	(59.5)
Total					**72,900**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

<u>GHG Emissions Displaced for the Renewable Energy Program Area</u>

A renewable energy project is defined as a project that: 1) achieves a cost-per-annual-energy-generated of less than $8,000 of total project cost per 10 million Btu; 2) is sited at the electric customer's location; 3) is used primarily to serve the electric customer's load (not primarily exported to the utility grid); and 4) has a system that, as designed, cannot generate more electricity than is consumed on-site annually (the combination of these qualifying conditions is commonly described as *behind the meter generation*).

The Renewable Energy Program Area offset fuels in the commercial sector. The Program Area achieved the majority of its savings from displaced electric and natural gas. The commercial savings and the associated GHGs displaced are listed in the following four tables.

Table 4-8. Displaced Net Annual GHG Emissions for Evaluated Projects in the Renewable Energy Program Area

Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO_2e/MWh)	Emissions Factor (lbs CO_2e/MMBtu)	Metric Tons (CO_2e)
Electric	2,140	MWh	826.00	N/A	801
Natural Gas	1,300	MMBtu	N/A	117.14	69.6
#6 / Residual	389	MMBtu	N/A	166.28	29.3
Propane	653	MMBtu	N/A	136.94	40.6
Wood	(568)	MMBtu	N/A	15.79	(4.07)
Total					**936**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

Table 4-9. Displaced Net Annual GHG Emissions for All Projects in the Renewable Energy Program Area

Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO_2e/MWh)	Emissions Factor (lbs CO_2e/MMBtu)	Metric Tons (CO_2e)
Electric	2,190	MWh	826.00	N/A	821
Natural Gas	2,650	MMBtu	N/A	117.14	141
#6 / Residual	372	MMBtu	N/A	166.28	28.1
Propane	625	MMBtu	N/A	136.94	38.9
Wood	(544)	MMBtu	N/A	15.79	(3.89)
Total					**1,020**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

Table 4-10. Displaced Net Lifetime GHG Emissions for Evaluated Projects in the Renewable Energy Program Area

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO_2e/MWh)	Emissions Factor (lbsCO_2e/ MMBtu)	Metric Tons (CO_2e)
Electric	62,700	MWh	826.00	N/A	23,500
Natural Gas	25,900	MMBtu	N/A	117.14	1,380
#6 / Residual	7,780	MMBtu	N/A	166.28	587
Propane	16,300	MMBtu	N/A	136.94	1,010
Wood	(14,200)	MMBtu	N/A	15.79	(102)
Total					**26,400**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

Table 4-11. Displaced Net Lifetime GHG Emissions for All Projects in the Renewable Energy Program Area

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO_2e/MWh)	Emissions Factor (lbsCO_2e/ MMBtu)	Metric Tons (CO_2e)
Electric	64,300	MWh	826.00	N/A	24,100
Natural Gas	52,800	MMBtu	N/A	117.14	2,800
#6 / Residual	7,450	MMBtu	N/A	166.28	562
Propane	15,600	MMBtu	N/A	136.94	971
Wood	(13,600)	MMBtu	N/A	15.79	(97.3)
Total					**28,300**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

GHG Emissions Displaced for the Transportation Program Area

Transportation projects were funded within the NYSERDA ARRA Efficient Transportation System Implementation Projects, under the EECBG. The national EECBG program awards grants to municipalities throughout the states for projects that change driving behaviors, improve air quality, stimulate job creation in the community, and reduce energy use and GHG emissions. A key provision of ARRA was to fund shovel-ready projects that were ready for construction. An EECBG project must be initiated and overseen by a small municipality and receive no more than $500,000 of NYSERDA funds to complete.

This evaluation focused on transportation projects funded within NYSERDA Clean Fleets. The transportation savings by fuel type and the associated GHGs displaced are listed in the following four tables.[68]

Table 4-12. Displaced Net Annual GHG Emissions for Evaluation Projects in the Transportation Program Area

Transportation Sector Fuel Type	**Amount Displaced**	**Units**	**Emissions Factor (lbs CO_2e/MMBtu)**	**Metric Tons (CO_2e)**
Gasoline	9,910	MMBtu	159.09	715
Diesel	4,880	MMBtu	163.22	361
Total				**1,080**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

Table 4-13. Displaced Net Annual GHG Emissions for All Projects in the Transportation Program Area

Transportation Sector Fuel Type	**Amount Displaced**	**Units**	**Emissions Factor (lbs CO_2e/MWh)**	**Emissions Factor (lbs CO_2e per MMBtu)**	**Metric Tons (CO_2e)**
Gasoline	8,920	MMBtu	N/A	159.09	643
Diesel	4,390	MMBtu	N/A	163.22	325
Total					**968**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

Table 4-14. Displaced Net Lifetime GHG Emissions for Evaluation Projects in the Transportation Program Area

Transportation Sector Fuel Type	**Amount Displaced**	**Units**	**Emissions Factor (lbs CO_2e/MMBtu)**	**Metric Tons (CO_2e)**
Gasoline	99,100	MMBtu	159.09	7,150
Diesel	48,500	MMBtu	163.22	3,600
Total				**10,800**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

[68] The Team's emission analysis for the Transportation Program Area included specific analysis of emissions from electricity consumption, whereas other sections of this evaluation determined the total MMBtu impacts of the Program Area regardless of fuel type.

Table 4-15. Displaced Net Lifetime GHG Emissions Savings for All Projects in the Transportation Program Area

Transportation Sector Fuel Type	**Amount Displaced**	**Units**	**Emissions Factor (lbs CO_2e/MWh)**	**Emissions Factor (lbs CO_2e/MMBtu)**	**Metric Tons (CO_2e)**
Gasoline	89,200	MMBtu	N/A	159.09	6,430
Diesel	43,700	MMBtu	N/A	163.22	3,230
Total					**9,660**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

GHG Emissions Displaced for the Energy Code Program Area

The Energy Code Program Area provided technical assistance to the building community and local energy conservation CEOs. The Program Area goal was to achieve the highest practical levels of compliance with provisions set forth in the new Energy Code. This effort was closely coordinated between NYSERDA and the DOS, an agency that promulgates and provides limited training to code officials on the Energy Code. The EECBG funding directly supported the provision of plan review services to CEOs, and supported CEO and building industry training jointly with SEP funding. The Cadmus Team did not calculate displaced GHG emissions for the activities supported by the Energy Code Program Area.

In addition to assessing the impacts of the activities funded by EECBG, the Cadmus Team examined the impacts of early adoption of the residential and commercial building energy codes associated with the ARRA requirements. These impacts did not result from EECBG-funded activities, but constituted an important energy savings contribution of ARRA. The Team calculated displaced GHG emissions for the effects of early code adoption.

The early code adoption savings by fuel type and the associated GHGs displaced are listed in the following two tables.

Table 4-16. Residential and Commercial Combined Displaced Net Annual GHG Emissions for the Energy Code Program Area

Energy Code Sector Fuel Type	**Amount Displaced**	**Units**	**Emissions Factor (lbs CO_2e/MWh)**	**Emissions Factor (lbs CO_2e/MMBtu)**	**Metric Tons (CO_2e)**
Electric	9,180	MWh	826.00	NA	3,440
Natural Gas	85,100	MMBtu	NA	117.14	4,520
Total					**7,960**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

Table 4-17. Residential and Commercial Combined Displaced Net Lifetime GHG Emissions for the Energy Code Program Area

Energy Code Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO_2e/MWh)	Emissions Factor (lbs CO_2e/MMBtu)	Metric Tons (CO_2e)
Electric	275,000	MWh	826.00	NA	103,000
Natural Gas	2,550,000	MMBtu	N/A	117.14	136,000
Total					**239,000**

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents.

4.3 ECONOMIC IMPACT

4.3.1 Introduction and Purpose

The goal of the macroeconomic impact analysis was to estimate net statewide employment impacts resulting from NYSERDA's EECBG-funded Program Areas. Impacts arise from direct short-term investment activities, such as building retrofits, and from longer-term benefits due to the persistence of energy savings and avoided energy generation, which induce changes in household/business/government spending. These evaluation results encompass a broader range of job impacts (direct, indirect, and induced) than those reported by ARRA recipients, which only included direct, full-time equivalent jobs.

4.3.2 Methodology and Data Sources

The Cadmus Team used an economic forecasting model from REMI, called Policy Insights$^+$ (PI$^+$), to model employment impacts. This model is customizable to fit a user-defined study region, and is also available at different levels of industry granularity. For consistency, the Cadmus Team used the same PI$^+$ model as used by NYSERDA and the New York State Economic Development Council, which covers 70 industries in the State of New York. The Cadmus Team worked with NYSERDA staff to ensure that the methodology is consistent with NYSERDA's standard approach. The Cadmus Team also consulted with staff working on a national evaluation[69] and referenced DOE's SEP evaluation guidelines, which call for job creation as a national ARRA evaluation metric.

4.3.3 About PI$^+$

PI$^+$ is a dynamic economic forecasting model incorporating aspects from input-output (I/O) analysis, general equilibrium, econometrics, and economic geography. At its core, PI$^+$ has an I/O matrix, which captures how industries within the region interact. General equilibrium captures the long-term stabilization of the economic system as supply and demand become balanced. Econometrics estimates responses to economic changes and the speed at which they happen. Economic geography represents spatial characteristics of the economy, such as productivity and competitiveness, arising from industry clustering and labor market access. Unlike I/O models, PI$^+$ is dynamic, demonstrating annual economic changes over the study period.

[69] KEMA uses REMI to assess job impacts for its national evaluation.

4.3.4 Modeling Approach

The Cadmus Team analyzed two primary scenarios:

1. ***Evaluated impacts*** of EECBG projects completed through June 30, 2012
2. ***Projected impacts*** of all evaluated and planned EECBG projects

The Cadmus Team netted out all spending activities within New York State so there is no net change in spending within the region (e.g., increases in consumer spending on efficient appliances were balanced by decreases in spending on other goods and services, such that the total spending remains constant). Funds entering or leaving the State, however, are considered net gains or losses to the regional economy. These include federal money spent in the New York economy, such as ARRA funds. The cost/repayment of federal funds is not modeled, as it is outside the scope of this evaluation.[70] The positive and negative impacts modeled are summarized in Table 4-18. For each positive impact modeled, a negative impact is included, where appropriate.

[70] It is the Cadmus Team's understanding, based on conversations with DOE consultant Nick Hall from TecMarket Works, that DOE's main interest is the immediate impacts of stimulus spending, not how stimulus costs are distributed to residents and organizations in New York.

Table 4-18. Summary of Economic Stimuli Impacts Modeled

Positive Impacts Modeled	Negative Impacts Modeled
ARRA-funded incentives towards the purchase of programmatic goods and services.	None, ARRA funds originate from a source external to New York State.
Co-funding or participants' out-of-pocket spending towards the purchase of programmatic goods and services, net of freeridership. (If the participant would have purchased the good or service even if there were no Program Area, then there would not be a change in spending behavior).	Co-funding costs reduce participants' spending on nonprogrammatic goods and services.
Avoided resource costs/electricity bill savings modeled as increased disposable income and lowered electricity costs for residential and commercial participants, respectively. Cost savings in the government/institutional sector were modeled as an increase in spending without increasing taxes or other sources of revenue. These effects persist through the EUL of the measures implemented, for up to 30 years. In this analysis, the Cadmus Team modeled measure savings as step functions, in which savings do not degrade prior to reaching the EUL, but remain constant and then drop to zero upon reaching the EUL. The Team used wholesale electric prices to model the benefits as the pass-through portion of the bill. Because the national evaluation is using retail prices to monetize electric savings, this evaluation also presents results from analyses substituting retail prices for wholesale prices. In the retail price scenarios, the Team made no other changes in order to isolate the effect of the price change.	The Cadmus Team did not model electric utility revenue losses, because utilities are allowed cost recovery from ratepayers to cover their fixed costs. The positive impact modeled uses wholesale electric prices, eliminating the need to make a negative adjustment. In New York, utilites generally do not own the generators. Impacts to electric generators from energy-efficiency programs in New York arise both from selling fewer kWh and from lower wholesale prices per kWh (i.e., price suppression, discussed separately below). Per discussion with NYSERDA staff, the economic impacts due to selling fewer kWh are negligible because: 1) approximately 40% of electricity on the margin is imported from out of State, and 2) over 90% of generation costs for the remaining 60% of electricity generated within the State are for fuel, which is imported. The majority of the economic loss accrues in regions outside the study area (and therefore outside the scope of this evaluation).
Other bill savings include non-electric industry impacts. These effects persist through the EUL of the measures implemented.	The Team modeled other industry revenue losses from efficiency and renewable projects as a decrease in the final demand for industry output (natural gas, fuel oil, etc.). These effects persist through the EUL.
Price suppression is the value to all electricity consumers (both participants and nonparticipants) of very small decreases in wholesale electricity prices achieved through reduced electricity demand in the wholesale market. NYSERDA generated data for this impact using ICF's Integrated Planning Model.* The value is $0.036 per kWh of energy-efficiency savings (in 2011 dollars).	The Team did not model electric industry (i.e., generator owners) revenue losses from price suppression. Generators in New York are largely owned by national and international firms, so the economic impacts on generator owners due to price suppression are widely distributed outside of New York. The portion that affects New York is negligible.

* For more information about NYSERDA's methodology, see: State Energy Planning Board. *2009 New York State Energy Plan Energy Efficiency Assessment*, page 25. 2009.

Additional modeling specifications include:

- **Program Area years.** The period of impact reporting is 2011 to 2040. Although the Program Areas occurred between 2009 and 2012, for simplicity, the Team modeled direct ARRA Program Area spending to occur entirely in 2011, while modeling the persistence of energy savings through the weighted average measure life of each Program Area.
- **Baseline.** The Team used the standard regional control (built into PI^+) to determine net changes in employment resulting from ARRA investments.

- **Energy savings.** The Team monetized energy savings in constant 2011 dollars for electricity, natural gas, and fuel oil. NYSERDA provided price forecasts for electricity (retail[71] and wholesale), natural gas, and fuel oil. The Team also used Energy Information Administration data for propane and diesel.
- **Net-to-gross.** The Cadmus Team incorporated evaluated NTG values into the analysis of evaluated scenarios to capture what would have happened if the ARRA-funded Program Areas had not been implemented. For the projected scenario, the Team assumed a 10% freeridership rate for all Program Areas.
- **Cap and trade, market transformation.** The Team did not account for these effects due to a lack of data to support their impacts.

4.3.5 Data Sources

The Team derived macroeconomic impacts and cost-effectiveness analyses from the same base data, which are the summarized and evaluated Program Area results, along with the following supplementary data provided by NYSERDA:

- Measure life
- Freeridership (this only applies to savings and participant co-funding/spending, it does not apply to stimulus funds)
- Project costs
- ARRA incentives disbursed
- Measure quantity
- Annual kWh, natural gas, oil, gasoline, propane, and other fuel savings
- Market sectors
- ARRA overhead and administration costs

4.3.6 Program Area Specific Inputs

See Table 4-19 for an outline of the specific Program Area inputs.

[71] The retail electricity prices used are as follow: residential $0.1634/kWh; commercial $0.1756/kWh.

Table 4-19. Summary of Specific Impacts Modeled by Program Area

Program	Direct Spending	Bill Savings	Co-funding	Industry Impact
Energy-Efficiency	Installation and equipment	Accrue to local government/institution sector	Portion of measure/project costs paid by participants	Reduced revenue for energy and fuel industries
Renewable Energy	Installation and equipment	Accrue to the residential, commercial, and government/institution sectors	Portion of measure/project costs paid by participants	Reduced revenue for energy and fuel industries
Transportation	Traffic signal synchronization, GPS tracking	Accrue to the government/institution sector	Portion of measure/project costs paid by participants	Reduced revenue for petroleum industry
Portfolio Level	Administration (NYSERDA), marketing, and implementation	System-wide benefit from price suppression	None	None

4.3.7 Results

Summary

The reported employment impacts are all relative to the PI+ control forecast, and include both part-time and full-time jobs. During the first Program Area year, and cumulatively from 2011 to 2040, the EECBG-funded portfolio of Program Areas results in net positive job-years in New York State under all scenarios analyzed, as shown in Table 4-20. Note that the projected impacts are slightly higher than the evaluated impacts. This is a result of more completed projects being reflected in the projected scenarios. The use of retail prices also increased the net number of job-years created. This substitution, as expected, increased the magnitude of the positive bill savings stimuli.

Table 4-20. First and 30-Year Cumulative Employment Impacts in New York State

Scenario	First Year Net Job-Years		30-Year Cumulative Net Job-Years	
	Wholesale Prices	Retail Prices	Wholesale Prices	Retail Prices
Evaluated impacts	107	119	298	387
Projected impacts	135	155	325	471

Table 4-21 shows the net number of first-year jobs created per million dollars of ARRA spending, which ranges from 5.0 to 6.0. This range is slightly higher than NYSERDA's estimate of 3.2 net jobs per million dollars of SBC spending per year. This increase is likely because of the ARRA funding entering the regional economy, which results in a net gain in employment according to the REMI model. Note that the projected scenario has a greater impact per million dollars of EECBG funding than the evaluated scenario.

Table 4-21. First Year Net Jobs/Million in ARRA Funding

Scenario	EECBG Funding (incentives and administration)	Net Job-Years (per million in funding)	
		Wholesale Prices	Retail Prices
Evaluated impacts	$21.5 million	5.0	5.5
Projected impacts	$26.0 million	5.2	6.0

Table 4-22 shows the employment impacts from the EECBG Program Areas and early Energy Code adoption. Details on the early Energy Code adoption analysis are included in Appendix G. In the first year, the early Energy Code adoption will result in creating job years on the same order of magnitude as the EECBG Program Areas. However, the employment impact of early Energy Code adoption over 30 years is larger by an order of magnitude. This is because the bill savings and the persistence of bill savings with early Energy Code adoption are greater than that with EECBG.

Table 4-22. Employment Impacts of EECBG and Early Code Adoption

Program	Net Job-Years (Wholesale Prices, Evaluated Scenario)	
	First Year	30-Year
EECBG	107	298
Early Energy Code Adoption	93	1,485
EECBG and Early Energy Code Adoption	**200**	**1,783**

<u>Year-Over-Year Results</u>

Figure 4-1 and Figure 4-2 show the employment impact by year and by stimuli type for both the evaluated and projected scenarios, respectively, when modeled using wholesale electric prices. The grey line shows the net impact resulting from summing the negative and positive stimuli. In all cases, the majority of first-year jobs are a result of ARRA and co-funding direct spending. The persistence of bill savings continues to generate positive job impacts long after the stimulus projects are complete. The positive effects of the direct spending outweigh the negative effects of the co-funding costs.

Figure 4-1. Employment Impact of EECBG by Stimuli Type (evaluated with wholesale prices)

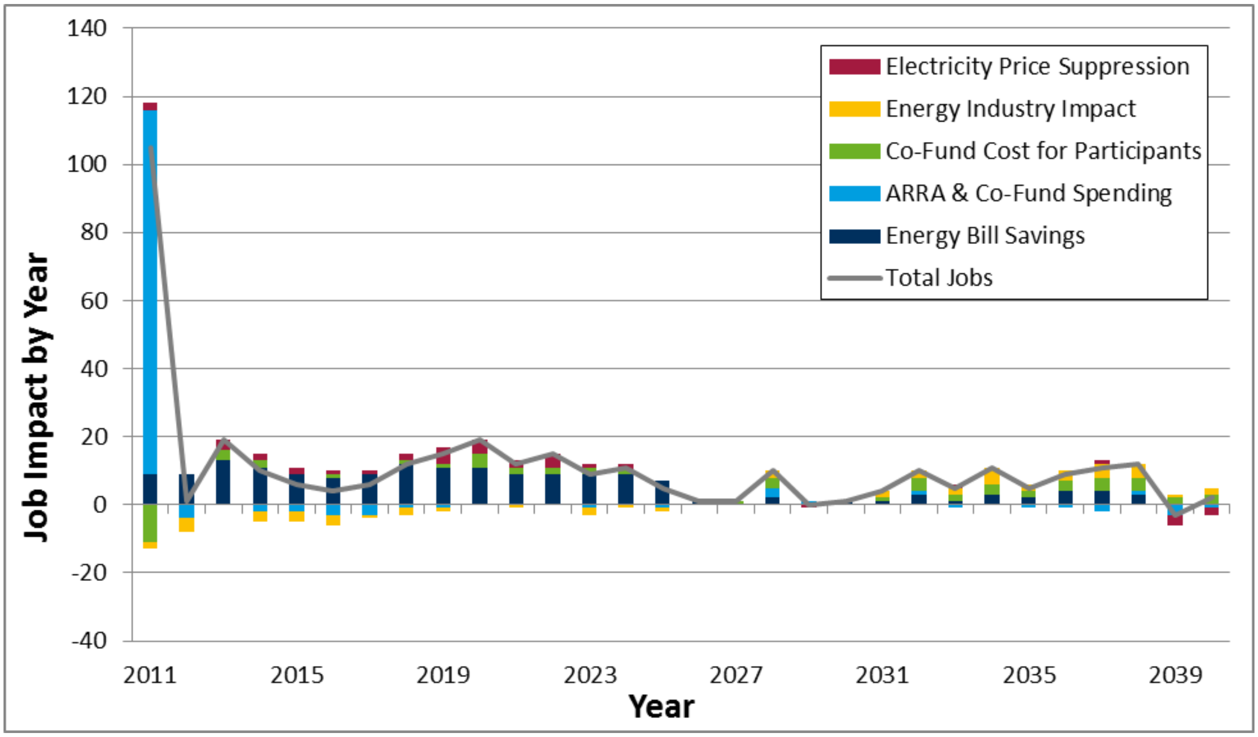


Figure 4-2. Employment Impact of EECBG by Stimuli Type (projected with wholesale prices)

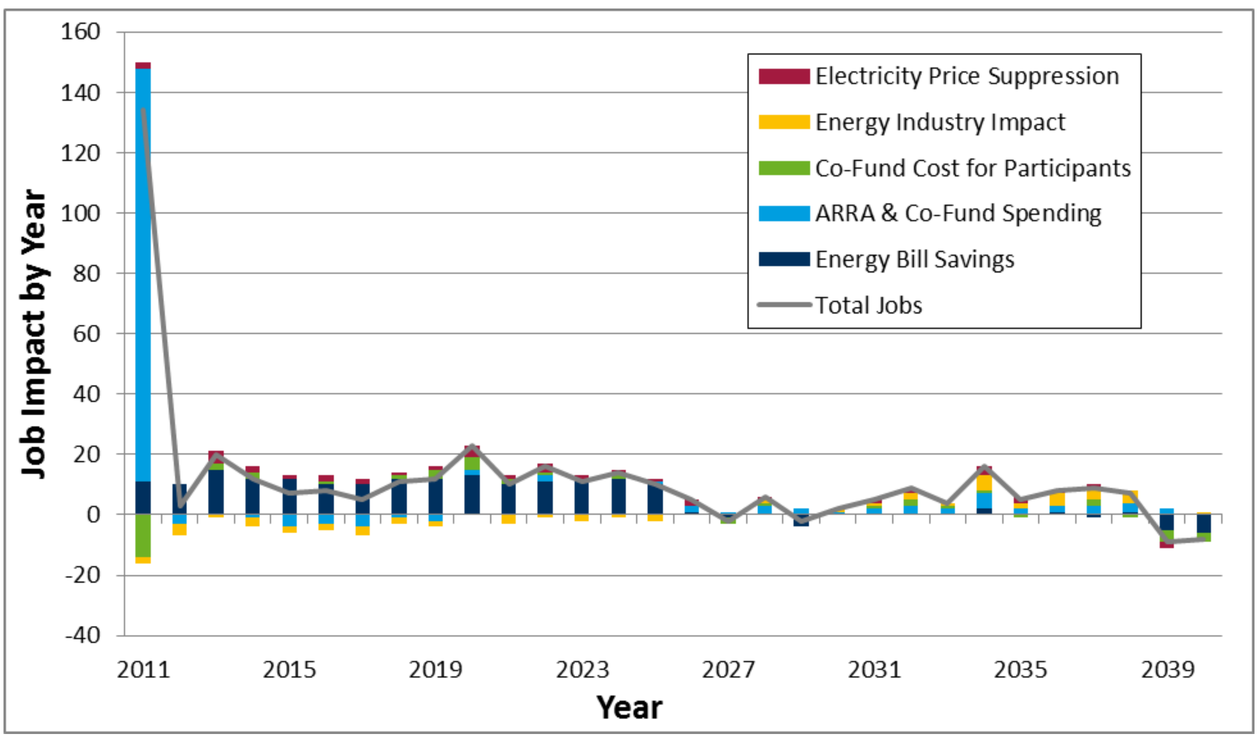


Figure 4-3 and Figure 4-4 show the employment impacts by year and by stimuli type for both scenarios, respectively, when modeled using retail electric prices. Bill savings are more pronounced in these results than in the results above using wholesale prices; electricity consumers retain extra monetary savings per kWh saved due to the difference between retail and wholesale prices. Note that there is no mechanism on the negative side offsetting the use of retail prices in calculating electric bill savings.

Figure 4-3. Employment Impact of EECBG by Stimuli Type (evaluated with retail prices)

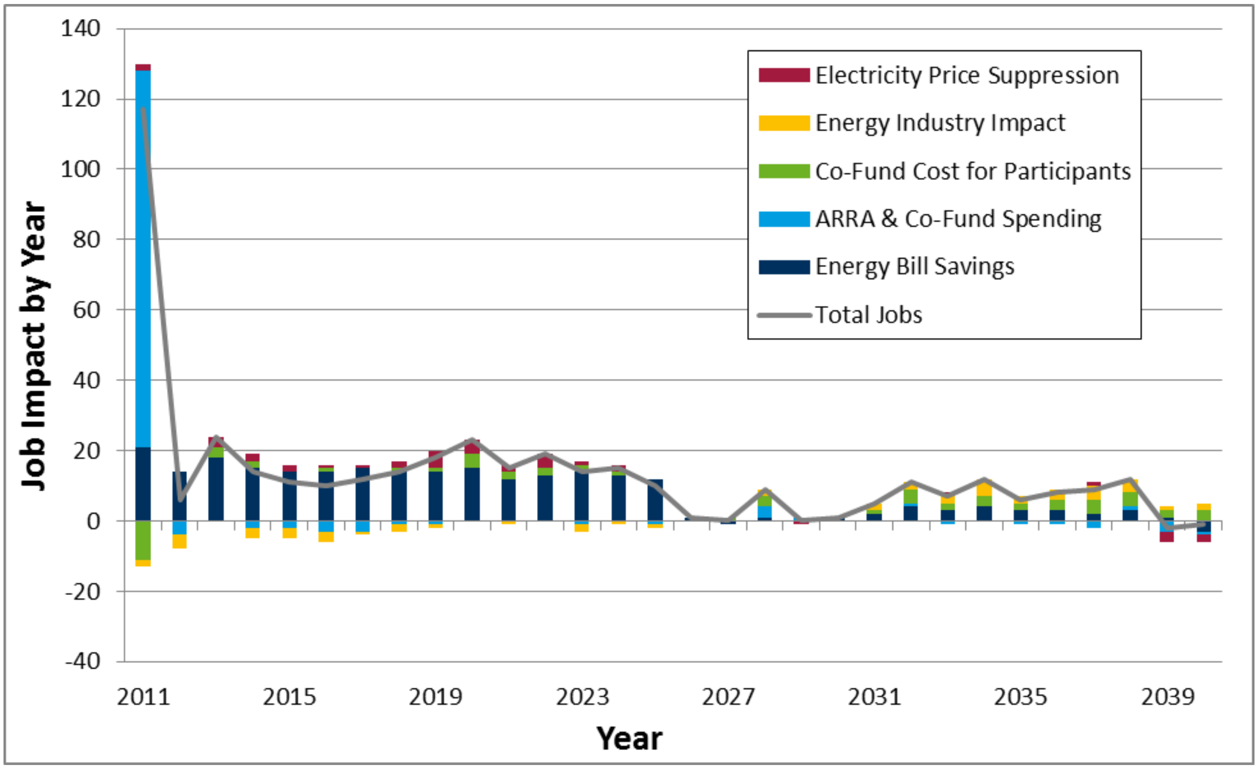
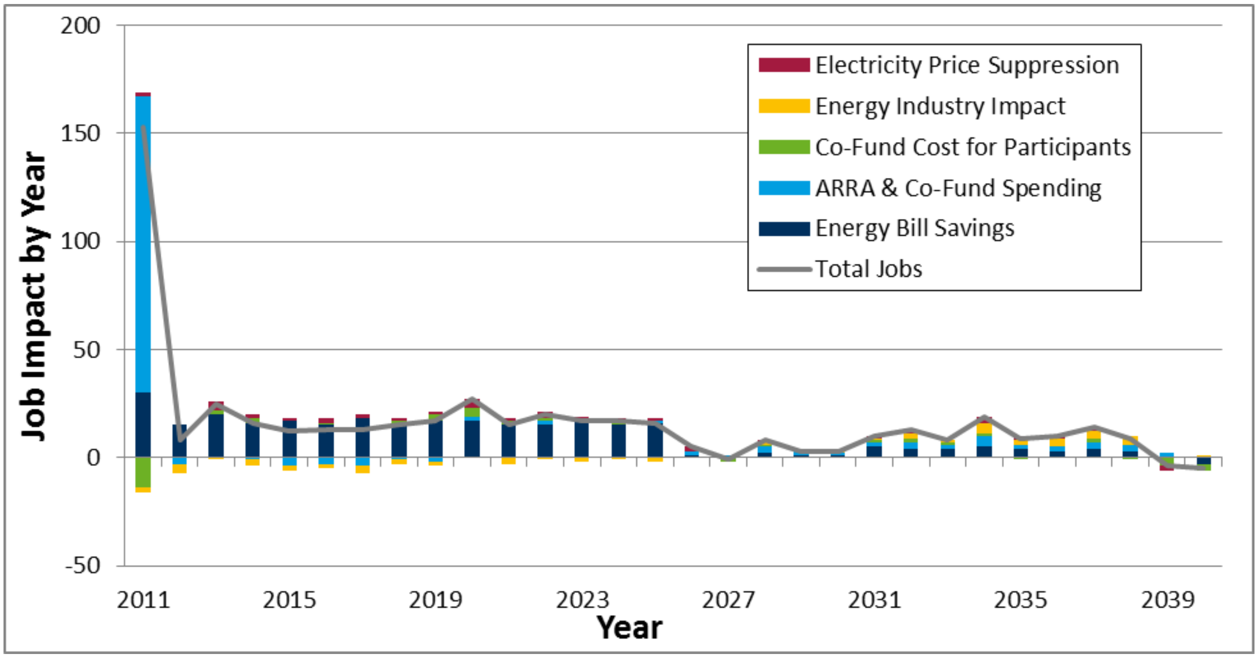


Figure 4-4. Employment Impact of EECBG by Stimuli Type (projected with retail prices)



<u>Results by Program Area</u>

Table 4-23 shows the first year and 30-year (cumulative) impacts by Program Area for both scenarios (evaluated and projected) using wholesale prices, based on the analysis performed using REMI. All Program Areas result in net positive employment impacts, except for the Transportation Program Area in the 30-year projected scenario. Please see Figure 4-5 and its accompanying text for an explanation of the negative impacts observed in the Transportation Program Area in the 30-year projected scenario.

The administration and price suppression category is the largest contributor to the employment impacts. The Energy-Efficiency Program Area is the greatest contributor over 30 years.

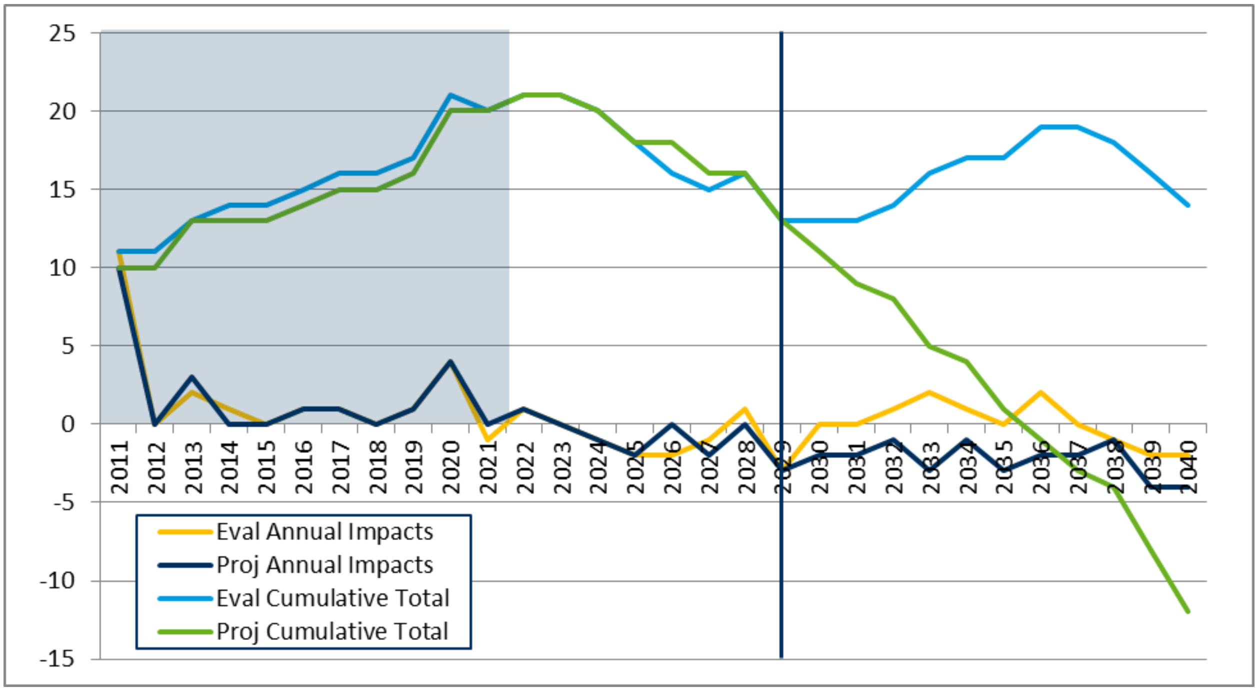
Table 4-23. First and 30-Year Employment Impacts by Program Area (with wholesale prices)

Program Area	Evaluated Scenario (Job-Years)	Projected Scenario (Job-Years)
First Year Impacts		
Energy-Efficiency	23	24
Renewable Energy	26	32
Transportation	11	10
Administration and Price Suppression (for all Program Areas)	46	68
Total	**107**	**135**
30-Year Impacts (cumulative)		
Energy-Efficiency	119	135
Renewable Energy	25	53
Transportation	19	-11
Administration and Price Suppression (for all Program Areas)	135	147
Total	**298**	**325**

Note: Columns may not sum due to rounding.

Figure 4-5 shows the annual and cumulative impacts of the Transportation Program Area for both scenarios (evaluated and projected) using wholesale prices. The 30 year cumulative impact between the two scenarios is quite significant. The shaded region indicates the period in which Transportation Program Area energy bill savings and industry impacts persisted. This period accounts for the first 10 years of the 30-year modeled period. The vertical black line indicates the point at which the evaluated and projected cumulative impacts diverge. This point occurs well after the direct effects of the Transportation Program Area cease. Thus, the negative impacts observed in the Transportation Program Area in the 30-year projected scenario are most likely a result of the accumulation of noise in the model outputs over the last ten years. The interaction of model inputs results in the noise pattern.

Figure 4-5. Employment Impact of the Transportation Program Area (evaluated and projected with wholesale prices)

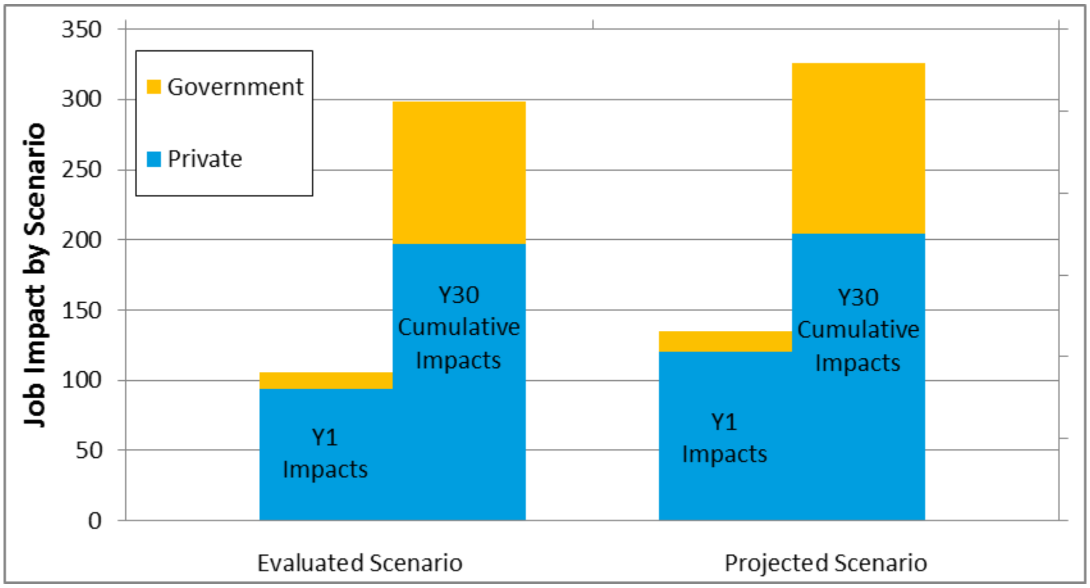


<u>Results by Sector</u>

Because the EECBG grant was targeted to saving energy in various government municipalities, it is expected that some fraction of the net jobs created will also accrue to the government sector. Furthermore, because of the limitations of the REMI model, all bill savings accruing to the government sector are modeled as increased government spending without needing any increase in taxes (as was described in Table 4-18), leading to increases in government job creation.

Figure 4-6 shows the decomposition of first year and 30-year cumulative net job impacts on private sector jobs versus government sector jobs for both the evaluated and projected scenarios (using wholesale prices). Most of the net first year jobs were created in the private industry, and over time, net job years in both the private and government sectors increase.

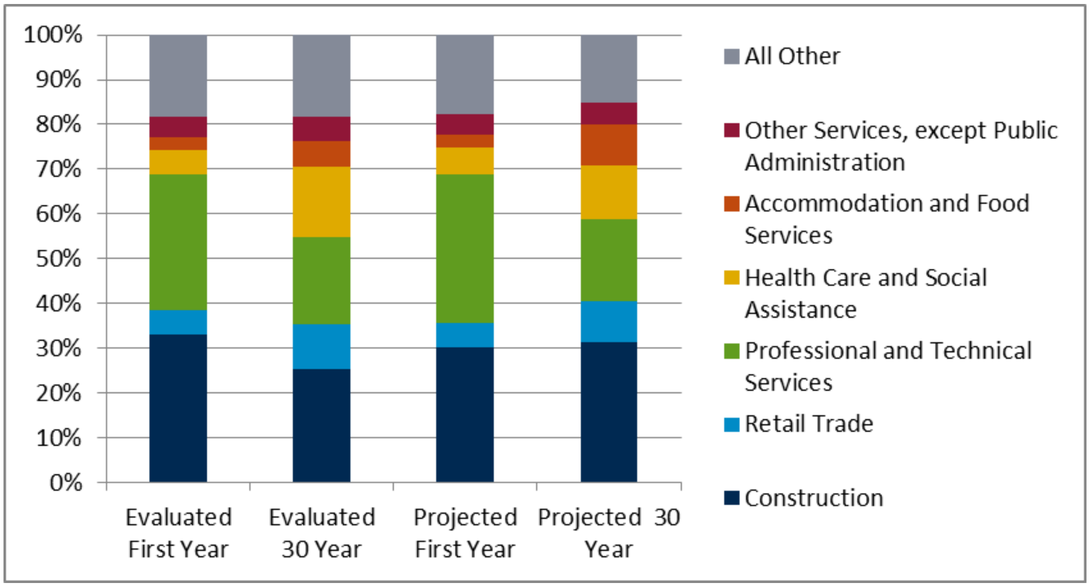
Figure 4-6. First Year and 30-Year (cumulative) Employment Impact of EECBG by Sector (private vs. government)



Results by Industry

Figure 4-7 shows the distribution of jobs created during the first year and cumulatively over 30 years for both scenarios (using wholesale prices) in the top six private sector industries, plus all others industries combined together. This figure shows that a substantial proportion of the jobs created are in the construction and professional and technical services industries, both during the first year and cumulatively over 30 years. This figure also shows that the share of jobs added in other industries increases over 30 years; these include health care and social assistance, retail trade, and accommodation and food services.

Figure 4-7. Top Industries by Net Jobs Added (first and 30-year cumulative)



4.3.8 Conclusions

Within the limitations of the PI$^+$ model and the Cadmus Team's assumptions, the results indicate that NYSERDA's EECBG Program Areas and the early Energy Code adoption resulted in net positive job creation within New York over what would have occurred without the Program Areas. Jobs are created as a result of short-term direct spending associated with Program Area activities, and the long-term persistence of bill savings. More projects completed translate into more job-years added to the regional economy.

Although these findings indicate that NYSERDA's ARRA-funded/induced DSM programs result in *net* positive employment impacts, this may not translate into a noticeable change in the unemployment rate. According to the U.S. Bureau of Labor Statistics, the New York civilian labor force in July 2012 was 9,581.4 thousand and there were 870.1 thousand unemployed.[72] In comparison, the net job impacts from the first year EECBG Program Areas and the early Energy Code adoption amounts to hundreds of jobs, which will not significantly impact the 9.1% unemployment rate.

In addition, without accounting for the full opportunity costs associated with the ARRA funds, the true impact of the stimulus on New York and the broader United States cannot be conclusively determined. Further study should be conducted on how DSM programs compare with other economic development approaches, in order to inform future policy decisions on the best approaches to economic stimulus and meeting employment goals.

4.4 COST-EFFECTIVENESS ANALYSIS

4.4.1 Approach

In assessing cost-effectiveness, the Cadmus Team analyzed the costs and benefits for each Program Area from four different perspectives, using Cadmus' DSM Portfolio Pro[73] model. The Team based the benefit-cost ratios conducted for these tests on methods described in the California Standard Practice Manual[74] for assessing demand-side management (DSM) program cost-effectiveness. In addition to the California tests, the Team used DOE Recovery Act Reporting Requirements for the SEP[75] to determine the SEP-RAC test ratio. Although the SEP-RAC test is not part of the DOE reporting requirements for EECBG, it is included here for consistency with other Recovery Act reports.

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[72] http://www.bls.gov/xg_shells/ro2xg02.htm

[73] DSM Portfolio Pro has been independently reviewed by various utilities, their consultants, and a number of regulatory bodies, including the Iowa Utility Board, the New York PSC, the Colorado Public Utilities Commission, and the Nevada Public Utilities Commission.

[74] California Public Utilities Commission. *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.* October 2001.

[75] DOE. *Recovery Act Reporting Requirements for the SEP*. SEP Program Notice 10-06. March 1, 2010.

A description of all the tests used in this report are as follows:

- **SEP-RAC Test:** This test, which is an SEP reporting requirement of the DOE, measures the avoided source Btu that would have been consumed for each $1,000 of total investment by the State's ARRA-funded Program Areas.
- **Total Resource Cost (TRC) Test:** This test examines the benefits and costs from a total resource perspective. It measures the total costs and benefits in the territory served. Benefits are avoided energy and capacity costs, adjusted for line losses. Costs include any administration and implementation costs associated with funding the Program Area, as well as any costs incurred by ratepayers and Program Area participants.
- **Program Administrator (PA) Cost Test:** This test examines the Program Area benefits and costs from NYSERDA's perspective. Benefits are avoided energy and capacity costs, adjusted for line losses. Costs include any administration, implementation, and incentive costs associated with funding the Program Area.
- **Societal Cost Test (SCT):** This test measures the total Program Area costs and benefits to society. Benefits are avoided energy and capacity costs, adjusted for line losses, and any additional quantifiable benefits. Costs include any administration and implementation costs associated with funding the Program Area, as well as any costs incurred by Program Area participants. This test includes the benefits of avoided GHG emissions.

Table 4-24 presents the benefit and cost components of each of the tests the Cadmus Team calculated.

Table 4-24. Benefit and Cost Components of Evaluated Tests

Elements		SEP-RAC	TRC	PA	SCT
Benefits	Avoided Energy	✓	✓	✓	✓
	Avoided Electricity (supply, T&D)	x	✓	✓	✓
	Avoided Fossil Fuels (supply, T&D)	x	✓	✓	✓
	Environmental Benefits	x	x	x	✓
Costs	ARRA Administration and Implementation Costs	✓	✓	✓	✓
	NYSERDA Administration and Implementation Costs	x	✓	✓	✓
	ARRA Incentives	✓	✓	✓	✓
	Direct Participant Costs	x	✓	x	✓

The Cadmus Team evaluated the cost-effectiveness of each Program Area, as well as for the portfolio of all Program Areas broken out by the major ARRA-funding streams. The results from this examination demonstrate the cost-effectiveness of each technology (e.g., renewable energy), as well as the cost-effectiveness of the suite of activities funded by each separate funding stream (e.g., all projects funded by EECBG). The various funding streams and the Program Areas they support that are represented in this report are documented in Table 4-25.

The Team evaluated and reported on SEP and SEEARP-funded Program Areas in a separate report, with the exception of the Energy Code Program Area. Energy Code is an integrated Program Area in which benefits and costs are not well defined between funding streams. Because of this, the Energy Code Program Area incorporates SEP and EECBG into the cost-effectiveness analysis. The full Early Building Energy Code Adoption Report is included as Appendix F.

Table 4-25. ARRA Funding Streams Used for Cost-Effectiveness Testing

Program Area	EECBG Costs	EECBG Benefits	SEP Benefits	SEP Costs
Energy-Efficiency	✓	✓	x	x
Renewable Energy	✓	✓	x	x
Transportation	✓	✓	x	x
Energy Code	✓	✓	✓	x

The Cadmus Team separated the Program Area and funding stream scenarios into evaluated versus projected. The evaluated scenario includes costs, incentives, and savings incurred by projects that were complete by June 30, 2012. The projected scenario includes all projects that are assumed will be complete by the end of the Program Areas' timeframes. Test results for all scenarios are located in the Results subsection.

Unlike the SEP reporting requirements, the DOE has no required cost-effectiveness test for EECBG. For consistency with the SEP report, and as a reference for NYSERDA, the Cadmus Team used the SEP-RAC test for EECBG projects. The test is described as follows:

> *This cost effectiveness test means that, on average across each state's portfolio of programs, the energy impacts to be achieved should be no less than 10 million source BTUs per year per $1,000 of SEP Recovery Act funds spent. […] This test is called the SEP Recovery Act Cost Test (SEP-RAC test). There are no other cost effectiveness test requirements for SEP Recovery Act project portfolios. [sic]*[76]

Considering line losses and adjusting for the source Btu of electricity with a fossil fuel power factor, the Cadmus Team used Equation 4-1 to calculate the annual energy benefits using the SEP-RAC test.

Equation 4-1. Annual Energy Benefits Using SEP-RAC Test

$$\begin{aligned} &SEP\ RAC\ Benefits \\ &\quad = Electric\ Savings\ \times Fossil\ Fuel\ Power\ Factor \\ &\quad + All\ Other\ Fossil\ Fuel\ Savings \end{aligned}$$

The Team then used the fossil fuel power factor to convert electricity savings at the plug into fossil fuel energy savings at the source of generation (this was defined in the SEP-RAC Assumptions subsection.) The final ratio, as required by the SEP-RAC test, is in tens of millions of source Btu avoided per each one-thousand dollars spent (Equation 4-2).

Equation 4-2. SEP-RAC Test

$$SEP\ RAC\ Test = \frac{SEP\ RAC\ Benefits\ in\ tens\ of\ millions\ Btu}{ARRA\ Funds\ in\ thousands\ of\ dollars} = \frac{10\ MMBtu\ savings}{\$1{,}000\ spent}$$

[76] DOE. *Recovery Act Reporting Requirements for the SEP*. SEP Program Notice 10-06. March 1, 2010.

A ratio greater than or equal to 1 indicates that the funding passed the test.

In addition to the SEP-RAC test, the Cadmus Team conducted other tests for NYSERDA's reference. For these, the Team used Cadmus' proprietary cost-effectiveness model, DSM Portfolio Pro. The Team populated DSM Portfolio Pro with NYSERDA's avoided costs and financial inputs, as well as with weather-adjusted, 8,760 hourly end-use load shapes. The Cadmus Team worked with NYSERDA to compile the model inputs and underlying assumptions to ensure that the tests were calculated with the greatest reasonable degree of accuracy.

The TRC test is commonly used to determine program and portfolio cost-effectiveness. It is a ratio of the lifecycle benefits of the portfolio over the lifecycle costs. The TRC test determines whether energy efficiency is more cost-effective overall than supplying energy. It does not provide the necessary information to determine whether a portfolio or program is cost-effective from the perspective of the program administrator, nor does it consider some of the wider implications to society. Therefore, the Cadmus Team calculated additional tests (the SCT and the PA cost test) based on the California Standard Practice Manual for the portfolio of Program Areas and for each individual Program Area that NYSERDA implemented through ARRA.

The Cadmus Team began the TRC test with a valuation of each Program Areas' total resource benefits (measured by the energy avoided costs) compared to the total costs of acquiring the savings (measured by the total incremental costs of measures installed and administrative costs associated with the Program Area). A Program Area is cost-effective when Equation 4-3 is true.

Equation 4-3. Cost-Effectiveness Calculation

$$\frac{PV\ Total\ Resource\ Benefits}{PV\ Total\ Resource\ Costs} \geq 1$$

Where:

$$Total\ Resource\ Benefits = PV\ (\sum_{year=1}^{Measure\ life} (\sum_{i}^{i=8,760} (impact_i \times avoided\ cost_i)))$$

(where *impact* is the avoided energy and capacity impact adjusted for line losses); and

$$Total\ Resource\ Cost\ =\ PV\ (Incremental\ Measure\ Costs\ +\ Program\ Adminstrative\ Costs)$$

Similarly, the Team measured SCT values for each Program Areas' total resource benefits by the energy avoided costs, avoided emissions, and additional savings, such as operation and maintenance (O&M) and water savings. The Cadmus Team then compared those benefits to the total cost of acquiring the savings (i.e., the total incremental costs of measures installed and administrative costs).

The PA cost test is a valuation of the costs and benefits directly accrued by a program administrator, and is measured by the energy avoided costs, the incentive costs (i.e., utility measure costs), and administrative costs associated with a program.

Equation 4-4 shows the calculation for PA benefits and Equation 4-5 shows the calculation for PA costs.

Equation 4-4. Program Administrator Benefits

$$Program\ Administrator\ Benefits = PV\left(\sum_{year=1}^{Measure\ life}\left(\sum_{i}^{i=8,760}(impact_i \times avoided\ cost_i)\right)\right)$$

Equation 4-5. Program Administrator Costs

$$Program\ Administrator\ Cost = PV\left(\sum_{year=1}^{Measure\ life}(PA\ Measure\ Costs + PA\ Adminstrative\ Costs)\right)$$

4.4.2 Data Sources

The data source input definitions presented in this section are broken out by the following areas of analysis: program administration, Program Areas, measures, and SEP-RAC.

Program Administrator Assumptions

The following definitions are applicable to all Program Areas and all measures. Definitions are arranged roughly by level of importance and impact to the results.

Avoided Energy Costs are the annual generation and T&D costs that were saved as a result of each Program Area. NYSERDA provided data on the avoided costs for electricity and gas, as filed with the New York PSC. The Cadmus Team calculated fuel oil, gasoline, and diesel avoided costs as the delivered cost to the customer based on fuel price forecasts from NYSERDA and the Energy Information Administration.

Avoided Capacity Costs are avoided costs resulting from a reduction in peak energy demand over an average number of peak events during a year. For each energy-efficiency measure included in a Program Area, the Cadmus Team adjusted hourly (8,760) system-avoided costs by the hourly load shape of measure end-use. This captured the on-peak impact of the electricity savings. NYSERDA provided dollar values on the avoided capacity costs, as filed with the New York PSC.

Line Loss is the percentage of energy lost during T&D. In DSM Portfolio Pro, both energy and capacity line losses are applied to measure-level savings, reflecting the total savings from the point of generation. Line loss assumptions are 7.2%, as outlined in the January 16, 2009 PSC Order and provided by NYSERDA. In other words, the Team multiplied all plug savings by 0.928 to obtain electric source savings.

Load Shapes show the hourly energy use over a year of each end-use included in DSM Portfolio Pro. In most cases, the Team used hourly end-use load shapes for New York from work that Cadmus completed for the New York State Electric and Gas Corporation and the New York DPS. The Team developed renewable energy load shapes from solar and wind power specifically for this evaluation.

Discount Rates are used to determine the net present value of benefits for a program. For this evaluation, all tests except SEP-RAC discount the future benefits of a Program Area by 5.5%, based on the New York DPS value for cost of capital.

Peak Definitions are used to determine any time or seasonal differentiation between rates and avoided costs. The New York DPS avoided capacity model defines peak as the sixteenth hour of the second day of the thirty-first week of the year (which was originally July 27, 2009 at 4:00 p.m., and the Team adjusted for the current year).

Externalities are non-energy benefits associated with electricity generation and natural gas use. The Cadmus Team applied these benefits on the basis of tons saved per avoided kWh or therm. A cost for carbon dioxide of $15/metric ton was provided by New York DPS. These benefits only apply to the SCT.

Indirect Benefits are benefits in addition to energy savings that are associated with installing high-efficiency and alternative energy measures. These include reduced water consumption and reduced O&M costs. Indirect benefits only apply to the SCT.

<u>Program Assumptions</u>

Sectors and Segments identify the customer class of the participants from each Program Area. Sectors for EECBG Program Areas include mainly governmental with some impacts to residential and commercial. Examples of segments used in DSM Portfolio Pro include single family, small office, and large office. Sectors and segments dictated which rates and load shapes the Team used for analysis.

Program Administrative Costs include any expenses associated with Program Area development, marketing, delivery, operation, and EM&V. These costs are not measure-specific, and were assessed at the Program Area or portfolio level. The SEP-RAC test only considered costs that were covered by ARRA funding. The costs between the evaluated and projected scenarios will change as more costs are incurred after 2011. The categories included in the portfolio are outlined in Table 4-26.

Table 4-26. Implementation and Administrative Costs

Cost Category	Description
Implementation	Incremental costs associated with performing Program Area implementation tasks, including customer service, application processing, and customer outreach.
Incentives	Rebates and incentives paid through the various ARRA funding streams.
Administration	Costs to administer Program Areas, including fully-loaded incremental personnel costs and activities associated with market research outside of EM&V.
Evaluation	Activities associated with determining and evaluating ARRA-funded Program Areas. These activities include benefit-cost ratio analysis, impact and process analysis, and customer research.
Marketing	Cost to increase awareness of Program Areas.

<u>Measure Assumptions</u>

Measure Life is used to calculate the lifetime benefits of each measure. The Cadmus Team based the life of each measure first on information from the New York Technical Reference Manual, where available, then on the NYSERDA *Deemed Savings Database*, Program Area documentation, and secondary research.

End Use is used to assign each measure to a specific load shape. Examples of end uses in DSM Portfolio Pro include water heating, HVAC, and lighting.

Savings are the annual electric kWh and natural gas therm savings associated with installing and implementing each measure. DSM Portfolio Pro used the *ex post* gross savings and applied the NTG ratio. The Team input fuel oil, propane, gasoline, and diesel savings as monetized values at their respective retail costs.

Incremental Costs are the expenses associated with a measure that are above the assumed baseline costs for that measure. Incremental cost is the difference between the cost of purchasing and installing the high-efficiency measure and the cost of purchasing and installing the baseline measure. The incentive payment to the customer is not netted out. The Team based incremental costs on information from NYSERDA, the Program Area implementer, Program Area documentation, and secondary research.

Incentive Level is the dollar amount of the rebate paid to the customer through ARRA funding streams. NYSERDA provided the incentive amount for each measure. This amount increases from the evaluated to projected scenario due to more projects being completed and incentives being paid out.

Freeridership is the percent of participants who would have taken the same action (i.e., installed the same measure) in the absence of the Program Area. The Cadmus Team based freeridership on the evaluation work performed for each Program Area. The Team based the evaluated scenario NTG on evaluated freeridership. The projected scenario combines freeridership and spillover into one projected NTG value of 0.9.

Spillover is the percent of participants who installed additional energy-savings measures without receiving incentives as a result of their participation in the Program Area. The Cadmus Team based the evaluated scenario NTG on 0% spillover. For the projected scenario, the Team combined freeridership and spillover into one projected NTG value of 0.9.

Participation is the number of customers who participated in the Program Area or the quantity of measures verified by the Cadmus Team.

SEP-RAC Assumptions

Fossil Fuel Power Factor is the ratio of energy from fossil fuels used to generate electricity over all the electricity generated for use in the territory. Essentially, it is the overall fossil fuel power plant efficiency multiplied by the percent of electricity from fossil fuels. NYSERDA provided this number as 9,949.2 source Btu per kWh generated. Measure savings for other types of energy (such as natural gas and diesel) are already being saved at the source and are 100% fossil fuel based, thus the Team did not make adjustments for line losses or the fossil fuel source.

4.4.3 Results

Portfolio Results

Table 4-27 presents Program Area cost-effectiveness analysis results, including evaluated NTGs for the lifetime of all Program Area measures in the evaluated scenario. Energy Code benefits are the result of SEP and EECBG activities, while Energy Code costs only reflect EECBG. (Energy Code costs for SEP-funded activities are included in the SEP report. That report reflects no savings benefits, as they were not available. Savings benefits are presented here.)

Some details of the table results include:

- A benefit-cost ratio equal to or greater than 1 is considered beneficial, or passing.
- All costs are reported in dollars, rounded to the nearest thousand; this aligns with SEP-RAC test requirements.
- SEP-RAC benefits are reported in MMBtu, rounded to the nearest ten; this aligns with SEP-RAC test requirements.

- SEP-RAC ratios are reported in the DOE requirement of 10 MMBtu/$1,000.
- The TRC test, PA cost test, and SCT benefits are reported in dollars.
- The TRC test, PA cost test, and SCT ratios are reported in the California requirements of benefit dollars compared to cost dollars.

Table 4-27. Evaluated Portfolio Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Funding Stream	Costs	Benefits	Benefit-Cost Ratio
SEP-RAC	EECBG (no Energy Code)	$20,496,000	126,120 MMBtu	0.6
	Energy Code	$990,000	176,440 MMBtu	17.8
	Portfolio	$21,486,000	302,560 MMBtu	1.4
TRC	EECBG (no Energy Code)	$21,836,000	$21,257,000	1.0
	Energy Code	$18,195,000	$31,444,000	1.7
	Portfolio	$40,031,000	$52,702,000	1.3
PAC	EECBG (no Energy Code)	$20,498,000	$21,257,000	1.0
	Energy Code	$990,000	$31,444,000	31.8
	Portfolio	$21,487,000	$52,702,000	2.5
SCT	EECBG (no Energy Code)	$21,836,000	$21,306,000	1.0
	Energy Code	$18,195,000	$33,398,000	1.8
	Portfolio	$40,031,000	$54,704,000	1.4

Note: The values presented here do not necessarily match the values found in other sections of the report due to rounding.

Table 4-28 shows the same type of results as Table 4-27, but reflects the projected scenario in which it is assumed that unfinished projects will be completed soon and all funding will be spent.

Table 4-28. Projected Portfolio Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Funding Stream	Costs	Benefits	Benefit-Cost Ratio
SEP-RAC	EECBG (no Energy Code)	$23,334,000	147,190 MMBtu	0.6
	Energy Code	$2,623,000	176,440 MMBtu	6.7
	Portfolio	$25,956,000	323,640 MMBtu	1.2
TRC	EECBG (no Energy Code)	$24,845,000	$24,291,000	1.0
	Energy Code	$19,828,000	$31,444,000	1.6
	Portfolio	$44,673,000	$55,735,000	1.2
PAC	EECBG (no Energy Code)	$23,300,000	$24,291,000	1.0
	Energy Code	$2,623,000	$31,444,000	12.0
	Portfolio	$25,924,000	$55,735,000	2.1
SCT	EECBG (no Energy Code)	$24,845,000	$24,505,000	1.0
	Energy Code	$19,828,000	$33,398,000	1.7
	Portfolio	$44,673,000	$57,903,000	1.3

Note: The values presented here do not necessarily match the values found in other sections of the report due to rounding.

Table 4-29 shows a break out of the cost inputs the Cadmus Team used to calculate the SEP-RAC test into two categories: incentives payments used to directly benefit the Program Area, and administrative costs that NYSERDA and its implementers used to manage the Program Area funding and supporting activities. Table 4-29 shows evaluated scenario inputs, while Table 4-30 shows projected scenario inputs. These costs only include EECBG-related costs.

Table 4-29. Evaluated ARRA Expenditures by Program Area for SEP-RAC Test

Program Area	Incentives Paid	Administrative Cost	Program Cost
Energy-Efficiency	$5,005,000	$1,897,000	$6,902,000
Renewable Energy	$10,110,000	$2,116,000	$12,225,000
Transportation	$1,189,000	$180,000	$1,369,000
Subtotal	**$16,304,000**	**$4,193,000**	**$20,496,000**
Energy Code	$0	$990,000	$990,000
Total	**$16,304,000**	**$5,183,000**	**$21,486,000**

Table 4-30. Projected ARRA Expenditures by Program Area for SEP-RAC Test

Program Area	Incentives Paid	Administrative Cost	Program Cost
Energy-Efficiency	$5,938,000	$2,297,000	$8,235,000
Renewable Energy	$11,130,000	$2,562,000	$13,691,000
Transportation	$1,189,000	$219,000	$1,407,000
Subtotal	**$18,257,000**	**$5,078,000**	**$23,333,000**
Energy Code	$0	$2,623,000	$2,623,000
Total	**$18,257,000**	**$7,701,000**	**$25,956,000**

Energy-Efficiency Program Area Results

Table 4-31 presents EECBG evaluated Energy-Efficiency Program Area cost-effectiveness analysis results, including the evaluated NTG for the entire Program Area. Table 4-32 shows the results for the projected scenario. The Program Area passed all cost-effectiveness tests.

Table 4-31. Evaluated Energy-Efficiency Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit-Cost Ratio
SEP-RAC	$6,902,000	88,100 MMBtu	1.3
TRC Test	$7,693,000	$12,049,000	1.6
PA Cost Test	$6,902,000	$12,049,000	1.7
SCT	$7,693,000	$12,720,000	1.7

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents, and do not affect the ratios.

Table 4-32. Projected Energy-Efficiency Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit-Cost Ratio
SEP-RAC	$8,235,000	108,810 MMBtu	1.3
TRC Test	$9,715,000	$15,029,000	1.5
PA Cost Test	$8,235,000	$15,029,000	1.8
SCT	$9,715,000	$15,860,000	1.6

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents, and do not affect the ratios.

Renewable Energy Program Area Results

Table 4-33 presents EECBG Renewable Energy Program Area cost-effectiveness analysis results for the evaluated scenario. Table 4-34 shows the projected scenario using a NTG of 0.9. This Program Area failed all cost-effectiveness tests.

Table 4-33. Evaluated Renewable Energy Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit-Cost Ratio
SEP-RAC	$12,225,000	23,230 MMBtu	0.2
TRC Test	$12,461,000	$6,138,000	0.5
PA Cost Test	$12,227,000	$6,138,000	0.5
SCT	$12,461,000	$5,369,000	0.4

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents, and do not affect the ratios.

Table 4-34. Projected Renewable Energy Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit-Cost Ratio
SEP-RAC	$13,691,000	25,080 MMBtu	0.2
TRC Test	$13,598,000	$6,499,000	0.5
PA Cost Test	$13,696,000	$6,499,000	0.5
SCT	$13,598,000	$5,750,000	0.4

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents, and do not affect the ratios.

Transportation Program Area Results

Table 4-35 presents EECBG Transportation Program Area cost-effectiveness analysis results, including evaluated NTG for all Program Area measures. Overall, the Transportation Program Area performed well. In the evaluated scenario, the Program Area passed all cost-effectiveness tests. However, as shown in Table 4-36, in the projected scenario the Program Area does not pass the SEP-RAC test. This is due to lower net benefits from the lower NTG value, and slightly higher projected administrative costs in the projected scenario.

Table 4-35. Evaluated Transportation Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit-Cost Ratio
SEP-RAC	$1,369,000	14,790 MMBtu	1.1
TRC Test	$1,682,000	$3,070,000	1.8
PA Cost Test	$1,369,000	$3,070,000	2.2
SCT	$1,682,000	$3,217,000	1.9

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents, and do not affect the ratios.

Table 4-36. Projected Transportation Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit-Cost Ratio
SEP-RAC	$1,407,000	13,310 MMBtu	0.9
TRC Test	$1,532,000	$2,763,000	1.8
PA Cost Test	$1,369,000	$2,763,000	2.0
SCT	$1,532,000	$2,896,000	1.9

Note: Differences between savings reported here and savings reported in executive summary tables are due to differences in rounding from source documents, and do not affect the ratios.

Energy Code Program Area Results

Results of the Energy Code Program Area can be found in the Early Building Energy Code Adoption Report, included as Appendix F.

Section 5:

CONCLUSIONS AND RECOMMENDATIONS

5.1 ENERGY CODE PROGRAM AREA CONCLUSIONS AND RECOMMENDATIONS

The Energy Code Program Area funded by ARRA provided significant benefits to support code compliance and lay the groundwork to achieve 90% compliance by the year 2017. In addition, New York accelerated Energy Code adoption in response to ARRA; the Cadmus Team's analysis to estimate savings from early code adoption is described in Appendix F.

The Cadmus Team assessed the plan review services from T.Y. Lin that were supported with EECBG funds. Based on this assessment, the Team drew several significant conclusions about the Program Area and developed key recommendations for steps NYSERDA can take to continue and increase the effectiveness of the Energy Code Program Area.

The Cadmus Team interviewed a relatively large proportion of the CEOs who received plan review services (35%). The CEOs who took advantage of these services generally gave them high marks. Significant pluses the Cadmus Team identified during research were:

- T.Y. Lin is well respected by the CEOs, and the CEOs considered the services they delivered to be very thorough, clear, and beneficial.
- These services improved the understanding and comprehension of energy codes for all the groups interviewed.
- The services helped spread Energy Code awareness among the contractors and designers who developed the plans that were submitted for review.
- The services were especially useful for the more complex requirements of the commercial Energy Code.
- The CEOs considered both the checklist and text explanation of the review findings to be very useful and thorough.
- The advantages of a third-party review were clear: it improved compliance with and understanding of the energy codes in rural and small town areas of New York, particularly because T.Y. Lin has a strong local area reputation.
- Having a credible third-party provide the services also helped the CEOs make a stronger case for changes or updates with the applicant.
- These services helped applicants and CEOs identify alternative ways of meeting the code requirements.

Although the responses to the plan review services were very positive overall, T.Y. Lin and the CEOs identified the following challenges and concerns:

- Recruiting CEOs to participate required a fairly significant effort, and word-of-mouth marketing and direct phone calls to CEOs from a reputable organization proved to be the most productive forms of outreach.
- CEOs reported difficulties with enrolling in plan review services through NYSERDA's online registration. Many found the online registration process difficult to locate and use, and T.Y. Lin had to assist several CEOs with completing the online process.
- Provision of the services started several months after the Energy Code had gone into effect, so they were not provided to the industry and CEOs in time to affect the early implementation phases of the Energy Code.
- In some cases, the plan review services took long enough that the normal flow of the review process was disrupted and interfered with the project progress.
- In one case, a CEO said he did not have the opportunity to learn about the Energy Code through the process.
- The checklist does not directly indicate whether supporting information is missing in the submittal, nor does the checklist always mention the applicable Energy Code section.

Through their plan review services, T.Y. Lin identified some common problems across building projects that provided insights into where future training, plan review services, and other Program Area efforts should focus. Problems they identified through these services included:

- Lack of adequate documentation submitted with plans to verify compliance (this was the most common problem).
- Inconsistencies among the different materials submitted for a single project. In particular, information provided with the compliance software outputs (e.g., COMcheck) often did not match information shown on the plans.
- Insulation for slabs in residential buildings was often missing or poorly documented.
- Information on air sealing in both residential and commercial buildings was often missing or poorly documented.
- Inadequate information related to sealing and insulation of ducts.
- In commercial buildings, the compliance problem areas covered a wide spectrum including heating vents, insulation, HVAC (including oversizing), motors, and the building envelope.

In addition, some CEOs expressed concerns that the materials they submitted with the plans and compliance documentation did not match what was actually built.

Based on this study, the Cadmus Team makes the following recommendations regarding the plan review services:

- ***Continue to provide the plan review services for CEOs.*** Expand these services to other areas of the State and have them delivered by trusted and respected contractors who have the resources to continue marketing services through word-of-mouth and direct phone calls to CEOs. Create a simple registration process for CEOs, then test and refine it as needed to minimize registration obstacles. Institute a process for collecting voluntary feedback from the CEO participants to encourage use of the Program Area as a learning opportunity and to collect data on the effectiveness of the service, ways to improve it, and the results of the permit process.

- ***Incorporate the plan review in an integrated package of services provided to enhance Energy Code compliance and enforcement.*** Provide these services in conjunction with ongoing training, and include industry professionals along with CEOs to improve understanding of the code.
- ***Make the services available earlier for future Energy Code upgrades.*** To be most effective and minimize negative responses to new codes, phase in the services early in the implementation of the new Energy Code.
- ***Enhance marketing of the services.*** Document and use the experiences of CEOs who participated in the services to inform other CEOs about the service and benefits. Use the CEO network to communicate the available services to CEOs throughout the State. Offer the services to the building industry through professional organizations and networks to increase industry acceptance of the services.
- ***Implement the plan review services in a way that increases consistency across jurisdictions.*** Providing services to a large number of jurisdictions will minimize differences in how the Energy Code is interpreted and enforced.
- ***When designing the training and other services, take into account what T.Y. Lin has learned about CEOs knowledge through providing the plan review services.*** For both residential and commercial buildings, educate the industry and CEOs about the need to provide thorough documentation as a demonstration of Energy Code compliance. In the residential sector, focus training on topics such as slab insulation requirements, air infiltration, and duct sealing and insulation. Establish a process for feeding information from future plan review services into the training program.
- ***Enhance the plan review checklists.*** Add a box that indicates if information is missing or the measure does not comply. Also, indicate specific code sections related to any deficiencies on the checklist.
- ***Explore the possibility of extending similar services to site inspections.*** Offering similar services during site inspections could be very beneficial. However, some CEOs or architects/builders may be sensitive about having a third-party participate in this process, so investigate with CEOs the best way to implement such a service.

5.2 ENERGY-EFFICIENCY PROGRAM AREA CONCLUSIONS AND RECOMMENDATIONS

Overall, the Energy-Efficiency Program Area achieved a total gross savings realization rate of 99%. However, because of a freeridership rate of 19%, the total Program Area net savings achieved an 80% realization rate. From a technical aspect, the Program Area was successful: approximately the same gross savings as was originally predicted were realized. The Program Area also achieved a freeridership rate that is typical for these types of projects.

The Cadmus Team provides the following Program Area conclusions:

- ***Benchmarking freeridership.*** The Cadmus Team benchmarked NYSERDA's Energy-Efficiency Program Area freeridership results with results from similar programs.[77] In these other studies, freeridership averaged between 13% and 30%. One example is Questar Gas' business energy-efficiency program, which had a freeridership rate of 26%.[78] Another example is NYSERDA's previous commercial and industrial energy-efficiency program, FlexTech, which had a freeridership rate between 9% and 36%.[79] NYSERDA's Energy-Efficiency Program Area's freeridership of 19% falls within the range of the other programs' freeridership rates. None of the comparison evaluations were of an economic stimulus program, so they are not necessarily comparable to the NYSERDA ARRA Program Area.
- ***Lighting.*** The majority of electric savings came in the form of lighting projects. These projects were deployed more quickly than other types of projects.

The Cadmus Team provides the following recommendations for future similar programs:

- ***Have better data transparency and availability.*** The Cadmus Team balanced being persistent with participants and respecting their reasons for not providing data more readily. As an independent evaluator, the Cadmus Team's requests and site visits were to occur after other similar requests and visits were conducted by other parties. Coordination of those requests and visits (while still performing an otherwise autonomous review) could have increased participant data collection. The Cadmus Team recommends establishing a process in which data requests and site visits are scheduled such that they reduce the impact on the participant while still allowing the reviews to be autonomous.
- ***Maintain flexible marketing options.*** Research revealed that word-of-mouth, contractors and installers, the NYSERDA Website, the NYSERDA FlexTech Program, and Program Area marketing materials were all equally successful marketing channels. At this point, it cannot be conclusively said that any one marketing channel is better than others.

5.3 RENEWABLE ENERGY PROGRAM AREA CONCLUSIONS AND RECOMMENDATIONS

5.3.1 Gross Generation Conclusions

RFP 10 provided funding for a variety of renewable energy technologies, which are shown in Table 5-1. When deriving gross generation estimates, realization rates for some technologies were equal to or greater than 100%, such as for solar PV, indicating that relatively mature performance modeling techniques were used for these technologies. The lower realization rates for other technologies, such as solar thermal (i.e., solar walls), were driven by inaccurate pre-installation assumptions.

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[77] The Cadmus Group, Inc. *Evaluation of DEER 2011 Non-Residential Energy-Efficiency NTG*. and The Cadmus Group, Inc. *Avista 2010 Multi-Sector Gas Impact Evaluation Report.* 2011.

[78] Questar Gas. *Utah Energy Efficiency Results.* 2010. Available online: http://www.psc.state.ut.us/utilities/gas/gasindx/1105706indx.html.

[79] NYSERDA. *New York Energy $mart Program Evaluation and Status Report Volume 2*. May 2004.

Table 5-1. Gross Energy Generation by Technology, Renewable Energy Program Area

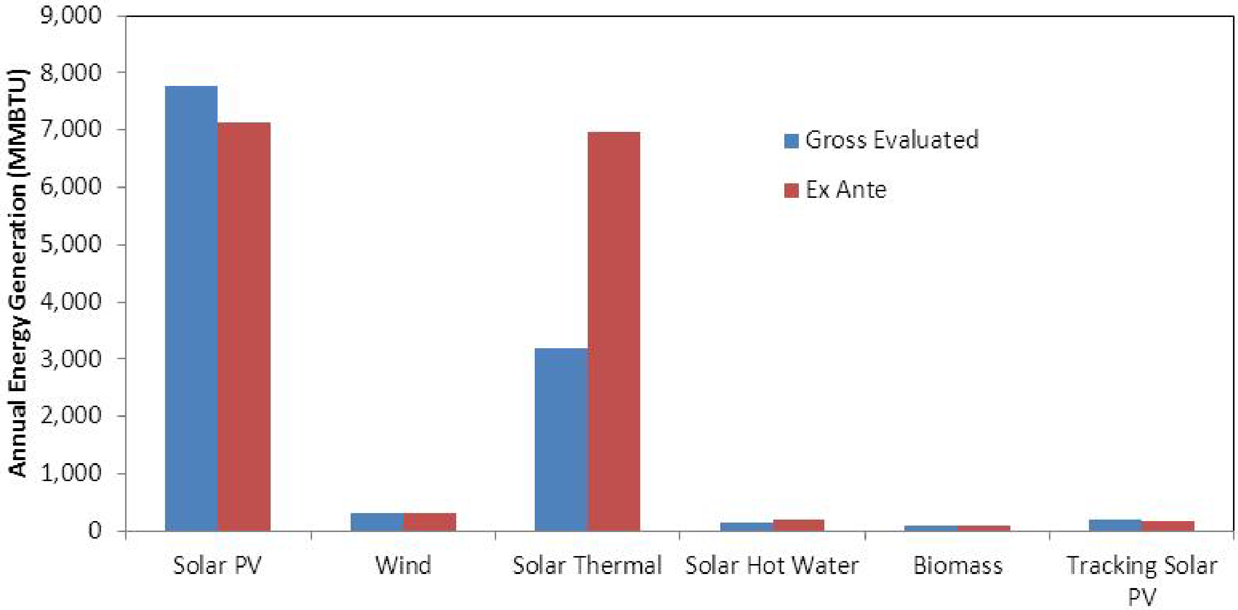
	Annual Gross Population Generation/Savings: All Funded Projects							
	Number of Projects	**Electric (MWh)**	**Electric (MMBtu)***	**Gas (MMBtu)**	**Oil (MMBtu)**	**Propane (MMBtu)**	**Other Fuels (MMBtu)**	**Total (MMBtu)**
PV Upstate	44	1,736	5,923	N/A	N/A	N/A	N/A	5,923
PV Downstate	11	546	1,862	N/A	N/A	N/A	N/A	1,862
Wind Upstate	3	90	307	N/A	N/A	N/A	N/A	307
Wind Downstate	0	N/A	N/A	N/A	N/A	N/A	N/A	0
Solar Thermal Upstate	2	-12	-41	2,826	N/A	N/A	N/A	2,813
Solar Thermal Downstate	1	N/A	N/A	N/A	414	N/A	N/A	414
SHW Upstate	2	4	14	121	N/A	N/A	N/A	136
SHW Downstate	0	N/A	N/A	N/A	N/A	N/A	N/A	0
Biomass Upstate	1	N/A	N/A	N/A	N/A	695	-604	91
Biomass Downstate	0	N/A	N/A	N/A	N/A	N/A	N/A	0
Tracking Solar PV Upstate	1	62	213	N/A	N/A	N/A	N/A	213
Tracking Solar PV Downstate	0	N/A	N/A	N/A	N/A	N/A	N/A	0
Total	**65**	**2,426**	**8,278**	**2,947**	**414**	**695**	**-604**	**11,731**

Note: Columns and rows may not sum correctly due to rounding.

* Electricity conversion was accomplished at the project site, using a conversion of 3.412×10^{-3} MMBtu/MWh.

Figure 5-1 displays the predicted (*ex ante*) and evaluated (*ex post*) energy generation values for the Renewable Energy Program Area. As shown, the majority of technologies resulted in high realization rates, with the exception of solar thermal, as discussed previously.

Figure 5-1. Gross Evaluated and *Ex Ante* Generation Estimates for Projects, Renewable Energy Program Area



In total, the renewable energy projects that were funded and installed by June 30, 2012, under RFP 10 are expected to generate approximately 9,588 MMBtu annually, primarily reducing the consumption of electricity and fuel oil. The expected annual energy generation for all funded projects is 11,731 MMBtu.

5.3.2 Recommendations for Future Programs

NYSERDA has a long history of implementing successful programs that promote the development of renewable energy technologies. Based on the findings of this evaluation, the Cadmus Team provides the following recommendations for future similar programs:

Technology-Related Recommendations

- ***Fund a tracking solar PV system pilot program.*** Tracking solar PV generates significantly more electricity than a fixed array system of the same size. However, although the systems installed with the ARRA funding performed well in excess of expectations (realization rate of 119%), widespread adoption of the technology will require further investment to reduce installation costs and improve reliability. The Cadmus Team recommends that NYSERDA consider funding a pilot program to support the installation and monitoring of additional tracking solar PV systems. This effort would help in determining whether these systems can be reliable and cost-effective for long-term installation in New York, particularly if long-term reliability of the tracking mechanism can be included.

Program Structure-Related Recommendations

- ***Consider and weigh the trade-off between cost-effectiveness and visibility/awareness.*** Even with the existing incentive programs, which cover between 20% and 40% of the installed costs for mature renewable energy technologies, municipalities and public entities often have difficulty completing projects, as they have minimal cash on hand and are not able to take advantage of the available tax credits that private entities use. Given these difficulties, RFP 10 was an effective way to support the development of renewable energy at public sites. Public projects are more visible and could reduce barriers to future development by raising public awareness of renewable energy.

The Cadmus Team recommends that NYSERDA carefully consider the goals of RFP 10 before adopting a more widespread version. The relative merits of a more cost-effective program versus the visibility and awareness benefits of public projects needs to be carefully considered and aligned with the appropriate Program Area structure. Also, the increased use of Power Purchase Agreements has provided public entities and other cash-constrained or tax credit ineligible entities with more options for procuring on-site renewable energy.

Evaluation-Related Recommendations

- ***Evaluate demand impacts, particularly for grid-congested areas.*** This represents a potential, largely unclaimed, benefit of these types of programs. Given the high peak loads in areas like NYC, this is worth further examination during future evaluations.
- ***Focus evaluation efforts on systems with more operational history.*** Although conducting the evaluation largely in parallel with Program Area implementation provided a more real-time view to the Cadmus Team, it would be beneficial to evaluate projects with longer operating periods, especially given that many renewable energy technologies operate on a seasonal basis.

5.4 TRANSPORTATION PROGRAM AREA CONCLUSIONS AND RECOMMENDATIONS

The Transportation Program Area was successful in reducing GHG emissions and fuel usage. The NYSERDA ARRA-funded transportation projects included the installation of Synchro software to coordinate traffic signals along three corridors of traffic in the Cities of North Tonawanda, Jamestown, and Lackawanna, and the integration of RouteSmart software in the City of Watertown's GIS system to determine the optimal route for seven refuse and recycling vehicles. The following Program Area impacts were limited, however, by the small number of projects:

- ***Marketing evaluation.*** The effectiveness of marketing ARRA-funded NYSERDA transportation projects was outside the scope of this evaluation. It would be useful for NYSERDA to have a better understanding of: 1) why the applications for green transportation project funding fell short of expectations; and 2) why one project dropped out after being approved.
- ***Freeridership calculation.*** The four project respondents exhibited no freeridership, as evidenced by their responses to the respondent survey. Freeridership rates for Transportation Program Area participants of RFP 10 should be interpreted cautiously due to the very small sample size (n=4). Although the Cadmus Team used these freeridership results to adjust the ultimate claimed savings, caution should be exercised when considering them in future Program Area planning or projections.
- ***Improved data collection.*** Prior to project implementation, project contacts should be clearly informed about the types of data that will be required of them at the end of the process. Labor versus materials provided an obstacle for several project contacts, who were required to make subjective decisions about the appropriate category. Although they calculated all data consistently, it would aide future evaluations to provide clear guidelines. For instance, project contacts were challenged when determining diesel versus gasoline reductions, as they were not aware they would need to report findings this way. NYSERDA may want to make it easier for project applicants to report their expected fuel savings by including a simple table for them to fill

out the fuel usage before, and expected fuel usage after project implementation, for each vehicle impacted.

- ***Concise direction on milestones and points of contact.*** Several contacts noted that the multiple points of contact at NYSERDA was confusing, as were the process, the reporting structure, and the big picture. NYSERDA could consider streamlining the process so that the municipalities do not face the frustration of spending their resources figuring it out.

5.5 DISPLACED GHG EMISSIONS CONCLUSIONS

Table 5-2 summarizes the Program Areas' displaced emissions.

Table 5-2. Summary of Displaced Emissions (metric tons of CO_2e)

Program Area	Evaluated Lifetime Displaced Emissions	Projected Lifetime Displaced Emissions
Renewable Energy	26,400	28,300
Energy-Efficiency	59,000	72,900
Transportation	10,800	9,660
Subtotal	**96,200**	**111,000**
Energy Code	239,000	239,000
Overall Total	**335,000**	**350,000**

5.6 ECONOMIC IMPACTS CONCLUSIONS AND RECOMMENDATIONS

Within the limitations of the PI^{+} model and the Cadmus Team's assumptions, the results indicate that NYSERDA's EECBG Program Areas and the Early Code adoption resulted in net positive job creation within New York over what would have occurred without the Program Areas. Jobs are created as a result of short-term direct spending associated with Program Area activities, and the long-term persistence of bill savings. More projects completed translate into more job-years added to the regional economy.

Although these findings indicate that NYSERDA's ARRA-funded/induced DSM programs result in *net* positive employment impacts, this may not translate into a noticeable change in the unemployment rate. According to the U.S. Bureau of Labor Statistics, the New York civilian labor force in July 2012 was 9,581.4 thousand and there were 870.1 thousand unemployed.[80] In comparison, the net job impacts from the first year EECBG Program Areas and the Early Code adoption amounts to hundreds of jobs, which will not significantly impact the 9.1% unemployment rate.

In addition, without accounting for the full opportunity costs associated with the ARRA funds, the true impact of the stimulus on New York and the broader United States cannot be conclusively determined. Further study should be conducted on how DSM programs compare with other economic development approaches, in order to inform future policy decisions on the best approaches to economic stimulus and meeting employment goals.

[80] http://www.bls.gov/xg_shells/ro2xg02.htm

5.7 COST-EFFECTIVENESS ANALYSIS CONCLUSIONS

The EECBG portfolio with the Energy Code Program Area passed all cost-effectiveness tests. The Energy Code Program Area represents a large portion of the portfolio benefits.

The EECBG portfolio without the Energy Code Program Area passed all of the California Standard Practices cost-effectiveness tests with a 1.0. The portfolio failed the SEP-RAC test, largely due to removal of the Energy Code Program Area benefits. The Cadmus Team analyzed the portfolio with these benefits removed because they are partly attributed to the SEP portfolio, and were not entirely EECBG funded.

The Energy-Efficiency Program Area passed all benefit-cost tests with ratios varying between 1.3 and 1.8 depending on the test and scenario. This Program Area performed well.

The Renewable Energy Program Area failed all tests for the evaluated and projected scenarios. For comparable dollars, renewable energy technologies do not generate the amount of energy saved from efficiency measures. Their large capital cost and their associated increase in O&M create very long payback periods compared to buying traditional electricity from the grid.

The Transportation Program Area passed the evaluated scenario SEP-RAC test using a NTG of 1.0, but failed the projected scenario when the NTG was set to 0.9 and some projected administrative costs were added. The Transportation Program Area passed all other tests in both scenarios.

More information on the Energy Code Program Area can be found in Appendix F.