NYSERDA American Reinvestment and Recovery Act 2012 Impact Evaluation Report: State Energy Programs

Prepared For

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NOTICE

ABSTRACT

This report contains the findings of the evaluation of the State Energy Program (SEP) and State Energy Efficiency Appliance Rebate Program (SEEARP) portions of the American Recovery and Reinvestment Act (ARRA) 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. (Cadmus), Beacon Consultants Network, Inc. (Beacon), Energy & Resource Solutions (ERS), NMR Group, Inc. (NMR), Navigant Consulting, Inc. (Navigant), Population Research Systems (PRS), Abt SRBI Inc., Discovery Research Group (DRG), Malcarne Contracting, Dynamic Construction of Northern New York, Aspire Clean Energy, James D. Warren and Sons, Inc., Eldor, and Triangle Electrical Systems, Inc., collectively known as the Cadmus Team, from 2010 through April 2012. The purpose of the evaluation is 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 (GHG) emissions displacement and macroeconomic impacts (including jobs creation) generated by the Program Areas; and to calculate the cost-effectiveness of the Program Areas.

TABLE OF CONTENTS

LIST OF APPENDICES (attached separately)

Table of Figures

Table of Tables

EXECUTIVE SUMMARY

BACKGROUND

On February 13, 2009, in response to a deepening recession in the United States economy, the American Reinvestment and Recovery Act (ARRA) was passed by the U.S. Congress. 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, and
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 bill 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 SEP and $29.8 million 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
SEP	Energy Conservation Studies (PON 4)
SEP	Transportation (RFP 1613 – Clean Fleets)
SEP	Energy Efficiency and Renewable Energy for Municipalities, Schools, Hospitals, Public Colleges and Universities, and Non-Profits (RFP 1613)
EECBG	Energy Efficiency, Transportation, and Renewable Energy for Small Municipalities (RFP 10), Material Conservation, and Energy Management Personnel
SEP	Energy Code Trainings (RFP 1621)
EECBG	Energy Code - Locally Based Circuit Riders (RFP 1621)
SEP	Energy Code Baseline Compliance
SEP	Renewable Energy (PON 1686)
SEEARP	Appliance Rebate
All	RFP 1656 ARRA 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 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 complemented the programs and public policies that support achievement of that aggressive goal, and also contributed to the targeted reduction in energy use.

The State's Public Service Commission, through its System Benefits Charge (SBC), Energy Efficiency Portfolio Standard (EEPS), Renewable Portfolio Standard (RPS), and utility rate proceedings, put forth a comprehensive set of rate-payer 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 that are funded by the proceeds from auctions of carbon dioxide (CO_2) allowances under the Regional Greenhouse Gas Initiative (RGGI). NYSERDA also has and continues to receive appropriations of State funds, and has been the recipient of federal funding through the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and the Federal Highway Administration. This additional State and federal funding is 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 (NYPA) 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. The Action Plan is included as Appendix C. 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 as included in Appendix C.

Excepting the impacts of the project changes noted above, this report contains the findings of the evaluation of the SEP and SEEARP-funded Program Areas as described in the Action Plan. The findings from the evaluation of the EECBG-funded Program Areas will be addressed in a separate report scheduled for completion in September 2012.

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 each Program Area

- Computing the greenhouse gas (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 programs

The Cadmus Team ensured that work undertaken in 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 (Appliance Rebate, Energy Code, Energy-Efficiency, Renewable Energy, Transportation, Energy Conservation Studies [ECS]) – 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 programs as a whole, as well as the activities funded through each of the major ARRA-funding streams (SEP, EECBG, and SEEARP). Geographic analysis for all Program Areas in the gross and net impact portion of the evaluation was performed for New York State as a whole, and was further divided by Upstate and Downstate territories. Similarly, the Cadmus Team investigated the relative impacts of Program Area marketing efforts in the Upstate versus Downstate regions.[4] For this evaluation, the Downstate region included the utility service territories of Consolidated Edison (New York City (NYC) and parts of Westchester County) and LIPA (Long Island, which is Nassau and Suffolk Counties). The Upstate region included the balance of the State.

FINDINGS

At the time this report was written, many of NYSERDA's SEP-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 contractual requirements between the Cadmus Team and NYSERDA, the evaluation of these Program Areas needed to be reported on before the end of April 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

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[1] The environmental impacts measured vary by Program Area. In addition to GHG emissions, the Appliance Rebates Program Area includes water savings; and the Program Area with clean fleets includes 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 Public Service Commission 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] This analysis 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 were contingent upon survey length time constraints, and consequently, the final inclusion of this analysis was contingent on the Cadmus Team having obtained sufficient confidence and precision in the findings in both the Upstate and Downstate regions.

the decision-making process. This proximity of evaluation to the decision making timeframe promises 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 left 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.[5]

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.[6] Spillover may take months or years to occur depending on the technology, cost, and the experience a customer has with program measures. In most cases of this evaluation effort, spillover was not able to be measured 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 projects or portions of projects that are installed and operational as of December 31, 2011.

The Cadmus Team relied on participant surveys delivered in person during project site visits or completed electronically or by phone following the visit to determine the attribution of Energy-Efficiency Program Area impacts. Although the original plan was to administer 142 surveys (125 delivered on-site and 17 via telephone), project cancellations and delays meant that only 51 survey responses could be secured. Likewise, the data collection and reporting schedule did not allow the Cadmus Team to perform the follow-up surveys that had originally been planned when drafting the Action Plan. Specifically, projects were not far enough along in the implementation process for participants to answer the anticipated follow-up questions.

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

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

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[5] NAPEE. *Model Energy Efficiency Program Impact Evaluation Guide.* Available at: http://www.epa.gov/cleanenergy/documents/suca/evaluation_guide.pdf. Retrieved on April 9, 2012.

[6] Ibid.

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)
Appliance Rebate*	12,862	12.03**	154,738	0.41	91,295*
Renewable Energy (1686)	2,500	1.13	2,825	0.39	1,723
Renewable Energy (1613)	3,347	1.12	3,749	0.04	3,599
Energy-Efficiency	42,721	0.94	40,158	0.27	29,315
Transportation	Fuel Savings Only				
Energy Code***	N/A				
Energy Conservation Studies****	159,149*****	0.15	23,872	0.70	7,162
Total	**220,579**	**N/M********	**225,342**	**N/M********	**133,094**
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)**
Appliance Rebate*	47,328	1.00	47,328	0.33	31,710*
Renewable Energy (1686)	Electric Generation Only				
Renewable Energy (1613)	18,083	0.77	13,924	0.04	13,367
Energy-Efficiency	278,328	1.07	297,811	0.27	217,402
Transportation	10,455	0.24	2,485	0.81	472
Energy Code***	N/A				
Energy Conservation Studies****	1,487,288*****	0.17	252,839	0.70	75,852
Total	**1,841,482**	**N/M********	**614,387**	**N/M********	**338,803**

Note: This table summarizes the savings as detailed in each of the Program Area evaluation chapters in Section 3. Results of this report. Confidence and precision values for each of these evaluated findings is equal to, or better than 90/10 with the exception of ECS Program Area which is 90/20. Please reference the specific Program Area chapters in Section 3 for additional detail on confidence and precision.

* Appliance Program Area savings are larger in the first years because some new appliances are replacing older units that were still operational and would not have otherwise been replaced for some time. This higher level of savings is used until the Effective Useful Life (EUL) of the old appliance is reached at which time the savings baseline for thes units becomes the same as for the other units in the program – the standard efficiency level. This table shows the higher savings value of the first year. Cost effectiveness, macroeconomic impacts and emissions were calculated using lower levelized net savings values of 73,597 MWh/year and 18,730 MMBtu/year.

** The Program Area records did not track all of the available savings, consequently the evaluated gross savings are significantly higher as shown by the high Realization Rate.

*** Energy Code savings are being estimated as part of a independent evaluation effort as described in the Energy Code Program Area chapter of Section 3.

**** For the purposes of readability, the Program Area evaluation results are being summarized in the same categories as other programs. For the ECS program, the value shown as the Savings Weighted Realization Rate is actually the product of the measure adoption rate (MAR, which equals 0.16) and the Realization Rate (0.94 for electricity and 1.07 for fuel). The value shown for Freeridership is one minus the product of one minus the overlap factor (1-0.33, or 0.67) and one minus the evaluated freeridership(1-0.55, or 0.45). These values are discussed further in Section 3.

***** NYSERDA did not report any direct electricity or fossil fuel savings for the ECS program. Claimed savings is 0. In this table the values shown in the ECS row for the Total Claimed Savings column is the evaluation's team calculated estimate of the ECS authors' total savings for all recommended measures, based on NYSERDA program tracking system data.

****** Weighted overall RR and FR are not meaningful and therefore have been replaced with N/M in the table above.

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 D presents a study conducted on behalf of another client in which Cadmus 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.[7] Furthermore, NYSERDA and the New York Department of Public Service (DPS) have a precedent of accepting a deemed NTG of 0.9 for planning purposes.[8] Given the requirements from the U.S. DOE that ARRA programs 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 will necessarily understate the likely impacts of the Program Areas. This is due to the fact that freeridership will be much more clearly measurable than spillover, which, although likely to occur in the future, is not currently present at a level that can be evaluated. For this reason, 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 SEP/SEEARP-funded projects, this evaluation effort has reviewed the level of savings that are expected to be achieved, in addition to the savings that have been evaluated to date. The realization rate that was derived by the evaluation for projects completed as of December 31, 2011 is applied to the total expected savings, and the resulting projected gross savings are adjusted for the deemed NTG to arrive at a projection for the total savings that will occur from the Program Areas. These projections are presented in Table ES-3.

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[7] Ibid.

[8] 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)
Appliance Rebate*	12,862*	12.03	154,738	0.90	139,264*
Renewable Energy (1686)	3,640	1.13	4,113	0.90	3,702
Renewable Energy (1613)	4,100	1.12	4,592	0.90	4,133
Energy-Efficiency	52,357	0.94	49,216	0.90	44,294
Transportation	Fuel Savings Only				
Energy Code**	N/A				
Energy Conservation Studies***	159,149	0.37	58,885	0.60	35,331
Total	**232,108**	**N/M*******	**271,544**	**N/M*******	**226,724**
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)**
Appliance Rebate*	47,328	1.00	47,328	0.90	42,595*
Renewable Energy (1686)	Electric Generation Only				
Renewable Energy (1613)	19,053	0.77	14,671	0.90	13,204
Energy-Efficiency	361,356	1.07	386,651	0.90	347,986
Transportation	10,791	0.65	6,994	0.90	6,295
Energy Code**	N/A				
Energy Conservation Studies***	1,487,288****	0.42	624,661	0.60	374,797
Total	**1,925,816**	**N/M*******	**1,080,305**	**N/M*******	**784,877**

* Please see note regarding Appliance savings values in Table ES-2 above

** As noted in Table ES-2 above, Energy Code savings are being estimated as part of a independent evaluation effort as described in the Energy Code Program Area chapter of Section 3.

*** For the purposes of readability, the ECS Program Area evaluation results are being summarized in the same categories as other programs. For the ECS program, the value shown as the Savings Weighted Realization Rate is actually the product of the projected long-term measure adoption rate (MAR, which equals 0.39) and the Realization Rate (0.94 for electricity and 1.07 for fuel). The value shown for Net-to-Gross is the product of one minus the overlap factor (1-0.33, or 0.67) and the projected Net-to-Gross (0.90). These values are discussed further in Section 3.

**** NYSERDA did not report any direct electricity or fossil fuel savings for the ECS program. Claimed savings is 0. In this table the values shown in the ECS row for the Total Claimed Savings column is the evaluation's team calculated estimate of the ECS authors' total savings for all recommended measures, based on NYSERDA program tracking system data.

***** Weighted overall RR and FR are not meaningful and therefore have been replaced with N/M in the table above.

HIGH-LEVEL EVALUATION CONCLUSIONS

Based on the findings from the evaluation of all SEP/SEEARP-funded Program Areas, overall calculations of the economic impacts and the cost-effectiveness of the Program Areas shows that these funds cost-effectively returned net benefits to the residents of New York in the form of job growth and 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 SIT 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 that readers of this document should understand when reviewing the displaced greenhouse gas (GHG) emissions. The first is that 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, if another tool were used, the calculations could come out slightly different. Each calculation method also has its own set of variables, such as temperature, measures and fuel types included, and 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 below presents the lifetime evaluated and projected displaced GHG emissions. Please see the GHG Displaced Emissions by Program Area chapter (Section 4.2.7) for additional detail on displaced emissions calculations.

Table ES-4. Summary of Displaced Emissions (Metric Tons of CO2e)

Program Area	Evaluated Lifetime Displaced Emissions	Projected Lifetime Displaced Emissions
Appliance Rebate	225,000	348,000
Renewable Energy*	81,200	110,000
Energy-Efficiency	425,000	650,000
Transportation	995	6,480
Energy Conservation Studies	136,000	632,000
Total	**868,000**	**1,750,000**

* Residential and commercial combined displaced emissions for the Renewable Energy Program Area

Economic Impacts

The SEP/SEEARP is expected to have an overall positive impact on the State of New York in both scenarios modeled. The majority of jobs added are a result of the long-term persistence of bill savings resulting from the installed energy-efficiency and renewable energy measures and have yet to be realized. Most of the job impacts accrue to the government sector (local and State), as this sector received the largest amount of SEP/SEEARP funds.

Cost-Effectiveness Analysis

In assessing cost-effectiveness, the Cadmus Team analyzed Program Area costs and benefits from four different perspectives, using Cadmus' DSM Portfolio Pro[9] model. Benefit-to-cost ratios conducted for these tests were based on methods described in the California Standard Practice Manual[10] for assessing DSM Program Areas' cost-effectiveness. In addition to the California tests, the DOE Recovery Act Reporting Requirements for the SEP were used to determine the SEP Recovery Act Cost test ratio (SEP-RAC test). Detailed results by program and a discussion of the assumptions behind those results are presented in the Cost-Effectiveness Analysis chapter, Section 4.4. As a basic definition, any program 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 SEP- and SEEARP-funded programs were found to be cost-effective and the benefit cost ratio per the DOE-required SEP-RAC test is 1.6 for activities completed by December 31, 2012 and 2.3 for all projects.

Table ES-5. SEP Cost Effectiveness Test Findings

Evaluation Scenario	Cost-Effectiveness Test	Costs	Benefits	Benefit/Cost Ratio
Evaluated	SEP-RAC	$ 89,362,000	1,432,130 MMBtu	1.6
Projected	SEP-RAC	$108,803,000	2,522,000 MMBtu	2.3

[9] 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 Public Service Commission (PSC), the Colorado Public Utilities Commission, and the Nevada Public Utilities Commission.

[10] CPUC. *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.* October 2001.

Section 1:

INTRODUCTION

On February 13, 2009, in response to a deepening recession in the United States economy, ARRA was passed by the U.S. Congress. 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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Components of this bill 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 SEP and $29.8 million 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 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 1-1.

Table 1-1. Overview of NYSERDA's ARRA-Funded Activities

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The Program Areas discussed in this report were run by NYSERDA, in conjunction with contractors and implementers which were selected through competitive bidding processes. The key implementers for these Program Areas include TRC, Arcades, and Lockheed Martin. Throughout the remainder of this report, these implementation contractors are individually or collectively referred to as the Program Area Implementer(s).

1.1 PROGRAM DESCRIPTIONS AND PARTICIPATION

For the purposes of this evaluation, the SEP/SEEARP-funded activities are summarized into six Program Areas:

- Appliance Rebate
- Energy Code
- Energy Efficiency
- Renewable Energy
- Transportation
- Energy Conservation Studies (ECS)

The budgets, spending, energy savings goals, participation goals, 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 SEP-Funded Program Area Budgets and Expenditures

Program Area and Metric	DOE Application Budget	Actual Program Area Expenditures (December 31, 2011)	Projected Program Area Expenditures
Appliance Rebate			
Total Program Area Cost	$18,700,000	$18,642,436	$18,651,155
Total Incentive Cost	$16,531,759	$16,531,130	$16,531,130
Renewable Energy			
Total Program Area Cost (SEP)	$31,020,000	$25,436,700	$32,968,455
Incentive Cost	$19,829,208	$20,907,467	$27,561,277
Energy Efficiency			
Total Program Area Cost	$82,607,000*	$33,035,232	$44,666,605
Incentive Cost	$26,655,060	$26,655,060	$37,499,266
Transportation			
Total Program Area Cost	$4,643,000	$2,301,833	$2,421,302
Incentive Cost	N/A	$1,866,530	1,909,280
Energy Code			
Total Program Area Cost	$4,840,000	$3,968,656	$3,968,656
Incentive Cost	$3,993,456	N/A	N/A
Energy Conservation Studies			
Total Program Area Cost	N/A	$5,204,673	$5,279,319
Incentive Cost	$4,961,359	$4,979,642	$4,979,642
Total			
Budget	$141,810,000	$88,589,529	$107,955,491
Incentive Cost	$93,369,542	$71,313,889	$88,854,655

* Energy Efficiency DOE application budget includes renewable energy and transportation projects under RFP 1613

Table 1-3. Summary of SEP-Funded Program Area Ex Ante Claimed (Pre Evaluation) Gross Impacts

Program Area and Metric	Claimed (Ex Ante) Gross Installed (Dec. 31, 2011)	Claimed (Ex Ante) Gross Projected (Under Contract)
Appliance Rebate		
Annual Electricity Savings (MWh)	12,862	12,862
Annual Fuel Savings (MMBtu)	47,328	47,328
Annual Water Savings (Gallons)	735,138	735,138
Renewable Energy (1613 and 1686)		
1686 Annual Electricity Generation (MWh)	2,825	3,640
1613 Annual Electricity Generation/Savings (MWh)	3,347	4,100
1613 Generation Savings (MMBtu)	18,083	19,053
Energy Efficiency		
Annual Electricity Savings (MWh)	42,721	52,357
Annual Fuel Savings (MMBtu)	278,328	361,356
Transportation		
Annual Electricity Savings (MWh)	N/A	N/A
Annual Fuel Savings (MMBtu)	10,455	10,791
Energy Codes*		
Annual Electricity Savings (MWh)	TBD	TBD
Annual Fuel Savings (MMBtu)	TBD	TBD
Energy Conservation Studies		
Annual Electricity Savings (MWh)	159,149	159,149
Annual Fuel Savings (MMBtu)	1,487,288	1,487,288
Total		
Annual Electricity Savings (MWh)	220,904	232,108
Annual Fuel Savings (MMBtu)	1,841,482	1,925,816

* Savings for the Energy Code Program Area will be included in the SEP Base Grant Report in May 2012.

The following table presents the program goals as they were included in the original DOE applications for SEP funding.

Table 1-4. Program Area Goals from DOE Applications

Program Area	Annual Fuel and Source Electric Savings (MMBtu)*	Jobs Created	Number of Projects
Appliance**	39,656**	183	172,987 (Rebates)
Energy Code	937,600	72	500 (Training courses and plan reviews)
Energy-Efficiency	1,400,000	876	200
Renewable Energy	116,000	300	100 (PV systems)
Transportation	44,741****	43	130 (Vehicles)
Energy Conservation Studies	N/A	27	350 (Studies)
These goals were developed using the best professional judgment of program staff regarding levels of participation for programs that had never previously existed at NYSERDA. Due to the economic conditions that resulted in the passage of the American Recovery and Reinvestment Act (ARRA) in the first place, the ability to accurately forecast participation in these programs is not a realistic condition. Additionally, the primary objective of ARRA was to spur job creation, not to achieve some of the other goals set forth above. Consequently, while these goals are useful for understanding the background planning of the Program Areas and for highlighting how significantly the Program Areas have evolved over time, the ultimate success of the programs should be judged on the job creation impacts discussed in the Macroeconomic Analysis sections and on the cost effectiveness of the programs.			

* MMBtu savings goals combine both electricity and fuel savings goals. Electicity savings are converted to source MMBtu savings using a conversion factor of 9,668 Btu/kWh.

** Appliance goals also included electricity savings of 15,118 MWh not included in the MMBtu goal, as well as water savings of 469,211,264 gallons per year and emission reductions of 23,213,807 lbs of CO_2 per year

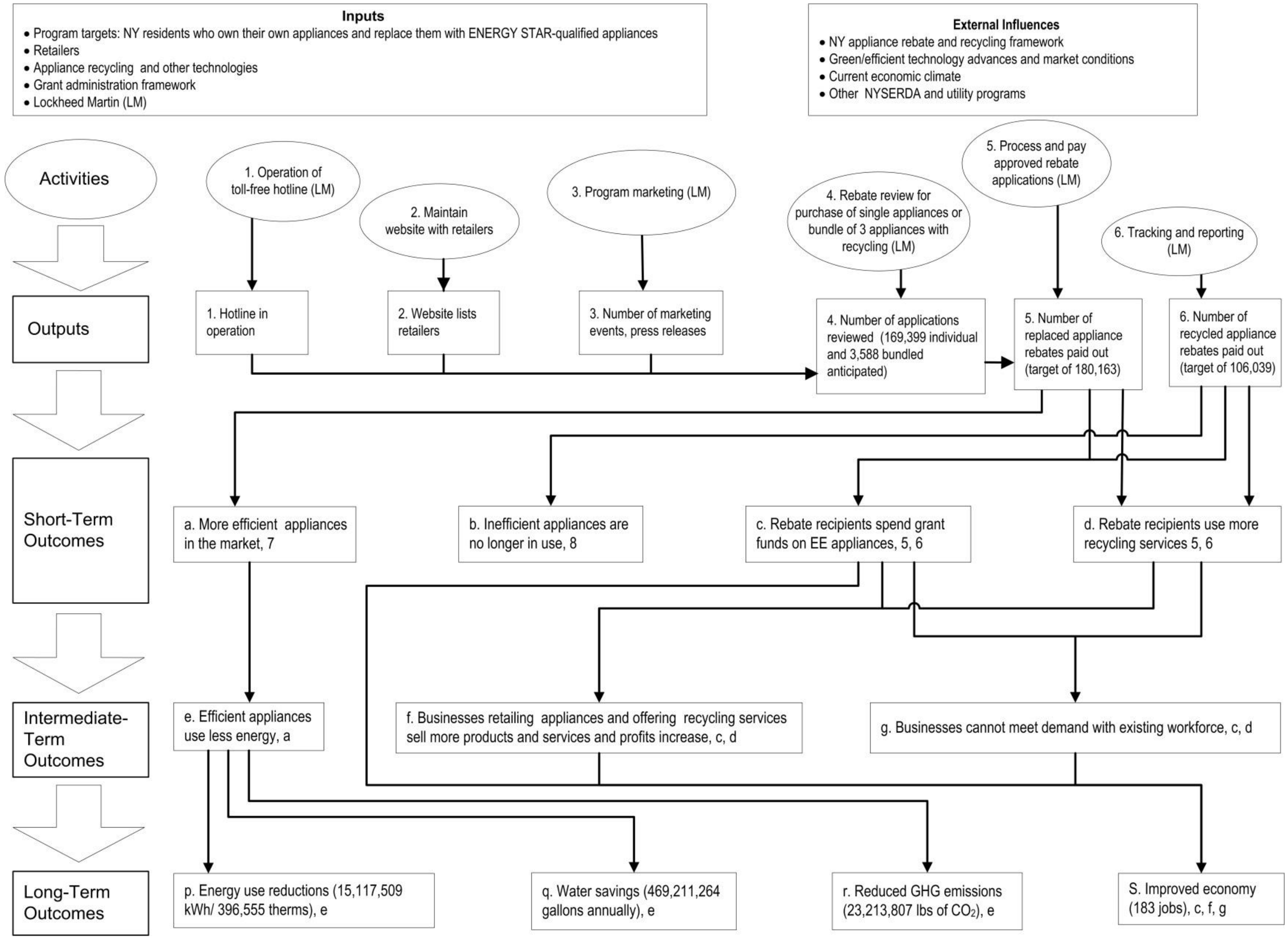
*** Energy Code goals also included emission reductions of 237,048 metric tons CO_2e per year.

**** The application goal of 350,000 gallons of petrolium is expressed here as MMBtu using conversion factors of 0.11609 MMBtu/gallon for gasoline, 0.12845 MMBtu/gallon for diesel, and assuming 95% of petrolium savings come from deisel, 5% from gasoline (weighted average conversion would therefore be 0.12783 MMBtu/gallon petrolium).

1.1.1 Appliance Rebate Program Area

The New York State Energy-Efficient Appliance Rebate Program Area (Appliance Rebate Program Area) paid rebates funded by ARRA to consumers who replaced inefficient appliances with new ENERGY STAR® qualified appliances. The Appliance Rebate Program Area also offered additional incentives to customers who recycled their replaced appliances. The Program Area was available to New York residents who owned their appliance(s) and replaced them with ENERGY STAR-qualified appliances from any retailer. The Program logic model, shown in Figure 1-1, highlights the key features of the Program Area, indicating the logical linkages between activities, outputs, and outcomes. The inputs for the Program are funding and other support from NYSERDA, and the expertise of any Program Area implementers and subcontractors.

Figure 1-1. Appliance Rebate Program Area Logic Model



The Program Area launched on February 12, 2010 and concluded in March 2011. A consumer purchasing an appliance to be installed in a New York residence could reserve a rebate through the Program Area Website or by calling the Program Area hotline, and then would complete the process by submitting the application and required proof of purchase information by mail. Consumers received the rebate after NYSERDA's implementer approved their application, proof of purchase, and, if applicable, their recycling documentation. The Program Area was not intended for use by multifamily building owners, contractors, or builders.

Two Program Area options were available. Option 1 offered a rebate for the purchase of any one of three ENERGY STAR-qualified appliances: refrigerator, freezer, or clothes washer. Option 2 offered a larger rebate for the purchase of a bundle of three appliances: a refrigerator, a clothes washer, and a dishwasher. Option 2 also required that these appliances met not only ENERGY STAR labeling requirements, but also that they met the stricter Consortium for Energy Efficiency (CEE) guidelines of at least Tier 2 for refrigerators and clothes washers and Tier 1 for dishwashers. Both options 1 and 2 offered an additional incentive of $25 to $55 to those who recycled their replaced appliance(s). Table 1-5 summarizes the rebate offerings.

Table 1-5. Appliance Rebate Program Area Offerings

Appliance or Bundle	Rebate Without Recycling	Rebate With Recycling
Option 1: Refrigerator	$75	$105
Option 1: Freezer	$50	$75
Option 1: Clothes Washer	$75	$100
Option 2: Bundle of Refrigerator, Clothes Washer, and Dishwasher	$500	Up to $555*

* Consumers that recycled all three appliances in the Option 2 package received $555. Recycling fewer than three appliances resulted in a lower rebate.

Rebates were available on a first-come, first-served basis, and NYSERDA's implementer maintained a Website to track the amount of funding reserved through online applications (this information was also available on the Program Area hotline). In anticipation of some consumers not completing the required follow-up paperwork or purchasing ineligible appliances, NYSERDA accepted a wait list of additional participants to ensure that all the funding would be spent.

NYSERDA's implementer processed 162,756 rebates for Option 1 and 2,370 rebates for Option 2. NYSERDA spent some additional marketing and advertising funds from the SBC to promote the Program Area after the initial launch. The implementer assigned a unique rebate reservation number to each application, allowing the application to be recorded and tracked throughout the approval and rebate payment process.

Since 1999, NYSERDA has operated a program to promote ENERGY STAR-qualified appliances, the **New York Energy $mart^{SM} Products** (NYESP) Program. The NYESP Program continued to operate while the Appliance Rebate Program Area was operating, and will continue to operate after the conclusion of all Program Area activities. Through the NYESP Program, NYSERDA partners with approximately 350 retailers selling energy-efficient appliances, providing promotional incentives, sales force training, new product information, collaboration opportunities with builders and contractors, and point-of-purchase educational materials in exchange for monthly sales data. NYSERDA leveraged this promotional network to notify New York residents of the Program Area rebates. NYSERDA used SBC funding to cross-promote the Appliance Rebate Program Area with the Home Performance with

ENERGY STAR Program. Retail NYESP Program partners were allowed to cost-share co-operative advertising that promoted qualifying appliances, as well as promoting the Appliance Rebate Program Area. NYSERDA also issued press releases and public service announcements to inform New York residents of the Program Area status. Additionally, the Appliance Rebate Program Area was promoted on NYSERDA's website, as well as through NYSERDA's program hotline.

Evaluation Goals

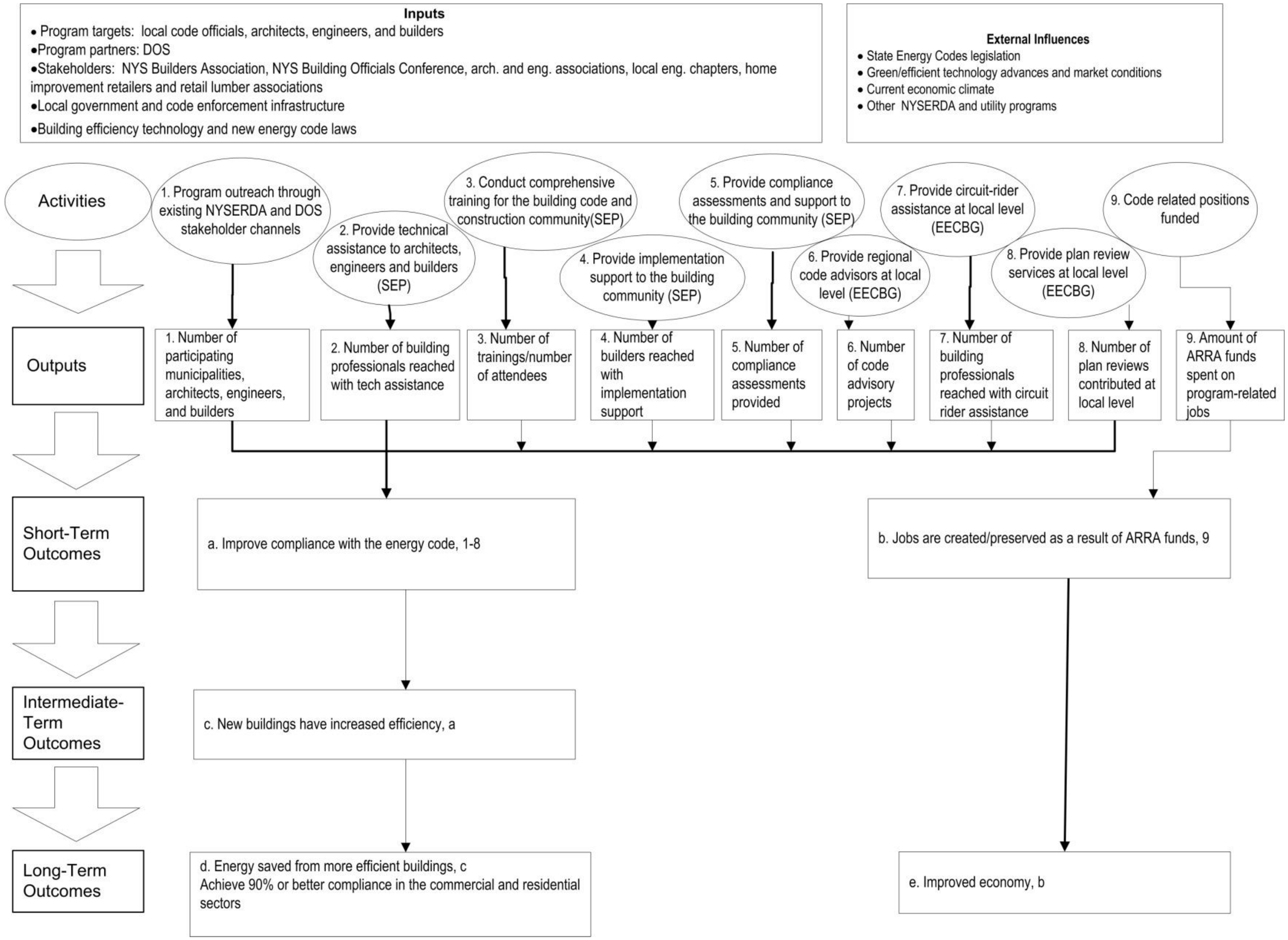
The objectives of this evaluation were to estimate the following Appliance Program Area impacts:

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

1.1.2 Energy Code Program Area

The Energy Code Program Area, supported by ARRA SEP funding, provided 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 limited training to code officials on the Energy Code. Figure 1-2 summarizes the logic for this Program Area. The Program logic model, shown in Figure 1-1, highlights the key features of the Program Area, indicating the logical linkages between activities, outputs, and outcomes. The inputs for the Program are funding and other support from NYSERDA, and the expertise of any Program Area implementers and subcontractors.

Figure 1-2. 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.[11] The intent is to reduce the statewide energy use by 15% below forecast levels by 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. The ARRA-funded code training, support, and compliance assessment Program Areas were developed by NYSERDA in close cooperation with DOS. These initiatives supported the Governor's effort to adopt a more stringent Energy Code and provided 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 code enforcement officials (CEOs) in the 1,600 municipalities 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.

Activities funded through the SEP under NYSERDA RFP 1621 and RFP 1720 broadly provided implementation support, training services, and compliance assessments to the building community across the State. Program Area activities under these RFPs focused on in-person and online training, general technical assistance, plan review support, publications, other pilot programs that explored means of providing direct project support through regional code advisors, and compliance assessment.

Program Area services were provided by nine NYSERDA contractors 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

[11] http://www3.dps.ny.gov/W/PSCWeb.nsf/All/06F2FEE55575BD8A852576E4006F9AF7?OpenDocument

- 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
- A separate benchmarking compliance assessment to establish a baseline of compliance levels with the existing codes before the new code was to take effect on December 28, 2010

Evaluation Goals

The objectives of this evaluation 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
- Cost-effectiveness

1.1.3 1613 Energy-Efficiency Program Area, Renewable Energy Program Area, and Transportation Program Area

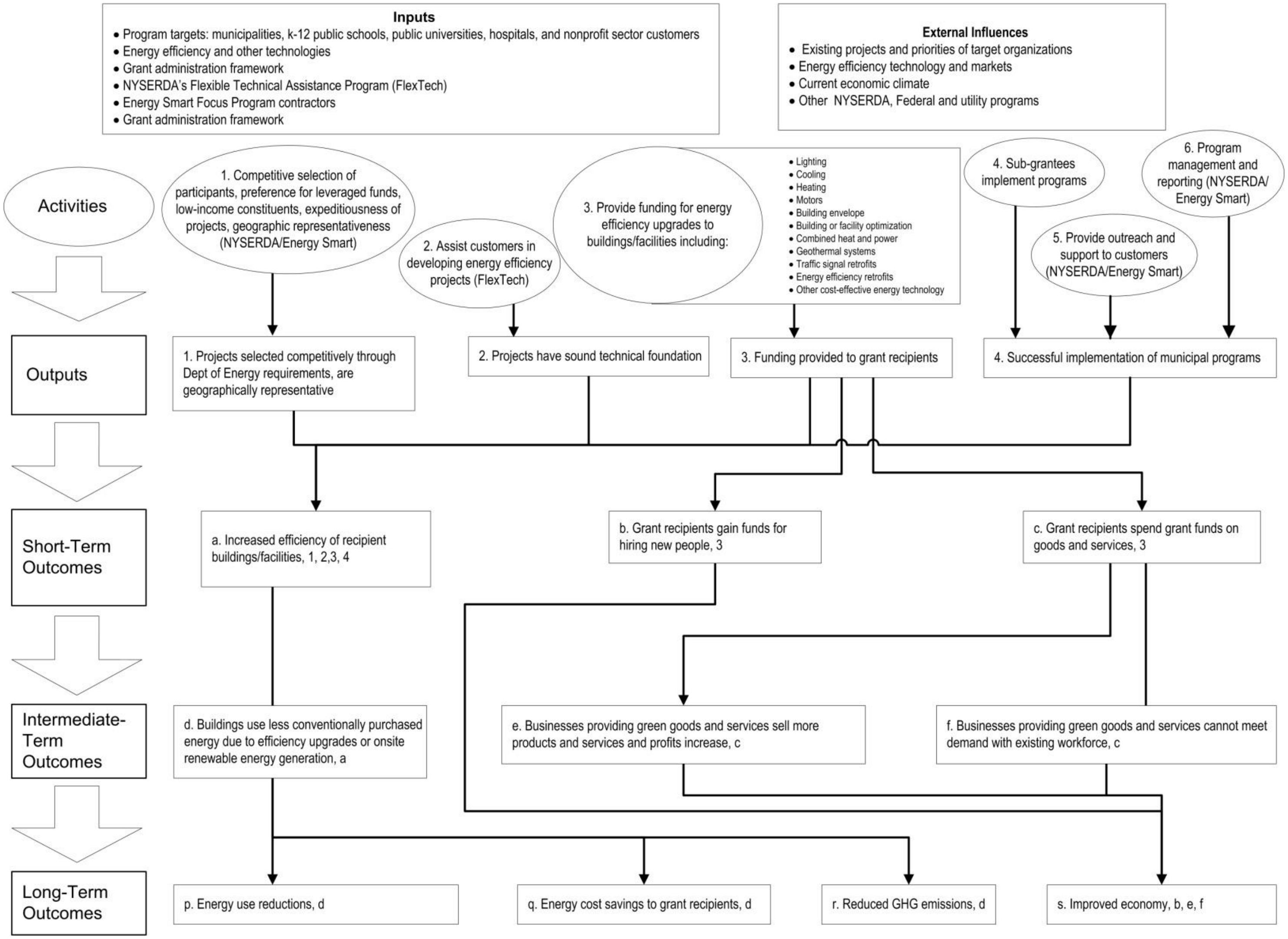
The American Recovery and Reinvestment Act included funding for the State Energy Program via RFP 1613. Through RFP 1613 $8.3 Million of New York's allocation of ARRA SEP funds were distributed to eligible energy conservation projects on a competitive basis. NYSERDA administered the SEP funds in New York State pursuant to a program plan approved by the U.S. Department of Energy. Energy efficiency, renewable energy, and clean fleet projects were all eligible. Eligible Proposers include: municipal governments, public K-12 schools, Boards of Cooperative Educational Services (BOCES); public universities or colleges (including SUNY, SUNY community colleges, CUNY, and CUNY community colleges), public and private hospitals, and not-for-profits (defined as an Internal Revenue Code Section 501(c)(3) qualifying organization formed prior to February 17, 2009). Eligible Proposers agreed to comply with all required Federal and State requirements for use of the funds. In the RFP's award design, NYSERDA sought to ensure a geographically equitable distribution of the funds through allocations to approximately seven regions across the State and through funding caps.

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 $900 of total project cost per 10 million BTUs source energy savings. Energy-efficient technologies eligible for funding under RFP 1613 included (not limited to): lighting, cooling, heating, motors, building envelope, building or facility optimization, combined heat and power (CHP), and geothermal systems.

Figure 1-3 summarizes the logic for this Program Area. The Program logic model, shown in Figure 1-3, highlights the key features of the Program Area, indicating the logical linkages between activities, outputs, and outcomes. The inputs for the Program are funding and other support from NYSERDA, and the expertise of any Program Area implementers and subcontractors.

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:

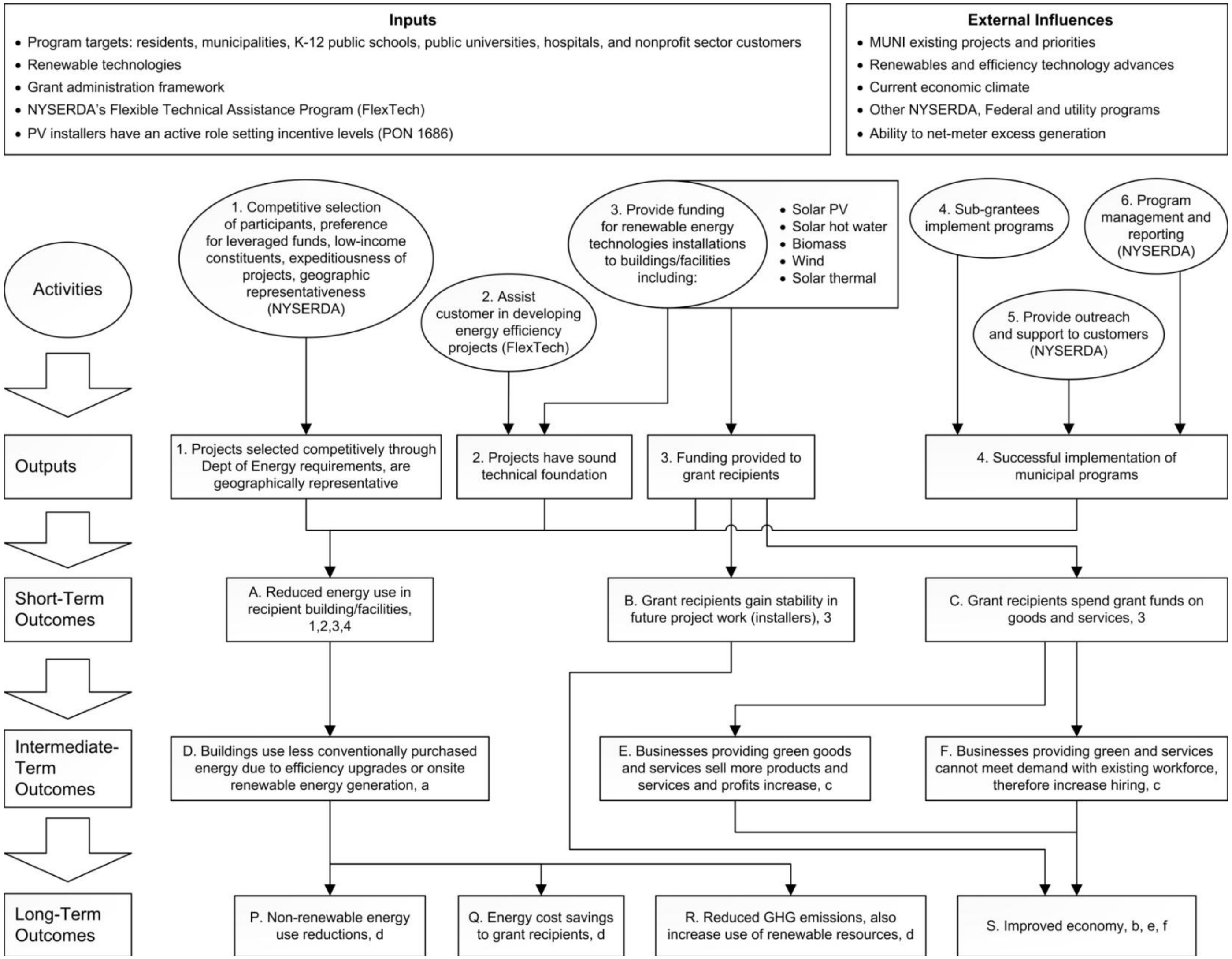
- Gross energy savings
- Net energy savings (the amount of gross savings attributable to the Energy-Efficiency Program Area)
- Avoided GHG emissions
- Jobs created by the Energy-Efficiency Program Area
- Areas where the Energy-Efficiency Program Area could be improved
- Cost-effectiveness

<u>Renewable Energy Program Area</u>

Renewable energy projects taking part in this evaluation fell under two separate NYSERDA Program Area offerings (RFP 1613 and PON 1686). Each Program Area offering had its own unique characteristics, requirements, and evaluation challenges. A Renewable Energy Project is defined as a project that: achieves a cost per annual energy generated of less than $8,000 of total project cost per 10 million BTUs generated or saved; is sited at the electric customer's location; is used primarily to serve the electric customer's load (i.e., not primarily exported to the utility grid); and the system 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.

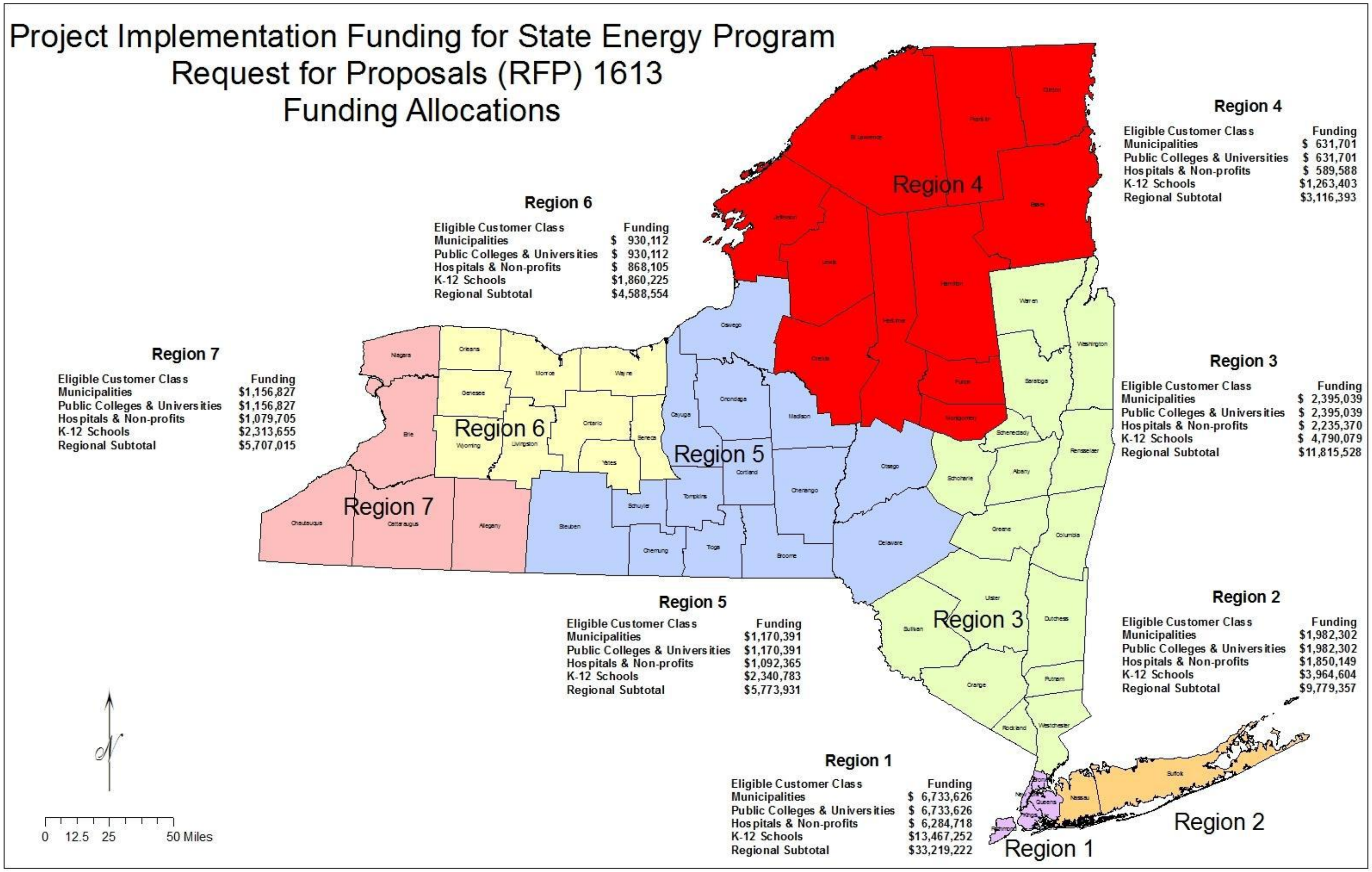
The logic model, shown in Figure 1-4, highlights the key features of the Program Area, indicating the logical linkages between activities, outputs, and outcomes. The inputs for the Program are funding and other support from NYSERDA, and the expertise of any Program Area implementers and subcontractors.

Figure 1-4. Renewable Energy Program Areas Logic Model



In the RFP'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 1-5).

Figure 1-5. Funding Allocations for Renewable Energy Program Area



PON 1686

The PON 1686 Renewable Energy Program Area was designed to expand the use of solar energy in commercial and residential PV systems across New York State. NYSERDA provided capacity-based incentives to PV vendors, who passed these incentives along to their customers in order to induce the installation of aggregated PV systems at a lower cost. This approach enhanced business opportunities for installers through increased installation volume and the ability for standardization. PON 1686 goals were to increase the amount of energy generated from renewable resources, reduce greenhouse gas emissions, and create jobs.

A large barrier to widespread adoption of PV is the initial high capital cost. The market for PV in New York is driven by national, State, and local incentive programs (various forms of rebates, performance payments, legislation, and tax credits) that are designed to bring the financial cost of the PV installation close to the level of the financial benefits the system will deliver. A complementary program funded through another ratepayer source, the NYSERDA PV Incentive Program, provides a fixed, capacity-based incentive for relatively small installations (up to 7 kW) for customers that pay a Renewable Portfolio Standard (RPS) charge for the electricity used in the building where the PV system is to be located. For non-residential use, incentives are provided for up to 80 kW systems.

With SEP ARRA funds, NYSERDA developed a new competitive Program Area that allowed market participants to propose the incentive level necessary for them to install aggregated capacity-defined blocks of PV systems. A competitive solicitation ranked proposals according to a set of predefined criteria, with priority given to those requesting the least amount of incentive funding per watt of installed PV.

Evaluation Objectives

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

- Gross energy generation[12]
- 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

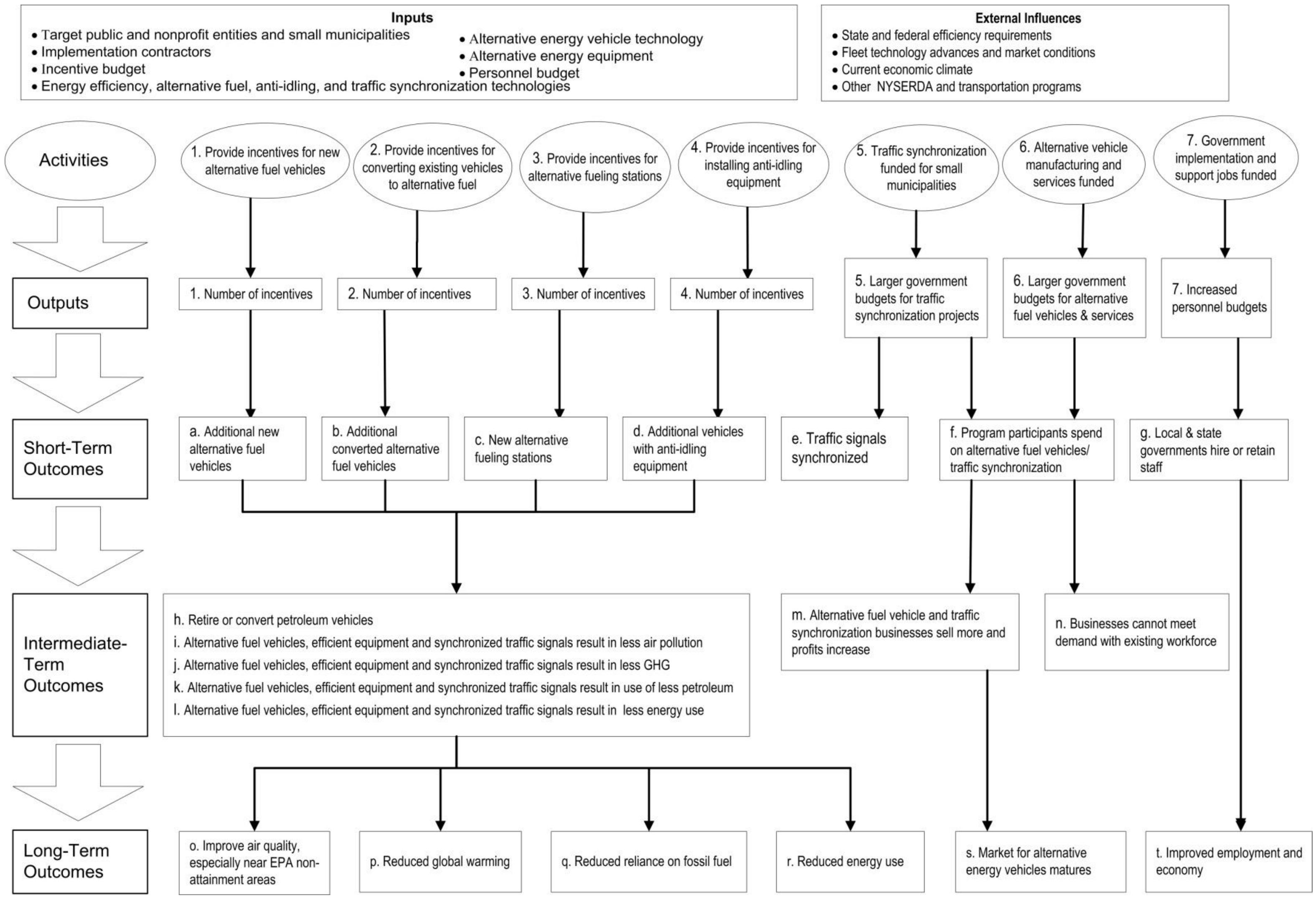
[12] For purposes of this report, the energy benefits of renewable energy systems will be referred to as "generation" to distinguish the benefits of renewable energy technology from the benefits derived from energy-efficiency and conservation measures.

Transportation Program Area

Transportation projects were funded within the NYSERDA ARRA Clean Fleets program. A Clean Fleet Project is defined as a project that achieves a cost per annual energy saved threshold of less than $5,000 of requested funding per 10 million BTUs source energy savings. The specific objectives for the Clean Fleets projects as outlined in NYSERDA's application to DOE included the following metrics: 350,000 gallons of petroleum reduced annually; 130 alternative fuel vehicles purchased; 40 conventional vehicles converted to run on alternative fuel; and four alternative refueling stations put in place.

The Program logic model, shown in Figure 1-6, highlights the key features of the Program Area, indicating the logical linkages between activities, outputs, and outcomes. The inputs for the Program are funding and other support from NYSERDA, and the expertise of any Program Area implementers and subcontractors.

Figure 1-6. Transportation Program Area Logic Model



Evaluation Objectives

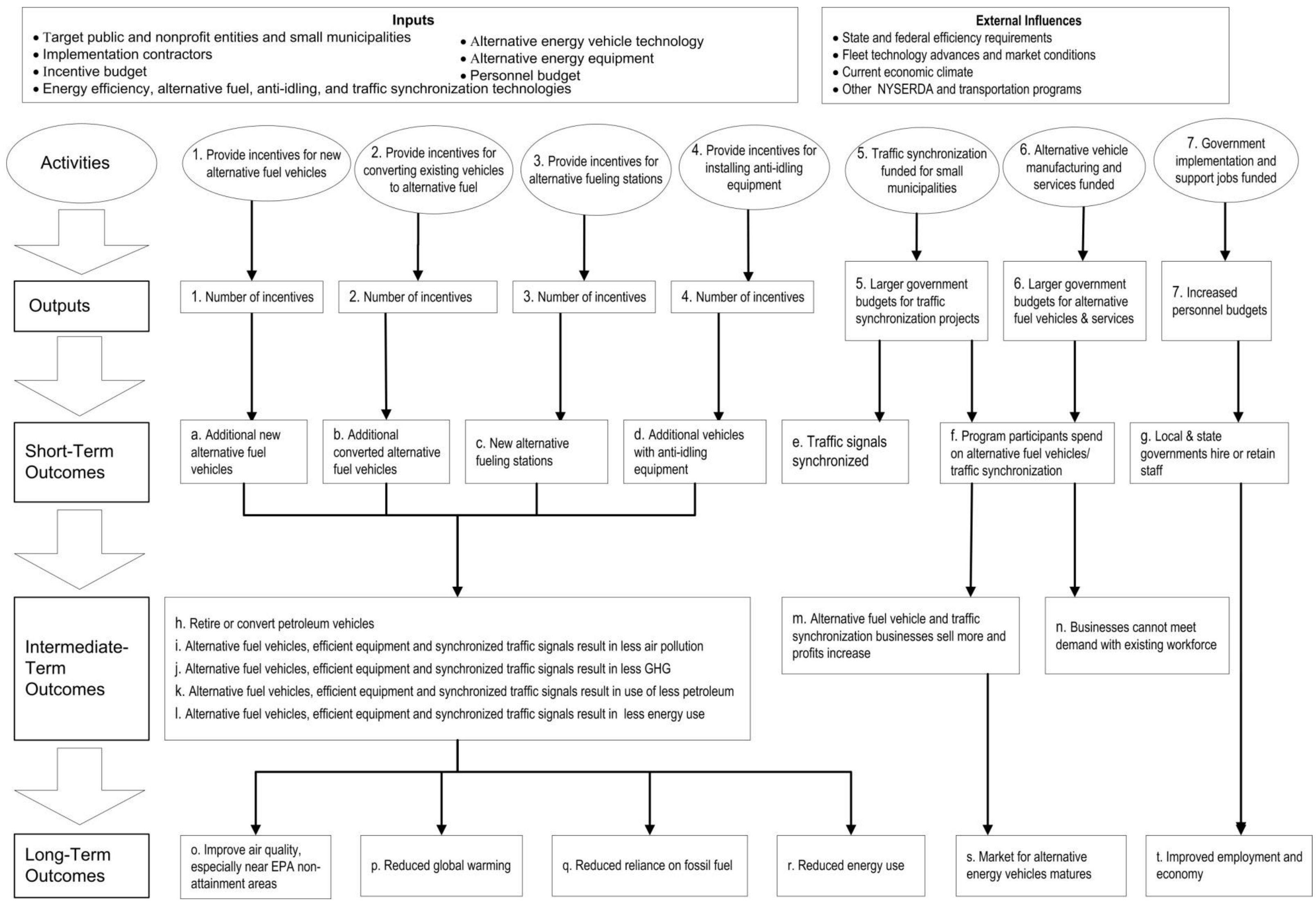
The objectives of this evaluation were to estimate the following Transportation Program Area impacts:

- 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

1.1.4 Energy Conservation Studies Program Area

PON 4 ECS (or energy audit) ARRA assistance was a funding mechanism that allowed New York municipal governments, public K-12 schools, public universities or colleges (including The State University of New York (SUNY), SUNY community colleges, The City University of New York (CUNY), and CUNY community colleges), hospitals, and not-for-profits [defined as 501(c)(3)] to apply for ECS. The intent was for these studies to encourage subsequent applications for ARRA-funded installations through RFP 10 and RFP 1613, or for other NYSERDA programs. Furthermore, NYSERDA intended for the studies to supply required technical information to document the energy savings and costs of proposed projects. The Program logic model, shown in Figure 1-7, highlights the key features of the Program Area, indicating the logical linkages between activities, outputs, and outcomes. The inputs for the Program are funding and other support from NYSERDA, and the expertise of any Program Area implementers and subcontractors.

Figure 1-7. Energy Conservation Studies Program Area Logic Model



RFP 10 and RFP 1613 applicants were not required to complete PON 4 studies, and PON 4 study applicants were not required to install any measures. Additionally, eligible applicants could apply for funding for multiple studies. However, regardless of the number of studies for which applicants received funding, each eligible applicant under the ECS Program Area could only receive funding that amounted to the lesser of $30,000, 100% of the cost of the study or studies, or 25% of the site energy costs.

Overlap Among Programs

During this evaluation, the Cadmus Team used best efforts to minimize the possibility of double counting program impacts. The potential for double counting savings occurs when customers participate in more than one Program Area, and may attribute the savings for one or more particular actions to multiple Program Areas. The Cadmus Team identified the potential for this overlap at the beginning of the evaluation effort and put protocols in place for quantifying and attributing impacts to mitigate this risk.

One Program Area in particular, ECS, has the greatest potential for considerable overlap with the energy-efficiency and renewable energy PONs. This potential for overlap was not an issue in the original plans, as the ECS Program Area administrators have not reported any direct energy savings impact associated with PON 4 ECS. The Program Area has predominantly been considered a marketing effort to motivate customers to install projects which are later funded in part by incentives from other ARRA or non-ARRA efficiency programs. By omitting reported savings directly associated with the ECS Program Area, NYSERDA avoids the possibility of two separate programs claiming savings for one project.

The Cadmus Team assessed the direct impacts of the ECS Program Area by collecting data on installation activities that occurred as a result of the study's recommendations, and also by analyzing the frequency with which those installations earned incentives through the Energy-Efficiency and Renewable Energy Program Areas, RFP 10 and RFP 1613, or other installation incentive programs. This evaluation assigns all savings to the ECS Program Area that are associated with the installation of a recommended measure that did not also receive installation incentive funding from another State, federal, or utility program. Conversely, the ECS Program Area receives no credit for installations funded by another program, even if the study recommended the measure.

Evaluation Objectives

In 2010, NYSERDA contracted with a team of consultants to conduct an evaluation of their ARRA-funded programs. The evaluation was conducted by The Cadmus Group, Inc. (Cadmus), Beacon Consultants Network, Inc. (Beacon), Energy & Resource Solutions (ERS), NMR Group, Inc. (NMR), Navigant Consulting, Inc. (Navigant), Abt SRBI Inc. These firms, along with eight additional companies,[13] which provided additional support on an as-needed basis, are collectively referred to as the Cadmus Team.

The objectives of the Cadmus Team evaluation were to determine:

- Gross energy and water savings
- Net energy and water savings (the amount of gross savings attributable to each Program Area)
- Avoided GHG emissions

[13] These additional companies were Population Research Systems (PRS), Discovery Research Group (DRG), Malcarne Contracting, Dynamic Construction of Northern NY, Aspire Clean Energy, James D. Warren and Sons, Inc., Eldor, and Triangle Electrical Systems, Inc.

- Jobs created by each Program Area
- Program Area cost-effectiveness
- Areas where the Program Areas could be improved

Section 2:

EVALUATION METHODOLOGY

The previous section provided some background on NYSERDA's ARRA-funded Program Areas as implemented since 2010. Prior to beginning any fieldwork to measure energy use and savings from measures promoted and installed through the Program Areas, the Cadmus Team interviewed staff at NYSERDA, with the DPS, DOE, and implementation contractors in order to develop an understanding of 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 in order to develop the findings contained in this report. The remaining sections are focused on describing the evaluated savings, gross and net, achieved by the programs, and estimating or projecting savings that will continue to occur as a result of program activities.

To evaluate the SEP/SEEARP-funded Program Areas, the Cadmus Team administered nearly 2,000 surveys and conducted over 100 site visits. These efforts are summarized in Table 2-1.

Table 2-1. Data Collection Summary

Program	Surveys	Site Visits	Document Review
Appliance Rebate	560	0	N/A
ECS	42	0	42
Energy Efficiency	60	52	80
Energy Code	1,237	0	N/A
Renewable Energy (RFP 1613)	35	32	32
Renewable Energy (RFP 1686)	37	19	19
Transportation	5	0	5
Total	1,976	103	178

Each of the evaluation efforts gathered 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 consistent with previous operation

Where possible and appropriate, measurement and verification of gross savings was conducted in accordance with the International Performance Measurement and Verification Protocol (IPMVP) as shown in.

Table 2-2. Evaluation Approaches Used

Program	IPMVP Option	Explanation
Appliance Rebate	N/A	Phone surveys and economic modeling combined with verification of assumptions from Tech Manual and secondary sources.
Energy Conservation Studies	N/A	
Energy Efficiency	B	Retrofit Isolation
Energy Code	N/A	
Renewable Energy (RFP 1613)	B	Retrofit Isolation
Renewable Energy (RFP 1686)	B	Retrofit Isolation
Transportation	N/A	

2. Attribution

Attribution assessment is used by evaluators to determine what would have happened in the absence of the Program Area. In essence, the evaluator must measure a counterfactual—something that never actually happened. The nature of ARRA funding adds 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 for the attribution assessment, 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 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. 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 at: http://www.nyserda.ny.gov/Page-Sections/Program-Evaluation/NYE$-Evaluation-Contractor-Reports.aspx.[14]

3. Process

a. Whether the program 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 any other Program Areas being offered by NYSERDA

[14] Accessed on April 27, 2012.

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

Section 3:

RESULTS

3.1 APPLIANCE REBATE PROGRAM AREA

3.1.1 Data Sources

The Cadmus Team used the following data sources for the evaluation:

- NYSERDA Program Area staff interviews
- Participant phone surveys
- Rebate tracking database
- Sales data from NYESP program partners
- ENERGY STAR and CEE Product Lists[15]
- New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs; Residential, Multi-Family, and Commercial/Industrial Measures. October 15, 2010. (Tech Manual)[16]
- Appliance recycling savings estimates from secondary research

3.1.2 Approach: Surveys Sample Design and Analysis

Participant Surveys

The Cadmus Team conducted 560 surveys during June and July 2011 with consumers who participated in the Program Area between February 2010 and March 2011. Each participant survey took up to 20 minutes.

The sample design stratified participants from Downstate (customers within the service territories of the LIPA or Consolidated Edison in NYC (New York City) and the counties of Westchester, Nassau, and Suffolk) and Upstate (the balance of the State) into four categories each: one for each appliance type for Option 1 participants (those who bought ENERGY STAR-qualified refrigerators, freezers, or clothes washers) and one category for Option 2 participants (those who bought a bundle of higher-efficiency ENERGY STAR-qualified appliances that also met stricter CEE efficiency standards). The total number of completed surveys provided a maximum 9.8% margin of error at the 90% confidence level for each of the subgroups, and a 3.5% margin of error for the overall sample (Table 3-1).

Unless otherwise indicated, the data presented in this report were weighted proportionately by the type and number of Program Area-rebated appliances purchased by geographic region (Upstate and Downstate). Reported sample sizes are unweighted.

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15 Exact references vary by appliance and are noted in the appropriate sections.

16 http://www.dps.ny.gov/TechManualNYRevised10-15-10.pdf

Table 3-1. Participant Survey—Sample Design, Appliance Rebate Program Area

Assumptions	Upstate	Downstate	Sample Size Total
Total Completed Surveys	280	280	560 total
Option 1: ENERGY STAR-qualified Refrigerator	70	70	140
Option 1: ENERGY STAR-qualified Freezer	70	70	140
Option 1: ENERGY STAR-qualified Clothes Washer	70	70	140
Option 2: Appliances Bundle (CEE high-efficiency refrigerator, clothes washer, and dishwasher)	70	70	140
Survey Length			20 minutes
Margin of Error at 90% Confidence Level	N/A	N/A	9.8% for each subgroup (geographic and option), 3.5% overall

Rebate Tracking Database

The Program Area implementer supplied the Cadmus Team with the rebate tracking database, which contained the following information about each rebate paid:

- Participant contact information
- Application date
- Product purchase date
- Product purchased
- Store where purchased
- Recycling date
- Age of product recycled
- Recycling location
- Model number

The Cadmus Team summarized the database information to better understand the Program Area and to use in the gross savings analysis.

NYESP Program Sales Data

NYSERDA's Program Area implementer collects ENERGY STAR-qualified and non-ENERGY STAR-qualified sales data from partner retailers. Partner retailers are a subset of all retailers who sell appliances through the ARRA Appliance Rebate Program Area. These retailers supply monthly counts of all ENERGY STAR-qualified and total appliances sold, including refrigerators, freezers, dishwashers, and clothes washers rebated through the Program Area. The Cadmus Team used these data as a proxy for the entire appliance retail market to assess whether sales trends changed over the course of the ARRA rebate Program Area period.

New York Standard Approach to Estimating Energy Savings from Energy-Efficiency Programs (Tech Manual)[17]

The Cadmus Team used the Tech Manual to estimate gross savings for each appliance sold or recycled through the Program Area.

NYSERDA Program Area Staff Interviews

The Cadmus Team interviewed NYSERDA staff and the implementer's staff to understand the Program Area design and implementation, as well as Program Area difficulties and successes. The individuals interviewed were four NYSERDA Program Area management staff and the implementation manager from the Program Area Implementer. 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 retailer feedback received.

3.1.3 Process Findings

Participant Survey Findings

The Cadmus Team used the participant surveys to explore key process questions, such as sources of information about the Program Area, the application process, and ease of participation.

Appendix G summarizes the awareness, motivation, economic factors, alternative funding, and spillover characteristics of the Appliance Program Area recipients.

Program Area Information Sources and Enrollment

Using a scale of 1 (very difficult) to 5 (very easy), respondents were asked to rate their experience with completing various steps of the application process. Regardless of how they applied—whether over the phone, online, in writing, or using more than one method—respondents rated the process as relatively easy, with overall ratings above 4 for each of the application methods.

The Program Area required that all applicants submit original receipts showing the make, model, price, and date of purchase for the qualifying appliance(s). If the replaced appliance was recycled, applicants were also required to submit a proof-of-recycling receipt with the make and model of the replaced appliance or the confirmation number from the New York City 311 hotline (if the applicant was a New York City resident who recycled a refrigerator or freezer).

Respondents in the survey were asked to rate the ease of providing proof of compliance. The mean ratings for the ease of providing proof of purchase and proof of recycling were 4.6 and 4.5, respectively. The few respondents who expressed difficulty with providing proof of purchase said that they had sent in the wrong receipt, lost the receipt, or had problems copying the receipt. Respondents who expressed difficulty with providing proof of recycling said that they didn't know the appliance details, didn't have a receipt number, or had difficulties communicating with the Program Area staff due to problems with the phone system or confusion with the Website.

The majority of respondents (80%) said the application process was "somewhat easy" or "very easy." The few respondents who expressed difficulty said that they were confused over which appliances qualified and the Program Area requirements, felt that the Program Area requirements were burdensome or too

[17] Ibid

strict, experienced technical difficulties online, felt that the process took too long, or were frustrated by being wait-listed (Table 3-2).

Table 3-2. Overall Ease of Participating in Appliance Rebate Program Area

Level of Difficulty (Scale 1 to 5)	Overall	Upstate	Downstate
Sample size	*402*	*184*	*218*
Average (Scale 1 to 5)	3.7	3.6	3.7
1 Very difficult	1%	1%	1%
2 Somewhat difficult	7%	7%	7%
3 Neither	11%	10%	13%
4 Somewhat easy	29%	30%	28%
5 Very easy	51%	52%	50%
Don't know/refused	1%	1%	1%

Note: This question was added to the survey after fielding had started. Therefore, the base is the subset or respondents who completed the survey after the question was added.

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

Purchase Behavior

The Cadmus Team asked participants a series of questions about their timing and decision-making process for purchasing their new appliance(s). Questions included the influence of retailer sales staff and participants' intentions to purchase the appliance(s) if the Program Area had not been available.

Participants in Option 1 purchased a single ENERGY STAR-qualifying refrigerator, freezer, or clothes washer. Participants in Option 2 purchased a bundle of all three appliances (refrigerator, clothes washer, and dishwasher) that were higher-efficiency ENERGY STAR-qualified and also met the stricter CEE guidelines of Tier 2 or Tier 3 for refrigerators and clothes washers, and Tier 1 or Tier 2 for dishwashers. Throughout this report, as applicable, findings for the appliances are presented individually.

Intention in Absence of Rebate

Respondents who learned about the rebates available through the Program Area before they purchased the appliance (i.e., the vast majority of respondents) were asked whether they had planned to purchase that type of appliance before they heard about the rebate.

The results for respondents who purchased a freezer or dishwasher are shown in Table 3-3. Approximately three-quarters (77%) of the freezer group and more than one-half (55%) of the dishwasher group reported that they had planned to purchase the appliance before hearing about the rebate.

Table 3-3. Planned Appliance Purchase before Learning of Rebate, Appliance Rebate Program Area

Purchase Intention		Overall	Upstate	Downstate
Freezer	*Sample size*	*137*	*69*	*68*
	Yes	77%	77%	78%
	No	23%	23%	19%
	Don't know/refused	1%	0%	3%
Dishwasher	*Sample size*	*134*	*65*	*69*
	Yes	55%	54%	59%
	No	44%	45%	42%
	Don't know/refused	1%	1%	0%

Note: Base is respondents who learned about the rebate before purchase, by appliance type.

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

Table 3-4 shows the results for respondents who bought a refrigerator or a clothes washer through Program Area Option 1. Over three- quarters (80%) who bought a refrigerator, and just over two-thirds (70%) who bought a clothes washer, said they had intended to buy the appliance before they heard about the rebate.

Table 3-4. Planned Appliance Purchase before Learning of Rebate—Option 1, Appliance Rebate Program Area

Purchase Intention		Overall	Upstate	Downstate
Refrigerator (Option 1)	*Sample size*	*129*	*66*	*63*
	Yes	80%	80%	78%
	No	19%	18%	21%
	Don't know/refused	2%	2%	2%
Clothes Washer (Option 1)	*Sample size*	*134*	*66*	*68*
	Yes	70%	71%	68%
	No	30%	29%	32%
	Don't know/refused	0%	0%	0%

Note: Base is respondents who learned about the rebate before purchase, by appliance type.

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

Among respondents who bought refrigerators and clothes washers as a bundled purchase (along with dishwashers—Option 2), almost three-quarters (71%) reported that they had planned to purchase the refrigerator, and just under two-thirds (63%) had planned to buy the clothes washer, before hearing about the rebate (Table 3-5).

Table 3-5. Planned Appliance Purchase Before Learning of Rebate—Option 2, Appliance Rebate Program Area

Purchase Intention		Overall	Upstate	Downstate
Refrigerator (Option 2)	*Sample size*	*134*	*69*	*65*
	Yes	71%	70%	74%
	No	28%	29%	26%
	Don't know/refused	1%	1%	0%
Clothes Washer (Option 2)	*Sample size*	*134*	*69*	*65*
	Yes	63%	62%	65%
	No	36%	36%	35%
	Don't know/refused	1%	1%	0%

Note: Base is respondents who learned about the rebate before purchase, by appliance type.

Respondents who learned about the rebate before purchasing the appliance were asked when they would have bought the appliance if the rebate had not been available—sooner, at the same time, within a year, more than a year later, or not at all. Responses by appliance type are shown in Table 3-6 through Table 3-8.

Among respondents who purchased freezers, almost one-half (49%) would have bought it at the same time, and 22% would have bought it within a year. Twenty percent (20%) would have made the purchase more than a year later. Four percent (4%) would have purchased sooner, and the same proportion would not have made the purchase at all (Table 3-6).

Among respondents who bought dishwashers, approximately one-third (35%) would have purchased it at the same time, and 19% would have made the purchase within one year. Just over one quarter (28%) would have bought the dishwasher more than a year later, and 17% would not have purchased at all without the rebate. No respondents would have bought the dishwasher sooner in absence of the rebate (Table 3-6).

Table 3-6. Timing of Purchase in Absence of Rebate, Appliance Rebate Program Area

Timing		Overall	Upstate	Downstate
Freezer	*Sample size*	*137*	*69*	*68*
	Sooner	4%	4%	4%
	At same time	49%	49%	49%
	Within a year	22%	24%	22%
	More than a year later	20%	18%	20%
	Would not have made purchase at all	4%	4%	4%
	Don't know/refused	0%	2%	0%
Dishwasher	*Sample size*	*134*	*69*	*65*
	Sooner	0%	0%	0%
	At same time	35%	33%	39%
	Within a year	19%	20%	15%
	More than a year later	28%	28%	28%
	Would not have made purchase at all	17%	19%	14%
	Don't know/refused	1%	0%	5%

Note: Base is respondents who learned about the rebate before purchase, by appliance type.

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

Table 3-7 shows the results for respondents who purchased a refrigerator or clothes washer through Program Area Option 1. Nearly two-thirds (65%) who purchased a refrigerator would have done so at the same time. Over one-tenth would have bought it within a year (12%), or more than a year later (10%). Seven percent (7%) would have made the purchase sooner and 6% would not at all

Overall, 59% who purchased a clothes washer through Option 1 would have purchased the appliance at the same time, with Upstate residents (67%) being significantly more likely to do so than Downstate residents (44%). The Downstate residents (32%) were significantly more likely than those Upstate (18%) to say that they would have made the purchase within a year (23% overall). Few respondents overall (8%) would have bought the washer more than a year later. Those Downstate were significantly *less* likely to say they would not have purchased the appliance at all (0% Downstate versus 4% Upstate and 2% overall), and only 5% of respondents who bought a clothes washer through Option 1 would have made the purchase sooner if the rebate had not been available.

Table 3-7. Timing of Purchase in Absence of Rebate—Option 1, Appliance Rebate Program Area

Timing		Overall	Upstate	Downstate
Refrigerator (Option 1)	*Sample size*	*129*	*66*	*63*
	Sooner	7%	5%	8%
	At same time	65%	70%	62%
	Within a year	12%	14%	11%
	More than a year later	10%	6%	12%
	Would not have made purchase at all	6%	3%	8%
	Don't know/refused	1%	2%	0%
Clothes Washer (Option 1)	*Sample size*	*134*	*66*	*68*
	Sooner	5%	5%	4%
	At same time	59%	67%*	44%
	Within a year	23%	18%*	32%
	More than a year later	8%	6%	12%
	Would not have made purchase at all	2%	0%*	4%
	Don't know/refused	4%	5%	3%

Note: Base is respondents who learned about the rebate after purchase, by appliance type.

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

* Statistically different between Upstate and Downstate at the 90% confidence level.

Table 3-8 shows results for those who purchased refrigerators and clothes washers through Option 2. Almost 40% (39%) of respondents would have bought their refrigerator at the same time, while one-fourth (25%) would have bought it within a year. Nearly one-fourth (23%) would have made the purchase more than a year later, while 9% would not have bought the refrigerator at all. Few (3%) would have bought the refrigerator sooner.

Results for the Option 2 clothes washers are similar. Nearly 40% (38%) would have bought the clothes washer at the same time, while about one-fourth (23%) would have bought it within a year (24%) or more than a year later (22%). Twelve percent (12%) would not have purchased the washer at all without the rebate. Few respondents (3%) would have bought the clothes washer sooner.

Table 3-8. Timing of Purchase in Absence of Rebate—Option 2, Appliance Rebate Program Area

Timing		Overall	Upstate	Downstate
Refrigerator (Option 2)	*Sample size*	*134*	*69*	*65*
	Sooner	3%	3%	1%
	At same time	39%	38%	41%
	Within a year	25%	25%	26%
	More than a year later	23%	22%	25%
	Would not have made purchase at all	9%	12%	5%
	Don't know/refused	2%	1%	1%
Clothes Washer (Option 2)	*Sample size*	*134*	*69*	*65*
	Sooner	3%	4%	2%
	At same time	38%	39%	35%
	Within a year	24%	23%	25%
	More than a year later	22%	22%	22%
	Would not have made purchase at all	12%	10%	15%
	Don't know/refused	1%	1%	2%

Note: Base is respondents who learned about the rebate after purchase, by appliance type.

Note: Columns might not equal 100% due to rounding.

Influence of Retail Salesperson

Table 3-9 through Table 3-11 show that across all appliance types, the majority of participants said the salesperson at the store where they bought the appliance(s) mentioned appliance models that qualified for the rebate.

About two-thirds (67%) of those who bought a freezer, and three-quarters (75%) of those who bought a dishwasher, reported that the salesperson mentioned models that qualified for the rebate (Table 3-9).

Table 3-9. Salesperson Mention of Qualified Models, Appliance Rebate Program Area

Salesperson Mention		Overall	Upstate	Downstate
Freezer	*Sample size*	*140*	*70*	*70*
	Yes	67%	69%*	49%
	No	22%	20%*	40%
	Don't know/refused	11%	11%	11%
Dishwasher	*Sample size*	*140*	*70*	*70*
	Yes	75%	77%	71%
	No	23%	20%	29%
	Don't know/refused	2%	3%	0%

* Although some differences between Upstate and Downstate are large, differences are not statistically significant at the 90% confidence level unless noted by *.

Note: Base for each appliance is respondents who purchased that appliance.

Just over one-half (52%) of respondents who bought a refrigerator through Option 1, and 62% of respondents who bought a clothes washer through Option 1, said that the salesperson mentioned Program Area qualifying models (Table 3-10).

Table 3-10. Salesperson Mention of Qualified Models—Option 1, Appliance Rebate Program Area

Salesperson Mention		Overall	Upstate	Downstate
Refrigerator (Option 1)	*Sample size*	*140*	*70*	*70*
	Yes	52%	54%	49%
	No	40%	37%	44%
	Don't know/refused	8%	9%	7%
Clothes Washer (Option 1)	*Sample size*	*140*	*70*	*70*
	Yes	62%	61%	63%
	No	34%	34%	33%
	Don't know/refused	4%	4%	4%

Note: Base for each appliance is respondents who purchased that appliance through Option 1.

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

Among respondents who purchased all three appliances through Option 2, 63% said that the salesperson mentioned Program Area qualifying models of refrigerators, and 72% reported that the salesperson mentioned qualifying models of clothes washers (Table 3-11).

Table 3-11. Salesperson Mention of Qualified Models—Option 2, Appliance Rebate Program Area

Salesperson Mention		Overall	Upstate	Downstate
Refrigerator (Option 2)	*Sample size*	*140*	*70*	*70*
	Yes	63%	60%	69%
	No	34%	37%	29%
	Don't know/refused	3%	3%	3%
Clothes Washer (Option 2)	*Sample size*	*140*	*70*	*70*
	Yes	72%	74%	66%
	No	27%	26%	30%
	Don't know/refused	1%	0%	4%

Note: Base for each appliance is respondents who purchased that appliance through Option 2

Across all appliance types, the majority of respondents also reported that the salesperson talked about models that were ENERGY STAR-qualified. These results are shown in Table 3-12 through Table 3-14, by appliance type.

Table 3-12 shows that, among those who purchased a freezer or dishwasher, 80% said that the salesperson had mentioned models that were ENERGY STAR-qualified, with Upstate residents reporting a significantly higher percentage than Downstate residents (81% versus 64% for freezers and 84% versus 71% for dishwashers).

Table 3-12. Salesperson Mention of ENERGY STAR-Qualified Models, Appliance Rebate Program Area

Salesperson Mention		Overall	Upstate	Downstate
Freezer	*Sample size*	*140*	*70*	*70*
	Yes	80%	81%*	64%
	No	13%	11%	26%
	Don't know/refused	7%	7%	10%
Dishwasher	*Sample size*	*140*	*70*	*70*
	Yes	80%	84%*	71%
	No	19%	14%*	27%
	Don't know/refused	1%	1%	1%

* Statistically different between Upstate and Downstate at the 90% confidence level.

Note: Base for each appliance is respondents who purchased that appliance.

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

Over three-quarters (78%) of respondents who purchased a refrigerator through Option 1 said that the salesperson mentioned ENERGY STAR-qualified models, while 84% of respondents who bought a clothes washer through Option 1 said the same (Table 3-13).

Table 3-13. Salesperson Mention of ENERGY STAR-Qualified Models—Option 1, Appliance Rebate Program Area

Salesperson Mention		Overall	Upstate	Downstate
Refrigerator (Option 1)	*Sample size*	*140*	*70*	*70*
	Yes	78%	80%	74%
	No	18%	16%	21%
	Don't know/refused	4%	4%	4%
Clothes Washer (Option 1)	*Sample size*	*140*	*70*	*70*
	Yes	84%	86%	81%
	No	11%	10%	14%
	Don't know/refused	4%	4%	4%

Note: Base for each appliance is respondents who purchased that appliance through Option 1.

Among respondents who bought appliances through Option 2, 76% said the salesperson mentioned ENERGY STAR-qualified models of refrigerators, and 81% said that the salesperson mentioned ENERGY STAR-qualified models of clothes washers (Table 3-14).

Table 3-14. Salesperson Mention of ENERGY STAR-Qualified Models—Option 2, Appliance Rebate Program Area

Salesperson Mention		Overall	Upstate	Downstate
Refrigerator (Option 2)	*Sample size*	*140*	*70*	*70*
	Yes	76%	77%	74%
	No	21%	21%	21%
	Don't know/refused	2%	1%	4%
Clothes Washer (Option 2)	*Sample size*	*140*	*70*	*70*
	Yes	81%	83%	76%
	No	18%	16%	23%
	Don't know/refused	2%	1%	1%

Note: Base for each appliance is respondents who purchased that appliance through Option 2.

Participants in Option 2 also reported whether the salesperson mentioned the higher-efficiency CEE-qualifying models of appliances (i.e., appliances that meet CEE Tier 2 or Tier 3 standards for refrigerators and clothes washers and CEE Tier 1 or Tier 2 for dishwashers). These results are shown in Table 3-15 through Table 3-17.

Table 3-15 shows that 59% of respondents who purchased a dishwasher reported that the salesperson mentioned CEE-qualifying models, with a significantly larger percentage of Upstate respondents (64%) than Downstate respondents (49%) reporting this outcome.

Table 3-15. Salesperson Mention of CEE-Qualifying Models, Appliance Rebate Program Area

Salesperson Mention		Overall	Upstate	Downstate
Dishwasher	*Sample size*	*140*	*70*	*70*
	Yes	59%	64%*	49%
	No	22%	19%	30%
	Don't know/refused	19%	17%	21%

* Statistically different between Upstate and Downstate at the 90% confidence level.

Note: Base is respondents who purchased a dishwasher.

Nearly 40% of respondents (39%) who bought a refrigerator through Option 1, and 47% who bought a clothes washer through Option 1, said that the salesperson mentioned CEE-qualifying models (Table 3-16).

Table 3-16. Salesperson Mention of CEE-Qualifying Models—Option 1, Appliance Rebate Program Area

Salesperson Mention		Overall	Upstate	Downstate
Refrigerator (Option 1)	*Sample size*	*140*	*70*	*70*
	Yes	39%	43%	31%
	No	40%	40%	40%
	Don't know/refused	21%	17%*	29%
Clothes Washer (Option 1)	*Sample size*	*140*	*70*	*70*
	Yes	47%	46%	50%
	No	31%	31%	29%
	Don't know/refused	22%	23%	21%

* Statistically different between Upstate and Downstate at the 90% confidence level.

Note: Base for each appliance is respondents who purchased that appliance through Option 1.

Compared to participants who purchased a refrigerator or clothes washer under Option 1, Option 2 participants were significantly more likely to report that the sales staff mentioned CEE-qualifying models. Fifty-seven percent (57%) of those who purchased appliances through Option 2 reported that the salesperson mentioned CEE-qualifying models of refrigerators, and 64% said that the salesperson mentioned CEE-qualifying models of clothes washers (Table 3-17).

Table 3-17. Salesperson Mention of CEE-Qualifying Models—Option 2, Appliance Rebate Program Area

Salesperson Mention		Overall	Upstate	Downstate
Refrigerator (Option 2)	*Sample size*	*140*	*70*	*70*
	Yes	57%	57%	56%
	No	28%	26%	31%
	Don't know/refused	16%	17%	13%
Clothes Washer (Option 2)	*Sample size*	*140*	*70*	*70*
	Yes	64%	66%	60%
	No	23%	21%	27%
	Don't know/refused	13%	13%	13%

Note: Base for each appliance is respondents who purchased that appliance through Option 2.

Efficiency and Choices of Appliance Models

Respondents who purchased a refrigerator and/or a clothes washer were asked the efficiency level of their new appliance(s). Table 3-18 and Table 3-19 show these results. Rebates issued under Option 1 required that the appliances, at a minimum, met ENERGY STAR standards. Individual refrigerators or clothes washers rebated under Option 1 could also have been CEE Tier 2 or Tier 3, but no additional rebate amounts were given for these higher-efficiency options. All Option 2 purchases were required to meet the CEE-qualifying efficiency levels.

Table 3-18 shows that over half (53%) of those who purchased a refrigerator through Option 1 reportedly knew whether the appliance met CEE standards or only ENERGY STAR standards. Almost one-third (32%) reported that their unit was efficient to CEE standards, and 21% said their refrigerator was only efficient to ENERGY STAR standards.

Among respondents who purchased a clothes washer through Option 1, 48% said the unit was efficient to CEE standards, while 11% said the unit was only efficient to ENERGY STAR standards. Approximately 40% (41%) did not know the efficiency level of their clothes washer, but the fact that almost 60% (59%)of customers were able to discuss the efficiency of their clothes washer at all is an important indication of the success of NYSERDA programs in New York.

Table 3-18. Respondent Reported Efficiency Level of Purchased Appliance—Option 1, Appliance Rebate Program Area

Efficiency Level		Overall	Upstate	Downstate
Refrigerator (Option 1)	*Sample size*	*140*	*70*	*70*
	Efficient to CEE standards	32%	33%	29%
	Efficient to ENERGY STAR standards only	21%	23%	16%
	Don't know/refused	48%	44%	56%
Clothes Washer (Option 1)	*Sample size*	*140*	*70*	*70*
	Efficient to CEE standards	48%	49%	46%
	Efficient to ENERGY STAR standards only	11%	9%	17%
	Don't know/refused	41%	43%	37%

Note: Base for each appliance is respondents who purchased that appliance through Option 1.

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

Among Option 2 respondents, 59% correctly said their refrigerator was efficient to CEE standards, while 66% correctly said their clothes washer was efficient to CEE standards. The remaining either stated they did not know (39% refrigerators and 29% clothes washers), or mistakenly said it was efficient to ENERGY STAR standards only (refrigerators: 2%; clothes washers: 5%; Table 3-19).

Table 3-19. Respondent Reported Efficiency Level of Purchased Appliance—Option 2, Appliance Rebate Program Area

Reported Efficiency Level		Overall	Upstate	Downstate
Refrigerator (Option 2)	*Sample size*	*140*	*70*	*70*
	Efficient to CEE standards	59%	60%	56%
	Efficient to ENERGY STAR standards only	2%	3%	1%
	Don't know/refused	39%	37%	43%
Clothes Washer (Option 2)	*Sample size*	*140*	*70*	*70*
	Efficient to CEE standards	66%	67%	64%
	Efficient to ENERGY STAR standards only	5%	6%	3%
	Don't know/refused	29%	27%	33%

Note: Base for each appliance is respondents who purchased that appliance through Option 2.

Respondents who would have purchased the appliance without the rebate were asked whether, in absence of the rebate, they would have bought the same model. These results are shown in Table 3-20 through Table 3-22. The majority of respondents would have bought the same model in absence of the Program Area; however, the results vary across appliance types and between Options 1 and 2.

Table 3-20 shows that, among those who purchased a freezer, 81% would have bought the same model without the rebate, while 12% would have bought a different model. Downstate residents were significantly more likely than Upstate residents to have purchased a different model (22% versus 10%).

Nearly 60% of respondents (57%) who purchased a dishwasher would have purchased the same model without the rebate, while 29% would have purchased a different model.

Table 3-20. Model Choice in Absence of Rebate, Appliance Rebate Program Area

Model Choice		Overall	Upstate	Downstate
Freezer	*Sample size*	*134*	*67*	*67*
	Same	81%	82%	72%
	Different	12%	10%*	22%
	Don't know/refused	7%	7%	6%
Dishwasher	*Sample size*	*118*	*57*	*61*
	Same	57%	58%	56%
	Different	29%	26%	34%
	Don't know/refused	14%	16%	10%

Note: Base is respondents who would have made the purchase in absence of a rebate.

* Statistically different between Upstate and Downstate at the 90% confidence level.

Among respondents who purchased a refrigerator through Option 1, 87% would have bought the same model without the rebate, and 8% would have bought a different model (Table 3-21). Slightly more than 80% of respondents (82%) who purchased a clothes washer would have purchased the same model without the rebate, with Upstate residents being significantly more likely than Downstate residents to say they would have purchased the same model (89% versus 69%) and significantly *less* likely to say they would have purchased a different model (9% versus 27%).

Table 3-21. Model Choice in Absence of Rebate—Option 1, Appliance Rebate Program Area

Model Choice		Overall	Upstate	Downstate
Refrigerator (Option 1)	*Sample size*	*133*	*65*	*68*
	Same	87%	89%	82%
	Different	8%	5%	13%
	Don't know/refused	6%	6%	4%
Clothes Washer (Option 1)	*Sample size*	*137*	*70*	*67*
	Same	82%	89%*	69%
	Different	14%	9%*	27%
	Don't know/refused	3%	3%	5%

Note: Base is respondents who would have made the purchase in absence of a rebate.

* Statistically different between Upstate and Downstate at the 90% confidence level.

Table 3-22 shows that the majority of respondents who purchased a refrigerator and a clothes washer through Option 2 would have purchased the same models in absence of the rebate. Over 60% (62%) would have purchased the same model of refrigerator, and 65% would have purchased the same model of clothes washer. For both appliance types, the Upstate residents were significantly more likely than those

Downstate to report that they would have bought the same model (68% versus 52% for refrigerators and 70% versus 53% for clothes washers).

Table 3-22. Model Choice in Absence of Rebate—Option 2, Appliance Rebate Program Area

Model Choice		Overall	Upstate	Downstate
Refrigerator (Option 2)	*Sample size*	*129*	*62*	*67*
	Same	62%	68%*	52%
	Different	30%	26%	37%
	Don't know/refused	8%	7%	11%
Clothes Washer (Option 2)	*Sample size*	*123*	*63*	*60*
	Same	65%	70%*	53%
	Different	25%	21%	35%
	Don't know/refused	10%	10%	12%

Note: Base is respondents who would have made the purchase in absence of a rebate.

* Statistically different between Upstate and Downstate at the 90% confidence level.

Respondents who would have chosen a different model of appliance in absence of the rebate reported what differences they would have chosen. Table 3-23 through Table 3-25 show the results by appliance type. Across all appliance types, respondents most commonly said that they would have chosen a less expensive model if the rebate had not been available.

As shown in Table 3-23, 34% of those who purchased a freezer would have bought a less expensive model. Slightly more (37%) would have chosen a model with features that were not available on qualifying models. Fifteen percent (15%) said they would have chosen a different size freezer, and 12% said they would have chosen a less efficient freezer.

Approximately one-half (51%) of those who bought a dishwasher would have purchased a less expensive model without the rebate, and 26% would have purchased a less efficient model. Almost 15% (14%)would have chosen a model with features that were not available on qualifying models.

Table 3-23. How Model Choice Would Have Been Different in Absence of Rebate, Appliance Rebate Program Area

Differences		Overall	Upstate *	Downstate
Freezer	*Sample size*	*22*	*7*	*15*
	Less expensive	34%	29%	60%
	Features not available on ENERGY STAR-qualified models	37%	43%	13%
	Lower efficiency	12%	14%	0%
	Different size	15%	14%	20%
	Purchased at different store	1%	0%	7%
	Different brand	1%	0%	7%
	Better quality	0%	0%	0%
	Other	0%	0%	0%
Dishwasher	*Sample size*	*36*	*15*	*21*
	Less expensive	51%	47%	57%
	Features not available on ENERGY STAR-qualified models	14%	13%	14%
	Lower efficiency	26%	27%	24%
	Different size	4%	7%	0%
	Purchased at different store	0%	0%	0%
	Different brand	6%	0%	14%
	Better quality	4%	7%	0%
	Other	2%	0%	5%

Note: This was an open-ended question for which surveyed participants provided multiple responses.

Note: Base is respondents who would have made a different purchase in the absence of a rebate.

* Statistically different between Upstate and Downstate at the 90% confidence level.

Almost three-quarters (74%) of Option 1 respondents who would have purchased a different model of refrigerator would have chosen a less expensive model, and 13% would have chosen a model with features that were not available on qualifying models.

Among those Option 1 respondents who would have purchased a different clothes washer without the rebate, 60% would have purchased a less expensive model, and 13% would have chosen a model with features that differed from those available on qualifying models (Table 3-24).

Table 3-24. How Model Choice Would Be Different in Absence of Rebate—Option 1, Appliance Rebate Program Area

Differences		Overall	Upstate	Downstate
Refrigerator (Option 1)	*Sample size*	*12*	*3*	*9*
	Less expensive	74%	100%*	56%
	Features not available on ENERGY STAR-qualified models	13%	0%	22%
	Lower efficiency	7%	0%	11%
	Different size	0%	0%	0%
	Newer model	0%	0%	0%
	Other	0%	0%	0%
	Don't know/refused	7%	0%	11%
Clothes Washer (Option 1)	*Sample size*	*24*	*6*	*18*
	Less expensive	60%	50%	67%
	Features not available on ENERGY STAR-qualified models	13%	17%	11%
	Lower efficiency	7%	17%	0%
	Different size	3%	0%	6%
	Newer model	7%	17%	0%
	Other	3%	0%	6%
	Don't know/refused	7%	0%	11%

Note: This was an open-ended question for which surveyed participants provided multiple responses.

Note: Base is respondents who would have made a different purchase in the absence of a rebate.

* Statistically different between Upstate and Downstate at the 90% confidence level.

Among Option 2 respondents who would have purchased a different refrigerator and/or clothes washer, 44% would have bought a less expensive refrigerator, and 55% would have chosen a less expensive clothes washer. These results were significantly different between Upstate and Downstate residents (31% versus 60% for refrigerators, respectively, and 39% versus 76% for clothes washers, respectively).

One-quarter (25%)would have chosen a refrigerator model with features not available on qualifying models, and 13% would have chosen a clothes washer with different features. Thirty percent (30%) would have chosen a less efficient refrigerator, and 26% would have chosen a less efficient clothes washer (Table 3-25).

Table 3-25. How Model Choice Would be Different in Absence of Rebate—Option 2, Appliance Rebate Program Area

Differences		Overall	Upstate	Downstate
Refrigerator (Option 2)	*Sample size*	*41*	*16*	*25*
	Less expensive	44%	31%*	60%
	Features not available on ENERGY STAR-qualified models	25%	25%	24%
	Lower efficiency	30%	25%	28%
	Different size	7%	13%	0%
	Different brand	3%	0%	8%
	Don't know/refused	4%	8%	0%
Clothes Washer (Option 2)	*Sample size*	*34*	*13*	*21*
	Less expensive	55%	39%*	76%
	Features not available on ENERGY STAR-qualified models	13%	15%	10%
	Lower efficiency	26%	23%	29%
	Different size	4%	8%	0%
	Different brand	0%	0%	0%
	Don't know/refused	11%	15%	5%

Note: This was an open-ended question for which surveyed participants provided multiple responses.

Note: Base is respondents who would have made a different purchase in the absence of a rebate.

* Statistically different between Upstate and Downstate at the 90% confidence level.

The survey included a question asking how easy or difficult it was to find an appliance that qualified for the rebate, on a scale from 1 (indicating that it was very difficult) to 5 (indicating that it was very easy). Across all appliance types, participants said that it was relatively easy to find appliances that met efficiency guidelines set by the Program Area, but Option 2 purchasers expressed greater difficulty than Option 1 purchasers. These results are shown by appliance type in Table 3-26 through Table 3-28.

As shown in Table 3-26, 90% of respondents who purchased a freezer found it either "very easy" or "somewhat easy" to find an appliance that qualified, whereas only 5% found it "somewhat difficult" or "very difficult." Specific difficulties mentioned were a limited selection of qualifying freezers and that some qualifying models were out of stock. The mean rating was 4.5.

Approximately 80% of respondents (81%) who bought a dishwasher found it "very" or "somewhat" easy to find a qualifying model, and 16% said it was "somewhat" or "very" difficult, with a mean rating of 4.3. The few respondents who elaborated on their difficulty mentioned that finding qualifying dishwasher models at retailers was difficult, salespeople did not know about energy efficiency, qualifying dishwashers did not have the features they wanted, and the information about qualifying models was confusing.

Table 3-26. Ease of Finding Appliance that Qualified for Rebate, Appliance Rebate Program Area

Level of Difficulty (Scale 1 to 5)		Overall	Upstate	Downstate
Freezer	*Sample size*	*140*	*70*	*70*
	Average (Scale 1 to 5)	4.5	4.5	4.4
	1 Very difficult	0%	0%	0%
	2 Somewhat difficult	5%	4%	9%
	3 Neither	4%	4%	6%
	4 Somewhat easy	27%	27%	23%
	5 Very easy	63%	63%	61%
	Don't know/refused	1%	1%	1%
Dishwasher	*Sample size*	*138*	*70*	*68*
	Average (Scale 1 to 5)	4.3	4.2	4.4
	1 Very difficult	4%	6%	1%
	2 Somewhat difficult	12%	13%	9%
	3 Neither	2%	1%	4%
	4 Somewhat easy	17%	17%	16%
	5 Very easy	64%	63%	67%
	Don't know/refused	1%	0%	2%

Note: Base for each appliance is respondents who purchased that appliance.

As shown in Table 3-27, 91% of Option 1 respondents who bought a refrigerator reported that it was "somewhat" or "very" easy to find a qualifying model, whereas 2% found it "somewhat difficult." Some of these respondents explained that there was a limited selection of energy-efficient refrigerators at the store and that it was difficult to find the right size of refrigerator to qualify for the rebate. The mean rating for the Option 1 refrigerator group was 4.6.

Among those who purchased a clothes washer through Option 1, 94% said that it was "somewhat" or "very" easy to find a model that qualified for the rebate, and two people out of 140 said it was difficult to find a qualifying model. Their specific difficulties were the limited selection and lack of desired features on qualifying models, and that qualifying clothes washers were too expensive. On average, clothes washer buyers gave an ease rating of 4.7.

Table 3-27. Ease of Finding Appliance that Qualified for Rebate—Option 1, Appliance Rebate Program Area

Level of Difficulty (Scale 1 to 5)		Overall	Upstate	Downstate
Refrigerator (Option 1)	*Sample size*	*140*	*70*	*70*
	Average (Scale 1 to 5)	4.6	4.6	4.6
	1 Very difficult	0%	0%	0%
	2 Somewhat difficult	2%	3%	1%
	3 Neither	5%	6%	3%
	4 Somewhat easy	19%	16%	26%
	5 Very easy	72%	73%	69%
	Don't know/refused	2%	3%	1%
Clothes Washer (Option 1)	*Sample size*	*140*	*70*	*70*
	Average (Scale 1 to 5)	4.7	4.7	4.6
	1 Very difficult	0%	0%	0%
	2 Somewhat difficult	1%	0%	3%
	3 Neither	5%	6%	3%
	4 Somewhat easy	20%	19%	23%
	5 Very easy	74%	76%	70%
	Don't know/refused	1%	0%	1%

Note: Base for each appliance is respondents who purchased that appliance through Option 1.

Among respondents who purchased appliances through Option 2, 74% said that it was "somewhat" or "very" easy to find a qualifying refrigerator model (mean of 4.1), and 90% said that it was "somewhat" or "very" easy to find a clothes washer (mean of 4.5). Close to one-quarter (22%) thought it was difficult to find a qualifying refrigerator, and 7% thought it was difficult to find a qualifying clothes washer (Table 3-28). Option 2 participants mentioned the same difficulties with finding qualifying refrigerators and clothes washers as Option 1 participants who bought these appliances.

Table 3-28. Ease of Finding Appliance that Qualified for Rebate—Option 2, Appliance Rebate Program Area

Level of Difficulty (Scale 1 to 5)		Overall	Upstate	Downstate
Refrigerator (Option 2)	*Sample size*	*140*	*70*	*70*
	Average (Scale 1 to 5)	4.1	4.0	4.3
	1 Very difficult	5%	7%	1%
	2 Somewhat difficult	17%	19%	13%
	3 Neither	2%	1%	4%
	4 Somewhat easy	14%	13%	17%
	5 Very easy	60%	59%	63%
	Don't know/refused	1%	1%	1%
Clothes Washer (Option 2)	*Sample size*	*140*	*70*	*70*
	Average (Scale 1 to 5)	4.5	4.5	4.5
	1 Very difficult	3%	4%	0%
	2 Somewhat difficult	4%	3%	6%
	3 Neither	4%	3%	6%
	4 Somewhat easy	20%	20%	19%
	5 Very easy	70%	70%	69%
	Don't know/refused	0%	0%	0%

Note: Base for each appliance is respondents who purchased that appliance through Option 2.

Purchases of Bundled Appliances—Option 2

Table 3-29 and Table 3-30 show that the majority of Option 2 respondents who learned about the rebate prior to their purchase had not planned to purchase all three appliances prior to learning about the rebate.

Table 3-29 shows that, overall, fewer than one-half of Option 2 respondents (44%) had planned to purchase all three appliances, with the Downstate group being significantly more likely than the Upstate group to give this response (60% versus 36%). Fifteen percent (15%) of Option 2 respondents had not planned to purchase any of the appliances, with a significantly greater proportion of Upstate respondents than Downstate respondents reporting no prior plans to purchase appliances (19% versus 6%). Twenty-percent (20%) of respondents overall who learned about the rebate prior to their purchases had planned to purchase one of the appliances, and a similar percent had planned to buy two of them.

Table 3-29. Planned Appliance Purchases Prior to Learning about Rebate—Option 2, Appliance Rebate Program Area

Appliance Type	Overall	Upstate	Downstate
Sample size	*134*	*69*	*65*
Planned to purchase all three appliances	44%	36%*	60%
Refrigerator and clothes washer only	8%	9%	6%
Refrigerator and dishwasher only	6%	7%	5%
Clothes washer and dishwasher only	6%	7%	3%
Refrigerator only	10%	12%	6%
Clothes washer only	6%	6%	6%
Dishwasher only	5%	4%	8%
Did not plan to purchase any	15%	19%*	6%

Note: Base is respondents who learned about the rebate before making purchases.

* Statistically different between Upstate and Downstate at the 90% confidence level.

All Option 2 participants were asked whether, if the rebate had not been available, they still would have purchased the group of all three appliances, would have purchased just one or two of the appliances, or would not have purchased any appliances (Table 3-30). Over 30% of respondents (31%) would have purchased all three appliances, 29% would have purchased just two appliances, and 30% would have purchased just one appliance. Approximately 11% would not have purchased any appliances without the rebate.

Table 3-30. Intention to Purchase in Absence of Rebate—Option 2, Appliance Rebate Program Area

Appliances	Overall	Upstate	Downstate
Sample size	*140*	*70*	*70*
All three appliances	31%	30%	34%
Two appliances	29%	27%	31%
One appliance	30%	30%	29%
Would not have purchased any	11%	13%	6%

Note: Base is all Option 2 respondents.

Table 3-31 shows whether Option 2 respondents who would have purchased at least one appliance would have made the purchase sooner, at the same time, within a year, more than a year later, or would not have purchased the bundle of three appliance(s) at all. More than 40% (43%) would have bought the appliance(s) at the same time, 27% would have made the purchase within a year, and 26% would have purchased over a year later. One out of 127 said they would not have purchased any appliances at all, and 3% would have made their purchase sooner. Upstate respondents were significantly more likely than Downstate respondents to say that they would have bought the appliances within a year (31% versus 18%).

Table 3-31. Timing of Purchase in Absence of Rebate—Option 2, Appliance Rebate Program Area

Timing	Overall	Upstate	Downstate
Sample size	*127*	*61*	*66*
Sooner	3%	2%	4%
At same time	43%	39%	51%
Within a year	27%	31%*	18%
More than a year later	26%	28%	23%
Would not have made purchase at all	<1%	0%	2%
Don't know/refused	<1%	0%	2%

Note: Base is Option 2 respondents who would have purchased at least one appliance.

Note: Totals might not equal 100% due to rounding.

* Statistically different between Upstate and Downstate at the 90% confidence level.

Respondents who would have purchased at least one appliance in absence of the rebate were asked whether they would have bought the same or different models if the rebate had not been available. One-half (50%) of these respondents would have chosen the same models for all three appliances, while 42% would have chosen a different model for at least one appliance (Table 3-32).

Table 3-32. Type of Models That Would Have Been Purchased in Absence of Rebate—Option 2, Appliance Rebate Program Area

Model Type	Overall	Upstate	Downstate
Sample size	*140*	*70*	*70*
Same for all three	50%	54%	41%
Different models for two appliances	14%	11%	20%
Different model for one appliance	28%	26%	31%
Don't know/refused	8%	9%	7%

Note: Base is Option 2 respondents who would have purchased at least one appliance in the absence of a rebate.

As shown in Table 3-33, 35% of respondents who would have chosen a different model for at least one appliance said that they would have chosen an appliance(s) that was less expensive, with a significantly larger proportion of Downstate residents than Upstate residents giving this response (53% versus 23%, respectively). Over one-fourth (26%) would have purchased less efficient models, and 13% would have chosen models with features that were not available on qualifying models.

Table 3-33. How Purchased Models Would Have Been Different in Absence of Rebate—Option 2, Appliance Rebate Program Area

Difference	Overall	Upstate	Downstate
Sample size	*62*	*26*	*36*
Less expensive	35%	23%*	53%
Features not available on qualifying models	13%	12%	14%
Lower efficiency	26%	23%	31%
Larger appliances	3%	4%	3%
Different brand	7%	12%*	0%
Other	8%	8%	8%
Don't know/refused	12%	13%	11%

Note: Surveyed participants provided multiple responses to this question.

Note: Base is Option 2 respondents who would have purchased different models in the absence of a rebate.

* Statistically different between Upstate and Downstate at the 90% confidence level.

Option 2 respondents were required to purchase appliances that exceeded the ENERGY STAR standards of efficiency. In response to a survey question asking these respondents why they decided to purchase these higher-efficiency models, 70% said they did so either to save energy or to save money on their utility bills. Over one-quarter (28%) chose the higher-efficiency appliances to get the rebate. Just over 10% (12%) made their higher-efficiency purchasing decision because these appliances are of higher quality than less efficient appliances, and 10% indicated wanting to help the environment. Other reasons respondents cited include that the appliances had desired features and that they were less expensive than some other models (Table 3-34).

Table 3-34. Why Purchased Higher Efficiency Models—Option 2, Appliance Rebate Program Area

Reason	Overall	Upstate	Downstate
Sample size	*140*	*70*	*70*
To save energy	37%	40%	31%
To save money on utility bills	33%	31%	37%
To get the rebate	28%	33%	23%
They are better quality	12%	13%	11%
To help the environment	10%	11%	9%
They had desired features	6%	6%	7%
Less expensive than others	3%	3%	3%
Other	5%	4%	6%

Note: This was an open-ended question for which surveyed participants provided multiple responses.

Note: Base is respondents who purchased appliances through Option 2.

As shown in Table 3-35, 90% of Option 2 respondents purchased all three appliances from the same retailer.

Table 3-35. Where Purchased Three Appliances—Option 2, Appliance Rebate Program Area

Number of Retailers	Overall	Upstate	Downstate
Sample size	*140*	*70*	*70*
Same retailer for all three	90%	91%	87%
More than one retailer	10%	9%	13%

Note: Base is respondents who purchased appliances through Option 2.

Respondents who purchased appliances through Option 2 were asked to rate on a 1 to 5 point scale how easy or difficult it was to find qualifying models for the bundled purchase. Over three-quarters (76%) judged it to be "somewhat easy" or "very easy," whereas 19% found it to be "somewhat difficult" or "very difficult," with a mean rating of 4.1 (Table 3-36).

Table 3-36. Ease of Finding Qualifying Models for Bundled Purchase, Appliance Rebate Program Area

Level of Difficulty (Scale 1 to 5)	Overall	Upstate	Downstate
Sample size	*140*	*70*	*70*
Average (Scale 1 to 5)	4.1	4.1	4.1
1 Very difficult	3%	4%	0%
2 Somewhat difficult	16%	16%	17%
3 Neither	4%	3%	7%
4 Somewhat easy	22%	23%	20%
5 Very easy	54%	53%	56%
Don't know/refused	1%	1%	0%

Note: Base respondents who purchased appliances through Option 2.

Option 2 participants who said that finding qualifying models was "somewhat" or "very" difficult were then asked to cite specific difficulties (Table 3-37). Respondents reported a limited selection of qualifying models at the store (32% for refrigerators, 18% for dishwashers, and 17% for clothes washers). Ten percent (10%)of respondents mentioned each of the following issues: the complexity of matching the model numbers of qualifying units with those at the store, the high cost of qualifying refrigerators, and the high cost of qualifying dishwashers. Other difficulties mentioned include that the salespeople did not know about energy efficiency, that the cost of qualifying clothes washers was too high, and that some models on the qualifying list were no longer being manufactured.

Table 3-37. Difficulties Finding Qualifying Models for Bundled Purchase, Appliance Rebate Program Area

Difficulty	Overall	Upstate	Downstate
Sample size	*26*	*14*	*12*
Limited selection of qualifying models of refrigerators at store	32%	38%	17%
Limited selection of qualifying models of dishwashers at store	18%	16%	25%
Limited selection of qualifying models of clothes washers at store	17%	16%	17%
Was complicated to match model numbers of qualifying models with those at store	10%	7%	25%
Cost of qualifying refrigerators was too high	10%	14%	0%
Cost of qualifying dishwashers was too high	10%	14%	0%
Salespeople did not know about energy efficiency	8%	7%	8%
Cost of qualifying clothes washers was too high	5%	7%	0%
Some models on list were not being made anymore	5%	7%	0%
Qualifying dishwashers did not have desired features	2%	0%-	8%
Time consuming to find qualifying models	2%	0%	8%
Other	5%	7%	0%
Don't know/refused	2%	0%	8%

Note: This was an open-ended question for which surveyed participants provided multiple responses.

Note: Base is respondents who purchased appliance through Option 2.

Staff Interview Findings

The staff interviews revealed detailed information about Program Area processes and implementation. The Cadmus Team held one joint meeting with all five NYSERDA and the Program Area Implementer stakeholders in attendance. NYSERDA staff reported that they began working on the Program Area plans in June 2009, in anticipation of the funding opportunity that was issued in July 2009. NYSERDA submitted the plan in October, which included a list of eligible appliances and rebate levels. The plan was approved in December, which allowed time for the press releases and Program Area announcements to build anticipation with consumers and retailers. Opening day was set for February 2010.

NYSERDA anticipated the Program Area to be short-lived, assuming that rebates would sell out within weeks. In reality, however, the initial phase of the Program Area lasted until June 2010, after which NYSERDA added new applications to a waiting list (and rebates were not guaranteed). They re-opened the Program Area in October 2010. After October, NYSERDA approved all applications on a first-come, first-served basis. The stakeholders experienced a number of hurdles (described below), which caused the slower-than-anticipated Program Area completion.

Program Area applicants could apply online to reserve their rebate, and then follow up with a completed application. According to interviewed staff, approximately 30% of the applications they received were not complete. NYSERDA sent these applications back asking for additional information, which was usually a request for the original receipt, a signature, or the recycling information.

Another group of approximately 25,000 applicants reserved the funds online, but never followed up with the complete application. In addition, some applications were duplicates, which may have been due to the website keeping started but incomplete applications in the system. Interviewed staff believe that some people abandoned their application and then started a new one, creating duplicates in the system. Modifications to the on-line process were eventually put into place that would not allow a consumer to initiate more than one application for the same appliance using the same address.

Another complication that arose was a postal service truck fire, which resulted in a number of burnt applications. This incident occurred in November, but NYSERDA wasn't informed until January. NYSERDA tried to reach out to online applicants who hadn't submitted a completed application and who lived near the area of the incident. They accepted copies of receipts for those approximately 900 applicants. All other applications required an original receipt—a requirement that interviewed staff felt deterred some potential applicants.

The uptick in sales due to the Program Area was not as high as staff expected. Two suggested reasons for this were economic factors and the size of the rebates relative to those offered elsewhere. According to Program Area staff, the rebates offered in Massachusetts, for example, were significantly higher and were fully reserved the first day. However, many of those reserving an appliance did not follow through with a purchase, and Massachusetts reissued their program. Another staff member thought that because NYSERDA required people to make the purchase first and then send in the rebate application, some people believed it was a hassle. NYSERDA and the Program Area Implementer assisted customers with their applications in order to minimize this barrier. Program Area staff found that helping people complete the application over the phone resulted in higher follow-through.

Initially, NYSERDA did not market the Program Area because press releases regarding ARRA funds and how they would be spent created significant interest. Starting in October 2010, NYSERDA applied some cross-promotion SBC funding from their ongoing Home Performance with ENERGY STAR Program for television and newspaper advertisements telling consumers the money was available. According to staff, this attracted a different audience, which tended to be an older demographic. the Program Area Implementer took most of these applications by phone, walking applicants through the process. Staff felt this service resulted in better quality applications that met all the requirements.

Interviewed staff were asked what aspects of the Program Area worked well and what aspects did not work well. Program Area staff indicated that reserving the funds online encouraged people to respond more rapidly and follow through more quickly. Program Area staff also felt that having the phone support for customers to call with problems worked well. Many applications were not signed, leading staff to feel that the signature, requiring participants to attest they replaced an appliance with an ENERGY STAR-qualified version, did not work as well as they hoped. The signature was an unavoidable DOE requirement. Program Area staff also expressed concern that the application was too long. It is also worth noting that the Program Area Implementer mailed a lot of original receipts back to participants who wanted to keep them for their own records.

When asked how the Program Area could be improved, staff suggested that larger rebates would probably have been more effective. Although many partners promoted the Program Area on their own, increased advertising through devoting a larger share of the money to promotion was another common recommendation.

Overall, interviewed staff were satisfied with the Program Area. Staff believe the Program Area was well received and that there were sufficient opportunities to make changes throughout the implementation. Staff were particularly proud of the bundled option for the higher tiered appliances, which provided a great opportunity to educate consumers. Staff reported that the DOE and retailers were also very satisfied with the Program Area. The Program Area launched at the right time for retailers, providing them with a needed boost, particularly at the onset with all the hype about the Program Area. Staff also reported that the Program Area helped them build relationships with their ongoing appliance program partners. Staff said that customers were mostly satisfied with the Program Area, and that most received their rebate checks within four to five weeks.

3.1.4 Program Area Savings Assumptions

The Cadmus Team performed an engineering analysis to estimate gross energy savings for each appliance, whether replaced at burnout or replaced prior to the end of their prescribed effective useful life (EUL). The Tech Manual (which contains the agreed upon approaches to estimating energy savings from ratepayer funded energy-efficiency programs in New York) formed the basis for the appliance replacement calculations, and are described in more detail below. Appendix B contains a summary of each assumption and source for each measure.

Early Replacement

Based on the Program Area database, a significant percentage of the rebated appliances were replaced before reaching their EUL. These are considered early-replacement measures. These measures achieve additional savings through the predicted remaining useful life of the existing equipment because the unit energy consumption (UEC) of the existing equipment is typically greater than the current federal standard.

The Cadmus Team calculated the full first-year electric savings from these early-replacement measures using the incremental savings approach described below for each appliance type, along with the *Ratio Approach to the Dual Baseline* described in Appendix M of the Tech Manual. This ratio approach calculates the relationship between the full savings of an early-replacement measure and the incremental savings for a normal replacement measure:[18]

Equation 3-1. Ratio Approach to the Dual Baseline, Appliance Rebate Program Area

$$\text{Full Savings} = \text{Incremental Savings} / \text{Ratio}$$

The EUL and prescribed ratio for each type of appliance measure is shown in Table 3-38.

[18] Normal replacement, as defined in the Tech Manual (page M-5), refers to "*replacement of equipment which has reached or passed the end of its measure-prescribed EUL.*"

Table 3-38. EUL and Ratio by Measure for *Ratio Approach to the Dual Baseline*, Appliance Rebate Program Area

Measure	EUL* (years)	Median Ratio of Incremental Savings to Full Savings**
Refrigerators	17	0.11
Freezers	17	0.11
Clothes Washers	11	0.39
Dishwashers	11	0.33

* The Cadmus Team used the EULs listed in Table M-1, Appendix M of the Tech Manual. No values are provided for residential freezers, so values were assumed to be to the same as refrigerators.

** The Cadmus Team obtained the ratios from Table M-4 for refrigerators and from Table M-9 for clothes washers and dishwashers in Appendix M of the Tech Manual. No values are provided for residential freezers, so values were assumed to be to the same as refrigerators.

3.1.5 Gross Savings Calculations

Refrigerators

The Cadmus Team used the following Tech Manual-specified calculations (page 19) to determine Program Area refrigerator savings:

Equation 3-2. Appliance Rebate Program Area Refrigerator Savings Calculation

$$\Delta kW_{S} = units \times \left[\frac{kWh_{base}}{8760} - \frac{kWh_{ee}}{8760} \right] \times CF_s \times (1 + HVAC_d) \times F_{market}$$

$$\Delta kW_{S} = units \times (kWh_{base} - kWh_{ee}) \times (1 + HVAC_c) \times F_{occ} \times F_{market}$$

$$\Delta therm = \Delta kWh \times HVAC_g$$

Where:

ΔkW_S	=	Gross coincident demand savings
units	=	Number of units installed under the Program Area
kWh_{base}	=	Annual UEC for the replaced unit
8,760	=	Conversion factor (hr/yr)
kWh_{ee}	=	Annual UEC for the new unit
CF_s	=	Coincidence factor (1.0)
$HVAC_d$	=	HVAC system interaction factor at utility peak hour
F_{market}	=	Market effects factor accounting for replaced units that enter the used appliance market
ΔkWh	=	Gross annual energy savings
$HVAC_c$	=	HVAC system interaction factor for annual UEC
F_{occ}	=	Occupant adjustment factor

Δtherm = Gross annual gas impacts from heating system interactions

$HVAC_g$ = HVAC system interaction factor for annual gas consumption

To calculate savings for refrigerators replaced at the end of their EUL, the Cadmus Team used Program Area measure data, the ENERGY STAR Qualified Product List,[19] and the CEE Product List[20] to look up the rated annual electricity use and corresponding federal standard for the purchased models. The averages of those values were used for kWh_{base} and kWh_{ee} in the savings equations for the ENERGY STAR-qualified and CEE Tier 2 levels.

Appendix D of the Tech Manual contains tables showing the HVAC interaction factors (HVAC c, d, and g from Equation 3-2 above) based on the appliance location, building type, and HVAC equipment. The Cadmus Team estimated the following values, weighted based on DOE data for the type of HVAC equipment and fuel used in New York, and using participant location data from the rebate tracking database to determine an average value across climate zones for each appliance type:[21]

- ENERGY STAR-Qualified Refrigerators
  - $HVAC_c = -0.002$
  - $HVAC_d = 0.05$
  - $HVAC_g = -0.01$
- CEE Tier 2 Qualified Refrigerators
  - $HVAC_c = -0.001$
  - $HVAC_d = 0.05$
  - $HVAC_g = -0.01$
- ENERGY STAR-Qualified Freezers
  - $HVAC_c = -0.01$
  - $HVAC_d = 0.04$
  - $HVAC_g = -0.01$

Based on the Tech Manual (page 20) and the average of 2.64 occupants per New York household, the Cadmus Team determined an occupant adjustment factor of 1.12.[22] Using the proportion of recycled appliances from Program Area data, the Cadmus Team calculated market effects factors of 0.94 for the ENERGY STAR-qualified appliances and 0.90 for CEE Tier 2 appliances. The average lifetime for refrigerators is 17 years, according to the Tech Manual (page 21).

The resulting Option 1 annual electricity savings were 135 kWh and 0.014 kW per unit, and the average gas use increase was 1.3 therms per unit (due to increased heating requirements from the reduction in

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[19] ENERGY STAR Refrigerator Qualified Product List: http://downloads.energy star.gov/bi/qplist/refrigerators.xls

[20] CEE Refrigerator Qualifying Product List: http://www.cee1.org/resid/seha/refrig/ResRefrigeratorQualifyingProductList.xls

[21] U.S. Department of Energy, Residential Energy Consumption Survey: http://www.eia.gov/consumption/residential/data/2009/

[22] U.S. Census: http://quickfacts.census.gov/qfd/states/36000.html

waste heat from the unit).[23] For Option 2, the unit savings were 183 kWh/year, 0.020 kW, and -1.8 therms.

Over half (53%) of the Program Area ENERGY STAR-qualified refrigerators and 61% of the CEE Tier 2 and Tier 3 refrigerators replaced units that were newer than 17 years (the refrigerator EUL). The average age of these early-replaced ENERGY STAR-qualified refrigerators was 10.3 years, while the average age of the units replaced by CEE Tier 2 or Tier 3 refrigerators was 10.5 years.

The Cadmus Team used the ratio approach described above to determine the full first-year electricity and natural gas impacts for early-replacement refrigerators. The adjusted unit savings for early replacement ENERGY STAR-qualified refrigerators is 1,223 kWh/year, 0.131 kW, and -12.2 therms/year. The adjusted unit savings for early replacement refrigerators that meet CEE Tier 2 or higher is 1,667 kWh/year, 0.179 kW, and -16.7 therms/year. Inputs are summarized in Appendix B.

<u>Freezers</u>

The Cadmus Team determined freezer savings following the same approach as was used for refrigerators: by calculating average kWh_{base} and kWh_{ee} values of purchased models using the Program Area data.[24] The market effects factor was calculated as 0.93 for freezers, based on the proportion of freezers recycled. The following HVAC interaction factors are based on the locations of participants who received a freezer rebate:

- $HVAC_c$ = -0.006
- $HVAC_d$ = 0.06
- $HVAC_g$ = -0.01

An average lifetime of 17 years was used for freezers, based on the value for refrigerators provided in the Tech Manual (page 21), because the Tech Manual did not provide freezer-specific values. The resulting annual electricity savings was 70 kWh and 0.008 kW per unit, and the average gas use increase was 0.7 therms per unit (due to increased heating requirements from the reduction in waste heat from the unit).

One-quarter (25%) of the Program Area ENERGY STAR-qualified freezers replaced units that had not reached the assumed freezer EUL of 17 years. The age of early-replacement freezers averaged 10.3 years.

The Cadmus Team used the ratio approach to determine the full first-year electricity and natural gas impacts for early-replacement freezers. Again, the Tech Manual does not provide a ratio for residential freezers, so the ratio for residential refrigerators was used as a reasonable proxy. The adjusted unit savings for early replacement ENERGY STAR-qualified freezers is 638 kWh/year, 0.069 kW, and -6.4 therms/year. Inputs are summarized in Appendix B.

[23] Based on the Tech Manual, only gas use is addressed; changes in other fuel sources, such as fuel oil or propane, are not included.

[24] ENERGY STAR Freezer Qualified Product List: http://downloads.energystar.gov/bi/qplist/Freezers%20Product%20List.xls

Clothes Washers

The Cadmus Team calculated the annual electricity savings for clothes washers based on the following formulas in the Tech Manual (page 25):

Equation 3-3. Annual Electric Savings Formulas for Clothes Washers,[25] Appliance Rebate Program Area

$$\Delta kWh = \Delta kWh_{washer} + \Delta kWh_{water\ heater} + \Delta kWh_{dryer}$$

$$\Delta kW = CF * \Delta kWh\ savings / 8{,}760$$

$$\Delta therm = \Delta therm_{water\ heater} + \Delta therm_{dryer}$$

The Tech Manual provides savings values for ENERGY STAR-qualified clothes washers, but they are based on an assumption that the actual efficiency ratings of each unit just meets the ENERGY STAR requirement. In practice, the efficiency of most purchased models exceeded the required minimum, so the Cadmus Team adjusted the ENERGY STAR savings based on a lookup[26] of the average modified energy factor (MEF) and water factor (WF) ratings for models purchased in the Program Area:

MEF = Capacity of the clothes washer divided by total electricity consumption per cycle

WF = Total water consumption per cycle divided by capacity of the clothes washer

For the CEE Tier 2 level, the Cadmus Team also calculated energy and water consumption based on the efficiency ratings of purchased models[27] and the Tech Manual (page 24) assumption of 392 cycles/year.

To determine the electricity and gas savings associated with water heating for clothes washers, the Cadmus Team applied the proportion of electric and gas water heaters as reported by respondents of the participant survey.[28]

Since energy-efficient clothes washers are more effective than non-energy-efficient washers at removing water from clothing during the spin cycles, each load washed in an energy-efficient washer requires less time in the dryer. When weighting dryer savings, the Cadmus Team leveraged dryer fuel shares from the DOE.[29]

[25] Refer to definitions for Equation 3-2.

[26] ENERGY STAR Clothes Washer Qualified Product List: http://downloads.energystar.gov/bi/qplist/res_clothes_washers.xls

[27] CEE Clothes Washer Qualifying Product List: http://www.cee1.org/resid/seha/rwsh/ResWashQualifyingProductList.xls

[28] Oil savings are not reported here, although they were calculated and applied in cost benefits, environmental, and macroeconomic analyses.

[29] U.S. Department of Energy, Residential Energy Consumption Survey: http://www.eia.gov/consumption/residential/data/2009/

The resulting Option 1 annual savings were 171 kWh, 0.0012 kW, 8.1 therms of gas, and 8,398 gallons of water per unit. For Option 2, the annual unit savings were 158 kWh, 0.0011 kW, 6.7 therms, and 8,227 gallons.[30]

Although the EUL for clothes washers is 11 years, based on the New York Guidelines for Early Replacement Conditions (Tech Manual, Table M-1),[31] nearly half (45%) of the units replaced with Program Area ENERGY STAR-qualified clothes washers were less than 11 years old. Similarly, 40% of the units replaced with CEE Tier 2 or Tier 3 clothes washers were also newer than 11 years old. The average age of the early-replacement clothes washers with an ENERGY STAR-qualified model was 7.4 years, and the average age of the early-replacement clothes washers with a CEE Tier 2 or Tier 3 was 7.8 years.

For both Option 1 and Option 2 clothes washers, the Cadmus Team used the ratio approach to calculate the full first-year electricity savings, then estimated natural gas and water savings using the method described above for normal replacement measures. The adjusted unit savings for early replacement ENERGY STAR-qualified clothes washers is 447 kWh/year, 0.003 kW, 18.7 therms/year, and 15,704 gallons/year of water. The adjusted unit savings for early replacement CEE Tier 2 or Tier 3 clothes washers is 459 kWh/year, 0.0031 kW, 16.1 therms/year, and 15,533 gallons/year of water. The water savings is substantial because the water efficiency of clothes washers has increased significantly in recent years, driven in part by the addition of a WF requirement to the federal standard in 2011. Inputs are summarized in Appendix B.

Dishwashers

The federal standard for dishwashers sets the maximum electricity consumption at 355 kWh/year and the maximum water consumption at 1,398 gallons/year, based on 215 annual washing cycles.[32,33] The Cadmus Team used Program Area data to determine the average rated electricity and water use by purchased models, then subtracted those averages from the federal standard level to determine annual savings for normal replacement units.[34] The water savings value and participant survey data on fuel shares were then used to calculate water heater energy savings. The Tech Manual ratio of ENERGY STAR-qualified model demand to electricity savings was used to calculate demand. The resulting Option 2

[30] Option 2 savings were less than Option 1 savings because the average actual models purchased by Option 1 participants were higher efficiency units than those purchased by Option 2 participants.

[31] Tech Manual Appendix M: http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/06f2fee55575bd8a852576e4006f9af7/$FILE/Appendix%20M%20final%205-05-2011.pdf

[32] Federal standard, Code of Federal Regulations, Title 10, Part 430, Subpart C: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=61b33caa9460da7b2e875b478972dfdc&rgn=div6&view=text&node=10:3.0.1.4.18.3&idno=10

[33] Federal test procedure, Code of Federal Regulations, Title 10, Part 430, Subpart B, Appendix C: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=3772727b97d4c72981fe6b26b962cff5&rgn=div9&view=text&node=10:3.0.1.4.18.2.9.6.10&idno=10

[34] CEE Dishwasher Qualifying Product List: http://www.cee1.org/resid/seha/dishw/ResDishwasherQualifyingProductList.xls

annual normal replacement savings are 88 kWh, 0.026 kW, and 1.6 therms.[35] Water savings are 618 gallons per year.

More than one-third (39%) of the CEE Tier 2 or Tier 3 dishwashers replaced units newer than the dishwasher EUL of 11 years, based on the New York Guidelines for Early Replacement Conditions (Tech Manual Table M-1). The average age of the early-replaced dishwashers was 7.5 years. As a result, the savings described above apply to 61% of the Program Area units, with additional savings available for the 39% of units that were early replacements. These additional savings are due to the replaced baseline unit being less efficient than units that met the current federal code.

The Cadmus Team used the ratio approach (described at the beginning of this section, Appliance Rebate Program Area, Gross Savings Calculations) to determine full first-year electricity savings for the average early-replacement machine, then estimated natural gas and water savings using the percentage of hot water energy and the ratio of water to hot water energy developed in the normal replacement analysis. The adjusted unit savings for dishwashers is 265 kWh/year, 0.078 kW, 5.0 therms/year, and 1,872 gallons/year of water. Dishwashers have also seen a significant increase in water efficiency in recent years, driven by the addition of a water efficiency requirement to the federal standard in 2010. Inputs are summarized in Appendix B.

Recycled Refrigerators and Freezers

The Cadmus Team used a multivariate regression model to estimate recycled refrigerators' and freezers' gross UECs. This model used the independent variables of appliance age, configuration (e.g., top-freezer, single door), cubic-feet of volume, and location of the appliance in the home. For this evaluation, the approximate age of the appliance was the only reliable key variable available in the Program Area tracking database. While make and model numbers were available for some units, they were inconsistently named and were unreliable for determining efficiency levels.

To complement the primary data collected during this evaluation effort, the Cadmus Team reviewed and leveraged results from the evaluations of two other appliance recycling programs:

1. A long-running program from investor-owned utilities in California.[36] This program was similar to NYSERDA's in that:
    a. Southern California includes large, densely populated metropolitan areas similar to NYC.
    b. The average age of the units in the NYSERDA Program Area database was relatively young and very similar to the average age of units in the California program (16.85 years and 16.75, respectively).

[35] Oil savings are not reported here, although they were calculated and applied in cost benefits, environmental, and macroeconomic analyses

[36] The Cadmus Group, Inc. *Residential Retrofit High Impact Measure Evaluation Report* Prepared California Public Utilities Commission Energy Division, February 2010: http://calmac.org/publications/FinalResidentialRetroEvaluationReport_11.pdf

2. Ontario Power Authority's (OPA's) Great Refrigerator Roundup Program.[37] The OPA data were similar in that:
   a. Much of the population is in a weather zone similar to that of New York City.
   b. OPA's service territory also includes a large, concentrated metropolitan area in Toronto.
   c. The average age of freezers in the OPA evaluation was very similar to that of the units in NYSERDA's Program Area. Again, age, size, and configurations are all highly correlated.

Though the NYSERDA Program Area was the first year a utility-sponsored appliance recycling program was offered in New York, while California utilities have been offering programs for many years, the average recycled refrigerator age in NYSERDA's Program Area is closer to the average in California's program than to the average in OPA's program. Since the typical appliance recycling program focuses first on secondary refrigerators, a longer running program will have a higher share of primary units, which tend to be younger and larger than secondary units. Table 3-39 shows the average age of units recycled in the NYSERDA, California, and OPA programs.

Table 3-39. Average Age in Proxy Areas, Appliance Rebate Program Area

	NYSERDA	California	OPA
Average Refrigerator Age	16.85	16.75	21.9
Average Freezer Age	25.1	N/A	22.9

Since the Program Area collected only appliance age (and not other key appliance characteristics, such as size and configuration), it was necessary to rely on secondary sources for appliance size and configuration. These two proxies are valid since appliance age is highly correlated with size and configuration. The Cadmus Team recommends that all future appliance recycling programs collect the physical characteristics of recycled appliances, such as size and configuration, as well as which room the unit was kept in while in use. This information will provide more robust estimates of unit consumption.

Additionally, the Cadmus Team leveraged estimates of recycled refrigerator and freezer model coefficients using an aggregated *in situ* metering[38] dataset. This dataset has over 400 appliances that were metered as part of five California and Michigan evaluations conducted between May 2009 and April 2011.[39] Collectively, these evaluations offered a wide distribution of appliance ages, sizes, configurations, usage scenarios (primary or secondary), and climate conditions. This database is used to estimate the difference in energy use between the age, configuration, and size of units. The diversity of the dataset made it a good secondary data source for estimating energy savings when region-specific metering could not be conducted.

There are two reasons the in-home metered database is preferred for energy use estimates rather than estimates based on DOE testing protocols. First, metering the appliance in its original location captures

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[37] The Cadmus Group, Inc. *2008 and 2009 Great Refrigerator Roundup Program – Impact Evaluation.* Prepared for Ontario Power Authority. June 2010.

[38] *In situ* involves metering units in the environment where they are typically used. This contrasts with lab testing, where units are metered under controlled conditions.

[39] The data set included: Southern California Edison, Pacific Gas & Electric, San Diego Gas & Electric, DTE Energy, and Consumers Energy.

the impacts of critical external factors on energy use (such as door openings and weather); these factors cannot be accounted for when relying on DOE databases, which contain data on units metered under controlled conditions. Second, most existing DOE databases estimate energy consumption at the time of appliance manufacture, not unit retirement. Consequently, using these data in an evaluation requires devising and applying additional assumptions of appliance degradation. In-home metering data reflect the real usage of appliances actually participating in an appliance recycling program at the time of retirement.

Each entry in the aggregated dataset represents an appliance that was metered for a minimum of 10 days in a manner consistent with its pre-program use (i.e., in the same location, cooling food, and being used by the home’s occupants). The Cadmus Team mapped weather data to participating homes’ ZIP code-specific National Oceanic and Atmospheric Administration (NOAA) weather stations and collected additional on-site data on relevant appliance characteristics to adjust usage based on weather.

Table 3-40 details the data that were used for modeling unit consumption. Data from the NYSERDA Program Area tracking database were used whenever they existed. The California and OPA data were only used when there were no available data in the NYSERDA Program Area tracking database. The regression variables in the table were multiplied by the energy use factors from the metered unit database (containing data from metering studies in Michigan and California) to compute the average savings. A full description of the model specification and the resulting equation used to estimate the per-unit annual consumption is given in Appendix B.

Table 3-40. Appliance Regression Model Inputs and Data Source, Appliance Rebate Program Area

Independent Variable	Mean Value	Source	Rationale
Refrigerators			
Average Appliance Age (years)	16.85	NYSERDA	Data were in Program Area tracking database
Dummy: Manufactured Pre-1980 (share of units)	0.06	NYSERDA	Data were in Program Area tracking database
Dummy: Manufactured 1980s (share of units)	0.18	NYSERDA	Data were in Program Area tracking database
Dummy: Manufactured 1990s (share of units)	0.52	NYSERDA	Data were in Program Area tracking database
Size (cubic feet)	19.43	California	Data were not in Program Area tracking database
Dummy: Single Door (share of units)	0.03	California	Data were not in Program Area tracking database
Dummy: Side-by-Side (share of units)	0.31	California	Data were not in Program Area tracking database
Dummy: Kitchen Unit (share of units)	0.64	California	Data were not in Program Area tracking database
Garage CDDs	0.03	OPA	Data were not in Program Area tracking database
Freezers			
Average Appliance Age (years)	25.1	NYSERDA	Data were in Program Area tracking database
Dummy: Manufactured Pre-1990 (share of units)	0.41	NYSERDA	Data were in Program Area tracking database
Size (cubic feet)	16.21	OPA	Data were not in Program Area tracking database
Dummy: Chest Freezer (share of units)	0.83	OPA	Data were not in Program Area tracking database
Garage CDDs	0.24	OPA	Data were not in Program Area tracking database

Recycled Dishwashers and Clothes Washers

Because there is not a strong secondary market for dishwashers and clothes washers, and most households do not have more than one of each of these appliances, the Cadmus Team estimated recycling energy savings as zero. In order to generate savings, there would have to be a reasonable degree of certainty that the old unit would re-enter the market and be purchased in place of a brand new unit. A more likely alternative to purchasing a used unit would be to use a Laundromat for clothes or to hand-wash dishes, since the price of a new unit is typically much greater than that of a used unit.

Rebate Tracking Database Findings

The Cadmus Team analyzed the Program Area tracking database to assess the overall distribution of rebate applications, when appliances were purchased, the number of customers on the waiting list, recycling statistics, and purchase locations.

Table 3-41 summaries the rebate applications according to the appliance type and efficiency level (ENERGY STAR-qualified versus CEE). Although the bundled Option 2 required the purchases of three appliances (CEE tiered clothes washers, dishwashers, and refrigerators), these appliances were not purchased in equal numbers because some purchasers started in Option 1 buying one appliance (and received a single rebate for that appliance), then later also purchased the other two appliances, becoming an Option 2 participant. Therefore, there were 2,370 bundled Option 2 participants and 78,268 Option 1 participants (the total that bought one ENERGY STAR-qualified appliance and did not later also purchase the other two CEE appliances). An alternative count would be 2,370 Option 2 refrigerator participants and 78,268 Option 1 refrigerator participants; however, the count presented in Table 3-41 is more representative of the way in which customers entered the Program Area.

Table 3-41. Appliance Purchases, Appliance Rebate Program Area

Appliance	Count of Option Appliance
CEE Tier 2 or Tier 3 Clothes Washer	2,370
CEE Tier 1 or Higher Dishwasher	2,370
CEE Tier 2 or Tier 3 Refrigerator	2,354
ENERGY STAR-qualified Clothes Washer	80,246
ENERGY STAR-qualified Freezer	4,242
ENERGY STAR-qualified Refrigerator	78,284
Grand Total	**169,866**

The Cadmus Team assessed the percentage of applications that were wait-listed when first applying for the rebate. This is shown in Table 3-42.

Table 3-42. Percent Originally Wait-Listed, Appliance Rebate Program Area

Appliance	Originally on Wait List
CEE Tier 2 or Tier 3 Clothes Washer	3%
CEE Tier 1 or Tier 2 Dishwasher	3%
CEE Tier 2 or Tier 3 Refrigerator	3%
ENERGY STAR-qualified Clothes Washer	8%
ENERGY STAR-qualified Freezer	5%
ENERGY STAR-qualified Refrigerator	9%

Table 3-43 shows when applications were received for each appliance. The majority were received within the first few months of the Program Area start. Very few applications were received during the wait-list only period from June through September 2010. Once the Program Area started up again in October 2010, another surge of applications occurred.

Table 3-43. Month Applications Were Processed and Rebates Paid, Appliance Rebate Program Area

	CEE Tier 2 or Tier 3 Clothes Washer		CEE Tier 1 or Tier 2 Dishwasher		CEE Tier 2 or Tier 3 Refrigerator		ENERGY STAR-Qualified Clothes Washer		ENERGY STAR-Qualified Freezer		ENERGY STAR-Qualified Refrigerator	
Month	**Applications**	**%**	**Applications**	**%**	**Applications**	**%**	**Applications**	**%**	**Applications**	**%**	**Applications**	**%**
February 2010	991	42%	992	42%	983	42%	17,158	21%	1,523	36%	17,930	23%
March 2010	247	10%	246	10%	242	10%	11,860	15%	626	15%	10,185	13%
April 2010	228	10%	229	10%	228	10%	10,548	13%	405	10%	9,093	12%
May 2010	179	8%	177	7%	176	7%	9,851	12%	322	8%	9,540	12%
June 2010	91	4%	90	4%	90	4%	4,614	6%	165	4%	5,635	7%
July 2010	9	0%	9	0%	9	0%	962	1%	26	1%	1,359	2%
August 2010	4	0%	4	0%	4	0%	503	1%	15	0%	611	1%
September 2010	3	0%	3	0%	3	0%	555	1%	21	0%	662	1%
October 2010	256	11%	256	11%	256	11%	9,528	12%	569	13%	9,796	13%
November 2010	251	11%	252	11%	252	11%	9,022	11%	397	9%	8,780	11%
December 2010	22	1%	22	1%	22	1%	1,380	2%	44	1%	1,277	2%
January 2011	7	0%	7	0%	7	0%	532	1%	15	0%	526	1%
February 2011	53	2%	54	2%	53	2%	2,860	4%	82	2%	2,226	3%
March 2011	29	1%	29	1%	29	1%	869	1%	31	1%	656	1%
April 2011	0	0%	0	0%	0	0%	4	0%	1	0%	8	0%
Total	**2,370**		**2,370**		**2,354**		**80,246**		**4,242**		**78,284**	

Note: Totals may not equal 100% due to rounding.

Note: Increases and decreases in monthly counts are directly correlated with Program Area stops and starts and marketing pushes.

The Cadmus Team also looked at whether there was a significant time lag between the application date and the actual purchase date. In particular, the analysis was performed to assess freeridership for those who purchased an appliance before completing an application.

Table 3-44. Difference (in months) Between Application and Purchase Date, Appliance Rebate Program Area

Months	CEE Tier 2 or Tier 3 Clothes Washer	CEE Tier 1 or Tier 2 Dishwasher	CEE Tier 2 or Tier 3 Refrigerator	ENERGY STAR-Qualified Clothes Washer	ENERGY STAR-Qualified Freezer	ENERGY STAR-Qualified Refrigerator
-12 to -7	0%	0%	0%	0%	0%	0%
-6 to -1	0%	1%	1%	1%	0%	0%
0	85%	85%	43%	79%	83%	78%
1	12%	11%	11%	15%	12%	16%
2 to 5	3%	3%	3%	4%	3%	6%
6 to 10	0%	0%	42%	1%	0%	1%

Note: A positive number indicates that the appliance was purchased *before* an application was filled out.

Note: Totals may not equal 100% due to rounding.

The Cadmus Team analyzed the applications that included recycling rebates. Table 3-45 summarizes the percentage of participants who purchased each appliance option and also recycled. Participants who bought ENERGY STAR-qualified clothes washers were most likely to recycle their old appliance, and those who bought a dishwasher were the least likely to recycle.

Table 3-45. Percent of Old Appliances Recycled, Appliance Rebate Program Area

Appliance	% Recycled
CEE Tier 2 or Tier 3 Clothes Washer	47%
CEE Tier 1 or Tier 2 Dishwasher	46%
CEE Tier 2 or Tier 3 Refrigerator	48%
ENERGY STAR-qualified Clothes Washer	73%
ENERGY STAR-qualified Freezer	63%
ENERGY STAR-qualified Refrigerator	71%
Total Percentage of All Appliances	**71%**[40]

[40] ENERGY STAR-qualified clothes washers and refrigerators were also the largest selling appliances, therefore the overall recycling percentage is heavily weighted by the share of clothes washers and refrigerators recycled.

The Cadmus Team assessed the average age of recycled units. Only a small percentage of appliances (2% or fewer) were three years or newer. More than any other appliance, recycled freezers were more likely to be 16 or more years old (Table 3-46).

Table 3-46. Age of Unit Recycled, Appliance Rebate Program Area

Age of Unit Recycled (years)	CEE Tier 2 or Tier 3 Clothes Washer	CEE Tier 1 or Tier 2 Dishwasher	CEE Tier 2 or Tier 3 Refrigerator	ENERGY STAR-Qualified Clothes Washer	ENERGY STAR-Qualified Freezer	ENERGY STAR-Qualified Refrigerator
1 to 3	0%	1%	0%	2%	1%	1%
4 to 6	8%	9%	5%	10%	2%	5%
7 to 10	32%	29%	25%	33%	9%	20%
11 to 15	30%	31%	31%	29%	13%	27%
16 plus	30%	30%	39%	26%	76%	47%

Note: Units listed as being older than 40 years were outliers and were removed from the analysis. Some units were listed as being over 100 years old.

Note: Totals may not equal 100% due to rounding.

Table 3-47 shows the largest selling retailers and the percentage of Program Area participants who purchased from each store while recycling their old unit. Participants who purchased appliances at EB Feiden had the highest percentage of old units recycled, while those who purchased from S&W Appliance had the lowest percentage recycled.

Table 3-47. Percent of Old Units Recycled by Store Where New Units Were Purchased, Appliance Rebate Program Area

Store	% of Participants who Purchased Units and Recycled their Old Unit
EB Feiden	86%
Orvilles Home Appliance	85%
PC Richard	83%
RA-Lin	82%
Rosa's Home Appliances	82%
John D. Marcella Appliances	80%
Charlotte Appliances	78%
Lowes	73%
Sears	69%
Best Buy	67%
Home Depot	66%
S&W Appliance	9%

Table 3-48 shows stores that also recycled appliances directly and the percentage of units recycled at each of those stores. Sears and PC Richards were the most common recycling locations.

Table 3-48. Location Where Old Unit was Recycled, Appliance Rebate Program Area

Store	% of Old Units Recycled
Sears	22%
PC Richard	16%
Lowes	15%
Home Depot	6%
Best Buy	3%
Orvilles Home Appliance	3%
Rosa's Home Appliances	2%
Charlotte Appliances	1%
EB Feiden	1%
John D. Marcella Appliances	1%

Note: The stores listed in this table and the remaining tables represent those where appliances were most commonly purchased. All of the stores not listed in this table represented less than 1% of the locations where old units were recycled.

Table 3-49 through Table 3-55 show where each type of appliance was purchased. Table 3-49 provides the results for all appliances, while Table 3-50 through Table 3-55 show each type of appliance individually. Sears and Lowes were either the highest or next to highest sellers for all appliance types.

Table 3-49. All Appliance Sales by Store, Appliance Rebate Program Area

Store	Number of Appliances Sold	%
Sears	40,040	24%
Lowes	29,405	17%
PC Richard	24,060	14%
Home Depot	14,995	9%
Orvilles Home Appliance	7,482	4%
Best Buy	5,126	3%
Other Stores	48,758	29%
Total	**169,866**	

Table 3-50. CEE Tier 2 or Tier 3 Clothes Washer Sales By Store, Appliance Rebate Program Area

Store	Number of Appliances Sold	%
Sears	338	14%
Lowes	331	14%
Home Depot	177	7%
PC Richard	170	7%
EB Feiden	141	6%
S&W Appliance	112	5%
Best Buy	80	3%
Auction Mart	77	3%
Orvilles Home Appliance	68	3%
Other Stores	876	37%
Total	**2,370**	

Note: Total may not equal 100% due to rounding.

Table 3-51. CEE Tier 1 or Tier 2 Dishwasher Sales By Store, Appliance Rebate Program Area

Store	Number of Appliances Sold	%
Sears	351	15%
Lowes	329	14%
Home Depot	175	7%
PC Richard	165	7%
EB Feiden	143	6%
S&W Appliance	112	5%
Best Buy	78	3%
Auction Mart	77	3%
Orvilles Home Appliance	72	3%
Other Store	868	37%
Total	**2,370**	

Table 3-52. CEE Tier 2 or Tier 3 Refrigerator Sales By Store, Appliance Rebate Program Area

Store	Number of Appliances Sold	%
Lowes	328	14%
Sears	317	13%
Home Depot	187	8%
PC Richard	166	7%
EB Feiden	140	6%
S&W Appliance	113	5%
Auction Mart	77	3%
Best Buy	74	3%
Orvilles Home Appliance	69	3%
Ruby and Quiri Appliance	59	3%
Other Stores	824	35%
Total	**2,354**	

Table 3-53. ENERGY STAR-Qualified Clothes Washer Sales By Store, Appliance Rebate Program Area

Store	Number of Appliances Sold	%
Sears	19,922	25%
Lowes	13,061	16%
PC Richard	10,626	13%
Home Depot	7,826	10%
Orvilles Home Appliance	3,797	5%
Best Buy	2,653	3%
Other Stores	22,361	28%
Total	**80,246**	

Table 3-54. ENERGY STAR-Qualified Freezer Sales By Store, Appliance Rebate Program Area

Store	Number of Appliances Sold	%
Lowes	1,649	39%
Sears	1,302	31%
Home Depot	151	4%
PC Richard	92	2%
Auction Mart	72	2%
Olum's Appliance	65	2%
Other Stores	911	21%
Total	**4,242**	

Note: Totals may not equal 100% due to rounding.

Table 3-55. ENERGY STAR-Qualified Refrigerator Sales By Store, Appliance Rebate Program Area

Store	Number of Appliances Sold	%
Sears	17,810	23%
Lowes	13,707	18%
PC Richard	12,841	16%
Home Depot	6,479	8%
Orvilles Home Appliance	3,445	4%
Best Buy	2,182	3%
Other Store	21,820	28%
Total	**78,284**	100%

3.1.6 Net Savings Calculations

The Cadmus Team performed two types of analyses to understand the net savings for this Program Area:

1. Freeridership and an indication of spillover from participant surveys
2. NYSERDA NYESP Partner Sales Analysis (Sales Analysis) to identify possible spillover

The participant surveys were used to estimate freeridership. In this analysis, a freerider is defined as a Program Area participant who would have purchased an appliance of the same efficiency in the absence of the Program Area, sooner or at the same time.[41] This determination of freeridership is based on participant *awareness* of the Program Area prior to purchase and their *intention* to purchase the appliance in the absence of the Program Area. Survey questions that focused on Program Area awareness asked: "*At what point did you first learn about the rebate? Was it before you went to the store to make the purchase, at the store while you were making the purchase, or after you had already made the purchase?"* Survey questions that focused on intention to purchase asked:

1. *Had you planned to purchase a new [appliance] before learning about the rebate?*
2. *If New York's Great Appliance Swap Out rebate had not been available when you made your purchase, would you most likely have purchased the [appliance] sooner, at the same time, within a year, more than a year later, or would you not have made the purchase at all?*
3. *If New York's Great Appliance Swap Out Rebate had not been available, would you have purchased the same [appliance] model or a different model?* (The same model implicitly means that the efficiency level would have been the same.)

The participant surveys and sales analysis are also used to provide an *indication* of participant spillover, but not a full accounting of spillover. While freeridership can be measured immediately for a program, spillover typically occurs over time. A full accounting of spillover would have required a more complex evaluation design and additional survey work that was not included in the scope of this evaluation effort.[42] A fuller analysis of program spillover as traditionally defined would need to be conducted over time and would include a measure of participants who were influenced by the Program Area to purchase additional energy-efficient appliances or adopt other energy-efficient measures as a result of their participation in the Program Area (which is typically small). It would also include a measure of non-participant spillover—that is, customers who purchased energy-efficient appliances or adopted other energy-efficient measures and were influenced by the Program Area to do so, but did not receive a rebate. Non-participant program spillover will be credited to NYSERDA's NYESP[43] Program in future evaluations. NYESP evaluations

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[41] This definition is consistent with the definition of freeriders from the Northeast Energy Efficiency Partnership, Regional Evaluation Measurement, and Verification Forum Glossary of Terms (March 2009) which defines a freerider as "*A program participant who would have implemented the program measure or practice in the absence of the program. A freerider can be 1) total, in which the participant's activity would have completely replicated the program measure; 2) partial, in which the participant's activity would have partially replicated the program measure; or 3) deferred, in which the participant's activity would have completely replicated the program measure, but at a future time than the program's timeframe."*

[42] The NEEP EM&V Glossary defines Spillover as "*Reductions 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 nonparticipant spillover. Participant spillover is the additional energy savings that occur when a program participant independently installs energy efficiency measures or applies energy saving practices after having participated in the efficiency program as a result of the program's influence. Non-participant spillover refers to energy savings that occur when a program nonparticipant installs energy efficiency measures or applies energy savings practices as a result as a result of a program's influence.*"

[43] Colby, J. et al. *New York Energy $mart[SM] Products Program: Market Characterization and Assessment Evaluation.* Prepared for NYSERDA. 2011.

track ENERGY STAR market share in New York compared to other regions[44] over time. The net increases in ENERGY STAR market share, after subtracting out sales attributed to the ARRA Appliance Rebate Program Area, will be credited to the NYESP Program.

The sales analysis uses data from retailers involved in the NYESP Program, which are a subset of the retailers selling appliances eligible for the ARRA rebates. Trend analyses using sales data reported by NYESP Program retail partners over the years and through the duration of the ARRA Appliance Rebate Program Area illustrate the effects of supplementary ARRA stimulus funds on the ENERGY STAR-qualified appliances' market share level at NYSERDA's retail partner stores. ENERGY STAR market share changes for rebated appliances are compared to non-rebated appliances promoted through the NYESP Program, and the ENERGY STAR share is predicted by extrapolating the historical trend. The results show an apparent jump in the percentage of ENERGY STAR sales of most rebated appliances compared to non-rebated appliances. The Cadmus Team included additional analysis and discussion to suggest reasons why some appliance sales seemed to increase more than others. From this analysis, it appears that the ARRA Appliance Rebate Program Area did significantly impact ENERGY STAR sales. The approach utilizing a trend analysis had the effect of smoothing out volatile yearly sales. Analysis of trends are described in more detail in Appendices B and C. While this trend analysis is good at indicating whether or not annual numbers are outside the trend, it is not accurate enough to precisely calculate a NTG (Net-to-gross) ratio or net out spillover.

3.1.7 Gross Savings Results

Table 3-56 provides a comparison between evaluated unit savings and the DOE planning estimates. Planning estimates did not include any values for early replacement appliances or recycling. In general, evaluated savings are higher than the planning estimates. This is partly due to the fact that planning estimates assumed minimum compliance with the requirements, when in reality many participants purchased higher efficiency units than required to obtain a rebate.

[44] As defined in "Step 4," on Page 7 of the "NYSERDA New York Energy $mart[SM] Products Program, DRAFT Evaluation, Measurement and Verification Plan." August 18, 2009. http://www.dps.ny.gov/NYSERDA_E.Smart_Products.pdf (Retrieved on April 27, 2012).

Table 3-56. Comparison of DOE Planning Unit Savings Estimates to Evaluated Results, Appliance Rebate Program Area

	DOE Estimated Unit Gross Savings (kWh)	Evaluated Results Unit Gross Savings (kWh)	DOE Estimated Unit Gross Savings (MMBtu)	Evaluated Results Unit Gross Savings (MMBtu)	DOE Estimated Unit Gross Water Savings (gallons)	Evaluated Results Unit Gross Water Savings (gallons)
Refrigerator – Replace at Burnout	105	135	N/A	-0.13	N/A	N/A
Freezer – Replace at Burnout	48	70	N/A	-0.07	N/A	N/A
Clothes Washer – Replace at Burnout	68	171	0.66	0.81	7,548	8,398
CEE Tier 2 or Tier 3 Clothes Washer – Replace at Burnout	72	158	0.66	0.67	7,548	8,227
CEE Tier 1 or Tier 2 Dishwasher – Replace at Burnout	47	88	0.18	0.16	497	618
CEE Tier 2 or Tier 3 Refrigerator – Replace at Burnout	172	184	N/A	-0.18	N/A	N/A
Refrigerator – Early Replacement	N/A	1,223	N/A	-1.22	N/A	N/A
Freezer – Early Replacement	N/A	638	N/A	-0.64	N/A	0
Clothes Washer – Early Replacement*	N/A	477	N/A	1.87	N/A	15,704
CEE Tier 2 or Tier 3 Clothes Washer – Early Replacement*	N/A	459	N/A	1.61	N/A	15,533
CEE Tier 1 or Tier 2 Dishwasher – Early Replacement	N/A	88	N/A	0.16	N/A	1,872
CEE Tier 2 or Tier 3 Refrigerator – Early Replacement	N/A	265	N/A	0.5	N/A	0
Recycled Refrigerator	N/A	1,209	N/A	0	N/A	0
Recycled Clothes Washer	N/A	802	N/A	0	N/A	0
Recycled Dishwasher	N/A	0	N/A	0	N/A	0
Recycled Freezer	N/A	0	N/A	0	N/A	0

* Based on the tracking database, the average efficiency of early replacement clothes washers was higher for those meeting the minimum requirements for an Option 1 rebate than those meeting requirements for an Option 2 rebate.

Table 3-57 provides unit savings, participation, and gross Program Area savings results for each appliance type as calculated and described in Appliance Rebate Program Area, Gross Savings Calculations.

Table 3-57. Gross Appliance Rebate Program Area Savings Results

	Unit Gross Savings (kWh)	Number of Participants	Total Gross Savings (MWh)	Total Peak Demand Gross Savings (kW)	Total Gross Gas Savings (MMBtu)	Water Savings (1,000 gallons)
Refrigerator – Replace at Burnout	135	36,786	4,951	531	-4,951	N/A
Freezer – Replace at Burnout	70	3,182	223	24	-223	N/A
Clothes Washer – Replace at Burnout	171	44,135	7,528	52	35,719	370,667
Refrigerator – Early Replacement	1,226	41,482	50,752	5,446	-50,752	N/A
Freezer – Early Replacement	635	1,061	674	74	-677	N/A
Clothes Washer – Early Replacement	477	36,111	17,219	118	67,421	567,069
CEE Tier 2 or Tier 3 Clothes Washer – Replace at Burnout	158	1,422	225	2	953	11,699
CEE Tier 1 or Tier 2 Dishwasher – Replace at Burnout	88	1,446	127	37	238	893
CEE Tier 2 or Tier 3 Refrigerator – Replace at Burnout	184	924	169	18	-169	N/A
CEE Tier 2 or Tier 3 Clothes Washer – Early Replacement	459	948	435	3	1,524	14,725
CEE Tier 1 or Tier 2 Dishwasher – Early Replacement	265	924	245	72	462	1,730
CEE Tier 2 or Tier 3 Refrigerator – Early Replacement	1,668	1,446	2,410	258	-2,409	N/A
Subtotal of Purchases		**169,866**	**84,961**	**6,635**	**47,137**	**966,784**
Recycled Refrigerator	1,209	55,952	67,646	7,259	0	0
Recycled Freezer	802	2,657	2,131	232	0	0
Recycled Clothes Washer	911	60,043	0	0	0	0
Recycled Dishwasher	497	1,102	0	0	0	0
Subtotal Recycling*		**119,754**	**69,777**	**7,491**		
Total		**289,621**	**154,738**	**14,127**	**47,137**	**966,784**

* Recycled savings are mutually exclusive from purchased appliance savings, and were calculated based on estimates of whether or not the unit would have continued to be used as a secondary unit.

3.1.8 Net Savings Findings

The Cadmus Team determined the final net savings for the Program Area at a greater than 90% confidence level with a precision of plus or minus 9.8% for each of the subgroups, and a precision of plus or minus 3.5% for the overall sample (Table 3-1).

Table 3-58 shows the NTG results for each appliance purchase, along with the number of 2010 rebates paid, the difference in sales compared to both linear and third-order polynomial trends, and the estimated rebated appliance share of 2010 NYSERDA partner sales (provided as an indication of the Program Area's share of the overall ENERGY STAR market). These numbers are based on responses to the participant survey, which is regarded as the best practice approach. While the sales analysis indicated possible nonparticipant spillover, it cannot precisely quantify an amount. The Cadmus Team utilizes regression analyses to estimate long-term appliance sales trends without the Program Area, and then compared predicted sales to actual sales for 2010. The Cadmus Team analyzed several different regression models and the table includes results from both the linear and third-order polynomial models, with large variances in results. One weakness of the trend analysis is the likelihood that historical, ENERGY STAR sales have also been influenced by other incentive programs. The ongoing NYESP Program, which tracks sales over time and compares it to other regions without program activity, will capture spillover from this Program Area. Participant spillover (from Program Area participants undertaking additional energy-efficiency measures without any incentive) was also not accounted for in the participant survey method chosen, as it would require more elapsed time after the Program Area period and a more complex evaluation approach. This type of spillover is generally small.

Table 3-58. Freeridership Estimates, Rebates Paid, and Percentage Rebate Sales Shares, Appliance Rebate Program Area

Appliance	Percent of Total 2010 ES Sales Rebated (ARRA Rebates ÷ ES Sales)	Difference in 2010 ENERGY STAR Sales Compared to Linear Trend	Difference in 2010 ENERGY STAR Sales Compared to Polynomial Trend	2010 ARRA Rebates Paid (NYSERDA)*	FR Incentive Option 1 (Individual Appliance Purchase)	FR Incentive Option 2 (Bundled Appliance Purchase)	FR Recycling
Clothes Washer	32%	15,024	18,960	81,917	0.51	0.85	0.78
Dishwasher	1%	Negative	27,869	2,370	N/A	0.85	0.71
Freezer	18%	10,332	Negative	4,242	0.60	N/A	0.68
Refrigerator	20%	89,760	30,401	80,654	0.38	0.85	0.75

* Only 2010 rebates are counted here, in order to be consistent when comparing rebates to total ENERGY STAR sales.

Due to the unique nature of this Program Area (e.g., limited window of opportunity, large budget, significant amount of advertising and Program Area anticipation, and significant application requirements), the opportunity for Program Area spillover existed. In order to receive the rebate, consumers had to complete an application and mail in receipts for documentation. It seems likely that many customers might not have followed through to receive the rebate. Indeed, as the sales analysis shows, a much larger increase in ENERGY STAR-qualified appliance sales occurred, coincident with the Program Area initiation, than the number of rebates that were paid. The sales analysis indicated that

ENERGY STAR sales of refrigerators, freezers, and clothes washers occurred above and beyond the linear trend for 2010.

The Cadmus Team also compared refrigerator freeridership status as computed through the participant surveys to the average age of appliances replaced.[45] Appliances replaced prior to their EUL were considered early replacements, while those replaced after their EUL were considered normal replacements. Since not all participants provided unit age, some units (31%) could not be matched to freeridership status. As Table 3-59 shows, for the observations matched, there was no significant difference in freeridership between early replacement and normal replacement refrigerators.

Table 3-59. Refrigerator Freeridership by Early vs. Normal Replacements, Appliance Rebate Program Area

Option	Early Replacements	Normal Replacements
1	39%	40%
2	12%	13%
All	39%	40%

Detailed results of the freeridership analysis are described in Appendix F. Table 3-60 summarizes the Program Area's evaluated savings net of freeridership.

Table 3-60. Evaluated Appliance Rebate Program Area Savings Net of Freeridership by Measure

Recycling	Evaluated Total Gross Savings (MWh)	1-Freeridership	Evaluated MWh Savings Net of FR	Evaluated Peak kW Savings Net of FR	Evaluated Natural Gas (MMBtu) Savings Net of FR	Evaluated Water Savings (Gallons) Net of FR
Refrigerator – Replace at Burnout	4,951	0.38	1,881	205	(1,881)	N/A
Refrigerator – Early Replacement	50,752	0.38	19,286	2,104	(19,286)	N/A
CEE Tier 2 or Tier 3 Refrigerator – Replace at Burnout	169	0.85	144	14	(144)	N/A
CEE Tier 2 or Tier 3 Refrigerator – Early Replacement	2,410	0.85	2,049	173	(2,048)	N/A
Freezer – Replace at Burnout	222	0.60	133	14	(133)	N/A
Freezer – Early Replacement	674	0.60	404	43	(406)	N/A
Clothes Washer – Replace at Burnout	7,528	0.51	3,839	14	18,217	189,040

[45] Due to the limited success in data matching, the Cadmus Team did not similarly analyze other appliances.

Recycling	Evaluated Total Gross Savings (MWh)	1-Freerider ship	Evaluated MWh Savings Net of FR	Evaluated Peak kW Savings Net of FR	Evaluated Natural Gas (MMBtu) Savings Net of FR	Evaluated Water Savings (Gallons) Net of FR
Clothes Washer – Early Replacement	17,219	0.51	8,782	29	34,385	289,205
CEE Tier 2 or Tier 3 Clothes Washer – Replace at Burnout	225	0.85	191	2	810	9,944
CEE Tier 2 or Tier 3 Clothes Washer – Early Replacement	435	0.85	370	3	1,296	12,516
CEE Tier 1 or Tier 1 Dishwasher – Replace at Burnout	127	0.85	108	207	203	759
CEE Tier 1 or Tier 2 Dishwasher – Early Replacement	245	0.85	208	65	392	1,471
Subtotal Purchases	**84,961**	**0.44**	**37,395**	**2,733**	**31,582**	**502,936**
Recycled Refrigerator	67,646	0.78	52,764	5,662	N/A	N/A
Recycled Freezer	2,131	0.71	1,513	165	N/A	N/A
Recycled Clothes Washer	0	0.68	0	0	N/A	N/A
Recycled Dishwasher	0	0.75	0	0	N/A	N/A
Subtotal Recycling*	**69,777**	**0.78**	**54,277**	**5,827**	N/A	N/A
Total**	**154,738**	**0.59**	**91,295*** **	**8,559**	**31,582*** **	**502,936**

Note: Appliance savings are higher in 2010 and 2011 due to a dual baseline, in which higher savings can be claimed for early replacement appliances. These savings are presented here in order that they can be counted toward the 15/15 goals, however a levelized savings value of 73,597 MWh is used for the cost-effectiveness, Macroeconomic Impact and Carbon Emissions calculations.

* Recycled units are a mutually exclusive category and savings were calculated based on the likelihood that the unit would otherwise have continued to be used as a secondary unit.

***Totals may not match due to rounding when realization rates and attribution factors are applied at the Program Area level

The Cadmus Team compared the freeridership values found for the ARRA-funded Appliance Rebate Program Area offered by NYSERDA to freeridership values seen in other similar appliance programs. The freeridership numbers typical of other appliance programs range from 0.40 to 0.76,[46] while the NYSERDA Program Area results were 0.38 to 0.6 for Option 1 appliances and 0.85 for Option 2 appliances. With the exception of the values found for Option 2 appliances, the values found for the

[46] The Cadmus Team reviewed similar analyses performed for other clients in other U.S. regions within the past three years. These reports are not publicly available.

NYSERDA Program Area all fall within the expected range for appliance purchases. The Cadmus Team believes the lower freeridership value of 0.15 for the Option 2 appliances is appropriate given the requirement of purchasing all three appliances that all meet a higher CEE tier than is required by most other appliance rebate programs, as well as the higher incentive values than offered through the single appliance ENERGY STAR-qualified rebates.

For the recycling option, the Cadmus Team also compared freeridership results to those found for other appliance rebate programs in the United States over the past few years. In the typical appliance recycling program, consumers are paid a small incentive to have an appliance recycler pick up a secondary appliance. Recycling in the ARRA-funded NYSERDA Appliance Rebate Program Area is tied to a new appliance purchase, and consumers are responsible for making the recycling arrangement and providing a receipt to earn the rebate. The freeridership values for the NYSERDA ARRA recycling option are higher than for typical refrigerator and freezer recycling programs (which are around 0.5), [47] but this difference is likely due to the combination of this Program Area's requirement to purchase a new appliance, which is not required by most traditional recycling programs.

The Cadmus Team compared the level of freeridership to the share of the total purchase price covered by the incentive. As expected, freeridership rates decrease as the incentive share increases (Figure 3-1). illustrates the negative trend calculated for each appliance purchase offering in the Program Area. It should be noted that while freeridership rates decline with higher incentives, the overall Program Area cost will increase due to the higher incentives. Therefore, budget limitations may need to be balanced against the goal of minimizing freeriders.

47 Pacific Gas & Electric, from Residential Retrofit High Impact Measure Evaluation Report, California Public Utility Commission, The Cadmus Group, 2010, NTG=0.51; PowerWise Appliance Recycling Program, Salt River Project, FY 2009 Evaluation, The Cadmus Group, NTG=0.67; Impact and Process Evaluation of Ontario Power Authority's 2007 Great Refrigerator Roundup Program, The Cadmus Group, NTG=0.48; EM&V Study of 2004–2005 Statewide Residential Appliance Recycling Program, ADM Associates, Inc., NTG=.61; Residential Appliance Turn-In Program in Wisconsin, PA Consulting Group, 2008, NTG=.57 Evaluation of the Washington Refrigerator and Freezer Recycling Program, PacifiCorp, PY 2005–2006, KEMA, NTG=0.31;

Figure 3-1. Freeridership Compared to Percent of Measure Cost Incented, Appliance Rebate Program Area

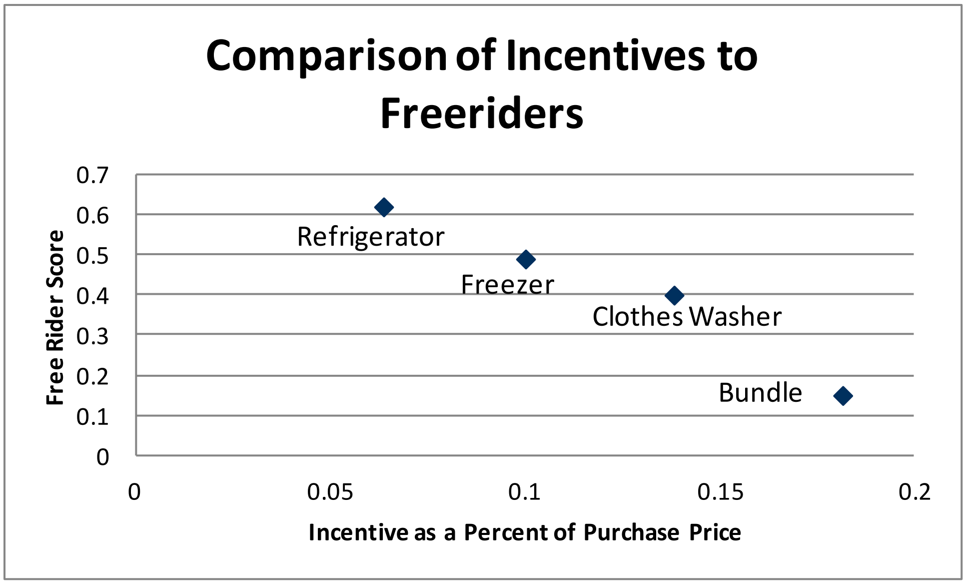

Table 3-61 summarizes the evaluated annual net impact as of the end of 2011.

Table 3-61. Savings Impact Evaluated Net of Freeridership through December 31, 2011, Appliance Rebate Program Area

	Total Claimed Savings from Installed Projects	Savings Weighted Realization Rate	Total Evaluated Gross Savings	Freeridership*	Evaluated Net of Freeridership
Electricity (MWh)	12,862	12.03	154,738	0.41	91,295
Gas (MMBtu)	47,328	1.00	47,328	0.33	31,710

* Overall freeridership was calculated by dividing total net savings into total gross savings, number presented here is rounded. Numbers vary by fuel type because they vary by appliance type and not all appliances have gas impacts.

3.2 ENERGY CODE PROGRAM AREA

3.2.1 Data Sources

The Cadmus Team used the following data sources for the Energy Code Program Area evaluation[48]:

- NYSERDA Program Area staff interviews
- DOS staff interviews
- Participant surveys administered online during the registration process and paper surveys distributed in class
- 2010 ECCCNYS documentation
- 2009 IECC documentation
- ASHRAE Standard 90.1-2007 documentation
- McGraw Hill/FW Dodge commercial construction forecast data
- Hanley Wood residential construction forecast data
- DOE EnergyPlus prototypical models
- VEIC. *New York Energy Code Compliance Study.* 2011

3.2.2 Approach: Surveys and Sample Design

The Cadmus Team conducted interviews with 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 Cadmus Team also conducted surveys with participants who received the training services provided by the NYSERDA contractors, including CEOs, architects, engineers, and builders.

NYSERDA Program Area Staff Interviews

The Cadmus Team interviewed six NYSERDA staff members directly responsible for the Energy Code Program Area and those involved in its evaluation in order to understand the Energy Code Program Area design and implementation, as well as Program Area difficulties and successes. The interviews focused on the Program Area implementation: how the ARRA requirements affected the code adoption process, training course design and curriculum, training course marketing, problems encountered, and energy savings calculations and attribution.

DOS Staff Interviews

The Cadmus Team interviewed two DOS staff to understand the Energy Code design and implementation, differences between the enacted code and 2009 IECC, and the code adoption process. DOS staff provided their perspectives on energy savings estimates due to early code adoption, as well as on compliance issues, code enforcement, and code training course development.

[48] The Cadmus Team used some of these data sources for the early code adoption savings analysis, which will be included in the SEP Base Grant Report in May 2012.

Participant Surveys

The Cadmus Team conducted 1,237 surveys in two waves (spring and fall 2011) with individuals who participated in the Program Area training courses. These surveys gathered information on participants' knowledge, as well as their satisfaction with the training courses. Trainings provided through the Program Area were:

- ECCCNYS 2010 for Vendors and Trade Allies
- ECCCNYS 2010 Residential Buildings
- ECCCNYS 2010 Commercial and Mechanical
- ECCCNYS 2010 Commercial Envelope and Lighting
- NYS Residential Builder Energy Code Training: Energy Conservation in Historic Buildings Workshop
- Home Builders: Energy-Efficient Best Practices
- Cracking the Code
- Residential Building Science

The trainings also included the following four International Code Council (ICC) courses:

- Commercial Energy Inspector Certification (practice course and examination)
- Residential Energy Inspector Certification (practice course and examination)
- Commercial Energy Plans Examiner Certification (practice course and examination)
- Green Building Residential Examiner Certification (practice course and examination)

NYSERDA Energy Code Program Area implementation staff noted that roughly half of the anticipated trainings have been completed to date, in accordance with the original schedule developed for SEP funding. NYSERDA and DOS will approve updates to in-person and online trainings implemented by contractors throughout 2012 based on feedback from the contractors and participants. Results from these later surveys will be included in NYSERDA's ARRA EECBG report in September 2012. This report will focus on trained participant responses from the early rounds of training performed in 2011.

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 a session during the first wave of trainings in spring 2011, referred to as "Wave 1." This effort was abandoned due to two factors: first, neither the Website nor surveys were available for the earliest training that was directly coordinated by DOS and other contractors. Second, the integration of a required online survey as an additional step for registrants was found to complicate online registration, frustrate those with minimal computer expertise, and ultimately inhibit training participation. NYSERDA Program Area implementation staff ultimately recommended removing the survey from the Website as a registration requirement and coordinated an alternate approach for "Wave 2" trainings with the Cadmus Team.

As part of the research design, the Cadmus Team planned to survey training participants several months after the training to determine what actions had been taken in response to the training. The Cadmus Team conducted a six-month follow-up survey with Wave 1 training participants. NYSERDA evaluation staff e-mailed all Wave 1 training registrants, requesting their participation in an online survey. The total number of post-training survey responses was small compared to the number of surveys completed when the survey was a requirement for Wave 1 pre-training registration.

The Cadmus Team took a different approach to surveying Wave 2 participants in the fall of 2011. The Cadmus Team worked with NYSERDA implementation staff to provide paper surveys for both pre- and post-training to the various training contractors. The contractors asked training participants to complete the paper surveys at the appropriate time during the training sessions. The contractors then mailed the completed surveys to NYSERDA, who scanned them as PDF files and sent them to the Cadmus Team. The Cadmus Team compiled and analyzed the results. The final distribution of completed surveys is shown in Table 3-62.

Table 3-62. Completed Code Training Participant Survey Counts, Energy Code Program Area

Sample	Number of Completed Surveys Received
Wave 1 Pre-Training	700
Wave 1 Post-Training	208
Wave 2 Pre- and Post-Training	329
Total	**1,237**

3.2.3 Process Findings

NYSERDA Program Area staff and DOS staff provided a comprehensive overview of the code adoption process and timing, as well as ARRA's impact on these topics.

Appendix G includes more process findings details.

Energy Code Timing

ARRA funding accelerated new Energy Code adoption in New York State by two years. New York introduced its first Energy Code in 1979, and transitioned to the ECCCNYS in 2002 (effective July 1, 2002) based on a national model energy code, with assistance from the 1999 DOE State Energy Code Assistance Grant. In April 2008, the Energy Code was updated based on ASHRAE 90.1-2004 for commercial buildings. This code is typically updated every three years.

DOS staff reported that the State was prepared to update to the 2006 IECC in April 2010. However, in early 2009, then-Governor David Paterson chose to take advantage of ARRA funding to advance the Energy Code, requiring the State to adopt the 2009 IECC and ASHRAE 90.1-2007. This effort passed implementation of the 2006 IECC entirely. The adoption process required considerable time to evaluate the impacts of the new code, determine New York-specific exceptions to the code, and confirm compliance with other State requirements. Early training curriculum was developed and delivered in advance of the code's effective date of December 28, 2010.

New York operated under the 2004 IECC for residential and ASHRAE 90.1-2004 for commercial from April 2010 to December 2010. Without ARRA, the State would have updated to the more stringent 2006 IECC during that time, although the commercial code would have remained the same. Any residential buildings that received construction permits during this period were therefore covered by a less stringent code, which likely resulted in lost energy savings potential for the State.

ARRA funding accelerated adoption of the 2009 IECC and ASHRAE 90.1-2007 by about 16 months. Based on the views of DOS staff, the schedule for future code adoptions will be unaffected by ARRA. These changes are shown in Table 3-63.

Table 3-63. Expected Effective Dates for Code Adoption, Energy Code Program Area

Effective Date	Without ARRA		With ARRA	
	Residential	Commercial	Residential	Commercial
Prior to April 2010	2004 IECC	2003 IECC/ASHRAE 04	2004 IECC	2003 IECC/ASHRAE 04
April 2010	**2006 IECC**	ASHRAE 04	2004 IECC	ASHRAE 04
December 28, 2010	2006 IECC	ASHRAE 04	**2009 IECC**	**ASHRAE 07**
April 2012	**2009 IECC**	**ASHRAE 07**	2009 IECC	ASHRAE 07
April 2015	**2012 IECC**	**ASHRAE 10**	**2012 IECC**	**ASHRAE 10**

Note: Cells with **bold text** indicate a code change under each scenario.

The earlier code adoption due to ARRA should result in considerable energy savings, which are expected to offset the lost energy potential from the planned code upgrade that was delayed from April 2010 to December 2010. The gross energy savings impacts for the code change and the elimination of the exemption will be calculated by the Cadmus Team in a follow-up report in May 2012.

Energy Code Compliance

Compliance represents the degree to which new buildings reflect the provisions of the prevailing Energy Code. One requirement of ARRA funding, as noted above, is that the State must develop and implement a plan to achieve 90% compliance with the target codes by 2017, including measuring current compliance each year.

Vermont Energy Investment Corporation (VEIC) conducted a baseline compliance study[49] for buildings constructed before the code update. VEIC used two different methodologies and determined that compliance with previous energy codes did not achieve 90% compliance. One method VEIC followed was using the DOE Building Energy Code Program (BECP) protocol to define compliance as the percentage of all Energy Code requirements that were met as determined using a checklist developed by Pacific Northwest National Laboratories. The other method VEIC followed was using a set of common compliance tools, REScheck™ and COMcheck™, to examine building component performance through the heat transfer rate.

NYSERDA and the Cadmus Team identified limitations in the VEIC analysis that affect the accuracy of the compliance rate estimates. Due to budget limitations, VEIC's new commercial building sample consisted of only 26 buildings, 22 of which were designed to the latest commercial code and four of which were designed to the prior code. The 22 designed to ASHRAE Standard 90.1-2007 represent only half the number of buildings recommended by the BECP protocol for new commercial buildings. In addition, VEIC included a sample of 44 new residential buildings (consistent with the BECP protocol). VEIC did not assess compliance for any commercial or residential renovation projects due to insufficient documentation to adequately identify and characterize renovation projects.

[49] VEIC. *New York Energy Code Compliance Study*. 2011.

However, VEIC's analysis produced a number of important recommendations, as well as a reasonable foundation for future compliance study projects. Their primary recommendations included:

- Modify and simplify the suggested BECP protocol to create a streamlined approach for ongoing monitoring and compliance assessment
- Systemize New York State data collection for compliance evaluation and interpretation
- Address gaps in compliance and enforcement priorities
- Address legislative context and obstacles

Additional details can be found in the VEIC report. The Cadmus Team believes these recommendations can improve compliance rates.

Future studies of code compliance will be conducted by NYSERDA under its SBC ratepayer-funded Technology and Market Development Program.

Training Participant Results[50]

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 requirements for 90% compliance by 2017 were a significant motivation for the increased level of training services.

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 3-64 and Table 3-65 indicate that providing continuing education credit was one of the main reasons participants attended these trainings.

VEIC's baseline compliance report recommended that New York State increase code knowledge in the building trades community. The survey results suggest that NYSERDA and DOS efforts are beginning to fulfill this objective, with industry professionals using the trainings to improve their professional understanding of code issues.

[50] See Appendix G for more detail

Table 3-64. Training Motivation for Wave 1 and Wave 2 Participants, Energy Code Program Area

	Wave 1		Wave 2	
Motivation	**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: Totals may not sum to 100% due to rounding.

Table 3-65. Training Motivation for Wave 2 Code Enforcement vs. Industry Professionals, Energy Code Program Area

	Code Enforcement Officials		Industry Professionals	
Motivation	**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**	

The Cadmus Team asked participants their overall level of satisfaction with the training. Table 3-66 shows the results. Participants rated their satisfaction on a 0 to 10 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, 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 the satisfaction with the training. In each case, industry professionals indicated slightly higher satisfaction than CEOs, consistent with the larger increase in their understanding as was shown in Table 3-66.

Table 3-66. 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. Program Area implementation staff indicated this training generated less than the expected interest among CEOs and industry professionals. Staff reported that although contractors performed good outreach, the training was only successful in one location. Staff believed the CEOs and industry professionals were uncomfortable with the thought of someone "looking over their shoulder" during the plan review process.

The Cadmus Team identified six participants who reported taking the Green Building Residential Plans Examiner Certification course. Participants rated the plan review overview portion of the training on a scale of 0 to 10, where 0 indicates that it was not at all helpful and 10 indicates that it was extremely helpful (Table 3-67). On average, participants considered the plan review overview to be slightly helpful (6.8).

Table 3-67. Participant Rating of Plan Review Overview Training Helpfulness, Energy Code Program Area

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

Program Area implementation 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.

3.2.4 Program Area Savings Assumptions

Based on NYSERDA's original projections, SEP funding for the Energy Code Program Area is expected to save 937,600 MMBtu through training courses, plan review services, and other efforts to increase compliance as noted herein. The Cadmus Team developed energy savings estimates through a spreadsheet analysis to examine incremental energy savings through 2015 from enhanced codes. The spreadsheet took into account projections of commercial and residential new construction and renovations, as well as the expected energy savings per unit produced by the enhanced codes. The analysis also included the impact of enhanced compliance rates from Energy Code Program Area activities (Table 3-68).

Table 3-68. Anticipated Savings for Energy Code Program Area

Funding	Program Areas/Technologies	Projected Projects	Projected Annual Energy Impact
SEP	Energy Code Trainings (RFP 1621)	1,347 training courses and plan review services	937,600 MMBtu

3.2.5 Gross Savings Calculations

In addition to estimating the savings due to increased compliance through the Energy Codes 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 analysis could not be completed. Thus, the Cadmus Team will calculate gross energy savings values using DOE prototypical models, in conjunction with residential and commercial construction forecast data. The gross energy savings from early code adoption will be reported in May 2012 after the separate analysis by Cadmus is completed. This effort is being supported with non-ARRA funds.

3.2.6 Gross Savings Calculations and Findings

The gross energy savings calculations will be included in the SEP Base Grant report in May 2012.

3.2.7 Net Savings Calculations and Findings

There is no net-to-gross component of the Energy Code Program Area evaluation.

3.3 ENERGY-EFFICIENCY PROGRAM AREA

3.3.1 Data Sources

The Cadmus Team used the following data sources for evaluating the Energy-Efficiency Program Area:

- NYSERDA Program Area staff interviews
- Participant surveys
- Participant project data
- Site visits and engineering estimates
- System performance monitoring

There were a total of 150 RFP 1613 projects at the beginning of the evaluation period. The Cadmus Team divided those projects into a sample to be physically visited and desk-reviewed, a sample to review project documentation and savings calculations, and a small sample of projects for which no action would be taken.

Of the original 150 projects, 26 were cancelled as of March 16th, 2012, three customers refused to allow site visits, and two projects were reclassified as part of the Renewable Energy Program Area, totaling 31 projects that were not able to be reviewed. In total, the Cadmus Team analyzed 86 of 119 available projects, or approximately 72% of available projects. Table 3-69 summarizes the status of the original 150 projects.

Table 3-69. Characteristics of Subset of Survey Respondents, Energy-Efficiency Program Area

Project Status	Number of Projects
Original RFP 1613 Projects	**150**
Cancelled Projects	26
Customers Refused Site Visit	3
Transferred to Renewable Energy Program Area	2
Total Projects Available for Review	**119**
Projects Receiving Evaluation File Review Only	34
Projects Receiving Evaluation File Review and Site Visit	52
Total Projects Evaulated	**86**
Percentage of Projects Evaluated	**72%**

3.3.2 Approach: Surveys and Sample Design

Participant Surveys

The original attribution sample design called for surveying every site-visited project (52), with representation by measure type, location (i.e., Upstate or Downstate), and expected savings. During the site visits, the engineer asked key personnel from the Energy-Efficiency Program Area to respond to the survey either in person or electronically. Many of the site-visit participants could not answer the survey during the site visit (usually because the key decision-maker was not available during the visit), so they filled out the electronic copy at a later date. The Cadmus Team secured surveys for 51 of the 52 site-visited projects. The total expected energy savings for these 51 projects was 399,967 MMBtu.

The Cadmus Team developed a weighting scheme based on the expected energy savings for all 119 active energy-efficiency projects for comparison to the 51 projects sampled for the survey (Table 3-70). The sampling error for the entire sample was 9%, at the 90% confidence level and assuming a 50% break in responses. Within individual groups of projects based on location and project type, the sampling error ranged from 24% for Upstate lighting projects to 10% for Downstate non-lighting projects. The weighting scheme adjusts for the disproportionate representation of project savings from Downstate locations compared to Update locations. Because of the small sample size of projects, the results are presented with an unweighted number of responses and a weighted percentage of responses.

Table 3-70. Respondents Characteristics and Survey Weighting Scheme, Energy-Efficiency Program Area

Characteristic	Population of Projects	Number of Respondents	Population Expected Savings*	Sample Expected Savings*	Sampling Error (based on savings)	Weight (based on savings)
Downstate Lighting	24	14	251,293	180,843	14%	0.951
Downstate Non-lighting	30	18	133,912	110,700	10%	0.828
Upstate Lighting	22	10	134,672	87,411	24%	1.054
Upstate Non-lighting	43	9	64,729	21,013	16%	2.107
Total	**119**	**51**	**584,605**	**399,967**	**9%**	**N/A**

* Reported in MMBtu.

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.

Program Area Implementation and Process

The NYSERDA Program Area management staff interviewed included three ARRA assistant project managers. NYSERDA staff reported that they began developing the Program Area plan about a month in advance of the March 2009 submission deadline with the DOE, and that some of the specifics in the Program Area plan were shaped by 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 funding are viable projects that they refer to another existing program. At any given time, Program Area staff estimate 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 note basic information, such as customer name, region, and project cost, before sending the proposal electronically 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. This review is then 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, Program Area staff begin the technical evaluation panel (TEP) process. Proposals are scored and ranked on a point system using scoring criteria outlined in the original RFP. A limit of $900 for every 10 MMBtu is used as a guide for allocating the NYSERDA Program Area portfolio. Cost sharing and dedicating a project manager to oversee the project were both encouraged and rewarded, but not required. "Shovel-ready" projects, or those that are poised to begin immediate construction, were given preference. Proposals with another utility, NYSERDA, SBC, or LIPA are excluded.

If alternative funding sources are not clear from the original proposal, they are explicitly requested on the award contract, which asks participants to list other sources of funding. Projects can leverage other ARRA dollars, but then are 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.

Proposals are then forwarded to the governor's office for final approval, which takes up to four weeks. Altogether, the average final award date is approximately eight weeks from when the proposal is first submitted. Program Area staff reported that around 80% to 90% of projects go through a bid process following the grant award. Given the competitive state of the economy, this bidding process allows participants to receive particularly low vendor prices.

Although the engineering review processes are fairly thorough, all proposals that are awarded funding are required to complete a project design review. Participants are asked to submit preliminary detailed estimates, depending on the project, which are reviewed by either program area implementers. As the projects begin the bidding processes, a second review is conducted to verify that the project scope remained the same as proposed.

These design review processes sometimes lead to contract changes initiated by the Program Area Implementers, and then forwarded to NYSERDA project managers for review. Further due diligence occurs with pre-, post-, and in-construction site visits, where photographs are taken 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,[51] 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 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 for a lump-sum payment, whenever the construction reaches one of several milestones, a payment in proportion to the amount of work that has been completed is issued. According to Program Area staff, 20% to 30% of the funding is

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[51] The following reference 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 impacts of those dollars.

provided when the vendor contract is signed. Another 20% to 30% is provided when the equipment is delivered on the site. Subsequent payments are made 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. Although, they also reported that participants usually appreciate the flexibility of the payment plan and understand the merits of having a staggered process.

Budget Gap

A budget gap began to affect the Program Area significantly, and projects that had been awarded grants were cancelled as funds ran out in a given region. At that time, Program Area staff launched a marketing campaign, traveling around the State and hosting Webinars and at least 30 regional meetings. The available funding percentages shifted significantly: from 100% to 10% in some cases. Since most of the projects were not viable without ARRA dollars, this led to many projects being cancelled. According to Program Area staff, only a few projects with decreased funding percentages were still able to continue. Program Area staff held debrief meetings with participants of each cancelled project, in which they suggested alternative programs and placed each cancelled project on a wait list.

Program Area Progress and Goals

Interviewed staff observed a large increase in the proportion of proposals submitted by not-for-profit organizations, although they noticed an overall decrease in the proportion of proposals submitted by public schools, colleges, and universities. Program Area staff mentioned several other types of funding sources that were used in conjunction with the Program Area, including Power Purchase Agreements (PPAs), performance contracting (mostly by schools and hospitals), bonds (exclusively by public schools), and cash. Program Area staff reported that very few proposals are funded by loans.

Staff mentioned that many proposals are behind schedule, which is heavily dependent on the type of project and type of participant. For example, municipalities and schools are required to establish more stringent bidding processes than not-for-profit organizations and hospitals, which may lead to delays with securing vendors and beginning construction. Moreover, certain types of projects are inherently more straightforward to complete, such as PV or lighting projects. Project progress also depends significantly on the season when the contract is executed: weather, as well as school and hospital schedules, dictate the progress of some projects. In addition, changes in scope are relatively frequent.

However, in most cases, the project costs decrease as prices in various markets decrease, such as the lighting and PV industries. These lower costs causes some projects to complete under budget, allowing participants to reallocate the unused funds for other measures or projects.

Program Area Challenges

Interviewed staff were asked 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 with DOE issuing massive changes through April 2011, it would have been difficult for NYSERDA to enter into any substantial renovation projects prior to DOE finalizing the rules, 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[52] for New York State are that New York projects have a letter from the manufacturer that includes a serial number and signature. The level of documentation, and the requirement itself, is a lesser burden in some other states.

Program Area Strengths

Interviewed Program Area staff were asked 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 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.

Additionally, the interviewed staff are pleased with the Btu-to-square-foot measure.

Site Visits and Engineering Estimates

Site visits were conducted at a representative sample of completed projects to determine the accuracy of Program Area information, in particular the estimated annual energy savings. Field inspectors with technical backgrounds in energy efficiency were assigned to each site and 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. System characteristics were generally assessed visually. Characteristics, such as nameplate values and instantaneous measurements (voltage, amperage, etc.), were collected on-site through spot metering and measurement.

System Performance Monitoring

Site visit data were supplemented through measurement and verification (M&V) efforts. Specifically, the Cadmus 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.

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

3.3.3 Process Findings

Participant Survey Findings

The attribution survey had the main purpose of collecting data that would allow the Cadmus Team to estimate freeridership and net savings resulting from the NYSERDA ARRA Energy-Efficiency Program Area. However, the survey also explored key process questions, such as sources of information about the Program Area, the application process, and ease of participation, summarized below. The remainder of the attribution survey is outlined in Appendix G which summarizes the awareness, motivation, economic factors, alternative funding, and spillover characteristics of the Energy-Efficiency Program Area.

Program Area Awareness and Motivation to Participate

As shown in Table 3-71, respondents learned about the Energy-Efficiency Program Area in a variety of ways. A large proportion heard about it through NYSERDA sources, with 17% having received an e-mail or mailing from NYSERDA, 16% having seen the Program Area on the NYSERDA Website, and three respondents (5%) citing Program Area marketing materials as their source of awareness. In addition, 19% of respondents had learned of the Energy-Efficiency Program Area through previously participating in another NYSERDA program. Contractors and installers (20%) as well as word-of-mouth (8%) were also sources of awareness. This finding supports a strategy of maintaining multiple channels of marketing future NYSERDA programs, as the NYSERDA ARRA Program Area funding is no longer available.

Table 3-71. How Participants Heard about Energy-Efficiency Program Area (Multiple Responses)

Sources of Awareness	
Sample size	*51*
Contractor/installer	20% (10)
NYSERDA Website	16% (10)
E-mail or mailing from NYSERDA	17% (9)
Participation in other NYSERDA program	19% (8)
Word-of-mouth (colleague, friend, family member)	8% (5)
Through NYSERDA's FlexTech Program	6% (4)
Program Area marketing materials	5% (3)
Announced by city agency	3% (2)
Energy consultant	3% (2)
Local government office	1% (1)
Grant writer	1% (1)
Independent research	2% (1)
Announced by U.S. president	1% (1)
University Sustainability Office	1% (1)
Don't know/refused	5% (2)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

Respondents were asked why they decided to apply for NYSERDA funds to implement the project. As shown in Table 3-72, a substantial proportion (40%) indicated that their budgets could not accommodate the work without the ARRA funding. Other reasons for applying for the funds include that the respondents' organizations could not find funding from other sources (21%) and that the work would reduce the energy costs for their facilities (12%) or further their own energy savings pursuits (9%). Respondents also thought there was a strong likelihood of getting the funding (8%) and that it would provide additional funds for the project (8%). Additional reasons, cited by smaller percentages of respondents were that the funding would accelerate the project and that the funding was better than in other programs. 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 may indicate that the project would have moved forward without NYSERDA ARRA funds.

Table 3-72. Why Applied for NYSERDA Funds (Multiple Responses), Energy-Efficiency Program Area

Reason	
Sample size	*51*
Could not afford the project without funding	40% (21)
Could not find funding from other sources	21% (8)
Would reduce energy costs for facility	12% (6)
Would further the pursuit of energy savings	9% (5)
Would provide additional funds for project	8% (5)
Thought chances of getting funding were good	8% (4)
Looking to accelerate project	4% (3)
Contractor suggestion	5% (2)
Organization always needs support	3% (2)
Funding better than other programs	3% (2)
Other sources required matching or leveraged funds	2% (1)
Requirement to reduce emissions by 30% by 2017	1% (1)
Needed to upgrade equipment	2% (1)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

When planning this evaluation, some NYSERDA Program Area staff members 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 staff members thought that the media attention and support for the goals of the broader ARRA legislation may have increased interest in the Program Area. Therefore, respondents were also asked 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 3-73 shows that 44% of 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" (32%) or a "critical positive factor" (24%)

in applying. The results indicate that the source of the funds was of moderate importance to the participants, and none originally viewed the fact that the funds came from ARRA as a negative factor.

Table 3-73. Influence of ARRA Funding on Decision to Apply for NYSERDA Funds, Energy-Efficiency Program Area

Influence	
Sample size	*51*
Mean	*3.8*
1 Critical negative factor	0
2 Somewhat of a negative factor	0
3 Not a factor at all	44% (21)
4 Somewhat of a positive factor	32% (17)
5 Critical positive factor	24% (13)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

The NYSERDA ARRA funds were to be distributed quickly, and NYSERDA believed that some participants may have applied for the funds because they offered a way to implement planned energy-efficiency projects on a shorter time frame than waiting for other sources of funding to manifest. In fact, staff members indicated that they encourage some organizations on the wait lists for other NYSERDA programs to apply for NYSERDA ARRA Program Areas in an effort to accelerate project implementation. The effect of the NYSERDA funds' timing on the decision to apply for funds was gauged by asking respondents, "*To what extent was your decision to apply for funds from NYSERDA affected by when the funds would become available?*" (Table 3-74). Respondents rated the influence of the funds timing on the same scale of 1 to 5 as in the previous question. The majority of respondents (67%) said that the timing was a positive factor in their decision to apply, while 31% said it was not a factor at all. Only one respondent (1%) indicated that the timing was a negative factor in applying for the funds. These findings support the Program Area theory that the short time frame in which the NYSERDA ARRA funds became available was a positive factor in inducing participation.

Table 3-74. Influence of NYSERDA Funds Timing on Decision to Apply, Energy-Efficiency Program Area

Influence	
Sample size	*51*
Mean	*4.0*
1 Critical negative factor	0
2 Somewhat of a negative factor	1% (1)
3 Not at all a factor	31% (19)
4 Somewhat of a positive factor	30% (14)
5 Critical positive factor	37% (17)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

In an effort to understand whether prior participation in other NYSERDA programs influenced participation in the Program Area, the Cadmus Team asked the respondents a series of questions about 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 3-75, over three-quarters of respondents (76%) reported that they had.

Table 3-75. Previous Participation in Other NYSERDA Energy Efficiency, Energy Conservation, or Renewable Energy Programs, Energy-Efficiency Program Area

Participation in Another NYSERDA Program	
Sample size	*51*
Yes	76% (36)
No	18% (11)
Don't know/Refused	6% (4)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

Those who had previously taken part in other programs were next asked to describe the type of prior program in which they had participated. Table 3-76 shows that many of the interviewees had participated in multiple programs of various types. More than two-thirds (69%) of respondents who had participated in other NYSERDA programs said they had participated in programs involving incentives for replacing equipment, while 50% had participated in an energy audit. A slightly smaller percentage had participated in new construction programs or technical studies (45% and 48%, respectively). Twelve percent of respondents had participated in a renewable energy program.[53] The fact that many respondents have taken part in more than one type of NYSERDA program suggests they are committed to energy efficiency and renewable energy.

[53] Several of the interviewees specified the NYSERDA program(s) in which they had participated. Eight respondents reported having participated in the FlexTech Program, four had participated in an energy conservation measure program, one had participated in a NYSERDA community project, and one had taken part in the Green Jobs Green New York Program.

Table 3-76. Types of NYSERDA Programs in Which Respondents Have Participated (Multiple Responses), Energy-Efficiency Program Area

Influence	
Sample size	*36*
Equipment replacement incentive	69% (25)
Energy audit*	50% (17)
Technical study*	48% (16)
New construction	45% (15)
Renewable energy	12% (3)
Other	4% (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 reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

Using a scale from 1 (indicating a negative influence) to 5 (indicating a positive influence), 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 3-77, more than three-quarters of these respondents (80%) indicated that the prior programs positively influenced their decision to apply for NYSERDA funds (i.e., gave a rating of 4 or 5), while the remaining respondents (20%) 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 least some informal spillover for the NYSERDA ARRA Program Area, in that a positive prior experience contributed to the reasons most respondents applied for the NYSERDA ARRA Program Area.

Table 3-77. Influence of Past NYSERDA Program Experience on Decision to Apply for ARRA Funds, Energy-Efficiency Program Area

Influence	
Sample size	*36*
Mean influence rating	*4.2*
1 Negatively influential	0
2 Somewhat negatively influential	0
3 Not at all influential	20% (7)
4 Somewhat positively influential	40% (15)
5 Positively influential	40% (14)

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

Note: The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

NYSERDA staff 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 ECS Program Area. Therefore, the final question about prior participation asked respondents whether the measures installed through the current Program Area had been recommended in a previous NYSERDA energy-efficiency audit or study (Table 3-78) Over one-third (38%) responded affirmatively, eight of whom said that the measures were recommended in a FlexTech Program study or audit, although these assertions have not been verified with the FlexTech Program data. It appears that NYSERDA ARRA provided a source of funds for at least some participants to implement measures recommended in prior studies, which was desirable based on the Program Area theory.

Table 3-78. 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	
Sample size	*36*
Yes	38% (13)
No	62% (23)

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

Note: The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

3.3.4 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. Systems receiving performance measurement were monitored according to the International Measurement and Verification Protocol (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 variable parameter (hours of use for lighting) was measured. For more variable measures such as HVAC all parameters impacting energy consumption were measured.

Lighting

IPMVP Option and Measurement Boundary

Table 3-79 shows the measure description and planned assessment protocol for lighting retrofit measures.

Table 3-79. 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 are calculated from known and measured wattages and measured hours-of-use. Impacts beyond boundary (i.e., cooling savings) are 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 lighting project in which ECM lighting replaces existing lighting measures, the existing energy consumption during the baseline period (while the existing lighting measures were in place) would be used 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 3-80).

Table 3-80. 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 electrical energy savings resulting from the implemented ECMs was calculated as follows:

Equation 3-4. Lighting Energy Savings, Energy-Efficiency Program Area

In the above calculation, energy savings are expressed in kWh, demand is expressed in kW, and operating time is defined as the number of hours.

The electrical demand savings resulting from the implemented ECMs was calculated as follows:

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

For projects where the necessary information was available, the following demand savings adjustments were applied: :

- **Interactive effects:** Both heating and cooling interactive effects are used to calculate gross savings. For example, reduced waste heat from a lighting retrofit effectively decreases the building's cooling need.
- **Seasonal operational characteristics:** Since the reporting period does not encompass an entire year, data were calibrated based on seasonal business hours or other information advised during the customer interview.

Billing analysis was also used 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: Data for various parameters were collected on an intermittent (spot) basis. These data were used to confirm baseline or reporting conditions if presumed static (meaning that the measured value remained constant and didn't require data logging), to check data from alternative sources, or to diagnose equipment status and configuration. Table 3-81 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, monitoring of the operating hours was performed as shown in Table 3-81.

Table 3-81. 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. Data for various parameters of interest were either spot-metered, metered on the day of a site visit, or meters were installed and left 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. These data were used to monitor baseline or reporting conditions (if presumed dynamic) and to check data from alternative sources.

The variables measured for each site were generally the same, but the method of obtaining the metered data varied:

- Data loggers and appropriate measurement device (e.g., current transducer, temperature probe, light status)
- Energy management system 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 data collection would seek to collect data to better define the true usage. Table 3-82 shows parameters of interest and the associated metering equipment.

Table 3-82. 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

Modeling or baseline calculations for the purpose of evaluating the project were thoroughly reviewed for accuracy and to ensure that standard engineering practices were followed. The models were adjusted, as needed, to account for any recorded discrepancies between the model and actual system installed.

Metering Accuracy. The individual meter accuracies are detailed in the tables above. The overall accuracy of the calculated data was driven by the measured variable with the widest range of accuracy.

Sampling and Accuracy. A sampling method was used 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.

HVAC

IPMVP Option and Measurement Boundary

Table 3-83 shows the description and implemented assessment protocol for HVAC measures.

Table 3-83. 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, system setpoints, kW, and TMY2 weather data for bin analysis.	Energy and demand savings are calculated from verified measured usage data. Other pertinent factors, such as refrigerant charge and airflow, are 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 3-84).

Table 3-84. 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, valid metering may not have been recorded due to the absence of an adequate cooling load and runtime over a representative sample of temperature bins.

** For all sites evaluated, efforts were taken to obtain valid metered data during the peak and swing temperature bins. This ensured that the Cadmus Team obtained a valid sample of data.

Calculations and Adjustments: Savings Analysis Procedure

The electrical energy savings resulting from the implemented ECMs were generally calculated as follows:

Equation 3-6. HVAC Energy Savings Calculation, Energy-Efficiency Program Area

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

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

.The following equation is used 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 3-7. EER-Based Energy Savings Calculation, Energy-Efficiency Program Area

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

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 following equation was used to calculate demand savings:

Equation 3-8. HVAC Demand Savings Calculation, Energy-Efficiency Program Area

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

Where:

kW_{base} = Metered or calculated baseline kW

kW_{post} = Metered reporting period kW

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, systems were metered over a period that included a full range of ambient conditions (outdoor temperature and relative humidity). A sufficient metering period that covered the range of ambient conditions was used in order to develop a model. Either cooling degree days (CDDs), heating degree days (HDDs), or enthalpy (a function of temperature and relative humidity) was used to develop the relationship between energy consumption and ambient conditions.

Since outdoor conditions often have a buildup effect, an enthalpy buildup was used 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). These methods were used to estimate the yearly energy use of the efficient measure and baseline measure.

When energy savings were calculated 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 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 savings were extrapolated using process requirements.

Measurement Specifications, Responsibilities, and Accuracy

Spot Measurements. Data for various parameters were collected on an intermittent (spot) basis. These data were used to confirm baseline or reporting conditions if presumed static, to check data from alternative sources, or to diagnose equipment status and configuration. Table 3-85 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, monitoring of the operating hours was performed as shown in Table 3-85.

Table 3-85. 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 is not appropriate)	Accuracy: ± 7%

Metering. Data for various parameters of interest were either spot-metered, metered on the day of a site visit, or meters were installed and left 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. These data were used to monitor baseline or reporting conditions (if presumed dynamic) and to check data alternative sources.

The variables measured for each site were generally the same, but the method of obtaining the metered data varied according to the following:

- Data loggers and appropriate measurement device (e.g., current transducer, temperature/relative humidity sensor, anemometer)
- Energy Management System (EMS) trending (when available)
- VFD (Variable frequency Drive) 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 3-86 shows parameters of interest and the associated metering equipment.

Table 3-86. Metering Equipment and Configuration, Energy-Efficiency Program Area

Parameter	Data Source	Interval	Measurement Range
Chiller, AC or HP, or PTAC 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 (150mm): ± 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, equipment model numbers were used to determine the size, efficiency, kW, and other information needed to calculate or model the system energy usage. Additionally, any modeling or baseline calculations performed by the participant for the purpose of evaluating the project were thoroughly reviewed for accuracy and to ensure that standard engineering practices were followed. The models were adjusted, as needed, to account for any recorded discrepancies between the model and actual system installed.

Metering Accuracy. The individual meter accuracies are detailed in the tables above. 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. A sampling method was used 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.

3.3.5 Gross Savings Findings

Please see Appendix I for Table I-3 which 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 107%.

3.3.6 Confidence and Precision

The realization rate for the Energy Efficiency projects was calculated from 74 projects completed before January 1, 2012 which received an on-site visit, data collection and engineering review or only an engineering review. The confidence and precision were based on the variance of the realization rate weighted for the total energy savings of each project. Utilizing a mean realization rate of 1.0748 and a standard deviation of 0.986, the program realized a confidence of 90 percent with plus or minus 8.3 percent precision. Table 3-87 summarizes the results.

Table 3-87. Energy Efficiency Confidence and Precision

Confidence	Precision
90%	± 8.3%

3.3.7 Net Savings Calculations

The Cadmus Team relied on participant surveys delivered in person during project site visits, over the phone or through electronic survey to determine the attribution of Energy-Efficiency Program Area impacts. Although the original plan was to administer 142 surveys (125 delivered on site and 17 via telephone), project cancellations and delays meant that only 51 survey responses could be secured. Likewise, 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.

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 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 vetted with New York regulators and other third-party evaluation contractors on prior evaluations, then updated by NYSERDA and the Cadmus Team to align more closely with the design of the NYSERDA ARRA Program Area.[54]

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[54] The Cadmus Team also develop two alternative estimates that attempted to take into account 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 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 (i.e., other grants, non-profit organization, etc.,); lacking this information—and verifying that taking the adjustment had little effect on free ridership estimates—leads the Cadmus Team to recommend not using the adjusted free ridership 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.

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[55]
4. Weighting by the energy savings

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

- FR6A, likelihood of installing the same measure without ARRA funds (direct freeridership score)[56]
- FR6B, percentage of energy-efficiency measures that would have been installed without ARRA funds (direct freeridership score)[57]
- 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)
- FR5, importance of Program Area (Program Area influence score)
- E6, likelihood of completing the project without ARRA funds, limited to respondents that had lost or declined other funds (Program Area influence score)
- AF8, likelihood of completing an additional energy-efficiency or renewable energy project if respondent had not been able to divert funds because of receipt of ARRA funds (Program Area influence score, limited to respondents who had diverted funds to other energy-efficiency or renewable energy project. This was the only measure of spillover in the algorithm.)
- AF1, portion of the project paid by NYSERDA ARRA funds, but the Cadmus Team ultimately recommends an estimate of NTG that does not use this adjustment for reasons discussed in Footnote 53.

Freeridership results are detailed in Appendix F. This assessment does not account for spillover, because the energy-efficiency projects had been completed too recently to allow spillover to have occurred.[58]

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[55] 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 MCAC (Market Characterization, Assessment, and Causality) 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 (CIPP) Market Characterization, Market Assessment and Causality Evaluation*. 2007.

[56] Each respondent may have answered one or both of questions FR6a and FR6b based on the nature of the project.

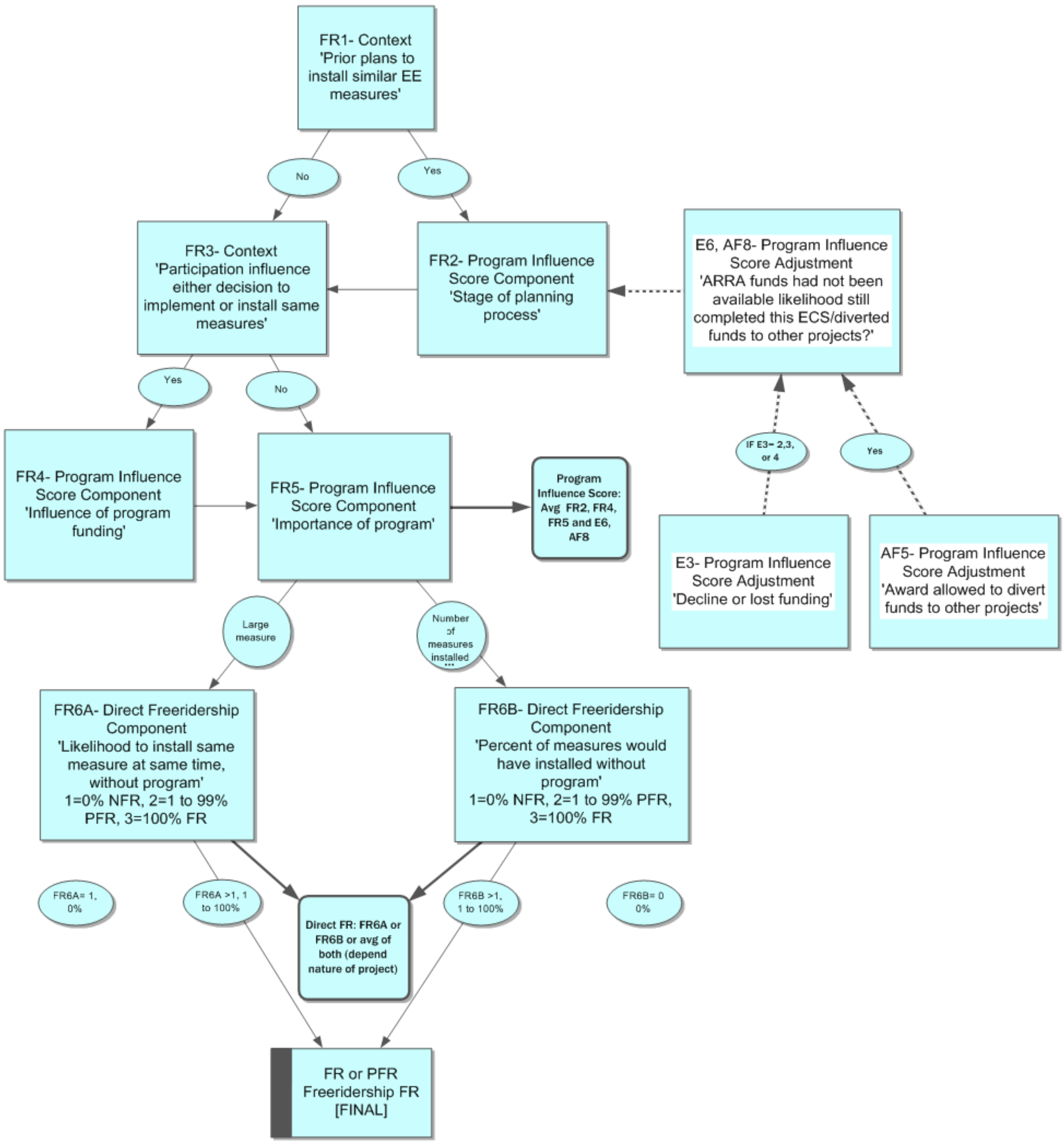
[57] Ibid.

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

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 note 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. This could be considered a form of spillover, and was incorporated into the algorithm as a slight increase in the Program Area influence score.

Figure 3-2 presents the algorithm graphically. The "FR," "AF," and "E" letters in the figure refer to questions from the survey, presented in Appendix E. The full algorithm and detailed calculations are also presented in Appendix E, while a summary of the calculations and the responses to the questions used to calculate the final freeridership estimate are presented in Appliance Rebate Program Area Savings Assumptions.

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



3.3.8 Net Savings Findings

This section presents estimates of freeridership and NTG ratios and summarizes the results of the attribution survey administered to respondents associated with 51of the energy-efficiency projects. The Cadmus Team determined the net savings for the Program Area at a 90% confidence level with a precision of plus or minus 8.3%. The precision for the process findings is slightly different at the 90% confidence level with a precision of plus or minus 9%.

The five steps involved in estimating freeridership are illustrated in Table 3-88. The calculations used in each step are described in Appendix F. The final freeridership rate, without adjusting for the percentage of each project funded by NYSERDA, is 27%, with a confidence interval of 19% to 35% (the variability of this interval reflects the small sample size). Adjusting for the percentage of each project funded by NYSERDA increases freeridership slightly, to 28% (based on survey responses) and 29% (based on tracking data). The freeridership rate changes little when adjusting for the percentage of each project funded by NYSERDA; given concerns about the lack of reliable information about the source of additional funding (described below), the Cadmus Team recommends using of the 27% as the freeridership rate, yielding a NTG ratio of 73%.

Table 3-88. Freeridership Scores for RFP 1613, Energy-Efficiency Program Area

	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	*51*	*51*	*51*
(1) Mean direct freeridership; FR6A, FR6B, or their average, depending on the nature of the project	27%	27%	27%
(2) Mean Program Area influence score; average score of FR2,* FR4, FR5, and, if applicable, FR6** and AF8 (with a score of 1 meaning weak Program Area influence and 5 meaning strong Program Area influence)	4.00	4.00	4.00
(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 F for more detail)	25%	25%	25%
(4) and (5) Freeridership, weighted by savings attributable to NYSERDA ARRA funding	27%	28%	29%
90% confidence interval	19% to 35%	20% to 36%	21% to 37%

* 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.

** FR6 was reverse-scored such that the response indicating the greatest influence of NYSERDA ARRA funding also received the highest score.

The Cadmus Team benchmarked NYSERDA's Energy-Efficiency Program Area freeridership results with results from similar programs. In these other studies[59,60]freeridership averaging between 13% and

[59] Cadmus' evaluation of DEER 2011 Non-Res EE NTG.

30%. Questar Gas' business energy-efficiency program had a freeridership rate of 26%.[61] NYSERDA's Energy-Efficiency Program Area's freeridership of 27%, falling within the range of the other rates examined. It should be noted that none of these other evaluations were of an economic stimulus program, so they are not necessarily comparable to the NYSERDA ARRA program.

The remainder of this section summarizes responses to the survey questions that factored into the freeridership calculation, as well as 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 elucidate the importance of NYSERDA ARRA funding on the completion of the projects.

A survey question was used 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 3-89). Nearly one-quarter of projects (23%) were fully funded by ARRA, while NYSERDA ARRA funded between 50% and 99% of the cost for the majority of projects (64%). Thirteen percent of respondents reported that the NYSERDA ARRA funded less than one-half of the total project cost. The average proportion of project costs covered by the ARRA funds was 73%.

As mentioned above, the Cadmus Team did calculate 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, as stated above, the Cadmus Team recommends use of the freeridership rate that does not adjust for answers to this question.

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[60] The Cadmus Group, Inc. *Avista 2010 Multi-Sector Gas Impact Evaluation Report*, 2011.

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

Table 3-89. Percentage of Total Project Budget Covered by NYSERDA Funds, Energy-Efficiency Program Area

Percentage of Budget	
Sample size	*51*
Mean percent of budget	*73%*
1% to 24%	5% (3)
25% to 49%	8% (4)
50% to 74%	24% (11)
75% to 99%	40% (20)
100%	23% (13)

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

Note: The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted 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 it was anticipated that NYSERDA ARRA would serve as a source of these matching funds. Moreover, it was expected that at least some participants had previously secured funding but lose it due to the financial crisis. The survey included a series of questions designed to elucidate how other funding sources—or the lack of them—may have influenced participation in NYSRDA ARRA.

Respondents were asked whether non-NYSERDA project funding had required that they obtain matching funds (a.k.a., leverage funds) from other sources. As shown in Table 3-90, only four respondents (8%) said that other sources had indeed required matching funds. In a follow-up question, these four respondents were asked to rate the influence of this requirement on their decision to apply for the NYSERDA funds, on a scale from 1, indicating that it was a critical negative factor, to 5, indicating it was a critical positive factor. In response, two respondents gave a rating of 2, indicating that this requirement was a somewhat negative factor in their decision to apply for ARRA funding, one respondent gave a rating of 4, indicating that the requirement was a somewhat positive factor, and the remaining respondent gave a rating of 3, indicating that it was not a factor at all. These results indicate that the need to secure matching funds was not a major driver to participation in the NYSERDA ARRA Program Area.

Table 3-90. Whether Other Financing Sources Required Matching Funds, Energy-Efficiency Program Area

Response	Required Matching Funds	Attempted to Secure Other Funds	Able to Divert Funds to Other Projects
Sample size	*39*	*51*	*51*
Yes	8% (4)	18% (9)	32% (15)
No	92% (35)	82% (42)	68% (36)

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

Note: Total may not sum to 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

Additional questions asked respondents about any previous attempts they might have made to secure financing for the project before they applied for NYSERDA funds, as well as whether those attempts were successful. The respondents also reported how they used previously secured funds. Table 3-90 above shows that 18% of respondents had tried to obtain financing for the project before applying for NYSERDA funds. Follow-up questions reveal that two of these nine respondents who attempted to obtain funding for the project before applying for the NYSERDA funds were successful. One used those funds to pay for part of the costs of the energy-efficiency project they implemented through NYSERDA, and the other one used those funds to pay for another project. No respondents reported losing funds (i.e., having previously secured funding go unfulfilled) or declining them (i.e., turning down funds promised by another funder), suggesting that NYSERDA ARRA funds did not "make up" for lost funds, but instead served as a source of funds for energy-efficiency projects at a time when access to revenue was difficult for participants to secure.

Respondents also indicated whether the NYSERDA funding allowed them to divert money that had been budgeted for the energy-efficiency project to other projects (Table 3-90), which would indicate a form of Program Area spillover (both energy and non-energy related). Fifteen participants (32%) reported that they had been able to divert funds to other projects. Among those 15 respondents, 11 (75%) said that these other projects included the installation of additional energy-efficient equipment (Table 3-91). The energy-efficient equipment for which diverted funds were used include: chilled water optimization work, HVAC controls, lighting, submeters, variable speed drives, and cogeneration projects. Note that these savings are not directly included in the estimate of gross savings, as there were only a few respondents and the Cadmus Team did not take further action to quantify the savings. However, these projects are taken into consideration in the calculation of the Program Area influence score, used to estimate freeridership.

Table 3-91. Whether Diverted Funds Financed Additional Energy-Efficiency Projects, Energy-Efficiency Program Area

Whether Diverted Funds Financed the Installation of Additional Renewable Energy or Energy-Efficiency Measures	
Sample size	*15*
Yes	75% (11)
No	25% (4)

Note: Base is respondents who reported that NYSERDA allowed them to divert projects funds to finance other projects.

Note: Total may not sum to 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

The 11 respondents who reported using funds diverted from the Program Area energy-efficiency project for other energy-efficiency projects then rated the likelihood that they would have diverted those funds if the NYSERDA funds had not been available. Four of these respondents said that it was either somewhat unlikely or not at all likely, while five said that it was either somewhat likely or very likely that they would have diverted the funds without NYSERDA funding. The remaining two said that it was neither likely nor unlikely (Table 3-92).

Table 3-92. Likelihood of Diverting Internal Funds to Other Energy-Efficiency Projects in Absence of NYSERDA Funds, Energy-Efficiency Program Area

Likelihood	
Sample size	*11*
Mean (scale of 1 to 5)	*3.3*
1 Not at all likely	6% (1)
2 Somewhat unlikely	28% (3)
3 Neither likely nor unlikely	14% (2)
4 Somewhat likely	30% (2)
5 Very likely	21% (3)

Note: Base is respondents who reported using diverted funds for other energy-efficiency projects.

Note: Total may not sum to 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted 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. Likelihood was indicated 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). Interviewers were instructed to ask this first question for projects that involved equipment or services that could not easily be divided into individual measures (e.g., comprehensive retro-commissioning projects or the installation of a single piece of equipment).

A second, related question asked respondents to estimate the percent of efficiency measures that they would have installed without the NYSERDA funds. Interviewers were instructed to ask this question for projects that involved the installation of several individual measures (e.g., lighting measures). However, interviewers asked both the first and second questions if there was any doubt about which question to ask. Most of the respondents were asked both questions, which is reflected in the sample sizes for each question (n=40 for the first question and n=49 for the second question).

Table 3-93 shows the results of these two questions. More than one-half (55%) of the respondents who were asked about the likelihood of installing the same exact measure (the first column of results) 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 19% of respondents thought there was at least a 90% chance that they would have done so. The remaining respondents estimated probabilities between these two extremes. On average, respondents estimated that the likelihood of installing the same equipment at the same time was 27%.

The second table column 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 stronger influence from the Energy-Efficiency Program Area on the scope of the projects. One-half of respondents who were asked this question (50%) said that they would have installed less than 10% of the measures without the Program Area, whereas 16% said they would have installed at least 90% of the measures in absence of the Program Area. The average estimated share of measures that would have been installed is 28%.

Table 3-93. Likelihood of Installing Same Efficiency Measures in Absence of Energy-Efficiency Program Area

	Percent Likelihood	Percent of Measures
Sample size	*40*	*49*
Mean percent likelihood	*27%*	*28%*
0-9%	55% (22)	50% (24)
10-19%	4% (2)	2% (1)
20-29%	9% (3)	15% (8)
30-39%	2% (1)	3% (2)
40-49%	5% (1)	2% (1)
50-59%	7% (4)	8% (4)
60-69%	0	0
70-79%	0	3% (2)
80-89%	0	0
90-100%	19% (7)	16% (7)

Note: Base is respondents who were asked each question; depending on the nature of the project, some respondents were asked the likelihood question, some were asked the percent of measures questions, and some were asked both questions.

Note: Total may not equal 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

Influence of the NYSERDA ARRA Program Area on the Project

While the questions summarized earlier in this section provided information 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 as described above. 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.

Respondents were asked whether they had planned to install similar measures before they applied for the NYSERDA ARRA funds. As shown in Table 3-94, 64% said they had such plans.

Table 3-94. Prior Plans to Install Similar Measures, Energy-Efficiency Program Area

Whether Respondents Planned to Install Similar Energy-Efficiency Measures Before Participating	
Sample size	*51*
Yes	64% (32)
No	36% (19)

Note: Total may not sum to 100% due to rounding.The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

Respondents were then presented with a list of statements describing the process of planning the energy-efficiency project, and were asked to indicate which statement best described their plans before they participated in the Energy-Efficiency Program Area.[62] Table 3-95 shows that the projects varied widely in terms of their pre-participation stage in the planning process. Slightly less than one-tenth (8%) were in the latest stage of planning, having identified specific equipment models for the project and incorporated the project into their budget. A larger proportion (34%) had also identified specific models, but they had either not started the budgeting process (7%) or their budget did not allow for the project to be implemented (27%). Nearly one-half of respondents (49%) had taken only the initial steps toward considering the equipment or measures, including either discussing options with a vendor, contractor, or installer (28%), or having in-depth discussions about the positive/negative attributes and costs of specific types of equipment (21%). The remaining 9% of respondents 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.

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

Table 3-95. Point in Project Planning Process before Participating in Energy-Efficiency Program Area

Planning Process	
Sample size	*32*
Had preliminary, internal discussions but no plans and no contact with a vendor, contractor, or installer.	9% (2)
Had taken initial steps toward considering the equipment/measures, such as requesting information from or discussing options with a vendor, contractor, or installer.	28% (10)
Had in-depth discussions of specific types of equipment, including positive and negative attributes and costs.	21% (7)
Had identified specific equipment, manufacturers, and models but hadn't begun budgeting process.	7% (3)
Had identified specific equipment, manufacturers, and models but budget didn't allow completion of project.	27% (7)
Had identified specific equipment, manufacturers, and models and incorporated project into budget.	8% (3)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

An additional question assessed 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?*"[63] Table 3-96 shows that a large majority of respondents (92%) said that the Program Area had indeed influenced their project decision making.

Table 3-96. 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	
Sample size	*51*
Yes	92% (46)
No	8% (5)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

The respondents who indicated that their Energy-Efficiency Program Area participation influenced their project were then asked about the nature and extent of that influence. Presented with a list of statements describing various levels of influence, respondents were asked to choose the statement that best indicated the effect of the Program Area on their decision process. As shown in Table 3-97, the majority of these respondents (52%) said that the Energy-Efficiency Program Area funding was the *primary reason* the

[63] The original Flex Tech/Technical Assistance version of this question asked about type and amount; NYSERDA also directed the Cadmus Team to ask about "size" because of the nature of the ARRA projects. The wording of the questions allows for the influence of the project to be on any or all of these characteristics.

project was implemented, with another 24% saying it was a major driver in increasing the scope of the project or the efficiency of the equipment. Twenty percent of respondents indicated that the funding allowed them to implement a project that had been considered (9%), or allowed them to follow through with a decision to invest in high efficiency (11%). Only two respondents (4%) said that the funding had no influence on the project.

Table 3-97. Influence of Energy-Efficiency Program Area on Decision to Install Equipment

Description of Influence	
Sample size	*46*
No influence; all the measures would have been installed at the same efficiencies and in the same amounts without the Energy-Efficiency Program Area.	4% (2)
The Energy-Efficiency Program Area funding helped in making the final decision on the measures that had already been thoroughly considered.	9% (4)
The Energy-Efficiency Program Area funding lent credibility to the decision to invest in high efficiency.	11% (5)
The Energy-Efficiency Program Area funding was a major driver in expanding the quantity, scope, or efficiency of the equipment installed.	24% (11)
The Energy-Efficiency Program Area funding was the primary reason that the measures were installed.	52% (24)

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 reflect weighted data, while the numbers inside the parentheses reflect unweighted 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 (indicated it was not at all important) to 5 (indicating it was very important). As shown in Table 3-98, 89% of respondents indicated that it was somewhat or very important, whereas 7% said it was not at all important. The average importance rating was 4.4.

Table 3-98. Importance of Energy-Efficiency Program Area in Decision to Incorporate High Efficiency Measures

Importance	
Sample size	*51*
Mean (Scale 1-5)	*4.4*
1 Not at all important	7% (3)
2 Somewhat unimportant	0
3 Neither important nor unimportant	3% (2)
4 Somewhat important	20% (12)
5 Very important	69% (34)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

Although the freeridership and NTG estimates presented above and described in more detail in Appendix F 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 3-99, the most common response (47%) 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 (26%), that it would have been reduced in scope (18%), that the equipment installed would have been less efficient (7%), and that the project would have been implemented in stages, rather than all at once (5%). Only one respondent (2%) said the project would have been completed earlier without the Energy-Efficiency Program Area, noting that the paperwork and other Program Area requirements delayed the installation process, and another (2%) said the project would have been the same without the Program Area funds. These responses indicate that the participants overall believe that the funds made these projects possible, increased the level of efficiency, 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.

Table 3-99. Likely Nature of Project in Absence of NYSERDA Funds, Energy-Efficiency Program Area (Multiple Responses)

Nature of Project	
Sample size	*51*
Project would not have been implemented at all	47% (21)
Project would have happened later or taken longer to complete	26% (14)
Project would have been reduced in scope	18% (8)
Equipment would have been less efficient	7% (4)
Project would have been implemented in stages	5% (3)
Project would have been completed earlier	2% (1)
Project would have been the same	2% (1)
Other	2% (1)

Note: Total may not equal 100% due to rounding. The percentages before the parentheses reflect weighted data, while the numbers inside the parentheses reflect unweighted frequencies.

Evaluated Savings Net of Freeridership

Accounting for all of the above factors, the evaluated savings net of freeridership are 73% of the gross savings, or 29,315 MWh and 217,402 MMBtu.

Table 3-100 summarizes the evaluated expected annual net impact as of the end of 2011.

Table 3-100. Savings Impact Evaluated Net of Freeridership through December 31, 2011, 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)	42,721	0.94	40,158	0.27	29,315
Fuel (MMBtu)	278,328	1.07	297,811	0.27	217,402

3.3.9 Example Energy-Efficiency Projects

In order to convey the general evaluation approach, the following five examples outline energy-efficiency project evaluations. The Cadmus Team followed a general approach to reviewing project data and assumptions, developing an evaluation strategy to test those assumptions, collecting necessary data, and evaluating the savings. The 80 projects reviewed by the Cadmus Team were each comprised of their own unique characteristics, requiring slight adaptations to each evaluation to ensure a thorough analysis. The following five project examples portray the diversity of evaluation activities and approaches.

Project #1

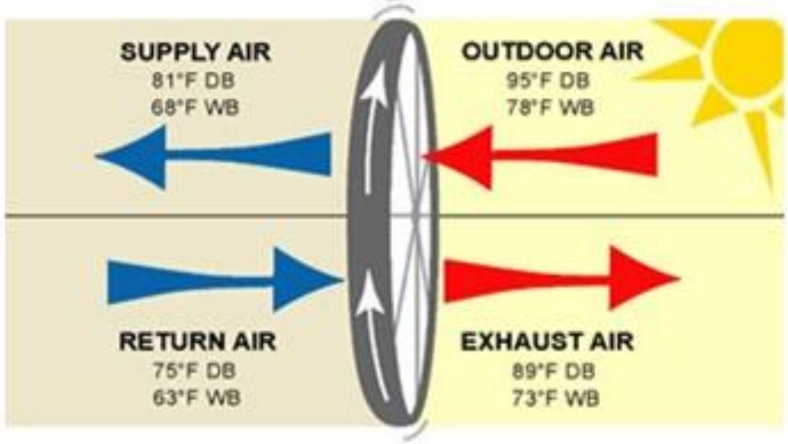
Overview

The Cadmus Team visited Project #1 in June of 2011. Facilities personnel gave a tour of the mechanical systems. The heating and cooling central plant, the enthalpy wheels, and the ducting system were visually inspected. Trend data were collected and verified with spot measurements. The Cadmus Team also interviewed staff. The evaluation effort found that savings for this project were over-stated, mainly because the savings methodology assumed there was no heat recovery prior to installing the new enthalpy wheels.

Project Description

The conditioned space of the facility is roughly 300,000 square feet. The heating and cooling system consists of various forced air units. Five of the units included heat recovery devices installed in 1970. Project #1 replaced three heat recovery wheels and one Wing enthalpy wheel with four Energy Recovery (enthalpy) wheels. An enthalpy wheel transfers both heat and moisture (sensible and latent heat) to reduce the energy content of incoming outdoor air during summer conditions. This effectively reduces the electrical energy consumption of the chillers. Figure 3-3 illustrates a situation where the outdoor air is cooled by the enthalpy wheel from 95° F dry bulb/78° F wetbulb to 81° F drybulb/68° F wetbulb. The return air stream is effectively heated before exiting the Building.

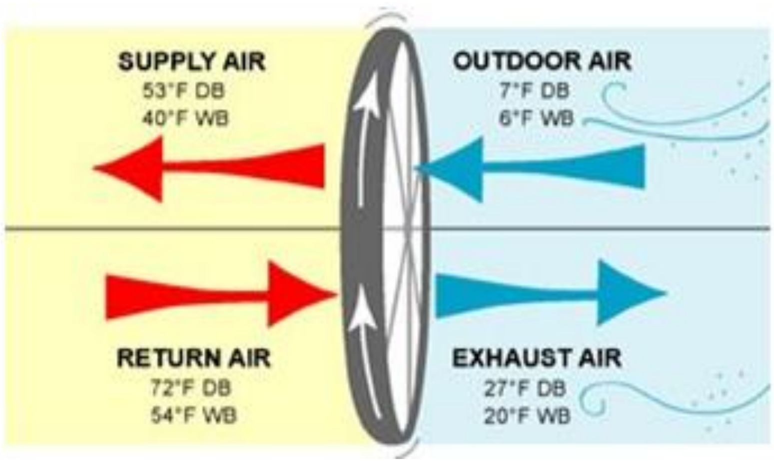
Figure 3-3. Heat Exchange at Project #1, Summer Conditions, Energy-Efficiency Program Area



Source: http://www.zigersnead.com/blog/wp-content/uploads/2008/03/entropy-wheel-image-05-combined1.jpg

Figure 3-4 shows the opposite situation of Figure 3-3, in which the incoming outdoor air is pre-heated by the exhaust air. This simple concept was used to estimate water heating energy savings for Project #1.

Figure 3-4. Heat Exchange at Project #1, Winter Conditions, Energy-Efficiency Program Area

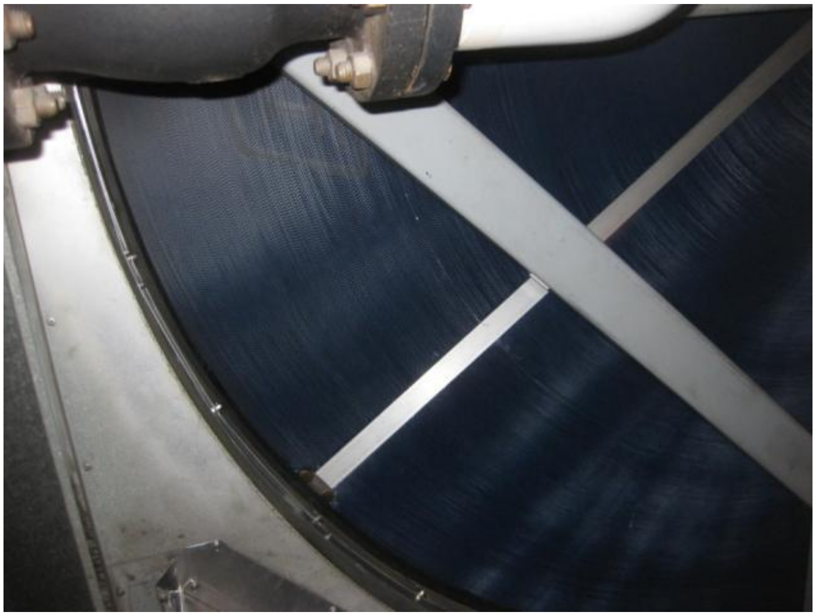


Source: http://www.zigersnead.com/blog/wp-content/uploads/2008/03/entropy-wheel-image-05-combined1.jpg

Verification Activities

The installation of all four enthalpy wheels was verified during the site visit. Inspection revealed that the installation was consistent with the design specifications listed in the project description file. All four wheels were operating as expected. Figure 3-5 shows evidence of the quality of the device and the perimeter seals (for air handling unit (AHU) 6).

Figure 3-5. Enthalpy Wheel at Project #1 (AHU 6), Energy-Efficiency Program Area



Energy savings are generally calculated according to the following equation:

Equation 3-9. Heat Transfer Equation, Energy-Efficiency Program Area

Where:

Q	=	Heat transfer
$\dot{m}$	=	Mass flow rate
	=	Enthalpy difference

This equation calculates heat transfer based on the mass flow rate of air and the enthalpy difference across the enthalpy wheel. The mass flow rate of air can only be determined if the volumetric flow rate of air and the conditions (temperature/humidity) of the air stream are known. The enthalpy difference (Δh) is measured with temperature/humidity sensors in the air stream on either side of the wheel. The Cadmus Team took spot measurements of air temperature and relative humidity and compared them to trend data. The measurements were similar and did not deviate further than the expected tolerance of the sensors. All available trend data were collected, which included 15-minute interval data for AHU 3516, AHU 6, AHU 12, and AHU 13 for the following points:

- Return air temperature
- Exhaust air temperature
- Return air enthalpy
- Exhaust air enthalpy
- Outside air temperature

The mass flow rate of air was also verified. Figure 3-6 shows one of the main ducts. Figure 3-7 shows the holes drilled in ducts for cross-sectional airflow measurement. The average velocity of the airstream was estimated with a hot wire anemometer. Design documents were reviewed and physical measurements taken of two ducts (AHU 6 and AHU 12) to calculate the duct cross-sectional area. These measurements were used to estimate the mass flow rate of air.

Figure 3-6. Duct System at Project #1, Energy-Efficiency Program Area

Figure 3-7. Duct Airflow Measurement at Project #1, Energy-Efficiency Program Area

The airflow measurements taken in the field were compared to the airflow used to estimate savings(the enthalpy wheel manufacturer). Savings estimates seemed to be based on an existing condition (baseline) that had no heat recovery. The new enthalpy wheels replaced enthalpy wheels installed in 1970, and although these wheels were old and very inefficient, Project #1 staff confirmed that they were functional prior to the project implementation.

The Cadmus Team contacted the engineering firm that was contracted for installation, who confirmed that the savings were based on the baseline condition of zero heat recovery. Details of the enthalpy wheels that were replaced are not available. The Cadmus Team also contacted the enthalpy wheel implementer to attempt to better understand the efficiency of the old heat recovery system, but no information was available. Figure 3-8 through Figure 3-10 show the inputs and savings calculation results for AHU 6. Similar data were available for all air handlers.

Figure 3-8. Project #1 AHU 6 Manufacturer Energy Savings Calculation Tool, Energy-Efficiency Program Area

THERMOTECH ENTERPRISES,INC.

Energy Recovery Wheel Savings Analysis **Date:** 8/21/2009

PROJECT NAME: [redacted]

UNIT DESIGNATION:

Weather Data Location:

Yellow Fields are customer provided input data. *Gray* Fields are TEI inputs used for the calculations.

SELECTED MOD. NO. : **474** MEDIA TYPE: **MHP** NUMBER OF UNITS: **1**

SUPPLY AIR DESIGN CONDITION:	Air Vol. Rate CFM=	37500				
SUMMER:	DB deg.F=	60.0	WB deg.F=	54.0	Enthalpy Btu/Lb. =	**22.6**
WINTER:	DB deg.F=	60.0	WB deg.F=	50.0	Enthalpy Btu/Lb. =	**20.4**
RETURN AIR DESIGN CONDITION:	Air Vol. Rate CFM=	36500				
SUMMER:	DB deg.F=	72.0	WB deg.F=	60.1	Enthalpy Btu/Lb. =	**26.4**
WINTER:	DB deg.F=	72.0	WB deg.F=	60.1	Enthalpy Btu/Lb. =	**26.4**

COST OF ELECTRICITY $/kwh: 0.0505 COST OF HEATING AND TYPE: 11.36/MMBTU

CONVERTED COST OF HEATING $/Million Btu: **11.36** HOURS OF OPERATION PER DAY: 24

COEFFICIENT OF PERFORMANCE (COP) FOR THE COOLING SYSTEM: 3.5

EFFECTIVE FACE AREA PER AIR STREAM (MODEL NO x NO of UNITS / 10) Square Ft.: 47.4

ASHRAE DEFINED UNIT EFFECTIVENESS: **94.3%** SUPPLY AIR EFFICIENCY: 91.8%

PRESSURE DROP & EFFECTIVENESS DERATION FACTOR : **1.00**

SUPPLY AIR FACE VELOCITY fpm: 791 RETURN AIR FACE VELOCITY fpm: 770

SUPPLY AIR PRESSURE DROP : **0.74** RETURN AIR PRESSURE DROP : **0.44**

Figure 3-9. Project #1 AHU 6 Manufacturer Data Analysis, Energy-Efficiency Program Area

Source: Engineering Weather Data, Dept. of the Air Force, the Army, and the Navy.

	A	B	C	D	E	F	G	H
Observation Number	Operating Mode Cooling Heating No Recovery	Hours of Observation Hrs.	Outdoor DB / WB Deg. F	Outdoor Enthalpy Level Btu/Lb.	Supply and Outdoor Enthalpy Difference Btu/Lb.	Recoverable Enthalpy Btu/Lb.	Total Required Enthalpy Hours Btu-Hr./Lb.	Recovered Enthalpy Hours Btu-Hr./Lb.
No. 1	Cooling	1	97/76	36.6	10.2	12.8	10	13
No. 2	Cooling	19	92/75	38.5	12.1	14.6	229	277
No. 3	Cooling	98	87/72	35.8	9.4	12.1	918	1187
No. 4	Cooling	237	82/70	34.0	7.6	10.5	1794	2480
No. 5	Cooling	414	77/67	31.6	5.2	8.3	2140	3420
No. 6	Cooling	627	72/65	30.0	3.6	6.8	2238	4259
No. 7	Cooling						0	0
No. 8	Cooling						0	0
No. 9	Cooling						0	0
No. 10	No Recovery	755	67/61	27.2	0.8	4.2	581	0
No. 11	No Recovery	718	62/57	24.6	-1.8	1.8	-1314	0
No. 12	Heating	675	57/53	22.2	-4.2	-0.4	-2855	-248
No. 13	Heating	656	52/48	19.2	-7.2	-3.1	-4743	-2047
No. 14	Heating	655	47/44	17.2	-9.2	-2.9	-6046	-1924
No. 15	Heating	651	42/39	15.0	-11.4	-5.0	-7441	-3227
No. 16	Heating	780	37/35	13.0	-13.4	-6.8	-10475	-5298
No. 17	Heating	937	32/30	11.5	-14.9	-8.2	-13989	-7654
No. 18	Heating	625	27/25	9.0	-17.4	-10.5	-10894	-6540
No. 19	Heating	402	22/21	7.7	-18.7	-11.7	-7529	-4686
No. 20	Heating	247	17/16	5.9	-20.5	-13.3	-5071	-3287
No. 21	Heating	172	12/11	4.5	-21.9	-14.6	-3772	-2510
No. 22	Heating	72	7/7	3.2	-23.2	-15.8	-1673	-1137
No. 23	Heating	23	2/2	1.2	-25.2	-17.6	-580	-405
No. 24	Heating	4	-3\ -2	0.0	-26.4	0.0	-106	0
No. 25	Heating	1	-8/-8	-2.0	-28.4	-22.6	-28	-23
No. 26	Heating	1	-13/-13	-3.0	-29.4	-21.5	-29	-21
No. 27	None				0.0	0.0	0	0
No. 28	None				0.0	0.0	0	0
	TOTAL HOURS :	8770			COOLING TOTALS:		3743	11636
					HEATING TOTALS:		72377	38759

E = Outdoor Air - Supply Air Enthalpy Difference
F = Recovered Enthalpy = (Outdoor Air - Return Air Enthalpy) x Supply Air Efficiency
G = Total Required Enthalpy Hours = (Outdoor Air - Supply Air Enthalpy Difference) x Hrs. = E x B
H = Recovered Enthalpy x Hrs. = F x B

The hours of observation were reviewed using Bin Maker Pro, and the hours shown in Figure 3-9 are reasonable.

Figure 3-10. Project #1 AHU 6 Manufacturer Data Analysis, Energy-Efficiency Program Area, Continued

Qc = Annual Cooling Energy Savings = Saved Enthalpy Hours x Supply Air Volume x 60 x 0.075 [Btu/year] = 1.9636E+09

Sc = Annual Cooling Cost Saving = (Qc x p) / (C x E x COP) = **$8,733**

where
p = Cost of Electricity [$/Kwh]
C = Energy value of the fuel [Btu/Kwh] 3415
E = Efficiency value of the system 0.95
COP = Coefficient of performance of the AC system

Qh = Annual Heating Energy Savings = Saved Enthalpy Hours x Supply Air Volume x 60 x 0.075 [Btu/year] = 6.5406E+09

Sh = Annual Heating Cost Saving = (Qh x P) / E = **$99,068**

where
P = Cost of Heating [$/MBtu]
E = Efficiency value of the system 0.75

Qa = Added energy for the heat wheel motor and added blower pressure loss[Kwh]

Qa=M x.746xHx365+[(Vs x dPs/Deration Factor+Vr x dPr/Deration Factor) x .746 x Hx365] / 6356 x E [Btu/year]= 56340

where
Vs = Supply air volume [CFM]
Vr = Return air volume [CFM]
M= 2 HP for the heat wheel motors
E= 0.80 Blower efficiency
dPs = Supply air pressure loss through the wheel [in.wc.]
dPr = Return air pressure loss through the wheel [in.wc.]
H = Hours of operation per day.

Total added energy cost = Qa x p = **$2,845**

The Cadmus Team reviewed the project savings calculation and found that all inputs and savings estimates were conservative. The Cadmus Team noticed, however, that claimed savings were equivalent to the annual heating energy savings (6.5406E+09 in Figure 3-10, for example). This is inaccurate: it does not account for the fan energy or the efficiency of the heating system. Furthermore, claimed savings do not consider electric energy savings from cooling heat exchanged by the enthalpy wheel.

Trend data for all air handlers was reviewed to confirm proper operation of the heat exchangers. Figure 3-11 shows exhaust air enthalpy (light blue line) rising above return air enthalpy (purple line) when it is warm outside, and vice versa when it is cool outside. Verification of the proper operation of enthalpy wheels and of airflow measurements is sufficient, because the baseline condition is unknown. The Cadmus Team also used the manufacturer's savings calculation tool to verify the energy savings. An example is shown as Figure 3-12.

Figure 3-11. Trend Data for Project #1 AHU 6, Energy-Efficiency Program Area

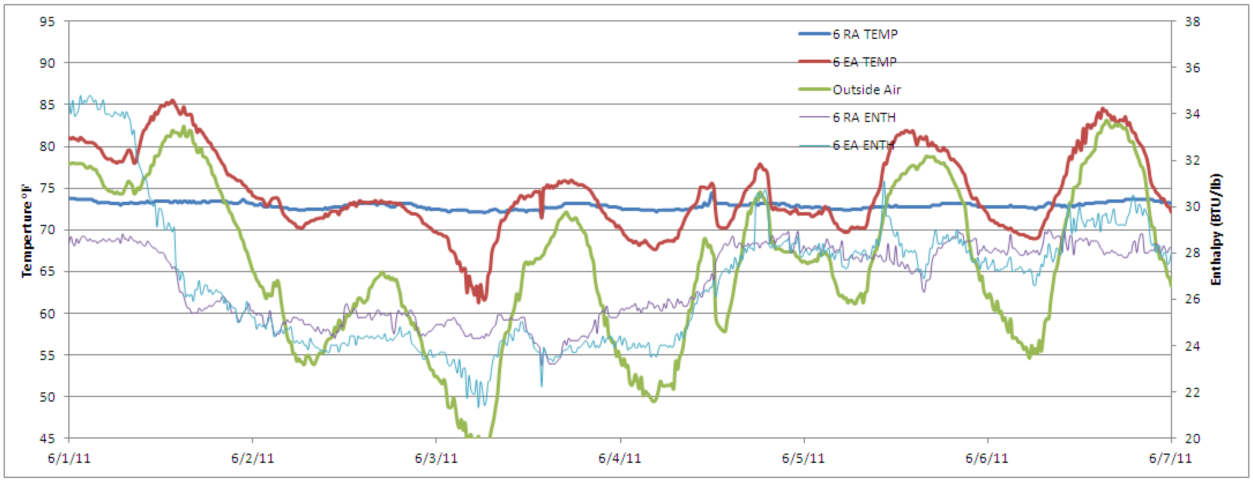
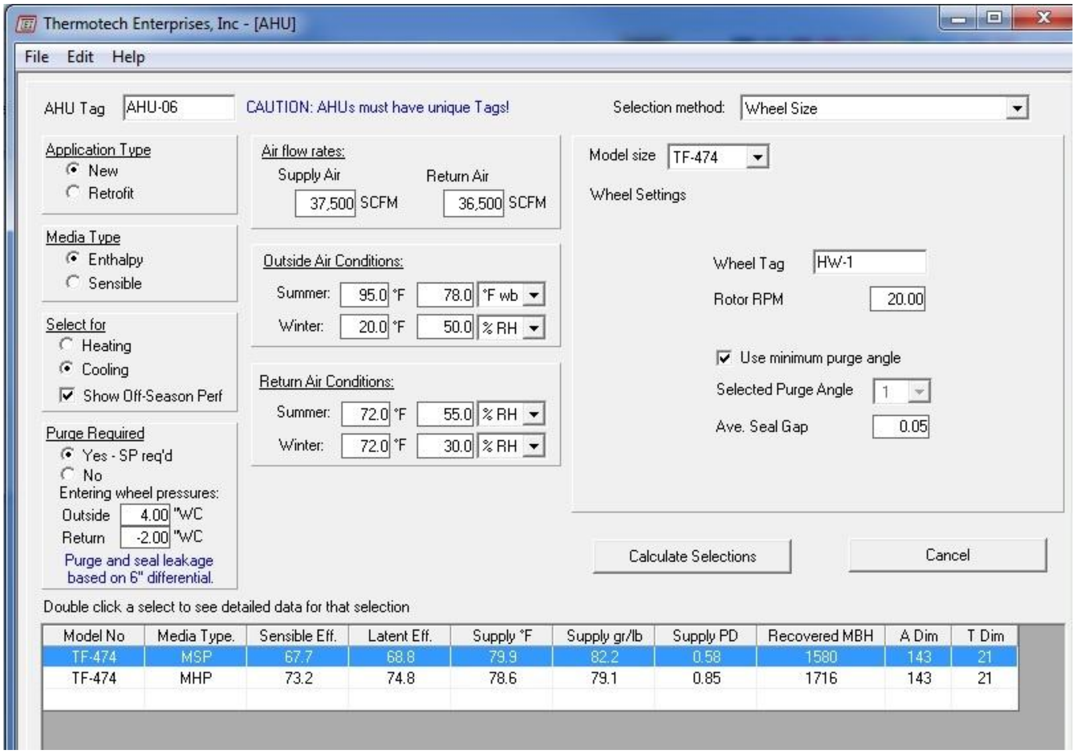


Figure 3-12. Savings Calculation Tool, Energy-Efficiency Program Area



Final Savings Analysis

The Cadmus Team verified the savings calculation inputs, hours of heat gain and heat loss for the geographic area, as well as the volumetric airflow rate of the air handlers. All estimates are reasonable and inputs are accurate. Savings are over-estimated: according to facilities personnel, the inefficient enthalpy wheels were at least somewhat functional. In absence of any trend data or commissioning reports from the pre-existing system, the Cadmus Team leveraged in-house knowledge of old, inefficient enthalpy wheels to estimate savings. The following baseline assumptions were used to develop a more conservative savings estimate:

- Less airflow restriction in the new system (based on interview of facility staff regarding duct pressure)
- Heat transfer of old system is 50% efficiency of new system
- Reduced coefficient of performance of system from 3.5 to 3.0 (based on review and inspection of cooling system)

Total savings claimed for this project was 13,888 MMBtu. Savings should be a combination of heating and cooling energy saved due to the installation of four enthalpy wheels. The electrical energy saved by this project was not claimed, which was probably an oversight. Claimed savings (13,888 MMBtu) were the sum of the following:

- AHU 3513 1,613 MMBtu
- AHU 6 6,541 MMBtu

- AHU 12 2,867 MMBtu
- AHU 13 2,867 MMBtu

The Cadmus Team re-calculated savings based on the assumptions listed above. Table 3-101 shows the original reported savings and the evaluated/realized energy savings.

Table 3-101. Realized Energy Savings at Project #1, Energy-Efficiency Program Area

AHU 3513	AHU 6	AHU 12	AHU 13	Total	Source and Unit
23,650	95,916	42,045	42,045	**203,656**	Realized: Cooling (kWh)
1,008	4,088	1,792	1,792	**8,680**	Realized: Heating (MMBtu)

The realization rate for total project energy savinsg (MMBtu) is: 68%. The Cadmus Team confirmed that there was heat recovery prior to this project. These realization rates are low primarily due to the original savings calculations assumed a baseline of no heat recovery.

Project #2

Overview

The Cadmus Team met with the facilities manager and key personnel at the Project #2 in September of 2011, to discuss the project and to tour the facility. The Cadmus Team reviewed the energy management system, took spot measurements to verify a random sample of sensors, and reviewed data collection and trending capabilities. During the site visit, staff were interviewed to discuss the project and provide an understanding, in their opinion, of how it saved energy. It was determined that savings could be verified by a detailed review of trend data.

Project Description

Project #2 is a 1-million square foot facility. A combined heat and power (CHP) cogeneration plant was installed about 20 years ago. The first of two energy-efficiency measures were the installation of variable frequency drives (VFDs) and implementation of a revised operating strategy. VFD's were installed on the four cooling towers and on two 1,000-ton electric chillers.

The second of the two energy-efficiency measures, a CHP cogeneration system upgrade, was intended to increase the performance (system efficiency) of the CHP cogeneration plant. Significant changes, such as the removal of on-site laundry and discontinuing the use of an 800-ton absorption chiller, can increase or decrease steam demand. The use of steam for domestic hot water (DHW) and sterilization is required throughout the year. A low-pressure, absorption infill chiller and a 275 kW microturbine also use steam.

Verification Activities

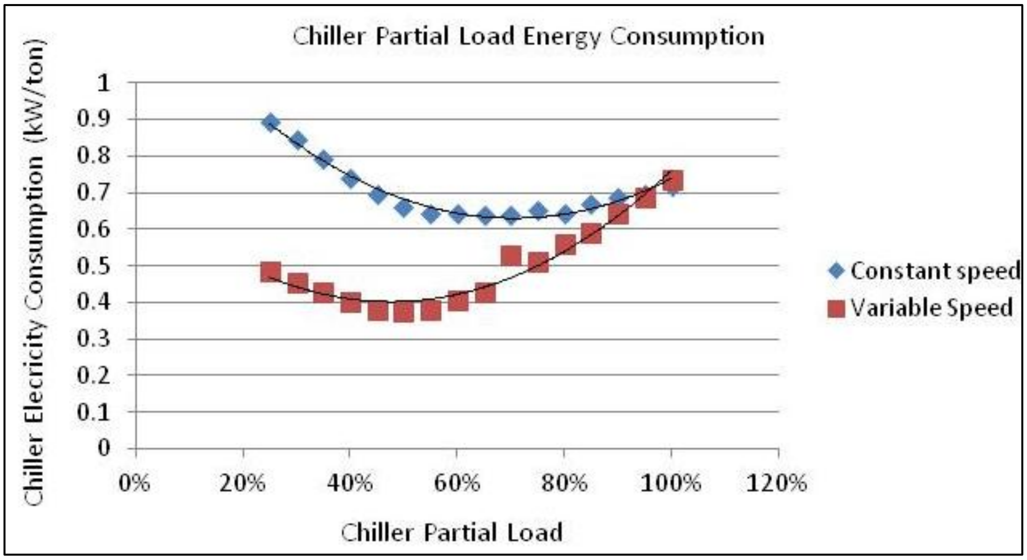
The following verification activities were conducted, along with a site visit, data collection effort, and project review.

Measure 1: Improved Chiller Controls and Installation of VFD's

Two existing 1,000-ton chillers were retrofitted with a York VFD. During the site visit, facilities personnel discussed the improvements in both energy and control from this project. According to staff, the original chillers modulated capacity with variable inlet guide vanes. Currently, the chiller control modulates both the chiller speed and the inlet guide vane position.

The engineering design firm provided a graphical illustration of the improvement of the chiller at various loads. Figure 3-13 shows the modeled energy-efficiency improvement of the chiller due to improved controls and installed VFDs. The main goal of the site visit and data collection effort was to verify the efficiency reported in Figure 3-13; this was not possible, however, because chilled water flow could not be metered while on-site. Instead, the claimed efficiency was reviewed to ensure reasonableness. The Cadmus Team also conducted a literature review of the Carrier hermetic liquid centrifugal chillers (Model #19EB 8981 DP) with and without VSDs (Variable speed drive). The efficiency modeled in Figure 3-13 is reasonable based on this review.

Figure 3-13. Chiller Efficiency Improvement at Project #2, Energy-Efficiency Program Area



The Cadmus Team worked with facilities personnel to determine what data should be trended though the building management system. An on-site engineer diligently sent the trend logs for review. Figure 3-14 through Figure 3-19 show a snapshot of trend data collected. All available data were reviewed, mainly to confirm that the chiller system is operating as intended and that the assumptions used to estimate savings are reasonable. The following six graphs represent the same two-day duration, in which outdoor temperature fluctuated from 67° F[64] to 87° F.

[64] Project #2 requires active cooling at 68° F.

Figure 3-14. Condenser Water and Outdoor Dry Bulb Temperature at Project #2, Energy-Efficiency Program Area

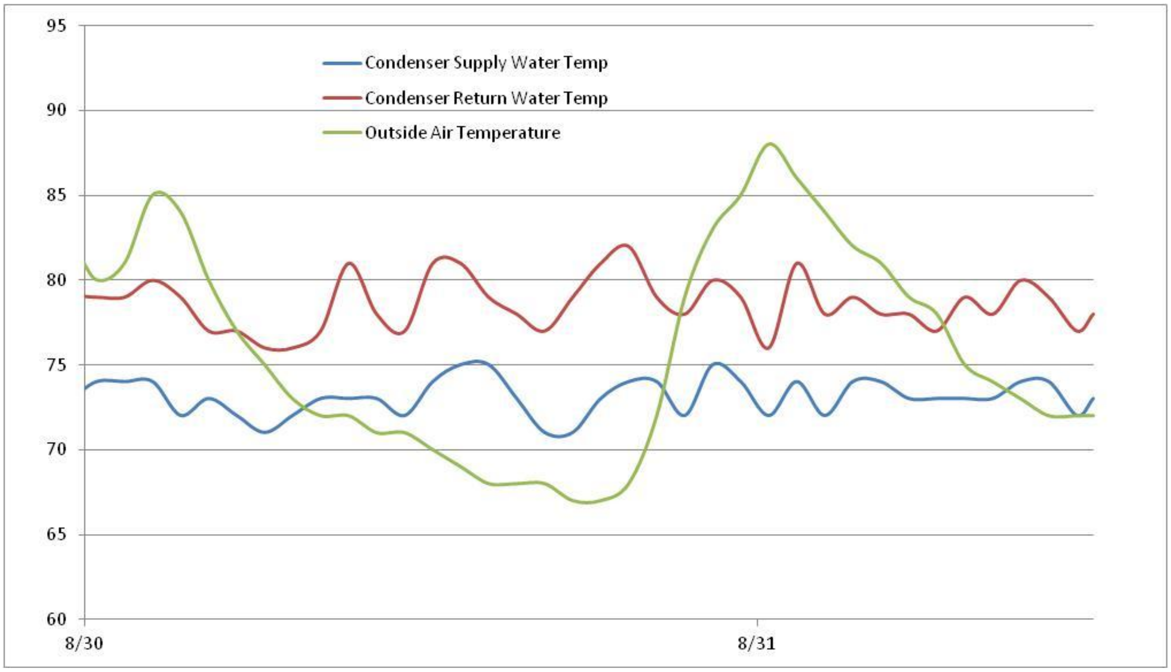


Figure 3-15. Cooling Tower VFD Trending at Project #2, Energy-Efficiency Program Area

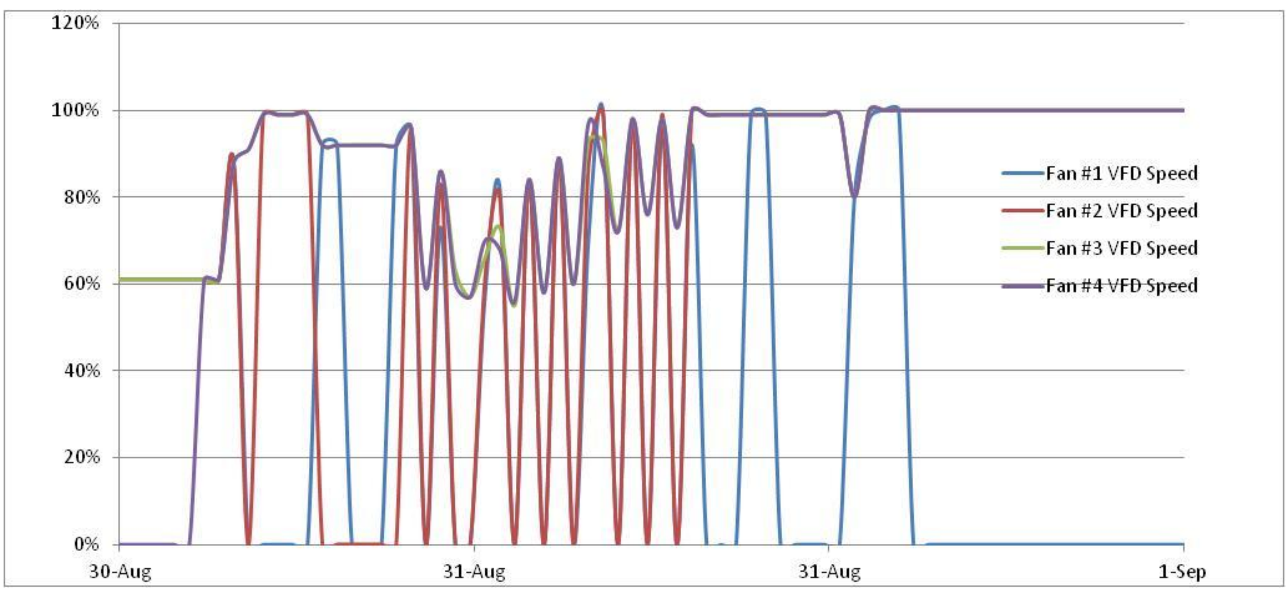


Figure 3-16. Chiller Capacity Trending at Project #2, Energy-Efficiency Program Area

Figure 3-17. Chiller Speeds at Project #2, Energy-Efficiency Program Area

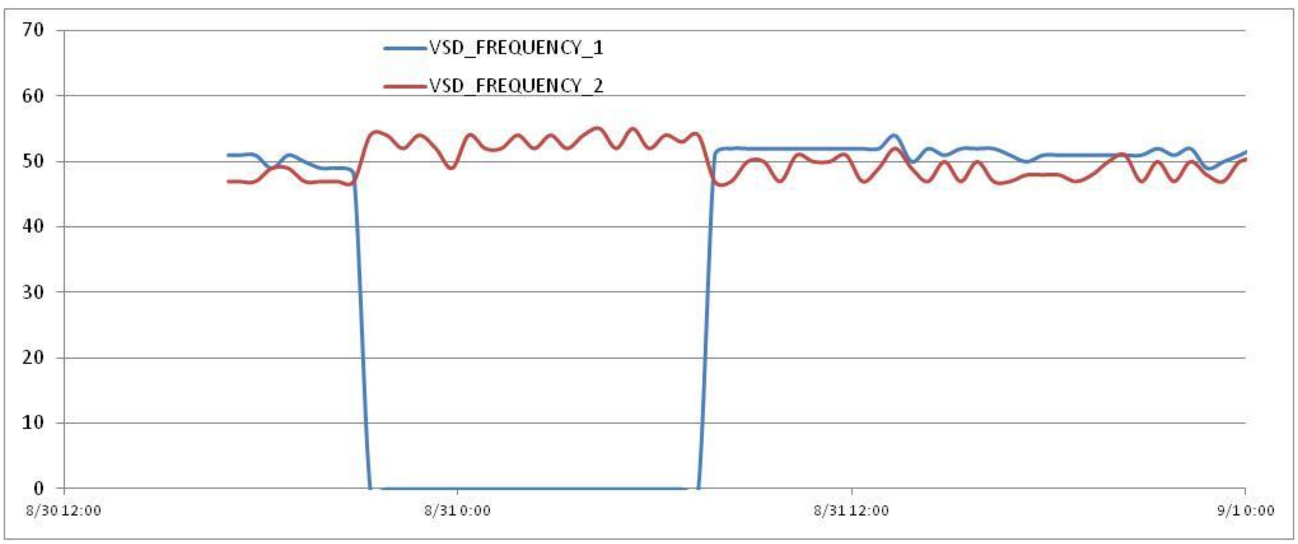


Figure 3-18. Chiller Capacity at Project #2 (October 1 thru October 20, 2011), Energy-Efficiency Program Area

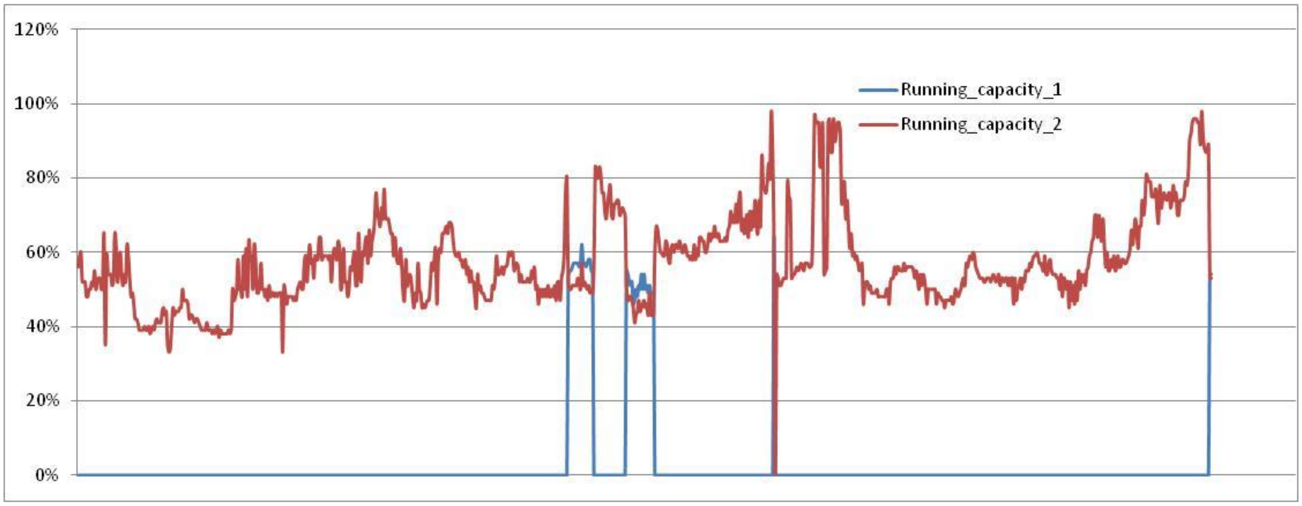


Figure 3-19. Chiller Capacity at Project #2 (August 31 thru September 3, 2011), Energy-Efficiency Program Area

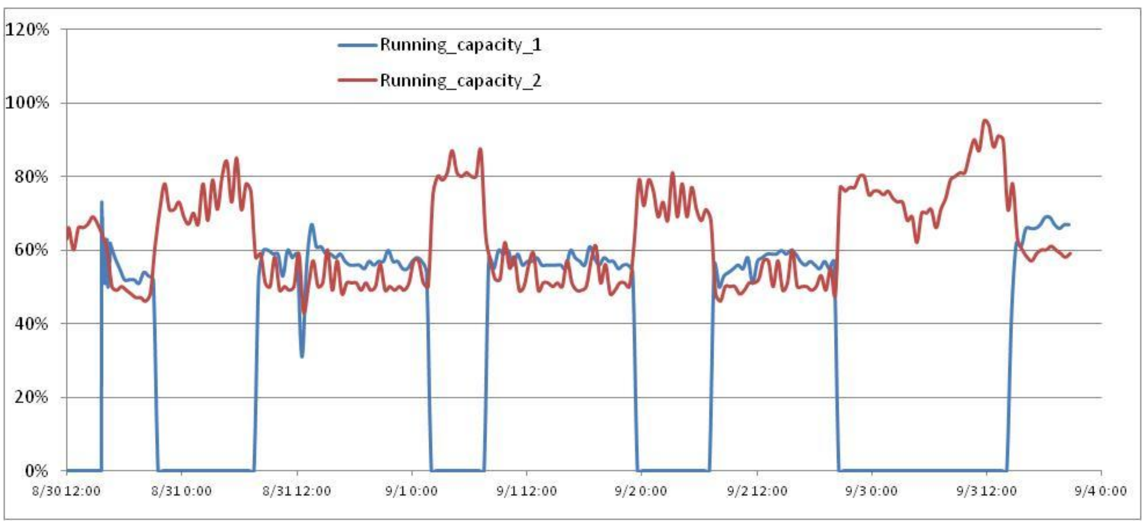


Figure 3-13 shows that the chiller operates at its highest efficiency around 50% capacity. Notice from the above graphs that the chillers typically operate at approximately 50% capacity. As cooling need increases, the second chiller turns on to maintain lower capacity and higher efficiency. The chiller controls seem to be operating as expected. In addition to improved chiller control, there was an operational change: the VFD-driven chillers operate in place of the 800-ton absorption chiller, and as a result, electrical energy is used instead of steam generated by electrical energy.

<u>Measure 2: CHP Cogeneration System Upgrade</u>

The Cadmus Team was unable to coordinate with the utility co-generation expert while on-site to thoroughly review and discuss the co-generation plant. All available information was reviewed. The radiator was changed so that the generators are capable of operating at 100% in the summer. This upgrade was necessary from an operational standpoint because of a decrease in the hot water consumption. The upgrade enabled maximum electrical energy consumption because more steam, not hot water, is produced. The installation of the new Ecodyne radiator was verified. The implementer provided the information in Table 3-102 and Table 3-103, which show overall project energy savings. These savings values were generated by modeling and gross approximation of co-generation efficiency.

Table 3-102. Implementer Provided Power Savings Summary at Project #2, Energy-Efficiency Program Area

Scenario Description	Central Chillers	Engine Output (kW)	Annual CHP Steam Generated (MMBtu)	Annual CHP Steam Utilized (MMBtu)	Annual Commerical Electricity (kWh)	Annual CHP Electricity (kWh)	Annaul Gas (Therms)	Annual Energy (MMBtu)	Annual Energy Cost ($)
Base Case Scenario	S,E,E	700	13,464	13,236	16,520,269	7,474,740	1,524,515	312,169	4,061,284
Start Both Electrics First	E,E,S	700	13,464	13,236	17,550,033	7,474,740	1,304,737	300,147	3,960,858
Install Chiller VFD	E,E,S	700	13,464	13,236	16,956,362	7,474,740	1,304,737	294,408	3,899,796
Install CT VFDs	E,E,S	700	13,464	13,236	16,737,272	7,474,740	1,304,737	292,290	3,868,859
Upgrade CHP	E,E,S	800	25,246	23,845	10,196,012	14,016,000	1,749,053	273,480	3,480,415

Table 3-103. Estimated Steam Use at Project #2 (MMBtu), Energy-Efficiency Program Area

Month	Old CHP		Upgraded CHP		Chillers		Cooling Towers	
	Steam Generated by CHP	CHP Steam Utilized	Steam Generated by CHP	CHP Steam Utilized	no VFD	with VFD	no VFD	with VFD
1	1,446	1,446	2,144	2,144	0	0	0	0
2	1,306	1,267	1,937	1,853	0	0	0	0
3	1,446	1,367	2,144	1,965	0	0	0	0
4	1,119	1,076	2,075	1,841	1,080	652	194	29
5	1,012	1,012	2,144	2,069	2,398	1,449	429	62
6	980	980	2,075	2,054	2,620	1,673	415	90
7	1,012	1,012	2,144	2,132	2,931	1,920	430	119
8	868	868	2,144	2,140	3,059	2,003	441	127
9	840	840	2,075	2,043	2,524	1,590	415	80
10	871	860	2,144	1,801	1,668	964	332	33
11	1,123	1,090	2,075	1,728	0	0	0	0
12	1,427	1,419	2,112	2,076	0	0	0	0
Total	**13,450**	**13,237**	**25,213**	**23,846**	**16,280**	**10,251**	**2,656**	**540**

The implementer's review notes state: "*under any condition in which the steam is to be dumped, the cogen output is no better than grid derived electricity. Dumped steam represents an energy loss which should be subtracted from the energy savings calculations.*" According to the implementer, 1,369 MMBtu is unused, and was therefore subtracted from the energy savings estimate. Table 3-104 shows the reported and verified savings estimates. Further trending data from both measures is necessary to fully understand the savings associated with this project. After thoroughly reviewing savings estimates and approximately 6 weeks of trend data, the Cadmus Team found the savings estimates to be reasonable and conservative. Claimed savings are 100% realized; however, a full year of trend data should be reviewed to confidently assess savings attributable to this project.

Table 3-104. Verified Savings at Project #2, Energy-Efficiency Program Area

	Savings Estimate (MMBtu)	Revised Submission by Implementer (MMBtu)	Verified Savings (MMBtu)
Measure #1: Improved Chiller Controls	16,750*	17,526	17,526
Measure #1: Installation of VFD's		2,118	2,118
Measure #2: Co-generation Upgrade	15,834	10,609	9,240
Total Project	**32,584**	**30,253**	**28,884**

* This is the combined savings from both measures (improved chiller controls and installation of VFDs).

Project #3

Overview

The Cadmus Team met with the facilities manager at Project #3 in October 2011, to discuss the project and tour the facilities. The Cadmus Team installed lighting loggers to record multiple light levels. During the site visit, staff were interviewed about the project to allow the Cadmus Team to understand their opinions of how it saved energy. It was determined that savings could be verified by estimating the run time and control of the lighting system.

Project Description

A lighting upgrade was proposed for three gymnasiums and an ice area. Energy-efficient lights were installed at both locations to directly reduce demand. Additionally, lighting controls were added so that lights could be reduced to 50% in the gymnasiums. Part of the project was not yet complete. Lighting controls in the ice arena had not been implemented at the time of the site visit, but this effort was planned for completion by the end of January 2012. According to a follow-up interview with the facilities manager, the staff has not been using 50% reduced lighting levels, which was confirmed by the meter data described below. The facilities manager would like to continue to improve lighting control by installing occupancy sensors.

Verification Activities

The following verification activities were conducted along with a site visit, on-site and follow-up interviews, and a project file review.

- Verification of new fixture installation
- Installation of lighting loggers set to record both 100% and 50% lighting levels (see Figure 3-20)
- Interview to confirm hours of operation and pre-measure conditions
- Meter data analysis and extrapolation to 8,760 hours/year of operation

Figure 3-20. Installation of Lighting Loggers in Project #3, Energy-Efficiency Program Area

Note: The sensitivity of one logger was set to turn off when light levels are at 50%.

Meter data showed that lighting levels in Building 1 were generally always at 100%. Only a portion of the Building showed some reduced light levels (half-level lights were operating approximately 6% of the time the lights were on). Lights were generally on for approximately 18 hours per weekday, and sporadically over the weekends.

Extrapolating meter data to the entire year yields 5,200 hours-of-use for Building 1 and 5,800 hours-of-use for Building 2. These estimates are higher than the original hours-of-use estimates, and savings increase as a result. Hours of operation at the 50% lighting level were very low, and therefore add little savings. Based on the interview with the facilities manager, the use of 50% lighting at Building 1 should improve. Furthermore, the controls had not been installed at the time of the site visit.

The facilities manager noted that numerous staff use the Building, so educating them on proper control is challenging and he would like to add occupancy sensors to reduce the hours-of-use at the 100% lighting level. He also mentioned that a small group of facilities personnel operates Building 1, and he expects that they will utilize the controls to reduce lighting levels. The reported calculations do not consider the additional reduction in hours. Savings have increased regardless due to higher-than-estimated hours of operation. In absence of any control improvements, the installation of high-efficiency lights with higher assumed operating hours has increased savings.

Table 3-105 outlines the pre- and post-measure conditions of the lights and their associated hours-of-use.

Table 3-105. Project #3 Lights and Runtimes at Pre and Post Measure Conditions, Energy-Efficiency Program Area

Existing						Verified		
Location	**Existing**	**No. Fixtures**	**Hours-of-Use**	**KWh Consumption**	**kWh Savings Calimed**	**kWh Consumption**	**kWh Savings**	**kW Savings**
1	250 W Metal Halide	36	5,161	54,814	10,764	54,814	0	0
2	250 W Metal Halide	72	5,217	110,817	38,808	85,924	24,893	4
3	Compact Flourescent Exit Signs	8	8,760	1,051	841	210	841	0
4	1,000 W Metal Halide	64	5,813	401,789	135,475	71,885	329,904	39
	500 W Incandescent	12	0	0	0	0	0	0
5	400 W Metal Halide	16	5,813	42,597	8,509	13,478	29,119	2
6	2’ x 4' 32 W T8	58	5,813	18,880	1,914	7,830	11,050	1
	4’ x 4' 32 W T8	26	5,813	16,927	1,794	6,942	9,985	1
Total		**292**		**646,875**	**198,105**	**241,083**	**405,792**	**47**

As discussed, the verified savings at Project #3 listed in Table 3-106 are conservative and will increase as the staff learn to use lower light levels and Building 2 controls are installed. The realization rate is high mainly because the assumed hours of operation were low compared to the metered data.

Table 3-106. Verified Savings, Energy-Efficiency Program Area

Savings Estimate	Evaluated Savings Estimate	Realization Rate
198,105 kWh	405,793 kWh	205%

Project #4

Overview

The Cadmus Team visited Project #4 in June and October 2011. During the initial visit, the Cadmus Team met with the facilities manager and key personnel to tour the facility, discuss the project, and install meters on all affected systems to establish a baseline. Where meters could not be installed, spot measurements were taken. During the follow-up site visit on October 18, 2011, meters were collected and staff were interviewed on the progress of the project and their opinion of how it saved energy.

Project Description

The following measures were implemented or will be implemented:

1. Install VFDs on:
    a. One primary chilled water pump at each of the two chiller plants
    b. Two secondary hot water pumps
    c. One primary hot water pump
2. Install VFD on AHU 4 supply fan
3. Install VFDs on AHU 9 supply and return fan
4. Replace one existing standard-efficiency boiler with four condensing hot water boilers at the hot water heating plant. The four smaller boilers will have a combined capacity that equals the one boiler in the original scope.
5. Extension of the building automation system (BAS):
    a. To include to the hot water heating plant
    b. To include AHU 6, AHU 7, the kitchen exhaust hoods, and the spaces served by AHU 7
    c. To include AHU 5 and the 16 critical reheat coils (zones) for the spaces served by AHU 3, AHU 5, AHU 8, and AHU 9
    d. To reset the schedule and shut down the chilled and condenser water pumps to take advantage of the other BAS extensions when possible
    e. To install three variable air valve terminal units and temperature sensors in the supply ductwork to the office spaces/patient room zones served by AHU 4

The original project included a lighting upgrade and installation of a new boiler stack, but these measures were not implemented.

Verification Activities

The Cadmus Team reviewed all project files before conducting the site visits. Project files contained very little information and did not define the savings estimate methodology. The following verification activities were conducted during the initial site visit:

- Metered true power of chiller (basement)
- Metered true power of basement chiller chilled hot water (CHW) pump
- Metered incoming outside air temperature and relative humidity
- Metered penthouse chiller
- Metered AHU 9 mixed, supply, and return air temperature and relative humidity
- Metered Pump 1 (20 HP penthouse chilled water pump)
- Took spot measurements of pumps and fans

Air Handling Unit 9

AHU 9 was a good candidate for detailed metering. It brings in outside air as needed and was set to run continuously. True power meters were installed to establish baseline energy consumption estimates. Unfortunately, the contractor who performed the equipment upgrades removed and discarded the true power meters on AHU 9 motors and CHW Pump 1 in the penthouse. Spot measurements were taken and the control strategy was documented during the follow-up site visit in October. In addition, valuable information was collected from the baseline and post-measure periods. Figure 3-21 shows consistent energy consumption of AHU 9 prior to installing the VSD.

Figure 3-21. Project #4 AHU 9 Supply and Return Fan Power, Energy-Efficiency Program Area

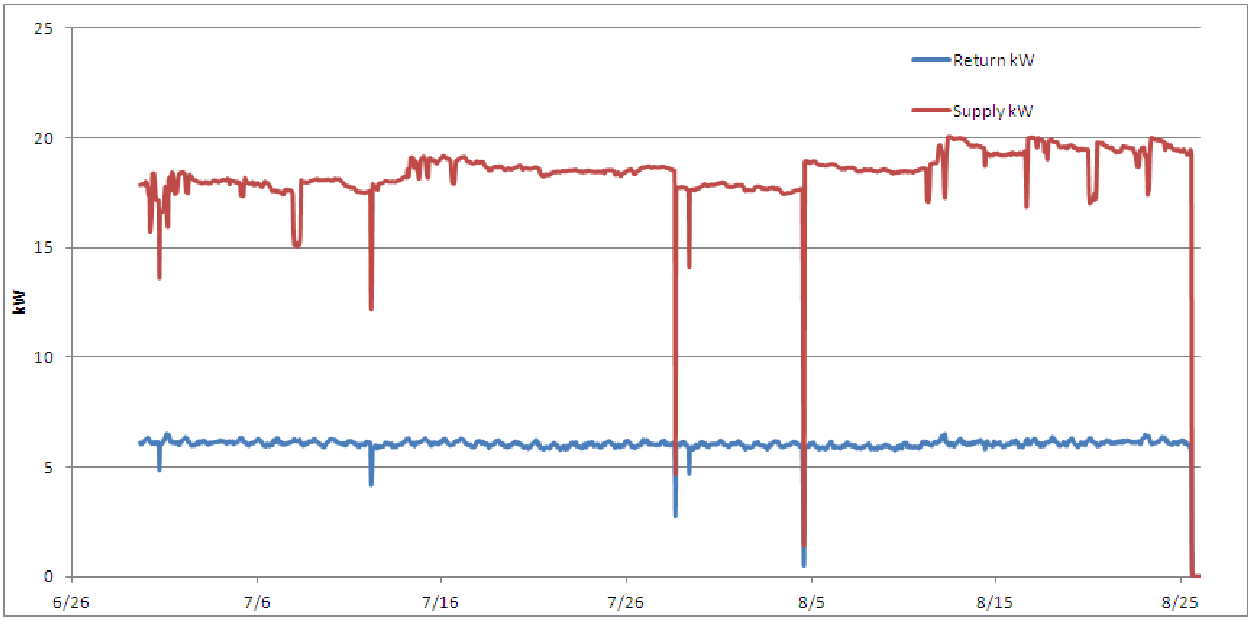
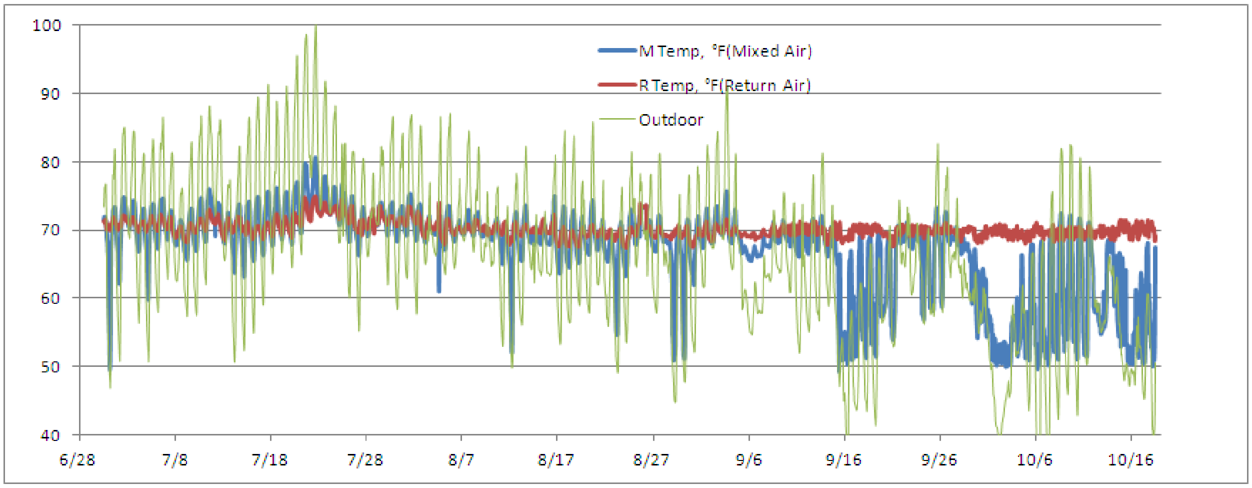


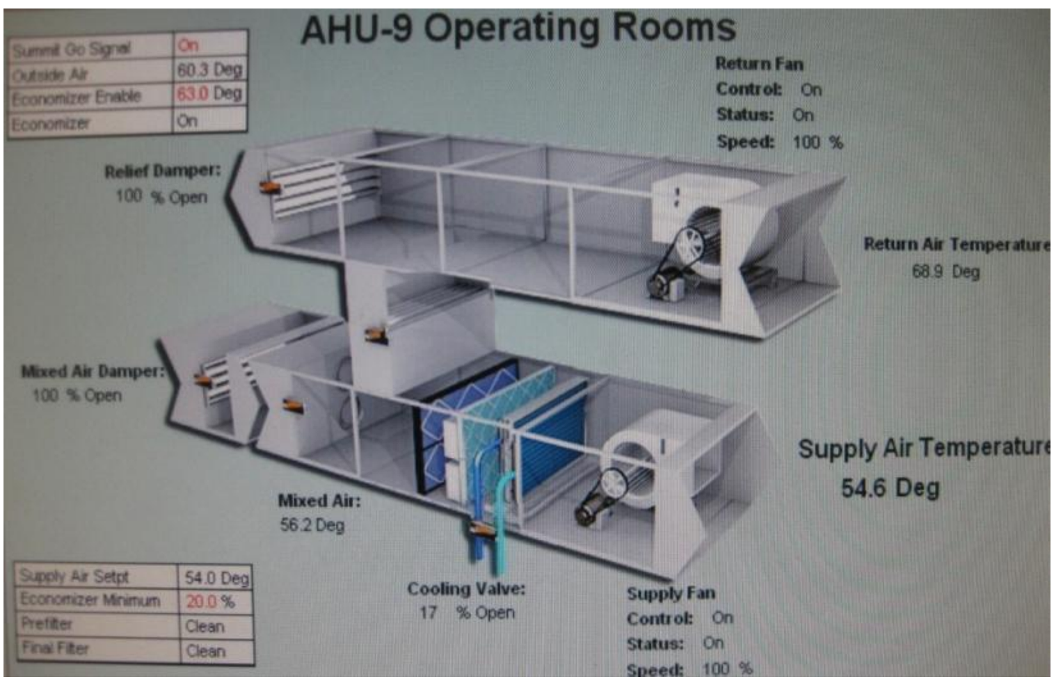
Figure 3-22 shows the temperature trends recorded for the duration of the study, outlining the control strategy and volume of outside air delivered by AHU 9.

Figure 3-22. Project #4 AHU 9 Temperature, Relative Humidity, and Outdoor Air, Energy-Efficiency Program Area



AHU 9 serves the operating room (OR). The OR temperature is maintained at 69° F and outside air is controlled with an economizer (minimum set at 20%). Figure 3-23 is a diagram from the BAS that shows operational set points of the air handler. This air handler does not supply heat.

Figure 3-23. Project #4 AHU 9 Schematic, Energy-Efficiency Program Area



The Cadmus Team measured airflow with a hand-held anemometer. This spot measurement was used to calibrate the estimate mix of incoming outdoor air at AHU 9. The percentage of outside air was calculated using the following equation:

Equation 3-10. Percentage of Outside Air, Energy-Efficiency Program Area

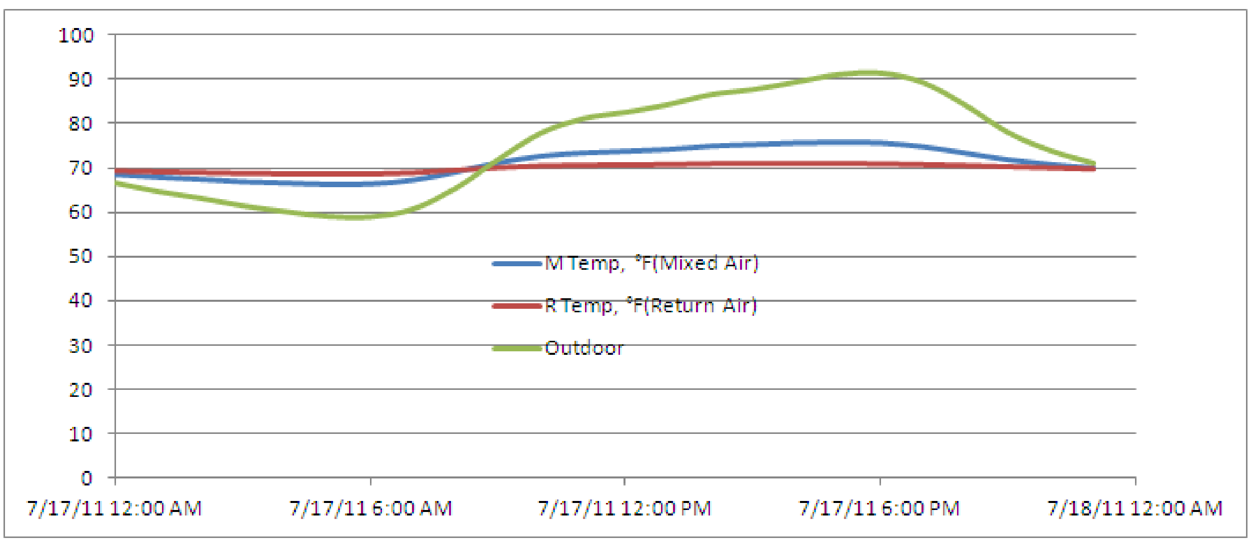
Where:

$T_{mixed\ air}$	=	Temperature of mixed air
$T_{return\ air}$	=	Temperature of return air
$T_{outside\ air}$	=	Temperature of outside air

The accuracy of this equation improves as the difference between the outdoor temperature and the return air temperature increases. Numerous locations were tested to determine the best mixed air temperature sensor placement. Based on the measurements, the average incoming outside air temperature is approximately 25% of the return air temperature from the end of June through mid-September 2011. The meter data support the spot measurements and shows that the OR temperatures held constant (see the return air temperature in Figure 3-24).

According to the metered data, the air handler is controlled as expected. Mixed temperature should be between the outdoor air temperature and return air temperature. Figure 3-24 shows that the temperature sensor placement was reasonable. As the outdoor air temperature rises above the return air temperature, the mixed air temperature corresponds accordingly.

Figure 3-24. Constant Speed AHU 9 Trending at Project #4, Energy-Efficiency Program Area



After the VSDs and improved control were installed in September 2011, the outside air temperature percentage increased; mainly because the variable speed fans were moving less air (see Figure 3-25). Notice there is a high apparent percentage of outdoor air (larger deviation between mixed air and return air) during unoccupied hours.

Figure 3-25. Variable Speed AHU 9 Trending at Project #4, Energy-Efficiency Program Area

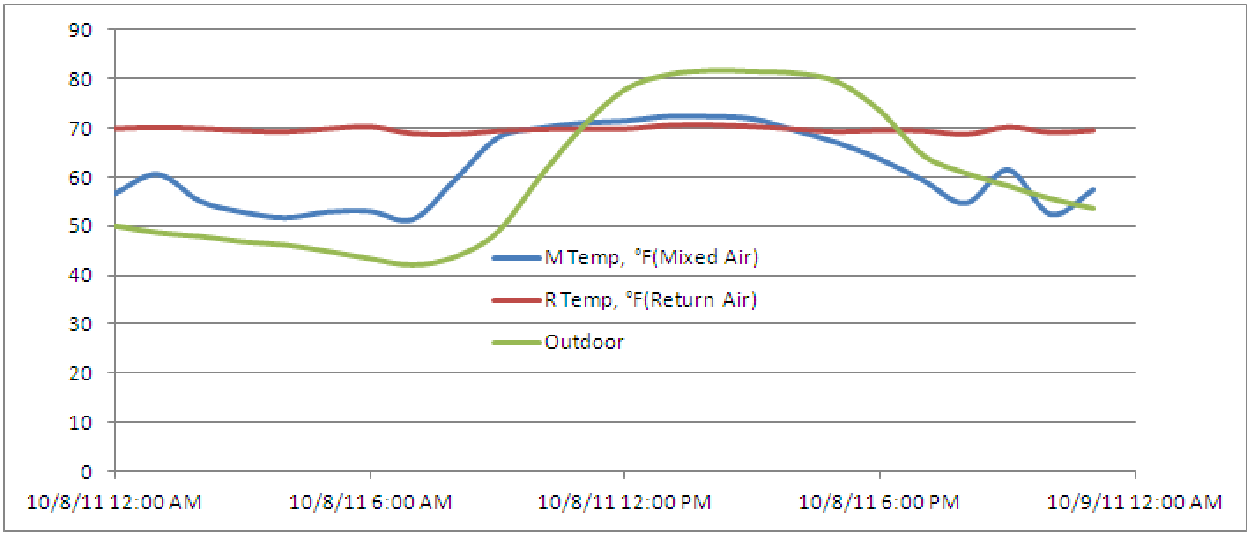
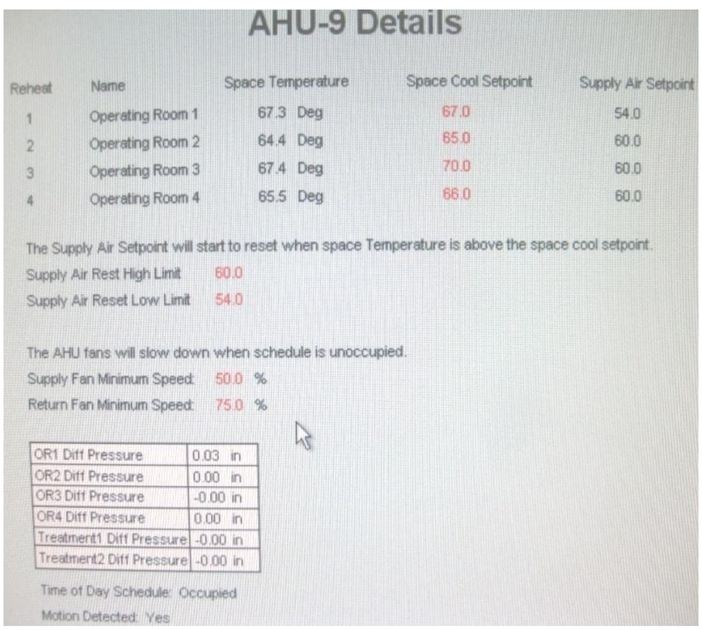


Figure 3-26 shows the control strategy of AHU 9. Based on a review of the meter data, AHU 9 is operating as intended. It is controlled by occupancy and throttles back to unoccupied mode frequently and as expected.

Figure 3-26. Project #4 AHU 9 Control Strategy, Energy-Efficiency Program Area



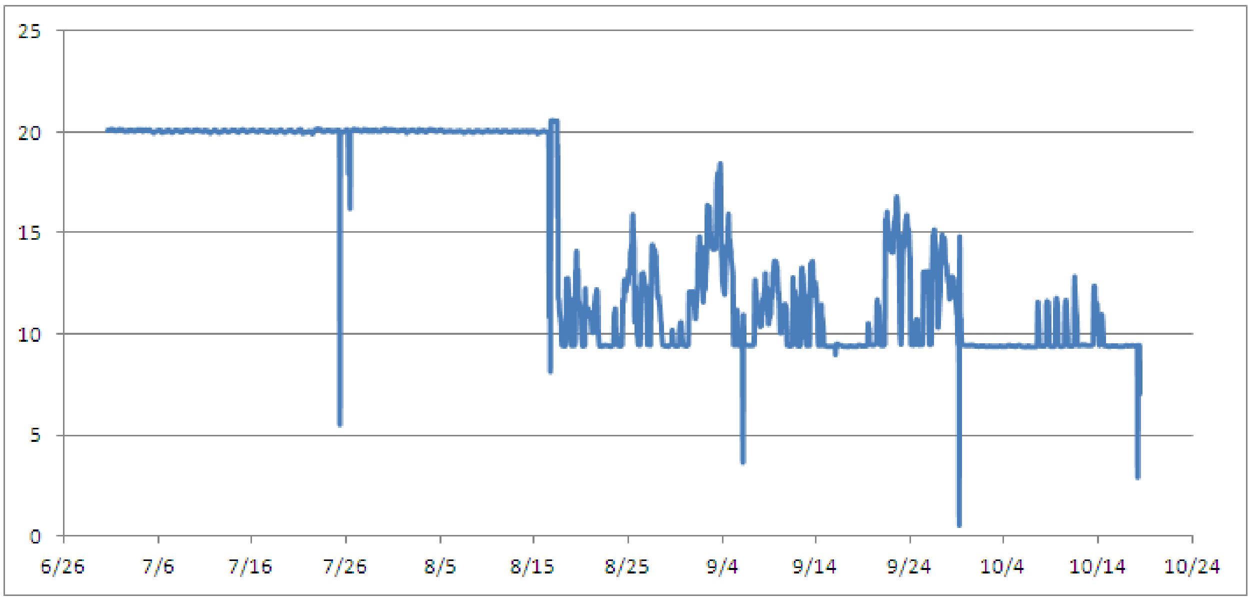
Discussion of Additional Measures

The operation and savings of AHU 6 and AHU 7 was verified. Unlike AHU 9, these air handlers shut down during unoccupied times (from 8:00 p.m. to 5:00 a.m.). The control strategy of both air handlers was verified to be operating as intended.

AHU 3 and AHU 8 did not change in operation schedule. Four additional zone sensors were added. The supply air temperature set point of AHU 4 is now calculated based on the zone temperatures. AHU 4, which brings in 100% outside air, had three dampers added that close at night. A VSD was also added, and supply temperature is controlled based on zone temperatures. Savings for this measure are attributable to the decrease in outside air (which must be conditioned) and the electric savings from the VSD fan speed reduction.

A VSD was installed on the basement chiller chilled water pump. The Cadmus Team noticed that the pump was not controlled, but was set to full speed. A true power meter was installed from the end of June through October 2011. Figure 3-27 shows that a control strategy was implemented around August 18, 2011. The minimum VSD speed was set at 75%, which is approximately 9 kW.

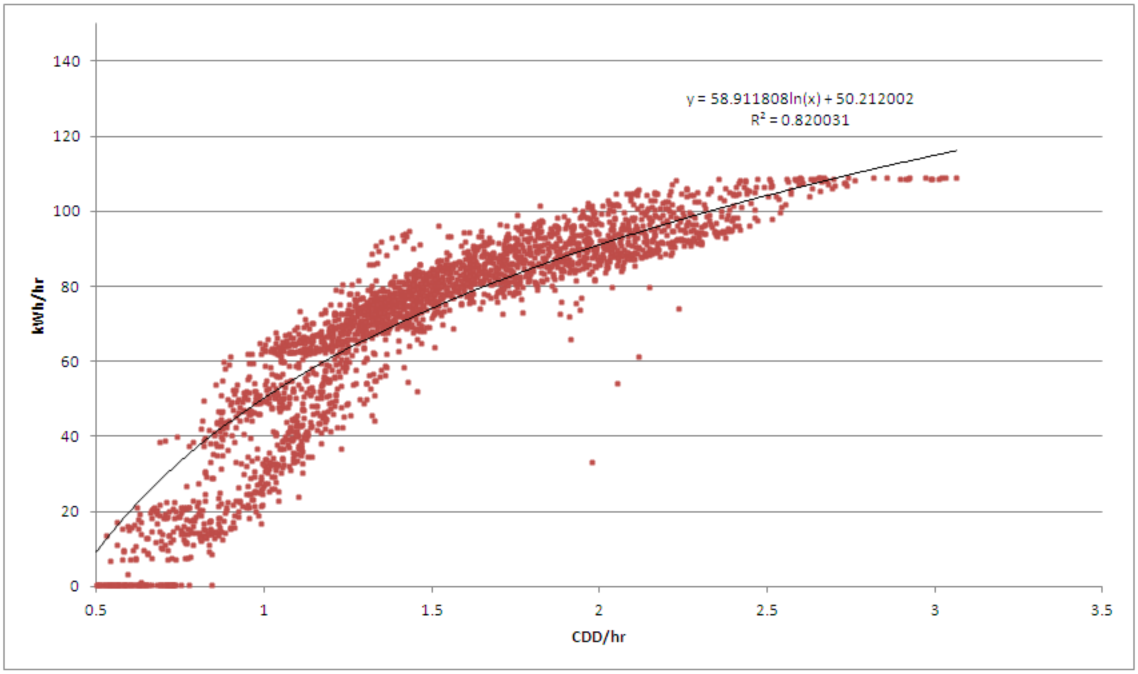
Figure 3-27. Project #4 Basement Chilled Water Pump Control Implemented Approximately August 18, 2011, Energy-Efficiency Program Area



The penthouse chiller pump was also metered; however, this meter was discarded during the project implementation work. The Cadmus Team noted that the original demand of this system was approximately 14 kW. The VSD recorded an average energy consumption of approximately 6.8 kW (yielding roughly 7.2 kW average savings).

The penthouse chiller was also metered. The Cadmus Team used the meter data to develop a model to estimate consumption throughout the entire year. Figure 3-28 shows the actual data and the model (logarithmic) developed. The CDD base temperature was varied to determine the best correlation between CDDs and kWh consumption. The result of meter data vs. CDD/hour is shown in Figure 3-28.

Figure 3-28. Project #4 Penthouse Chiller Energy Signature at 32° F CDD Base Temperature, Energy-Efficiency Program Area



This analysis either verifies savings or establishes a baseline for energy consumption. Some of the major measures were not yet complete as of the October 18, 2011 site visit. Continued trending data analysis is recommended to estimate savings. The initial review and site visit confirm that the savings estimate of 9,590 MMBtu is reasonable The savings estimate of 345,400 kWh is also reasonable (Table 3-107).

Table 3-107. Project #4 Electric Savings Review, Energy-Efficiency Program Area

Boiler Pumps	Estimated Savings (direct kW reduction)	Hours-of-Use	Yearly Savings (kWh)
AHU 6 and AHU 7	14.4	3,285	47,304
Penthouse CHW Pump	7.7	5,256	40,471
Basement CHW Pump	9.23	8,760	80,855
AHU 9	12.5	8,760	109,500
Total			**358,985**

Table 3-108 outlines the project savings for Project #4.

Table 3-108. Project #4 Project Savings Review, Energy-Efficiency Program Area

Claimed	Verified	Realization Rate
345,400 kWh	358,985 kWh	104%
9,590 MMBtu*	9,590 MMBtu	100%

* The verified Btu savings are different from claimed savings. A revised statement of work, submitted on October 14, 2011, replaced the original project statement of work and changed the claimed savings from 5,952 MMBtu to 9,590 MMBtu.

Project #5

Overview

The Cadmus Team visited Project #5 on September 2, 2011, meeting with the facilities manager and key personnel to discuss the project and tour the facility. The EMS was reviewed and the systems associated with each energy-efficiency measure were visually inspected. During the site visit, staff discussed the project and how, in their opinion, it saved energy. The Cadmus Team determined that savings could be verified through installing data loggers, with spot measurements, and by interviewing staff to determine equipment operating schedules.

Project Description

Project #5 is located in Westchester, New York. There are two, 2-story buildings and another two buildings with four floors. The buildings are generally heated by AHUs with hot water coils. One of the buildings uses 12-psi steam coils. There are three air-cooled chillers that provide chilled water to the AHUs. There are also some DX package AHU units. The energy-efficiency project aimed to improve the efficiency of both heating and cooling throughout the facility. The measures implemented through this project include:

- Demand control ventilation of 14 AHUs
- Unoccupied shut-off and commissioning of various spaces
- Add VFD’s to building hot water heater pumps
- Improve AHU control of various building sections
- Convert vortex dampers to VFDs for AHU 1 through AHU 6

Verification Activities

The Cadmus Team selected various systems for metering to verify initial savings estimated by the engineering firm. The following verification activities were conducted with a site visit, data collection effort, and project review.

Measure 1: Demand Control Ventilation

AHU 1 through AHU 6, as well as the AHUs in other areas, had CO2 sensors installed in the return air ducts. CO2 levels control the amount of outside air brought in by the air handler. The Cadmus Team installed a CO2 meter on one example system, shown in Figure 3-29. Power meters were also installed on the AHU 4 supply and return fan motors.

Figure 3-29. CO2 and Temperature Sensor in Project #5 AHU 4, Energy-Efficiency Program Area

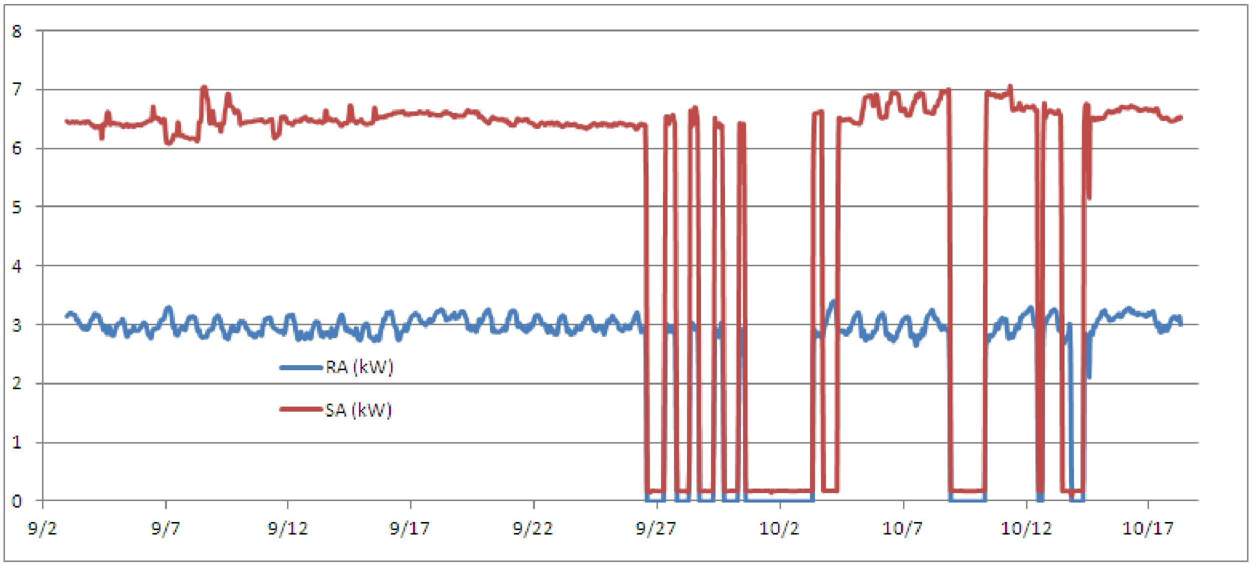
Review of the data shows that the system is operating as expected. Since the reliability of savings depends on the baseline condition, which was not metered, the Cadmus Team was only able to confirm whether savings are reasonable. This metering effort verified one of the 14 units with DCV controls, and these findings were used to validate the savings estimated by the implementer engineering team. When requested, the engineering team offered their savings estimates for each of the air handlers. Savings were estimated with temperature bin data, and the average heat content at each temperature bin was used to estimate savings that come from reduced heat entering the building during cooling periods and from heat loss when cold air enters the building during heating periods.

Savings for each of the 14 AHUs was reviewed and confirmed to be reasonable. Additionally, the Cadmus Team took spot measurements of airflow using the AHU fan curve and differential pressure at AHU 4, and found that it was within 10% of the airflow rate assumed.

Measure 2: Unoccupied Shut-off and Commissioning of AHUs

The Cadmus Team metered AHU supply and return air. The power trend data are shown in Figure 3-30. Notice that prior to September 26, 2011, there was no change in operation. The AHU began cycling as expected per the measure description during the week of September 26, 2011, and did not operate over the weekend. The following week, however, shows that the AHU resumed 24 hour-per-day operation. The Cadmus Team followed up with facilities personnel to explain these findings: they confirmed that the operation during the week of September 26, 2011 is now representative of that air handler. Electric savings claimed from this measure are 49,044 kWh, which is very conservative based on a cooling system efficiency of 1.2 kW/ton. Meter data does not sufficiently confirm savings estimates, so the conservative savings estimates for this measure are acceptable.

Figure 3-30. Project #5 Kitchen Supply and Return Air Power Trending, Energy-Efficiency Program Area



Measure 3: Add VFDs to Building Hot Water Heater Pumps

VFDs of 30 HP each were installed on some of the hot water heater (HWH) pumps, and VFDs of 15 HP each were installed on the other HWH pumps. The Cadmus Team metered these pumps to establish baseline information. One building's pump never ran, and demand for the other building's pump was steady at approximately 11 kW.

This measure aims to decrease pump power by controlling differential pump pressure. The savings estimated (95,983 kWh) are reasonable, but the post-measure energy use signature was not verified by metering. To verify savings, at least a portion of the 2012 heating season would need to be metered, or additional trend data would need to be collected.

Measure 4: Partial Variable Air Valve System

Implementation of this measure required installing VSDs on various AHUs. The assumption used to estimate savings is that the VSD will reduce in speed to an average of 75% of capacity. With a total of 25 HP on VSDs, a conservative estimate of electric savings is 100,000 kWh. This estimate assumes that motors are 90% efficient and the fan law is not quite cubic. Claimed savings based on unknown assumptions was slightly higher (121,192 kWh).

Measure 5: Conversion of Vortex Dampers to Variable Frequency Drives

The Cadmus Team confirmed the AHU fan motor sizes shown in Table 3-109 during the site visit.

Table 3-109. Measure 5 Systems at Project #5, Energy-Efficiency Program Area

System	Supply Fan HP	Return Fan HP
AHU 1	7.5	1.5
AHU 2	30	15
AHU 3	25	15
AHU 4	20	7.5
AHU 5	20	7.5
AHU 6	20	7.5

The VFDs listed in Table 3-110 are set to control static pressure. The assumption used to estimate savings is that the installed VSDs will reduce in speed to an average of 75% of capacity. With a total of 175 HP on VSDs, a conservative estimate for electric savings is 700,000 kWh. This estimate assumes that motors are 90% efficient and the fan law is not quite cubic. Claimed savings based on unknown assumptions was lower (608,495 kWh).

Table 3-110. Reported and Verified Savings at Project #5, Energy-Efficiency Program Area

	Reported		Verified		Realization Rate	
	kWh	MMBtu	kWh	MMBtu	kWh	Btu
Measure 1: Demand Control Ventilation	246,910	4,060	246,910	4,060	100%	100%
Measure 2: Unoccupied Shut-off and Commissioning	49,044	382	49,044	382	100%	100%
Measure 3: Add VFDs	95,983	0	95,983	N/A	100%	N/A
Measure 4: Partial VAV System	121,192	-71	100,003	-71	83%	100%
Measure 5: Conversion of Vortex Dampers to VFD	608,495	N/A	700,021	N/A	115%	N/A
Total	**1,121,624**	**4,371**	**1,191,961**	**4,371**	**106%**	**100%**

3.4 RENEWABLE ENERGY PROGRAM AREA

3.4.1 Data Sources: RFP 1613

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

- NYSERDA Program Area staff interviews
- Participant online surveys
- Weather data
- Site visits and engineering estimates
- System performance monitoring

3.4.2 Approach: Surveys and Sample Design: RFP 1613

Participant Online Surveys

To estimate freeridership for the Renewable Energy Program Area, the Cadmus Team relied on an online participant survey. A total of 44 online surveys were conducted with RFP 1613 project participants. Responses were received between September 12, 2011 and December 19, 2011.[65]

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 the Calculations for Evaluation Generation Net of Freeridership Section (described in Appendix F).

The implemented sample design stratified participants from Upstate (all of New York State except 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 3-111. The associated error margins were estimated at the 90% confidence level, assuming a 50/50 proportion in responses for each of the strata.

[65] Survey data were collected in two phases. Thirty five completed surveys were included in the analysis of process-related questions. Data for nine additional surveys were received on February 10, 2012, and were included in the attribution analysis. The data collection and reporting schedule did not allow the Cadmus Team to perform the follow-up surveys described in the Action Plan.

Table 3-111. Participant Survey Sample Design (Population), Renewable Energy Program Area

PON 1613	Population (projects)	Sample Size (Completed Surveys)	Sampling Error at 90% Confidence Level
PV Upstate	49	29	9.9%
PV Downstate	16	8	22.0%
Non-PV (all Upstate)	12	7	21.7%
Overall	77	44	8.5%

NYSERDA Program Area Staff Interviews

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.

Weather Data

To calibrate each site's performance model to actual weather data, the Cadmus Team used actual total horizontal solar radiation data. The actual radiation data for eleven applicable sites was downloaded from the Solar Data Warehouse Website.[66] The Cadmus Team developed an algorithm that selected the appropriate actual weather data for each site based on the nearest linear distance between the site and the data station.

Site Visits and Engineering Estimates

Site visits were conducted at 32 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, with 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. Characteristics, such as system tilt, orientation, irradiance, and power output, were measured at the site. Inspectors also reviewed shading: both instantaneous shading at the time of the site visit and the annual reduction in energy output due to shading. Shading measurements were taken with the Solmetric SunEye and Solar Pathfinder tools.

One of the most important aspects of the field inspection process was to verify reasonable system operation. This was accomplished using two methods. First, field staff measured real-time weather

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

conditions (solar irradiance, air temperature, etc.) and compared those values with simultaneous system power output readings to determine whether the system's instantaneous power output correlated with the available irradiance levels and module temperatures. This spot measurement approach is useful for identifying potential anomalies, such as inoperative strings in a solar PV system, which may not be apparent through a review of the metered energy output to date. Second, the Cadmus Team compared the operational period energy output, as determined from the on-site meter reading and confirmation of system interconnection date, 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.

Second, in addition to field inspections conducted at completed solar PV projects, the Cadmus Team used field inspections to gather data relevant to predicting the energy impact of non-solar PV projects, in cases where more detailed monitoring was not feasible. 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 tower and obstruction height for wind projects.

The Cadmus Team's 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 to ensure data quality and identify 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.

The Cadmus Team's evaluation activities, by technology and region, are summarized in Table 3-112.

Table 3-112. Impact Evaluation Activities by Technology and Region, Renewable Energy Program Area

	Population	Field Inspections*	Monitoring	Sampling Precision (at 90% Confidence)**
PV Upstate	48	(19) 21	0	9.5%
PV Downstate	16	(2) 5	0	
Wind Upstate	1	1	0	**
Wind Downstate	1	1	0	**
Solar Thermal Upstate	2	0	1	**
Solar Thermal Downstate	1	0	0	**
SHW Upstate	2	0	2	**
SHW Downstate	2	0	0	**
Biomass Upstate	3	0	1	**
Biomass Downstate	0	0	0	**
Tracking Solar PV Upstate	1	0	1	**
Tracking Solar PV Downstate	0	0	0	**

* Numbers in parentheses indicate site visits providing valid data for analysis. Sample precision was calculated using the valid data points only.

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

As shown in Table 3-112, some site visits did not result in valid 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
- Insufficient operational history (less than 30 days)

Prior to conducting site visits, the Cadmus Team attempted to obtain complete project information but, in some cases, this information did not match information from on-site personnel. Where this occurred, the Cadmus Team attempted to clarify or obtain the inaccurate/missing information. In cases where the operational history/generation data were not sufficient, despite efforts to obtain additional data needed to run the modified SAM models, the sites were excluded from the final sample.

The sampling precision, 9.5%, was calculated for both the PV Upstate and Downstate categories combined.

System Performance Monitoring

Site visit data for non-PV systems were supplemented through M&V efforts. Specifically, the Cadmus Team installed data acquisition systems (DASs) on select systems in order 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).[67]

Due to delays in completing funded projects, it was only feasible to monitor the performance of five systems. 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.

3.4.3 Process Findings: RFP 1613

When planning this evaluation, some NYSERDA staff members wanted to know if the fact that ARRA was the source of the funds enticed participants to apply for the NYSERDA funds. 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, respondents were asked 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 (a major driver of applying; Table 3-113). While the majority (54%) said this was not a factor in their decision at all, a substantial proportion (46%) 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 not a negative factor for any of the respondents.

Appendix G summarizes the awareness, motivation, economic factors, alternative funding, and spillover characteristics of the Renewable Energy Program Area.

Table 3-113. 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	*35*	*24*	*5*	*6*
Critical negative factor	0% (0)	0% (0)	0% (0)	0% (0)
Somewhat of a negative factor	0% (0)	0% (0)	0% (0)	0% (0)
Not at all a factor	54% (20)	58% (14)	60% (3)	50% (3)
Somewhat of a positive factor	19% (7)	21% (5)	20% (1)	17% (1)
Critical positive factor	27% (8)	21% (5)	20% (1)	33% (2)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

It is also the case that the NYSERDA ARRA funds were to be distributed quickly, and NYSERDA believed that some participants may have 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 when the funds became available?*"

[67] 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.

(Table 3-114). For 64% of respondents, the timing was a positive factor, whereas timing was not a factor at all in the remaining respondents' decision to apply for the funds. These findings support the Program Area theory that the short time frame in which the NYSERDA ARRA funds became available was a positive factor in inducing participation.

The timing of the funds appears to have been less of a factor in the Downstate PV respondents' decisions to apply for the funds compared to the other populations; 80% of Downstate respondents said that the timing was not a factor at all, versus 25% of the Upstate PV group and 33% of the non-PV group.

Table 3-114. 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	*35*	*24*	*5*	*6*
Critical negative factor	0% (0)	0% (0)	0% (0)	0% (0)
Somewhat of a negative factor	0% (0)	0% (0)	0% (0)	0% (0)
Not at all a factor	36% (12)	25% (6)	80% (4)	33% (2)
Somewhat of a positive factor	44% (15)	50% (12)	0% (0)	50% (3)
Critical positive factor	20% (8)	25% (6)	20% (1)	17% (1)

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

Note: 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 3-115 shows that the majority (63%) had participated in a previous program(s).

Considering the populations separately, the Downstate PV respondents were less likely than their Upstate PV and non-PV counterparts to have participated in other NYSERDA programs; only one-fifth (20%) of this group reported having participated in a NYSERDA program before.

Table 3-115. Past Participation in Other NYSERDA Programs, Renewable Energy Program Area

Response	Overall*	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*35*	*24*	*5*	*6*
Yes	63% (22)	71% (17)	20% (1)	67% (4)
No	38% (13)	29% (7)	80% (4)	33% (2)

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

Note: 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 programs in which they had participated (Table 3-116). Approximately one-quarter (26%) had undergone an energy audit, and a similar proportion (22%) had participated in a new construction program. Somewhat fewer (19%) had a technical study conducted, 7% had received incentives for replacing equipment, and 7% had previously participated in another renewable energy program(s).

Table 3-116. 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	*22*	*17*	*1*	*4*
Energy audit*	26% (6)	29% (5)	0% (0)	25% (1)
New construction	22% (4)	12% (2)	100% (1)	25% (1)
Technical study*	19% (3)	12% (2)	0% (0)	25% (1)
Equipment replacement incentive	7% (3)	18% (3)	0% (0)	0% (0)
Renewable energy	7% (3)	18% (3)	0% (0)	0% (0)
Other	47% (10)	47% (8)	0% (0)	50% (2)

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

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

* It is unclear if respondents understand the differences between technical studies and energy audits, as the Cadmus Team did not probe respondents to clarify what they meant by giving these responses.

These respondents were then asked how their participation in these other NYSERDA programs affected their decision to apply for the Renewable Energy Program Area (Table 3-117). 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, whereas a “critical positive influence” indicates that previous participation was a major driver towards deciding to apply.

Overall, the large majority (97%) indicated that their previous experience with NYSERDA programs was a positive influence, and just one Upstate PV respondent indicated that it was a negative 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 the reasons why most respondents applied for the NYSERDA ARRA Program Area.

Table 3-117. 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	*22*	*17*	*1*	*4*
Critical negative influence*	5% (1)	6% (1)	0% (0)	0% (0)
Somewhat of a negative influence	0% (0)	0% (0)	0% (0)	0% (0)
Not at all a influence	9% (2)	12% (2)	0% (0)	0% (0)
Somewhat of a positive influence	55% (12)	59% (10)	0% (0)	50% (2)
Critical positive influence	32% (7)	24% (4)	100% (1)	50% (2)

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

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

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

* There was no follow-up question, so the reason this respondent answered "critical negative influence" is unknown.

The final question about prior participation asked respondents whether the measures installed through the current Program Area had been recommended in a previous NYSERDA energy-efficiency audit or study. Out of the respondents who had participated in past NYSERDA programs, 30% 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 3-118). It appears, then, that NYSERDA ARRA provided a source of funds for at least some participants in other programs to implement measures recommended in prior studies, which was desirable based on the Program Area theory.

Table 3-118. 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	*22*	*17*	*1*	*4*
Yes*	30% (4)	12% (2)	0% (0)	50% (2)
No	70% (18)	88% (15)	100% (1)	50% (2)

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

Note: 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, but only one respondent was able to specify a program (in this case, FlexTech).

Staff Interview Findings

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

- The inclusion of technologies in RPF 1613 was partially driven by stakeholder input. For example, fuel cells were included as an eligible technology based on stakeholder input, though 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 between RFP 1613 and existing Renewable Portfolio Standard (RPS) programs for small wind and solar PV projects. Applicants under RPS programs were allowed to reapply under RFP 1613, thereby foregoing RPS funding in favor of ARRA funds[68]

3.4.4 Program Area Generation Assumptions and Engineering Analysis: RFP 1613

The Cadmus Team completed an engineering analysis of gross energy generation for the renewable energy technologies included in this evaluation, as described below. Systems receiving performance monitoring followed the IPMVP Option B-Retrofit Isolation methodology, as outlined in IPMVP's *Guidelines for Development and Approval of Custom Measure Protocols.*[69]

Biomass

Three biomass boiler projects were funded under RFP 1613. While the precise configuration of each system is unique, the general purpose of the boilers is to provide space and/or hot water heating to facilities by burning woody biomass, such as wood chips or pellets. These projects generally supplant consumption of fossil fuels, such as propane, oil, or natural gas. Some examples of boiler photographs are shown in Figure 3-31.

[68] 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.

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

Figure 3-31. Biomass Boiler System Installed, Renewable Energy Program Area

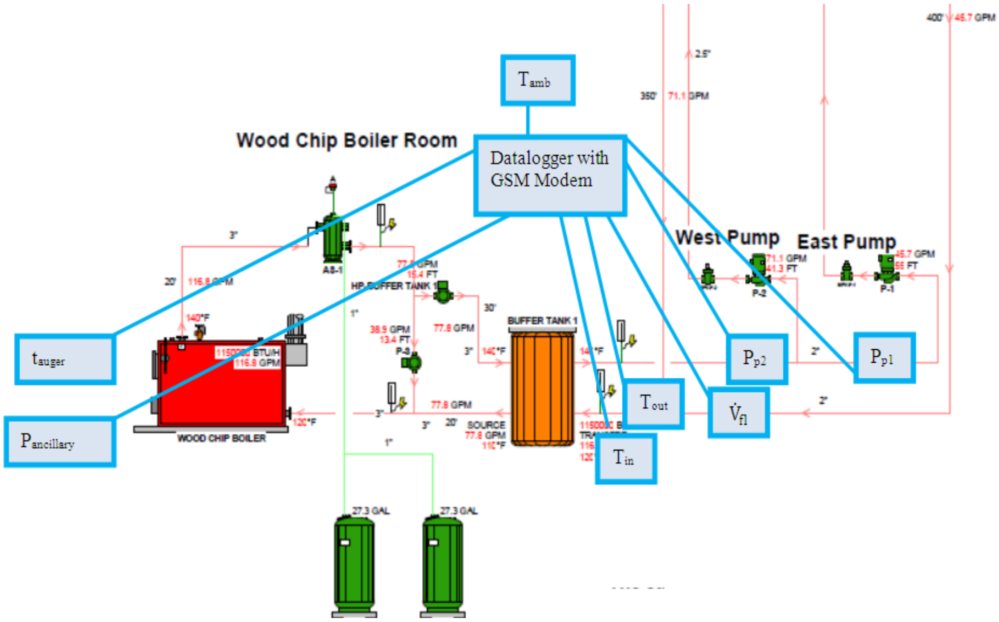
Fuel Storage Silo Boiler Unit

The Cadmus Team monitored the performance of one biomass boiler project. In order to calculate generation, the Cadmus Team collected data on:

- Ambient outdoor temperature
- Boiler inlet/outlet temperature
- Boiler loop flow rate
- Run-time of fuel-feed auger
- Electrical energy consumption of pumps and ancillary equipment

The placement of the various sensors for the project is shown in Figure 3-32.

Figure 3-32. Monitoring Configuration of Biomass Boiler, Renewable Energy Program Area



The Cadmus Team calculated the following metrics for the monitoring period and for a TMY:

- Existing boiler thermal efficiency
- New boiler thermal efficiency (full and partial load)
- Thermal energy delivered
- Fuel consumed

The Cadmus Team calculated the useful energy delivered by the biomass boiler using Equation 3-11.

Equation 3-11. Energy from Biomass Boiler Calculation, Renewable Energy Program Area

Where:

	=	The measured water flow rate in gallons per minute (GPM)
c_p	=	The specific heat capacity of the working fluid (Btu/lb; ^oF)
T_{out}	=	The working fluid temperature leaving the boiler (^oF)
T_{in}	=	The working fluid temperature entering the boiler (^oF)

The results of Equation 3-11 were summed for the monitoring period.

Ancillary Equipment Energy Consumption

Biomass boilers generally require additional electrical energy to operate compared with fossil fuel-fired boilers. The bulk of this additional electricity is involved in the fuel distribution process. For biomass boilers installed remotely to the thermal load, additional pumps may be required to incorporate heat from the biomass boiler into the existing building heating system.

The Cadmus Team measured the energy consumption of pumps, auger motors, and the biomass boiler itself, then considered this additional energy consumption in the gross generation calculation.

Fossil Fuel Savings

The avoided fossil fuel usage ($Fuel_{saved}$) was calculated using Equation 3-12.

Equation 3-12. Avoided Fossil Fuel Calculation, Renewable Energy Program Area

Where:

cf_{fuel}	=	Energy content of propane fuel
$Q_{delivered}$	=	Calculated energy delivered to thermal load
η_{fossil}	=	Efficiency of baseline boiler (estimated)

Extrapolating Energy Generation

The Cadmus Team normalized fuel generation by the HDDs, corresponding to the monitoring period as reported by the weather station closest to the site. A simple ratio was used to adjust fuel generation, based on the following factors, for long-term average HDDs:

- Unoccupied periods (e.g., vacations)
- Unusual operating conditions/facility use
- Measurement abnormalities or data gaps
- Downtime or performance anomalies with system

The Team used Equation 3-13 to calculate typical fuel generation based on adjusting monitoring data to typical weather conditions.

Equation 3-13. Fuel Generation Calculation, Renewable Energy Program Area

Where:

A	=	Linear regression coefficient between $Fuel_{saved}$ and HDD_{MP}
HDD_{Typ}	=	Long-term average HDDs[70]
HDD_{MP}	=	HDDs during the monitoring period

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 circulates a working fluid (water, or a water/glycol mix) in a thermally insulated absorber plate that 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 DHW in an insulated hot water tank. Four solar hot water (SHW) systems were funded under RFP 1613. Figure 3-33 shows photographs of SHW system components. The photograph on the left depicts an array of roof-mounted flat plate solar collectors. The image on the right depicts a pumping station and controller for the same system, as well as a tank for storing the water pre-heated by the SHW system before it enters the building hot water loop.

[70] Obtained from NOAA based on data compiled from 1971-2000. See: http://cdo.ncdc.noaa.gov/climatenormals/clim81_supp/CLIM81_Sup_02.pdf for further details on HDD data.

Figure 3-33. Solar Hot Water System Collector Array, Pumping Station, and Preheat Tank, Renewable Energy Program Area

Note: The sensors were added by the Cadmus Team.

The Cadmus Team monitored the performance of two SHW systems, collecting data on factors such as:

- Solar irradiance
- Ambient outdoor temperature
- Fluid temperature
- DHW consumption
- Energy consumption of backup hot water heater

SHW Delivered Thermal Energy Output

The useful energy produced by SHW systems each day was calculated using the metered performance data and Equation 3-14. This equation sums the energy delivered during each averaging interval (10 minutes) on the data logger on a daily basis. Data for longer periods was based on a combination of daily sums.

Equation 3-14. Useful Energy Produced by SHW Systems, Renewable Energy Program Area

Where:

Q_{SWH}	=	Energy delivered by SWH system
$Flow_{SHW}$	=	GPM (t_{int}) through the hot water system
t_{int}	=	The 10-minute sampling period (integrated to 1,440 minutes, or 24 hours)

D_{water}	=	Density of water (8.34 lbs/gallon)
c_p	=	Specific heat capacity of water (1.0 Btu/lb °F)
$T_{SHW\text{-}out}$	=	Water temperature leaving the solar tank/entering back-up tank (°F)
$T_{SHW\text{-}in}$	=	Water temperature entering the solar tank (°F)

Solar Resource

The energy output of a SHW system is primarily driven by incident solar radiation and the temperature of the SHW storage tank. Other factors, such as ambient outdoor temperature and system operation under partly cloudy skies, also affect energy collection, but are generally secondary effects since SHW system operation tends to be digital based on having sufficient solar radiation and a low enough storage tank temperature. The Cadmus Team used solar radiation data from the National Solar Radiation Data Base, which presents hourly solar radiation for a typical year (i.e., TMY2 or TMY3 files). These files are widely used by tools, such as RETScreen, to estimate the performance of solar energy projects. The Cadmus Team compared the solar radiation data measured on-site with the TMY3 hourly profile for the same monitoring period. The Cadmus Team used the ratio of the cumulative energy inputs of the actual and TMY3 monitoring periods to adjust Q_{sav}, as shown in Equation 3-15. For example, if the monitoring period happened during unusually cloudy months, Q_{SHW} might appear artificially low and would be higher in a year with typical irradiance levels.

Equation 3-15. Adjustment to Energy Savings, Renewable Energy Program Area

Where:

I_{TMY}	=	Global horizontal solar radiation for a TMY, obtained from the nearest available weather station to the site and corresponding to the monitoring period
I	=	Measured on-site global horizontal solar radiation

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.[71] 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 TMY (e.g., TMY2) solar radiation data for 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.[72] PVWatts was also developed by NREL and uses the same TMY2 data and general calculation methods employed in SAM. The

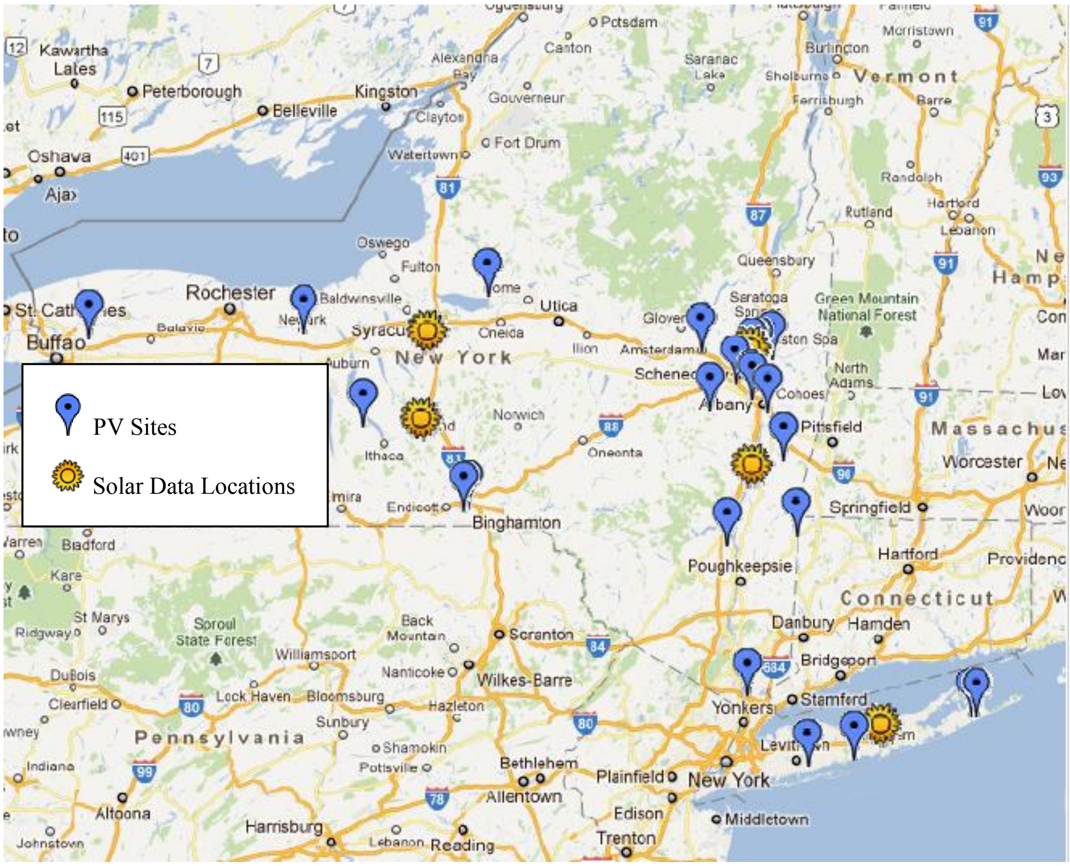
[71] Access online at: https://sam.nrel.gov/.

[72] Access online at: http://www.nrel.gov/rredc/pvwatts/.

Cadmus Team elected to use SAM, however, because of SAM's more flexible interface and data export capabilities.

A total of 68 solar PV systems were funded under RFP 1613. The Cadmus Team conducted 26 on-site inspections of installed solar PV systems.

Figure 3-34. RFP 1613 Solar PV Site Visit Locations, Renewable Energy Program Area



Using historical data from the weather stations indicated in Figure 3-34, the Cadmus Team compared operational period energy output with irradiance over the same period. The Cadmus Team used Equation 3-16 to identify possible sources of modeling bias in the SAM tool and to adjust the raw annual estimate. Since SAM uses a variety of derate and adjustment factors, R_{model} is useful for determining whether these values match real world conditions.

Equation 3-16. Calculation to Identify Modeling Bias, Renewable Energy Program Area

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 by the Cadmus Team 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, Equation 3-17 was used to determine the gross generation for each site.

Equation 3-17. Gross Generation Determination, Renewable Energy Program Area

Where:

AEP_{SAM}	=	Predicted annual electricity production as calculated by the Cadmus Team using NREL's SAM
R_{model}	=	Adjustment factor accounting for weather and performance variability between observed system performance and model predictions

Solar Wall

One solar wall project was funded under RFP 1613. Figure 3-35 and Figure 3-36 show photographs of this project.

Figure 3-35. Monitored Project Solar Wall Fan Unit and Distribution Duct, Renewable Energy Program Area

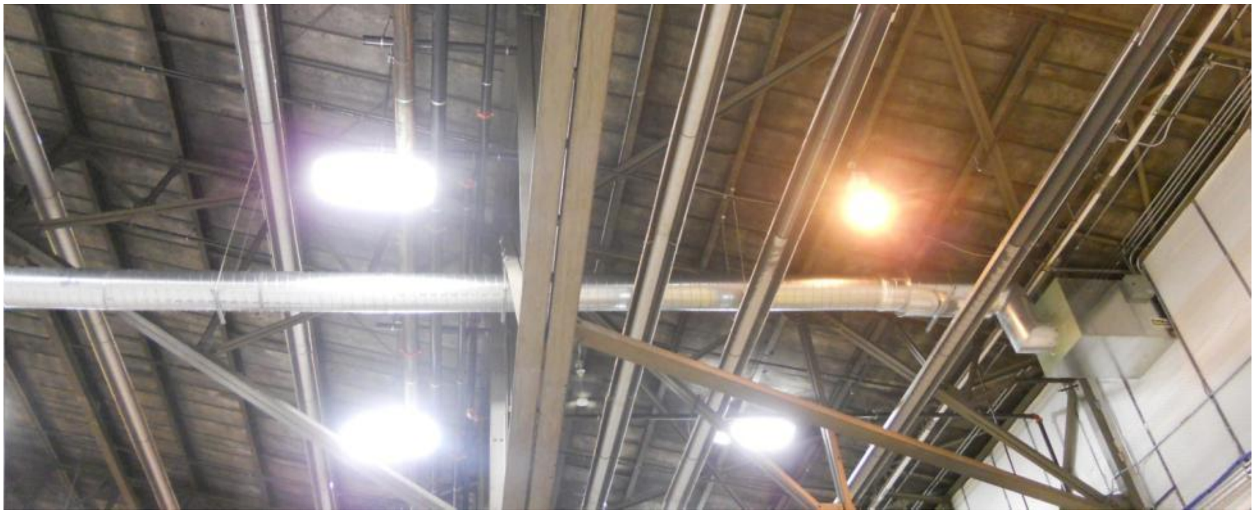


Figure 3-36. Solar Wall Collectors (Exterior View) at Monitored Project, Renewable Energy Program Area

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 3-18.

Equation 3-18. Daily Thermal Energy Contribution of Solar Wall, Renewable Energy Program Area

Where:

t_{int}	=	The 10-minute sampling period (integrated to 1,440 minutes, or 24 hours)
$flow_{fl}$	=	Air flow from solar wall (CFM)
ρ	=	Air density (lb/ft^3)
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

In determining the energy savings of the Solar Wall system, the two fan units' electricity consumption, calculated using Equation 3-19, was added to the energy produced by the Solar Wall system.

Equation 3-19. Fan Unit Electricity Consumption, Renewable Energy Program Area

Where:

t_{int}	=	Logging interval in minutes
P_{int}	=	Average power ($Q_{electric1}$ + $Q_{electric2}$) recorded over the sampling interval (BTU/hr)

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 regression equation was applied to typical meteorological year (e.g., TMY2), daily average irradiance, and HDD values.

Vertical Temperature Profile

The air in a large open heated area (specifically 1,093,794 ft^3 for this project) will naturally stratify based on the laws of thermodynamics, which causes warm air to rise and cold air to sink. Heating load and system performance may be impacted by this condition. Stratification of the heated air could negatively impact system performance and heating demand.

The Cadmus Team reviewed vertical temperature profiles within the heated space to identify the amount of time with and without the solar wall operating that the temperature near the ceiling of the facility exceeded the thermostatic set point for the gas heating unit. When the temperature near the ceiling exceeds the thermostatic set point while the gas heating unit is operating, then destratifying the interior airspace could provide additional, unrealized generation.

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 for 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.

One tracking solar PV system was funded under RFP 1613. The Cadmus Team monitored the performance of this system in order to better understand possible deviations between expected and achieved energy generation.

Figure 3-37 and Figure 3-38 show a two-axis mounting system supporting 30 modules that is programmed to move in lock-step with the sun to maximize output from the PV panels.

Figure 3-37. Monitored Project Tracking Solar PV System (Multiple Arrays), Renewable Energy Program Area

Figure 3-38. Solar Tracker From the Back, Renewable Energy Program Area

The manufacturer of the tracking system developed an algorithm of movement in a programmable logic controller that articulates in two axes periodically throughout the day to keep the panels nearly perpendicular to the sun. With this configuration, the array begins the day facing east at a steep tilt angle, moves through the day increasing azimuth toward west, and tilt dropping toward solar noon, and then returning to a steep angle toward day's end, as shown in Figure 3-38.

Wind

Two distributed wind energy systems were funded under RFP 1613, one of which is shown in Figure 3-39.

Figure 3-39. RFP 1613 Funded Small Wind Turbine at Monitored Project, Renewable Energy Program Area

Due to the extensive implementation delays involved with wind projects, it was not possible to conduct a detailed monitoring campaign of the installed projects. The Cadmus Team conducted on-site inspections of the two installed projects, using a protocol similar to that described for solar PV projects.

However, the performance of wind energy systems is subject to significant variability and is based on the available wind resource, which is largely dictated by particular site characteristics, such as the presence of trees, buildings, and other significant terrain features near the turbine. In order to reflect these characteristics and generate an accurate estimate of annual energy output, the Cadmus Team employed a modified version of the Commonwealth Wind Evaluation and Siting Tool (CWEST). Cadmus developed this tool for the Massachusetts Clean Energy Center to address inaccuracies in other types of small wind modeling tools. CWEST accounts for site characteristics, such as terrain and obstructions, to provide a more accurate estimate of wind system annual energy output than those from more basic, commonly available modeling tools.

It was not possible, however, to make a meaningful comparison of actual energy output of the funded systems, as they have only been operational for a short time.

3.4.5 Net Generation/Savings Calculations: RFP 1613

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 Participant Online Surveys Section (described in Appendix G).

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, but updated by NYSERDA and the Cadmus Team 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).[73] Finally, freeridership is 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 involves five steps:

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

[73] 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 greenhouse gases reduced. 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 the savings.

3. Adjusting direct freeridership based on the Program Area influence score[74]
4. Adjusting freeridership by the percent of the project funded by NYSERDA ARRA
5. Weighting by the energy generation

Freeridership results are presented in Renewable Energy Program Area, Net Savings Findings: RFP 1613, and the calculations are detailed in Appendix F.

The assessment does not take spillover[75] into account, because the renewable energy projects had been completed too recently to allow for spillover to have occurred.[76] 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 1613 participants: PV systems installed Upstate, PV systems installed Downstate, and non-PV systems.[77] Freeridership was estimated 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, an overall freeridership rate was developed for RFP 1613. The Cadmus Team developed weights based on anticipated *ex ante* generation from all active RFP 1613 renewable energy projects (Table 3-119). For the overall freeridership rates, each stratum was weighted 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 1613 renewable energy projects in Renewable Energy Program Area, Net Savings Findings: RFP 1613.

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[74] 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.

[75] 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. http://neep.org/uploads/EMV%20Forum/EMV%20Products/EMV_Glossary_Version_2.1.pdf.)

[76] Peters and Bliss, 2010.

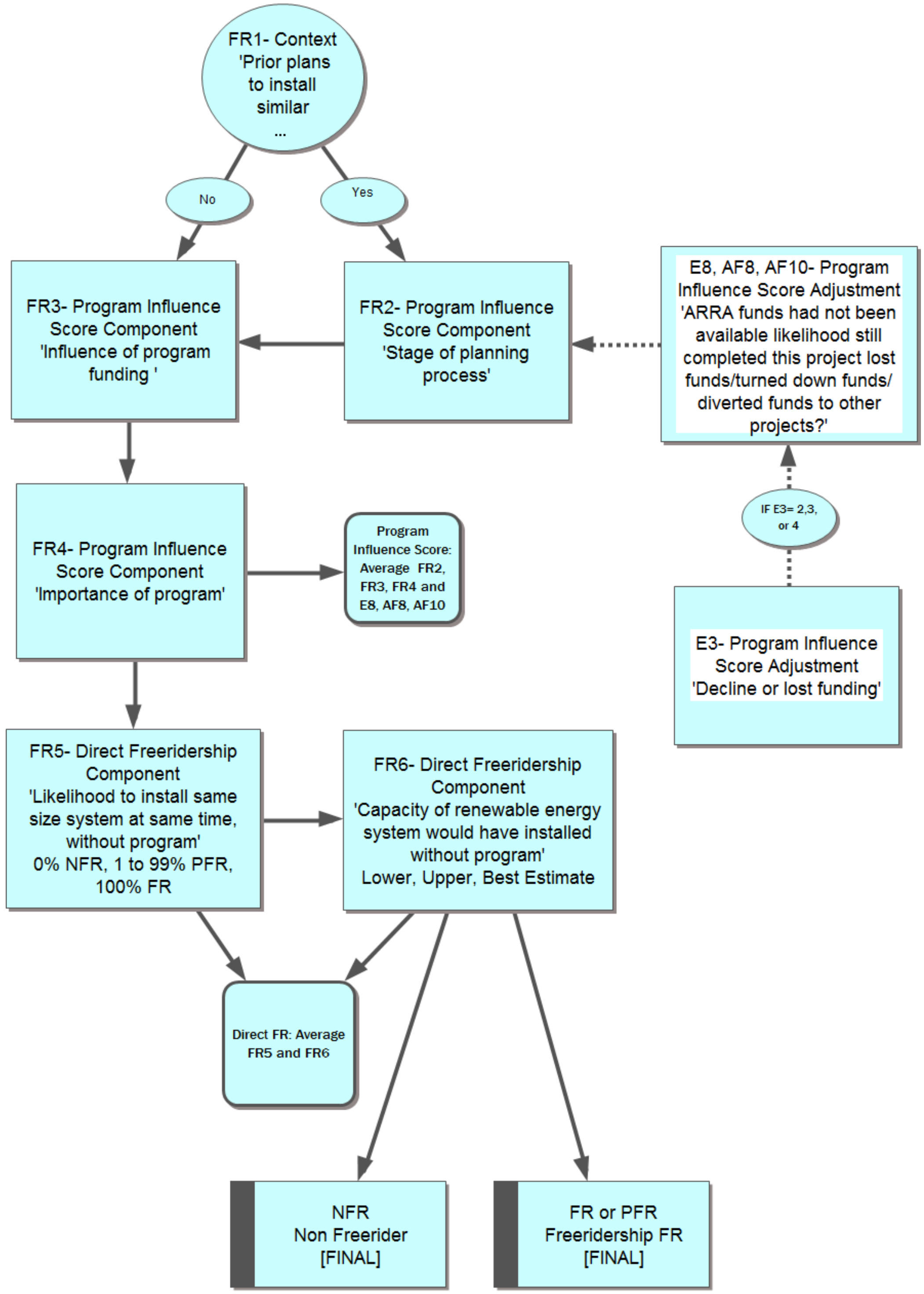
[77] The non-PV projects included wind turbines, biomass boilers, solar water heaters, solar walls, and solar CHP. For purposes of attribution, tracking solar PV was combined with PV Upstate and PV Downstate categories.

Table 3-119. Population, Sample Sizes, and Weights for RFP 1613 Projects, Renewable Energy Program Area

	Population (projects)	Sample Size (projects)	Population (generation; MMBtu)	Sample (generation; MMBtu)	Weight
PV Upstate	49	29	7,619	4,790	0.29
PV Downstate	16	8	3,004	1,545	0.36
Non-PV (all respondents Upstate)	12	7	50,464	4,936	1.89
Overall	**77**	**44**	**61,087**	**11,271**	

Figure 3-40 presents the algorithm graphically. The “FR,” “AF,” and “E” letters in the figure refer to questions from the survey, which is presented in Appendix E. The full algorithm and detailed calculations are presented with the survey in Appendix E while the responses to the questions and the calculation of the final freeridership estimate are presented in Renewable Energy Program Area, Net Savings Findings: RFP 1613 (described on page 3-177).

Figure 3-40. Freeridership Algorithm Flow Chart, Renewable Energy Program Area



3.4.6 Gross Generation/ Savings Findings: RFP 1613

The Cadmus Team conducted a variety of performance monitoring, site visits, and engineering analyses on systems funded under RFP 1613, as was shown in Table 3-112. As summarized in Table 3-120, solar PV and biomass projects dominated the overall attributable generation/savings for the Renewable Energy Program Area, with significant contributions also made by biomass and solar thermal technologies.

Table 3-120. Evaluated Gross Generation/Savings by Technology for All Projects Funded Under RFP 1613, Renewable Energy Program Area

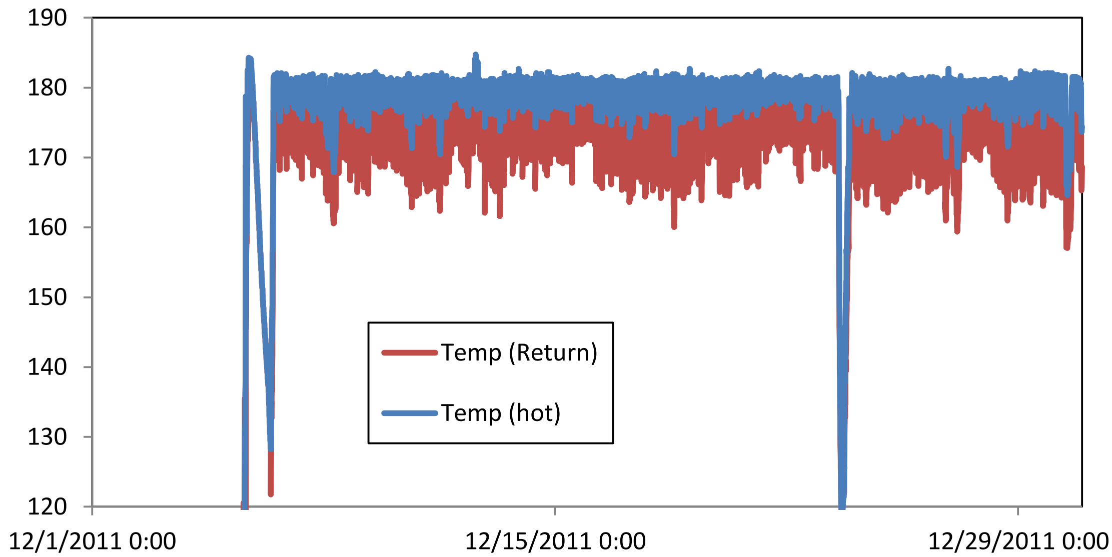
	Annual Gross Population Savings: Projects Completed by 12/31/2011					
	Population	Electric (MWh)	Gas (MMBtu)	Oil (MMBtu)	Propane (MMBtu)	Total Fuel (MMBtu)
PV Upstate	48	2,593	0	0	0	0
PV Downstate	16	960	0	0	0	0
Wind Upstate	1	26	0	0	0	0
Wind Downstate	1	10	0	0	0	0
Solar Thermal Upstate	2	-3	982	0	0	982
Solar Thermal Downstate	1	81	61	0	0	61
SHW Upstate	2	32	158	0	0	158
SHW Downstate	2	0	225	460	0	685
Biomass Upstate	3	0	0	11,507	531	12,038
Biomass Downstate	0	0	0	0	0	0
Tracking Solar PV Upstate	1	50	0	0	0	0
Tracking Solar PV Downstate	0	0	0	0	0	0
Total	**77**	**3,749**	**1,426**	**11,967**	**531**	**13,924**

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

<u>Biomass</u>

The Cadmus Team monitored the performance of one biomass boiler project, funded under RFP 1613. In a biomass boiler, as in other types of boilers, water is circulated past burning fuel to increase its temperature. As the hot water passes through radiators and raises the temperature inside the conditioned space, the water temperature decreases. Many systems are designed to experience a 10-degree drop in temperature between the boiler outlet and inlet. Figure 3-41 illustrates this temperature difference.

Figure 3-41. Biomass Boiler Supply and Return Water Temperature



The monitored biomass boiler is designed to use a variety of biomass feedstock, including irregular wood chips/shavings and fabricated wood pellets.

As it was not possible to monitor the system for a full heating season, the Cadmus Team extrapolated data collected from August 31 through December 30, 2011 to determine annual savings. The first step in this process was to develop a regression between delivered thermal energy and HDDs, on a daily basis. Once this relationship was established, it was applied to a typical year's annual HDD total to determine the gross savings for the project. From there, the gross savings were adjusted to include electrical energy consumption for the balance of system (BOS) components, such as pumps and auger motors.

Based on this process, the monitored boiler is expected to provide approximately 1,600 MMBtu of thermal energy (1,588 MMBtu), reducing fuel consumption by 1,809 MMBtu/year. The various savings achieved by the monitored system are summarized in Table 3-121. The savings reflect a realization rate of 93%, which, when applied to the population of four biomass boiler projects funded under RFP 1613, provides an overall fuel savings of 43,690 MMBtu/year, with the bulk of those savings offsetting oil consumption. The breakdown of savings by fuel type is presented in Table 3-121. Note that, due to equipment efficiency, the fuel energy savings are greater than the thermal energy delivered to the space.

Table 3-121. Biomass Boiler Savings Summary, Renewable Energy Program Area

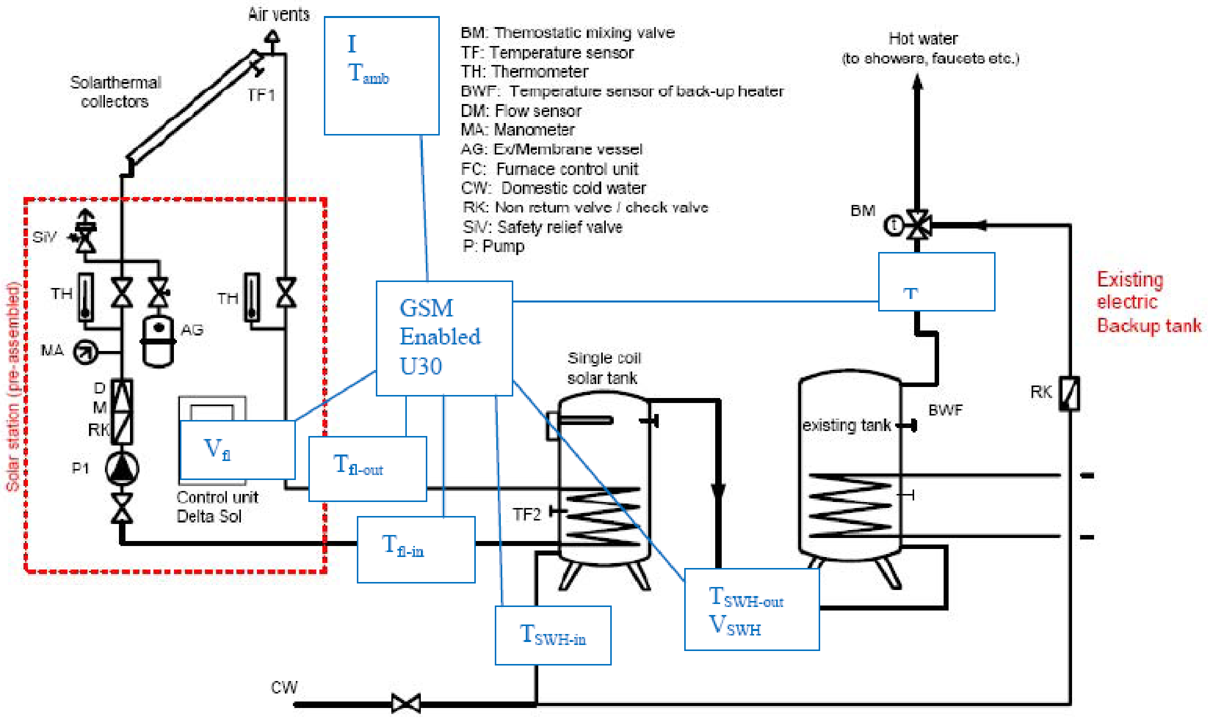
Monitored Biomass Boiler	Annual Energy Savings (MMBtu)
Thermal Energy Delivered	**1,558**
Fuel Savings	
Oil	1,333
Propane	545
Electricity	(-69)
Total Energy Saved	**1,809**

Solar Hot Water (SHW)

The Cadmus Team's monitoring of ARRA-funded SHW systems provided some interesting results. The energy savings attributable to the SHW system, particularly as compared to predicted savings, not only varies based on expected factors, such as system size and available irradiance, but also based on system complexity. More complex systems require correspondingly complex control sequences which, if not properly executed, can lead to inefficient system operation and reduced savings.

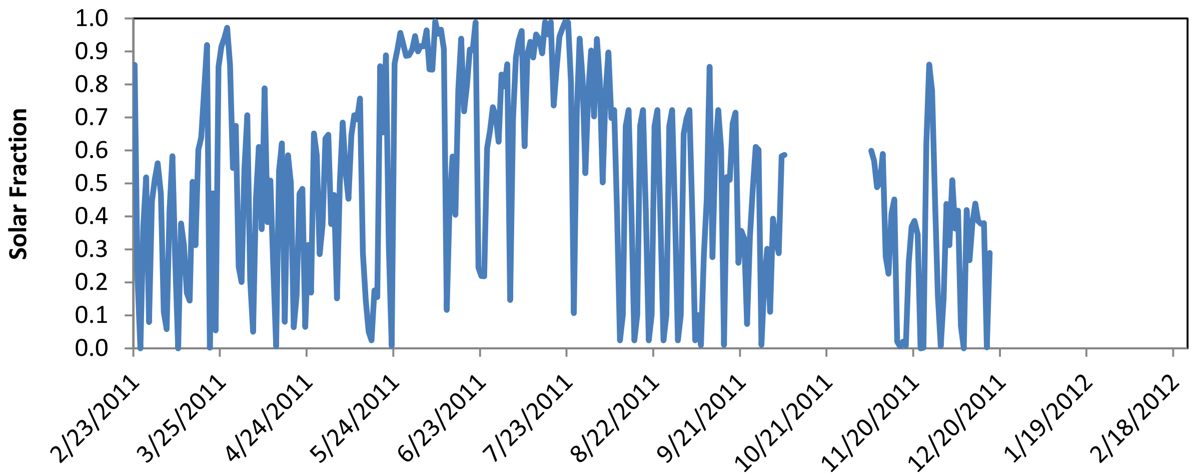
An example of a simple SHW system that was installed using RFP 1613 funds is shown, with the Cadmus Team's monitoring points, in Figure 3-42. The system consists of a series of roof-mounted solar collectors, which transfer heat to a glycol/water mixture. This mixture is pumped through the collectors by an integrated pump/controller station mounted at the solar pre-heat tank. The existing DHW tank, rather than drawing cold water from the municipal water supply, draws it from the solar pre-heat tank. By monitoring the flow and temperature of water to and from the solar pre-heat tank, it is possible to determine the amount of useful, hot water heating energy that is being accomplished by the SHW system, including tank standby and other losses. Additional monitoring of total DHW load and other variables was used diagnostically and to levelize the monitoring period performance to an annual value for comparison with *ex ante* estimates.

Figure 3-42. Piping Diagram and Monitoring Points for a Simple Solar Hot Water System, Renewable Energy Program Area



One of the values often discussed relative to SHW systems is the solar fraction, or the portion of the total hot water heating load that is supplied by the SHW system. Figure 3-43 shows the daily solar fraction for a simple SHW system that was installed using RFP 1613 funds.

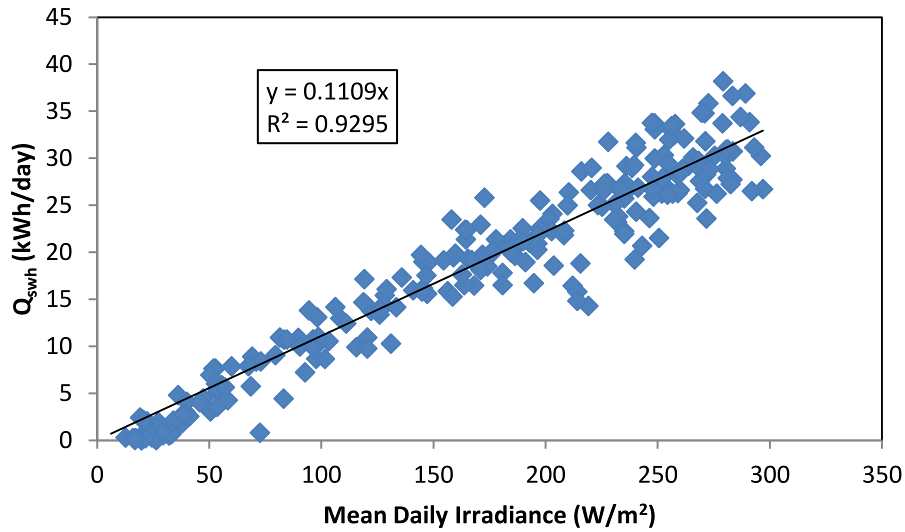
Figure 3-43. Daily Solar Fraction for a Simple Solar Hot Water System, Renewable Energy Program Area



Note: The DAS failed and did not deliver data from October 5 through November 5, 2011. The SHW system was, to the Cadmus Team's knowledge, fully functional during this period.

The gross energy savings attributable to a SHW system are driven primarily by available irradiance, assuming that the hot water load generally exceeds the contributions of the SHW system (i.e., the solar fraction is less than or equal to 1). As was shown in Figure 3-43, the solar fraction of the RFP 1613-funded SHW project was generally much less than 1, so it was possible to develop a correlation between daily delivered thermal energy and daily irradiance levels, as shown in Figure 3-44. The strength of this regression made it possible to extrapolate the measured regression equation to an annual savings value comparable to the *ex ante* estimated savings.

Figure 3-44. Linear Regression of SHW System Savings with Daily Irradiance Level



As shown in Table 3-122, the performance of the simple SHW system matched quite well with the *ex ante* estimated generation.

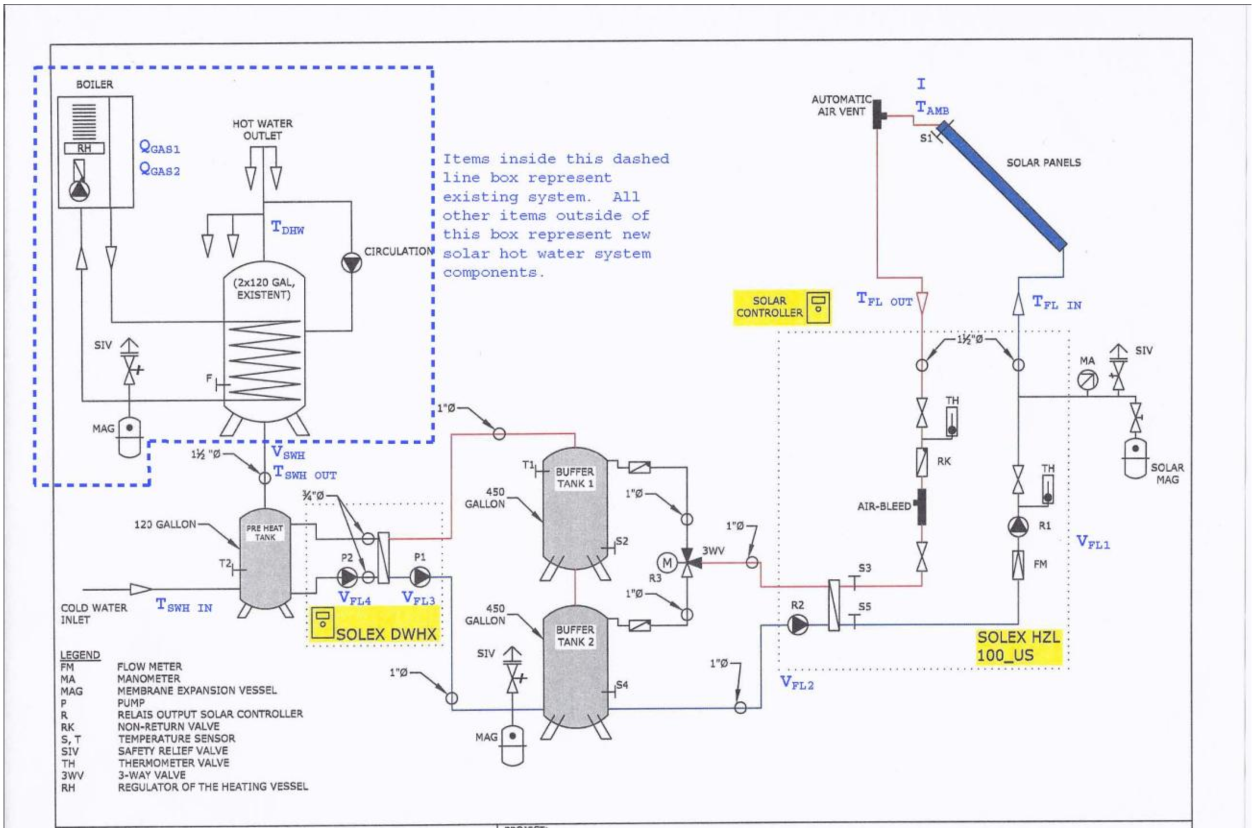
Table 3-122. Comparison of Evaluation and *Ex Ante* Generation Estimates for Simple Solar Hot Water System, Renewable Energy Program Area

	Annual Energy (kWh/yr)
Delivered by SHW System	7,253
Consumed by BOS*	132
Overall Gross Savings	7,121
Ex Ante Savings	7,735
Realization Rate	92%

* This includes pumps, controllers, and other electrically powered components.

The Cadmus Team also evaluated the performance of a more complex SHW system installed with RFP1613 funding, as shown in Figure 3-45. This system included several intermediary storage tanks, as well as a hot water recirculation loop. However, the fundamental method for estimating the contribution of the SHW system remains unchanged, and the Cadmus Team focused on measuring the flow rate and temperature rise in the solar pre-heat portion of the system.

Figure 3-45. Plumbing Diagram and Monitoring Points of Complex Solar Hot Water System, Renewable Energy Program Area



Due to project implementation delays, changes to SHW system configuration, and issues related to the DASs, only data for the month of November 2011 was sufficient for use in estimating energy savings. Based on TMY2 data, November generally accounts for approximately 3.5% of the total annual irradiance for the Albany area. An on-site pyranometer, installed as part of the Cadmus Team's DAS, provided actual irradiance levels for the monitoring period. These irradiance levels were compared with the TMY2 values to determine the relative annual irradiance levels.

During November 2011, solar radiation was 118% of TMY2 data. The percent of yearly irradiance and percent of TMY were both applied to the measured solar delivered energy for November 2011, yielding a forecast of 142.2 MMBtu/year of thermal energy delivered. Since the back-up system operates at 90% system efficiency (96% firing efficiency, 6% stand-by losses), the solar delivered energy offsets 158.1 MMBtu/year of gas usage, which is substantially lower than the *ex ante* value of 259.4 MMBtu/year.

Figure 3-46 shows the contractor's TSOL[78] model of the complex SHW system's output.

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[78] TSOL is a SHW system software modeling package, created and sold by Valentin Software. See vendor Website for more information: http://www.valentin.de/en/products/solar-thermal/14/tsol-pro.

Figure 3-46. Contractor's TSOL Model of Solar Hot Water System Output, Renewable Energy Program Area

Results of Annual Simulation

Installed Collector Power:	179.92 kBtu/hr	
Installed Gross Solar Surface Area:	810.85 sq.ft	
Collector Surface Area Irradiation (Active Surface):	363.84 MMBTU	489.90 kBtu/sq.ft
Energy Produced by Collectors:	162.74 MMBTU	219.12 kBtu/sq.ft
Energy Produced by Collector Loop:	149.78 MMBTU	201.67 kBtu/sq.ft
DHW Heating Energy Supply:	227.58 MMBTU	
Solar Contribution to DHW:	142.17 MMBTU ←	
Energy from Auxiliary Heating:	97.9 MMBTU	
Natural Gas (H) Savings:		**7,270.3 m³**
Natural Gas (H) Savings:		**2,594.42 therm** ←
CO2 Emissions Avoided:		**33,894.40 lbs**
DHW Solar Fraction:		**59.2 %**
Fractional Energy Saving (EN 12976):		**59.1 %**
System Efficiency:		**39.1 %**

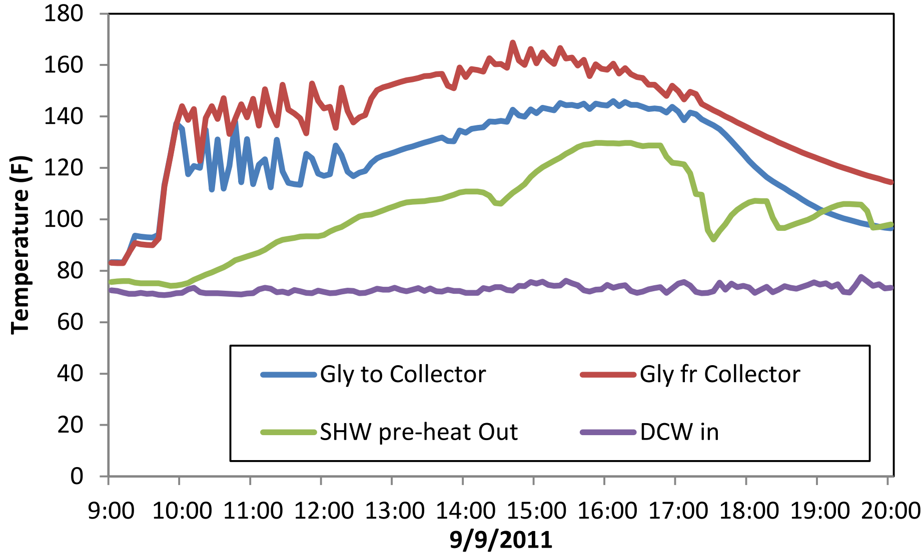
Note: This figure shows 55% gas back-up system efficiency (142.17/259.4). The actual gas back-up system efficiency is 90% (96% firing efficiency with 6% stand-by and recirculation losses).

The additional monitoring data collected at the site, such as measurement of the solar collector loop fluid temperatures, can provide insight into possible contributing factors for the discrepancy in back-up system efficiency that was shown in Figure 3-46. The largest source of error appears to be the applicant's assumption that the baseline heating system efficiency is 55%, when in fact, the site installed a relatively new gas hot water heating system with an overall efficiency likely closer to 90%.

In addition, proper control of SHW systems is necessary to maximize their benefit, since they need to operate during times of available solar energy and water heating needs without over-running. In the case of PV systems, this process is managed by the inverter. With SHW systems, the installer is responsible for proper placement of sensors/control points and for programming the controller. The controller for this complex SHW system does not appear to be working optimally, as it often runs the solar loop pump without transferring heat to the buffer tanks, and it experiences frequent cycling of the solar-to-buffer pump.

Figure 3-47 illustrates the measured temperature profile over the course of the day when the system is running normally. As expected, when the temperature in the glycol loop increases, there is a corresponding increase in the SHW pre-heat tank water temperature. This indicates that energy is successfully being transferred between the collector loop and the SHW pre-heat tank.

Figure 3-47. Measured Fluid Temperatures for Solar Heated Water, Domestic Cold Water, and Glycol Loops to and from the Solar Pre-Heat Tank, Renewable Energy Program Area

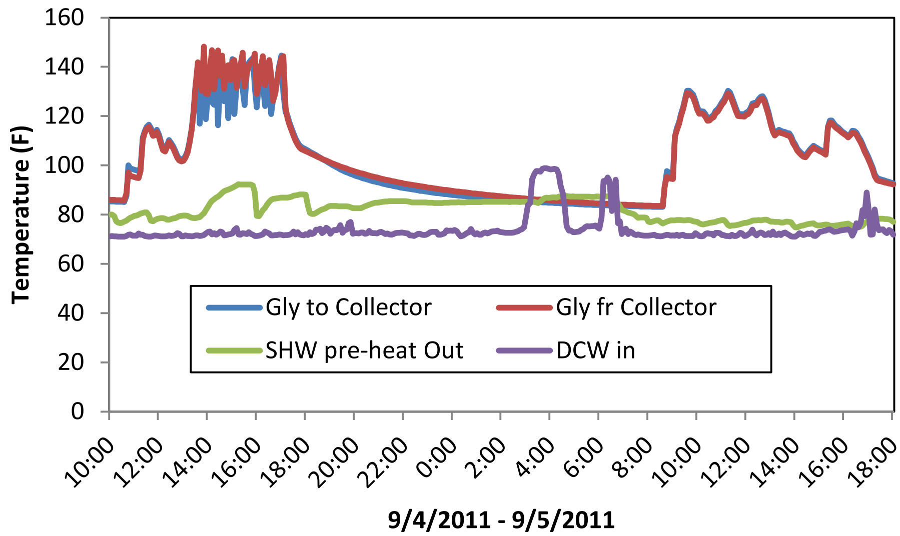


Note: DCW indicates domestic cold water.

When the system is not running normally, there is a significant amount of pump cycling or pump operation with no heat transfer, suggesting there is a loss of solar collection opportunity and wasted electricity for operating the collector loop pumps. In Figure 3-48, for example, the collector loop pump experiences a large number of on/off events during the day, only transferring a small amount of energy to the solar pre-heat tank. On the second day, glycol solution is entering collectors at the same temperature as it is when leaving, with no energy being transferred to the solar pre-heat tank. On both days, the collector loop pump ran extensively, despite only having a small amount of the available energy being transferred to the hot water heating load of the facility.

The situation appears to be driven by the placement of pump-control sensors. The operation of the pumps in this case is controlled at the heat exchanger between the collector loop and buffer tank loop. This placement can lead to rapid on/off cycles due to a mismatch in flow rates on each side of the heat exchanger. Thus, when cold water enters the heat exchanger from the buffer tank, it rapidly cools the fluid from the collector loop, drops the temperature in the heat exchanger to below the set point, and turns off the buffer tank pump, even though there is still energy available from the collector. This situation underscores the importance of sensor placement and proper control sequencing of SHW systems.

Figure 3-48. Minimal Heat Transfer Between Collector Loop and Solar Hot Water Pre-Heat Tank, Renewable Energy Program Area



As shown in Figure 3-49, the SHW controller ran the collector loop pump during sunlight hours, initially with no heat being conveyed to the SHW pre-heat system, and then cycled the solar-to-buffer loop pump, raising SHW pre-heat temperatures. This is shown by the high collector loop temperatures, while the SHW pre-heat out temperature remains nearly the same as that of the domestic cold water inlet for most of the day.

Figure 3-49. Solar Hot Water System Daily Profile Illustrating Lost Savings Due to Pump Programming, Renewable Energy Program Area

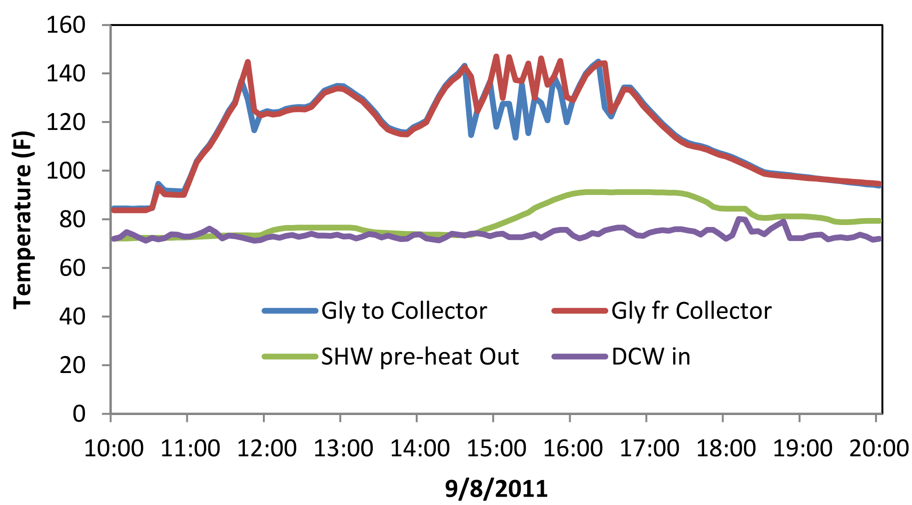


Table 3-123 compares the *ex ante* and evaluation savings estimates for the monitored complex SHW system.

Table 3-123. Comparison of Evaluation and *Ex Ante* Savings Estimates for Complex Solar Hot Water System, Renewable Energy Program Area

	Annual Energy (MMBtu/yr)
Delivered by SHW System	158
Consumed by BOS	7.5*
Ex Post Savings	151.5
Ex Ante Savings	259.4
Realization Rate	58%

* This number represents the site electrical energy consumption for additional pumps, controllers, and BOS.

Based on a comparison of Table 3-122 and Table 3-123, the realization rate for the more complex SHW system appears to be significantly lower than that of the simple SHW system. However, the major cause of the low realization rate for the complex system is the use of 55% as an assumed gas hot water heater system efficiency. Had the applicant used a value of 90%, the realization rate would have been similar to that of the simple SHW system. Nevertheless, the data from the complex system suggests that additional savings may be possible with a closer analysis, and possible refinement, of the system control settings.

Solar Photovoltaic

A total of 68 solar PV systems were funded and completed under RFP 1613. Of these, the Cadmus Team conducted site visits and engineering analyses at 26 sites, obtaining valid results for 21 projects. The Cadmus Team was forced to discard site visit results for five projects. These five 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 21 funded solar PV systems, the overall population of energy generation was determined to be higher than *ex ante* estimates, as shown in Table 3-124, yielding an overall realization rate of 115% for solar PV systems.

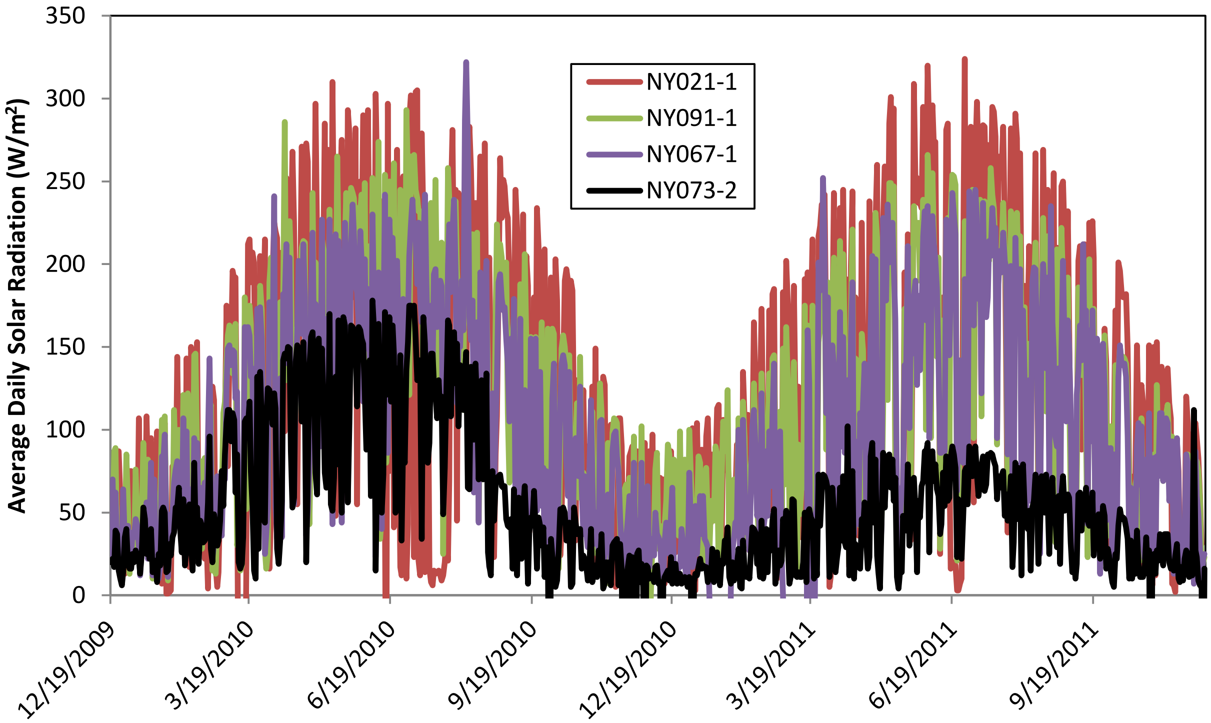
Table 3-124. Solar PV Sample Realization Rate, Renewable Energy Program Area

	Annual Energy Generation
Sample Size	*21*
Ex Ante Generation (kWh)	976,460
Ex Post Generation (kWh)	1,119,064
Realization Rate	1.15

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. Figure 3-50 displays the historical irradiance data from several territory weather stations. These data were obtained from the Solar Data Warehouse, a private company that sells ground-based solar radiation data.

While these data were generally useful, data from one weather station were consistently and significantly lower than irradiance levels at other weather stations. These data were ultimately excluded from gross generation calculations. In all cases, the Cadmus Team matched each site visited with the nearest weather station and extracted the system's operational period irradiance data from the station data file. These historical data were then compared to TMY3 data to normalize the Cadmus Team's SAM predictions to actual weather conditions, as described previously.

Figure 3-50. Historical Irradiance Data from December 19, 2009 Through December 19, 2011, Renewable Energy Program Area



Applying the sample realization rate from Table 3-124 to the entire population of 68 solar PV systems funded under RFP 1613 yields a total population generation of 3,346 MWh/year.

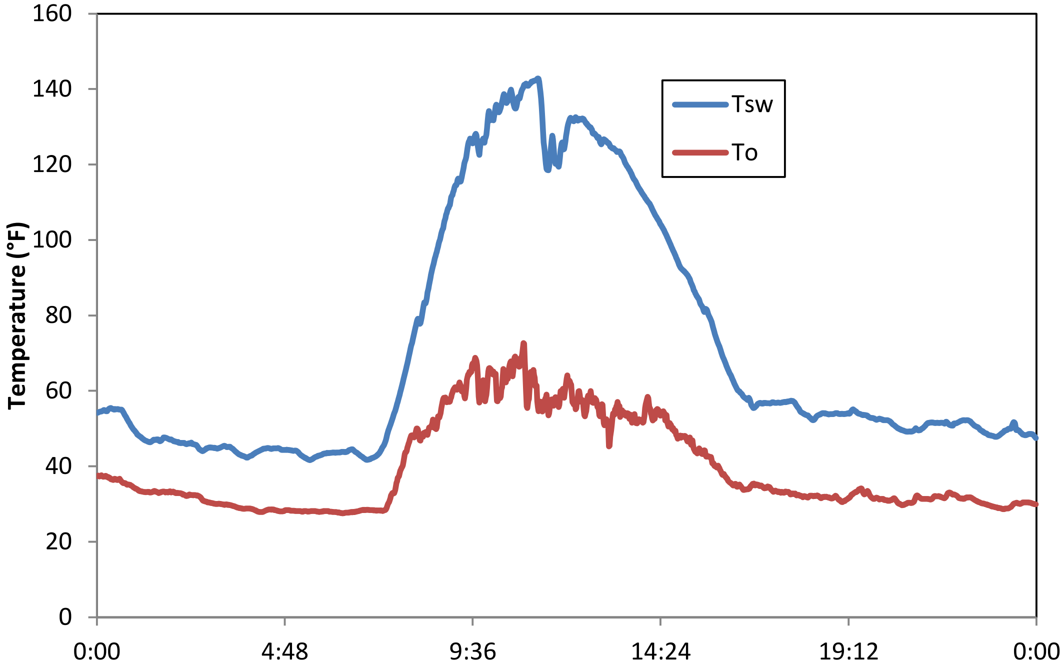
<u>Solar Wall</u>

One solar wall project was funded under RFP 1613. The Cadmus Team monitored the performance of the funded solar wall, including relevant BOS components, such as fan units and controllers.

Figure 3-51 depicts the typical daily operation of the solar wall, taken from one 24 hour segment. 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. Not surprisingly, the greatest temperature difference between the solar wall heated air and the outdoor ambient air occurs during the middle of the day during peak sunlight hours, corresponding to periods when the solar wall is actively pulling heated air from the outside.

The temperature difference observed during non-sunlight hours is due to the placement of the T_{SW} sensor in the interior distribution duct, where the temperature is approximately equal to the interior ambient air. Based on these characteristics, the Cadmus Team used the position of the fresh air damper, the operation of the fan, and the controller time-based settings to bound the operational period of the solar wall and ensure an accurate accounting of savings.

Figure 3-51. Example Daily Temperature Profile of Solar Wall Heated Air and Ambient Outdoor Air, Renewable Energy Program Area



In order to extrapolate the 31-day monitoring period, occurring from December 1 through December 31, 2011, to an annual savings value, the Cadmus Team performed a linear regression of the daily thermal energy delivered as a function of daily HDDs and average irradiance level during the monitoring period. This regression was then applied to typical annual weather data, as shown in Equation 3-20.

Equation 3-20. Regression Applied to Typical Annual Weather Data, Renewable Energy Program Area

Where:

HDD	=	Daily HDDs from TMY3 dataset
I	=	Daily average global horizontal irradiance

The results of this analysis, applied over a 365 day year, are summarized in Table 3-125. While observed savings were less than *ex ante* estimates, the most remarkable difference is the savings from temperature destratification. Since the solar wall distribution duct and fan unit are located in the roof structure of a 35-foot tall building, the influx of heated air driven by the solar wall fan units was expected to mix with lower level air in the building and reduce gas consumption.

Table 3-125. Solar Wall Energy Savings Summary, Renewable Energy Program Area

	Fuel Savings (MMBtu)	
	Observed	***Ex Ante***
Thermal Energy Delivered	775	512
Heat Loss Reduction	63	91
Fan Energy Consumption	(-9)	0
Temperature Destratification	0	334
Total	**828**	**937**

Note: The savings in this table, provided as part of the project application, do not match the total provided in the Program Area tracking data, which indicates a total savings of 874 MMBtu/year for this project. This table is only provided to illustrate the relative magnitude of the various savings contributions.

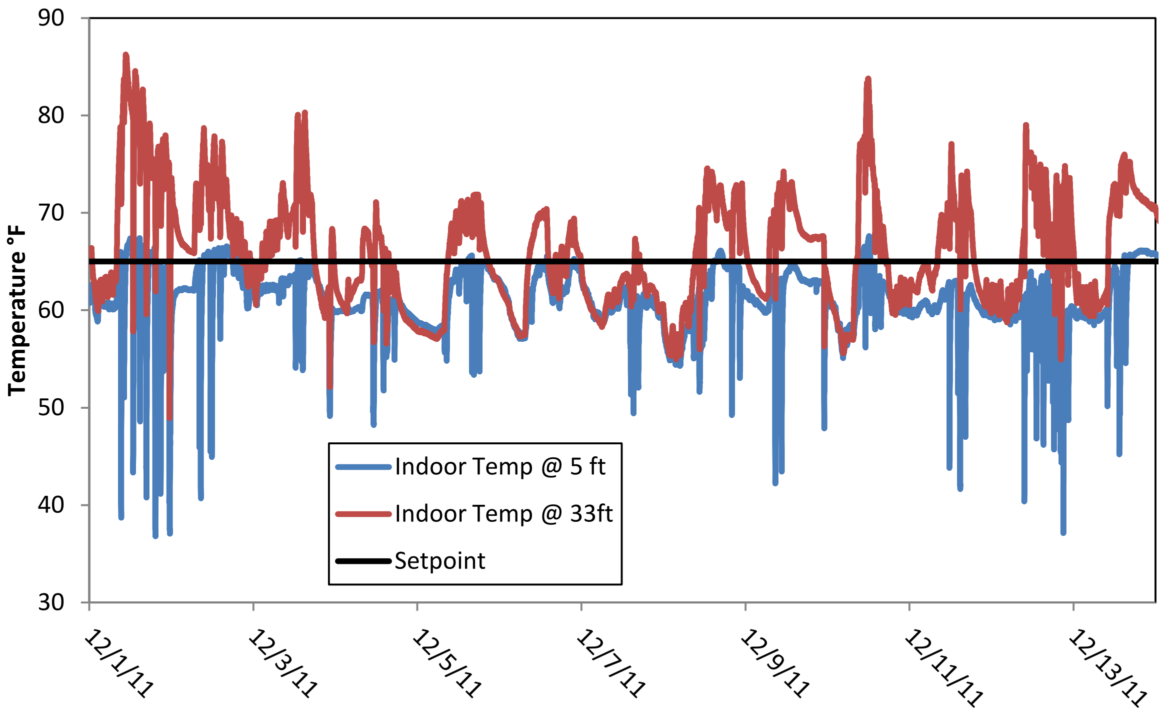
It appears that, if heated air could be moved from 33-feet to 5-feet, the thermostat controlling the gas heating units could be operated approximately half as frequently as it was during the monitoring period, as shown in Table 3-126. Unfortunately, the Cadmus Team did not have ready access to gas consumption data during this period, and therefore could not quantify the potential reduction in gas consumption.

Table 3-126. Solar Wall Temperature Destratification Results, Renewable Energy Program Area

	Solar Wall Operating
Average Temperature at 5-feet	61
Gas Heating Hours	291
Average Temperature at 33-feet	67
Gas Heating Hours	150
Excess Gas Consumption Due to Stratification	48%
Average Outdoor Temperature	33
Average Delta T	6

Figure 3-52 illustrates the potential destratification savings. Much of the heated solar wall outlet air remains in the upper portions of the building, where it is unable to affect the run-time of the gas heating units or user comfort.

Figure 3-52. Comparison of Vertical Temperature Profile with Gas Heater Controlling Thermostat, Renewable Energy Program Area



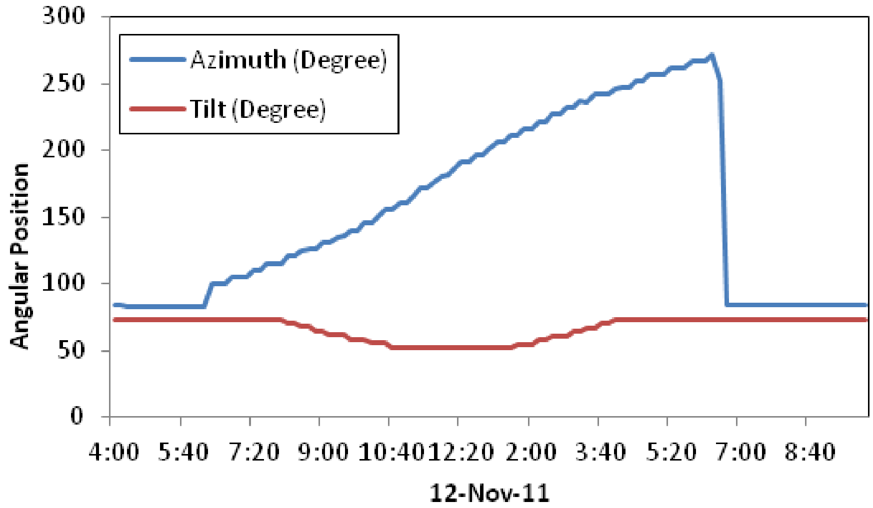
Tracking Solar Photovoltaic

The Cadmus Team monitored the performance of the only tracking solar PV system installed using funds from RFP 1613.

To monitor the operation of PV panels mounted on tracking systems, the Cadmus Team outfitted a 27.6 kW, four tracker array with position, weather, and power measurement equipment. A pyranometer was mounted on the tracker and power meter on the inverter output to determine how well the tracker generation matched expected generation values from PV watts.

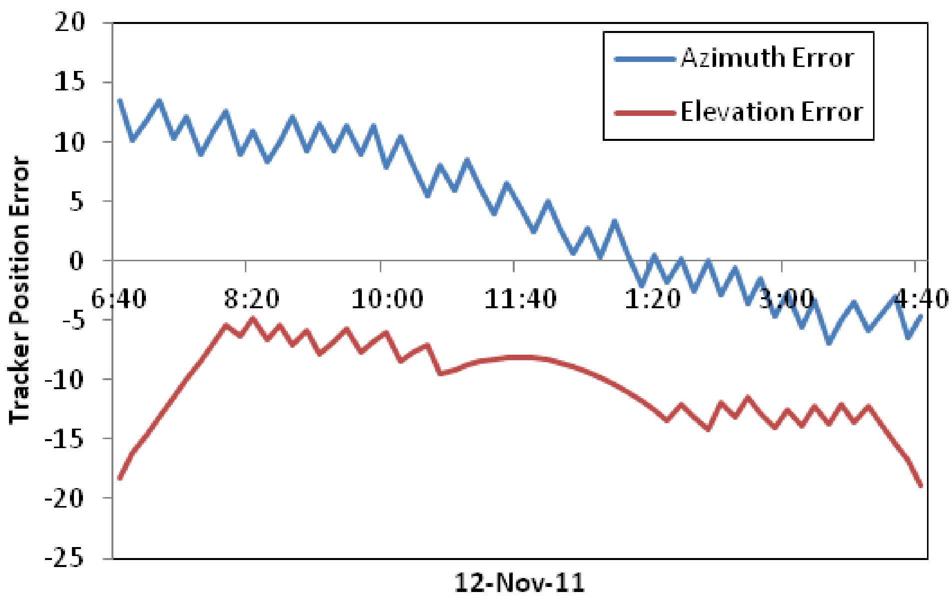
The manufacturer of the tracking equipment also provided position signal information to a data logger, allowing the Cadmus Team to compare tracking operation with theoretical sun position information available from scientific sources. For example, in Figure 3-53, the collector's tilt and azimuth change throughout a typical day, following the sun across the sky. At approximately 6:30 p.m., the tracker azimuth returns to 90 degrees (east), where it remains until the sun rises the next day. Figure 3-54 shows the difference between the solar position and tracker position between sunrise and sunset on November 12, 2011.

Figure 3-53. Typical Day Tracker Position, Renewable Energy Program Area



Note: 180 degrees corresponds to true south.

Figure 3-54. Tracker Position Error Compared to Calculated Sun Position for Typical Day, Renewable Energy Program Area

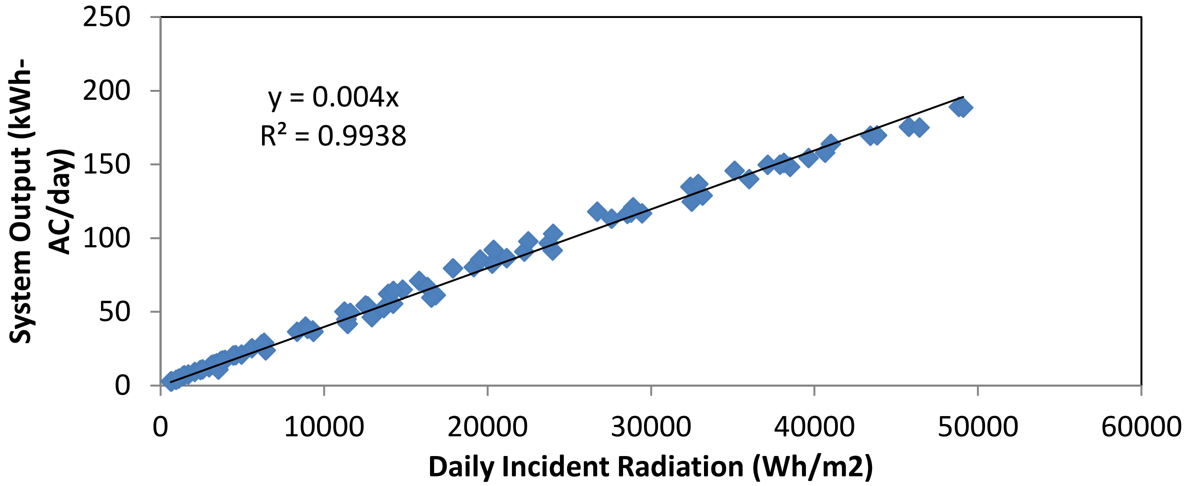


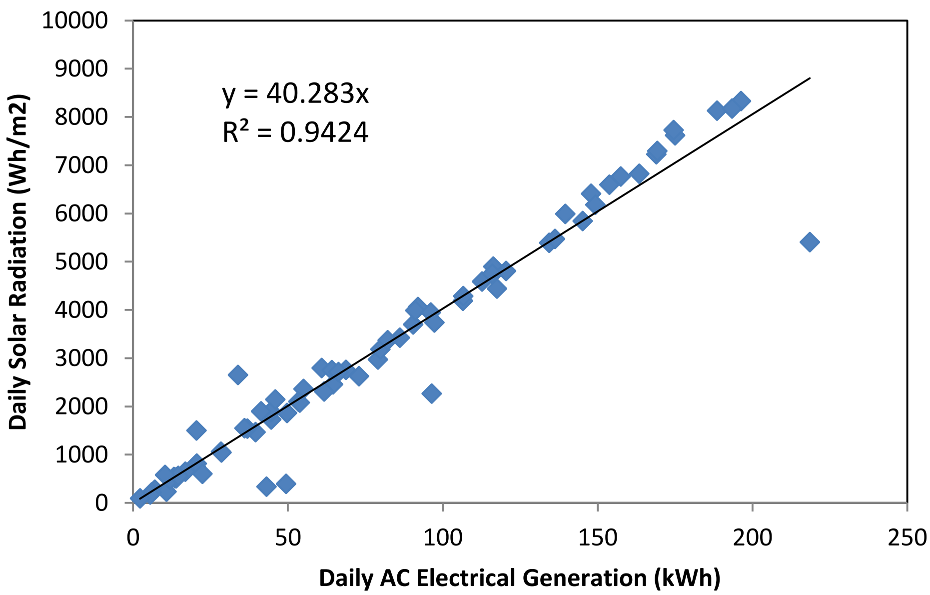
The position error is less than 15% for an overwhelming majority (99%) of the energy generation period between 8:00 a.m. and 5:00 p.m., so the tracker is keeping the panels within the desired angular alignment with the sun's position on November 12, 2011, which is true for most of the days during the monitoring period.[79]

The correlation between the tracker irradiation measurement and energy collected was quite strong, as can be seen in Figure 3-55, verifying that PV array output is a direct function of the amount of energy available and providing a useful correlation for extrapolating system performance based on annual average irradiance.

[79] The monitoring period occurred between October 6 and December 31, 2011.

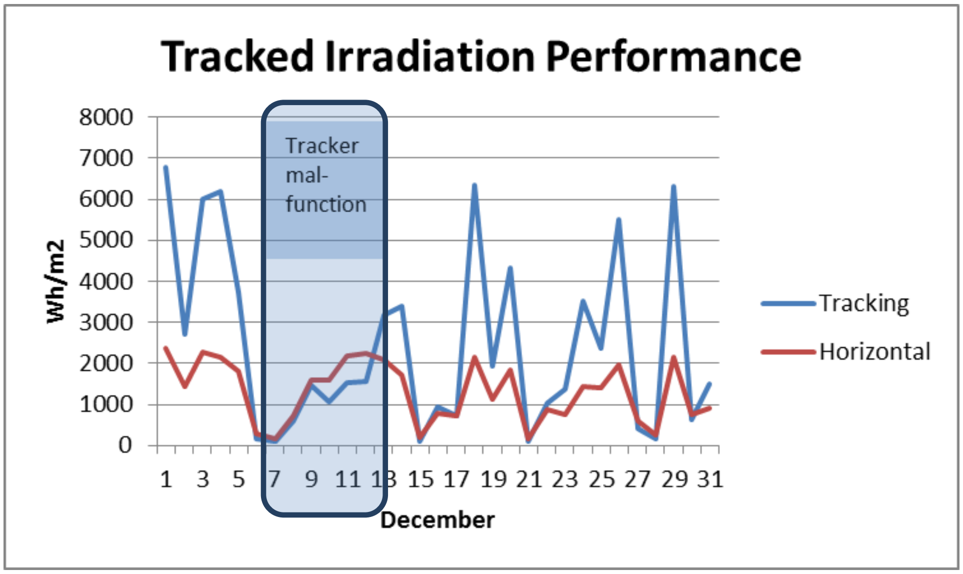
Figure 3-55. Measured Collector Plane Solar Radiation Versus Energy Collected (kWh), Renewable Energy Program Area





Unfortunately, the solar tracking system was also down for 12 out of 87 days of the monitoring period. The exact cause of the failures is not known, but the system returns to normal operation after a manual re-set of the control system. While a tracking system can significantly increase energy collection when operating as intended, the generation suffers when the tracker does not move. Figure 3-56 shows the measured irradiance of the tracker compared to a fixed angle reference measurement on the nearby building.

Figure 3-56. Tracked Irradiation Performance, Renewable Energy Program Area



It is apparent that the tracker greatly increases available irradiance on sunny days when operating properly, often more than doubling the solar exposure. Days with lower measured irradiation show less of an advantage with the tracker, since the diffuse light of cloudy or overcast weather is much less directional than the high intensity of beam radiation, and is collected more equally independent of collector orientation.

As was shown in Figure 3-56, when the tracker stalled at its nighttime rest position between December 7 and December 14, 2011, the output was equal to or less than the horizontal measurement, since the collector was pointed away from the high intensity beam radiation for much of the day due to its easterly azimuth.

The Cadmus Team extrapolated the annual performance of the tracking solar PV system based on three months of data (October-December 2011; Table 3-127).

Table 3-127. Tracking Solar PV Irradiance and Generation Comparison, Renewable Energy Program Area

	TMY		Measured	
	Irradiance Totals (kWh/m^2)	**AC Energy Generation (kWh)**	**Irradiance Totals (kWh/m^2)**	**AC Energy Generation (kWh)**
October	149.7	3,168	98.5	2,452
November	82.8	1,795	103.7	2,645
December	84.9	1,952	75.7	1,855
Total	**317.4**	**6,915**	**277.9**	**6,952**
Weather Adjustment	**88%**	**0**	**0**	**0**
Realization Rate	**0**	**0**	**0**	**115%**

As shown in Table 3-127, despite lower-than-typical solar irradiance levels, the system generated slightly more than the predicted amount of AC electrical energy over the three-month monitoring period. The observed generation was also reduced by approximately 13 days of downtime for the tracking mechanism, accounting for 15% of the monitoring period. Had the tracking system functioned normally, the system would have generated slightly more energy. Based on discussions with the system installer, and the Cadmus Team's on-site inspection of the system, it is reasonable to expect that the majority of these issues are short-term and related to system startup, and will not continue at the observed rate over the life of the system. Based on this, the Cadmus Team calculated a realization rate of 115% and a gross generation of 50,273 kWh/year.

As two-axis tracking solar PV systems have not been widely adopted in the northeastern U.S., the Cadmus Team considered the relative merits and drawbacks of two-axis tracking systems compared to the more common fixed array configurations.

There are three general configurations for mounting PV panels for optimizing the contributing costs and benefits: horizontal (low slope), optimized tilted racking, and tracking (one or two axis). Horizontal mounting tends to be the least expensive option for collectors on low-slope roof arrays. Low-slope arrays tend to have the highest density of collectors per total square footage of array, and show the least amount of sensitivity to azimuth, but they also produce less energy per watt of PV panel. Sloped arrays that face south improve energy collection but also increase mounting costs. Two-axis tracking maximizes energy collection, but also maximizes installed cost and complexity.

Table 3-128 shows the relative energy output values for a 27.6 kW_{DC} PV array installed using the three different mounting configurations.

Table 3-128. PV Watts[80] Energy Generation Prediction for 27.6 kW Array in Albany, New York, Renewable Energy Program Area

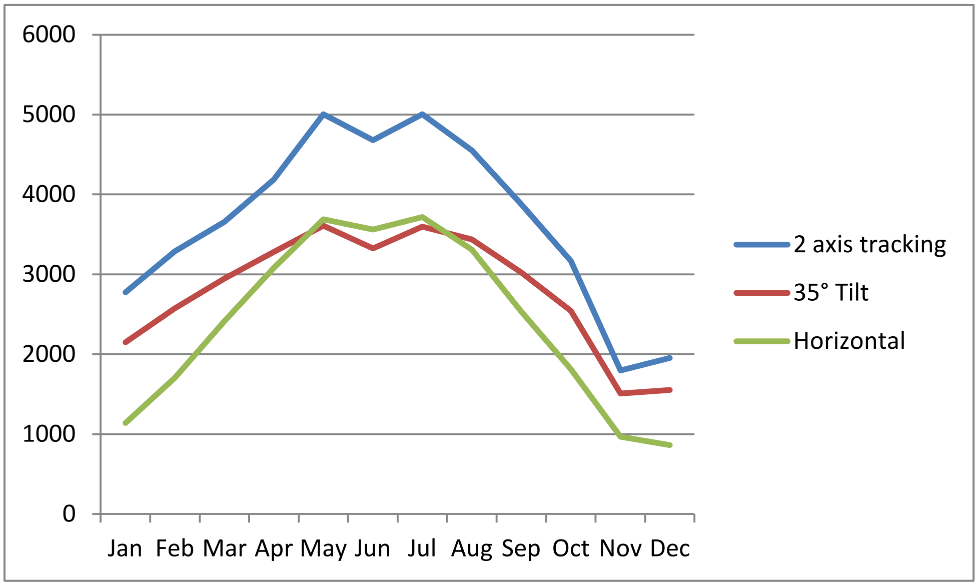
PV Watts Prediction		
27.6 kW	**kWh/yr**	**% of Horizontal**
Horizontal	28,788	0
35° Tilt	33,545	117%
Two-axis tracking	43,936	153%

The tracking system is expected to generate 53% more electricity than a horizontal array and 31% more than a system installed with a tilt of 35° (true south azimuth).

The various mounting types also have different profiles of energy generation over the course of the year, primarily as a function of the angle of the sun. As can be seen in Figure 3-57, all the types of systems deliver the largest amount of energy in the summer, but the two-axis tracker provides the best proportional output in the winter at nearly 250% of horizontal, due to the ability of the tracking system to directly face low sun angles.

[80] http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/US/New_York/Albany.html

Figure 3-57. Annual Generation Profile of Various Collector Mounting Configurations, Renewable Energy Program Area



Although tracking solar PV systems, such as the one funded under RFP 1613, undoubtedly have the potential to generate significantly more electricity than their fixed orientation counterparts, the primary drawback of these more complex systems is the cost. This cost is reflected in both upfront cost, including the added cost of tracking controls and hardware, and the lifetime operation and maintenance (O&M) costs. As with any piece of machinery, two-axis tracking systems require periodic upkeep and repair, which may mitigate significant portions of the additional generation derived revenue. The tracking system, in only three months of operation, required the installer to make numerous site visits to troubleshoot problems, make repairs, and verify the system's operational status. When asked in an informal interview, the system installer indicated that upkeep and maintenance costs in the first nine months of operation were approximately $2,300. The success of these types of systems, at least initially, appears to be contingent upon a diligent and dedicated installation-system owner partnership.

<u>Wind</u>

Two wind turbine projects, comprising three wind turbines, were funded under RFP 1613. The Cadmus Team conducted site visits at both projects (Monitored Project 1 and Monitored Project 2) to develop independent annual energy output estimates. During these site visits, the Cadmus Team:

- Surveyed local terrain and obstructions that could impact the available wind resource
- Inspected installed equipment
- Measured site elevation and turbine coordinates

The results of these site visits were used to model wind turbine energy generation in the CWEST modeling tool. Wind resource data were obtained from the Small Wind Resource Explorer. While the Cadmus Team would normally favor monitoring small wind turbines' performance, given the highly variable nature of the wind resource, that was not possible in this case due to delays in project implementation.

Monitored project 1 has two turbines, and is located in a sparsely populated, rural-agricultural region situated on the coast of Lake Ontario. An overview of the immediate site is shown in Figure 3-58.

Figure 3-58. Aerial View of Monitored Project 1 Turbine Locations, Renewable Energy Program Area

East turbine: The east turbine is sited directly alongside a line of tall, mostly deciduous trees standing 50 to 70-feet tall and situated in a row extending north to south. To the north of the turbine lie shorter, scattered trees sitting atop a short 6 to 8-foot embankment that extends to the lakeside. To the south and southwest of the turbine is a large, open field extending 300 to 400-feet to seven small, single story residences. To the west of the turbine, several more single story structures, standing approximately 10 to 12-feet tall, form an east-to-west row that begins approximately 150-feet from the base of the turbine. The inverter is located approximately 400-feet from the base of the turbine.

West turbine: The west turbine is sited directly west of a large evergreen tree farm, standing approximately 30 to 50-feet tall and situated 30-feet from the base of the turbine. The tree line extends for several hundred feet to the north and south of the turbine location. Directly to the north and south of the turbine are large, mostly open fields with spotted, deciduous trees and utility poles. Located directly to the southwest, west, and northwest of the turbine are several deciduous trees standing 20 to 40-feet tall, followed by taller evergreen trees at a distance of 200-feet. The inverter is located approximately 400-feet from the base of the turbine.

The second site, monitored project 2, is located on Long Island, approximately 1 mile from the southeast-facing coast. The immediate area around the turbine is shown in Figure 3-59. The area is characterized by mostly flat terrain with dense pockets of trees surrounded in an otherwise medium density agricultural region. The prevailing winds are from the west-southwest direction. The turbine site has a large municipal building standing approximately 35-feet tall and several pockets of deciduous trees ranging from 20 to 50-feet tall. The turbine is situated among several pockets of large trees, located 15 to 20-feet to the north, west, and south. A narrow, open field is situated to the northeast of the turbine. The inverter is located approximately 150 meters (500-feet) from the base of the turbine.

Figure 3-59. Turbine Location at Monitored Project 2, Renewable Energy Program Area

Table 3-129 summarizes the results of evaluation activities at the two funded wind projects.

Table 3-129. Evaluation and *Ex Ante* Values for RFP 1613 Funded Wind Projects, Renewable Energy Program Area

	Site 1 (East)	Site 1 (West)	Site 2
New York Small Wind Explorer* annual average wind speed estimate at hub height	5.97 meters/second (m/s; 13.37 mph)	5.90 m/s (13.22 mph)	5.31 m/s (11.89 mph)
Wind generation system(s)	Bergey Excel-S 10 kW	Bergey Excel-S 10 kW	Bergey Excel-S 10 kW
Tower hub height	36.6 meters (120 feet)	36.6 m (120 feet)	36.6 m (120 feet)
Installer's estimated annual energy generation	35,474 kWh/yr		8,800 kWh/yr
The Cadmus Team's estimated annual energy generation	13,842 kWh/yr	11,851 kWh/yr	9,773 kWh/yr
Realization Rate	72%		111%

* This online software tool was developed by AWS Truepower. More information is available at the vendor Website: www.awstruepower.com.

3.4.7 Net Savings Findings: RFP 1613

This section summarizes the results of the freeridership-related questions of the survey. As described previously in Renewable Energy Program Area, Net Generation/Savings Calculations: RFP 1613, 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), 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).[81] In summary, estimating freeridership involves five steps:

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

[81] 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 funds 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 greenhouse gases reduced. To avoid double counting savings, the DOE concluded that the best approach is to have ARRA-funded programs claim Program Area effects only in proportion to the savings.

3. Adjusting direct freeridership based on the Program Area influence score[82]
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 3-130. The calculations used in each step are described in detail in Appendix F.

The results suggest that freeridership was approximately 4% for RFP 1613 as a whole. The Cadmus Team determined the final net savings for the Program Area at a 90% confidence level with a precision of plus or minus 9% or better.[83]

The Cadmus Team estimates that freeridership for each technology group is also approximately 4% (i.e., PV Upstate, PV Downstate, and non-PV projects).[84] Freeridership and net-of-freeridership estimates with 90% confidence intervals are presented in Table 3-130. However, due to the small sample sizes 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).

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[82] 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.

[83] Other renewable energy programs' report similar low levels of freeridership, though 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 $martSM End-use Renewable Energy Program.

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

Table 3-130. Freeridership Scores for RFP 1613, Renewable Energy Program Area

	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*44*	*29*	*8*	*7*
(1) Mean direct freeridership; average response to FR5 and FR6	5%	6%	13%	3%
(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)	4.45	4.71	4.51	4.26
(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 F for more details)	6%	5%	8%	7%
(4) & (5) Freeridership, weighted by generation attributable to NYSERDA ARRA funding (90% confidence interval (CI))	4% (90% CI: 0%, 9%)	4% (90% CI: 0%, 9%)	4% (90% CI: 0%, 15%)	4% (90% CI: 0%, 16%)

* 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.

Note: The 0% is the lower bound of the 90% confidence interval.

The Cadmus Team benchmarked this Program Area's freeridership results with results from other studies that evaluated similar programs. In these other studies[85,86], freeridership rates averaged around 0.22. One report calculated freeridership at less than 5% with a NTG close to 1.0 for solar PV measures.[87] A recent evaluation of a commercial solar PV program in Oregon estimated freeridership rates of 11% .[88] A recent evaluation of a solar PV program in Wisconsin estimated freeridership rates of 19% for residential participants and 21% for commercial participants. [89] The Renewable Energy Program Area freeridership rate of 4% for RFP 1613 is at the low end of the range 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 to follow the order they were incorporated into the calculations of freeridership as presented in Table 3-130 (i.e., direct freeridership questions, Program Area influence questions, and percentage of the projects funded by NYSERDA ARRA).

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

[86] The Cadmus Group, Inc. *WI Focus on Energy Renewables Impact Evaluation Report*. 2010.

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

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

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

Direct Measures of Freeridership (FR5 and FR6)

The first step in estimating freeridership was based on responses to two questions that measured freeridership directly by asking 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 would have been installed if the NYSERDA ARRA funds had not been available (FR6). Direct freeridership was estimated by calculating the average of the responses 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. Likelihood was indicated 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).

Table 3-131 shows that nearly all the respondents indicated that it was very unlikely that they would have installed the same efficiency and size system at the same time—98% reported a likelihood between 1% and 25%. One respondent said that it was 90% likely that they would have had the same system installed at the same time. The average likelihood reported was 5.4%.

Table 3-131. 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	*44*	*29*	*8*	*7*
Mean percent likelihood	5.4%	4.0%	11.3%	5.0%
1-25%	98% (43)	100% (29)	88% (7)	100% (7)
26-50%	0% (0)	0% (0)	0% (0)	0% (0)
51-75%	0% (0)	0% (0)	0% (0)	0% (0)
76-100%	2% (1)	0% (0)	13% (1)	0% (0)

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

Note: Question was open-ended.

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Next, respondents were asked to estimate the capacity of the renewable energy system that would have been installed if the NYSERDA ARRA funds had not been available (Table 3-132). Overall, the systems that would have been installed without ARRA funds would have had 5.3% of the capacity of the installed systems. Considering the populations separately, without ARRA funds, the Downstate PV respondents on average would have installed systems representing a larger percentage of the installed capacity than Upstate PV systems or non-PV systems.

Table 3-132. 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	*44*	*29*	*8*	*7*
Mean percent	5.3%	8.4%	15.2%	1.1%
0-25%	89% (39)	86% (25)	80% (7)	100% (7)
26-50%	2% (1)	3% (1)	0% (0)	0% (0)
51-75%	2% (1)	3% (1)	0% (0)	0% (0)
76-100%	7% (3)	7% (2)	20% (1)	0% (0)

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

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The Cadmus Team estimated the direct freeridership by first calculating the average of responses reported in Table 3-131 and Table 3-132 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 5.3% (Table 3-133). Considering the populations separately, direct freeridership is highest for the Downstate PV respondents (13.2%), followed by Upstate PV respondents (6.2%) and non-PV respondents (3.1%).

Table 3-133. 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	*44*	*29*	*8*	*7*
Mean direct freeridership	5.3%	6.2%	13.2%	3.1%
0.00-0.25	93% (41)	93% (27)	88% (7)	100% (7)
0.26-0.50	0% (0)	0% (0)	0% (0)	0% (0)
0.51-0.75	5% (2)	7% (2)	0% (0)	0% (0)
0.76-1.00	2% (1)	0% (0)	12% (1)	0% (0)

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

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Program Area Influence Score

The second step in estimating freeridership required calculating a Program Area influence score, which was 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 3-134 shows that 21% of respondents were planning to install a similar system.

Table 3-134. FR1, Prior Plans to Install Similar System, Renewable Energy Program Area

Response	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*44*	*29*	*8*	*7*
Yes	18% (8)	14% (4)	25% (2)	29% (2)
No	82% (36)	86% (25)	75% (6)	71% (5)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The eight respondents who indicated that they had been planning to install a similar system were then presented with a list of statements describing various stages in the planning process, and were asked to indicate which statement best described the project before they participated in the Renewable Energy Program Area. A response of 1 indicates preliminary planning and strong Program Area influence on the decision to install the renewable energy system (Table 3-135). Four out of eight 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. Two respondents were 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 had had in-depth discussions of specific types of renewable equipment, including positive and negative attributes, as well as costs. The remaining respondent was in a fairly advanced stage of planning, having chosen specific equipment models, but their organization's budget could not cover the cost for the entire project.

Table 3-135. 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	*8*	*4*	*2*	*2*
Had preliminary internal discussions, but no plans and no contact with a vendor, contractor, or installer.	25% (2)	25% (1)	50% (1)	0% (0)
Had taken initial steps toward considering the equipment, such as requesting information from or discussing options with a vendor, contractor, or installer.	50% (4)	75% (3)	0% (0)	50% (1)
Had in-depth discussions of specific types of renewable equipment, including positive and negative attributes and costs.	13% (1)	0% (0)	0% (0)	50% (1)
Had identified specific equipment and models but hadn't begun the budgeting process.	0% (0)	0% (0)	0% (0)	0% (0)
Had identified specific equipment and models but budget did not allow completion of project.	13% (1)	0% (0)	50% (1)	0% (0)
Had indentified specific equipment and models and incorporated project into budget.	0% (0)	0% (0)	0% (0)	0% (0)

Note: Base is respondents who had prior plans to install a renewable energy system.

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

* These percentages and counts reflect unweighted data due to the small sample size.

The next question gauged the influence of the NYSERDA funding on respondents' decision to install their system. Presented with a list of statements describing various levels of influence, respondents were asked to choose the statement that best indicates the effect of the Renewable Energy Program Area on their decision process. As shown in Table 3-136, a large majority (82%) said that the funding was either a major driver in the decision or the primary reason that the system was installed. Ten percent said that the funding "*helped in choosing to install a system that had been discussed but not thoroughly considered,*" while 8% said that the funding "*helped in making the final decision*" to install a system that had already been considered.

Table 3-136. 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	*44*	*29*	*8*	*7*
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.	8% (1)	0% (0)	0% (0)	14% (1)
The Renewable Energy Program Area and funding helped in choosing to install a system that had been discussed but not thoroughly considered.	10% (3)	3% (1)	13% (1)	14% (1)
The Renewable Energy Program Area funding was a major driver in the decision to install the system.	36% (19)	48% (14)	38% (3)	29% (2)
The Renewable Energy Program Area funding was the primary reason that the system was installed.	46% (21)	48% (14)	50% (4)	43% (3)

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

Note: 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 (88%) indicated that it was very important, while the remaining 12% said it was somewhat important to their decision (Table 3-137).

Table 3-137. 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	*44*	*29*	*8*	*7*
Mean (Scale 1-5)	4.9	5.0	4.8	4.9
1 Not at all important	0%	0%	0%	0%
2 Somewhat unimportant	0%	0%	0%	0%
3 Neither important nor unimportant	0%	0%	0%	0%
4 Somewhat important	12% (4)	3% (1)	25% (2)	14% (1)
5 Very important	88% (40)	97% (28)	75% (6)	86% (6)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Additional Program Area influence questions were included in the average Program Area influence score 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).

Respondents whose projects were not fully covered by NYSERDA funds were asked 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.

The next few survey questions 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 3-138 shows that 9% of respondents had tried to obtain funding for the project before applying for NYSERDA funds.

Table 3-138. 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	*44*	*29*	*8*	*7*
Yes	9% (4)	7% (2)	0% (0)	29% (2)
No	91% (40)	93% (27)	100% (8)	71% (5)

Note: 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 used these funds to pay for part of the costs of the renewable energy project. No respondents reported losing funds or declining them, suggesting that, contrary to expectations, NYSERDA ARRA funds did not make up for lost funds. Further, because only 9% 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.

Respondents were then asked 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). Fewer than one-tenth (9%) responded in the affirmative (Table 3-139).

Table 3-139. 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	*44*	*29*	*8*	*7*
Yes	9% (4)	10% (3)	0% (0)	14% (1)
No	91% (40)	90% (26)	100% (8)	86% (6)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The four 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. Three of the four said that it is very unlikely they would have diverted these funds to other projects (indicating strong Program Area influence), while the fourth said it was somewhat likely that they would have (Table 3-140).

Table 3-140. 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	*4*	*3*	*0*	*1*
Mean (scale of 1 to 5)	2.9	1.0	N/A	4.0
1 Not at all likely	75% (3)	100% (3)	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	25% (1)	0% (0)	0% (0)	100% (1)
5 Very likely	0% (0)	0% (0)	0% (0)	0% (0)

* These percents and counts represent unweighted data due to the small sample size.

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

A follow-up question asked whether the projects for which the diverted funds were spent were related to renewable energy or energy efficiency. Of the four participants who used diverted funds for other projects, only one reported that it was for an additional renewable energy project. This Upstate respondent, who had installed non-PV equipment with NYSERDA funds, reported that the diverted funds were used for PV panels.

The three respondents who diverted funds but did *not* use them to fund other energy efficiency or renewable energy projects were asked how they did use the diverted funds. Two used them for other capital improvement projects (additional highway building and "*yet to be decided but likely to offset taxpayer costs*") and one used the funds to retain one staff position within their organization.

The Program Area influence score is the average of the three individual Program Area influence questions (FR2, FR3, and FR4), plus, for the respondents who diverted funds to other projects after securing ARRA funds, responses to AF10. Because none of the respondents lost funds that had been previously 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 F, and is summarized here.

The Cadmus Team reverse-scored[90] questions FR2 and AF10, such that the response indicating the greatest influence of NYSERDA ARRA funding on the project also received the highest score. Question FR2 was then adjusted so that the answers were converted to a 5-point scale by multiplying the outcome by 5/6. Overall, RFP 1613 was rated as being very influential on respondents' decisions to install a renewable energy system (a 4.45 on a scale from 1 to 5; Table 3-141).

[90] The reverse score of FR2 was obtained 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 3-141. Renewable Energy Program Area Influence Score

Average Program Area Influence	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*44*	*29*	*8*	*7*
Mean (Scale 1-5)	4.45	4.71	4.51	4.26

Adjusting Direct Freeridership Based on the Program Area Influence Score

Following the approved algorithm, presented in Appendix F, direct freeridership scores were adjusted based on the Program Area influence score. The Program Area influence score provides lower and upper bounds of freeridership, as defined in Table 3-142 and the algorithm in Appendix F.[91] A direct freeridership score was compared to the upper and lower bounds of the Program Area influence score (Table 3-142). Wherever the direct freeridership fell outside the bounds of the Program Area influence score, the preliminary estimate of freeridership was changed to either the lower or upper bound value (whichever was closest).

Table 3-142. 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 6% (Table 3-143). Comparing the individual populations, Upstate PV respondents had the lowest adjusted freeridership (5%), followed by non-PV participants (7%) and Downstate PV respondents (8%).

[91] 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.

Table 3-143. Adjusted Freeridership Score, Renewable Energy Program Area

	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*44*	*29*	*8*	*7*
Average preliminary freeridership score	6%	5%	8%	6%

Adjusting Freeridership by the Percent of the Project Funded by NYSERDA ARRA (AF1 and AF2) and Weighting by the Energy Generation

Freeridership values were applied to the estimated portion of generation attributable to NYSERDA ARRA and weighted by the expected generation.

Respondents were asked 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 3-144, the vast majority of respondents (98%) said that NYSERDA funds covered more than one-half of the project budget, with 37% of projects being fully covered by the funds. The average percentage covered by NYSERDA funds was 87%. 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 3-144. 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	*44*	*29*	*8*	*7*
Mean Percent of Budget	87%	86%	89%	86%
0-10%	0% (0)	0% (0)	0% (0)	0% (0)
11-20%	1% (1)	3% (1)	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%	1% (1)	3% (1)	0% (0)	0% (0)
51-60%	1% (1)	3% (1)	0% (0)	0% (0)
61-70%	17% (3)	3% (1)	0% (0)	29% (2)
71-80%	14% (6)	14% (4)	13% (1)	14% (1)
81-90%	22% (11)	21% (6)	50% (4)	14% (1)
91-99%	8% (6)	10% (3)	38% (3)	0% (0)
0100%	37% (15)	41% (12)	0% (0)	43% (3)

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

Note: 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 3-145, more than one-half (55%) of the sample of respondents used funds from their organization's operating budget, and a similar proportion (52%) used funds from their organization's capital improvement budget. Individual Upstate PV projects were also partially funded by municipal bonds, tax credits, rebates on equipment, loans, and taxpayers.

Table 3-145. Non-Renewable Energy Program Area Funding Sources (Multiple Responses)

Funding Sources	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*23*	*15*	*5*	*3*
Operating budget	55% (11)	40% (6)	60% (3)	67% (2)
Capital improvement budget	52% (11)	47% (7)	40% (2)	67% (2)
Municipal bonds	3% (1)	7% (1)	0% (0)	0% (0)
Tax credits	2% (1)	7% (1)	0% (0)	0% (0)
Rebates on equipment	2% (1)	7% (1)	0% (0)	0% (0)
Loans	2% (1)	7% (1)	0% (0)	0% (0)
Taxpayers	2% (1)	7% (1)	0% (0)	0% (0)

Note: Base is respondents whose projects were not entirely funded by NYSERDA/ARRA funds.

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The final freeridership score, weighted by generation attributable to NYSERDA ARRA funding, was approximately 4% for RFP 1613 as a whole, with a 90% confidence interval of 0% to 9%, and a net-of-freeridership value of 96%, with a 90% confidence interval of 91% to 100% (Table 3-146). The Cadmus Team estimates that freeridership for each technology group is also 4% (i.e., PV Upstate, PV Downstate, and non-PV projects).[92] Freeridership and net-of-freeridership estimates with 90% confidence intervals are presented in Table 3-146. However, due to the small sample sizes 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 3-146. Final Freeridership Scores, Renewable Energy Program Area

	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*44*	*29*	*8*	*7*
(4) & (5) Freeridership, weighted by generation attributable to NYSERDA ARRA funding (90% confidence interval)	4% (90% CI: 0%, 9%)	4% (90% CI: 0%, 9%)	4% (90% CI: 0%, 15%	4% (90% CI: 0%, 16%

Note: The 0% is the lower bound of the 90% confidence interval.

<u>Takeback</u>

Respondents were asked two questions designed to gauge whether their energy consumption had increased since the installation of the renewable energy system (a phenomenon known as takeback*)*. Examples of takeback might include leaving lights on longer, taking longer showers, or other activities

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

that could reduce the net benefit of the installed renewable energy system. There is little evidence of widespread takeback.

The first question assessed whether there was any change in energy use at the facilities where the systems were installed. As shown in Table 3-147, 67% of respondent reported that their energy usage had decreased since installing the system, whereas 32% said it had stayed the same. Just 2% said their energy use had increased.

Table 3-147. Change in Energy Usage Since Installation, Renewable Energy Program Area

Response	Overall	Solar PV, Upstate	Solar PV, Downstate	Non-Solar PV
Sample size	*35*	*24*	*5*	*6*
Increased	2% (1)	4% (1)	0% (0)	0% (0)
Decreased	67% (20)	50% (12)	60% (3)	83% (5)
Stayed the same	32% (14)	46% (11)	40% (2)	17% (1)

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

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Respondents whose energy use at the facility had either stayed the same or increased were presented with a list of possible energy-related actions and were asked which, if any, had been taken in their building since the system was installed (Table 3-148). One Upstate solar PV respondent reported that a building addition had been constructed and a Downstate solar PV respondent reported that a large piece of equipment had been installed. However, the majority of respondents (i.e., those included in the “other” category in the table) responded that there had been no change in their energy-use behavior or that the renewable energy project had been installed too recently to gauge whether the energy usage had changed. A few respondents also said that they were now more aware of energy usage or that they had installed additional energy-efficient equipment.

Table 3-148. 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	*15*	*12*	*2*	*1*
Installation of additional large piece of equipment	11% (1)	0% (0)	50% (1)	0% (0)
Building addition	2% (1)	4% (1)	0% (0)	0% (0)
Other responses/No change	87% (13)	96% (11)	50% (1)	100% (1)

Note: Base is respondents whose energy use increased or stayed the same.

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Table 3-149 summarizes the evaluated expected annual net impact as of the end of 2011.

Table 3-149. RFP 1613 Savings Impact Evaluated Net of Freeridership Through December 31, 2011, Renewable Energy Program Area

	Total Claimed Electricity Generation / Savings from Installed Projects	Savings Weighted Realization Rate	Total Evaluated Gross Electricity Generation / Savings	Freeridership	Evaluated Net of Freeridership
Electricity (MWh)	3,347	1.12	3,749	0.04	3,599
Fuel (MMBtu)	18,083	0.77	13,924	0.04	13,367

3.4.8 Data Sources: PON 1686

The Cadmus Team used the following data sources for evaluating the PON 1686 Renewable Energy Program Area, in addition to those already discussed for RFP 1613:

- End user telephone surveys
- Telephone interviews with participating installers
- Claimed installation characteristics
- Site visits and engineering estimates

3.4.9 Approach: Surveys and Sample Design: PON 1686

<u>End-User Telephone Surveys</u>

The telephone surveys of end-users included questions that sought to ascertain the following:

- End-user awareness of NYSERDA and funding from NYSERDA ARRA
- Why end-users installed a PV system
- Whether end-users used tax credits to help finance their PV system
- Whether end-users increased their energy usage after installing their PV system (known as a take-back effect)
- Whether end-users had installed additional renewable energy systems or energy-efficient equipment, or whether they had adopted energy saving behaviors since installing the PV system (which is used as a qualitative measurement of spillover)
- Characteristics of the households or organization receiving the funds

The survey also included a number of questions designed to estimate Program Area-induced installation of PV systems and energy generation by estimating end-users' willingness to pay (WTP) more than the incentivized price for their PV installations. The Cadmus Team used respondents' answers to these questions to calculate freeridership.

Table 3-150 reports the final sample sizes and the associated error margin at the 90% confidence level, assuming a 50/50 proportion in responses for each strata.

Survey data were collected in two phases. A total of 28 telephone surveys were completed between November 23 and December 4, 2011. Additional WTP data were collected from 11 additional respondents between February 8 and February 12, 2012.

Table 3-150. Participant Survey Sample Design, PON 1686 (Population), Renewable Energy Program Area

	Population*	Sample Size	Sampling Error at 90% Confidence Level
Residential	66	28	12%
Commercial	9	3	42%

* Note that the population at the time surveys were fielded was 54 residential and five commercial projects. The final sampling error was increased due to some projects being completed after surveys were fielded and prior to preparation of this report.

Telephone Interviews with Participating Installers

The telephone interviews with installers addressed several topics, including Renewable Energy Program Area awareness, Program Area diversion, application and paperwork issues, impacts on PV installations, and economic impacts.

The interviews also included a number of questions designed to estimate the Program Area-induced installation of PV systems by asking installers if they believe end-users would have installed PV systems without the incentives (indicating freeridership).

Claimed Installation Characteristics

System configuration data were readily available for PON 1686 and were provided to the Cadmus Team in a tracking spreadsheet by the implementation contractor. The baseline data used for comparison was received on November 4, 2011. The Cadmus Team used the following applicable installation characteristics to help quantify how well installers tracked and reported solar system installation characteristics:

- Installed system size (kW_{DC})[93]
- Orientation (degrees)
- Tilt (degrees)
- Shading losses (kWh/yr or %)
- Expected annual generation (kWh/yr)

Although the claimed installation characteristics did not directly feed into realization rate calculations, the Cadmus Team compared these claimed characteristics to the site characteristics collected on-site to quantify discrepancies.

[93] Solar PV modules generate direct current electricity.

Site Visits and Engineering Estimates

Site visits were conducted at 19 completed projects to determine the accuracy of primary verification field data collected on-site. The Cadmus Team documented the following information for each site-visited project:

1. Verify all installed system characteristics (as documented in the spreadsheet titled *PON 1686 tracking sheet 11-4-2011.xls*):
    a. Nameplate PV module
    b. Number of modules
    c. Nameplate PV inverter
    d. Number of inverters
    e. Shading derate factors
    f. Tilt
    g. Azimuth
2. Note of any damage or evidence of tampering/theft/vandalism
3. Note levels of soiling on surface
4. Spot measurement at inverter, or read output off inverter (if available)
5. Note generation-to-date (kWh) from inverter and/or generation output meter
6. Note any other possible contributing factors to loss (or gain) of generation

Quality Control

The field engineers entered site data into an online database on the day of each site visit. On the next business day, a Cadmus Team analyst reviewed the data, following a quality control procedure to ensure that the data were collected and entered properly, to clarify any doubts, and to correct any issues while data collection was ongoing. The Cadmus Team contacted the field engineers promptly to discuss any issues.

Recruiting

The target site visit sample consisted of all PON 1686 sites that had been interconnected for at least nine months (22 residential and four nonresidential). Therefore, the recruiting goal was to schedule and complete a site visit for all the sites in the sample.

The Renewable Energy Program Area goal was to recruit all sites in the PON 1686 sample for a site visit. To this end, NYSERDA sent an advance letter to Program Area participants, outlining the purpose of this study and informing participants that the Cadmus Team would be contacting them to schedule site visits.

Recruiting sites for field data collection was conducted in the most convenient manner for all sites, based on logistics, scheduling, and geography. If a site was dropped from the sample, for a reason such as non-response or refusal to participate in evaluation, measurement, and verification (EM&V), then the Cadmus Team directed recruiting efforts to the next primary sample site.

Site Visits

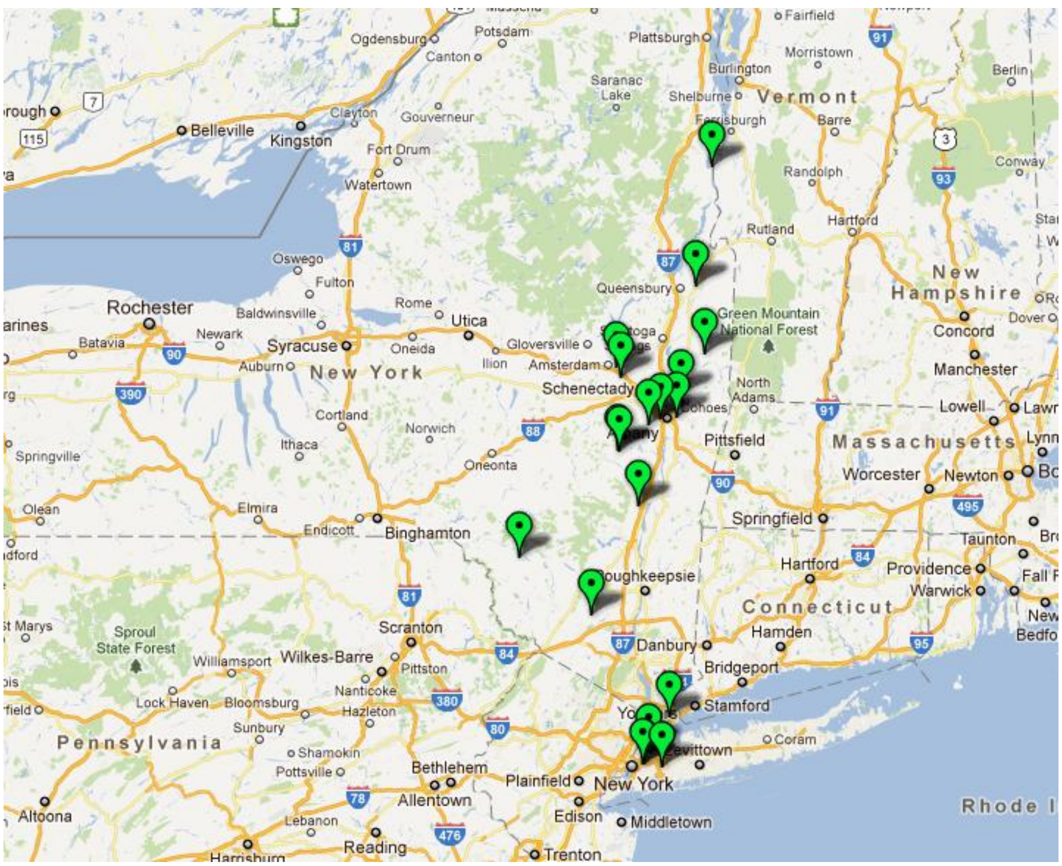
Once the initial forms, procedures, and data collection system were drafted, the Cadmus Team conducted preliminary site visits to pilot the field data collection protocol. A small number of pilot site visits bears great value over the course of full deployment. Preliminary site visits almost always reveal inefficiencies in the draft procedures, and by conducting these as part of a pilot, they can be quickly and easily remedied.

Once the procedures were piloted and fully vetted, the Cadmus Team field engineers were trained in the final data collection methods. Training ensures both the quality and consistency of reporting across all staff conducting the field work. All personnel that collect data in the field were required to attend training. The finalized field protocols were provided in advance of the training so that staff could become familiar with the procedures and have informed questions for the trainer. The training sessions covered everything the field engineers needed to know in order to successfully complete the engagement, including appropriate customer interactions, how to fill out the forms, how to conduct spot measurements and use a SunEye™, and how to make sure the data collected in the field was transferred to the FACT system and the project managers.

After the pilot site visits and training, the Cadmus Team began full deployment of the site visits. The Cadmus Team utilized a local field engineer who is familiar with local conditions for the measurement and verification activities, which also served to reduce travel costs.

The following map in Figure 3-60 and site visit summary in Table 3-151 summarize the results of the Cadmus Team's recruiting efforts, showing the sites that received field verification.

Figure 3-60. Map of Projects that Received Field Verification, Renewable Energy Program Area



Source: Google Maps.

Table 3-151. Summary of Projects That Received Field Verification, Renewable Energy Program Area

Sector	Installer	Population (# of Projects)	Site Visits Completed # Projects and Capacity (kW)		Total Capacity for Population (kW)
Residential	Installer 1	14	0*	0	358.08
	Installer 2	22	10	87.92	323.55
	Installer 3	30	5	30.93	842.38
Commercial	Installer 4	0	0	0	178.64
	Installer 5	7	4	414.81	1041.11
	Installer 6	2	0	0	850.08
Total		**75**	**19**	**533.66**	**3,593.84**

* Completed project totals in table reflect data as of December 31, 2011. To meet reporting deadlines, however, the Cadmus Team concluded site visits for PON 1686 in mid-November 2011. Installers receiving no site visits did not have completed projects as of the time site visits were conducted, but were able to completed projects before December 31, 2011.

Note that installers whose projects received no site visits did not have completed projects available for site visits at the time of the Cadmus Team's field inspections. Some, such as Installer 6, were able to complete projects subsequent to the Cadmus Team's site visits but prior to preparation of this report.

3.4.10 Process Findings: PON 1686

This section presents the results of a telephone survey of PON 1686 end-users, an ARRA-funded offering focusing on renewable energy in the form of solar PV electric systems. Respondents included both residential (n=28) and commercial (n=3) customers.[94] All residential systems were installed Upstate and all commercial systems were installed Downstate.

Appendix G summarizes the awareness, motivation, economic factors, alternative funding, and spillover characteristics of the Renewable Energy Program Area recipients.

<u>Motivation</u>

One portion of the survey focused on respondents' motivation to install PV systems, with questions about the importance of funding in their installation decision, why they decided to install the system, and how they dealt with the installation process.

Respondents were asked to rate the importance of federal and state tax credits using a scale of 1 to 5, with 1 indicating that it was extremely important and 5 indicating that it was not important at all. Both federal and state tax credits were instrumental in residential and commercials respondent's decision to install their systems. All 17 residential respondents and both commercial respondents who made use of the federal tax credit rated it as extremely important in their decision to install (mean score = 1.0). Similarly, the 16 residential respondents and the three commercial respondents who utilized the state tax credit said the funding was extremely important, with a mean score of 1.1 for residential and 1.0 for commercial respondents (Table 3-152).

[94] Valid data for the WTP questions was collected from 19 residential respondents.

Table 3-152. Importance of Federal and State Tax Credits in Decision to Install System, Renewable Energy Program Area

Importance of Tax Credit	Federal		State	
	Residential	Commercial	Residential	Commercial
Sample size	*17*	*2*	*16*	*3*
Mean (Scale 1-5)	1.0	1.0	1.1	1.0
1 Extremely important	100% (17)	100% (2)	88% (14)	100% (3)
2 Somewhat important	0% (0)	0% (0)	13% (2)	0% (0)
3 Neither important nor unimportant	0% (0)	0% (0)	0% (0)	0% (0)
4 Not very important	0% (0)	0% (0)	0% (0)	0% (0)
5 Not at all important	0% (0)	0% (0)	0% (0)	0% (0)
Don't know/refused	0% (0)	0% (0)	0% (0)	0% (0)

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

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Respondents then reported their reasons for installing their PV system. Most frequently, they reported a desire to reduce energy bills and have energy savings (reported by 39% of residential respondents and all three commercial respondents). This was followed by concern for the environment, cited by 29% of residential respondents and one commercial respondent. Commercial respondents also pointed to reducing their company's carbon footprint and emissions, as well as green marketing/public relations as motivations to install. Residential respondents cited promoting renewable energy and reducing their carbon footprint, among other motivations (Table 3-153).

Table 3-153. Why Installed System (Multiple Responses), Renewable Energy Program Area

Reason	Residential	Commercial
Sample size	*28*	*3*
Reduce energy bills/energy savings	39% (11)	100% (3)
Concern for environment	29% (8)	33% (1)
Promote renewable energy/help increase the adoption of renewable energy	11% (3)	0% (0)
Reduce home/company carbon footprint and emissions	7% (2)	33% (1)
It was a no-cost option	4% (1)	0% (0)
To have another power source	4% (1)	0% (0)
Enhance the value of the property	4% (1)	0% (0)
Hedge against future increases in energy prices	0% (0)	0% (0)
Green marketing/public relations	0% (0)	33% (1)
Regulatory requirements or mandate	0% (0)	0% (0)
Don't know/refused	4% (1)	0% (0)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

The next area of assessment was how respondents became aware of the opportunity to install their PV system. For residential respondents, the most common source of awareness was a story on the TV, radio, or newspaper, reported by 25%. This was followed by word-of-mouth (18%) and an online resource (11%). Each additional response was only reported by individual residential respondents. This finding seems to support a strategy of maintaining multiple channels of information about future NYSERDA programs.

Two of the commercial respondents reported awareness of the installation opportunity from word-of-mouth, and two learned from brochures or catalogues from a PV dealer/installer. One commercial respondent became aware from an environmental consultant (Table 3-154).

Table 3-154. How Became Aware of Opportunity to Install PV System (Multiple Responses), Renewable Energy Program Area

Sources of Awareness	Residential	Commercial
Sample size	*28*	*3*
Story on TV/radio/newspaper	25% (7)	0% (0)
Word-of-mouth (e.g., friend, family, neighbor, colleague)	18% (5)	66% (2)
Online	11% (3)	0% (0)
Brochure or catalogue from a PV dealer/installer	4% (1)	66% (2)
NYSERDA Website	4% (1)	0% (0)
Trade show	4% (1)	0% (0)
Seeing PV on other homes	4% (1)	0% (0)
School	4% (1)	0% (0)
Home shows	4% (1)	0% (0)
My job	4% (1)	0% (0)
Home Depot	4% (1)	0% (0)
Environmental consultant	0% (0)	33% (1)
Don’t know/refused	7% (2)	0% (0)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

After they had found out about the opportunity to install a system, respondents were also asked how they found an installer. The most common answer from residential respondents was word-of-mouth (39%). Other popular sources from residential respondents were the phone book, the internet, and from a Web search (25%). Other residential responses included a brochure or catalogue from a PV dealer/installer, direct contact by a PV installer, and home shows (7% each). Further responses were only mentioned by individual residential respondents (Table 3-155). The three commercial respondents found their installers through word-of-mouth, an environmental consultant, and an economic development corporation. This finding suggests that PV installers employ multiple modes of marketing and outreach to potential customers, but that word-of-mouth recommendations from satisfied customers may be the most important marketing tool.

Table 3-155. Method for Finding System Installer, Renewable Energy Program Area

Sources	Residential	Commercial
Sample size	*28*	*3*
Word-of-mouth (e.g., friend, family, neighbor, colleague)	39% (11)	33% (1)
Phone book/internet/Web search	25% (7)	0% (0)
Brochure or catalogue from a PV dealer/installer	7% (2)	0% (0)
Direct contact by a PV installer	7% (2)	0% (0)
Home shows	7% (2)	0% (0)
PV installer's Website	4% (1)	0% (0)
Newspaper	4% (1)	0% (0)
Referral from other PV system owner	0% (0)	0% (0)
NYSERDA Website	0% (0)	0% (0)
Environmental consultant	0% (0)	33% (1)
Economic development corporation	0% (0)	33% (1)
Don't know/refused	7% (2)	0% (0)

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

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Freeridership – End Users' Willingness to Pay and Price Elasticity

Freeridership for PON 1686 was estimated with responses to questions pertaining to end-users' WTP more than the incentivized price for their PV installations.[95] End-users' WTP for the PV installations was determined by asking respondents if they would have paid for the system at price points above the one they actually paid by moving upward in price in three $400 increments (i.e., $400 more per kW, $800 more per kW, and $1,200 more kW) to determine how much they would have paid without the ARRA-funded incentives.

Freeridership was calculated by using an estimated average full price per kW (based on Program Area records), an average discounted price per kW (based on Program Area records), and an average WTP price (based on survey data). WTP responses were weighted by the capacity of the respondent's PV system. With this method, the average price the respondents were willing to pay is compared to the incentivized price in the following fashion:

Equation 3-21. PON 1686 Freeridership Calculation, Renewable Energy Program Area

96

[95] Because of the design of PON 1686, end-users may not have been aware that the price of their PV system was reduced by NYSERDA ARRA incentives or of the value of the incentives. WTP questions were used to estimate freeridership rather than a standard battery of freeridership questions because end-users may not have been aware that they were program participants.

Freeridership was estimated separately for residential and commercial respondents.[97]

For residential respondents, the average price respondents said they were willing to pay was $4,752 per kW, while the average incentivized price as $4,632 per kW and the average non-incentivized price was $6,267 per kW, resulting in a freeridership rate of 7% (Table 3-156). All three commercial respondents said they were willing to pay more than non-incentivized price of their system, resulting in a freeridership rate of 100%.

The estimate of freeridership for commercial respondents should be viewed very cautiously, as they are contradicted by the PV installers.

Table 3-156. Initial Estimates of Freeridership Based on End-User Survey, Renewable Energy Program Area

Sources	Residential	Commercial
Sample size	*19*	*3*
Overall freeridership	**7%**	**100%**

Freeridership – PV Installers

Freeridership was also estimated by PV installers during the in-depth interviews. Four of the six installers interviewed by the Cadmus Team worked with commercial customers. All four commercial installers believed that freeridership was very low or non-existent for their commercial customers, with freeridership estimates ranging from 0% to 29%. In addition, some installers described their commercial customers as being very price sensitive and requiring short (five-year) payback periods. Further, two of the four installers reported that projects were installed approximately two months sooner because of the ARRA funding. The average freeridership score provided by commercial installers was 12%.

There was much less consensus among the three out of six interviewed installers who worked with residential customers, and only one of those three could provide an estimate of freeridership. One installer reported low levels of freeridership and estimated that 25% of the customers were freeriders. A second installer reported that all of the residential systems would have been installed through NYSERDA's Power Naturally Program in absence of ARRA funding, although the systems would have been smaller as a result of having less funding; the installer did not estimate the number of systems that would have been installed in the absence of any subsidy. The third installer could not estimate freeridership. There was general agreement among the residential installers that residential customers are less price-sensitive than commercial customers.

Overall, the Cadmus Team does not recommend estimating freeridership based on the interviews with residential PV installers, since only one of three interviewed installers could provide an estimate.

[96] Freeridership was estimated using data from 19 residential respondents. WTP data for the remaining residential respondents was not used because the end-user survey programming erroneously used the full (non-incentivized) price as the base price in their WTP questions.

[97] Because all residential projects were completed Upstate and all commercial projects were completed Downstate, the Cadmus Team did not develop Upstate/Downstate weights for PON 1686.

Freeridership – Final Estimate

The Cadmus Team adjusted the freeridership for commercial end-users based on freeridership estimates provided by the four commercial PV installers. Because only one of the three residential installers could provide an estimate of freeridership, installer interview data were not used to adjust residential freeridership.

Final freeridership for commercial respondents was calculated by taking the average of the participants' score (100%) and the installers' score (12%) for an initial score of 56%. Then, because two of four installers said their projects were installed an average of two months sooner because of ARRA funding, the Cadmus Team reduced freeridership by 1/12.[98] This resulted in a commercial freeridership estimate of 51%. No adjustments were made to the residential freeridership value of 7% (Table 3-157).

Because of the extremely small sample size of commercial participants, and the contradictory estimates of commercial freeridership provided by the PV installers, the Cadmus Team recommends treating these values as indicative of freeridership, but not using them to estimate net energy generation at this time. The sample size of the residential respondents is also relatively small, suggesting the results should be interpreted cautiously. However, residential freeridership rates are comparable to those found in a recent evaluation of renewable energy programs.[99]

Table 3-157. Final Estimates of Freeridership, Renewable Energy Program Area

Sources	Residential	Commercial
End-user estimate	7%	100%
Installer estimate	N/A	12%
Average end-user and installer estimate	N/A	56%
Adjustment, early installation of systems (PV installer estimate)	N/A	1/12
Final freeridership estimate (90% confidence interval)	**7% (90% CI: 0%-17%)**	**51% (N/A)**
Final net of freeridership value (90% confidence interval)	**93% (90% CI: 83%-100%)**	**49% (N/A)**

Note: The 0% is the lower bound of the 90% confidence interval.

98 Two installers estimated that their projects were installed approximately two months sooner because of the NYSERDA ARRA program (i.e., 1/6 of a year). Averaging the earlier installations across the four commercial installers yields a value of 1/12.

99 A recent evaluation of a commercial solar PV program in Oregon estimated freeridership rates of 11% (Research Into Action. *Final Report Fast Feedback Program Rollout: Nonresidential & Residential Program Portfolio*. 2010. http://energytrust.org/library/reports/101231_Fast_Feedback_Rollout.pdf).

A second evaluation of a solar PV program in Wisconsin estimated freeridership rates of 19% for residential participants and 21% for commercial participants (TetraTech. *Renewables: Impact Evaluation CY10 September 2009 through June 2010*. 2011. http://www.focusonenergy.com/files/Document_Management_System/Evaluation/renewablesimpactevaluationcy10_evaluationreport.pdf).

The Cadmus Team benchmarked this Program Area's freeridership results with results from other studies which evaluated similar programs. In these other studies[100,101], freeridership rates averaged around 0.22. One report calculated freeridership at less than 5% with a NTG close to 1.0 for solar PV measures.[102] The Renewable Energy Program Area freeridership rate of 39%[103] for PON 1686 is on the high end relative to these other programs, though should be viewed with some skepticism due to the small sample size for commercial projects.

Takeback and Spillover

Next, survey respondents were asked about takeback effects (or the reduction in conservation efforts because of installing a renewable system) and spillover (or renewable generation actions or energy saving actions taken as a result of the Program Area). There is little evidence of widespread takeback effects related to the Renewable Energy Program Area, while there is limited evidence of spillover by residential respondents in the form of energy-efficient equipment installed in their homes or energy-efficient actions taken by respondents (Table 3-158). Overall, spillover savings likely nullify, and possibly exceed, takeback effects.

Table 3-158. Changes in Energy-Related Behavior Since Installation of System (Multiple Responses), Renewable Energy Program Area

Behavioral Change	Residential	Commercial
Sample size	28	3
Evidence of any takeback	25% (7)	33% (1)
Spillover: Installed energy-efficient equipment and was strongly influenced by PV system*	18% (5)	0% (0)
Spillover: Adopted any energy-saving actions or behaviors and was strongly influenced by PV system*	50% (14)	0% (0)

* Strong influence was defined as a rating between 7 and 10 on the 10-point scale (a 10 indicates that the PV system was the most influential on their decision to install or purchase high-efficiency equipment).

Note: The numbers before the parentheses are unweighted frequencies, while the percentages inside the parentheses reflect weighted data.

Survey respondents were asked about takeback effects, which may reduce some of the renewable system benefit because overall energy use increases. There is little evidence of widespread takeback effects related to the Renewable Energy Program Area.

To assess whether the PV system installation may have led to increased energy consumption, respondents were asked about any changes in their energy-related behavior since the installation of their system. Table 3-159 reports potential increases in energy use since the system installation. Across the entire sample, few

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

[101] The Cadmus Group, Inc. *WI Focus on Energy Renewables Impact Evaluation Report*. 2010.

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

[103] Based on combination of residential and commercial. See the Renewable Energy Program Area, Gross Savings Calculations section.

respondents reported increases in energy consumption. For residential respondents, 14% indicated they had decreased their thermostat settings during the summer and increased their electricity use for plug-in devices. One residential respondent increases their home thermostat settings during the winter, one leaves lights on more frequently, and one installed an additional large piece of electrical equipment. One commercial respondent reported installing more equipment that uses electricity and also increased hot water use (Table 3-159).

Table 3-159. Takeback: Changes in Energy-Related Behavior Since Installation of System (Multiple Responses), Renewable Energy Program Area

Behavioral Change	Residential	Commercial
Sample size	*28*	*3*
Any change in energy-related behavior	25% (7)	33% (1)
Decreased thermostat settings during summer	14% (4)	0% (0)
Increased use of electricity for plug-in electrical devices	14% (4)	0% (0)
Increased thermostat settings during winter	4% (1)	0% (0)
Left lights on more frequently	4% (1)	0% (0)
Installed additional large piece of electrical equipment	4% (1)	0% (0)
Installed more equipment that uses electricity	0% (0)	33% (1)
Left office equipment on overnight	0% (0)	0% (0)
Increased hot water use	0% (0)	33% (1)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data

To understand the potential influence of the PV installation on takeback behaviors, respondents who reported increases in energy use were asked why they had made the changes. For commercial respondents, it became clear that the PV system had no influence on increased energy consumption. Only one of the three commercial respondents reported changes in energy-related behavior (increased hot water use and installed new equipment), and both of these changes were described as a result of the company growing in size, not the PV system installation.

However, the few residential respondents who reported changes in their energy-related behaviors were influenced by the installation of the PV system. Four residential respondents (14%) specifically reported increased use directly as a result of the PV system. For these respondents, the PV system produced more energy than they had been using, and they preferred to increase their energy usage rather than be credited for excess generation under New York's net metering rules.

- One respondent described their household's decision as follows: "*When looking at how we are currently producing more energy than we are using, we realized that at the end of the year we only get paid back a supply fee and not a delivery fee. It is in our best interest to utilize all that we have. I guess I see it as better to put it to use than get paid pennies for something that would not really be refunded.*"
- A second respondent replied as follows: "*The electricity we used was free electricity. It was an overage produced by our system. We wanted to zero the system out. If we have a surplus, we don't want to give it to the utility company.*"

These sentiments indicate that some participants are not satisfied with current net metering rules. However, while several respondents reported increasing their energy use, far more respondents reported decreasing their energy usage by installing energy-efficient equipment (Table 3-160) or adopting energy-efficient behaviors (Table 3-163).

Spillover

The survey also asked questions used to make an initial, qualitative assessment of spillover. Respondents were asked if they had installed additional renewable energy capacity, installed energy-efficient equipment, or engaged in energy-saving behaviors since installing their PV system. Overall, there is limited evidence of spillover in the form of energy-efficient equipment installed in respondents' homes or energy-efficient actions taken by respondents. However, spillover may be underestimated and may increase over time. Spillover was assessed soon after the installation of the PV systems and often takes more time to occur.

No additional renewable energy capacity had been installed, and 18% of residential respondents and none of the three commercial respondents attributed the installation of energy-efficient equipment to the installation of their PV system. However, about half of all residential respondents reported that they have adopted energy-savings behaviors because of their PV systems, including turning off lights more frequently, decreasing hot water use, and installing energy-efficient light bulbs.

Two residential respondents had considered adding more renewable energy capacity, with one considering adding more solar capacity and a second who had looked into other technologies, such as geothermal and micro combined heat and power. Neither respondent had actually installed more renewable capacity at the time of the survey.

Eleven of 28 residential respondents had installed energy efficient or ENERGY STAR-qualified equipment since having their PV system installed. Types of equipment installed included water heaters (14%), refrigerator/freezers (11%), heat pumps (7%), lighting (7%), and air conditioners, clothes washers, and windows/doors (4% each). One of the three commercial respondents had installed ENERGY STAR-certified lighting (Table 3-160).

Respondents were also asked how influential their PV system had been on their decision to install more energy-efficient equipment, on a scale of 0-10 (with 0 indicating that it was not at all influential, and 10 indicating that it was very influential). Of the 11 residential respondents who had installed such equipment, five ranked the PV system as highly influential in that decision (rated between a 7 and a 10 on the 10 point scale). The PV equipment influenced the installation of two water heaters, one heat pump, lighting, and one clothes washer (Table 3-160). The one commercial respondent who had installed energy-efficient lighting did not rate the PV installation as influential in that decision.

Table 3-160. Energy Efficient or ENERGY STAR-Rated Equipment Installed Since Installation of Solar PV System (Multiple Responses), Renewable Energy Program Area

Equipment	Residential		Commercial	
	Installed Equipment	Strongly Influenced by PV System*	Installed Equipment	Strongly Influenced by PV System*
Sample size	*28*	*28*	*3*	*3*
Installed energy-efficient equipment	39%(11)	18% (5)	33% (1)	0% (0)
Water heater	14%(14)	7% (2)	0% (0)	0% (0)
Refrigerator/freezer	11%(3)	0% (0)	0% (0)	0% (0)
Heat pump	7%(2)	4% (1)	0% (0)	0% (0)
Lighting	7%(2)	4% (1)	33% (1)	0% (0)
Air conditioner	4%(1)	0% (0)	0% (0)	0% (0)
Clothes washer	4%(1)	4% (1)	0% (0)	0% (0)
Windows/doors	4%(1)	0% (0)	0% (0)	0% (0)
None	61%(17)	N/A	66% (2)	N/A
Don't know/refused	0%(0)	N/A	0% (0)	N/A

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data

* Strong influence was defined as a rating between 7 and 10 on the 10-point scale (a 10 indicates that the PV system was the most influential on their decision to install or purchase high-efficiency equipment).

Respondents then reported whether they had received a rebate or tax credit for the additional ENERGY STAR-qualified equipment they had installed (Table 3-161). Of the 11 residential respondents who had installed ENERGY STAR-qualified equipment, seven (64%) had received a rebate or tax credit to help finance at least one piece of equipment. The one commercial respondent who had installed energy-efficient lighting also received a rebate.

Table 3-161. Whether Received Rebate or Tax Credit for Additional Equipment Installed (Multiple Responses), Renewable Energy Program Area

Type of Equipment Rebated/Tax Credit	Residential	Commercial
Sample size	*11*	*1*
Received rebate or tax credit	**64% (7)**	**100% (1)**
Water heater	75% (8)	0% (0)
Refrigerator/freezer	33% (4)	0% (0)
Heat pump	100% (11)	0% (0)
Lighting	0% (0)	100% (1)
Air conditioner	100% (11)	0% (0)
Clothes washer	0% (0)	0% (0)
Windows/doors	0% (0)	0% (0)
Did not receive rebate or tax credit	36% (4)	0% (0)
Don't know/refused	0% (0)	0% (0)

Note: Base is respondents who installed ENERGY STAR-qualified equipment since having the solar PV system installed.

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data

The residential respondents received financing from a number of sources, including federal and state tax credits and a Central Hudson credit (Table 3-162). The one commercial respondent used a ConEdison rebate to help pay for the installed lighting.

Table 3-162. Rebate or Tax Credit Program Used for Additional Energy Savings Measures (Multiple Responses), Renewable Energy Program Area

Sources	Residential	Commercial
Sample size	*7*	*1*
Federal tax credit	43% (3)	0% (0)
State tax credit	29% (2)	0% (0)
Central Hudson	29% (2)	0% (0)
ConEdison rebate	0% (0)	100% (1)
Don't know/refused	29% (2)	0% (0)

Note: The numbers before the parentheses are unweighted frequencies, while the percentages inside the parentheses reflect weighted data.

As a final survey measure, respondents described any energy saving actions they had taken since the installation of their PV system. These behaviors provided a contrasting view of the energy consuming behaviors reported earlier. Although commercial respondents did not report any energy saving actions since the installation of their systems, residential respondents did. The most common energy-saving action reported was turning off lights more frequently (32%), followed by decreasing the amount of electrical equipment plugged in (18%). Decreasing hot water use and installing energy-efficient light bulbs were also reported by residential respondents (11% each). Other behaviors were not reported with great frequency, and all answers are shown in Table 3-163. Overall, half of all respondents reported that at least one of their energy saving actions was strongly influenced by the installation of their PV systems (assessed on a scale of 1-10).

Table 3-163. Energy Saving Actions Taken Since Installation of Solar PV System (Multiple Responses), Renewable Energy Program Area

	Residential (n=28)		Commercial (n=3)	
Actions/behaviors	**Adopted Behavior**	**Strongly Influenced by PV System***	**Adopted Behavior**	**Strongly Influenced by PV System***
Adopted any energy-saving actions or behaviors	64%(18)	50%(14)	0%(0)	0%)
Turn off lights more frequently	32%(9)	14%(4)	0%(0)	0%)0
Decrease amount of electrical equipment plugged in	18%(5)	7%(2)	0%(0)	0%(0)
Decrease hot water use	11%(3)	7%(2)	0%(0)	0%(0)
Installed energy-efficient light bulbs	11%(3)	4%(1)	0%(0)	0%(0)
Increase thermostat settings in summer	4%(1)	0%(0)	0%(0)	0%(0)
Decrease thermostat settings in winter	4%(1)	0%(0)	0%(0)	0%(0)
Turn furnace off during the day	4%(1)	4%(1)	0%(0)	0%(0)
Installed wood burning stove	4%(1)	0%(0)	0%(0)	0%(0)
Shut doors in the summer	4%(1)	0%(0)	0%(0)	0%(0)
Installed energy-efficient heater	4%(1)	4%(1)	0%(0)	0%(0)
Turn off water heater when not home	4%(1)	4%(1)	0%(0)	0%(0)
Use fewer appliances	4%(1)	0%(0)	0%(0)	0%(0)
Installed ceiling fans	4%(1)	4%(1)	0%(0)	0%(0)
Installed insulation between every floor	4%(1)	4%(1)	0%(0)	0%(0)
None	36%(10)	N/A	100%(3)	N/A
Don't know/refused	0%(0)	N/A	0%(0)	N/A

* Strong influence was defined as a rating between 7 and 10 on the 10-point scale (a 10 indicates that the PV system was the most influential on their decision to adopt the reported behavior or action).

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data

3.4.11 Program Area Generation Assumptions and Calculations: PON 1686

Gross generation for PON 1686 were calculated using the same methodology described for solar PV systems in Renewable Energy Program Area, Program Area Generation Assumptions and Engineering Analysis: RFP 1613.

3.4.12 Net Generation/Savings Calculations: PON 1686

Freeridership for PON 1686 was estimated with responses to questions pertaining to end-users' WTP more than the incentivized price for their PV installations. End-users' WTP for the PV installations was determined by asking respondents if they would have paid for the system at price points above the one they actually paid by moving upward in price in three $400 increments (i.e., $400 more per kW, $800 more per kW, and $1,200 more per kW) to determine how much they would have paid without the ARRA-funded incentives.

Freeridership was calculated by using an estimated average full price per kW (based on Program Area records), an average discounted price per kW (based on Program Area records), and an average WTP price (based on survey data). WTP responses were weighted by the capacity of the respondent's PV system. With this method, the average price the respondents were willing to pay is compared to the incentivized price in the following equation:

Equation 3-22: Freeridership Equation, Renewable Energy Program Area

$$FR = (\text{average price WTP} - \text{average discounted price}) / (\text{average full price} - \text{average discounted price})$$ [104]

Freeridership was estimated separately for residential and commercial respondents.[105]

The Cadmus Team then adjusted the freeridership for commercial end-users based on estimates of freeridership provided by the four commercial PV installers. Because only one of the three residential installers could provide an estimate of freeridership, installer interview data were not used to adjust residential freeridership.

The assessment does not take spillover into account, because the renewable energy projects had been completed too recently to allow for spillover to have occurred.[106] Although the exact timing of when the Cadmus Team could expect spillover to occur is uncertain, it is reasonable to expect spillover to begin to materialize within one or two years after participation.

3.4.13 Gross Generation/Savings Findings: PON 1686

The Cadmus Team's field verifications demonstrated that PV systems installed under the Renewable Energy Program Area are generally operating as expected or better. However, the field verification effort did uncover discrepancies of reported installation characteristics, which the Cadmus Team used as inputs to the verified SAM models. Table 3-164 shows a comparison by installer of the percentage of installed capacity that contained some discrepancy between *ex ante* Program Area data and what was observed on the site. For example, Installers 2 and 3 both installed systems at azimuth angles different than what was recorded in the Program Area records more than half of the time. Installers 2 and 3 also did not accurately report on-site shading characteristics in 26.4% and 36.3% of cases, respectively. The Cadmus Team did not use these percentages directly in any realization rate calculations. Also, the Cadmus Team has no insight on the installer protocols for collecting and reporting installation characteristics, making it difficult to understand why these discrepancies exist.

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[104] Freeridership was estimated using data from 19 residential respondents. WTP data for the remaining residential respondents was not used because the end-user survey programming erroneously used the full (non-incentivized) price as the base price in the WTP questions.

[105] Because all residential projects were completed Upstate and all commercial projects were completed Downstate, the Cadmus Team did not develop Upstate/Downstate weights for PON 1686.

[106] Peters and Bliss. *Final Report Fast Feedback Pilot: Existing Buildings and Production Efficiency Programs*. 2010. (http://energytrust.org/library/reports/100310_FastFeedback.pdf).

Table 3-164. Percent of Installed Capacity with Some Type of Inspection Discrepancy, Renewable Energy Program Area

	Residential		Non-Residential
Issue	**Installer 2**	**Installer 3**	**Installer 5**
Tilt angle	28.5%	54.3%	0%*
Azimuth	57.0%	58.4%	18.8%
Shading	26.4%	36.3%	9.4%

* No *ex ante* tilt data exists for two of the four sites installed by Installer 5.

Tilt Angle

The tilt angle has a significant effect on system performance, as tilt dictates the amount of sunlight the panels receive throughout the year. While there is some inherent error in measuring tilt, the Cadmus Team inspection protocol defines a consistent method for capturing accurate tilt measurements. The Cadmus Team recorded a discrepancy for tilt angles that differed by more than 3° from the *ex ante* value. Discrepancies were frequent in the residential sector.

Additionally, three sites had adjustable tilt arrays that were not reflected in the ex ante Program Area tracking data. Two of the four commercial sites (one commercial respondent had two systems installed) did not report *ex ante* tilt data, so there was no basis for verification. This was most likely a result of the tracking system/spreadsheet being unable to account for sites with multiple arrays having different tilt values.

Azimuth

Similar to tilt angle, system azimuth also significantly affects system performance. There can be significant error when measuring azimuth, due to magnetic interference with compasses. The inspection protocol included methods to minimize this measurement error; however, if the Cadmus Team's inspector was unable to obtain a consistent azimuth measurement due to interference, the Cadmus Team used Google Earth to estimate azimuth.

The Cadmus Team recorded a discrepancy for azimuth bearings that differed by more than 5° from the *ex ante* value. These incidents of discrepancies were significant, especially in the residential sector.

Shading

Installers reported *ex ante* shading factors in the Renewable Energy Program Area tracking data two different ways:

1. Expressed as a percentage of total solar resource available on an annual basis after accounting for shading, or
2. Expressed as the total annual energy (kWh) lost due to shading.

The Cadmus Team calculated all ex ante shading values to a consistent percentage basis, and compared this to the field-verified annual shading percentage for each site. Discrepancies were recorded for *ex ante* shading percentages that varied by more than 5%. These incidents of discrepancies were significant, especially in the residential sector.

Array Grouping

When an installation is split into sections or arrays with different tilt angles or different azimuth orientations, it is generally good practice to estimate the generation of each array separately and combine the estimates to produce a site-level generation estimate. Based on the limited data provided on installation parameters, it appears that installers used average parameters for sites with multiple unique arrays, and that they ran one site-level model for the entire system. The Cadmus Team does not have enough data to verify this theory, which is a possible source of uncertainty. This outcome could also be a result of the tracking system/spreadsheet being unable to track multiple arrays for a single site.

Installation Quality

Several factors that are unrelated to the physical equipment can influence the output of a particular PV array. Geographic variations in weather can cause two identical PV systems in different regions to perform differently, just as temporal variation in weather can cause the same array to produce different levels of energy from year to year.

Vertical tilt angle and horizontal orientation (azimuth angle) are two system characteristics that affect the amount of sunlight that is captured by a specific array. Although theoretically there is an optimum tilt and azimuth for each array that maximizes annual energy output, it is often difficult in practice to build arrays to those specifications based on various site conditions, such as the orientation and slope of a roof. Generally, to maximize energy generation, the optimum azimuth is close to due south.

The Cadmus Team did not encounter any significant installation quality issues at the sites visited. Although not an installation issue, one commercial PV system had a large amount of cement dust coating the panels. The installer and owner were both aware of the problem, and corrective measures have since been taken.

System Interconnect Dates

An interconnected project, for purposes of this evaluation, is defined as a PV system that has been installed, rebated, tied to the utility grid, and is expected to be producing power. In this analysis, the interconnect date directly impacts the expected (modeled) system energy generation to date. The Cadmus Team spent significant time verifying this important parameter.

Interconnect dates were frequently inconsistent with on-site findings. There were several sources of data for interconnect dates, including inverter nameplates, owner interviews, generation data, inspection documentation, and the tracking database. Inconsistent interconnect dates contribute to the overall uncertainty of modeled generation results.

3.4.14 Realization Rates: PON 1686

At a high level, the realization rate illustrates the percentage of claimed generation that is likely to be realized, or actually produced, in a typical year. Table 3-165 and Table 3-166 illustrate strata-level, weighted average realization rates by sector and installer, respectively. Note that realization rates are consistently high, indicating that PV systems are producing more energy on an annual basis than is currently being claimed in the tracking data.

Initial results, calculated using SAM, indicated high realization rates, as shown in Table 3-165. Upon investigating these results, which appeared unusually high, the Cadmus Team discovered a notable difference between the SAM tool and commonly used shading measurement tools, such as the Solmetric Suneye and the Solar Pathfinder.

Typically, installers calculate the percent of annual generation lost to shading directly from either the SunEye™ or another similar device, which ignores all diffuse energy generation during direct beam shading. In geographic regions with an abundant solar resource, ignoring diffuse radiation during shading could have minimal impacts since direct beam radiation vastly outweighs diffuse radiation. However, in regions like New York, diffuse radiation represents a greater proportion of total available irradiance. The Cadmus Team estimates that approximately 42% of available solar radiation in New York State is due to diffuse radiation. In other words, up to 42% of the energy claimed as lost due to shading may still be available to the solar PV system in the form of diffuse radiation. Calculating the realization rate using a method similar to what was likely used by installers (e.g., not considering possible gain due to diffuse radiation) results in a realization rate of 1.13 for both residential and commercial projects. It was not possible with the available data to draw definitive conclusions regarding which shading treatment more closely matches realized electricity generation.

Table 3-165. Realization Rate by Sector for PON 1686, Renewable Energy Program Area

Sector	Sample Size	Realization Rate (SAM)	Realization Rate (No Diffuse)	Standard Deviation
Residential	15	1.16	1.13	0.131
Commercial	4	1.20	1.13	0.047

Table 3-166. Realization Rate by Installer of Sampled Sites (No Diffuse Radiation Included), Renewable Energy Program Area

Installer	Number of Sites Inspected	Number of PV Arrays	Realization Rate	Total Installed kW
Installer R1	10	11	1.13	87.915
Installer R2	5	5	1.12	30.930
Installer NR1	4	7	1.13	414.810
Total	**19**	**23**	**1.13**	**533.655**

The takeaway message is that, regardless of sector or installer, NYSERDA-rebated solar systems are producing an average of 13% more energy than is currently being claimed in the Program Area tracking data. This estimate is based on a conservative assumption that shading will eliminate both direct and diffuse sunlight, as discussed in Table 3-165.

Applying the more conservative realization rate, 1.13, to the Program Area *ex ante* generation results in an evaluated gross electrical energy generation of 2,824,588 kWh per year.

3.4.15 Net Savings Calculations : PON 1686

The Cadmus Team determined the final net savings for the Program Area at a 90% confidence level with a precision of plus or minus 8.2% for all sectors combined.

Commercial respondents installed much larger PV systems than residential respondents. The average commercial system size was 103.7 kW, with individual systems ranging from 50.3 kW to 161.0 kW. In contrast, the average system size for residential respondents was 8.3 kW, with individual systems ranging in size from 2.1 kW to 24.6 kW (Table 3-167).

Table 3-167. Size of Solar PV System Installed, Renewable Energy Program Area

Size of System Installed	Residential	Commercial
Sample size	28	3
Mean	8.3	103.7*
Less than 5 kW	18% (5)	0% (0)
5-10 kW	0% (0)	0% (0)
11-20 kW	57% (16)	0% (0)
21-25 kW	18% (5)	0% (0)
50 kW or more	7% (2)	0% (0)

* This average actually represents four systems, as one commercial respondent installed two separate systems.

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data

The Cadmus Team estimated freeridership values of 7% for residential end-users and 51% for commercial end-users (Table 3-168). The freeridership calculations are detailed below.

Table 3-168. Freeridership Value for Residential and Commercial End-Users (PON 1686) , Renewable Energy Program Area

	Residential	Commercial
Final freeridership estimate (90% confidence interval (CI))	7% (90% CI: 0-17%)	51% (N/A)
Final net-of-freeridership (90% CI)	93% (90% CI: 83%-100%)	49% (N/A)

Table 3-169 summarizes the evaluated expected annual net impact as of the end of 2011.

Table 3-169. PON 1686 Savings Impact Evaluated Net of Freeridership, through December 31st 2011, Renewable Energy Program Area

	Total Claimed Electricity Generation from Installed Projects (MWh)	Savings Weighted Realization Rate	Total Evaluated Gross Electricity Generation (MWh)	Freeridership	Evaluated Net of Freeridership (MWh)
Electricity	2,500	1.13	2,825	0.39	1,723

3.5 TRANSPORTATION PROGRAM AREA

3.5.1 Data Sources

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

- NYSERDA Program Area staff interviews
- Participant phone Interviews
- Program Area-supplied data

This section presents results from measuring the energy impacts from the Transportation Program Area participation. There were the following five transportation projects funded via RFP 1613. (Transportation projects funded via RFP 10 will receive a separate evaluation and are not included in this report.)

1. Installation of a two-station compressed natural gas (CNG) fueling station, to allow the introduction of more CNG-powered vehicles into the fleet
2. Installation of two anti-idling measures: 53 fuel-operated heaters that pre-warm the engine and/or provide cab heat, and 48 Automatic Vehicle Locators (AVLs), which monitor location, speed, miles traveled, idling time, unnecessary vehicle use, and emissions
3. Installation of one electric vehicle (EV) charging station with plugs for five EVs at Level 2 Charging
4. Replacement of two conventional school buses with two hybrid electric buses; replacement of 12 diesel-powered paving screeds with 12 electric screeds; replacement of one conventional sanitation truck with one hybrid electric sanitation truck
5. Replacement of five conventional street sweepers with five hybrid electric street sweepers; replacement of two conventional rack trucks with two hybrid electric rack trucks

Program Area-supplied data. The Cadmus Team reviewed all original project applications and corresponding documentation. The Cadmus Team also reviewed all changes made to projects subsequent to the original applications being submitted. This information was collected from the main project contacts and the project case managers.[107]

Telephone interviews. The Cadmus Team developed a questionnaire and conducted telephone interviews with all five RFP 1613 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

3.5.2 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 (Department of Public Service) and Evaluation Advisory Group.

The sample was designed to complete telephone interviews with all five transportation participants in RFP 1613 who received awards. Telephone interviews were conducted soon after projects were underway

[107] Projects in the transportation Program Area, in addition to creating jobs as all ARRA-funded projects were intended to do, were intended to create fuel savings. In doing so, some projects caused increases in electricity consumption through the installation of electric vehicle charging stations. Program Area tracking records only recorded impacts, whether electric or fuel, in MMBtu, consequently the evaluation of this Program Area reports impacts in MMBtu, except for the emissions analysis in Section 4 where the different emission factors by fuel type is a significant concern, and electric impacts are analyzed separately.

in order to gain a more complete understanding of issues related to participation motivation, project implementation, and attribution. Follow-up telephone interviews were planned for the time of projects' completion in order to allow for the best evaluation of final project net impacts. However, the data collection and reporting schedule did not allow the Cadmus Team to perform the follow-up interviews described in the Action Plan.

3.5.3 Process Findings

Appendix G summarizes the awareness, motivation, economic factors, alternative funding, and spillover characteristics of the Transportation Program Area recipients.

3.5.4 Program Area Savings Assumptions

For transportation projects, savings stem from the net reduction in fuel usage before and after project implementation (Table 3-170).

Table 3-170. Sources of Fuel Reduction for Transportation Projects, Transportation Program Area

Project	Source of Fuel Reduction
Two-station CNG fueling station	Allows for replacement of conventional vehicles with CNG-powered vehicles. CNG is more fuel-efficient than gasoline and produces lower amounts of carbon dioxide, as well as lower amounts of harmful emissions such as nitrogen oxides, particulate matter, and toxic and carcinogenic pollutants.
Fuel-operated cab engine preheaters; AVLs	Fuel-operated heaters pre-warm the engine and provide cab heat without idling the main drive engine. Pre-warmed engines eliminate cold starts that result in extensive idling and reduced fuel economy. AVLs monitor location, speed, miles traveled, idling time, unnecessary vehicle use, and emissions. Drivers engaging in excessive idling can be identified and trained to eliminate the practice, which saves fuel.
EV charging station	Allows for replacing conventional vehicles with electricity-powered vehicles. Fuel use is eliminated entirely, although electricity is expended to power the charging station.
Replacement of two conventional school buses with two hybrid electric buses; replacement of 12 diesel-powered paving screeds with 12 electric screeds; replacement of one conventional sanitation truck with one hybrid electric sanitation truck	Replacing conventional school buses and a sanitation truck with hybrid versions saves diesel fuel (hybrid EVs use 20% to 50% less fuel). Replacing diesel-powered paving screeds with electric ones eliminates fuel use entirely, although electricity is expended to power the new screeds.
Replacement of five conventional street sweepers with five hybrid electric street sweepers; replacement of two conventional rack truck with two hybrid electric rack trucks	Replacing conventional street sweepers and rack trucks with hybrid versions saves diesel fuel (hybrid EVs use 20% to 50% less fuel).

3.5.5 Gross Savings Calculations

Due to the relatively small number of Transportation Program Area participants and the diversity of their 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 which are presented in Table 3-171 for the evaluated scenario. The five 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 3-171. Evaluated Annual Savings, Transportation Program Area

	Gallons Gasoline Reduced Annually	Gallons Diesel Reduced Annually	Gasoline Gallon Equivalent Compressed Natural Gas Used Annually	MWh Used Annually
Total	1,662	17,953	350.5	-
MMBtu Equivalent*	191	2,334	40.3	-
MMBtu Saved	2,525		N/A	
MMBtu Used	N/A		40.3	
Net MMBtu Saved	2,485			

3.5.6 Gross Savings Findings

As laid out in the Action Plan, one of the evaluation objectives for the five RFP 1613 Clean Fleets Program is to evaluate the gross savings impacts of the Program Area. Table 3-172 summarizes these findings.

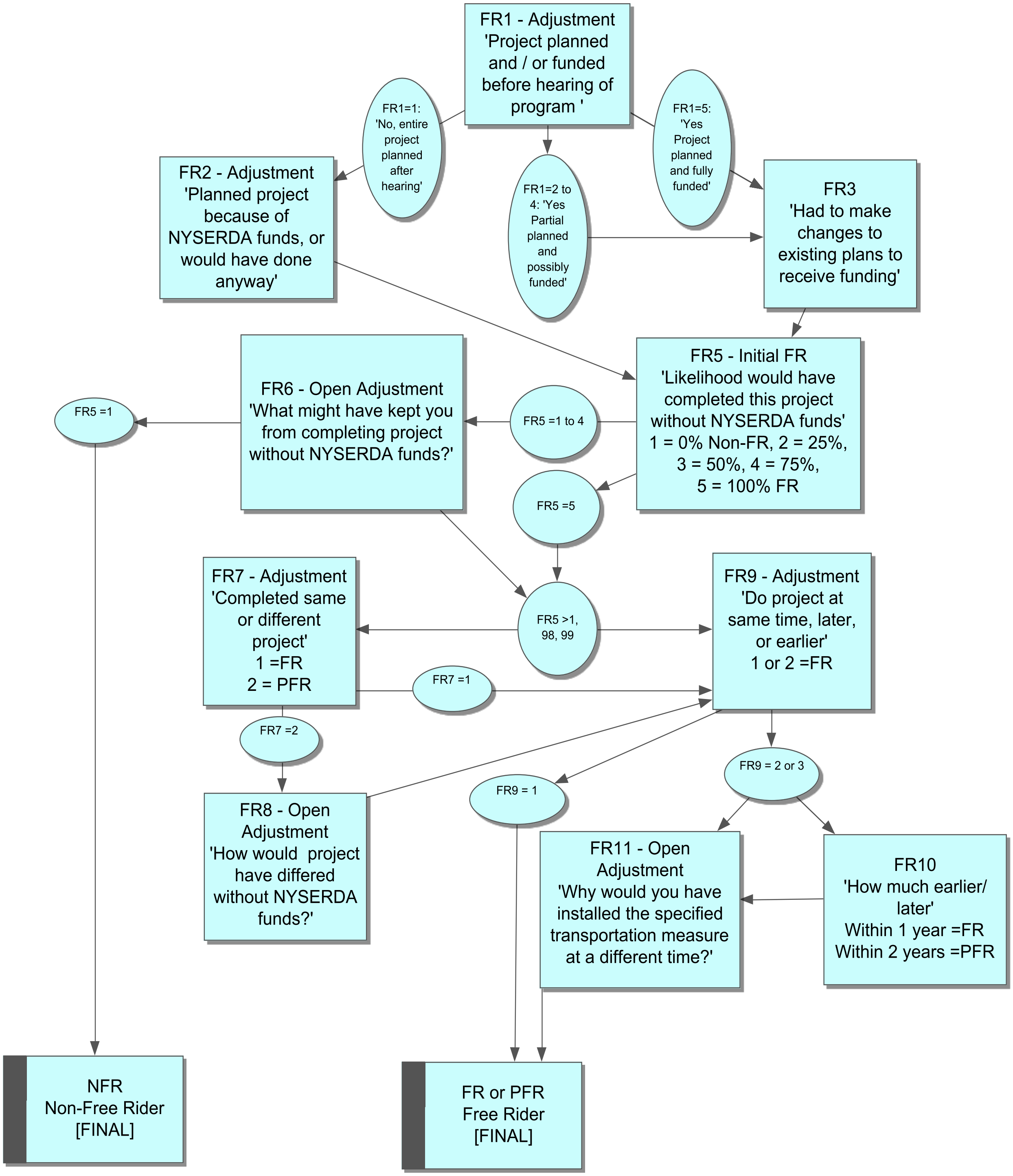
Table 3-172. Evaluated Gross Impacts for Clean Fleets Transportation Program Area

	Actual
Petroleum Reduced Annually	55,328
MMBtu Saved Annually	6,994
Alternative Vehicles Purchased	10
Alternative Refueling Stations Installed	2

3.5.7 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 3-61 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 3-61. Freeridership Algorithm Pathway, Transportation Program Area



The determination of Program Area freeridership relied on participant self-reported information. From September through December 2011, the Cadmus 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 this project 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 existing their 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, 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 FR (Full freerider) (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 NTG ratio using the following equation:

The last adjustment to the freeridership algorithm (Figure 3-61. Freeridership Algorithm Pathway, Transportation Program Area is the most substantial change from what had recently been used in FlexTech Program evaluations. The federal government directed ARRA recipients to prioritize the funding of projects that were ready to move forward but had not been able to secure funds due to the recession. NYSERDA and the Cadmus Team designed the algorithm to take this federal funding requirement into account when estimating freeridership.

As noted above, not enough time has 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 F. It is anticipated that as time progresses, quantifiable spillover savings may result which could be measured and reported in future follow-up evaluations.

3.5.8 Net Savings Findings

The freeridership questions assessed 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 surveys were conducted at a census level.

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.

The survey attempted to determine how far along respondents were with their project planning when they first heard of the NYSERDA ARRA Transportation Program Area. Respondents were asked to indicate which statement best described their plans before they participated. Table 3-173 shows that two out of the five respondents indicated that they planned the entire project *after* hearing about the NYSERDA ARRA-funded Program Area.

Table 3-173. Point in Planning Process When First Heard About Transportation Program Area

Planning process	Overall
Sample size	*5*
Planned entire project after hearing about the NYSERDA Program Area	2
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	1
Project was planned and fully funded	0
Other	0
Don't know/refused	1

Both respondents who planned the entire project after hearing about the NYSERDA Program Area did so *because* of the NYSERDA Program Area (Table 3-174).

Table 3-174. Why Project was Planned After Learning of NYSERDA ARRA Funds, Transportation Program Area

Response	Overall
Sample size	*2*
Planned the project because of the NYSERDA Program Area	2
Would have planned the project without the Program Area	0
Don't know	0
Refused	0

Note: Base is respondents who planned the entire project after hearing about the Transportation Program Area.

Respondents who indicated that the project was partially planned and/or partially funded at the time they heard about the NYSERDA ARRA Transportation Program Area were asked if they had to make changes to their project in order to qualify for Program Area funds. All respondents said they did not have to make any changes.

Respondents were asked 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 3-175 shows that two respondents were somewhat likely to have completed the same project without the funds. Another two respondents were unlikely to have completed the same project, while one respondent was neither likely nor unlikely to have done so.

Table 3-175. Likelihood of Completing Same Project in Absence of NYSERDA ARRA Transportation Program Area Funds

Likelihood	Overall
Sample size	*5*
Mean (Scale 1-5)	2.80
1 Not at all likely	1
2 Somewhat unlikely	1
3 Neither likely nor unlikely	1
4 Somewhat likely	2
5 Very likely	0

Respondents were then asked what barriers might have prevented them from completing the project without the NYSERDA ARRA funds (Table 3-176). Four out of five mentioned that lack of funding was the greatest barrier. One respondent said if they had not received the funding, other projects would have taken precedence.

Table 3-176. Barriers to Completing Project Without NYSERDA ARRA Funds, Transportation Program Area

Barriers	Overall
Sample size	*5*
Lack of funding	4
Higher priority projects would take precedence	1
Don't know	0
Refused	0

Respondents who indicated that they were somewhat unlikely through very likely (all but those who said it was not very unlikely) to complete the project without the Transportation Program Area were asked whether they would they have completed the same project or if it would have differed in some way (e.g., scale, efficiency level, scope) if the funds had not been unavailable. Two of the four respondents would have changed the project in some way. One respondent said the project would have been the same without the funds.

Table 3-177. Whether Project Would be Different Absent NYSERDA ARRA Funds, Transportation Program Area

Response	Overall
Sample size	*4*
Same	1
Different	2
Don't know	1
Refused	0

Note: Base is respondents who were somewhat unlikely through very likely to complete the same project without NYSERDA ARRA funds.

Of the two respondents who indicated that the project would have been different if the funds were not available, one would have completed a smaller-scale project and the other would have pursued a project with a different technology (Table 3-178). In summary, all of the respondents had a probability of completing the project(s) without funds; two respondents would have completed a different project in size, scope, scale.

Table 3-178. How Project Would Have Been Different, Transportation Program Area

Barriers	Overall
Sample size	*2*
Smaller in scale	1
Pursued a different technology	1
Don't know	0
Refused	0

Note: Base is respondents who said the project would have been different absent Program Area funds.

The next question assessed the Program Area's effect on the timing of the projects. Respondents who were somewhat unlikely to very likely to complete the project in the absence of the NYSERDA ARRA funds were asked if they would complete the transportation project earlier, later, or at the same time if the funds had not been available (Table 3-179). All respondents indicated they would have conducted the project later if they had not received the funds. Only one respondent quantified the time, as one and a half years later.

Table 3-179. Influence of NYSERDA ARRA Funds on Timing of Completion of the Project, Transportation Program Area

Response	Overall
Sample size	*3*
Same time	0
Earlier	0
Later	3
Don't know/refused	1
If yes, how much earlier or later (years)*	1.5

Note: Base is respondents who were somewhat unlikely to very likely to complete the same project without NYSERDA ARRA funds.

* Two of the three respondents did not know how much later they would have undertaken the project without NYSERDA ARRA funds.

Table 3-180 shows why the projects would have occurred later. The reason cited by all three respondents involved a lack of funds. Specifically, two respondents commented that, in absence of the NYSERDA funds, less money overall is available for energy-efficiency projects, and what is available may be allocated to higher priority projects. The third respondent replied that with limited availability of funds for efficiency projects, transportation projects may not be implemented.

Table 3-180. Why Projects Would Have Been Completed Later, Transportation Program Area

Barriers	Overall
Sample size	*3*
Would have less money in general affecting all projects	2
Based on the availability of the funds to implement the project	1
Don't know	0
Refused	0

Note: Base is respondents who said project would have been completed earlier or later without Transportation Program Area funds.

Table 3-181 shows the freeridership calculation for the five participants in the NYSERDA ARRA-funded Transportation Program Area. Freeridership was adjusted according to the freeridership algorithm illustrated in Figure 3-61 and the responses given to the freeridership battery of questions above. Overall, freeridership rates ranged from 0% to 95% for the five respondents.

Table 3-181. Transportation RFP 1613 Freeridership Calculation, Transportation Program Area

Q#	Purpose	Impact on FR	Respondent a	Respondent b	Respondent c	Respondent d	Respondent e
FR1	Sets Context	Response; Adjustment	2, Neutral (0%)	1, Down (-20%)	1, Down (-20%)	98, Neutral (0%)	4, Up (+20%)
		Running FR; GO TO	50%, FR6	-20%, FR2	5%, FR2	75%, FR6	95%, FR6
FR2	Sets Context	Response; Adjustment	0	1, Down (-20%)	1, Down (-20%)	0	0
		Running FR; GO TO	0	-40%, FR6	-15%, FR6	0	0
FR5	First-cut FR question	Response; Initial FR	3, 50%	1, 0%	2, 25%	4, 75%	4, 75%
		Running FR; GO TO	50%, FR1	0%, FR1	25%, FR1	75%, FR1	75%, FR1
FR6	Explanation for FR5	Response; Adjustment	Lack of funding. Down (-20%)	Lack of funding. Down (-20%)	Lack of funding. Down (-20%)	Lack of funding, possible delay. Down (-20%)	Another project might have been a higher priority. Down (-20%)
		Running FR; GO TO	30%, FR7	0%, FINAL	-35%, FR7	55%, FR7	75%, FR7
FR7	Probing for partial FR	Response; Adjustment	2, Depends on FR8	0	98	2, Depends on FR8	1, Up (+20%)
		1=FR, 2 depends on FR8; Running FR; GO TO	30%, FR8	0	-35%, FR8	55%, FR8	95%, FR9
FR8	Probing for partial FR	Response; Adjustment	Neutral (0%)	0	98	Smaller in scale. Neutral/Down (-10%)	0
		Running FR; GO TO	30%, FR9	0	-35%, FR9	45%, FR9	0
FR9	Probing for partial FR	Response; Adjustment	3, Depends on FR10 and FR11	0	98	3, Depends on FR10 and FR11	3, Depends on FR10 and FR11
		Running FR; GO TO	30%, FR10	0	0%, FINAL	45%, FR10	95%, FR10
FR10	Probing for partial FR	Response; Adjustment	1.5, Partial FR (50%) Neutral (0%)	0	0	98	98
		Running FR; GO TO	30%, FR11	0	0	45%, FR11	95%, FR11
FR11	Probing for partial FR	Response; Adjustment	Availability of the funds. Neutral/Down (-10%)	0	0	Less money - would have affected the projects. Corroborates FR6. Neutral (0%)	Less money - would have affected the projects. Corroborates FR6. Neutral (0%)
		Running FR	20%, FINAL	0	0	45%, FINAL	95%, FINAL
Total Adjustments			3 Neutral, 1 Neutral/Down, 1 Down	3 Down	3 Down	2 Neutral, 1 Neutral/Down, 1 Down	1 Down, 1 Neutral, 2 Up
Final FR Value			**20%**	**0%**	**0%**	**45%**	**95%**

Note: Questions FR3 and FR4 are to set context, but do not enter into the freeridership adjustment and final calculation; therefore, they are omitted here.

Freeridership rates for the Program Area are summarized in Table 3-182. There were no freeriders among Program Area participants; three participants were PFRs and two participants were NFRs. Overall unweighted average freeridership for the five transportation project participants was 32%. Freeridership weighted by size of project is 75%, resulting in evaluated savings net-of-freeridership of 729 MMBtu, as shown in Table 3-183.

Table 3-182. Freeridership Rates, Transportation Program Area

	Overall	
	n	**Freeridership**
FR (freeriders 100%)	0	0%
PFRs	3	60%
NFRs	2	40%
Average (unweighted) FR rate	**5**	**32%**

Table 3-183 summarizes the evaluated expected annual net impact as of the end of 2011.

Table 3-183. Savings Impact Program Area Evaluated Net of Freeridership Through December 31, 2011, 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)	10,455	0.24	2,485	0.81	472

3.6 ENERGY CONSERVATION STUDIES PROGRAM AREA

The Cadmus Team collected ECS Program Area tracking data and conducted a telephone survey to gather data on activities taken by ECS Program Area participants. These forty-two interviews were conducted at least six months after the completion of the study in order to ensure that some time had passed such that recommendations could have been acted upon and measures installed. Participants were asked about actions they had undertaken after they received the studies and the reasons they took such actions. Using these data, along with realization rate estimates from secondary sources, the Cadmus Team estimated the ECS Program Area's impact net of freeriders, exclusive of savings from projects funded through other programs.

3.6.1 Data Sources

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

- NYSERDA staff interviews
- A telephone survey of ECS Program Area participants
- Program Area-supplied data
- Secondary data

Program Area-supplied data. The Cadmus Team interviewed NYSERDA ECS Program Area administrators to learn more about the ECS Program Area's operation and available data. NYSERDA provided the ECS Program Area Microsoft Excel® database, which supplied project and measure-specific data as reported on the ECS applications. NYSERDA also gave the Cadmus Team access to individual project files with applications and final ECS reports.

Telephone survey. The Cadmus Team developed a questionnaire, modeled after a survey used in the FlexTech Program evaluation, and conducted a telephone survey to determine actions that respondents took after their participation in the ECS Program Area, and to enable an analysis of the attribution of those actions. The survey instrument is provided in Appendix E. It included questions about the following topics:

- Measure adoption rate (MAR)
- Freeridership and spillover (SO)
- Funding overlap with other programs and related financing
- Non-attributional questions about the respondents' motivation to solicit ARRA funding
- How respondents heard about the ECS Program Area
- Firmographics

Secondary data. While most of the Cadmus Team's ECS efforts focused on the primary data collection activities described above to estimate the current MAR, secondary data were also leveraged to estimate the following two key factors:

1. Realization rate, a ratio factor that is the Cadmus Team's estimate of the ECS Program Area participants' actual savings divided by the studies projections of savings
2. Long-term MAR

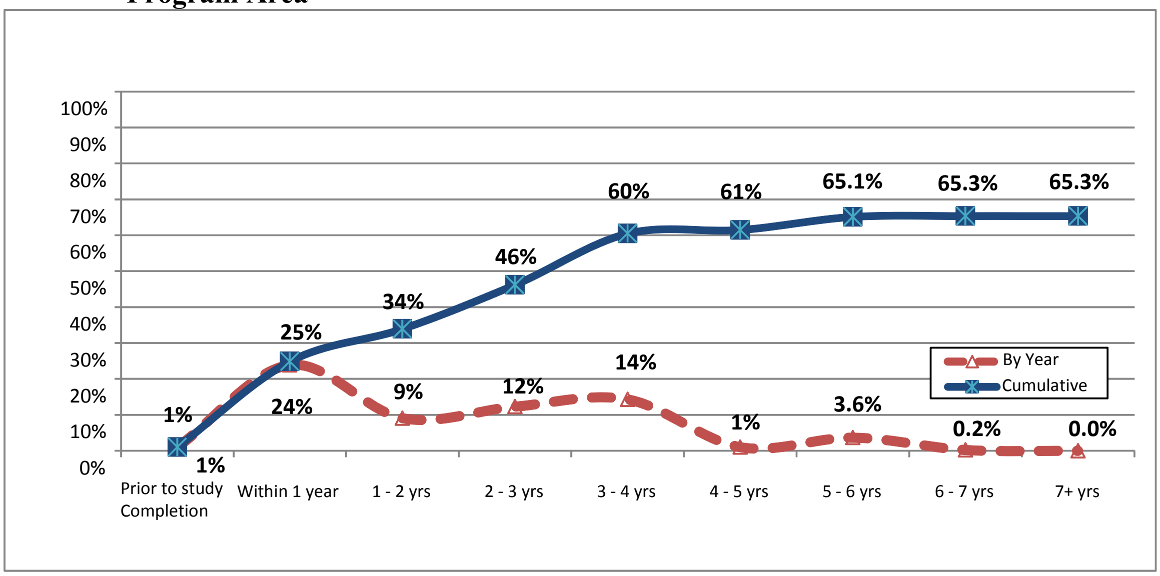
The primary data collection activities for this evaluation occurred within 24 months of the ECS Program Area completion. The majority of interviews were completed less than one year after the study completion. Prior research has shown that measure adoption can occur for up to seven years after study completion,[108] and the Cadmus Team found a material percentage of respondents reported that measure adoption had not yet been completed but was either in process or planned. The Cadmus Team used secondary data to aid in extrapolating the short-term MAR data into long-term estimates.

The realization rates were taken from research of the ARRA-funded RFP 1613 Program Areas in this evaluation portfolio.[109]

3.6.2 Approach: Surveys and Sample Design

General approach. The single biggest uncertainty in estimating the energy savings of a program that supports ECS is determining the MAR, which quantifies the percentage of recommended savings that is actually implemented. This value is time dependent: first gradually increasing and then eventually stabilizing, as illustrated in Figure 3-62.

Figure 3-62. FlexTech Program Study Recommended Measure Adoption Rate Over Time, ECS Program Area



Source: Megdal & Associates and ERS. *NYSERDA 2007 – 2009 FlexTech Program Impact Evaluation Final Report.* p. 1-3. January 2012.

The Cadmus Team conducted a telephone survey to determine the percentage of savings from measures recommended by the ECS Program Area-funded studies that were actually implemented. Next, by comparing early year ECS Program Area adoption rates with respondent long-term projections and the

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[108] Megdal & Associates and ERS. *NYSERDA 2007 – 2009 FlexTech Program Impact Evaluation Final Report*. January 2012.

[109] The realization rate for the Renewable Energy Program Area is discussed in the Renewable Energy Program Area, Realization Rates: PON 1686 section and the realization rate for the Energy-Efficiency Program Area is discussed in the Energy-Efficiency Program Area, Confidence and Precision section.

FlexTech Program long-term adoption rate curves shown above, the Cadmus Team projected the ECS long-term adoption rate.

The second most important factor to consider when evaluating an ECS program is the percentage of savings associated with implemented projects that received installation funding from other efficiency incentive programs. The Cadmus Team used a survey-based approach to determine this overlap.

Additionally, the Cadmus Team conducted telephone interviews to collect data necessary to estimate freeridership and spillover. The Cadmus Team used secondary data to estimate the realization rates for the conservation study projects.

Survey approach. The survey instrument was based on the questionnaire template used by NYSERDA's SBC impact evaluation team. The Cadmus Team tailored this template to the researchable subjects of this evaluation, including gross and net energy impacts, cost-effectiveness, and economic and emission impacts. The survey instrument focused on determining which of the recommended measures were adopted, the level of influence of the ECS Program Area on decisions to either install recommended measures or take actions beyond those recommended in the study, and the funding overlap between the ECS Program Area and other efficiency incentive programs.

Sample design. In order to create a sample of potential survey participants, NYSERDA first provided the Cadmus Team with a detailed list of projects and recommended measures on June 29, 2011. The final list included 207 studies, of which 204 were complete and had non-zero savings. The studies recommended 2,375 measures, or an average of 11.6 measures per study. The recommended measures had savings associated with electricity, natural gas, steam, other fossil fuels, and non-energy effects such as water and sewer savings.

The sampling unit was defined as the ECS Program Area's total source-equivalent[110] recommended and tracked MMBtu energy savings. Preliminary sample design planning indicated that 56 customers would need to be surveyed to ensure 10% relative precision for the results at 90% confidence, based on a stratified random sampling and a 0.5 coefficient of variance (CV). This was expected to be a conservative assumption, as prior research had indicated CVs between 0.25 and 0.44.[111]

The Cadmus Team substantially cleaned the population data to ensure that the record for each measure in the population included reported the source-equivalent annual MMBtu of energy savings and, to the extent the data were available, indicated the fuel sources associated with the energy savings. The records were then sorted by size, stratified into four approximately equal strata of total expected residual standard deviation, one project was added to each random stratum's target (to be conservative), and then the counts were reduced in the two census strata (because they had fewer than the target number of studies per stratum). This left a detailed sample design of 45 studies. Key information is shown in Table 3-184.

[110] The source-equivalent MMBtu savings conversion factor for electric energy is 103 kWh of electricity generated per source-equivalent MMBtu input to a power plant. This factor accounts for the standard 3,413 Btu/kWh unit conversion factor and a 35% marginal fossil fuel-fired utility power plant efficiency (1,000,000 Btu per MMBtu / (3,413 Btu per kWh / 35% plant efficiency) = 103 kWh per MMBtu). Expressed inversely, the conversion factor is 9,668 source Btu input per kWh.

[111] Parlin, Kathryn, West Hill Energy & Computing; S. Moran, ERS; and L. Megdal, Megdal & Associates. *Memorandum: MAR Sampling Design for Flexible Technical Assistance Participants*. Prepared for NYSERDA and the New York DPS. April 23, 2010.

Table 3-184. Studies and Savings by Size Stratum, ECS Program Area

Stratum	Sampling Method	Number of Projects in Population	Total Annual Savings in Stratum (Source MMBtu)	% of Total Savings	Maximum Annual Savings in Stratum (Source MMBtu)	Sample Size
1	Random	157	465,643	15	11,456	14
2	Random	30	640,607	21	40,506	14
3	Census	11	824,507	27	135,736	11
4	Census	6	1,095,182	36	210,815	6
Total		**204**	**3,025,939**	**100**		**45**

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

The final number of completed interviews was 42, as some census stratum study recipients declined to participate or were unreachable.

3.6.3 Process Findings

Appendix G summarizes the awareness, motivation, economic factors, alternative funding, freeridership, and spillover characteristics of ECS Program Area participants.

3.6.4 Program Area Savings Assumptions

The ECS Program Area anticipated that most of the savings the studies recommended would be implemented with incentive funding and claimed by those programs; thus the Program Area did not report any direct energy impacts. The gross claimed impact is 0; thus, there are no Program Area savings assumptions.

The studies' recommended savings were tracked, however. The individual ECS study authors, consisting of a large number of engineering consulting firms, energy service companies, equipment contractors, and other service providers, each used a different set of assumptions to estimate customer-purchased energy savings potential from their mixtures of energy efficiency, CHP, and renewable energy measure recommendations.

3.6.5 Gross Savings Calculations

NYSERDA staff entered savings data, recommended by the ECS, into the database using a variety of methods. For some ECS, site-based electricity kWh, natural gas therms, and other fossil fuel MMBtu savings were entered separately for each measure. For some ECS, only the combined total source-equivalent MMBtu savings were entered for each measure. Other ECS contained elements of both approaches. In every case, sufficient data were provided to compute the source-equivalent recommended measure energy savings.

The specific energy savings source (i.e., electricity, natural gas, or other) was identifiable for 28% of the total source-equivalent MMBtu in the database. The Cadmus Team estimated the ECS Program Area gross savings by fuel type under the assumption that the distribution of source measures identified for 28% of the database is representative of the population. In the formulas below, these results are referred to as the estimated tracked impact.

The Cadmus Team calculated evaluated gross impacts by multiplying the recommended and tracked savings by the evaluation's MAR and the realization rate. The Cadmus Team conducted the survey during September 2011 through January 2012. As discussed in the general approach, the MAR was expected to increase over time, including after the evaluation survey. The evaluated gross impact is reported two ways in this evaluation: (1) the impact as of the survey date; and (2) the long-term projected gross impact based on the expected eventual adoption rate over time, as shown by the equations below.

Equation 3-23. ECS Program Area Evaluated Gross Impact at the Time of Evaluation

Equation 3-24. ECS Program Area Projected Long-Term Gross Impact

Where:

Estimated tracked impact = Savings associated with measures recommended in ECS

RR = Realization rate

The first calculation (Equation 3-23) reflects actual installed savings to date, and thus, sampling statistics can be associated with the source-equivalent total savings. The second calculation (Equation 3-24) reflects the long-term impact of the ECS Program Area on New York's energy supply system.

Given that prior research shows adoption routinely occurring well into the third and fourth years after study completion, and in some cases as long as six or seven years after (see Figure 3-62, above), the Cadmus Team delayed ECS Program Area data collection for as long as possible to allow study recipients time to adopt the recommendations. Still, none of the interviews occurred more than two years after study completion, and many interviews occurred less than one year after the study.

The Cadmus Team used a combination of non-linear curve-fitting software, the survey's early adoption data binned by period, and the characteristic adoption rate curve in Figure 3-62 to develop an estimate of the long-term MAR.

As noted previously, the realization rate was taken from the results of the ARRA RFP 1613 Energy Efficiency Program Area impact evaluation research findings, described in the Energy-Efficiency Program Area section.

3.6.6 Calculations for Savings Net-of-Freeriders

The four steps involved in estimating freeridership are illustrated below in Table 3-185. The calculations used in each step are described in Appendix F. This yields a final average weighted freeridership of 55% (90% confidence interval of 49.5% to 60.5%), and 45% savings net of freeridership (1-FR).

Table 3-185. Freeridership Scores, ECS Program Area

	Overall
*Sample size**	*35*
(1) Mean direct freeridership; FR5 and FR7	0.35
(2) Mean Program Area influence score; average score of FR2,** FR3, FR4, and, if applicable, E3 and AF5*** (with a score of 1 indicating weak Program Area influence and 5 indicating strong Program Area influence)	4.14
(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 Program algorithm – see Appendix F for more details)	0.27
(4) Weighted by savings (90% confidence interval)	0.55 (CI=49.5%-60.5%)

* Sample size reflects respondents who answered the battery of freeridership questions.

** 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.

*** Question AF5 was reverse scored such that the response indicating the greatest influence of NYSERDA ARRA funding also received the highest score.

In order to assess the net impact of the ARRA-funded activities on the adoption of the ECS' recommended measures, the Cadmus Team examined the degree to which the NYSERDA ARRA funds led to the implementation of recommended measures that would not have occurred otherwise.

The estimation of freeridership relied on the participant surveys, which were delivered over the phone by a trained Cadmus Team technician. The Cadmus Team surveyed the person most responsible for deciding to conduct an ECS through the ECS Program Area and for deciding whether to implement any project measures. 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, but was updated by NYSERDA and the Cadmus Team to align more closely with the design of the NYSERDA ARRA Program Area.

The survey included questions that sought to ascertain the following:

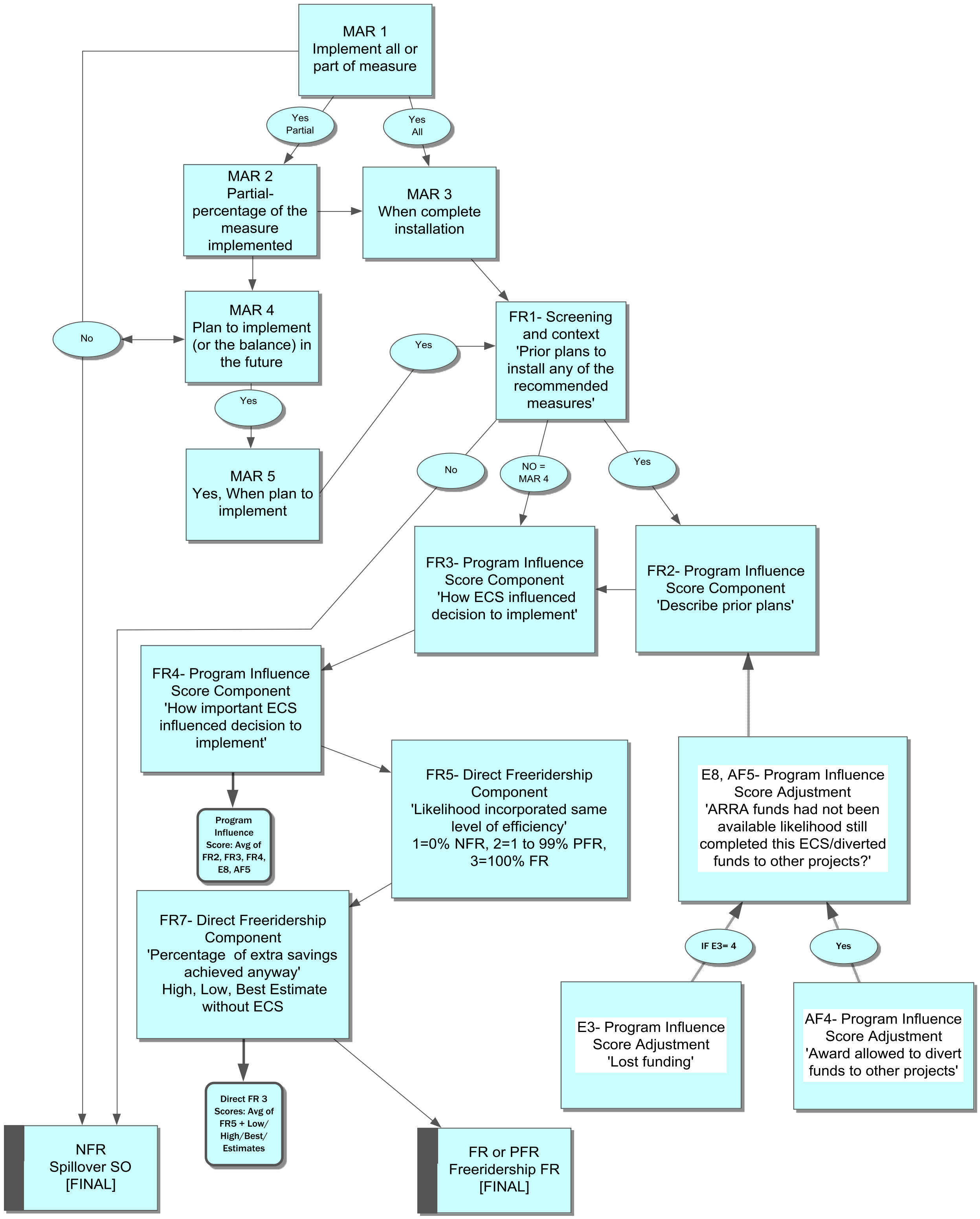
- **Freeridership.** To the best of the participant's knowledge, would any of the recommended measures have been implemented without the ECS recommendations? Would the implementation have occurred on the same timeline? Why or why not? Would the scope of the project have been the same without the ECS Program Area funding? Why or why not? Did the ECS lead the respondent to change their measure adoption plans in any way? If so, how?
- **Spillover.** What other actions, if any, have the participants taken to save energy or generate more electricity capacity as a result of installing the measure(s) addressed in the ECS?
- **Awareness and motivation**. How did the participants find out about the ECS Program Area? Why did they decide to apply for ECS funding through the ECS Program Area?
- **Economic factors.** For measures already implemented, did the participants have funding secured for the project before applying for the ECS Program Area funds? Did any of the project funding fall through because of tightening credit or other economic conditions related to the recession?

The freeridership algorithm is based on several sets of questions and calculations from the participant survey: direct freeridership questions (FR5 and FR7), Program Area influence freeridership questions (FR2, FR3, and FR4), Program Area influence questions based on the impacts of lost or declined funding (E3), and questions about whether the respondent diverted funds to other projects after securing NYSERDA ARRA funds (AF4). Finally, freeridership was weighted by the energy savings for each participant. The survey questions used in the algorithm are as follows:

- FR5, the likelihood of incorporating the measure with the same level of efficiency if respondent had not received the ECS Program Area report or recommendations (direct freeridership score)
- FR7, the percentage of extra energy savings that would have been achieved anyway, even if the ECS Program Area did not exist (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 the Program Area (Program Area influence score)
- E8, if funds had not been available, the likelihood of still completed the ECS (Program Area influence score)
- AF5, if funds had not been available, the likelihood that participant would have diverted internal funds to other projects (Program Area influence score)

Figure 3-63 illustrates the survey questions and decision paths taken that led to the determination of an individual respondent's freeridership status for the ECS Program Area. Responses to some of the questions provided a definitive NFR designation (for respondents that had no prior plans to implement any of the recommended measures), while other questions determined whether or not participants were assigned FR (100%) or PFR (1% to 99%) status.

Figure 3-63. Freeridership Pathways for Energy Conservation Studies Program Area



Respondents in the MAR categories who installed or partially installed any recommended measures, or planned to do so, were asked the battery of freeridership questions. Applying the freeridership algorithm divided respondents into three groups: NFR, PFR, and full FR.

Not enough time had elapsed since the ECS were conducted to allow for spillover to have occurred, so spillover is not incorporated into the algorithm. However, the Cadmus Team qualitatively noted whether the study induced the participant to adopt additional energy efficiency or renewable energy measures. Qualitative findings are found in Appendix F.

In summary, estimating freeridership for the ECS Program Area involved four steps:

1. Determining direct freeridership
2. Calculating the Program Area influence score
3. Adjusting direct freeridership based on the Program Area influence score[112]
4. Weighting by the energy savings

Freeridership results are presented in ECS Program Area, Net Savings Findings and the calculations are detailed in Appendix F.

This evaluation revealed that ECS recipients are saving energy they otherwise would not have been saving without the ECS Program Area. Impacts net-of-freeridership for MAR, realization rate (RR), freeridership (FR), and overlap (OL), is shown in Equation 3-25.

Equation 3-25. ECS Program Area Calculation of Impact Net-of-Freeriders Including Discount for Program Overlap

Where:

Net impact = ECS Program Area evaluated savings

Tracked impact = Savings associated with measures recommended in ECS studies

Evaluated gross impact is the tracked impact multiplied by the MAR and realization rate before applying the attribution and overlap factors. For this evaluation, spillover is applied at the portfolio level and not as part of the ECS evaluation. The gross impact results by variable are presented next.

Tracked impact. NYSERDA's ECS Program Area database tabulates the projected source-equivalent MMBtu impact of 2,375 measures recommended in 204 studies. Studies without any recommended measures with savings or without completed reports were excluded from the count. The total source-equivalent projected MMBtu savings for recommended measures is 3,025,940 MMBtu/year. 851 measures did not specify a fuel source. For 1,524 measures that represent 64% of the measures and 28%

[112] 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.

of the population's recommended savings, the amount is associated with a specific fuel source(s). 851 measures did not specify a fuel source. Based on these data, 51% of the source-equivalent Btus are associated with electric energy savings, 35% with natural gas, and 15% with other fossil fuels. Given the population source-equivalent savings, the proportions of savings, and the source-equivalent kWh/MMBtu conversion factor described in the methodology section, the Cadmus Team calculated the ECS Program Area's approximate recommended and tracked savings, as summarized in Table 3-186.

Table 3-186. Recommended and Tracked Gross Impact, ECS Program Area

Energy Source	Tracked Gross Impact
Electricity	159,149 MWh/yr
Natural Gas	1,044,512 MMBtu/yr
Other Fossil Fuels	442,776 MMBtu/yr

MAR. The telephone survey collected data on recipients' adoption rates after receiving the studies. The survey identified outcomes for 333 measures recommended in 42 studies. Table 3-187 summarizes the results.

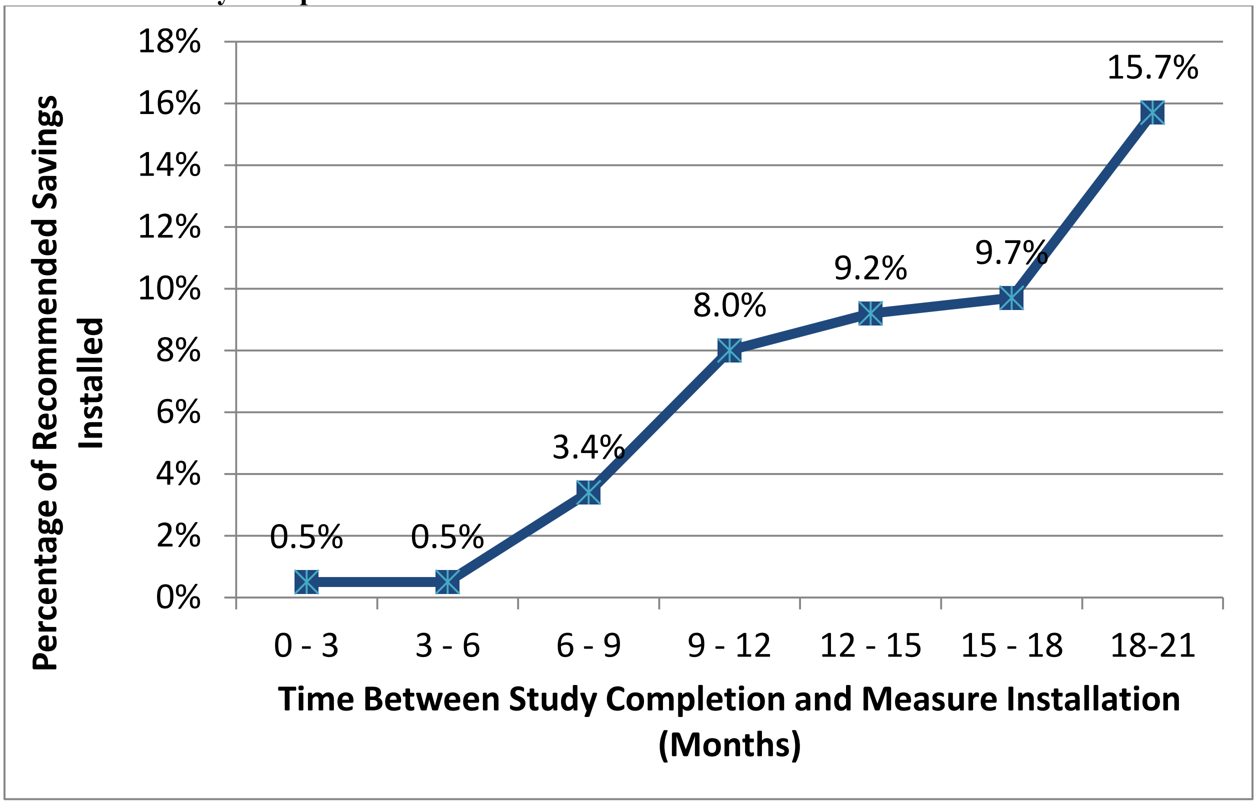
Table 3-187. MAR Survey Results To-Date, ECS Program Area

Stratum	Sampling Method	Number of Projects in Population (n)	Maximum Annual Savings in Stratum (Source MMBtu)	Initial Target Sample Size	Final Sample (n)	MAR as of Survey Date ($MAR_{to\ date}$)
1	Random	157	11,456	14	14	0.10
2	Random	30	40,506	14	14	0.25
3	Census	11	135,736	11	8	0.34
4	Census	6	210,815	6	6	0.02
Total		**204**		**45**	**42**	**0.16**
Relative precision of total MAR at 90% confidence						**20%**

Data collection for MAR and freeridership were both calculated at 90% confidence with 20% precision. The relative precision on the MAR estimate is 20% with 90% confidence. This is a greater relative uncertainty than the targeted 10%. However, the MAR estimate is more informative than the relative precision parameter alone suggests, and is not a cause for undo concern regarding the result validity. It is more helpful to consider the result in terms of absolute precision rather than relative precision. The absolute precision on the MAR estimate is ±0.032 (20% of 0.16). This means that the Cadmus Team is 90% confident that the true population MAR is between 0.128 and 0.192. Relative to the range of possible MARs, 0 to 1, a range of 0.064 is reasonably constrained. In fact, if the survey had been conducted a couple of years later and the population MAR increased to 0.32, the exact same variation in sample responses would result in the desired 10% relative precision. The Cadmus Team considered the benefits and costs of substantially increasing the sample size. Given the 0.16 MAR, the variances in responses to date (with an error ratio in excess of 1.1, which is driven higher by the low MAR), and the interview response rates, the entire ECS population would need to be attempted to be interviewed to come close to 10% relative precision. For the magnitude of savings involved and given calendar considerations, this was not a good investment of evaluation resources.

MAR to-date represents the proportion of recommended measure savings that customers had installed by the time of the interviews. The data revealed a trend of escalating installation, as shown in Figure 3-64.

Figure 3-64. ARRA ECS Program Area Cumulative MAR as a Function of Time Elapsed Since Study Completion

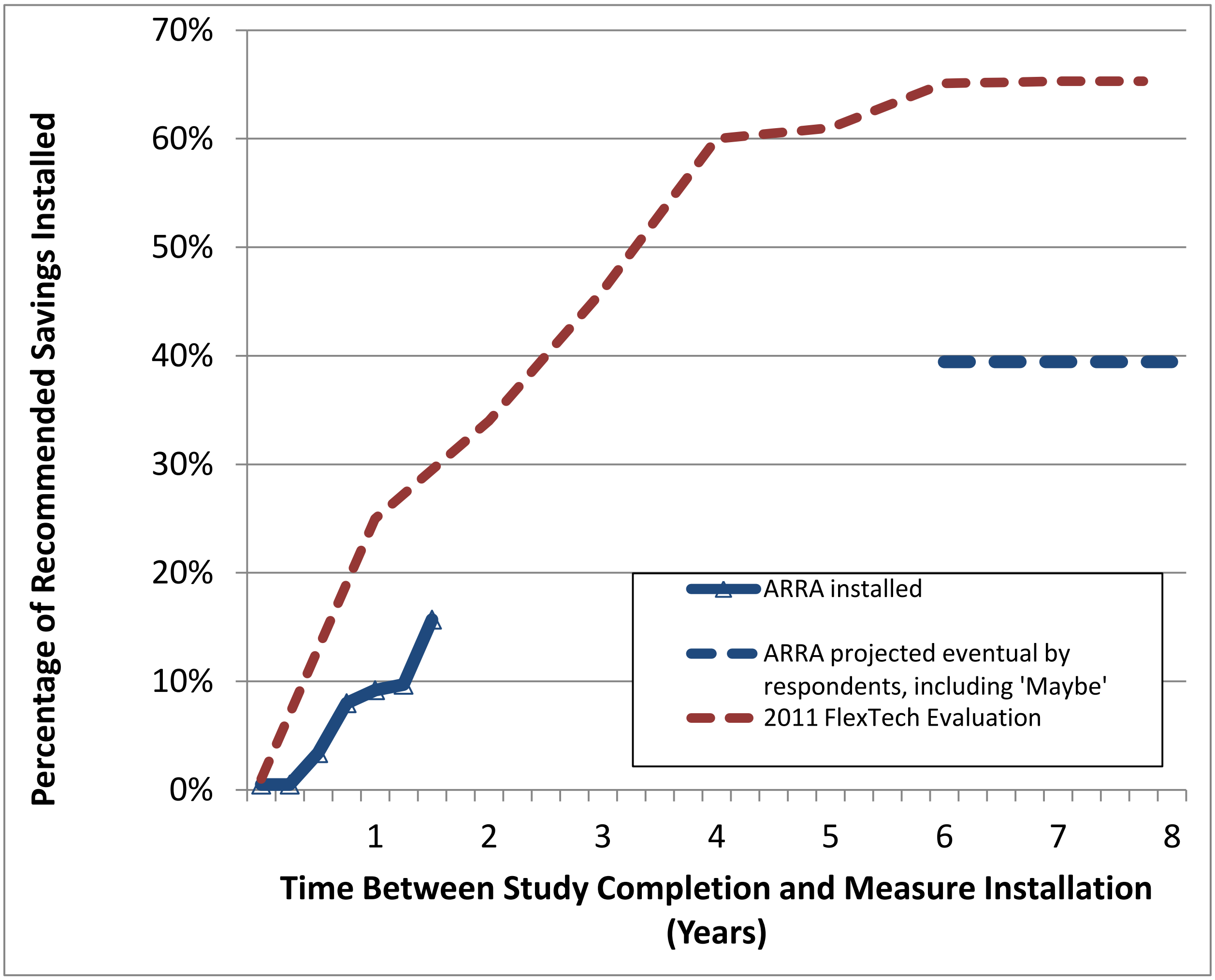


Analyzing MAR as a function of time shows that ECS recipients are continuing to implement measures. Figure 3-64 shows that the MAR has not plateaued. Recipients will likely install additional measures after this evaluation is complete. Thus, the MAR to-date parameter alone is not a balanced estimate of the ECS Program Area's final adoption rate for total impact calculations.

In order to project future behavior, the survey asked respondents about their future plans regarding implementation. About half of the respondents stated their intention to install additional recommended measures in the future. Many respondents were uncertain as to whether or not future installations would happen and when; others had firm plans. Overall, facilities managers reported expressed intent to install measures that will result in an additional 23% savings in the future, for an eventual total MAR of 39%.

The interview required respondents to speculate on future activities, which added substantial measurement uncertainty. Therefore, the Cadmus Team considered the responses regarding long-term expected implementation in the context of other data. The past and expected future MARs were plotted with each other and with the recently completed NYSERDA FlexTech MAR survey results in Figure 3-65. The FlexTech survey used virtually identical questions and computational methodology. Figure 3-65 shows both sets of curves and the ARRA-projected final ECS Program Area MAR on the same graph.

Figure 3-65. ARRA ECS Program Area and FlexTech Program MARs Over Time



Though similar in shape, the ECS Program Area MAR curve rises more slowly than the FlexTech MAR curve, meaning the final ECS Program Area MAR is expected to be less than the final FlexTech MAR. After 18 months, the ECS Program Area MAR is 49% of the FlexTech MAR at 18 months (15.7% ECS MAR compared to 31.8 % FlexTech MAR).

The eventual final expected ECS Program Area MAR reported by respondents fits reasonably well in the context of the other two curves. The projected ECS Program Area MAR plateau of 39%, which includes "maybe" responses, is just over half of the FlexTech MAR's 65% plateau. The use of a 39% long-term expected MAR is reasonable, considering actual early adoption rates and study recipients' expectations of long-term adoption.

<u>Quantified Savings Net-of-Freeriders</u>

Table 3-188 shows the freeridership results for the sample surveyed, along with the reduction of savings to freeridership (in MMBtu), and savings net-of-freeridership. Of the 253,022 MMBtu of savings recommended by the studies that were implemented by sample respondents, there was a reduction of 139,685 MMBtu due to FRs and PFRs, resulting in 113,338 MMBtu of savings net-of-freeridership.

This results in a weighted freeridership rate of the recommended projects of 55%. After accounting for sample expansion weights, the overall evaluated ECS freeridership on implemented measures is 45%. The statistical accuracy of freeridership is 20% relative precision at 90% confidence. As 80% of the respondents were freeriders (partial and full), those who implemented a large amount of recommended savings to date also tended to have higher freeridership rates.[113]

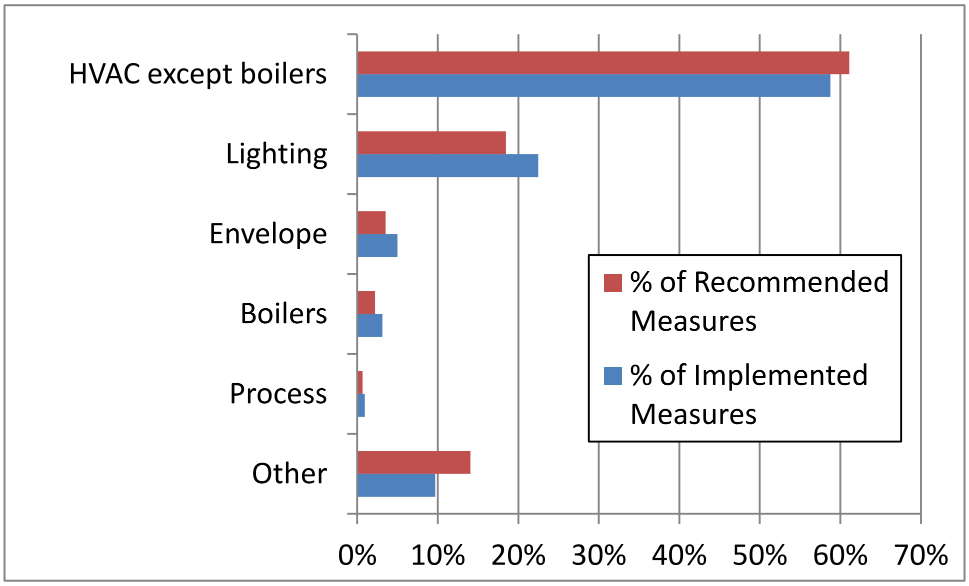
Table 3-188. Freeridership Estimates for ECS Program Area Participants

	FR	Gross Installed Savings	Savings Net of Freeridership
Average Unweighted FR	32%	N/A	N/A
Average Weighted FR	55%		
Total MMBtu		252,839	113,778

Figure 3-66 shows the distribution of measures by equipment type. Fifty-nine percent (59%) of the installed measures (unweighted) addressed participants' HVAC systems, and almost one-quarter of those improved lighting efficiency. The relatively low percentage of lighting measures suggests that ECS providers investigated opportunities beyond the most obvious and easiest measures. Boilers, controls, process measures, envelope, and "other" constituted the remainder of measures. This distribution of implemented measures closely corresponds with the (unweighted) distribution of recommended measures in the sample. Lighting has been implemented slightly more frequently than recommended, and envelope measures have been implemented less frequently than recommended. Neither of those differences is large or unexpected.

[113] One respondent represented a large amount of installed savings and is also a full (100%) freerider. This respondent represents over 30% of the sample savings and over 20% of the total weighted savings of 480,369 MMBtu, and therefore has a strong impact on the freeridership value.

Figure 3-66. Measure Type Distribution in the Sample (Unweighted), ECS Program Area



Realization rate. Studying the Program Area-specific realization rate for adopted measures was not in the scope of the ECS Program Area evaluation. Evaluation designers chose to invest most of the effort in MAR and attribution, where the greater impact uncertainty was expected, and not in realization rate. Also, because ECS was partially a feeder Program Area to RFP 1613, evaluators expected that realization rates for RFP 1613 measures would be representative of those implemented after ECS recommendations. The Cadmus Team leveraged the results from evaluations of ARRA-funded installation incentive programs solicited in RFP 1613. The Cadmus Team's energy-efficiency evaluation found the installed measure realization rates shown in Table 3-189. ECS evaluators used these estimates to calculate the evaluated gross impact.

Table 3-189. Realization Rates by Fuel Type, ECS Program Area

Energy Source and Type	Realization Rate
Electric Energy	0.94
Natural Gas	1.07
Other	1.07

Evaluated gross impact. The evaluated gross realization rates are shown in

Table 3-190 and Table 3-191**.** The use of the long-term expected MAR is more appropriate than the MAR to-date. The Net Savings Findings section, next, presents both the long-term expected impacts and impacts measured as of the end of 2011.

Table 3-190. ECS Program Area Evaluated Gross Impact by Fuel Type, Through December 31, 2011

Energy Source and Type	Tracked Gross Impact	MAR as of 12/31/2011	Realization Rate	Evaluated Gross Impact
Electric Energy	159,149 MWh/yr	0.16	0.94	23,872 MWh/yr
Natural Gas	1,044,512 MMBtu/yr	0.16	1.07	177,567 MMBtu/yr
Other Fuels	442,776 MMBtu/yr	0.16	1.07	75,272 MMBtu/yr

Table 3-191. ECS Program Area Projected Gross Impact by Fuel Type, Long -Term

Energy Source and Type	Tracked Gross Impact	Expected Long-Term MAR	Realization Rate	Projected Gross Impact
Electric Energy	159,149 MWh/yr	0.39	0.94	58,885 MWh/yr
Natural Gas	1,044,512 MMBtu/yr	0.39	1.07	438,695 MMBtu/yr
Other Fuels	442,776 MMBtu/yr	0.39	1.07	185,966 MMBtu/yr

3.6.7 Net Savings Findings

This section presents estimates of freeridership and summarizes the results of the attribution survey from 35 respondents (only 35 out of 42 respondents answered the battery of freeridership questions).[114]

[114] Some of the surveyed respondents were unable to answer some questions or abandoned answering the freeridership battery of questions.

As mentioned above, following an algorithm previously developed by NYSERDA and modified for this Program Area, the Cadmus Team estimated freeridership for the energy-efficiency projects through several sets of questions: direct freeridership questions (FR5 and FR7), Program Area influence freeridership questions (FR2, FR3, and FR4), Program Area influence questions based on the impacts of lost or declined funding (E3), and questions about whether participants diverted funds to other projects after securing NYSERDA ARRA funds (AF4). Finally, freeridership is weighted by the energy savings for each participant. The final average weighted freeridership of 55%, and 45% savings net of freeridership (1-FR) are provided above in the ECS Program Area, Calculations for Savings Net-of-Freeriders section.

<u>Influence of the NYSERDA ARRA Program Area</u>

Direct Freeridership Questions

The survey relied on two 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.

Respondents were asked to estimate the likelihood that they would have installed the same high level of efficiency equipment or measure, at the same time, if they had not received the ECS Program Area's report or recommendations. In this open-ended question, likelihood was indicated using a scale of 0% (for respondents who chose that they "*definitely would not have installed the measure with the same level of efficiency or capacity/rating*") to 100% (for respondents who chose that they "*definitely would have installed the measure with the same level of efficiency or capacity/rating*"). As shown in Table 3-192, almost one-quarter of the respondents (24%) would not have installed measures with the same high level of efficiency, whereas only 3% indicated they definitely would have. The mean unweighted percent likelihood of installing measures without the Program Area is 32%; note that this changes based on project size.

Table 3-192. Likelihood of Installing Same Efficiency Measures in Absence of ESC Program Area (FR5)

Percent Likelihood (0-100%)	Overall
Sample size	*27*
Mean percent likelihood	32%
0% (Definitely would NOT have installed same measure)	24% (10)
1-99%	36% (7)
100% (Definitely would have installed same measure)	3% (3)
Don't know/refused	36% (7)

Notes:

The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

This question was asked of a subset of respondents most of whom have installed a single measure. Other respondents – typically those who have installed multiple measures - were asked about the share of measures they would have installed in the absence of the program in questions FR6 and FR7.

Respondents then estimated the percent of energy savings they achieved with the newly installed measures that would have been achieved anyway (i.e., without the ECS Program Area recommendations). For example, an estimate of 50% means that half of the extra savings from the high-efficiency equipment would have been achieved anyway. They were asked to provide an estimate of the lower bound, upper bound, and best estimate for these potential savings. As shown in Table 3-193, the overall lower bound of estimated savings is reported to be 29%, with 51% for an upper bound and 40% of energy savings achieved as the overall best estimate.

Table 3-193. Likely Percent of Energy Savings Achieved in Absence of ECS Program Area (FR7)

	Lower Bound Overall	Upper Bound Overall	Best Estimate Overall
Sample size	*19*	*19*	*19*
Mean percent	**29%**	**51%**	**40%**
0%	10% (6)	10% (6)	10% (6)
1-20%	47% (4)	15% (1)	45% (3)
21-40%	4% (2)	30% (2)	1% (1)
41-60%	34% (4)	4% (2)	8% (4)
61-80%	2% (1)	7% (3)	30% (2)
81-99%	0% (0)	30% (2)	0% (0)
100%	4% (2)	6% (3)	6% (3)

Notes: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data. Additionally this question was asked of a subset of respondents most of whom have installed multiple measures. Other respondents – typically those who have installed a single measure - were asked FR5, discussed above.

Direct freeridership is estimated by calculating the average of responses to questions FR5 and FR7, which is equal to 35%.

Program Area Influence Score Questions

This section summarizes the series of questions that the Cadmus Team primarily used to estimate Program Area influence, which factored into the calculation of freeridership as described above. These questions addressed respondents' likely actions if they had not participated in the ECS 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 survey presented a list of statements describing the process of planning to install the recommended measures. Respondents were asked to indicate which statement best described their plans before they participated in the Program Area. Table 3-194 shows that almost one-third (27%) of respondents indicated that they "*Had preliminary, internal discussions but no plans and no contact with a vendor, contractor or installer*" regarding any of the recommended measures, indicating that the Program Area had a strong influence on the decision to implement the recommended measures. Sixteen percent (16%) of respondents reported they "*Had identified specific equipment/measures and models but budget didn't allow completion of a project*."

Table 3-194. Plans to Implement Measures Prior to Participation (FR2), ECS Program Area

Planning Process	Overall
Sample size	*17*
Had preliminary, internal discussions but no plans and no contact with a vendor, contractor, or installer.	27% (4)
Had taken initial steps toward considering the equipment/measures, such as requesting information from or discussing options with a vendor, contractor, or installer.	28% (4)
Had in-depth discussions of specific types of equipment/measures, including positive and negative attributes and costs.	5% (3)
Had identified specific equipment /measures and models but had not begun budgeting process.	24% (2)
Had identified specific equipment/measures and models but budget did not allow completion of project.	16% (1)
Had indentified specific equipment/measures and models and incorporated project into budget.	0% (0)
Other	0% (0)

Notes:

The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

This question was asked of all respondents who had indicated a plan to install any of the recommended measures prior to participating in ECS.

Respondents were then asked how the NYSERDA ARRA Program Area and funding influenced their decision to implement high efficiency measures at their site. Presented with a list of statements describing the influence, respondents were asked to choose the statement that best indicates the effect of the Program Area on their decision process. As shown in Table 3-195, the Program Area and funding had an influence on all the respondents when deciding to install high-efficiency measures. Forty-seven percent (47%) of respondents claimed that the NYSERDA ARRA Program Area and funding was the primary reason that the system was installed.

Table 3-195. Influence of ECS Program Area on Decision to Install High-Efficiency Measures (FR3)

Description of Influence	Overall
Sample size	*27*
No influence; same type and capacity system would have been installed without the Program Area.	0% (0)
The NYSERDA Program Area funding helped in making the final decision on the system that had already been thoroughly considered.	3% (3)
The NYSERDA Program Area and funding helped in choosing to install a system that had been discussed but not thoroughly considered.	21% (6)
The NYSERDA Program Area funding was a major driver in the decision to install the system.	30% (8)
The NYSERDA Program Area funding was the primary reason that the system was installed.	47% (10)

Notes:

The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

This question was only asked of customers who had installed measures by the time the interview was conducted.

When asked how important the Program Area was in the decision to incorporate high-efficiency measures at the site, on a scale from 1 (indicating that it was not at all important) to 5 (indicating that it was very important), 98% of respondents indicated that it was "somewhat" or "very" important, whereas only 1% of respondents said it was "somewhat unimportant" or "not at all important" (Table 3-196).

Table 3-196. Importance of ECS Program Area in Decision to Incorporate High-Efficiency Measures (FR4)

Importance	Overall
Sample size	*27*
Mean (Scale 1-5)	4.59
1 Not at all important	0% (0)
2 Somewhat unimportant	1% (1)
3 Neither important nor unimportant	1% (1)
4 Somewhat important	37% (8)
5 Very important	61% (17)

Notes:

The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

This question was only asked of customers who had installed measures by the time the interview was conducted.

The average of the questions FR2, FR3, and FR4 are the input for a Program Area influence score. The average unadjusted Program Area influence score for the sample of respondents is 4.59.

<u>Adjustments to Freeridership</u>

While the questions summarized earlier in this section provided information to calculate direct freeridership and a Program Area influence score, the Program Area influence score was adjusted based on responses to questions about funds lost due to tightening credit markets and whether the NYSERDA ARRA funding allowed a respondent to divert funds to other projects.

The survey included a number of questions about the funding sources for respondents' conservation studies. A series of questions asked respondents about whether they had attempted to secure financing for the project they completed through the NYSERDA ARRA-funded Program Area before they applied for the funds, as well as whether those attempts were successful and how the previously secured funds were used.

Table 3-197 shows that 19% of respondents had previously attempted to secure financing for the study, while 81% had not.

Table 3-197. Whether Respondents had Previously Attempted to Secure Financing for Study (E1), ECS Program Area

Response	Overall
Sample size	*38*
Yes	19% (12)
No	81% (26)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Of respondents who attempted to obtain funding for the study, 60% were successful in securing at least some other financing before applying for the NYSERDA ARRA funds (Table 3-198).

Table 3-198. Whether Respondents Successfully Secured Financing for Project (E2), ECS Program Area

Response	Overall
Sample size	*12*
Yes	60% (9)
No	40% (3)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

Table 3-199 shows how these funds that were obtained before participants applied to the Program Area were used. Thirty-eight percent (38%) of those who secured prior funds used them to help defray part of the study cost, but the ECS Program Area limited funding of studies to $30,000, so any costs above that were paid by the participant.

Table 3-199. How Previously Secured Funds Were Used (E3), ECS Program Area

Uses of Funds	Overall
Sample size	*9*
To pay for part of the study cost	38% (7)
Declined funds before receiving NYSERDA funds	0% (0)
Declined funds after receiving NYSERDA funds	0% (0)
Lost the funds	0% (0)
Have not used previously secured funds yet	0% (0)
Sewer repair project	54% (1)
Sprinkler upgrade project	8% (1)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data.

None of the respondents surveyed who secured previous funding lost or declined funds; therefore, there was not an adjustment to the Program Area influence score for this factor.

The Cadmus Team also examined the need for an adjustment to the Program Area influence score based on whether the respondents diverted NYSERDA ARRA funds to other projects. Respondents were asked whether the award allowed them to divert funds that had been budgeted for the study to go to other projects in need of financing. Table 3-200 illustrates that 36% of respondents were able to divert monies to other projects.

Table 3-200. Whether NYSERDA Allowed Respondent to Divert Funds to Other Projects (AF4), ECS Program Area

Response	Overall
Sample size	*37*
Yes	36% (17)
No	64% (20)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data

Of the respondents whose NYSERDA ARRA award allowed them to divert funds to other projects, 54% said that it was "not at all likely" that they would have diverted those funds to other projects if the NYSERDA ARRA funds had not been available (indicating strong Program Area influence; Table 3-201). Responses to question AF5 were included in the Program Area influence score.

Table 3-201. Likelihood of Diverting Internal Funds to Other Projects in Absence of NYSERDA Funds (AF5), ECS Program Area

Likelihood	Overall
Sample size	*17*
Mean (scale of 1 to 5)	2.35
1 Not at all likely	54% (11)
2 Somewhat unlikely	5% (2)
3 Neither likely nor unlikely	18% (1)
4 Somewhat likely	0% (0)
5 Very likely	24% (3)

Note: The numbers after the parentheses are unweighted frequencies, while the percentages reflect weighted data

Next, direct freeridership scores were adjusted based on the Program Area influence score. The Program Area influence score provides lower and upper bounds of freeridership, as defined in Table 3-202 and the algorithm in Appendix F.[115] The direct freeridership score was compared to the upper and lower bounds of the Program Area influence score. Wherever the direct freeridership fell outside the bounds of the Program Area influence score, the preliminary estimate of freeridership was changed to either the lower or upper bound value (whichever was closest).

[115] 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.

Table 3-202. ECS 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%

Freeridership rates for the ECS Program Area are shown in Table 3-203. Overall, there was only one freerider participant in the Program Area. PFRs and NFRs were split approximately three to one: 77% PFRs and 20% NFRs. The overall average freeridership rate for respondents as reported above was 27%.

Table 3-203. Freeridership Rates, ECS Program Area

	Overall	
	N	Freeridership Rate
Freeriders	1	3%
Partial freeriders	27	77%
Non-freeriders	7	20%

Overlap Factor. In the context of ECS Program Area evaluation, overlap refers to the percentage of savings associated with projects that recipients installed in response to ECS recommendations that also received installation incentive funding from other programs, such as NYSERDA RFP 10 or RFP 1613.

Eighteen respondents had installed a total of 57 measures. Eight of the respondents indicated that they had received installation incentive funding for installing at least one ECS-recommended measure.

To assess the quality of the responses, the Cadmus Team cross-checked the latest RFP 10 and RFP 1613 databases for customers with the same address and measure, and found one respondent that reported not having had any funding that did in fact receive funding. Conversely, one respondent who did not receive the ARRA funding reported having done so. Given the offsetting findings, the ECS survey results were not adjusted based on the database crosschecking exercise.

After adjusting for sample weights and energy savings, 33% of the energy savings associated with installed measures also received funding and had claimed savings through other programs. All identified installation incentive funding was either through ARRA (n=2), NYSERDA's Existing Facilities Program (n=3), another unspecified NYSERDA program (n=1), or from a gas utility company program (n=2).

18 respondents installed 57 measures. Of those 18 respondents, 8 stated they had received additional funding to implement measures. 2 measures received funding through ARRA RFP 1613 (cross checked and verified against RFP 1613 program tracking data), 3 received funding through NYSERDA's Existing Facilities Program, 1 received funding through a non-specified NYSERDA program, and 2 received funding through a gas utility company program.

Net impact. The ECS Program Area net impact calculation combines all factors as shown in the following equation:

Equation 3-26. ECS Program Area Impact Net-of-Freeriders Including Discount for Program Overlap

The spillover used for net impact was developed at the portfolio level; thus, the relevant final equation for ECS evaluation is:

Equation 3-27. ECS Program Area Impact of Freeridership and Overlap

Where:

Net impact = ECS Program Area evaluated savings

Tracked impact = Savings associated with measures recommended in ECS

RR = Realization rate

FR = Freeridership

OL = Overlap

Table 3-204 summarizes the evaluated expected annual net impact as of the end of 2011. For a program such as ECS that NYSERDA designed to have residual effects long after funding expires, Table 3-204's results are the most appropriate for consideration of Program Area impacts in benefit cost analysis.

Table 3-204. Savings Impact Evaluated Net of Freeridership by Fuel Type, Through December 31, 2011, ECS Program Area

Energy Source and Type	Tracked Gross Impact	MAR as of December 31, 2011	Realization Rate	Evaluated Gross Impact	Freeridership	Overlap	Evaluated Net of Freeriders
Electric Energy	159,149 MWh/yr	0.16	0.94	23,872 MWh/yr	0.55	0.33	7,162 MWh/yr
Natural Gas	1,044,512 MMBtu/yr	0.16	1.07	177,567 MMBtu/yr	0.55	0.33	53,270 MMBtu/yr
Other Fuel	442,776 MMBtu/yr	0.16	1.07	75,272 MMBtu/yr	0.55	0.33	22,582 MMBtu/yr

Section 4:

PORTFOLIO-LEVEL RESULTS

4.1 OVERALL NET SAVINGS

At the time this report was written, many of NYSERDA's SEP-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 contractual requirements between the Cadmus Team and NYSERDA, the evaluation of these Program Areas needed to be reported on before the end of April 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 promises 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 left 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.[116]

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.[117] Spillover may take months or years to occur depending on the technology, cost, and the experience a customer has with program measures. In most cases of this evaluation effort, spillover was not able to be measured 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 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 D presents a study conducted on behalf of another client in which Cadmus 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

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[116] NAPEE. *Model Energy Efficiency Program Impact Evaluation Guide.* Available at: http://www.epa.gov/cleanenergy/documents/suca/evaluation_guide.pdf. Retrieved on April 9, 2012.

[117] Ibid.

convert them into net Program Area load impacts.[118] Furthermore, NYSERDA and the New York Department of Public Service (DPS) have a precedent of accepting a deemed NTG of 0.9 for planning purposes.[119] Given the requirements from the U.S. DOE that ARRA programs 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 will necessarily understate the likely impacts of the Program Areas. This is due to the fact that freeridership will be much more clearly measurable than spillover, which, although likely to occur in the future, is not currently present at a level that can be evaluated. For this reason, 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 SEP/SEEARP-funded projects, this evaluation effort has reviewed the level of savings that are expected to be achieved, in addition to the savings that have been evaluated to date. The realization rate that was derived by the evaluation for projects completed as of December 31, 2011 is applied to the total expected savings, and the resulting projected gross savings are adjusted for the deemed NTG to arrive at a projection for 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.

[118] Ibid.

[119] 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)
Appliance Rebate*	12,862*	12.03	154,738	0.90	139,264*
Renewable Energy (1686)	3,640	1.13	4,113	0.90	3,702
Renewable Energy (1613)	4,100	1.12	4,592	0.90	4,133
Energy-Efficiency	52,357	0.94	49,216	0.90	44,294
Transportation	Fuel Savings Only				
Energy Code**	N/A				
Energy Conservation Studies***	159,149	0.37	58,885	0.60	35,331
Total	**232,108**	**N/M**	**271,544**	**N/M**	**226,724**
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)**
Appliance Rebate*	47,328	1.00	47,328	0.90	42,595*
Renewable Energy (1686)	Electric Generation Only				
Renewable Energy (1613)	19,053	0.77	14,671	0.90	13,204
Energy-Efficiency	361,356	1.07	386,651	0.90	347,986
Transportation	10,791	0.65	6,994	0.90	6,295
Energy Code**	N/A				
Energy Conservation Studies***	1,487,288****	0.42	624,661	0.60	374,797
Total	**1,925,816**	**N/M*******	**1,080,305**	**N/M*******	**784,877**

* Please see note regarding Appliance savings values in Table ES-2 above

** As noted in Table ES-2 above, Energy Code savings are being estimated as part of a independent evaluation effort as described in the Energy Code Program Area chapter of Section 3.

*** For the purposes of readability, the ECS Program Area evaluation results are being summarized in the same categories as other programs. For the ECS program, the value shown as the Savings Weighted Realization Rate is actually the product of the projected long-term measure adoption rate (MAR, which equals 0.39) and the Realization Rate (0.94 for electricity and 1.07 for fuel). The value shown for Net-to-Gross is the product of one minus the overlap factor (1-0.33, or 0.67) and the projected Net-to-Gross (0.90). These values are discussed further in Section 3.

**** NYSERDA did not report any direct electricity or fossil fuel savings for the ECS program. Claimed savings is 0. In this table the values shown in the ECS row for the Total Claimed Savings column is the evaluation's team calculated estimate of the ECS authors' total savings for all recommended measures, based on NYSERDA program tracking system data.

***** Weighted overall RR and FR are not meaningful and therefore have been replaced with N/M in the table above.

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 an overarching approach that was applied to each Program Area's net annual and net lifetime savings for projects completed by December 31, 2011. Then a second set of tables includes all projects that are assumed will be complete by the end of all projects in that Program Area. This overarching approach was refined for each specific Program Area as needed. The approach 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[120].

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*. The emissions factors assume CO2 equivalent conversions derived from global warming potential (GWP) numbers from the Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report.

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 NYSERDA electric emissions factor includes the electricity imported into New York State and accounts for transmission and distribution 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 CO2e/MWhr)	Transport (lb CO2e/MWhr)	Residential (lb CO2e/MWhr)	Commercial (lb CO2e/MWhr)	Industrial (lb CO2e/MWhr)
Electricity	826	826	826	826	826

Provided by NYSERDA. Source: Mas, Carl. *NYS Grid Emission Intensity*. 2010. Workbook 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.

[120] 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 going 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 now estimates displacements in emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), and sulfur dioxide (SO_2) associated with electric efficiency projects based on average emission rates that include emissions associated with imports of electricity. In the past, NYSERDA has reported emissions displacements using marginal emission factors; this transition to average emission factors was performed to be consistent with a footprint displacement framework (per NYSERDA April 10, 2012).

The fuel combustion emissions factors that NYSERDA provided came from the EPA's SITs released on January 3, 2011 and EPA's Inventory *of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006*, Annexes 2 and 3, April 2008. For transportation projects, the CO2e emissions factors did not vary by vehicle type, as they are on a per-fuel basis. Emissions factors for electricity were included in the transportation template to account for projects with EV charging stations.

NYSERDA provided the Cadmus Team with the fuel combustion emissions factors shown in Table 4-3 for this analysis.

Table 4-3. Fuel Combustion Emissions Factors by Sector (lb CO2 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 / LPG	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

Values represent aggregate CO2, 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 the EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006*, Annexes 2 and 3. April 2008.

4.2.3 Recommended Emissions Factors

The Cadmus Team supports NYSERDA's decision to reference their own electricity emissions factor for electricity and the EPA SIT for the fuel combustion emission factors. This tool is designed specifically 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*"[121] and are the basis for this tool. GWPs in the SIT are derived from the IPCC's Second Assessment Report.[122]

4.2.4 Calculation Methods

DOE stipulates that "*evaluations of SEP Recovery Act-funded efforts should document the resulting effects (energy savings, renewable generation, carbon reductions and job creation) that are above and beyond the effects that would have been achieved without those funds. That is, studies should focus on net effects of the SEP Recovery Act initiatives*," as stated in SEP Reporting Program Guidance v5.0. Thus, in order 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, if another tool were used, the calculations could come out slightly different. 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 an Approach to Estimating Emissions Displaced from Energy-Efficiency Program Area

Based on the assessments described above, the Cadmus Team recommends that NYSERDA use a hybrid approach for calculating emissions displaced across its portfolio of programs. The recommended approach leverages the emissions factors from the EPA SIT for fuel combustion and NYSERDA's developed electricity emissions factor, and combines these in a simple spreadsheet format, while being consistent with the WRI's Guidelines. The basis for this recommendation is:

- To ensure consistency of reporting across the organization
- To maximize the ability to compare savings across the Program Area 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 Cadmus Team used the verified net energy impacts, in terms of net metric tons of GHG emissions avoided over the 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 GHG Protocol[123] and the EPA SIT.

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[121] http://www.epa.gov/statelocalclimate/resources/tool.html

[122] The main activity of the IPCC is to provide regular Assessment Reports about the state of climate change knowledge.

[123] WRI's Greenhouse gas protocol: http://www.ghgprotocol.org/calculation-tools/all-tools

Using the fuel type, the amount of fuel, and the emissions factor, the Cadmus Team calculated aggregate GHG emissions in CO2e. The emissions factors provided by NYSERDA rely on the GWPs from the 2007 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 (carbon dioxide, methane, and nitrous oxide).

4.2.7 GHG Displaced Emissions by Program Area

NYSERDA offered ARRA-funded incentives for the following Program Areas: Appliance Rebate, Energy Code, Energy-Efficiency, Renewable Energy, Transportation, and ECS. This section presents how the Cadmus Team calculated the emissions displaced from projects receiving funding from these Program Areas.

The Cadmus Team calculated the displaced annual and lifetime GHG emissions for each Program Area using the inputs specified in Table 4-3. The net verified savings for each Program Area was multiplied 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. All displaced emissions were then summed and are reported as aggregate displaced GHG emissions in CO2e for both annual and lifetime periods.

GHG Emissions Displaced for the Appliance Rebate Program Area

The New York State Energy-Efficient Appliance Rebate Program Area paid rebates funded by ARRA to consumers who replaced inefficient appliances with new ENERGY STAR-qualified appliances. The Appliance Rebate Program Area also offered additional incentives to customers who recycled their replaced appliances. The Program Area was available to New York residents who owned their appliance(s) and replaced them with qualified ENERGY STAR-qualified appliances from any retailer.

The greatest source of program-area savings came from electric displacement. The following four tables illustrate these savings and the associated GHGs displaced.

Table 4-4. Displaced Annual GHG Emissions for the Appliance Rebate Program Area Through December 31, 2011

Residential Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	73,600	MWh	826	N/A	27,600
Natural Gas	22,800	MMBtu	N/A	117.14	1,210
#2 / Distillate	-4,070	MMBtu	N/A	163.78	-302
Total					**28,500**

Table 4-5. Displaced Annual GHG Emissions for All Projects in the Appliance Rebate Program Area

Residential Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	102,000	MWh	826	N/A	38,100
Natural Gas	32,500	MMBtu	N/A	117.14	1,730
#2 / Distillate	-11,000	MMBtu	N/A	163.78	-821
Total					**39,000**

Table 4-6. Displaced Lifetime GHG Emissions for the Appliance Rebate Program Area Through December 31, 2011

Residential Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	592,000	MWh	826	N/A	222,000
Natural Gas	177,000	MMBtu	N/A	117.14	9,400
#2 / Distillate	-92,500	MMBtu	N/A	163.78	-6,870
Total					**225,000**

Table 4-7. Displaced Lifetime GHG Emissions for All Projects in the Appliance Rebate Program Area

Residential Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	946,000	MWh	826	N/A	355,000
Natural Gas	194,000	MMBtu	N/A	117.14	10,300
#2 / Distillate	-228,000	MMBtu	N/A	163.78	-16,900
Total					**348,000**

GHG Emissions Displaced for the Energy-Efficiency Program Area

Energy-Efficiency Program Area projects in this evaluation came in the form of grants that were awarded on a competitive basis for projects associated with energy-efficiency retrofits, material conservation programs, energy distribution technologies, traffic signal and street lighting efficiency projects, renewable energy installation for government buildings, or technical consultant services. These grants were provided to municipalities, universities, schools, hospitals, and not-for-profits for energy-related projects.

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 4-8. Displaced Annual GHG Emissions for the Energy-Efficiency Program Area Through December 31, 2011

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBTu)	Metric Tons (CO2e)
Electric	29,200	MWh	826	N/A	10,900
Natural Gas	190,000	MMBtu	N/A	117.14	10,100
#2 / Distillate	3,890	MMBtu	N/A	163.78	289
#6/ Residual	13,800	MMBtu	N/A	166.28	1,040
Wood	1,290	MMBtu	N/A	15.79	9.23
Total					**22,300**

Table 4-9. Displaced Annual GHG Emissions for All Projects in the Energy-Efficiency Program Area

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBTu)	Metric Tons (CO2e)
Electric	44,100	MWh	826	N/A	16,500
Natural Gas	292,000	MMBtu	N/A	117.14	15,500
#2 / Distillate	17,300	MMBtu	N/A	163.78	1,290
#6/ Residual	36,900	MMBtu	N/A	166.28	2,780
Wood	1,590	MMBtu	N/A	15.79	11.4
Total					**36,100**

Table 4-10. Displaced Lifetime GHG Emissions for the Energy-Efficiency Program Area Through December 31, 2011

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	554,000	MWh	826	N/A	208,000
Natural Gas	3,620,000	MMBtu	N/A	117.14	192,000
#2 / Distillate	73,800	MMBtu	N/A	163.78	5,490
#6/ Residual	262,000	MMBtu	N/A	166.28	19,800
Wood	24,500	MMBtu	N/A	15.79	175
Total					**425,000**

Table 4-11. Displaced Lifetime GHG Emissions for All Projects in the Energy-Efficiency Program Area

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	794,000	MWh	826	N/A	298,000
Natural Gas	5,250,000	MMBtu	N/A	117.14	279,000
#2 / Distillate	311,000	MMBtu	N/A	163.78	23,100
#6/ Residual	664,000	MMBtu	N/A	166.28	50,100
Wood	28,600	MMBtu	N/A	15.79	205
Total					**650,000**

GHG Emissions Displaced for the Renewable Energy Program Area

A renewable energy project is defined as a project that: achieves a cost-per-annual-energy-generated of less than $8,000 of total project cost per 10 million BTUs; is sited at the electric customer's location; is used primarily to serve the electric customer's load (i.e., not primarily exported to the utility grid); and the system 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).

Eligible proposers included municipal governments, public K-12 schools, BOCES, public universities or colleges, public and private hospitals, and not-for-profits. Eligible proposers agreed to comply with all required federal and New York State requirements for use of the funds.

The Renewable Energy Program Area offset fuels in both the residential and commercial sector. Solar PV savings was also achieved in both sectors. A greater level of savings was achieved through renewable projects that took place in the commercial sector compared to the residential sector. The combined residential and commercial savings and the associated GHGs displaced are listed in the following four tables.

Table 4-12. Residential and Commercial Combined Displaced Annual GHG Emissions for the Renewable Energy Program Area Through December 31, 2011

Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	5,330	MWh	826	N/A	2,000
Natural Gas	1,370	MMBtu	N/A	117.14	72.7
#2 / Distillate	11,500	MMBtu	N/A	163.78	854
Propane	510	MMBtu	N/A	136.94	31.7
Total					**2,960**

Table 4-13. Residential and Commercial Combined Displaced Annual GHG Emissions for All Projects in the Renewable Energy Program Area

Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	7,840	MWh	826	N/A	2,400
Natural Gas	1,780	MMBtu	N/A	117.14	94.7
#2 / Distillate	10,800	MMBtu	N/A	163.78	800
Propane	478	MMBtu	N/A	136.94	29.7
Total					**3,320**

Table 4-14. Residential and Commercial Combined Displaced Lifetime GHG Emissions for the Renewable Program Area Through December 31, 2011

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbsCO2e/ MMBtu)	Metric Tons (CO2e)
Electric	158,000	MWh	826	N/A	59,200
Natural Gas	1,370	MMBtu	N/A	117.14	72.7
#2 / Distillate	284,000	MMBtu	N/A	163.78	21,100
Propane	12,700	MMBtu	N/A	136.94	791
Total					**81,200**

Table 4-15. Residential and Commercial Combined Displaced Lifetime GHG Emissions for All 59Projects in the Renewable Energy Program Area

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbsCO2e/ MMBtu)	Metric Tons (CO2e)
Electric	233,000	MWh	826	N/A	87,400
Natural Gas	37,300	MMBtu	N/A	117.14	1,980
#2 / Distillate	266,000	MMBtu	N/A	163.78	19,800
Propane	11,900	MMBtu	N/A	136.94	742
Total					**110,000**

GHG Emissions Displaced for the Transportation Program Area

NYSERDA offered ARRA-funded incentives for alternative transportation infrastructure and the purchase and conversion of alternative energy vehicles, via the Clean Fleets Program. A key provision of ARRA was to fund “shovel-ready” projects were ready for construction. This report focuses on transportation projects funded within NYSERDA Clean Fleets.

Clean fleets projects offered financial incentives to speed the introduction of light-, medium-, and heavy-duty alternative fuel vehicles and certain advanced vehicle technologies into local communities. The goals were to reduce the consumption of petroleum, reduce GHG emissions, improve air quality, and produce net job creation.

Those eligible for funding included municipal governments, public K-12 schools, BOCES, public universities or colleges, public and private hospitals, and not-for-profits. For applicants interested in purchasing a new vehicle, the Program Area offered up to 75% off the incremental purchase cost of each vehicle. For those interested in purchasing anti-idling or fueling and refueling/recharging equipment, the Program Area offered up to 75% off the incremental cost for the equipment.

This analysis included project specific assumptions, which are outlined in Appendix J.

The transportation savings by fuel type and the associated GHGs displaced are listed in the following four tables.[124]

Table 4-16. Displaced Annual GHG Emissions for the Transportation Program Area Through December 31, 2011

Transportation Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Gasoline	302	MMBtu	159.09	21.8
Diesel	1,410	MMBtu	163.22	104
Compressed Natural Gas	-42.5	MMBtu	117.25	-2.26
Total				**124**

Table 4-17. Displaced Annual GHG Emissions for All Projects in the Transportation Program Area

Transportation Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e per MMBtu)	Metric Tons (CO2e)
Gasoline	616	MMBtu	N/A	159.09	44.5
Diesel	5,780	MMBtu	N/A	163.22	428
Compressed Natural Gas	-47.9	MMBtu	N/A	117.25	-2.55
Electricity	-15	MWh	826	N/A	-5.52
Total					**464**

[124] As noted in Footnote 107 in Section 3.5.2, page 3-208, the emission analysis for the transportation Program Area includes specific analysis of emissions from electricity consumption whereas other sections of this evaluation are looking at the total MMBtu impacts of the program area regardless of fuel type.

Table 4-18. Displaced Lifetime GHG Emissions for the Transportation Program Area Through December 31, 2011

Transportation Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Gasoline	2,850	MMBtu	159.09	206
Diesel	11,100	MMBtu	163.22	823
Compressed Natural Gas	-644	MMBtu	117.25	-34.3
Total				**995**

Table 4-19. Displaced Net Evaluated Lifetime GHG Emissions Savings for All Projects in the Transportation Program Area

Transportation Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Gasoline	4,820	MMBtu	N/A	159.09	348
Diesel	83,800	MMBtu	N/A	163.22	6,200
Compressed Natural Gas	-725	MMBtu	N/A	117.25	-38.6
Electricity	-88	MWh	826	N/A	-33.1
Total					**6,480**

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.

Displaced GHG emissions were not calculated for the Energy Code Program Area.

GHG Emissions Displaced for the Energy Conservation Studies Program Area

Funding for this Program Area allowed New York municipal governments, public K-12 schools, public universities or colleges, hospitals, and not-for-profits to apply for ECS. The intent was for these studies to encourage subsequent applications of ARRA-funded installations through RFP 10 and RFP 1613, or for other NYSERDA programs. Furthermore, NYSERDA intended for the studies to supply required technical information to document the energy savings and costs of proposed projects.

Additionally, eligible applicants could apply for funding for multiple studies. However, regardless of the number of studies for which applicants received funding, each eligible applicant under the ECS Program Area could only receive funding that amounted to the lesser of $30,000, 100% of the cost of the study or studies, or 25% of the site energy costs.

The ECS Program Area achieved the greatest portion of its savings through the displacement of natural gas. These savings and the associated GHGs displaced are detailed in the following four tables.

Table 4-20. Displaced Annual GHG Emissions for the Energy Conservation Studies Program Area Through December 31, 2011

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	7,180	MWh	826	N/A	2,690
Natural Gas	53,600	MMBtu	N/A	117.14	2,850
#2 / Distillate	4,660	MMBtu	N/A	163.78	346
#6/ Residual	16,500	MMBtu	N/A	166.28	1,250
Wood	1,550	MMBtu	N/A	15.79	11.1
Total					**7,150**

Table 4-21. Displaced Annual GHG Emissions for All Projects in the Energy Conservation Studies Program Area

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	35,000	MWh	826	N/A	13,100
Natural Gas	262,000	MMBtu	N/A	117.14	13,900
#2 / Distillate	34,400	MMBtu	N/A	163.78	2,550
#6/ Residual	73,300	MMBtu	N/A	166.28	5,530
Wood	3,160	MMBtu	N/A	15.79	22.6
Total					**35,100**

Table 4-22. Displaced Lifetime GHG Emissions for the Energy Conservation Studies Program Area Through December 31, 2011

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	136,000	MWh	826	N/A	51,000
Natural Gas	1,020,000	MMBtu	N/A	117.14	54,200
#2 / Distillate	88,600	MMBtu	N/A	163.78	6,580
#6/ Residual	314,000	MMBtu	N/A	166.28	23,700
Wood	29,400	MMBtu	N/A	15.79	210
Total					**136,000**

Table 4-23. Displaced Lifetime GHG Emissions for All Projects in the Energy Conservation Studies Program Area

Commercial Sector Fuel Type	Amount Displaced	Units	Emissions Factor (lbs CO2e/MWh)	Emissions Factor (lbs CO2e/MMBtu)	Metric Tons (CO2e)
Electric	630,000	MWh	826	N/A	236,000
Natural Gas	4,710,000	MMBtu	N/A	117.14	250,000
#2 / Distillate	619,000	MMBtu	N/A	163.78	46,000
#6/ Residual	1,320,000	MMBtu	N/A	166.28	99,500
Wood	56,900	MMBtu	N/A	15.79	407
Total					**632,000**

4.3 ECONOMIC IMPACT

4.3.1 Introduction and Purpose

The goal of the macroeconomic impact analysis is to estimate statewide employment impacts resulting from NYSERDA's SEP/SEEARP funded Program Areas. Impacts arise from short-term investment activities, such as building retrofits, and from longer-term benefits due to 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 Regional Economic Models, Inc. (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 the methodology is consistent with NYSERDA's standard approach that has been developed for assessing macroeconomic impacts from energy programs. The Cadmus Team also consulted with staff working on the national evaluation[125] and DOE's State Energy Program evaluation guidelines, which calls for job creation as a national SEP 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 long-term stabilization of the economic system as supply and demand become balanced. Econometrics estimates responses to economic "shocks" to the system and the speed at which they happen. Economic geography represents spatial characteristics of the economy, such as productivity and competitiveness, arising from industry

[125] KEMA, the evaluation contractor for the national study, uses REMI to assess job impacts for its national evaluation.

clustering and labor market access. Unlike I/O models, PI^+ is dynamic, demonstrating annual economic changes over the study period.

4.3.4 Modeling Approach

The Cadmus Team analyzed two primary scenarios:

1. **Evaluated impacts** of projects completed through the end of December 2011
2. **Projected impacts** of all planned projects

All spending activities within New York State are netted out (e.g., increases in consumer spending on efficient appliances are balanced by decreases in spending on other goods and services such that the total spending remains constant), except for funds entering or leaving the State, which are considered gains or losses to the regional economy. These include the cost of federal money entering New York, such as ARRA funds, which is not accounted for and is outside the scope of this evaluation.[126] Likewise, money leaving New York State is modeled as 100% leakage from the regional economy. The positive and negative impacts modeled are summarized in Table 4-24. For each positive impact modeled, a negative impact is included, where appropriate.

[126] It is the Cadmus Team's understanding 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 4-24 Summary of Economic Stimuli

Positive Impacts Modeled	Negative Impacts Modeled
ARRA spending for goods and services.	None, ARRA funds originate from a source external to New York State.
Co-funding spending for goods and services, evaluated net-of-freeridership/projected net-to-gross.	Co-funding costs represents the participants' out-of-pocket costs for participation in the ARRA Program Area (after netting out ARRA incentives and freeridership).
Avoided resource costs/electricity bill savings are modeled as increased disposable income and lowered electricity costs for residential and commercial participants, respectively. Cost savings in the government sector are modeled as an increase in government spending without increasing taxes or other sources of revenue. These effects persist through the effective useful life (EUL) of the measures implemented, for up to 30 years for some measures. In this analysis, measure savings are modeled as step functions; savings do not degrade prior to reaching the EUL, but remain constant and then drop to zero upon reaching the EUL. Wholesale electric rates are used to model the benefits as the pass-through portion of the bill. Because the national evaluation is using retail electric rates to monetize electric savings, this evaluation also presents results from analyses substituting retail electric rates for wholesale electric rates. In the retail electric rate scenarios, no other changes were made in order to isolate the effect of the rate change.	Electric utility revenue loss is not modeled because utilities' are allowed recovery of fixed costs. Additionally, the positive impact modeled uses wholesale electric rates, negating the need to make a negative adjustment. In New York, utilities do not own generators. Impacts to electric generators in New York arise from having fewer kWh's sold and lower prices per kWh (price suppression). However, these impacts are negligible because: (1) 40% of electricity on the margin is imported from out-of-State, and (2) of the remaining 60% of electricity generated within the State, over 90% of generation costs are for fuel, most of which is imported. The majority of the loss accrues in regions outside of the study area and outside the scope of this evaluation.
Other bill savings including water and non-electric industry impacts (natural gas, fuel oil, propane, etc.). These effects persist through the EUL of the measures implemented.	Other industry revenue losses, from efficiency and renewable projects, are modeled as a decrease in the final demand for industry output (natural gas, fuel oil, water, etc.). These effects persist through the EUL.
Price suppression is the reduction in overall demand for electricity, which decreases the commodity portion of the electricity price. Data for this impact was generated by NYSERDA using ICF's Integrated Planning Model.* The value is $0.036 per kWh of energy-efficiency savings (in 2011 dollars).	Electric Industry Revenue Losses from price suppression are not modeled because decreases in the commodity price only affect the in-state generators, and this effect is negligible, as discussed previously.

* For more information about NYSERDA's methodology, see: State Energy Planning Board, *2009 New York State Energy Plan*, page 25. 2009. Available at: http://www.nysenergyplan.com/2009stateenergyplan.html (accessed on April 26, 2012).

Additional modeling specifications include:

- **Program Area Years** – The period of impacts reporting is 2011 to 2040. Although the Program Areas occurred between 2009 and 2012, for simplicity, direct ARRA Program Area spending was modeled to occur entirely in 2011, while the persistence of energy savings was modeled through the weighted average measure life for each Program Area analyzed.
- **Baseline** – The standard regional control (built into PI^{+}) was used to determine changes in employment resulting from ARRA investments.

- **Energy Savings** – Energy savings were monetized in constant 2011 dollars for electricity, natural gas, and fuel oil. NYSERDA provided price forecasts for electricity (retail[127] and wholesale), natural gas, and fuel oil. EIA data were also used for propane and diesel.
- **Water Savings** – Water cost savings were estimated from applying a flat rate that converts gallons saved to cost savings. A weighted average between Upstate and Downstate water rates were used (NYSERDA provided the estimates: $0.003/gallon Upstate and $0.007/gallon Downstate). Water savings were only available for the Appliance Rebate Program Area.
- **Freeridership/Net-to-Gross** – Evaluated freeridership and projected NTG values were incorporated into the analysis of evaluated scenarios to capture what would have happened had the ARRA-funded Program Areas not been implemented. For the projected scenario, a 0.9 net-to-gross ratio was assumed for all Program Areas.
- **Cap and Trade, Market Transformation** – These effects were not accounted for due to a lack of data to support the impacts.

4.3.5 Data Sources

The macroeconomic impacts and cost-effectiveness analyses both derive from the same base data, which came from summarized evaluated Program Area results and data provided by NYSERDA. These data include:

- Measure life
- Freeridership (This only applies to savings and participant co-funding/spending. This 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 sector
- ARRA implementation, administration and evaluation costs

4.3.6 Program Area Specific Inputs

See Table 4-25 for an outline of the Program Area specific inputs.

[127] The retail electricity rates used are as follow: residential $0.1634/kWh; commercial $0.1756/kWh.

Table 4-25 Summary of Specific Impacts Modeled by Program Area

Program	Direct Spending	Bill Savings	Co-funding	Industry Impact
Appliance Rebate	Appliances and recycling	Accrue to the residential sector	Portion of measure/project costs paid by participants	Reduced revenue for energy, fuel and water industries
Energy Code	Educational services, embership organizations, publishing, and travel accommodations	None	None	None
Energy-Efficiency	Installation and equipment	Accrue to local government 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 sectors	Portion of measure/project costs paid by participants	Reduced revenue for energy and fuel industries
Transportation	Technical services, electronics, and vehicles	Accrue to the government sector	Portion of measure/project costs paid by participants	Reduced revenue for petroleum industry
ECS	Technical services and building retrofits	Accrue to the government sector	Portion of measure/project costs paid by participants	Reduced revenue for energy and fuel industries
Portfolio Level	Implementation, marketing, administration, and evaluation	System-wide benefit from price suppression	None	None

4.3.7 Results

<u>Summary</u>

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 year, and cumulatively from 2011 to 2040, the SEP/SEEARP funded portfolio of Program Areas results in net positive job-years in New York State under all scenarios analyzed, as shown in Table 4-26.

Table 4-26. First and 30 Year Cumulative Employment Impacts in New York State (job–years)

Scenario	First Year Net Jobs		30 Year Cumulative Net Job-Years	
	Wholesale Rates	Retail Rates	Wholesale Rates	Retail Rates
Evaluated impacts	362	433	1,896	2,776
Projected impacts	540	659	3,731	5,552

Table 4-27. First Year Net Jobs/Million in ARRA Funding

Scenario	SEP/SEEARP Funding (Incentives and Administration)	Net Jobs/Million in funding	
		Wholesale Rates	Retail Rates
Evaluated impacts	$89.4 million	4.0	4.8
Projected impacts	$108.8 million	5.0	6.1

The first and 30-year projected Program Area impacts are higher than the evaluated Program Area impacts. This is a result of two effects:

1. Net of freeridership values (which do not include any spillover impacts) in the evaluated scenarios are generally lower than the static 90% NTG value assumed in the projected scenarios, and hence the effect of the ARRA funding is lower in the evaluated scenarios.
2. More projects are completed in the projected scenarios, leading to a greater effect.

The use of retail electric rates also increases the net number of job-years created, as expected, because this substitution increases the magnitude of the positive bill savings stimuli. In addition, the number of net first year jobs created per million dollars of ARRA spending ranges from 4.0 to 6.1, which is slightly higher than NYSERDA's estimate of 3.2 net jobs per million of systems benefits charges (SBC) spending per year. This effect was expected, as SEP/SEEARP funds are not costs to residents of New York in this analysis, while SBC charges are modeled as costs (negative stimuli) to New York ratepayers.

<u>Year-Over-Year Results</u>

Figure 4-1 and Figure 4-2 show the employment impact by year and by stimuli type for each scenario when modeled using wholesale electric rates. 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 added as 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 have been completed. The positive effective of the direct spending outweighs the negative effects of the confounding costs, because ARRA funds represent a net positive influx into the New York economy.

Figure 4-1. Employment Impact of SEP/SEEARP by Stimuli Type (evaluated with wholesale rates)

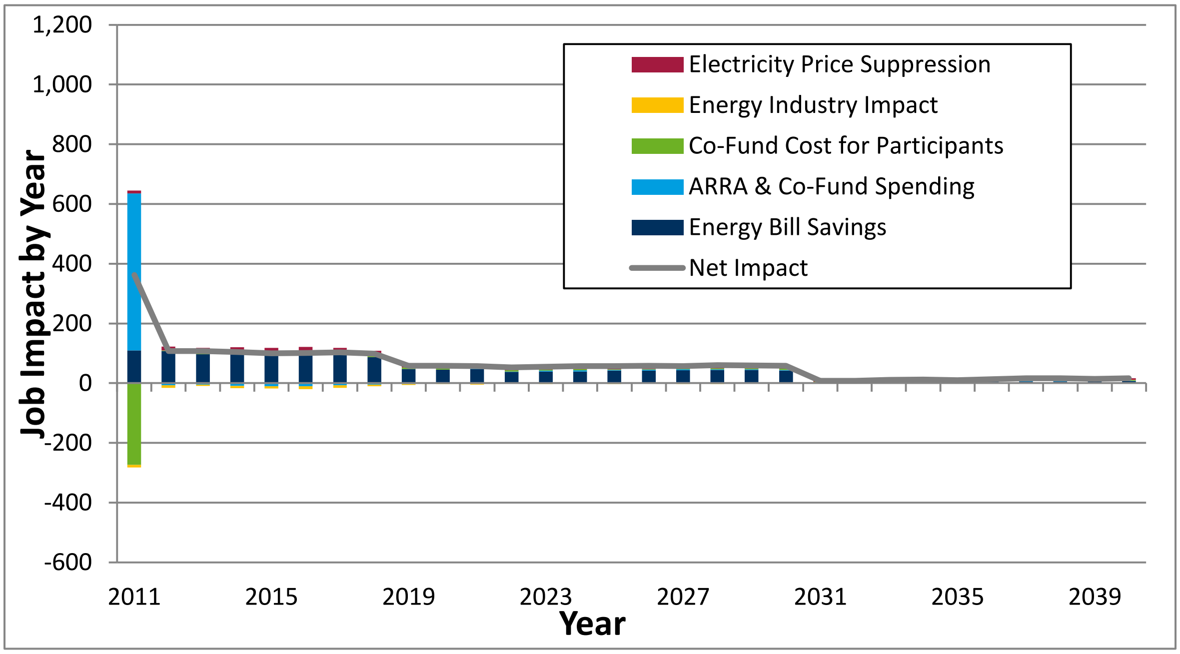


Figure 4-2. Employment Impact of SEP/SEEARP by Stimuli Type (projected with wholesale rates)

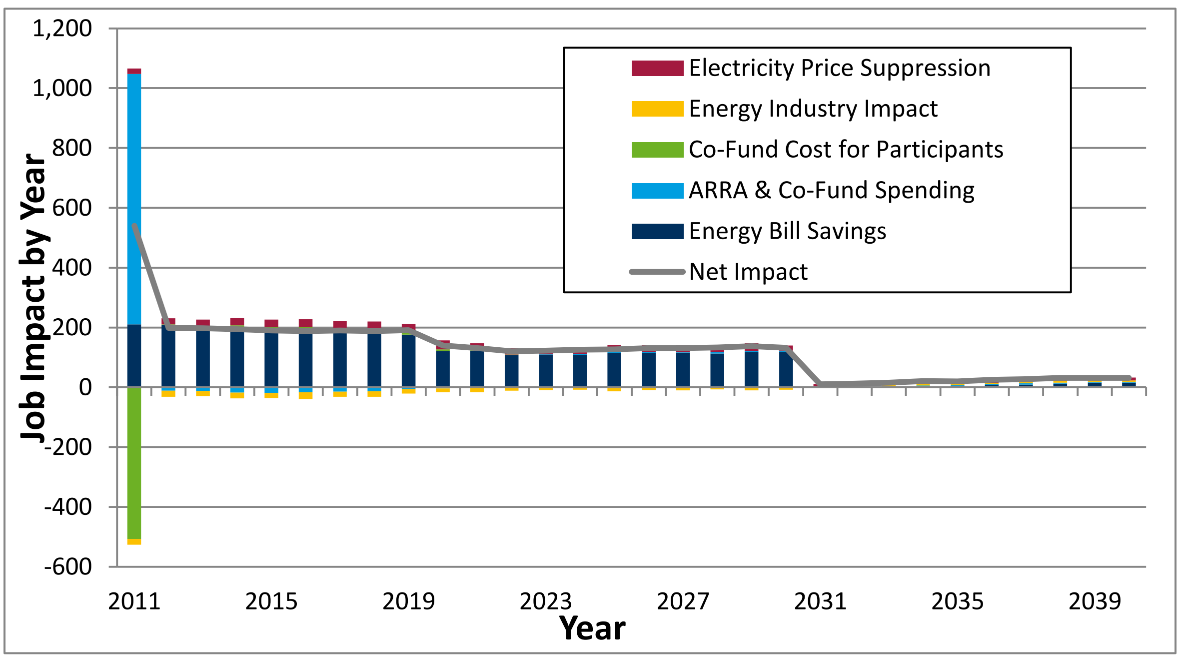


Figure 4-3 and Figure 4-4 show the employment impact by year and by stimuli type for each scenario when modeled with retail electric rates. Bill savings are more pronounced in these results than in the results of analysis using wholesale electric rates; however, there is no mechanism on the negative side to balance the use of retail electric rates in calculating electric bill savings.

Figure 4-3. Employment Impact of SEP/SEEARP by Stimuli Type (evaluated with retail rates)

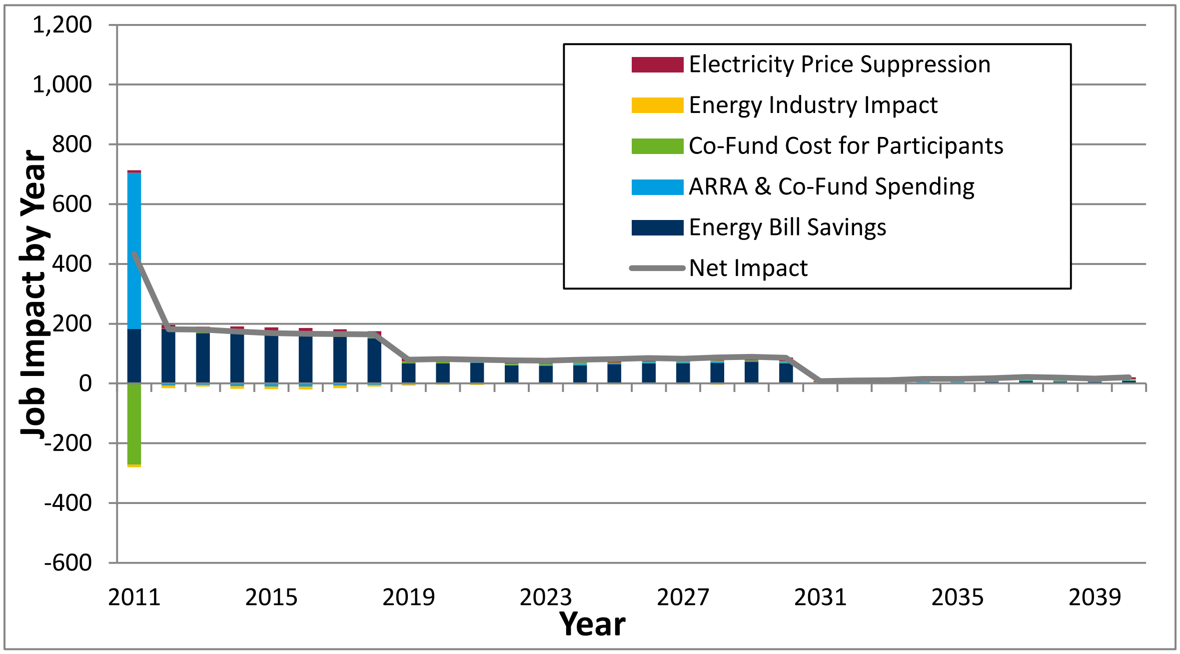
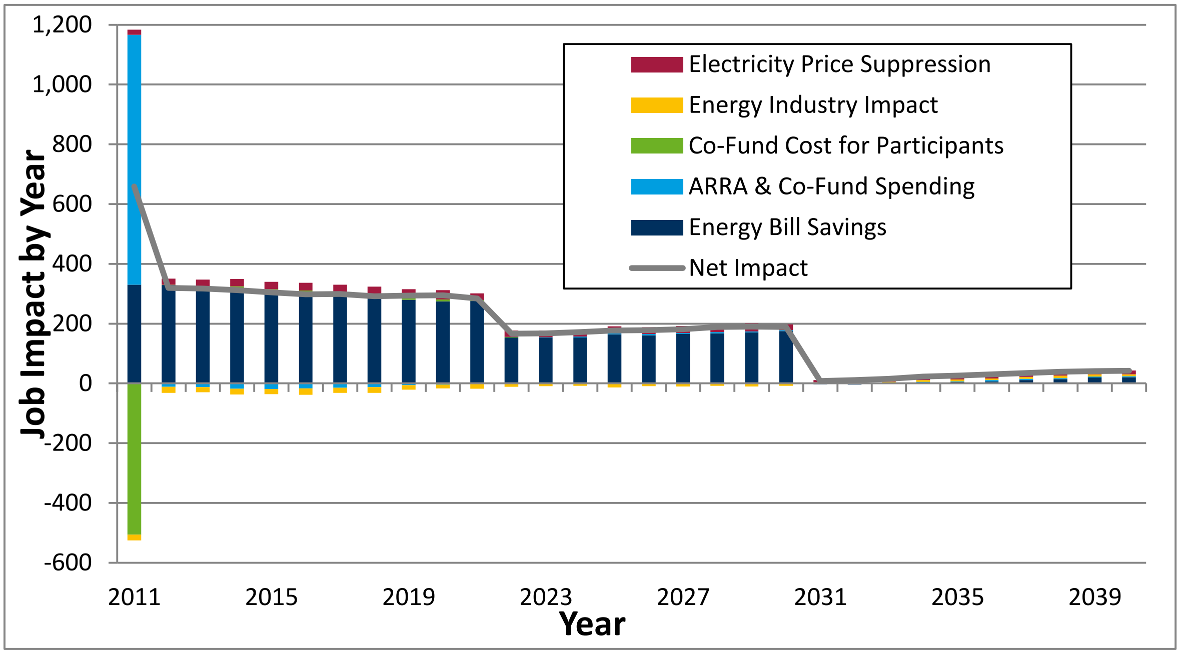


Figure 4-4. Employment Impact of SEP/SEEARP by Stimuli Type (projected with retail rates)



Results by Program Area

Table 4-28 shows first year and 30-year (cumulative) impacts by Program Area for each scenario (evaluated and projected using wholesale electric rates), based on the analysis performed using REMI. The first item of notice in Table 4-28 is that ECS is net negative in the first year. This is attributable to the large negative effective of government sector co-funding, which dominates over the positive effect of direct spending on retrofit equipment and construction. However, over the long term, the ECS Program Area has a net positive contribution to net employment impacts. Next, the effect of the high freeridership found in the evaluation causes Transportation, in the first year, to be positive in the evaluated scenario, but negative the projected scenario. This occurs because the amount of co-funding depends on the NTG value; projects which would have been completed regardless of the ARRA funding do not induce additional participant spending (co-funding), which is a negative stimuli.[128]

Table 4-28. First and 30-Year Employment Impacts by Program Area

Program Area	Evaluated (wholesale)	Projected (wholesale)
First Year Impacts		
Appliance Rebate	138	141
Energy Code	59	59
ECS	-185	-72
Energy-Efficiency	142	182
Renewable Energy	72	101
Transportation	8	-16
Admin and Price Suppression (for all Program Areas)	128	146
Total	**362**	**540**
30-Year Impacts (Cumulative)		
Appliance Rebate	472	622
Energy Code	60	60
ECS	76	865
Energy-Efficiency	700	1,143
Renewable Energy	194	305
Transportation	0	24
Admin and Price Suppression (for all Program Areas)	394	712
Total	**1,896**	3,**731**

[128] Transportation Program Area projects had a 0.83 freeridership value.

Results by Sector

Figure 4-5 shows the decomposition of first and 30-year cumulative job impacts into private sector jobs or government sector jobs for each scenario (wholesale electric rates). All of the net first year jobs were created in the private industry, with the government experiencing a small net loss of jobs. Over time, net jobs in the government sector increase in both projected and evaluated scenarios due to the bill savings accruing to the government sector.

Figure 4-5. First and 30-Year (cumulative) Employment Impact of SEP/SEEARP by Sector (private vs. government)

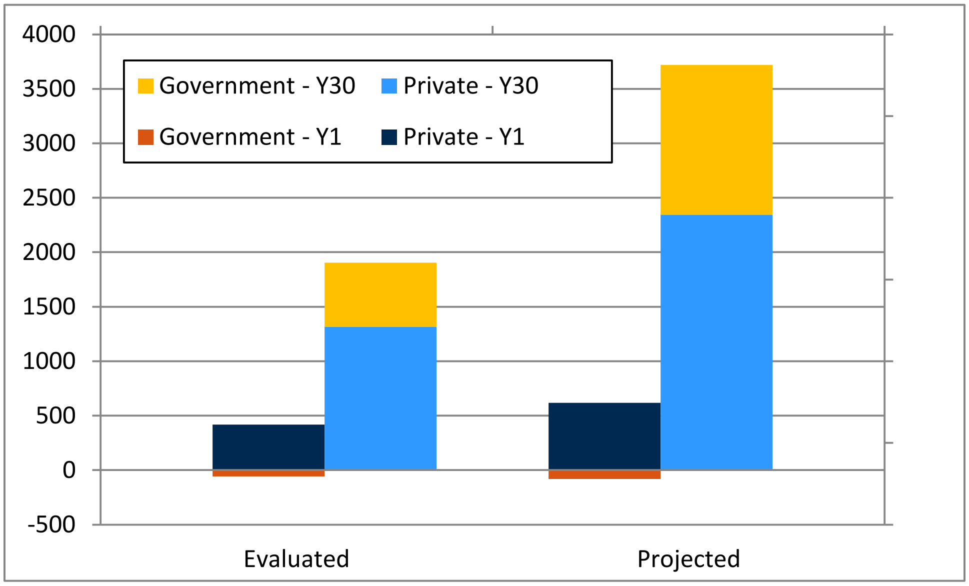
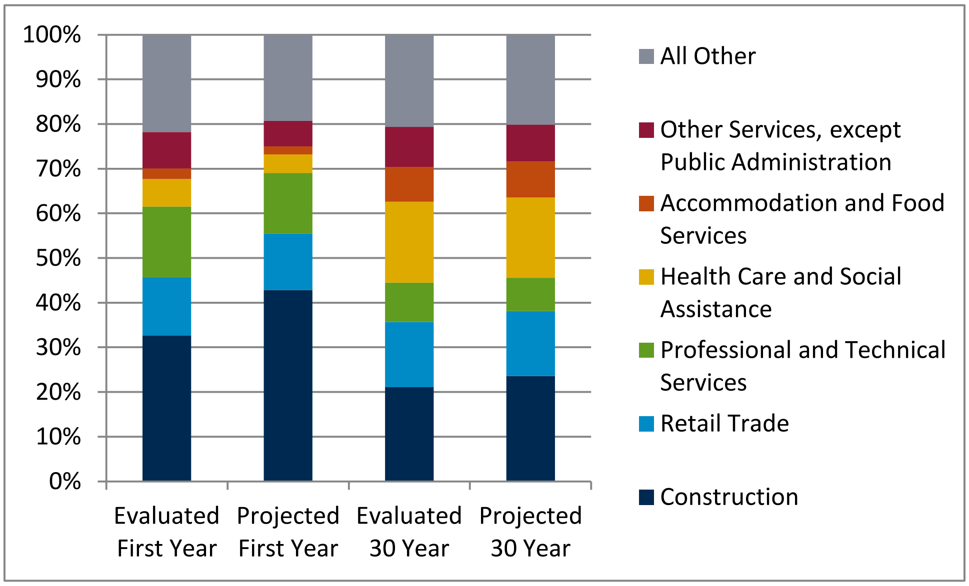


Figure 4-6 shows the distribution of jobs created in the first year and over 30 years for the top six private sector industries, plus all others together, for each scenario (evaluated and projected) using wholesale electric rates. This figure shows that a significant share of first year jobs are created in the construction industry, but over 30 years, the share of jobs added in other industries, such as healthcare and social assistance, increases.

Figure 4-6. Top Industries by Net Jobs Added (first and 30-year cumulative)



4.3.8 Conclusions

Within the parameters of the PI+ model and the Cadmus Team's assumptions, the results indicate that NYSERDA's SEP/SEEARP Program Areas 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. However, without accounting for the full costs associated with the ARRA funds, the net impact of the stimulus on New York and the broader United States cannot be conclusively determined.

Further research should be conducted to quantify the costs of ARRA funds and its net macroeconomic impacts, which will help inform future policy decisions on the best approaches to economic stimulus. This research should include a review NYSERDA's SBC programs as an example of energy-efficiency programs that result in net positive jobs, despite accounting for SBC program costs from ratepayers.

4.4 COST-EFFECTIVENESS ANALYSIS

4.4.1 Approach

In assessing cost-effectiveness, the Cadmus Team analyzed Program Area costs and benefits from four different perspectives, using Cadmus' DSM (Demand Side Management) Portfolio Pro[129] model. Benefit-to-cost ratios conducted for these tests were based on methods described in the California Standard Practice Manual[130] for assessing DSM Program Areas' cost-effectiveness. In addition to the California tests, the DOE Recovery Act Reporting Requirements for the SEP[131] were used to determine the SEP Recovery Act Cost test ratio (SEP-RAC test). All tests in this report are described as follows:

- **SEP-RAC Test:** This test, which is a reporting requirement of the DOE, measures the avoided source Btus 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 or 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, or 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 or 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 4-29. Benefit and Cost Components of Evaluated Tests presents the benefit and cost components of each of the tests that the Cadmus Team calculated.

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[129] 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.

[130] CPUC. *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.* October 2001.

[131] DOE. *Recovery Act Reporting Requirements for the SEP*. SEP Program Notice 10-06. March 1, 2010.

Table 4-29. Benefit and Cost Components of Evaluated Tests

Elements		SEP-RAC	TRC	PA	SCT
Benefits	Avoided Energy	✓	✓	✓	✓
	Avoided Electricity (supply, T&D (Transmission & Distribution))		✓	✓	✓
	Avoided Fossil Fuels (supply, T&D)		✓	✓	✓
	Environmental Benefits				✓
Costs	ARRA Administration and Implementation Costs	✓	✓	✓	✓
	NYSERDA Administration and Implementation Costs		✓	✓	✓
	ARRA Incentives	✓	✓	✓	✓
	Direct Participant Costs		✓		✓

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 will demonstrate the cost-effectiveness of each technology (e.g., efficient appliances), as well as the cost-effectiveness of the suite of activities funded by each separate funding stream (e.g., all projects funded by SEP). The various funding streams in this report and the Program Areas they support are documented in Table 4-30 (EECBG-funded Program Areas will be evaluated in a separate report).

Table 4-30. ARRA Funding Stream Test Scenarios

Program Area	SEP	SEEARP	Portfolio
Appliance Rebate		√	√
Energy Code	√		√
Renewable Energy	√		√
Transportation	√		√
Energy-Efficiency	√		√
Energy Conservation Studies	√		√

The Program Area and funding stream scenarios were then broken out into two more scenarios: evaluated and projected. The evaluated scenario includes costs, incentives, and savings incurred by projects complete by December 31, 2011. The projected scenario includes all projects that are assumed will be complete by the end of the Program Area. Test results of all scenarios are found in the Cost-Effectiveness Analysis, Results section.

The primary test, as require by the DOE, is the SEP-RAC test. It is described as follows:

> The *SEP Recovery Act Financial Assistance Funding Opportunity Announcement of March 12, 2009*, published by the United States DOE, specifies that "*Each state portfolio of projects funded by SEP ARRA grants should seek to achieve annual energy savings of at least 10 million source BTUs for each $1,000 of total investment.*"

These energy savings will occur each year over the EUL of the actions induced by the State's portfolio. The evaluations conducted using SEP Recovery Act funds should calculate and report the results from this test for the projects evaluated. There are no other cost-effectiveness test requirements for SEP

Recovery Act project portfolios. The cost-effectiveness test normally required within state regulatory environments that are focused on least-cost, net present value energy supplies do not apply to the SEP Recovery Act projects. DOE's objective is to achieve deep lasting savings that provide net energy efficiency, renewable energy, GHG displacement, and job impacts well into the long-term future.[132]

Considering line losses and adjusting for the source Btus of electricity with a fossil fuel power factor, the equation for calculating the annual energy benefits for SEP-RAC is:

Equation 4-1. Annual Energy Benefits for SEP-RAC

The fossil fuel power factor is used to convert electricity savings at the plug into fossil fuel energy savings at the source of generation; it is defined in the Cost-Effectiveness Analysis, SEP-RAC Assumptions section. The final ratio as required by the SEP-RAC test is tens of millions of source Btus avoided per thousands of dollars spent. Thus:

Equation 4-2. SEP-RAC Test

A ratio greater than or equal to one (≥1) indicates that the funding passed the test.

In addition to the test required by DOE, other tests were employed for use as reference by NYSERDA. For these, the Cadmus Team used Cadmus' proprietary cost-effectiveness model, DSM Portfolio Pro. DSM Portfolio Pro was populated 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 model inputs and underlying assumptions to ensure that the tests are calculated with the greatest reasonable degree of accuracy.

The test commonly used to determine Program Area and portfolio cost-effectiveness is the TRC test. The TRC test is a ratio of the lifecycle benefits of the portfolio over the life cycle costs. The TRC test determines whether energy efficiency is more cost-effective overall than supplying energy. The TRC test does not provide the necessary information to determine whether the portfolio or Program Area is cost-effective from the perspective of the Program Area administrator, nor does it consider some of the wider implications to society. Therefore, the Cadmus Team calculated additional tests based on the California Standard Practice Manual for the portfolio of Program Areas and for each individual Program Area that NYSERDA implemented through ARRA. Those tests, in addition to the TRC test, are the SCT and the PA Cost Test.

The TRC test begins with a valuation of each Program Area's 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).

[132] DOE. *Recovery Act Reporting Requirements for the SEP*. SEP Program Notice 10-06. March 1, 2010.

A Program Area is cost-effective when:

Equation 4-3. Cost-Effectiveness Calculation

Where:

(where *impact* is the avoided energy and capacity impact adjusted for line losses); and

Similarly, the SCT values for each Program Area's total resource benefits are measured by the energy avoided costs, avoided emissions, and additional savings, such as O&M and water savings. Those benefits are compared 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 the Program Area administrator, and is measured by the energy avoided costs, the incentive costs (i.e., utility measure costs), and administrative costs associated with the Program Area.

Equation 4-4. Program Area Administrator Benefits

Equation 4-5. Program Area Administrator Cost

4.4.2 Data Sources

The data source inputs presented in this section are broken out by these areas of analysis: Program Administration, Program, Measures, and SEP-RAC.

4.4.2.1 Program Administrator Assumptions

The following assumptions are applicable to all Program Areas and all measures.

Avoided Energy Costs are the full value of time and seasonally differentiated generation and transmission and distribution. For each energy-efficiency measure included in a Program Area, annual energy savings are multiplied by the regional avoided energy cost for that year. Avoided costs are provided for electricity and gas by NYSERDA, as filed with the New York PSC (Public Service Commission). Fuel oil and diesel avoided costs are calculated as the delivered cost to the customer based on fuel price forecasts from NYSERDA and the EIA.

Avoided Capacity Costs are avoided costs resulting from a reduction of peak energy demand over an average numbers of peak events during a year. For each energy-efficiency measure included in a Program Area, hourly (8,760) system-avoided costs are adjusted by the hourly load shape of the end-use affected by the measure to capture the full value of time and seasonally differentiated impacts of the measure. Avoided capacity costs are provided for electric capacity by NYSERDA as filed with the New York PSC.

Line Loss is the percentage of energy lost during transmission and distribution. In DSM Portfolio Pro, both energy and capacity line losses are applied to measure-level savings to reflect the total savings from the point of generation. Line loss assumptions are 7.2%, as outlined by the January 16, 2009 PSC Order and provided by NYSERDA.

Load Shapes show the hourly energy use over a year of each end-use included in DSM Portfolio Pro. In most cases, hourly end-use load shapes for New York were used from work that Cadmus completed for the New York State Electric & Gas Corporation and the New York DPS. Renewable energy load shapes from solar and wind power were developed specifically for this evaluation by the Cadmus Team.

Discount Rates are used to determine the net present value of benefits for each Program Area. 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 peak was defined as the sixteenth hour of the second day of the thirty-first week of the year as defined in the New York DPS avoided capacity model (originally July 27, 2009 at 4:00 p.m. and adjusted for the current year).

Externalities are non-energy benefits associated with electricity generation and natural gas use. These benefits were applied on a basis of tons saved per avoided kWh or therm. Cost assumptions were either provided by NYSERDA or based on previous work completed for the State of New York. Table 4-31 lists the source of externalities and their cost use in the model. These benefits apply only to the SCT.

Table 4-31. Externalities as a Result of Generation and Combustion

Source	Cost ($/ton)
Carbon Dioxide*	13.61
Carbon Monoxide	37.50
Nitrous Oxides	13.00
Sulfur Dioxide	37.50
Water	1.20

* The price per short ton was converted from the $15/metric ton price defined by NYSERDA.

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. These were applied to measures where the benefits were identified by the Cadmus Team. The indirect benefits apply only to the SCT, and they changed between evaluated and projected scenarios based on projected measure completion.

4.4.2.2 Program Assumptions

Sectors/Segments identify the customer class the participants from each Program Area belong to. Sectors for SEP and SEEARP Program Areas include residential and commercial. Examples of segments used in

DSM Portfolio Pro include single family, small office, and schools. Sectors and segments dictate which rates and load shapes were used during the analysis.

Program Administrative Costs include any expenses associated with Program Area development, marketing, delivery, operation, and evaluation, monitoring, and verification. These costs are not measure-specific, and are assessed at the Program Area or portfolio level. Only costs that were covered by ARRA funding are considered in the SEP-RAC test. The costs between the evaluated and projected scenarios will change as more costs are incurred after 2011.

Table 4-32. Implementation and Administrative Costs

Cost Category	Level	Description
Implementation	Program Area	Incremental costs associated with performing Program Area implementation tasks, including customer service, application processing, and customer outreach.
Incentives	Program Area	Rebates and incentives paid through the various ARRA funding streams.
Administration	Program Area /Portfolio	Costs to administer Program Areas including fully-loaded incremental personnel costs and activities associated with market research outside of EM&V.
Evaluation	Portfolio	Activities associated with the determination and evaluation of ARRA-funded Program Areas. These activities include benefit-cost ratio analysis, impact and process analysis, customer research, and all other analyses necessary for Program Area evaluation.
Marketing	Portfolio	Cost to increase awareness of Program Areas.

4.4.2.3 Measure Assumptions

Measure Life is used during the calculation of the total lifetime benefits for each measure. The life of each measure is based first on information from the New York TRM, where available, then the NYSERDA Deemed Savings Database, Program Area supported 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 kWh and therm savings associated with the installation and implementation of each measure. The savings used in DSM Portfolio Pro are the *ex post* gross savings. Fuel oil and diesel savings were input as monetized savings at their respective delivered costs. These values change between the evaluated and projected scenarios based on projected measure completion.

Incremental Costs are the expenses associated with the measures that are above the cost of the assumed baseline for that measure. These costs include the entire cost of purchasing and installing the measure and do not net out incentive payments to the customer. The incremental costs were based on information from NYSERDA, the Program Area implementer, Program Area supported documentation, and secondary research.

Incentive Level is the dollar amount of the rebate paid to the customer through ARRA funding streams. The incentive amount for each measure was provided by NYSERDA. This increases from the evaluated to projected scenario.

Freeridership is the percent of participants who would have taken the same action/installed the same measure in the absence of the Program Area. These were based on the evaluation work performed for each Program Area. The evaluated scenario's NTG was based on evaluated freeridership. The projected scenario combines freeridership and spillover into one projected NTG value.

Spillover is the percent of participants who installed additional energy savings measures without incentives due to their participation in the Program Area. The evaluated scenario's NTG was based on 0% spillover. The projected scenario combined freeridership and spillover into one projected NTG value.

Participation is the number of customers who participated in the Program Area or the quantity of measures verified by the Cadmus Team. In all cases except for the Appliance Rebate Program Area, due to the complexity and ambiguity of the Program Area design, participation was rolled-up at the Program Area level and reported as one value.

4.4.2.4 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. This number was provided by NYSERDA and equals 9,949.2 source Btus per kWh generated. Measure savings for other energy types (such as natural gas and diesel) are already being saved at the source and are 100% fossil fuel based, thus no adjustment for line loss or fossil fuel source were made.

4.4.3 Results

Portfolio Results

Table 4-33 presents Program Area cost-effectiveness analysis results, including evaluated NTG for all Program Area measures for the lifetime of the measures in the evaluated scenario. All tests passed.

Some notes to keep in mind when looking at all results tables include:

- A ratio ≥1 is considered beneficial, or passing
- All costs are reported in dollars rounded to the nearest thousand; in line with SEP-RAC test requirements
- SEP-RAC benefits are reported in MMBtu rounded to the nearest ten; in line with SEP-RAC test requirements
- SEP-RAC ratios are reported in the DOE requirement of 10 MMBtu/$1,000
- TRC test, PA Cost test, and SCT benefits are reported in dollars
- TRC test, PA Cost test, and SCT ratios are in the California requirements of benefit $/cost $

Table 4-33. Evaluated Portfolio Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Funding Stream	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	SEP	$ 70,720,000	681,200 MMBtu	1.0
	SEEARP	$ 18,642,000	750,930 MMBtu	4.0
	Portfolio	$ 89,362,000	1,432,130 MMBtu	1.6
TRC	SEP	$ 79,514,000	$ 125,397,000	1.6
	SEEARP	$ 14,807,000	$ 68,398,000	4.6
	Portfolio	$ 94,321,000	$ 193,795,000	2.1
PAC	SEP	$ 70,720,000	$ 125,397,000	1.8
	SEEARP	$ 18,642,000	$ 68,398,000	3.7
	Portfolio	$ 89,362,000	$ 193,795,000	2.2
SCT	SEP	$ 79,514,000	$ 127,075,000	1.6
	SEEARP	$ 14,807,000	$ 99,434,000	6.7
	Portfolio	$ 94,321,000	$ 226,509,000	2.4

Table 4-34 shows the same type of results for the evaluated scenario in which unfinished projects are assumed to be completed soon and all funding is spent. All tests passed.

Table 4-34. Projected Portfolio Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Funding Stream	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	SEP	$90,152,000	1,490,000 MMBtu	1.7
	SEEARP	$18,651,000	1,032,000 MMBtu	5.5
	Portfolio	$108,803,000	2,522,000 MMBtu	2.3
TRC	SEP	$ 135,037,000	$ 276,305,000	2.0
	SEEARP	$ 24,221,000	$ 102,588,000	4.2
	Portfolio	$ 159,258,000	$ 378,893,000	2.4
PAC	SEP	$ 90,152,000	$ 276,305,000	3.1
	SEEARP	$ 18,651,000	$ 102,588,000	5.5
	Portfolio	$ 108,803,000	$ 378,893,000	3.5
SCT	SEP	$ 135,037,000	$ 283,222,000	2.1
	SEEARP	$ 24,221,000	$ 135,216,000	5.6
	Portfolio	$ 159,258,000	$ 418,438,000	2.6

Note: The values presented here do not necessarily match values found in other sections of the report due to rounding. For appliances, savings are reported as levelized annual savings over the lifetime of the measures, not first year savings as reported in other sections.

In accordance with the DOE requirements, inputs used to calculate the SEP-RAC test are provided for re-creation of the results. Table 4-35 shows the end-use savings for each Program Area for one year of the evaluated scenario.

shows the projected scenario energy savings.

Table 4-35. Evaluated Annual Downstream Net Savings by Program Area

Program Area	Electric (MWh)	Natural Gas (MMBtu)	Fuel Oil (MMBtu)	Propane (MMBtu)	Wood (MMBtu)	Gasoline (MMBtu)	Diesel (MMBtu)
Appliance Rebate	73,597	22,770	-4,070	0	0	0	0
Energy Code	0	0	0	0	0	0	0
Energy-Efficiency	29,182	190,410	17,670	0	1,290	0	0
Renewable Energy	5,329	1,370	11,490	510	0	0	0
Transportation	0	0	0	0	0	30	400
Energy Conservation Studies	7,181	53,650	21,190	0	1,550	0	0
Total	**115,289**	**268,200**	**46,280**	**510**	**2,830**	**30**	**400**

Note: The values presented here do not necessarily match values found in other sections of the report due to rounding. For appliances, savings are reported as levelized annual savings over the lifetime of the measures, not first year savings as reported in other sections.

Table 4-36. Projected Annual Downstream Net Savings by Program Area

Program Area	Electric (MWh)	Natural Gas (MMBtu)	Fuel Oil (MMBtu)	Propane (MMBtu)	Wood (MMBtu)	Gasoline (MMBtu)	Diesel (MMBtu)
Appliance Rebate	101,606	32,480	-11,050	0	0	0	0
Energy Code	0	0	0	0	0	0	0
Energy-Efficiency	44,130	291,790	54,200	0	1,590	0	0
Renewable Energy	7,836	1,780	10,770	480	0	0	0
Transportation	0	0	0	0	0	520	5,780
Energy Conservation Studies	35,006	261,520	107,700	0	3,160	0	0
Total	**188,578**	**587,570**	**161,620**	**480**	**4,750**	**520**	**5,780**

Note: The values presented here do not necessarily match values found in other sections of the report due to rounding errors. For appliances, savings are reported as levelized annual savings over the lifetime of the measures, not first year savings as reported in other sections.

Table 4-38 breaks out 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 were used by NYSERDA and its implementers to manage the Program Area funding and supporting activities. Table 4-37 shows evaluated scenario inputs, while

Table 4-38 shows projected scenario inputs.

Table 4-37. Evaluated ARRA Expenditures by Program Area for SEP-RAC Test

Program Area	Incentives Paid	Administrative Cost	Total Cost
Appliance Rebate	$ 16,531,000	$ 2,111,000	$ 18,642,000
Energy Code	$ 3,993,000	$ 748,000	$ 4,742,000
Energy-Efficiency	$ 26,655,000	$ 6,380,000	$ 33,035,000
Renewable Energy	$ 20,907,000	$ 4,529,000	$ 25,437,000
Transportation	$ 1,867,000	$ 435,000	$ 2,302,000
Energy Conservation Studies	$ 4,980,000	$ 225,000	$ 5,205,000
Total	**$ 74,933,000**	**$ 14,429,000**	**$ 89,362,000**

Table 4-38. Projected ARRA Expenditures by Program Area for SEP-RAC Test

Program Area	Incentives Paid	Administrative Cost	Total Cost
Appliance Rebate	$ 16,531,000	$ 2,120,000	$ 18,651,000
Energy Code	$ 3,993,000	$ 823,000	$ 4,816,000
Energy-Efficiency	$ 37,499,000	$ 7,167,000	$ 44,667,000
Renewable Energy	$ 27,561,000	$ 5,407,000	$ 32,968,000
Transportation	$ 1,909,000	$ 512,000	$ 2,421,000
Energy Conservation Studies	$ 4,980,000	$ 300,000	$ 5,279,000
Total	**$ 92,474,000**	**$ 16,329,000**	**$ 108,803,000**

Appliance Rebate Program Area Results

Table 4-39 presents Appliance Rebate Program Area cost-effectiveness analysis results, including costs and net benefits for the evaluated scenario.

Table 4-40 shows the same for the projected scenario. All tests for all scenarios are greater than 1, thus passing the cost-effectiveness tests. The projected scenario has slightly higher costs due to post 2011 administration costs; and also has higher savings due to the higher NTG value for the scenario.

Table 4-39. Evaluated Appliance Rebate Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	$18,642,000	750,930 MMBtu	4.0
TRC	$14,807,000	$ 68,398,000	4.6
PAC	$18,642,000	$ 68,398,000	3.7
SCT	$24,221,000	$ 99,434,000	6.7

Table 4-40. Projected Appliance Rebate Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	$18,651,000	1,032,000 MMBtu	5.5
TRC	$ 24,221,000	$ 102,588,000	4.2
PAC	$ 18,651,000	$ 102,588,000	5.5
SCT	$ 24,221,000	$ 135,216,000	5.6

Energy Code Program Area Results

The Energy Code Program Area cost-effectiveness results are not shown here, because no benefits were calculated for this Program Area. Costs, however, are shown in Table 4-41 and are included in all portfolio-level results. The evaluated scenario assumes 100% NTG, while the projected scenario assumes 90% NTG.

Table 4-41. Evaluated and Projected Energy Code Program Area Costs

Cost-Effectiveness Test	Evaluated Costs	Projected Costs
SEP-RAC	$ 4,742,000	$ 4,816,000
TRC	$ 4,742,000	$ 4,417,000
PAC	$ 4,742,000	$ 4,816,000
SCT	$ 4,742,000	$ 4,417,000

Energy-Efficiency Program Area Results

Table 4-42 presents evaluated Energy-Efficiency Program Area cost-effectiveness analysis results, including the evaluated NTG for the entire Program Area. Table 4-43 shows the results for the projected scenario. Costs and benefits both increase for the projected scenario as more projects are completed. All tests passed.

Table 4-42. Evaluated Energy-Efficiency Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	$ 33,035,000	484,640 MMBtu	1.5
TRC	$ 34,547,000	$ 80,956,000	2.3
PAC	$ 33,035,000	$ 80,956,000	2.5
SCT	$ 34,547,000	$ 85,187,000	2.5

Table 4-43. Projected Energy-Efficiency Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	$ 44,667,000	748,150 MMBtu	1.7
TRC	$ 52,583,000	$ 126,876,000	2.4
PAC	$ 44,667,000	$ 126,876,000	2.8
SCT	$ 52,583,000	$ 133,267,000	2.5

Renewable Energy Program Area Results

Table 4-44 presents Renewable Energy Program Area cost-effectiveness analysis results, including the SEP-RAC breakout by funding stream. The residential and commercial sector projects of PON 1686 tended to be more cost-effective than the municipal, university, school, and hospital sector projects of RFP 1613. However, neither of the funding streams passed all the cost-effectiveness tests. Despite the environmental benefits, the SCT test results actually came in lower than the TRC test due to the large O&M expenses associated with owning power producing equipment. Removing these O&M costs did not cause the Program Area to pass the test.

Table 4-44. Evaluated Renewable Energy Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Funding Stream	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	PON 1686	$ 4,228,000	17,080 MMBtu	0.4
SEP-RAC	RFP 1613	$ 21,209,000	49,303 MMBtu	0.2
SEP-RAC	All SEP	$ 25,437,000	66,383 MMBtu	0.3
TRC	All SEP	$ 31,057,000	$ 18,202,072	0.6
PAC	All SEP	$ 25,437,000	$ 18,202,072	0.7
SCT	All SEP	$ 31,057,000	$ 14,484,057	0.5

Table 4-45. Projected Renewable Energy Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Funding Stream	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	PON 1686	$ 5,368,000	36,840 MMBtu	0.7
SEP-RAC	RFP 1613	$ 27,600,000	54,160 MMBtu	0.2
SEP-RAC	All	$ 32,968,000	91,000 MMBtu	0.3
TRC	All	$ 41,555,000	$ 24,343,000	0.6
PAC	All	$ 32,968,000	$ 24,343,000	0.7
SCT	All	$ 41,555,000	$ 19,162,000	0.5

Transportation Program Area Results

Table 4-46 presents Transportation Program Area cost-effectiveness analysis results, including evaluated NTG for all Program Area measures. Overall, the Transportation Program Area performed the worst in terms of cost-effectiveness. This was partly due to the expense of the projects without much savings potential, and partly due to the high freeridership. The projected scenario shown in Table 4-47 take out the low freeridership by using a NTG value of 90%, but the Program Area still does not pass the cost-effectiveness tests.

Table 4-46. Evaluated Transportation Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	$ 2,302,000	422 MMBtu	<0.1
TRC	$ 1,598,000	$ 84,715	0.1
PAC	$ 2,302,000	$ 84,715	<0.1
SCT	$ 1,598,000	$ 89,457	0.1

Table 4-47. Projected Transportation Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	$ 2,421,000	6,290 MMBtu	0.3
TRC	$ 4,748,000	$ 1,247,000	0.3
PAC	$ 2,421,000	$ 1,247,000	0.5
SCT	$ 4,748,000	$ 1,317,000	0.3

<u>Energy Conservation Studies Program Area Results</u>

Table 4-48 presents ECS Program Area cost-effectiveness analysis results, including evaluated NTG for all Program Area measures. Table 4-49 shows the projected scenario costs and benefits for the Program Area. The ECS Program Area benefits from the adoption of energy-saving measures that are not directly incentivized by the Program Administrator. The cost to the participant for installing these measures is based on the cost of similar measures studied in the Energy-Efficiency Program Area. In the projected scenario, benefits continue to accumulate as the measure adoption rate increases, without incurring much additional spending by the program administrator.

Table 4-48. Evaluated Energy Conservation Studies Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	$ 5,205,000	129,750 MMBtu	2.5
TRC	$ 7,571,000	$ 26,155,000	3.5
PAC	$ 5,205,000	$ 26,155,000	5.0
SCT	$ 7,571,000	$ 27,314,000	3.6

Table 4-49. Projected Energy Conservation Studies Program Area Cost-Effectiveness Results

Cost-Effectiveness Test	Costs	Benefits	Benefit/Cost Ratio
SEP-RAC	$ 5,279,000	644,200 MMBtu	12.2
TRC	$ 31,734,000	$ 123,839,000	3.9
PAC	$ 5,279,000	$ 123,839,000	23.5
SCT	$ 31,734,000	$ 129,476,000	4.1

Section 5:

CONCLUSIONS AND RECOMMENDATIONS

5.1 APPLIANCE REBATE PROGRAM AREA CONCLUSIONS AND RECOMMENDATIONS

As evidenced by the sales analysis and the participant survey, the Appliance Rebate Program Area was successful in increasing appliance sales above the general trend. A significant share of participants (19% to 30%) within each appliance type stated that they were not planning to purchase a new appliance before hearing of the Appliance Rebate Program Area. The fact that over half of the participants were knowledgeable enough to report whether the appliance met CEE standards or only ENERGY STAR standards is a significant indication of the market transformation success of NYSERDA programs in New York.

Energy savings greatly exceeded the planning goals for the Program Area, primarily due to a high percentage of early replacements. Customers were generally very satisfied with the Program Area. While NYSERDA and its implementation contractor, the Program Area Implementer, experienced some challenges with the Website, the postal service, and managing the waitlist to ensure more applications were not approved than budgeted, these issues did not significantly affect customers.

The Cadmus Team provides the following recommendations for future similar programs:

- **Higher incentives paired with even high efficiency requirements:** The Program Area incurred significant freeridership, as evidenced by the participant survey; however results are similar to those seen by other appliance rebate programs. One possible remedy to reduce the percentage of freeriders and shorten the Program Area period would have been to offer higher incentives, but in doing so, the balance between decreased freeridership and increased incentive costs would have to be optimized. Freeridership generally decreases when incentives (as a percentage of purchase price) increase. Since in some cases the incremental cost for ENERGY STAR-qualified appliances is not much greater than baseline, requiring even higher efficiency appliances along with higher incentives may be preferred.
- **Better unit recycling data on existing units:** The Cadmus Team also recommends requiring and recording in the Program Area database information on existing unit size and configuration, in addition to age, when paying incentives for recycling. This would allow for a more precise evaluation of savings.
- **Online applications:** One of the challenges faced by NYSERDA was the high rate of incomplete applications (30%).[133] Designing the application to be completed online by the retailer during the customer purchase (similar to how credit card applications are often taken in a retail store) could prevent this rate of incomplete applications from occurring in future programs.

[133] As reported by stakeholders during the stakeholder interviews.

5.2 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 2017. In addition, New York accelerated energy code adoption in response to ARRA, and early code adoption is expected to result in significant energy savings to support New York State's 15 x15 goal as part of the EEPS. The intent is to reduce the statewide energy use 15% below forecast levels by 2015. The Cadmus Team will quantify these energy savings in a forthcoming study in May 2012, funded outside of the ARRA SEP grant.

The Cadmus Team provides the following recommendations for future similar programs:

- **Improved compliance methods:** The ARRA-funded baseline compliance study conducted by VEIC indicated that there may be substantial opportunities to improve current compliance methods in order to achieve the 90% compliance goal by 2017. VEIC determined that compliance currently falls short of this level. However, the evaluated sample was only 25% of the amount recommended by DOE protocol, and is based on incomplete and nonrandom data due to difficulties in obtaining data.
- **Comprehensive compliance study:** NYSERDA should consider a comprehensive study to measure initial compliance with ECCCNYS 2010. The BECP protocol should be applied, with appropriate modifications based on lessons from the VEIC study, DOE pilot studies, and other research. The study also should include analysis using tools to provide estimates of the energy impacts of the code. NYSERDA is planning to perform this additional study.
- **Continued review of VEIC compliance study recommendations:** NYSERDA should continue to review and consider the feasibility of recommendations from the VEIC compliance study. Several of those recommendations may involve significant cooperation with and coordination from DOS and the New York State legislature, and could contribute to improving compliance to the 90% goal required by ARRA.
- **Continued training:** DOS typically provides code training opportunities for CEOs. ARRA funding allowed DOS and NYSERDA to expand these training opportunities for CEOs, as well as for a variety of professionals involved in code compliance, such as architects, engineers, and builders. On average, participants indicated being highly satisfied with the training, demonstrated a statistically significant increase in code understanding, and considered the increase in their professional knowledge to be one of the most important benefits of training. The participants also considered code enforcement and compliance to be important. These factors suggest the Energy Code Program Area trainings could play an important role in achieving the 90% compliance goal by 2017.

  NYSERDA and DOS should continue providing comprehensive code training on a regular basis, especially for code compliance individuals in the architectural, engineering, and building trades. Survey results indicated that respondents primarily participated in training to increase their professional knowledge, which should represent one of the more cost-effective methods necessary to achieve 90% compliance.
- **Effectively timed survey efforts:** Future survey efforts should be conducted with training participants immediately before and after trainings to obtain better feedback based on the participants' immediate reactions to their experiences.

5.3 ENERGY-EFFICIENCY PROGRAM AREA CONCLUSIONS AND RECOMMENDATIONS

Overall, the Energy-Efficiency Program Area achieved a total gross savings realization rate of 102%. However, because of a freeridership rate of 27%, total program net savings were evaluated as achieving a 75% realization rate. From a technical aspect, the program can be viewed as a success, more gross savings than expected were installed through the program. As for free ridership the program achieved a typical free ridership rate for these types of project. Thus with better than expected gross savings and an average free ridership rate, the program can be summarized as having better than average impacts.

The Cadmus Team provides the following conclusions:

- **Benchmarking freeridership:** The Cadmus Team benchmarked NYSERDA's Energy Efficiency Program freeridership results with results from similar programs. In these other studies[134, 135] freeridership averaged between 13% and 30%. Questar Gas's business energy efficiency program had a freeridership rate of 26%.[136] NYSERDA's previous C&I energy efficiency program, TA Flex Tech, had freeridership rates of between 9% and 36%.[137]
- **Different electric and fuel realization rates:** The realization rates for electric and fuel project varied quite significantly. While our analysis showed a 107% savings rate for fuel projects, electric projects realized only 94% of claimed savings.
- **Lighting:** The majority of electric savings came in the form of lighting projects. These projects seemed to be able to be deployed more quickly than other types of programs.

The Cadmus Team provides the following recommendations for future similar programs:

- **Better data transparency and availability of data:** The Cadmus Team balanced a fine line between 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.

Quantification of all energy savings: In several projects, the Cadmus Team observed that participants claimed only natural gas/heating oil savings, but not the associated electric savings. Participants may have been focused on the natural gas/heating oil savings and simply overlooked the electric savings. In some cases, the relative magnitude of electric savings was quite small when compared to natural gas/heating oil savings, so participants may have specifically chose not to report them. The Cadmus Team recommends that future participants include all electric and natural gas/heating oil savings regardless of their magnitude in order to more thoroughly understand the Program Area impacts.

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[134] Cadmus Evaluation of DEER 2011 Non-Res EE NTG

[135] The Cadmus Group, Inc. "Avista 2010 Multi-Sector Gas Impact Evaluation Report."

[136] Questar Gas. Utah Energy Efficiency Results 2010.

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

5.4 RENEWABLE ENERGY PROGRAM AREA CONCLUSIONS AND RECOMMENDATIONS

5.4.1 Gross Generation Conclusions

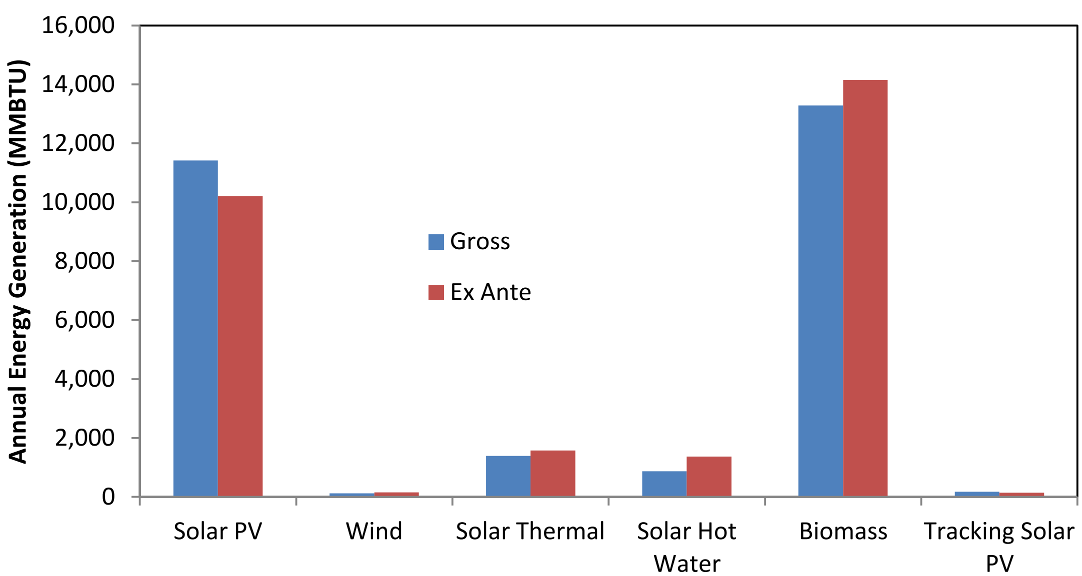
RFP 1613 provided funding for a variety of renewable energy technologies, which are shown in Table 5-1. When deriving gross generation estimates, realization rates for some technologies were equal to or greater than 1.00 (100%), such as solar PV, indicating that relatively mature performance modeling techniques were used for these technologies. The lower realization rates for other technologies, such as SHW, were primarily driven by pre-installation assumptions that did not, ultimately, match reality.

Table 5-1. Gross Energy Generation by Technology (RFP 1613)

	Annual Savings-Gross Evaluated Total						
	Project Quantity	**Realization Rate**	**Electric (MMBTU)**	**Gas (MMBTU)**	**Oil (MMBTU)**	**Other (MMBTU)**	**Total (MMBTU)**
PV Upstate	48	116%	8,847	N/A	N/A	N/A	8,847
PV Downstate	16	110%	3,275	N/A	N/A	N/A	3,275
Wind Upstate	1	72%	88	N/A	N/A	N/A	88
Wind Downstate	1	111%	33	N/A	N/A	N/A	33
Solar Thermal Upstate	2	96%	9	982	N/A	N/A	972
Solar Thermal Downstate*	1	70%	278	61	N/A	N/A	339
SHW Upstate	2	70%	110	158	N/A	N/A	268
SHW Downstate	2	70%	N/A	225	460	N/A	686
Biomass Upstate	3	76%	N/A	N/A	11,507	531	12,038
Biomass Downstate	0	76%	N/A	N/A	N/A	N/A	N/A
Tracking Solar PV Upstate	1	115%	172	N/A	N/A	N/A	172
Tracking Solar PV Downstate	0	115%	N/A	N/A	N/A	N/A	N/A
Total	**77**	**90%**	**12,793**	**1,426**	**11,968**	**531**	**26,717**

* Due to reporting deadlines and project schedules, the Cadmus Team was unable to complete either monitoring or a site visit at the single funded Downstate solar thermal system. The system in question utilizes evacuated tube SHW collectors, primarily for space heating, with DHW heating as a backup. Based on the technology used, the Cadmus Team assigned a realization rate based on an average of SHW realization rates. The other solar thermal technologies, installed in the Upstate region, were not deemed to be comparable to the single Downstate solar thermal system.

Figure 5-1. Gross and *Ex Ante* Generation Estimates for Projects Funded by RFP 1613



In total, the renewable energy projects funded, and installed by 12/31/2011, under RFP 1613 are expected to generate approximately 26,717 MMBTU annually, primarily reducing the consumption of electricity and fuel oil.

Gross generation for PON 1686 was generally found to exceed ex ante estimates. Based on streamlined ex ante reported project information tracked by NYSERDA, solar PV systems installed under PON 1686 are generating 113% of claimed electrical output. The total expected annual energy generation for all projects installed through 12/31/2011 with funding from PON 1686 is 2,825 MWh (9,646 MMBTU).

Freeridership was low for RFP 1613 (4%) and for residential participants of PON 1686 (7%), yet freeridership was higher for commercial participants of PON 1686 (51%). However, although used in this analysis to discount gross energy generation, the freeridership rates for commercial participants of PON 1686 should be interpreted cautiously—especially with regard to future program planning decisions due to the very small sample size (n=3) and because installers contradicted the responses from participants.

The net Program Area generation using the calculated NTG ratio of 0.96 for RFP 1613 is 26,649 MMBtu/year.

5.4.2 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, there are lessons from both RFP 1613 and PON 1686 that should be considered in future program iterations.

<u>The Cadmus Team provides the following recommendations for future similar programs:</u>

<u>Technology-Related Recommendations</u>

- **Continue to fund commercial biomass heating projects in order to alleviate high upfront cost of biomass fuel-switching projects and increase the availability and quality of fuel:** Biomass fuel-switching projects were technically viable, reliable, and capable of offering significant cost and environmental benefits compared with fuel oil, propane, and natural gas-fired equipment. Challenges to the widespread adoption of this technology that could be addressed by future NYSERDA programs include:

    - High upfront cost compared with fossil-fuel fired heating equipment
    - Availability and quality of fuel

    For example, NYSERDA could consider programs to train existing HVAC professionals on biomass boiler technologies, in conjunction with more direct funding support to offset a portion of the system costs. A companion program to improve system owners' access to high quality fuel suppliers could help to foster competition and reduce the price of wood pellet fuel.

- **Further research on diffuse radiation and peak demand-related benefits of Solar PV:** Solar PV is a mature technology that NYSERDA, and others, have been supporting for many years. As part of this evaluation, the Cadmus Team found that solar PV systems appear to be generating more energy than expected. While this is good news, it may suggest that the usual approaches taken by NYSERDA contractors towards shading measurements and performance prediction are more conservative than necessary.

    Though solar PV systems funded under these programs appear to be exceeding performance expectations, Cadmus recommends that NYSERDA consider further examination of the impact of diffuse radiation on shading measurements. Furthermore, as solar PV receives significant support from NYSERDA, Cadmus recommends that NYSERDA consider further research on the peak demand-related benefits of the technology, particularly in grid-congested areas.

- **Funding 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 115%), 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.

- **Continued performance data collection for small wind turbines:** Like solar PV, NYSERDA has been supporting the installation of small wind turbines for several years. Although two wind projects (consisting of three turbines) were funded under RFP 1613, the Cadmus Team was not able to collect performance data for purposes of this evaluation. Because of the limited data available on small wind system performance characteristics, the Cadmus Team recommends that NYSERDA continue to collect data on real-world system performance before making any Program Area changes. At a minimum, this should include collecting semi-annual electricity generation data from installed systems and comparing these data with pre-installation predictions. Other programs have found this a useful source of information for refining pre-installation site evaluation practices.

Program Structure-Related Recommendations

- **Consider and weigh the trade-off between the goals of cost-effectiveness and visibility and awareness:** Even with the existing incentive programs, which cover 20%-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 1613 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 1613 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 structure. It is also worth noting that 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.

- **Blanket contracts and fast-track review processes for high performing installers:** For a high volume of installations, there would likely be an administrative benefit to a program structure modeled after PON 1686. However, this structure does not facilitate technical design review and administrative oversight by NYSERDA, so it would be best to reserve this structure for highly repeatable installations. Furthermore, there are dozens of installers eligible for funding under PON 2112, as opposed to the six installer contracts in PON 1686. Given that PON 1686 is managed by NYSERDA, using blanket contracts, it would likely be difficult to accommodate the large number of installers currently working through PON 2112 with a structure like that of PON 1686. One possibility for incorporating the lower overhead of PON 1686 into existing NYSERDA programs would be to set up blanket contracts and a fast-track review process for eligible installers who demonstrate consistent quality and high installation volume.

Evaluation Related Recommendations

Based on our experience evaluating RFP 1613 and PON 1686, we suggest that NYSERDA consider the following items for future program evaluations:

- **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 New York City, this would be worth further examination in future evaluations.
- **Focus evaluation efforts on systems with more operational history:** Though conducting the evaluation largely in parallel with program implementation provided a more real-time view to the evaluation team, it would be beneficial to be able to evaluate projects with longer operating periods, especially given that many renewable energy technologies operate on a seasonal basis.

5.5 TRANSPORTATION PROGRAM AREA CONCLUSIONS AND RECOMMENDATIONS

This Program Area was successful in reducing harmful emissions, reducing GHG emissions, and reducing fuel usage. The NYSERDA ARRA-funded transportation projects included the installation of a CNG refueling station, replacement of several diesel fuel vehicles with hybrid electrics, the addition of automated vehicle locators, and the installation of an EV charging station. The process survey revealed that respondents applied for NYSERDA ARRA funding out of a desire to embrace green technology, whereas the Program Area also influenced respondents to implement additional energy-savings actions. The Program Area impact was limited, however, by the small number of projects actually carried out. While NYSERDA staff had originally laid out ambitious goals—to reduce 350,000 gallons of petroleum annually, purchase 130 alternative fuel vehicles, convert 40 conventional vehicles to run on alternative fuel, and install four alternative refueling stations—in the end, only nine Clean Fleets projects were approved, and of those, only five were completed.

- **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 funding for green transportation projects fell so far short of expectations; and 2) why four projects dropped out after being approved.
- **Increased funding:** The five project respondents exhibited moderate freeridership, as evidenced by their responses to the respondent survey. Individual freeridership values ranged from 0 to 95%, averaging 32%. When asked what barriers might have prevented them from completing the project without the NYSERDA ARRA funds (Table 3-176), four out of five respondents reported a lack of funding as the greatest barrier. Based on this response, targeting the RFP 1613 Clean Fleets Program with increased funding may lead to increased adoption of these transportation efficiency measures. It should be noted that freeridership rates for Transportation Program Area participants of RFP 1613 should be interpreted cautiously due to the very small sample size (n=5). Though these freeridership results were used in this study to adjust the ultimate claimed savings, caution should be exercised when considering them in future program planning or projections.
- **Improved data collection:** The Cadmus Team faced challenges collecting the necessary data from project staff, especially the baseline fuel usage, even though the original applications required estimates of fuel that would be saved as a result of the project, which presumably would necessitate a baseline in order to be calculated. NYSERDA may want to make it even easier for project applicants to report their expected fuel savings by including a simple table asking for fuel usage before, and expected fuel usage after project implementation, for each vehicle impacted.

- **Increased lead time in project implementation:** Due to delays in project implementation, this evaluation relied upon estimates of future fuel usage rather than actual data, as the five projects are at the very beginning stages of implementation and therefore do not have sufficient (or in some cases, any) actual data to collect. Ideally, a future evaluation would assume a longer lead time in project implementation so there would be more actual data to review.

5.6 ENERGY CONSERVATION STUDIES PROGRAM AREA CONCLUSIONS AND RECOMMENDATIONS

The ECS program funded energy efficiency and renewable energy studies to identify cost-effective measures for study recipients to install. The evaluation found that measures are being implemented, but it is taking time to do so. It will be about four more years before all recommended measures that are going to be installed are installed. Currently about 16% of the savings is being realized through adoption of recommended measures. The team expects that 39% of the savings ultimately will be realized after future projects are installed. Of that total, about 55 % would have been implemented absent the program, and about 33% non-free ridership savings already is being claimed by other programs that provide funding towards implementation. The balance of savings is directly attributable to this program. The evaluation indicates that NYSERDA should account for this savings. NYSERDA may be able to increase the adoption rate through proactive involvement.

<u>The Cadmus Team provides the following recommendations for future similar programs:</u>

- **Market NYSERDA EEPS programs to ARRA study recipients.** The overlap analysis show that 63% of savings are associated with installed projects that did not receive installation incentive funding. The ECS Program Area was less of a feeder program to other NYSERDA installation incentive programs than was expected at the time of Program Area design. This evaluation has demonstrated that the Program Area is the source of direct installed savings not being claimed by other Program Areas, and, like the other ARRA programs, it is contributing directly to NYSERDA's 15x15 goals. At the same time, the projected long-term installation rate is about half of that found for NYSERDA's FlexTech Program.

  The combination of low rates of NYSERDA funding for installations and relatively low implementation rates leads to the conclusion that ARRA study recipients are a ripe pool of end users for NYSERDA to target for implementing incentive programs, such as the Existing Facilities Program. The Cadmus Team determined that the ECS audit reports fell short in linking the recommendations to NYSERDA programs. Few respondents strongly integrated the Existing Facilities Program into the financial analysis, for example. Many respondents did not seem to have a strong relationship with NYSERDA.

  The Cadmus Team recommends that NYSERDA assemble a team of Program Area outreach staff to build on the goodwill that the study funding started, then use the technical research already completed to identify eligible study recipients, cultivate relationships with them, and increase the adoption rates in NYSERDA's other programs beyond what this evaluation identified as likely to occur.

<u>Additionally, Cadmus recommends the following for future program efforts</u>

- **Allow more time between study completion and survey efforts to allow recipients more time to adopt recommendations:** The survey activities for this evaluation occurred within 24 months of the ECS Program completion with the majority of interviews completed less than one year after the ECS study completion allowing very little time for project implementation. A material percentage of survey respondents noted that implementation was forthcoming, but this is not reflected in the current MAR as implementation had not occurred at the time of the survey.

- **Treat the program as a direct savings resource and track data to estimate impact and assess cost effectiveness:** NYSERDA did not report any direct electricity or fossil fuel savings for the ECS program. Claimed savings is 0. Treat the program as a direct savings resource and focus efforts on incenting this crop of potential projects.

- **Focus on outreach to increase measure adoption rate:** The ECS studies have laid the groundwork for numerous future projects. Many projects are in the early planning or budgeting stages, and there has been little use to date of NYSERDA implementation programs for ECS generated projects. A concerted outreach effort should be made to those that completed ECS studies in order to shepherd them into existing NYSERDA programs and increase the overall Measure Adoption Rate. In many ways the ECS program has created a slew of projects with vetted energy savings, ready for implementation. Surveys suggest that many of these projects are looking for capital internally or externally and are therefore good candidates for incentive programs.

5.7 DISPLACED CARBON EMISSIONS CONCLUSIONS

Table 5-2. Summary of Displaced Emissions (Metric Tons of CO2e)

Program Area	Evaluated Lifetime Displaced Emissions	Projected Lifetime Displaced Emissions
Appliance Rebate	225,000	348,000
Renewable Energy*	81,200	110,000
Energy-Efficiency	425,000	650,000
Transportation	995	6,480
Energy Conservation Studies	136,000	632,000
Total	**868,000**	**1,750,000**

* Residential and commercial combined displaced emissions for the Renewable Energy Program Area

5.8 ECONOMIC IMPACTS CONCLUSIONS AND RECOMMENDATIONS

Within the limitations of the PI$^+$ model and the Cadmus Team's assumptions, the results indicate that NYSERDA's SEP/SEEARP Program Areas 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 translates into more job-years added to the regional economy. However, without accounting for the full costs associated with the ARRA funds, the net impact of the stimulus on New York and the broader United States cannot be conclusively determined.

Further research should be conducted to quantify the costs of ARRA funds and its net macroeconomic impacts, which will help inform future policy decisions on the best approaches to economic stimulus. This research should include a review NYSERDA's SBC programs as an example of energy-efficiency programs that result in net positive jobs, despite accounting for SBC program costs from ratepayers.

5.9 COST-EFFECTIVENESS ANALYSIS CONCLUSIONS

The SEP portfolio (with and without SEEARP) passed the DOE-required SEP-RAC benefit-cost ratio test[138], as well as the TRC test, PAC Cost Test, and the SCT. This was true for the projects completed by December 31, 2011 (the evaluated scenario) and for all projects expected to be completed (the projected scenario). See the Cost-Effectiveness Analysis, Approach section for full explanations of each test.

The Appliance Rebate, Energy-Efficiency, and ECS Program Areas performed the best and passed all benefit-cost tests. Transportation and Renewable Energy Program Areas performed the worst, failing all benefit-cost tests. The Energy Code Program Area was not ranked due to having no energy savings or other quantifiable benefits attributed to it.

[138] DOE. *Recovery Act Reporting Requirements for the SEP*. SEP Program Notice 10-06. March 1, 2010.