Agriculture Disaster Program Impact Evaluation (2011–2013)

Final Report

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Prepared for:

The New York State
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Tracey A. DeSimone
Project Manager

Prepared by:

ERS
120 Water Street, Suite 350
North Andover, MA 01845
Phone: 978-521-2550

Principal Investigators:
ERS
Itron, Inc.
West Hill Energy and Computing, Inc.

NOTICE

ABSTRACT

This report describes the impact evaluation of the Agriculture Disaster Energy Efficiency Program (the ADEEP or, the Program). NYSERDA established the Program in 2012 to help agricultural producers whose equipment was damaged or lost due to Hurricane Irene (August 2011) and Tropical Storm Lee (September 2011). The Program electric realization rate and net-to-gross rate are 0.54 and 0.73, respectively; the natural gas realization rate and net-to-gross rate are 1.21 and 1.00, respectively. The rates were determined through on-site measurement and verification and interviews with farm operators.

The Program's greatest accomplishment may have been returning farms to production in the aftermath of two major storms. About one-third of the owners reported that they might have gone out of business without the Program. Those farms reporting the largest benefits tended to be the smallest operators (in terms of number of employees), and they may have had few other resources to help them weather the loss. The Program was effective in identifying farms in distress and in delivering aid quickly.

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SECTION 1: EXECUTIVE SUMMARY

This report describes the impact evaluation of the Agriculture Disaster Energy Efficiency Program (the ADEEP or, the Program). NYSERDA established the Program in 2012 to help farm producers whose equipment was damaged or lost due to Hurricane Irene (August 2011) and Tropical Storm Lee (September 2011) with energy efficient equipment. The Program's rapid rollout was in part accomplished by utilizing the measures, vendors, and relationships of the existing Agricultural Energy Efficiency Program. The goal of the Program was to bring farm operations back online as quickly as possible and to acquire this unique opportunity to generate long-term savings for the farmers by incentivizing the installation of energy efficient equipment.

During the period of October 2011 through April 2012, applications were accepted from 63 farms in 20 counties and included greenhouses, nurseries, orchards, and horse, vegetable, dairy, and poultry farms. In total, $3,932,892 was encumbered to replace damaged production equipment with high efficiency systems, with a projected annual savings of 1,077,061 kWh and 4,843 MMBtu of natural gas. Approximately 88% of the Program committed electric measures and all of the natural gas measures were installed by the end of 2013; this is the population that was evaluated.

The primary objective of this impact evaluation was to determine the net savings that resulted from the Program. Another important objective was to examine the effectiveness of the Program in aiding farms that had been impacted by the hurricane and tropical storm. Table 1-1 summarizes the net savings for measures installed through 2013.

Table 1-1. Agricultural Disaster Energy Efficiency Program Impact Evaluation Results for Measures Installed from Program Inception through 2013

Metric	Electric Energy[1] (kWh)	Natural Gas[1] (MMBtu)
A - Reported savings	944,669	4,843
B - Realization rate	0.54	1.21
C - Evaluated gross savings (A x B)	510,121	5,860
D - Net-to-gross ratio	0.73	1.00
E - Evaluated net savings (C x D)	372,389	5,860
Net savings precision at 90% confidence	±35%	No sampling error

[1] Peak demand savings and fossil fuel savings were estimated to be 18 kW and 790 MMBtu, respectvely.

The Program's greatest accomplishment may have been returning farms to production in the aftermath of two major storms. About one-third of the owners reported that they might have gone out of business without the Program. Those farms reporting the largest benefits tended to be the smallest operators (in terms of number of employees), and they may have had few other resources to help them weather the loss. The Program was effective in identifying farms in distress and in delivering aid quickly.

1.1 APPROACH

The evaluation determined the realization rate (RR) and net-to-gross ratio (NTGR) for electric and natural gas energy through on-site metering and verification activities at a statistically selected sample of 21 sites.

The on-site evaluation activities consisted of interviews with the farm staff (usually the owner), verification of the installed equipment and operation, and metering of select equipment for periods of two to eight weeks. The site-collected data, in conjunction with project files, engineering analysis, billing data, and secondary research, was used to establish energy savings.

The owner interviews were used to establish what the farm would have installed without the Program. The interviews were also used to collect feedback from the owner on how the Program helped the farms to resume business after the two big storms.

The methods utilized in this evaluation comport with the current New York Department of Public Service (DPS) Energy Efficiency Portfolio Standard (EEPS) evaluation guidelines.[1]

1.2 RESULTS

The Program was created in response to two back-to-back natural disasters in 2011 that had profoundly affected the farming community in New York State. While NYSERDA's existing Agricultural Energy Efficiency Program specifically targets farms and provides substantial incentives of up to 75% of the installed cost of approved measures, it was fully subscribed at the time of the events and was closed to further participation. The ADEEP was established to provide crisis funding for this sector along with a rapid deployment plan to offer immediate relief to distressed farms. NYSERDA designed and implemented the ADEEP using the existing networks established by the Agricultural Energy Efficiency Program.

During the on-site interviews, the evaluators asked the owner about the role the Program played in returning the farm to production. The interviewers heard repeatedly how important this assistance was to the farms' resumption of normal operation. To quote the feedback given by one particular farm owner: "It was a major role; otherwise, we would have gone out of business." The

[1] Evaluation Plan Guidance for EEPS Program Administrators, November, 2012, http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/766a83dce56eca35852576da006d79a7/$FILE/NY_Eval_Guidance_Aug_2013.pdf

assistance seemed to be particularly important to the smaller operators (as measured by number of employees). Approximately 94 employees kept their jobs because of the Program's support. The findings are presented in Table 1-2.

Table 1-2. ADEEP Role in Returning Farms to Production

Status	Farms That May Have Gone out of Business without the Program	Farms That Went Back into Production Earlier Due to the Program	Farms for Which the Program Did Not Impact the Return to Production[1]
Sites			
Number of sites (of 21 sampled sites)	7	5	8
Employees			
Average number of employees per sample site	6	10	23
Aggregate number of employees at farms participating in the Program	94	167	170

[1] Excludes a very large participant with 750 employees. This location reported that production was not impacted by the Program.

The Program succeeded in a primary goal: helping farms recover. The Program also played an important role in helping the participating farms to upgrade damaged equipment and to increase production capacity. Most of the farm owners indicated that without the Program, they would not have installed the same type of energy efficient equipment. Their options without the incentives would have been to repair the damaged equipment or to install the lowest-cost alternative available.

Six of the owners, or about a third surveyed, reported that the new technology was not only energy efficient but positioned the farms to increase production capacity should they choose to do so in the future. As an example, one owner noted that the improved ventilation technology increased an onion barn's ability to store and cure onions by 30% – 40%.

1.2.1 Realization Rates

The RR measures the difference between the program-reported savings and the evaluated savings and is calculated as follows:

$$\text{Realization rate} = \text{Evaluated savings}/\text{Reported savings}$$

Table 1-3 shows the aggregate RRs for the Program determined from on-site M&V activities at the sampled farms. The Program population consisted of the 58 farms that had completed one or more measures by the end of 2013. Because the Program does not track electric demand, an RR could not be calculated for this component.

Table 1-3. ADEEP Realization Rate Result Summary

Program Component	Sites[1]	Sample	RR
Electric energy	57	20	0.54
Natural gas energy	4	3	1.21

[1] Three of the participants installed measures that impacted both electric energy and natural gas consumption.

Table 1-4 summarizes the factors that led to changes in the RRs. The single largest source of differences between the program-reported and evaluated gross electric energy savings was the approach used to report impacts for fuel-switching projects. Five evaluated measures assumed electricity was consumed by the preinstalled equipment; however the equipment was actually fueled by gasoline or diesel so there were fossil fuel savings, but not electric savings. The high RR of the natural gas measures was driven by the use of a non-site-specific deemed savings, which underestimated the savings significantly for one of the natural gas measures.

Table 1-4. Sources of Differences in Realization Rates

Difference Category	Number of Observations	Net Impact Difference (kWh/MMBtu)	Program Realization Rate % Change
Electric Savings			
Fuel switching	5	(255,061)	-27%
Hours of operation	19	(37,787)	-4%
Deemed savings	8	(66,127)	-7%
Baseline	4	(28,340)	-3%
Quantity/capacity	11	(37,787)	-4%
As-built efficiency	6	(9,447)	-1%
Total	**53**	**(434,548)**	**-46%**
Natural Gas Savings			
Use of deemed savings value	1	2,422	50%
Load profile	1	(48)	-1%
Hours of operation	1	(1,356)	-28%
Total	**3**	**1,017**	**21%**

N/A = Not applicable

1.2.2 Program Attribution

The NTGR indicates the savings proportion of savings induced by the program, above and beyond the level of efficiency investment and/or changes to control practices that would have occurred in the absence of the Program. The evaluators determined free ridership (FR) and inside spillover (ISO) from owner interviews conducted at the sampled farms. The evaluators concluded that neither outside spillover (OSO) nor nonparticipant spillover (NPSO) was likely to be generated by this short-lived and targeted program, so these factors were not researched and are zero for the calculation of NTGR.

The formula for NTGR is:

$$NTGR = 1 - FR + ISO + OSO + NPSO$$ [2]

The results are summarized in Table 1-5.

Table 1-5. ADEEP Attribution Summary

Program Component	Program Sites[1]	Sample	FR (%)	ISO (%)	NTGR
Electric energy	57	20	27%	0%	0.73
Natural gas	4	3	0%	0%	1.00

1 Three of the participants installed measures that impacted both electric energy and natural gas consumption.

Although only four sites reported FR, one of them accounted for a large percentage of total program savings, leading to a moderately high FR rate. The FR along with a lack of SO for this program yielded a NTGR of 0.73 and 1.00 for electricity and natural gas savings, respectively. The relative precision of the net electric energy impacts is ±35% at the 90% confidence level. This result falls short of the ±20% relative precision target for this evaluation due to higher-than-predicted variability of the results and lower than predicted RR.

1.3 CONCLUSIONS AND RECOMMENDATIONS

The Program's greatest accomplishment may have been returning farms to production in the aftermath of two major storms. About one-third of the owners reported that they might have gone out of business without the Program. Those farms reporting the largest benefits tended to be the smallest operators (in terms of number of employees), and they may have had few other resources to help them weather the loss. The Program was effective in identifying farms in distress and in delivering aid quickly.

The new energy efficient technologies also positioned about one-third of the farms for increased production should the farms choose to do so in the future. As an example, the replacement of conventional ceiling-mounted paddle fans with high-volume, low-speed fans increased ventilation rates permitting onion barns to cure more onions in the same volume of space.

There are no recommendations for improving the Program, since the Program was designed to exist for a short period of time and is no longer open. However, since the ADEEP was derived

[2] Free ridership (FR) refers to Program participants who would have implemented the Program measure or practice in the absence of the Program. Additional energy efficiency actions that Program participants take inside the dwelling or facility served by the Program are referred to as inside spillover (ISO), while actions participants take or influence at other facilities not directly served by the Program are considered outside spillover (OSO). A nonparticipant who adopted a particular efficiency measure or practice as a result of a utility program is called a free driver and their savings are referred to as nonparticipant spillover (NPSO).

from the currently active Agricultural Energy Efficiency Program, the evaluators suggest that program staff review the screening criteria for irrigation pumps to ensure they properly account for the savings from any fuel switching.

The evaluators determined that the ADEEP implementation resulted in 372 MWh net electric energy savings and 5,860 MMBtu net natural gas savings as of December 31, 2013. The Program had a relatively low RR of 0.54 for the electric measures, primarily due to a non-standard approach to estimating savings for fuel-switching measures. The natural gas RR was 1.21. The evaluators also determined that the Program had a moderately high FR rate of 27% for electric measures and was not affected by SO. The Program commensurately reduced greenhouse gas emissions by an estimated 500 tons of CO_2 annually.

The precision of the electric savings was ± 35% at the 90% confidence, where the intention had been to achieve ±20% precision. However, the variation in site level RR was higher than had been projected, in large part due to the variation induced by fuel switching measures.

Since the mix of remaining committed measures is similar to the evaluated mix, the evaluators recommend calculating evaluated savings for any additional installed measures by multiplying the reported savings by the RR and NTGR factors presented in Table 1-1.

SECTION 2: INTRODUCTION

The New York Public Service Commission established the Energy Efficiency Portfolio Standard (EEPS) to fund energy efficiency assistance in New York. Customers of Central Hudson Gas and Electric Corporation, Consolidated Edison Company of New York, Inc., New York State Electric and Gas Corporation, Niagara Mohawk Power Corporation d/b/a National Grid, Orange and Rockland Utilities, Rochester Gas and Electric Corporation, Corning Natural Gas Corporation, KeySpan Gas East Corporation d/b/a National Grid, Brooklyn Union Gas Company d/b/a National Grid NY, and National Fuel Gas Distribution Corporation fund EEPS through payment of the System Benefits Charge (SBC) on utility bills.

This section presents the impact evaluation scope and methods.

2.1 PROGRAM DESCRIPTION

Hurricane Irene and Tropical Storm Lee did tremendous damage to New York State's farms. Initial federal and state sources of financial aid primarily focused on crop loss and soil conservation. If farms were to survive, many needed to replace equipment and systems damaged or lost due to these disasters.

The ADEEP was developed in 2011 by NYSERDA to assist farms in replacing systems and equipment damaged or lost due to the storm events. The Program worked with agriculture sector stakeholders, such as New York State Department of Agriculture and Markets, New York Farm Bureau, United States Department of Agriculture, Cornell Cooperative Extension, Federal Emergency Management Agency, and equipment dealers, to identify farms in need. The efficiency standards employed were similar to those currently used by the Agriculture Energy Efficiency Program.

The applications included many types of measures such as motor replacements, pump replacements, refrigeration upgrades, space heating and cooling upgrades, control replacements, and process system upgrades. In total, $3,932,892 was encumbered to assist the damaged farms of New York State.

2.1.1 Summary of Program Reported Savings

As of December 31, 2013, there were 58 sites with one or more completed measures. Table 2-1 presents the reported savings by farm type for the completed measures. The one site with a propane energy savings measure was not installed by the end of 2013.

Table 2-1. ADEEP Reported Savings for Installed Measures by Farm Type through December 2013

Farm Category	Number of Farms by Category	Reported Electric Savings (kWh)	Reported Natural Gas Savings (MMBtu)
Vegetable	18	340,106	0
Dairy	16	271,537	60
Greenhouse	11	182,428	4,670
Other	5	83,804	0
Poultry	3	18,659	0
Orchard	5	48,134	113
Program total	**58**	**944,668**	**4,843**

Table 2-2 tabulates the reported savings for installed measures by measure category.

Table 2-2. ADEEP Reported Savings for Installed Measures by Measure Type through December 2013

Measure Category	Number of Measures in Each Category	Electric Savings (kWh)	% of Program Electric Savings	Natural Gas Savings (MMBtu)	% of Program Natural Gas Savings
Ventilation	11	244,814	26%	N/A	N/A
Lighting	17	197,991	21%	N/A	N/A
Motors and VSDs	33	133,873	14%	N/A	N/A
Water supply	14	133,411	14%	N/A	N/A
Water heating	9	92,448	10%	N/A	N/A
Product refrigeration	21	55,743	6%	N/A	N/A
Controls	3	50,959	5%	973	20%
Dairy refrigeration	6	22,044	2%	N/A	N/A
Process system	6	5,711	1%	N/A	N/A
Building systems	1	2,525	0%	N/A	N/A
Photovoltaic	1	2,064	0%	N/A	N/A
Space heating	5	1,532	0%	3,870	80%
Appliances	1	914	0%	N/A	N/A
Space cooling	2	640	0%	N/A	N/A
Total	**130**	**944,668**	**N/A**	**4,843**	**N/A**

N/A = Not applicable

The ventilation measure category consists of fan installations in onion curing spaces, greenhouses, and barns and represents 26% of the program installed reported electric energy savings. Together, ventilation and lighting account for about half of the reported electric energy savings. The space heating measure category consists of heating equipment installations in greenhouses and represents about 80% of the program installed natural gas savings.

2.2 EVALUATION OBJECTIVES

The objectives of this impact evaluation included the following three tasks:

1. Establish evaluated gross impacts for electricity and natural gas based on a statistically valid sample of sites with on-site M&V.
2. Establish net impacts using self-reported surveys.
3. Assess the Program's impact in preserving New York farms.

The evaluation also explored the Program's role in disaster relief and captured lessons learned from field observations. Since the Program was designed to address a natural emergency and to exist for only a short period of time, OSO and NPSO were expected to be insignificant and were not researched.

This report complies with the requirements listed in New York Evaluation Plan Guidance for EEPS Program Administrators[3], which was issued by the DPS and is intended to provide robust, timely, and transparent results. The impact methods are in line with the guidelines of the National Action Plan for Energy Efficiency (NAPEE) Model Energy Efficiency Program Impact Evaluation Guide[4].

2.3 PREVIOUS EVALUATION RESULTS

A process evaluation was completed in September 2012 by Research Into Action.[5]

[3] http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/766a83dce56eca35852576da006d79a7/$FILE/NY_Eval_Guidance_Aug_2013.pdf

[4] http://www.epa.gov/cleanenergy/documents/suca/evaluation_guide.pdf

[5] https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/Program-Evaluation/2012ContractorReports/2012-ADP-Agriculture-Program.pdf

SECTION 3: METHODOLOGY

This section describes the techniques used to estimate the Program's savings and includes an overall approach, the sample designs, the RR methods, the NTG approach, the calculation of total program savings, and reporting. Intermediate outcomes, such as the sample disposition, are also provided.

3.1 OVERALL APPROACH

The Impact Evaluation Team conducted a retrospective evaluation of a sample of ADEEP farms with measures installed through December 31, 2013 using on-site measurement and verification (M&V) for a sample of 21 farms that impacted the electric energy consumption and three farms that impacted the natural gas consumption. The evaluators used stratified ratio estimation (SRE)[6] for the sample design.

This impact evaluation consisted of the following two major components:

1. Established first year evaluated gross savings for electricity (kWh) and natural gas (MMBtu) through on-site verification, on-site logging, billing analysis, and custom engineering assessments.
2. Establish net energy impacts accounting for FR and ISO derived from customer surveys.

3.1.1 Sampling Plan

The evaluators designed the sample with the goal of obtaining 20% relative precision at the 90% confidence interval (90/20) for net electric savings, which is a means of characterizing the reliability of the results. There is no significant sampling error associated with the estimates of natural gas savings, because all the natural gas measures in the sample frame were evaluated. The propane savings site was not installed by the end of 2013 and was not evaluated.

Although DPS evaluations guidelines call for targeting net energy savings with 10% relative precision at the 90% confidence interval, the relatively small program savings and an expected high variability in savings estimates warranted a relaxation of the standard for the electric savings, yielding a smaller evaluation sample size commensurate with the program spending.

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[6] An efficient sampling design technique which combines stratified sample design with a ratio estimator. It's most advantageous when the population has a large coefficient of variation. The ratio estimator uses supporting information for each unit of the population when this information is highly correlated with the desired estimate to be derived from the evaluation, such as the tracking savings and the evaluated savings.

The initial sample frame for on-site sampling included all program participants with one or more measures completed as of December 31, 2013. Sites with very small savings accounting for about 2% of total savings were then excluded. Table 3-1 summarizes the derivation of the sample frame.

Table 3-1. ADEEP Sample Frame

Category	Electric Sites	Electric Energy Savings	Natural Gas Sites	Natural Gas Savings
At least one measure installed by December 2013	57	944,669 kWh	4	4,843 MMBtu
Very small projects, excluded	16	17,341 kWh	1	113 MMBtu
Sample frame	41	927,328 kWh	3	4,730 MMBtu

The sample was designed to meet the confidence and precision target for each fuel type. Independent samples were drawn for electric and natural gas impacts. Because three of the sites had electric and natural gas impacts, they were included in both the electric and natural gas sampling frames. Table 3-2 presents the planning parameters.

Table 3-2. ADEEP Sample Planning Parameters

Sample Component	Sample Approach	Comments
Sample frame	Sites with one or more completed measure from January 1, 2012 through December 2013	Electric: The evaluators excluded very small projects with impacts totaling 2% of the program total completed measure savings. Natural gas: The evaluators included three projects that represent 98% of the program natural gas savings.
Estimated variables	Evaluated net impacts (kWh for electric energy and MMBtu for natural gas)	N/A
Method	Stratified ratio estimation (SRE)	SRE generally works well for RR because there is usually a strong correlation between program-reported and evaluated impacts.
Assumed error ratio	1.0	Based on experience with other newly deployed custom measure programs.
Primary sampling unit	Site (location)	Each site is one farm.
High-level stratification variables	Electric and natural gas	Because most of the farms were located upstate, the evaluators did not sample based on location.
Lower-level stratification variables	Size savings	The evaluators defined four size strata. Cutoffs were established using the method described in the CA Frameworks.
Definition of size	Site electric energy kWh and natural gas MMBtu savings	Includes all installed measures at a site
Expected precision of the on-site sample	N/A	20% with confidence at the 90% interval

N/A = Not applicable

3.1.2 Sample Disposition

The planned and final sample disposition for projects with electric energy impacts is presented in Table 3-3. Note that Stratum 5 consists of the small-saver sites that were excluded from the on-site sample.

Table 3-3. ADEEP Summary of On-Site Sample Components for Electric Energy Savings Measures

Stratum	# of Sites	Mean Savings (kWh/MMbtu)	Planned Sample Size	Number of Replacements	Final Number of Acquired Sites
Electric Sites					
1 (census strata)	5	61,776	5	0	5
2	7	34,836	5	0	5
3	11	18,728	5	1	5
4	18	9,366	5	2	5
5 (excluded)	16	1,084	N/A	N/A	N/A
Total	**57**	**N/A**	**20**	**3**	
Natural Gas Sites					
1	**3**	**4,730**	**3**	**0**	**3**
2 (excluded)	**1**	**113**	**N/A**	**N/A**	**N/A**
Total	**4**	**N/A**	**3**	**0**	**3**

N/A = Not applicable

A census attempt was made of the three sites in the natural gas sample frame. All three sites were successfully recruited.

3.2 REALIZATION RATE

The evaluation estimated the program RRs for electric and natural gas energy using an engineering approach for each of the completed measures at each site in the sample frame. The general form of the RR equation is[7]:

$$RR = \text{Evaluated gross savings/Reported savings}$$

where,

Evaluation gross savings = Evaluated M&V savings (by evaluation M&V contractor)

Reported savings = kWh savings reported by the Program

[7] The program level realization rate requires the application of strata case weights to expand the site results to program level RR as follows, where *i* is each site in the sample.

$$Program\ energy\ RR = \frac{\sum_{Sample} Evaluated\ gross\ savings_i \times Case\ weights_i}{\sum_{Sample} Reported\ gross\ savings_i \times Case\ weights_i}$$

The electric demand savings were not included in program tracking; therefore an electric demand savings RR could not be estimated. Program electric demand savings were estimated as the sum of the product of the site evaluated demand and the site case weight.

3.2.1 General On-Site Survey and Data Collection Process

The first step in evaluating a site was to review all pertinent project file documents and then develop a draft plan that laid out the M&V approach for the project. The draft M&V plan was then internally reviewed by the team leaders and sent to NYSERDA for approval. After NYSERDA's review, the evaluators finalized the M&V plan and conducted the on-site visit.

Site visits were conducted at each of the sites in the sample from August 2013 through January 2014. A site engineer inspected installed equipment, recorded nameplate information, interviewed site staff about operations, took measurements, and installed loggers according to the M&V plan. The metering requirements were defined by the evaluators in the M&V plans in accordance with the International Performance Measurement & Verification Protocol (IPMVP) terminology.

For sites with a significant amount of installed energy efficient equipment, e.g., sites with 20 new motors, the evaluators selected a random sample of the equipment to be evaluated during the on-site visit using a standard protocol.[8]

For the sites that partially installed the approved measures, the evaluators assessed only those measures that were reported as installed. Some of the measures that were installed were offline due to the season. For example, irrigation systems with fertilizer delivery functions operate primarily in the spring. Where the operation of the system could not be directly metered, the evaluators verified the installation of the measures, recorded timer settings when available, and interviewed site staff to gather information on the installed equipment's annual operation.

3.2.2 Levels of Rigor

The Impact Evaluation Team assigned the most appropriate of three possible M&V methods. The assignment was based on data availability, equipment accessibility, and complexity of measures. The planned and obtained levels of rigor are presented in Table 3-4.

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[8] *2008 SPC Procedures Manual,* Southern California Edison. https://www.sce.com/NR/rdonlyres/5F167323-AA2B-4B85-A534-5DACD99EBC8D/0/SCE_1_SPC_Policy022208.pdf

Table 3-4. ADEEP Allocation of Rigor

Level of Rigor and Approach	Design Allocation	Obtained Allocation
IPMVP A and B: equipment performance monitoring. Involves the partial (Option A) or full (Option B) measurement of isolated equipment affected by the evaluated measure. Relevant equipment variables are spot-measured when possible or stipulated when necessary.	45%	45% of the reported kWh impacts
IPMVP C: billing analysis with targeted measure M&V. Involves the use of utility meters to assess the performance of a total facility. Option C addresses measure impacts in aggregate, not individually, if the affected equipment is connected to the same meter	5%	64% of the reported natural gas impacts (one site)
Verification: involves on-site inspection and verification, spot measurement, and collection of scheduling information.	50%	55% of the reported kWh impacts 36% of the reported natural gas impacts
Total	**100%**	N/A

N/A = Not applicable

3.2.3 Analysis Approach

In addition to specifying a measurement and logger plan, the M&V plan detailed an analysis approach based on the technology and the available information. The analysis phase usually began with the inspection of the logger data quality. Regression analysis was conducted to identify relationships between the measured values and another value that could be extrapolated to a full year, such as outdoor air temperature, production, or time. In cases where it was not possible to log, for example, where the irrigation pump had been secured for the year, the evaluator calculated the impacts based on recorded setting from timers (when possible) or from annual measure operation details provided by the farm site staff.

The evaluators typically combined the metered data, the verified equipment performance data, the logger data, and the regression results into an 8,760 hour-per-year analysis in a spreadsheet. Savings estimates were normalized for site-specific production and pre-/post weather. Savings results were then checked against either the electric or natural gas bills, typically at least a year of pre-bills and six or more months of post, to ensure the evaluated savings were consistent with the pre- and post-billed usage.

The final step in the analysis was to investigate the sources of the differences between the application estimates and the evaluated savings. The site engineer characterized the factors driving the savings differences, such as hours of operation or equipment efficiencies, and determined the impact of that individual difference on site savings. The site engineer characterized each of the contributors using a standard list of categories to permit the compilation from all the sites to quantify program-level differences.

3.2.4 Baseline

Similar to other energy efficiency programs, the baseline was established by considering whether the equipment was at end of life or early replacement. Since the equipment had been destroyed, the end-of-life scenario was applicable and therefore the baseline references either building code or the least-expensive, feasible alternative.

A large majority of measures addressed farm production equipment so there were no code requirements that directly applied. The baseline in this case was the lowest-cost alternative to the damaged equipment. If the owner indicated that the farm would have gone out of business without the aid of the Program or that they would not rebuild a portion of the farm, the evaluators conservatively presumed that its production would be supplied by another farm in the state. In this case the participant farm's previously installed equipment was considered representative of a typical farm and was referenced as the baseline.

New York building code was referenced for domestic hot water heaters, boiler efficiencies, and motor efficiencies, since code requirements drive what is available in the marketplace. For dairy refrigeration equipment, the evaluators referenced Efficiency Maine's Commercial Technical Reference Manual version 2013.1. For other measures, such as the stock waterers and curing ventilation, the evaluators conducted online research to identify lower-cost equivalents on the market.

Five of the measures switched fuels from either gasoline or diesel to electricity. NYSERDA has established a practice of reporting positive savings for the original fuel (in this case gasoline or diesel) and negative savings for the installed fuel (in this case electricity). This is consistent with what the customers observe on their bills: the gasoline or diesel fuel usage decreases, but the electricity usage increases. This practice establishes the existing original fuel usage as the baseline for that fuel and zero usage as the baseline for electricity.

In each case of a fuel-switching measure, the application's baseline as determined by the ADEEP was the original fuel usage translated to kWh on a Btu basis. This baseline does not correctly characterize the actual baseline at the site, since electricity was not used for this purpose. The evaluators also considered whether the electric equipment may have been the least-cost, feasible alternative, in which case standard efficiency electrically driven equipment would have been the baseline. However, in each of the fuel-switching cases, the electric equipment was more expensive, primarily due to the cost of bringing in electric service. This perspective was confirmed in the interviews where the owners stated they would have installed the fossil fuel systems absent the Program.

3.2.5 Other Fuel Savings and Greenhouse Gas Emission Reductions

At the sites where fuel switching occurred, the site engineer determined savings from other fuels (gasoline and diesel) with a level of rigor similar to that used for the electricity and natural gas savings. The other fuel savings were aggregated on a program level using the electric measure case weights.

The greenhouse gas emissions reductions achieved by the Program were calculated as the product of the evaluated net energy savings by fuel and a conversion factor, which was derived from the EPA's Emission Factors for Greenhouse Gas Inventories, updated on 01/03/2011, as shown in Table 3-5.

Table 3-5. ADEEP CO_2 Emissions Reductions

Savings Category	Program Net Savings	Conversion Factor (lb of CO_2 /MMBtu or MWh)	CO_2 Reduction (lb)
Electric energy savings (MMBtu)	369 MWh	625.00 lb CO_2 /MWh	230,625
Natural gas savings (MMBtu)	5,726 MMBtu	117.14 lb CO_2 /MMBtu	670,744
Fossil fuel savings (MMBtu)	790 MMBtu	159.09 lb CO_2 /MMBtu	125,681
Total (lbs)	N/A	N/A	1.027,050

N/A = Not applicable

3.3 PROGRAM ATTRIBUTION

Program attribution accounts for the savings induced by the program effort, above and beyond the level of efficiency investment and/or changes to control practices that would have occurred in the absence of the Program. The general equation for the attribution factor, or NTGR, is as follows:

$$NTGR = 1-FR+ISO+OSO+NPSO$$

The evaluators concluded that neither OSO nor NPSO was likely to be generated by this short-lived and targeted program, so these factors were not researched and are zero for the calculation of NTGR.

Measure attribution was established for each evaluated project through customer self-reported responses to FR and ISO inquiries using a modeled partial net (MPN) approach. This approach was successfully used in the evaluation of the New Construction Program and was selected for ADEEP because of the unique impetus for customer participation – weather events had destroyed equipment – and the unique set of measures. The survey instrument is provided in Appendix B.

During the evaluation of the sampled projects, the Impact Evaluation Team interviewed program participants (typically the owners) to determine the attribution baseline of each installed measure. The fundamental goal of the questions was to ascertain if the farm owner would have:

- Installed the same equipment without support from the Program, leading to FR, or
- Installed other energy efficient measures influenced by participation in the Program, leading to SO

Based on the response, the attribution baseline was constructed for the measure, and the net savings was calculated as the difference between the attribution baseline and the evaluated gross savings. The program NTGR was computed independently for electric and natural gas measures using energy savings and aggregated to the program level[9]. The electric demand was assigned the electric energy NTGR.

[9] The individual site evaluated savings were aggregated to a program level using the site *i*, case weights. The final program-level NTGR is calculated as follows:

$$Program\ NTGR = \frac{\sum_{Sample} Evaluated\ net\ savings_i \times Case\ weights_i}{\sum_{Sample} Evaluated\ gross\ savings_i \times Case\ weights_i}$$

SECTION 4: RESULTS AND CONCLUSIONS

This section presents the results and conclusions of the impact evaluation study.

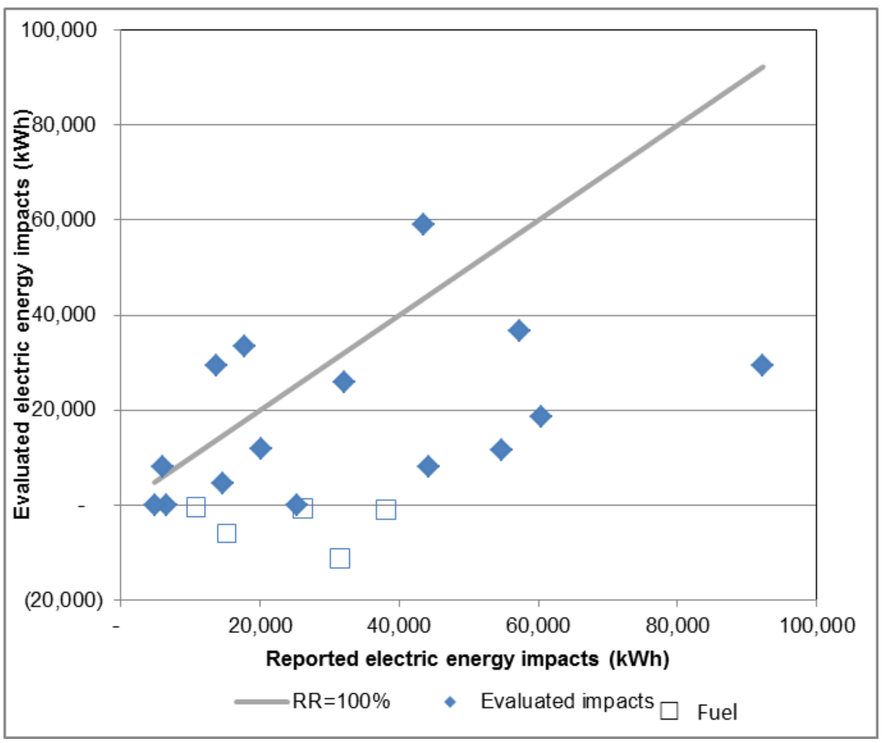
4.1 IMPACT RESULTS

This section presents impact evaluation results starting with site-by-site level and concluding with program level results.

4.1.1 Electric and Natural Realization Rate Results

Figures 4-1 compares the evaluated annual energy savings with the reported values for electric measures. Ideally, the evaluated savings would always match the program savings. This ideal is shown as a solid line on the charts. Actual findings are plotted as points on the scatter graph, with program-reported savings on the x-axis and evaluated gross savings on the y-axis. If all the points were to fall directly on the line, it would mean that the evaluated savings were exactly the same as the program-reported savings and the RR was 100%. A pattern of points below the ideal line suggests an RR of less than 100%; points above the line suggest an RR greater than 100%.

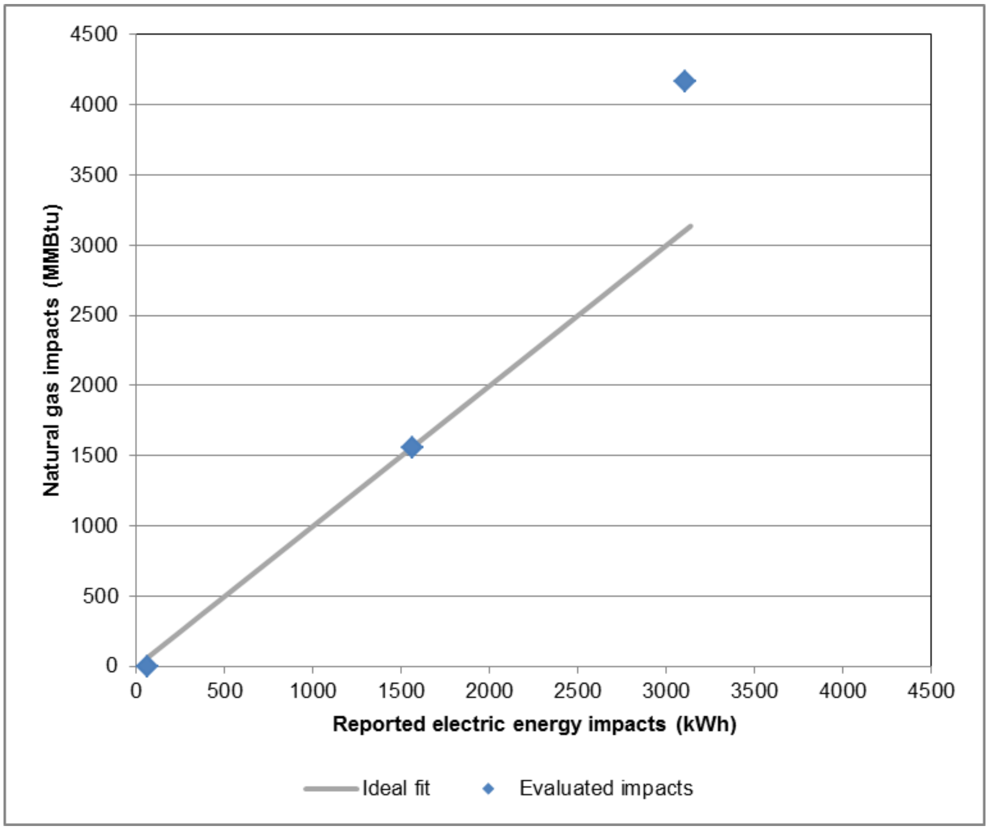
Figure 4-1. ADEEP Site Electric Reported vs. Evaluated Energy Savings



The electric measure savings in Figure 4-1 show wide scatter indicative of a high error ratio, with the majority of points appearing below the black line, indicative of the low RR. The graph highlights the five fuel-switching measures that substantially contributed to the lower RR.

Figure 4-2 presents a similar graph of natural gas results. Of the three sites in the sample frame that installed natural gas measures, all are on or above the black line, indicative of the high RR.

Figure 4-2. ADEEP Site Natural Gas Reported vs. Evaluated Savings



The program RR measures the difference between the program-reported savings and the evaluated savings. Table 4-1 shows the aggregate RRs for the Program determined from on-site M&V activities at the sampled farms.

Table 4-1. ADEEP Realization Rate Results Summary

Program Component	Sites[1]	Sample	RR
Electric energy	57	20	0.54
Natural gas energy	4	3	1.21

[1] Three of the participants installed measures that impacted both electric energy and natural gas consumption.

4.1.2 Sources of Realization Rate Differences

Figures 4-3 and 4-4 present the impact of savings differences on the program RR for both electric and natural gas measures, respectively. The intent of these tables is to provide further insight into those factors that drive the program RR away from a value of 1.0. The figures present both the negative and positive change in RR by difference category and also indicate the number of observations contributing to that category (indicated in bold next to the dash).

Figure 4-3. ADEEP Electric Energy Impact – Sources of Realization Rate Differences

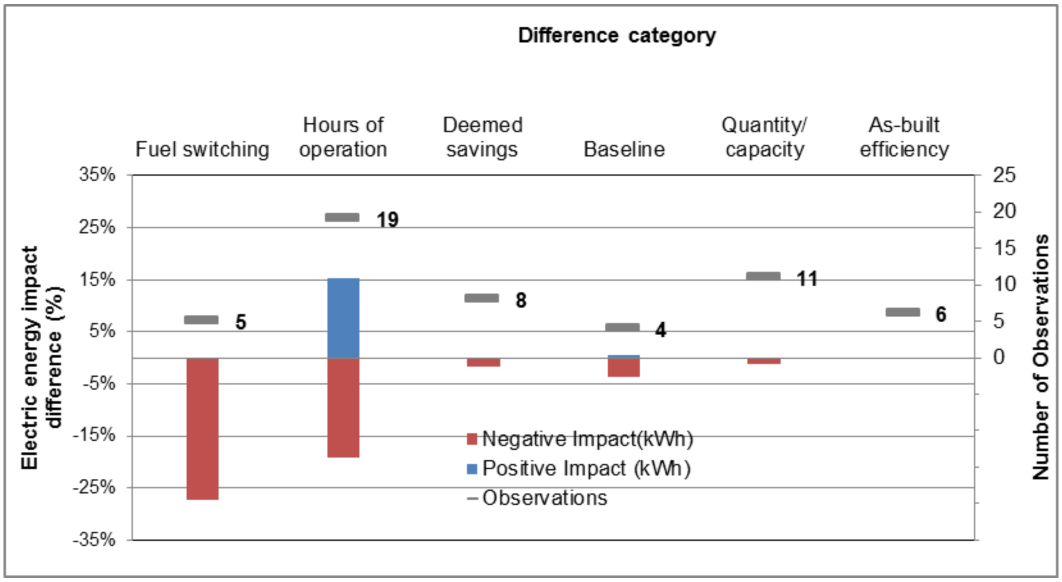
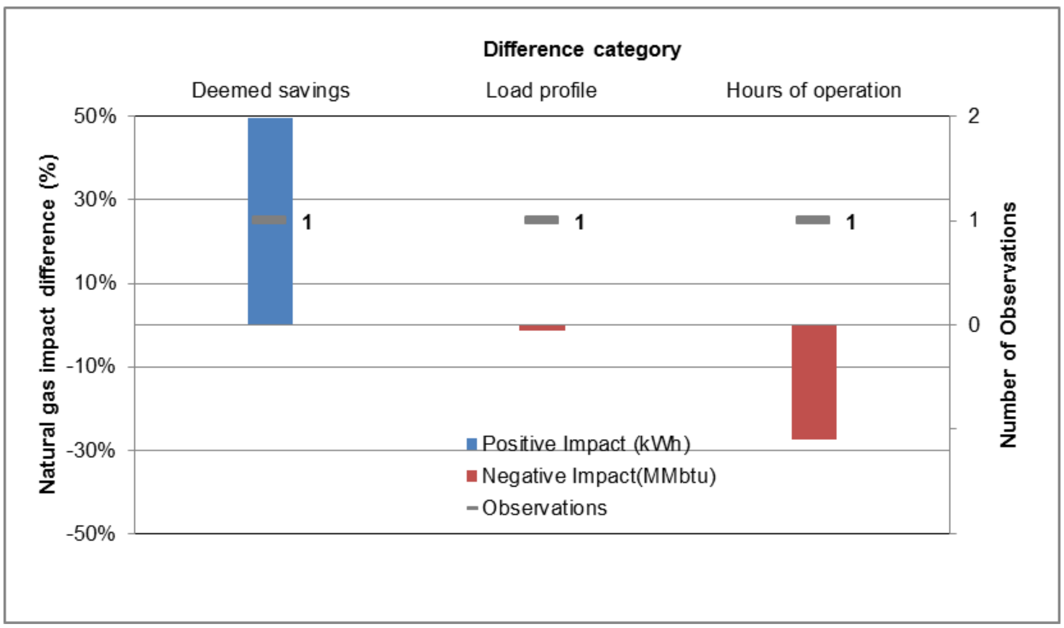


Figure 4-4. ADEEP Natural Gas Energy Impact – Sources of Realization Rate Differences



The difference values are presented in tabular form in Table 4-2.

Table 4-2. ADEEP Summary of Realization Rate Differences

Difference Category	Number of Observations	Positive RR Change	Negative RR Change	Realization Rate % Change	Net Impact Difference (kWh/MMBtu)
Electric Savings					
Fuel switching	5	0.0	-0.27	-0.27	-255,061
Hours of operation	19	0.15	-0.19	-0.04	-37,787
Deemed savings	8	0.04	-0.11	-0.07	-66,127
Baseline	4	0.01	-0.04	-0.03	-28,340

Difference Category	Number of Observations	Positive RR Change	Negative RR Change	Realization Rate % Change	Net Impact Difference (kWh/MMBtu)
Quantity/capacity	11	0.09	-0.13	-0.04	-37,787
As-built efficiency	6	0.01	-0.02	-0.01	-9,447
Total	**N/A**	**N/A**	**N/A**	**-0.46**	**-434,548**
Natural Gas Savings					
Use of deemed savings value	1	0.50	0.0	0.50	2,422
Load profile	1	0.0	-0.1	-0.01	48
Hours of operation	1	0.0	-0.28	-0.28	1,356
Total	**N/A**	**N/A**	**N/A**	**0.21**	**1,017**

N/A = Not applicable

In Figure 4-3, the first category on the left shows the impact of the fuel-switching measure, which reduced the RR by 0.27. The next category, "hours of operation," shows a large negative impact counter balanced by a positive impact where the difference in hours of operation led to an increase in savings at some of the sites. The net impact on the RR due to differences in hours of operation is a modest -0.04. While the net impact is not large, the wide range of understatement and overstatement of the hours of operation leads to higher variations in the results and poorer precision. The following list defines the categories and provides illustrative examples of each::

- **Fuel switching** – The application assumed an electric usage baseline, where the preinstalled and least-cost option was fueled by gasoline or diesel fuel. At Site A, a 5.5 hp gasoline-powered irrigation pump was replaced with one 5.0 hp electrically driven pumping system. The evaluator was able to meter the new pump for two months and verify its hours of operation. The measure reduced gasoline usage at the farm, but increased electrical usage. The reported electric energy savings were based on the kWh-equivalent thermal energy of the eliminated gasoline use.
- **Quantity or capacity** – The application incorrectly projected the number of units or the capacity of the units (such as hp) that were installed. At Site B, the application reported that four portable fans had been replaced. The evaluator determined that two portable fans had been replaced. The evaluator consequently calculated lower electric energy savings than the reported savings.
- **Reliance on non-site-specific deemed savings** – The application used deemed savings factors that were not representative of the site. At Site C, the applicant reported savings for installing VFD controls on ventilation fans using a 40% savings factor, while the evaluators

used metered data to calculate the measure savings, which yielded an average savings of 24%.

- **Baseline differences** – The application referenced an incorrect baseline efficiency or operation for the measure. At Site D, the application reported that the baseline domestic hot water (DHW) electric heater was 75% efficient, while the evaluators determined the baseline DHW electric heater was 90.4% efficient, which is the minimum efficiency available for a new hot water heater.
- **Differences between equipment hours of operation** – The application assumed hours of operation were incorrect. At Site E, the application reported that the unit operated 6,619 hours per year, while the evaluator determined that the unit full-load hour operation was 2,198 hours per year.

4.1.3 Attribution Results

The evaluators typically interviewed the owner at each site to determine how the Program influenced the installation of additional energy efficiency measures. Without exception, the participants reported that no additional energy efficiency measures had been installed at the sites; therefore there was no ISO associated with the Program. The evaluators concluded that neither OSO nor NPSO was likely to be generated by this short-lived and much-targeted program, so these factors were not researched.

The evaluators also asked the owners on a measure-by-measure basis what equipment they would have installed had they not had support from the Program. Only four sites reported that they would have installed the same equipment for one or more measures without the Program's support; however, one of those sites accounted for about a quarter of the evaluated gross savings, leading to a moderately high FR. Table 4-3 provides more detail about the participant responses.

Table 4-3. ADEEP Free-Ridership Survey Summary

Site Number	Site FR (%)	Notes
1	100%	The site contact indicated that the farm would have replaced all the damaged equipment with the exact same system without the ADEEP incentive.
2	100%	The site contact indicated that the farm would have replaced all the damaged equipment with the exact same system without the ADEEP incentive.
3	32%	The site contact indicated that the farm would have replaced the damaged equipment for one of the measures with the exact same system without the ADEEP incentive
4	4%	The site contact indicated that the farm would have replaced the damaged equipment for one of the measures with the exact same system without the ADEEP incentive

The program-level attribution results are summarized in Table 4-4.

Table 4-4. ADEEP Attribution Summary

Program Component	Sites[1]	Sample	FR (%)	ISO (%)	NTGR
Electric energy	57	20	27%	0%	0.73
Natural gas	4	3	0%	0%	1.00

[1] Three of the participants installed measures that impacted both electric energy and natural gas consumption.

The moderately high FR along with a lack of SO for this program yielded an NTGR of 0.73 and 1.00 for electricity and natural gas savings, respectively. The electric energy FR and ISO rates were adopted for the electric demand savings.

4.1.4 Program Evaluated Net Savings

The evaluated net savings are the program savings after they have been adjusted for the RR and the NTGR as follows:

$$\text{Net savings} = \text{Program-reported savings} \times RR \times NTGR$$

Table 4-5 shows the overall program evaluated impacts for projects installed through 2013.

Table 4-5. ADEEP Energy Efficiency Program Impacts for Measures Installed from Program Inception through December 31, 2013[1]

Metric	Electric Energy (kWh)	Natural Gas (MMBtu)
A - Reported savings	944,669	4,843
B - RR	0.54	1.21
C - Evaluated gross savings (A x B)	510,121	5,860
D - NTGR	0.73	1.00
E - Evaluated net savings (C x D)	372,389	5,860
Net savings precision at 90% confidence	±35%	No sampling error

[1]Peak demand savings and fossil fuel savings were estimated to be 18 kW and 790 MMBtu, respectvely.

The Program saved an estimated 790 MMBtu in fossil fuel (diesel and gasoline savings combined) from fuel-switching measures and produced 18 kW in peak demand reductions. There is no RR because the Program did not track other fossil fuel energy nor demand reductions.

4.2 GREENHOUSE EMISSIONS REDUCTIONS

The Program's electricity, natural gas, gasoline, and diesel fuel savings reduced CO_2 emissions as reported in Table 4-6.

Table 4-6. ADEEP CO_2 Emissions Reductions

Savings Category	Program Net Savings	Conversion Factor (lb of CO_2 /MMBtu)	CO_2 Reduction (lb)
Electric energy savings (MMBtu)	3,668 MWh	625.00 lb CO_2 /MWh	230,625
Natural gas savings (MMBtu)	5,726 MMBtu	117.14 lb CO_2 /MMBtu	670,744
Fossil fuel savings (MMBtu)	790 MMBtu	159.09 lb CO_2 /MMBtu	125,681
Total (lbs)	**10,185**	**N/A**	**1.027,050**

4.3 ECONOMIC BENEFITS

During the on-site interviews, the evaluators asked the participants about the role the Program played in returning the farm to production. The interviewers heard repeatedly how important this assistance was to the farms' resumption of normal operation. To quote the feedback given by two farm owners:

"It was a major role; otherwise, we would have gone out of business."

"Without the [Program] money we wouldn't have been able to install anything."

The assistance seemed to be particularly important to the smaller operators. When the evaluators extrapolated the results from the 21 sampled sites to the entire program evaluators they found that approximately 94 employees kept their jobs because of the Program's support. The findings are presented in Table 4-7.

Table 4-7. ADEEP Role in Returning Farms to Production

Status	Farms That May Have Gone out of Business without the Program	Farms That Went Back into Production Earlier Due to the Program	Farms for Which the Program Did Not Impact the Return to Production[1]
Sites			
Number of sites (of 21 sampled sites)	7	5	8
Employees			
Average number of employees per sample site	6	10	23
Aggregate number of employees at farms participating in the Program	94	167	170

[1] Excludes a very large participant with 750 employees. This location reported that production was not impacted by the Program.

The Program also played an important role in helping the participating farms to upgrade damaged equipment and to increase production. Most of the farm owners indicated that without the Program they would not have installed the energy efficient equipment, and they would have either attempted to repair the damaged equipment or installed the lowest-cost alternative available. To quote the feedback given by a particular farm owner:

> Yes, the incentive helped us get back in production. We have some other areas that we can now re-shift our resources to. So, we will be able to bring in more livestock (horses for breeding, in our case). . . . We might be hiring one or more people because of more livestock. It should help the business expand.

Six of the owners, or about a third surveyed, reported that the new technology was not only energy efficient but positioned the farms to increase production capacity should they choose to do so in the future. As an example, one owner noted that the improved ventilation technology increased an onion barn’s ability to store and cure onions by 30% – 40%.

4.4 CONCLUSIONS AND RECOMMENDATIONS

The Program’s greatest accomplishment may have been returning farms to production in the aftermath of two major storms. About one-third of the owners reported that they might have gone out of business without the Program. Those farms reporting the largest benefits tended to be the smallest operators (in terms of number of employees), and they may have had few other resources to help them weather the loss. The Program was effective in identifying farms in distress and in delivering aid quickly.

The new energy efficient technologies also positioned about one-third of the farms for increased production should the farms choose to do so in the future. As an example, the replacement of conventional ceiling-mounted paddle fans with high-volume, low-speed fans increased ventilation rates permitting onion barns to cure more onions in the same volume of space.

There are no recommendations for improving the Program, since the Program was designed to exist for a short period of time and is no longer open. However, since the ADEEP was derived from the currently active Agricultural Energy Efficiency Program, the evaluators suggest that program staff review the screening criteria for irrigation pumps to ensure they properly account for the savings from any fuel switching.

The evaluators determined that the ADEEP implementation resulted in 372 MWh net electric energy savings and 5,860 MMBtu net natural gas savings as of December 31, 2013. The Program had a relatively low RR of 0.54 for the electric measures, primarily due to a non-standard approach to estimating savings for fuel-switching measures. The natural gas RR was 1.21. The evaluators also determined that the Program had a moderately high FR rate of 27% for electric measures and was not affected by SO. The Program commensurately reduced greenhouse gas emissions by an estimated 500 tons of CO_2 annually.

Since the mix of remaining committed measures is similar to the evaluated mix, the evaluators recommend calculating evaluated savings for any additional installed measures by multiplying the reported savings by the RR and NTGR factors presented back in Table 1-1. The precision of the electric savings was ± 35% at the 90% confidence, where the intention had been to achieve ±20% precision. However, the variation in site-level RR was higher than had been projected in the design stage.

APPENDIX A: GLOSSARY OF TERMS[10]

ADEEP – the Agricultural Disaster Energy Efficiency Program. The NYSERDA program which is the topic of this impact evaluation.

appendix M[11] – An appendix to the New York Technical Manual (NYTM) that provides guidance to program administrators (PAs) and evaluators for the use of early replacement baseline versus normal replacement baseline. Appendix M does not directly apply to most of the projects in this evaluation population; however, its guidance will allow evaluators to define preexisting equipment as the evaluation baseline when appropriate.

billing analysis – Estimation of program savings through the analysis of utility consumption records comparing consumption prior to program participation and following program participation. This term encompasses a variety of analysis types, from simple pre/post to complex regressions.

census – All individuals in a group. In evaluations of energy efficiency programs census typically refers to all projects in a stratum of program projects.

early replacement – The replacement of equipment before its effective useful life (EUL) has been reached.

error ratio – In energy efficiency evaluation, the error ratio is a measure of the degree of variance between the reported savings estimates and the evaluated estimates. For a sample, the error ratio is:

$$er = \frac{\sqrt{\sum_{i=1}^{n} w_i \frac{e_i^2}{x_i^{\gamma}} \sum_{i=1}^{n} w_i x_i^{\gamma}}}{\sum_{i=1}^{n} w_i y_i}$$

where,

n is the sample size

w_i is the population expansion weight associated with each sample point i

x_i is the program reported savings for each sample point i

y_i is the evaluated gross savings for each sample point i, the constant gamma, $\gamma = 0.8$ (typically), and the error for each sample point $e_i = y_i - bx_i$, where b is the program realization rate

evaluated gross savings – The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated, as calculated by program evaluators.

[10] NYSERDA generally follows and uses the terms as defined in the "Northeast Energy Efficiency Partnerships Glossary of Terms", found at http://neep.org/uploads/EMV%20Forum/EMV%20Products/EMV_Glossary_Terms_Acronyms.pdf. This glossary defines those terms absent from the NEEP report or provides more specific definitions to generalized NEEP terms.

[11] Appendix M can be found at: http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/06f2fee55575bd8a852576e4006f9af7/$FILE/Appendix%20M%20final%205-05-2011.pdf

evaluated net savings – The total change in load that is attributable to an energy efficiency program, as calculated by program evaluators. This change in load may include, implicitly or explicitly, the effects of free drivers, free riders, energy efficiency standards, changes in the level of energy service, and other causes of changes in energy consumption or demand.

free rider, free ridership (FR) – A free rider is a program participant who would have implemented the program measure or practice in the absence of the program. Free ridership refers to the percentage of savings attributed to customers who participate in an energy efficiency program but would have, at least to some degree, installed the same measure(s) on their own if the program had not been available.

IPMVP Option A – This M&V option involves the partial measurement of isolated equipment affected by the evaluated measure. Relevant equipment variables are spot-measured when possible or stipulated when necessary.

IPMVP Option B – This M&V option involves full measurement of the isolated equipment affected by the evaluated measure. No stipulations are allowed. Both short-term and continuous data monitoring are included under Option B.

IPMVP Option C – This M&V option involves the use of utility meters to assess the performance of a total building. Option C addresses measure impacts in aggregate, not individually, if the affected equipment is connected to the same meter.

IPMVP Option D – This M&V option involves the use of computer modeling to determine facility or equipment energy use. Option D requires calibration with actual utility consumption data for either the pre-project or post-project period.

measure adoption rate (MAR) – A ratio that quantifies the percentage of ERP-recommended savings that customers chose to adopt after the MPP had ceased involvement in the project.

net savings - The total change in load that is attributable to an energy efficiency program. This change in load may include, implicitly or explicitly, the effects of spillover, free riders, energy efficiency standards, changes in the level of energy service, and other causes of changes in energy consumption or demand.

net to gross, net-to-gross ratio (NTG, NTGR) – The relationship between net energy and/or demand savings – where net is measured as what would have occurred without the program, what would have occurred naturally – and gross savings (often evaluated savings). The NTGR is a factor represented as the ratio of net savings actually attributable to the program divided by program gross savings. For NYSERDA programs the NTGR is defined as 1 minus free ridership plus spillover.

nonparticipants/nonparticipating – Any customer or contractor who was eligible but did not participate in the program under consideration. Nonparticipating contractors can include contractors that have never participated in the program and contractors that formerly participated, prior to the year(s) being evaluated, but have not participated since then.

normal replacement – The replacement of equipment that has reached or passed the end of its measure-prescribed EUL.

population expansion weight – The total number of units in a population divided by the number of units in the sample.

realization rate (RR) – The ratio of the evaluated gross savings to the Program's reported savings. The RR represents the percentage of program-estimated savings that the evaluator estimates as being actually achieved based on the results of the evaluation M&V analysis. The RR calculation for electric energy for a sampled project is shown below:

$$RR = \frac{kWh_{evaluation}}{kWh_{program}}$$

where,

RR is the realization rate

$kWh_{evaluation}$ is the evaluation M&V kWh savings (by evaluation M&V contractor)

$kWh_{program}$ is the kWh savings claimed by program

relative precision – Relative precision reflects the variation due to sampling as compared to the magnitude of the mean of the variable being estimated. It is a normalized expression of a sample's standard deviation from its mean. It represents only sampling precision, which is one of the contributors to reliability and rigor, and should be used solely in the context of sampling precision when discussing evaluation results.

Relative precision is calculated as shown below. It must be expressed for a specified confidence level. The relative precision (*rp*) of an estimate at 90% confidence is given below:

$$rp = 1.645\ \frac{sd(\mu)}{\mu}$$

where,

μ is the mean of the variable of interest

$sd(\mu)$ is the standard deviation of μ

1.645 is the *z* critical value for the 90% confidence interval

For the 90% confidence interval, the error bound is set at 1.645 standard deviations from the mean. The magnitude of the *z* critical value varies depending on the level of confidence required.

spillover (SO) – Refers to the energy savings associated with energy efficient equipment installed by consumers who were influenced by an energy efficiency program, but without direct financial or technical assistance from the program. SO includes additional actions taken by a program participant as well as actions undertaken by nonparticipants who have been influenced by the program. Sometimes SO is referred to as "market effects." Market effects are program-induced impacts or program-induced changes in the market. Market effects include impacts over time. These market effects may be current or may occur after a program ends. When market effects occur after a program ends, they are referred to as "momentum" effects or as "post-program market effects." SO is often a narrower definition because it does not include impacts that accrue due to program-induced market structure change and seldom look for effects that occur well after program intervention or effects that occur after a program ends. This evaluation addresses participant inside spillover, participant outside spillover, and nonparticipant spillover, but not the broader definition of program effects within market effects.

inside spillover (ISO)- Occurs when, due to the project, additional actions are taken to reduce energy use at the same site, but these actions are not included as program savings, such as when, due to the program, participants add efficiency measures to the same building where program measures were installed but did not participate in the program for these measures.

outside spillover (OSO)- Occurs when an actor participating in the program initiates additional actions that reduce energy use at other sites that are not participating in the program. This can occur when a firm installs energy efficiency measures they learned about through the program at another of their sites without having that other site participate in a NYSERDA program. OSO is also generated when participating vendors install or sell energy efficiency to nonparticipating sites because of their experience with the program.[12]

nonparticipant spillover (**NPSO) -** The reduction in energy consumption and/or demand from measures installed and actions taken at nonparticipating sites due to the program but not participating in the program and not induced by program participants – either building owners/managers or Program Performance Partners. These actions could be program-induced decision-making of nonparticipating building owners or encouraged by nonparticipating vendors or contractors because of the influence of the program.

stratified ratio estimator (SRE) – An efficient sampling design combining stratified sample design with a ratio estimator. It's most advantageous when the population has a large coefficient of variation, which occurs, for example, when a substantial portion of the projects have small savings, and a small number of projects have very large savings. The ratio estimator uses supporting information for each unit of the population when this information is highly correlated with the desired estimate to be derived from the evaluation, such as the tracking savings and the evaluated savings.

summer coincident peak demand period – For this evaluation NYSERDA defined the summer coincident peak demand period as the energy reduction during the hottest non-holiday summer (June through August) weekday during the hour ending at 5 p.m.

trade allies – Businesses that play a role in the development and/or implementation of program-qualifying energy efficiency projects. These are either developed through the program or outside of the program on the customer's own initiative. These trade allies include energy auditing firms (including the program's Performance Partner participants), and architect/engineering firms, contractors, and equipment vendors.

within-site sampling – When the quantity of uniquely controlled lighting circuits (or motors or other installed units) to be evaluated at a site is large, engineers will meter a sample of them. Within-site sampling refers to the process. In this evaluation the default within-site sample design targets ±20% relative precision at 80% confidence.

[12] This definition is one that NYSERDA has used throughout its history with energy efficiency programs. There may be other states where the latter circumstance of participating vendors influencing nonparticipating sites is defined as a type of nonparticipant spillover.