

R&D Demonstration Survey Round 3: Projects Completed from 2011-2013

Final Report

Prepared for:

New York State Energy Research and Development Authority (NYSERDA)
Albany, New York

Jennifer Phelps
Project Manager

Prepared by:

Industrial Economics, Incorporated (IEc)
2067 Massachusetts Avenue
Cambridge, Massachusetts 02140
617/354-0074

Peter Courtright
Senior Associate
pcourtright@indecon.com

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Section 1:

INTRODUCTION

This section begins with the background and purpose of the study. Next, it provides a brief overview of NYSERDA's Research and Development (R&D) Program, and offers definitions for demonstration and replication projects.

1.1 BACKGROUND

NYSERDA's Innovation Program employs a variety of approaches that aim to advance the development of innovative, reliable, efficient, and clean energy technologies, and increase their market acceptance and adoption. R&D demonstration projects are largely conducted within the Innovation Program and are one of NYSERDA's best-established strategies for promoting these goals. These projects aim to demonstrate and obtain objective information on the technical performance, cost, and environmental impacts of emerging clean and energy-efficient technologies. Demonstration projects are designed to showcase the value and effectiveness of a new technology or process, or the application of an existing technology in a commercial setting.

Demonstration projects cover a wide variety of technology areas and project types, including advanced materials, air and waste remediation, building systems, electric power delivery, energy storage, industrial products, heating and cooling, transportation, waste management, wastewater treatment, and others. While demonstration projects often generate benefits in their own right, these projects are designed to achieve additional impacts through successful replications.

NYSERDA finalized the first two studies of its R&D demonstration projects in 2012 and 2014.^{1, 2} The first study covered projects that were completed between 2004 and 2007. The second study surveyed projects completed between 2008 and 2010. These studies assessed: demonstration impacts, NYSERDA's influence on the demonstrations, replications and sales, demonstration influence on the replications, replication impacts, and participant satisfaction.

The current study updates the R&D demonstration survey with projects that were completed between 2011 and 2013. The survey was conducted on a census of all demonstration projects within the sample frame completed during the study period. Additionally, this study conducted follow-up surveys with some replication projects identified in the survey, and re-surveyed 13 respondents from the second study.

¹ *R&D Demonstration Survey Report*, prepared by Megdal & Associates, September 2012.

² *R&D Demonstration Survey Round 2: Projects Completed from 2008-2010*, prepared by Industrial Economics, Inc., March 2014.

1.2 PURPOSE OF THE STUDY

The study has the following objectives:

- Estimate the resource savings (e.g., kW, MWh, etc.), revenues, cost savings, and other impacts resulting from NYSERDA-funded demonstrations and replication projects.
- Characterize the number, scale, and type of replication projects.
- Determine the factors that helped or hindered replication.
- Assess the cost-effectiveness of NYSERDA's R&D demonstration portfolio.
- Evaluate participant satisfaction with NYSERDA's R&D Program.
- Determine whether projects from the previous study have attained additional benefits or replications.

1.3 OVERVIEW OF NYSERDA R&D PROGRAM

The R&D demonstration projects covered in this report are an important part of NYSERDA's R&D Program and are aligned with the program's overarching goals. Projects surveyed in this round were active while the Systems Benefits Charge rounds three and four (SBC III and SBC IV) were in effect.³ The overarching goals of SBC III include the following:

- Improve New York's energy system reliability.
- Reduce the energy cost burden of New Yorkers.
- Mitigate the environmental and health impacts of energy use.
- Create economic opportunity and promote economic well-being.⁴

The overarching goals of SBC IV include the following:

- Move new or underused technologies and services into the marketplace to serve as a "feeder" to help achieve Energy Efficiency Portfolio Standard (EEPS) and Renewable Portfolio Standard (RPS) goals;
- Validate emerging energy efficiency, renewable, and smart grid technologies/strategies and accelerate market readiness in New York;
- Stimulate technology and business innovation to provide more clean energy options and lower cost solutions, while growing New York's clean energy economy; and
- Spur actions and investments to achieve results distinct from incentive-based programs.⁵

In pursuit of these goals, NYSERDA funds and supports demonstration projects in a variety of program areas. Section 3.1 of this report shows the distribution of survey respondents across program areas.

³ SBCIII covered the period from July 2006 through the end of 2011. In October 2011, the New York Public Service Commission extended the SBC program through the end of 2016. The SBC program is administered by NYSERDA.

⁴ NYSERDA. 2007. *SBC-Funded Research and Development (R&D) Program: Sector-level Program Logic*. Final Report. Prepared by GDS Associates, Inc. September 2007.

⁵ NYSERDA. 2013. *Operating Plan for Technology and Market Development Programs (2012-2016), Second Revision*. February 15, 2013.

1.4 DEFINITION OF DEMONSTRATIONS AND REPLICATIONS

Demonstration projects are designed to test a new technology or a new application of an existing technology in order to accelerate commercialization, scale up production, or increase market adoption of successful technologies. Replication projects are a primary means by which demonstration projects achieve broader market impacts. This report characterizes demonstration and replication projects as follows:

- **Demonstrations** are defined as the demonstration of a new technology or process, or application of an existing technology in a commercial setting. Demonstration projects are designed to showcase the value and effectiveness of the technology or process being demonstrated. Given the breadth of projects across program areas, NYSERDA classifies demonstrations in three cross-cutting categories: (1) on-site power production, (2) on-site process improvement, and (3) product demonstration.⁶ Demonstration projects can be designed and proposed by three different types of market actors: (1) integrators, (2) vendors, and (3) site owners. Integrators bring together other market actors to create or “package” the demonstration project. Vendors supply the technology for the project. Site owners own the location where the project is demonstrated, and may or may not be involved with implementing the project at their site.
- **Replications** are defined somewhat differently depending on whether the market actor is an integrator, site owner, or vendor. For integrators and site owners, replication projects involve an additional installation or scaling up of the technology or process demonstrated under the NYSERDA-funded project. The replication could be at the same site as the NYSERDA demonstration project or at another site. Replications may be carried out by the same firm or a different firm than the original demonstration project. For vendors, replications are defined as additional sales of the same technology or services that were used in the NYSERDA-funded demonstration project. These additional sales could be to the same buyer that participated in the demonstration project or a different buyer. These definitions were provided to survey respondents to ensure consistency in responses.

⁶ No on-site power production projects were included in this round of the survey.

Section 2:

METHODS AND ANALYSIS

This section discusses the survey design process, sampling method, and framework for assessing NYSERDA's contribution to demonstration and replication projects.

2.1 SURVEY DESIGN AND IMPLEMENTATION

The R&D demonstration survey instrument, developed by IEC with input from NYSERDA evaluation and R&D staff, was designed to collect information about the benefits of demonstration projects, replications, NYSERDA's role, and participant satisfaction with NYSERDA's R&D program. The current instrument builds on the previous survey, but incorporates several refinements based on guidance from NYSERDA. Differences between the previous and current survey include the following:

- Asked open-ended responses first for list questions, then read each item on the list;
- For benefits questions, asked specific questions about energy efficiency, power production, and demand reduction, then asked for all other benefits;
- Changed the cost effectiveness questions to specify whether benefits are total or annual, and the time period over which benefits accrued;
- Administered the survey electronically and populated the database as each survey was completed;
- Developed a new survey instrument for replication projects identified in the primary survey; and
- Developed a new instrument to re-survey projects from the previous round.

The evaluators aimed to survey the individual that was most knowledgeable about each project. Since each project was unique, the type of person most knowledgeable about the impacts varied. The Principal Investigator (PI) listed in NYSERDA's R&D Metrics Database was assumed to be most knowledgeable and was the intended point of contact, but the survey allowed for a different respondent if the original PI was no longer with the firm, as long as that person was knowledgeable about the demonstration project. Depending on the project, the PI may be the integrator, vendor, or site owner. The database sometimes indicated the PI's role, but in many cases did not. As part of the scheduling process, APPRISE (the firm that scheduled and helped to administer the survey) determined whether the respondent was an integrator, vendor, or site owner to ensure that the appropriate survey instrument was used.

Although there were three separate survey instruments for integrators, vendors, and site owners, most of the questions in the three surveys were identical or extremely similar. The main difference between the surveys was the replication section. Specifically, the integrator and site owner surveys defined replication as *new installations or scaling up* of the demonstrated technology, while the vendor survey defined replication as additional *sales*. Other differences between the survey instruments were minor, and reflected differences in who was taking the survey (for example, the integrator survey asked about the respondent's interactions with vendors and site owners, while the site owner survey asked about interactions with integrators and vendors).

APPRISE pre-tested the survey with four respondents and IEC incorporated suggested revisions into the revised survey instruments. The main revision from the pre-test was to ensure sufficient space in the Microsoft Access survey instrument for the survey administrators to write notes for each question.

On December 28, 2015, NYSERDA sent an advance letter requesting PIs to participate in the survey. The letter introduced the evaluation team, specified the project that the survey would focus on, and provided NYSERDA and IEC contact information for the PIs to call if they had any questions. NYSERDA shared responses to this communication with IEC and APPRISE to inform the screening and scheduling task.

The screening and scheduling calls began the week of January 4, 2016. Scheduling calls were attempted at least three times per week, at different times of day and on different days of the week. During scheduling, if a contact's voicemail was reached, a message was left. Every effort was made to connect with the original PI when possible, but if the listed PI was no longer available, referrals were followed. While all surveys were scheduled by APPRISE, both IEC and APPRISE staff conducted them. Given the unique circumstances surrounding each demonstration project, the policy analysts who conducted the surveys were given the flexibility to tailor questions as necessary. Respondents were not incentivized for their participation.

Following the completion of primary surveys, IEC and APPRISE conducted a survey with replication projects identified during the primary survey. This survey used a new instrument developed by IEC and approved by NYSERDA evaluation staff. The survey asked many of the same questions as the demonstration survey, but to replication projects rather than demonstration projects. The primary goals of these surveys were to identify additional benefits and replications not reported in the primary survey.

IEC and APPRISE initially planned to survey site owners or integrators at sites where a vendor was the PI. However, no vendors surveyed were able to identify appropriate secondary contacts. In April 2016, NYSERDA and IEC decided to forego secondary surveys where vendors were the PIs.

IEC developed an Access database to capture and quantify the in-depth survey data. The survey analysts entered their survey data directly into the database during the survey. This was a change from the last survey, where responses were recorded on paper during the survey and entered into an electronic database after the survey was completed. Analysts at IEC and APPRISE reviewed the data to ensure their accuracy and consistency.

2.2 POPULATION AND SURVEY COMPLETIONS

The survey population was drawn from NYSERDA's R&D Metrics Database, which includes basic project information for all of NYSERDA's R&D demonstration projects. In addition to the screening criteria used in the previous two surveys, the current survey excluded project types that will be a smaller focus of NYSERDA's R&D efforts after 2015; these include: Combined Heat and Power (CHP), Industrial Products, and Industrial Process Efficiency projects. Additionally, NYSERDA excluded all customer-sited projects from the current survey.

IEC developed the sample frame in steps. First, IEC compiled a list of projects to be surveyed that included all product demonstration, on-site process improvement, and on-site power production projects with close dates of 2011-2013 from NYSERDA's Contracts Report spreadsheet. Then, IEC excluded CHP demos, CHP Incentives, Industrial Process Efficiency, and Industrial Products projects. Finally, IEC excluded any projects that were customer-sited or terminated. This process resulted in 79 unique projects to be surveyed.

IEC separately looked into whether any demonstration projects from the Emerging Technologies and Accelerated Commercialization (ETAC) program were completed during the 2011-2013 timeframe, as ETAC projects are not included in NYSERDA's Contracts Report spreadsheet. IEC found that ETAC did not commence any demonstrations until 2012 at the earliest, and no ETAC demonstrations were completed by the end of 2013. Thus, the survey did not include any ETAC projects.

Based on these screening criteria, IEC developed a sample frame containing 79 demonstration projects that were completed between 2011 and 2013.⁷ NYSERDA asked IEC to remove ten projects from the sample frame, including all four of the on-site power production projects identified and three Department of Transportation funded projects not intended for replication.⁸ Therefore, the final sample frame for this study consisted of 69 demonstration projects. The evaluation team attempted to conduct a full census rather than drawing a sample from the 69 eligible projects. The sample was not stratified in any way.

The team made an extensive effort to minimize non-response bias and obtain as many completed surveys as possible, resulting in 48 completed surveys (70 percent response rate), as shown in Table 2-1. Of the 21 non-completions, there were 10 projects for which the PI could not be reached or the contact had no knowledge of the project. Excluding the 10 PIs who had left their former firms, did not have contact information, or did not have any knowledge of the project, the adjusted response rate would be 81 percent.

Table 2-1. Final Survey Disposition

Status	Count
Starting Number of Projects	79
Out of Sample Frame	10
Removed by NYSERDA	5
Not a Demonstration Project	5
In Sample Frame	69
Completions	48
Refusals	1
PI Not Responsive	10
Respondent Left Company, No Contact Information, or no Project Knowledge	10
Response Rate (48 completions out of 69 projects in sample frame)	70%
Adjusted Response Rate (48 completions out of 59 projects, excluding the 10 PIs with no potential respondent)	81%

The sample frame for the replication survey consisted of 26 replications with contact information identified during the primary survey. Since many of these projects had not received grants from NYSERDA like the projects in the primary demonstration survey, it was more difficult to reach these respondents for a 30 minute survey. IEC and APPRISE surveyed 11 of the 26 replication projects identified during the primary survey, for a response rate of 42 percent.

⁷ The R&D Metrics Database does not include the project completion date; therefore, the contract closed date was used as a proxy. This is consistent with the methodology from the previous rounds of the survey. In some cases, project activities ended well before the contract was closed.

⁸ We initially conducted surveys with the three Department of Transportation projects that were removed by NYSERDA. We omitted these survey results from the report. There was one replication associated with these projects that was also removed.

2.3 METHOD FOR ESTIMATING DEMONSTRATION PROJECT IMPACTS

While the survey was the primary method for estimating demonstration benefits, the evaluators also consulted NYSERDA's R&D Metrics Database and final project reports. Following is a brief description of the information sought from each source:

- **Survey.** Respondents were asked to report their benefits, or to confirm benefits data from the R&D Metrics Database. Respondents were asked whether benefits were annual or total. If they were annual, respondents were asked for the year(s) when benefits accrued to determine if benefits persisted after the project ended. While most respondents were able to describe their benefits in qualitative terms, fewer were able to quantify the benefits. Therefore, this report presents the benefits data in two ways, qualitatively and quantitatively.⁹ Although the qualitative and quantitative results cannot be aggregated, the fact that many more respondents were able to provide qualitative data suggests that total benefits exceed what the respondents were able to quantify.
- **R&D Metrics Database.** NYSERDA requires demonstration participants to submit an annual summary of metrics addressing the energy, environmental, and economic benefits of their projects, during and after project implementation.¹⁰ Since 2009, NYSERDA has been collecting benefits data in an R&D Metrics Database. While the creation of the database is a positive development, the data are not as comprehensive as they could be. Out of 79 projects in the initial survey sample, 11 had resource savings (energy, non-energy, or air emissions) captured in the database. Nine of the 11 projects were in the final 69-project sample frame. Seven of these nine projects also reported net dollars (revenue generation or cost savings). Six projects reported jobs created or retained. The evaluators used this information as a starting point, and attempted to verify the figures with survey respondents.
- **Reports.** NYSERDA requires most demonstration participants to submit final reports that describe the demonstration project and the benefits realized at the end of the project. NYSERDA provided IEC with final project reports for 59 projects in the initial 79-project sample frame. In addition, APPRISE obtained a limited number of reports prior to conducting the surveys, either directly from the respondent or through a targeted Web search. Reports that were found prior to conducting a survey were used as a starting point for the discussion.

2.4 METHOD FOR ESTIMATING NYSERDA'S CONTRIBUTION

An important element in impact assessment is separating impacts to which the program contributed from impacts that would have occurred without the program. The current survey uses the same methodology to accomplish this task as Round 2 of the R&D Demonstration Survey.

The analysis estimates NYSERDA's contribution based on a composite of five factors, which are in turn based on the respondent's answers to a number of survey questions:

- **Novelty:** Was this the first time that participants had demonstrated the technology?
- **Importance:** How important was NYSERDA's assistance in developing the demonstration projects?
- **Likelihood:** What is the likelihood that participants would have carried out the demonstration projects without NYSERDA?

⁹ Qualitative results include respondents who were able to quantify their benefits *and* respondents who were not able to quantify their benefits.

¹⁰ The post-implementation reporting period varies by type of project.

- **Magnitude:** How did NYSERDA affect the magnitude of the impacts of the demonstration projects?
- **Timing:** How did NYSERDA affect the timing of the demonstration projects?

The evaluators used a similar method to estimate NYSERDA's contribution to replication projects. The complete methodology for estimating NYSERDA's contribution to demonstration and replication projects can be found in Appendix C.¹¹

¹¹ Appendix C also describes the methods for estimating replication project impacts and for calculating the cost-effectiveness of NYSERDA's R&D demonstration projects.

Section 3:

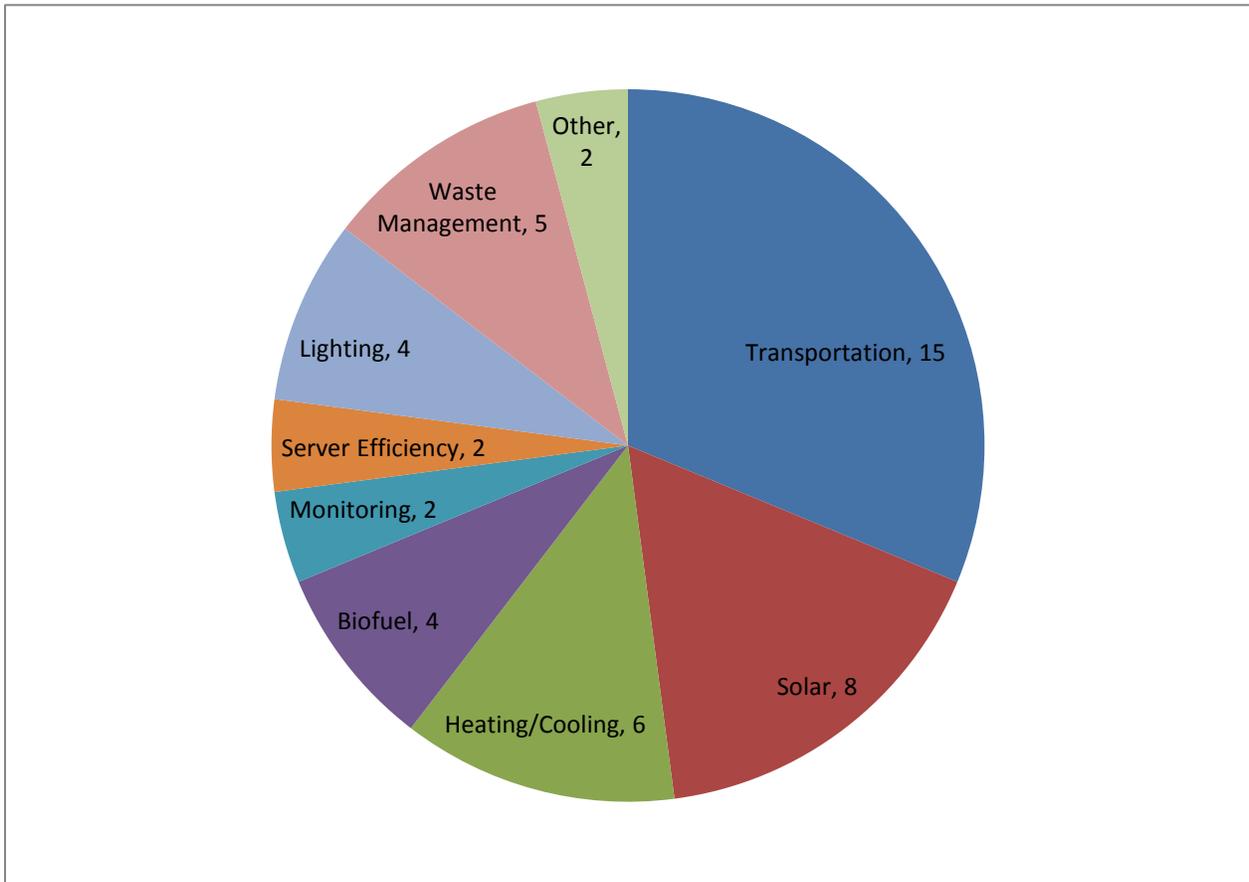
OVERVIEW OF NYSERDA DEMONSTRATION PROJECTS

This section provides an overview of demonstration projects with completed surveys in terms of project type and market actor, prior experience with demonstration projects, and the benefits and challenges associated with planning and executing the projects.

3.1 NYSERDA PROJECT TYPES AND PARTICIPANTS

Figure 3-1 shows the distribution of survey respondents across project type. Transportation was the most common project type among survey respondents, followed by Solar, Heating/Cooling, Waste Management, Lighting, and Biofuel. The rest of the project types had two or fewer respondents each.¹² There were two projects that fell in the “other” category - one project focused on lean manufacturing and the other project focused on renewable energy infrastructure.

Figure 3-1. Survey Respondents by Project Type (n=48)



¹² Both Monitoring projects were classified under the now-closed Transmission & Distribution program.

Given the breadth of projects across programs, NYSERDA classified the demonstration projects in the final sample frame into two distinct categories: on-site process improvement and product demonstration. (On-site power production projects were included in the previous study, but were excluded from this study.) NYSERDA defines these categories in the following ways:¹³

- **On-site Process Improvement:** These projects are intended to demonstrate process efficiency at a particular site, typically (but not always) a manufacturing facility. Expected benefits include savings of energy, water, and other resources. Examples of process improvement projects include: paper drying by hot pressing, water recycling at a paperboard recycling plant, and improved plastic injection mold base.
- **Product Demonstration:** These projects involve the demonstration of a commercially available product in its intended environment (this does not include on-site power generation projects). The goal is to increase sales and usage of the demonstrated product in the market. Results are used for product commercialization or to generate objective performance information for policymakers or end-users. Products funded in this category encompass a wide range of technologies.

Table 3-1 shows the number and percent of survey respondents associated with each project category. Product demonstration projects constituted 94 percent of the projects surveyed in this study.

Table 3-1. Demonstration Survey Respondents by NYSERDA Project Category

NYSERDA Project Category	Number of Surveyed Projects	Percent of Surveyed Projects
On-site Process Improvement	3	6%
Product Demonstration	45	94%
Total	48	100%

Demonstration projects can be designed and proposed by integrators, vendors, or site owners. For each project, only one of the three actors was solicited for the survey. As shown in Table 3-2, 77 percent of respondents were integrators, followed by vendors (17 percent) and site owners (six percent).

Table 3-2. Demonstration Survey Respondents by Participant Type

Participant Type	Number of Surveyed Projects	Percent of Surveyed Projects
Integrator	37	77%
Vendor	8	17%
Site Owner	3	6%
Total	48	100%

3.2 EXPERIENCE WITH DEMONSTRATION PROJECTS PRIOR TO NYSERDA PROJECT

Initial survey questions covered prior experience with demonstrating the technology and a comparison of the prior demonstrations (if any) to the NYSERDA-funded demonstration. As shown in Table 3-3, a solid majority of respondents (40 projects, or 83 percent) stated that the NYSERDA project was their first

¹³ Definitions provided by NYSERDA in *Project Types and Groups* (undated file).

time demonstrating the technology. Out of the seven projects that had demonstrated the same technology before, four had demonstrated it once prior to the NYSERDA project, while one project had demonstrated the same technology more than 10 times before.

Table 3-3. Number of Times the Technology was Demonstrated Prior to NYSERDA-Funded Project

Number of Times the Technology was Demonstrated Prior to the NYSERDA-Funded Project	Number of Projects (n=48)	Percent of Projects
Not At All	40	83%
Did Not Know If Technology Was Previously Demonstrated	1	2%
Technology Was Previously Demonstrated	7	15%
1 time	4	
2 to 10 times	0	
More than 10 times	1	
Don't Know or Did Not Specify How Many Times Previously Demonstrated	2	

Respondents who had previously demonstrated the same technology were asked to provide additional information regarding the differences (if any) between the NYSERDA-funded project and their previous demonstrations. As shown in Table 3-4, only one respondent indicated that the prior demonstration(s) were basically the same as the NYSERDA demonstration. Four of the respondents who had conducted prior demonstrations stated that the NYSERDA project was larger in scale than previous demonstrations. Three respondents indicated that the NYSERDA demonstration project used different inputs than previous projects.

Table 3-4. Scope of NYSERDA Demonstration Project in Comparison to Previous Demonstrations

Response	Number of Projects* (n=7)	Percent
No Difference	1	14%
Smaller in Scale Than Previous Demonstrations	0	0%
Larger in Scale Than Previous Demonstrations	4	57%
Different Inputs	3	43%
Different Application of the Technology	1	14%
Does Not Know Whether There Was a Difference	0	0%
Notes (*): Multiple responses were allowed. The responses reflect the seven projects with prior demonstration projects and percentages are calculated based on these seven projects.		

3.3 BENEFITS AND CHALLENGES

R&D efforts involve new and previously untested technologies where success is not assured. Therefore, the survey included a question to ascertain whether the demonstration projects accomplished their objectives. As shown in Table 3-5, 91 percent of respondents stated that their projects met “all” or “most” of their objectives, with over half of all projects meeting all of their objectives. Four respondents reported meeting some of their project objectives. No respondents reported meeting none of their project objectives.

Table 3-5. Extent to Which Demonstration Projects Achieved their Objectives

	Number of Projects (n=48)	Percent
All	28	58%
Most	16	33%
Some	4	8%
None	0	0%
Total*	48	100%

Note: (*) Figures do not sum exactly to 100% due to rounding.

Respondents whose projects did *not* meet *all* of their objectives were asked to explain why. The most common themes were:

- Operating and maintenance costs were higher than expected;
- Expected energy savings or productivity gains were lower than expected; and
- Acceptance by the target market was lower than expected.

Other responses included:

- Respondent was unaware of objectives so could not say whether all of them were met; and
- The project was unable to reach definitive conclusions about the technology.

The survey also investigated the benefits and challenges encountered by respondents in the process of planning and executing their projects. The benefits questions allowed for open-ended responses. The most common benefit reported was increased knowledge or experience with the technology, process, method, or approach. The range of benefits from planning and executing the projects is broad and includes the following:

- Gained knowledge about, and/or improved the technology, process, method, or approach;
- Gained valuable experience working with manufacturers, regulators, and market actors;
- Proved that the technology, process, or approach is viable;
- Established relationships with the community and potential business partners;
- Gained access to data that was previously unavailable;
- Identified the appropriate end users;

- Enabled the creation of a new independent organization;
- Obtained follow-up funding from other entities; and
- Obtained marketing benefits, including increased publicity and enhanced credibility or reputation.

The questions about challenges were close-ended and used similar answer choices as the previous survey. Technological issues and lack of interest among potential end users were the most common responses (29 percent and 23 percent, respectively), as shown in Table 3-6. Several respondents identified difficulty finding an appropriate site (17 percent), timing (17 percent), lack of funding (15 percent), and lack of qualified personnel or expertise (13 percent). Three respondents identified regulatory barriers, and two respondents identified cost.

Table 3-6. Challenges in Implementing the NYSERDA Demonstration Project

Challenge	Number of Projects* (n=48)	Percent
Technological issues	14	29%
Lack of interest among potential end users	11	23%
Could not find an appropriate site	8	17%
Timing was not right	8	17%
Lack of funding	7	15%
Lack of qualified personnel or expertise	6	13%
Regulatory barriers	3	6%
Cost prohibitive	2	4%
Other	19	40%

Notes (*): Multiple responses were allowed. The percentages are calculated based on the 48 projects.

As shown in the previous table, 40 percent of all respondents cited “other” barriers, reflecting the diverse suite of projects in NYSERDA’s R&D portfolio. “Other” challenges included the following:

- Lack of coordination or cooperation from various market actors or end users.
- Lack of data availability or poor-quality data from third parties or end users.
- Construction-related challenges and restrictions.
- Delays in the NYSERDA funding approval process (one respondent).

Section 4:

DEMONSTRATION IMPACTS AND NYSERDA CONTRIBUTION

This section describes the types of impacts reported by demonstration participants, and quantifies these impacts, where possible, using the survey responses and R&D metrics data. This section also describes NYSERDA's influence on the development of the projects and estimates NYSERDA's contribution to reported impacts.

4.1 TYPES OF IMPACTS

The survey was designed to make the fullest possible use of the information in NYSERDA's R&D Metrics Database. Survey respondents whose projects had data in the R&D Metrics Database were asked to confirm the types of benefits reported. Most of these respondents validated the accuracy of the data; however, several mentioned additional benefits that were not captured in the R&D Metrics Database. This is not unexpected given the broad variety of potential benefits generated by the projects.

Table 4-1 shows the distribution of direct benefits among the surveyed demonstration projects by project type. CO₂ emissions offset were considered a direct benefit for all project types that reported energy-related benefits.

Table 4-1. Direct Benefits by Project Type

Project Type	Number of Projects	Direct Benefit Type**	Number of Projects Reporting Direct Benefit*
Transportation	15	CO ₂ Emissions Offset	8
		Gasoline Saved	5
		Diesel Fuel Saved	2
		Electricity Saved	2
		Electricity Produced	1
		NOx and PM Emissions Offset	1
		Vehicle Miles Traveled Avoided	1
Solar	8	CO ₂ Emissions Offset	7
		Electricity Produced	3
		Electricity Saved	3
		Heating Fuel Saved	1
		SO ₂ Emissions Offset	1
		NOx and PM Emissions Offset	1
		Natural Gas Displaced	1
		Propane Displaced	1
Heating/Cooling	6	CO ₂ Emissions Offset	6
		Electricity Saved	6
		Promotion of Energy Efficient Technologies	1
Biofuel	4	CO ₂ Emissions Offset	3
		Heating Fuel Saved	2
		Electricity Produced	1
		SO ₂ Emissions Offset	1
		Promotion of Energy Efficient Technologies	1
Waste Management	5	CO ₂ Emissions Offset	3
		Electricity Saved	2
		Gasoline Saved	1
		Decrease in Runoff	1
		Nitrogen and Phosphorus Reduction	1
Lighting	4	CO ₂ Emissions Offset	4
		Electricity Saved	3
Monitoring	2	None - only indirect benefits reported	0
Server Efficiency	2	CO ₂ Emissions Offset	2
		Electricity Saved	2
Other	2	NOx and PM Emissions Offset	1
		Promotion of Energy Efficient Technologies	1
		Vehicle Miles Traveled Avoided	1
		CO Emissions Offset	1
		VOC Reduction	1

Note: (*) Multiple responses were allowed.

Note: (**) IEc calculated or re-calculated CO₂ benefits based on energy numbers provided by respondents. If respondents provided CO₂ benefits without energy benefits, the CO₂ benefits provided were used.

Table 4-2 summarizes the direct benefits reported by surveyed respondents. The single most commonly identified benefit was electricity saved (38 percent). Gasoline saved was cited as the second most commonly identified benefit (12 percent). Electricity produced followed as the third most commonly identified benefit (10 percent each). Other direct benefits, such as promotion of energy efficient technologies, NO_x and PM emissions offset, heating fuel saved, etc., were also reported by three or fewer projects each. As noted above, CO₂ emissions offsets were considered a direct benefit for all projects that report energy-related benefits (69 percent).

Table 4-2. Direct Benefits Reported by Survey Respondents

Direct Benefit Type	Number of Projects (n = 48)*	Percent
CO ₂ Emissions Offset	33	69%
Electricity Saved	18	38%
Gasoline Saved	6	12%
Electricity Produced	5	10%
Promotion of Energy Efficient Technologies	3	6%
NO _x and PM Emissions Offset	3	6%
Heating Fuel Saved	3	6%
Diesel Fuel Saved	2	4%
SO ₂ Emissions Offset	2	4%
Vehicle Miles Traveled Avoided	2	4%
VOC Reduction	1	2%
Natural Gas Displaced	1	2%
Propane Displaced	1	2%
Nitrogen and Phosphorus Reduction	1	2%
Decrease in Runoff	1	2%
CO Emissions Offset	1	2%

Note: (*) Multiple responses were allowed. Percentages were calculated based on the 48 projects.

Respondents were also asked to describe the indirect benefits of their projects. Indirect benefits include secondary or downstream benefits resulting from the direct project benefits. As shown in Table 4-3, CO₂ emissions offset was the most commonly cited indirect benefit (17 percent), although IEc calculated CO₂ emissions based on reported energy savings. CO₂ emissions offset were considered an indirect benefit for all projects that report energy-related indirect benefits. Electricity saved was the second-most commonly cited indirect benefit (8 percent). Time savings and improved understanding of emerging technologies were reported as the third-most commonly cited indirect benefits (six percent each).

Table 4-3. Indirect Benefits Reported by Survey Respondents

Indirect Benefit Type	Number of Projects (n = 48)*	Percent
CO ₂ Emissions Offset	8	17%
Electricity Saved	4	8%
Improved Understanding of Emerging Technologies	3	6%
Time Savings	3	6%
Gasoline Saved	2	4%
Electricity Produced	2	4%
Market Access	2	4%
Improvement to Surrounding Environment	2	4%
Promotion of Energy Efficient Technologies	2	4%
Job Creation	1	2%
Sound Reduction	1	2%
Land Conservation	1	2%
Material Waste Reduction	1	2%
Increased Safety	1	2%
Nitrogen and Phosphorus Reduction	1	2%
Compost Creation	1	2%

Note: (*) Multiple responses were allowed. Percentages were calculated based on the 48 projects.

4.2 QUANTIFIABLE IMPACTS OF DEMONSTRATION PROJECTS

Given the broad range of projects and benefit types, summarizing the benefits of NYSERDA’s R&D demonstration projects in a limited number of metrics is challenging. The challenge is compounded by the time that elapsed since projects were completed, which makes it difficult for respondents to recall the precise benefits that their projects produced. Respondents with data in the R&D Metrics Database were asked to confirm or amend the data; however, most respondents did not have metrics data. Therefore, respondents were asked to provide their best estimate of the impacts. It is possible that additional projects beyond those shown in the following tables had impacts, but there were no data to quantify their benefits.

Table 4-4 summarizes the number of surveyed projects that reported quantitative benefits data – electricity production, electricity savings, fuel savings, and emission offsets – by NYSERDA project category. Out of the 48 projects surveyed, 18 projects (38 percent) provided quantitative benefits data.

Table 4-4. Number of Surveyed Projects that Provided Quantitative Benefits Data, by NYSERDA Project Category

NYSERDA Project Category	Number of Surveyed Projects	Number of Projects Providing Quantitative Benefits			
		Electricity Produced	Electricity Saved	Fuel Saved	Emission Offsets*
Product Demonstration	45	4	8	6	4
On-Site Process Improvement	3	0	0	1	0
Total	48	4	8	7	4

Note: (*) The four projects that reported emission offsets also reported benefits in other categories.

Tables 4-5 and 4-6 summarize direct and indirect benefits, respectively, reported by survey respondents. Note that respondents were allowed to report multiple direct benefits. Benefit amounts were calculated as total benefits realized from the start of the project through the end of 2015.

Table 4-5. Quantifiable Direct Benefits Reported by Survey Respondents

Direct Benefit Type	Number of Surveyed Projects with Estimated Benefits	Amount*
CO ₂ Emissions Offset (lbs.)	18	82,208,511
Electricity Saved (kWh)	8	2,342,192
Gasoline Saved (gallons)	4	1,494,081
Electricity Produced (kWh)	4	157,767
Diesel Fuel Saved (gallons)	2	51,958
NO _x and PM Emissions Offset (lbs.)	2	58,860
Vehicle Miles Traveled Avoided	2	34,199,759
Heating Fuel Saved (gallons)	1	4,000,000
SO ₂ Emissions Offset (lbs.)	1	168
CO Emissions Offset (lbs.)	1	760,000
VOC Reduction (lbs.)	1	82,000
Natural Gas Displaced (therms)	1	1,080
Propane Displaced (gallons)	1	1,014

Note: (**) IEc calculated or re-calculated CO₂ benefits based on energy numbers provided by respondents. If respondents provided CO₂ benefits without energy benefits, the CO₂ benefits provided were used.

Table 4-6. Quantifiable Indirect Benefits Reported by Surveyed Respondents

Indirect Benefit Type	Number of Surveyed Projects with Estimated Benefits	Amount
CO ₂ Emissions Offset (lbs.)	2	1,461,240
Electricity Produced (kWh)	1	48,000

The R&D demonstration projects produced other benefits in addition to the benefits outlined above. Of the 69 projects in the sample frame, there was one project for which a final report was submitted, but a survey was not conducted due to difficulties identifying the appropriate project contact. This project's final report outlined annual benefits of 288 kWh saved and 168.6 tons of CO₂ saved. While these results could not be verified, the nature of the project indicates that the project is ongoing and benefits continue to be realized.

In addition to providing quantifiable impacts of identified direct and indirect benefits, respondents also provided job creation and loss figures. Fifteen out of 48 demonstration projects (31 percent) reported that they affected the number of employees in New York. Fourteen projects (29 percent) reported that they created or retained jobs, including both full-time and part-time contractor jobs. These 14 projects reported that 152 jobs were created and/or retained in New York. One project reported that they created 55 jobs in New Jersey and California. One project (two percent) reported a loss of jobs, but could not quantify the number.

4.3 REVENUES AND COST SAVINGS OF DEMONSTRATION PROJECTS

This study also evaluated revenues and cost savings that demonstration projects achieved. Revenues and cost savings were calculated either through projects' decommissioning date or through 2015 (the year the survey was conducted) if the project was reported to still be in use. NYSERDA's R&D Metrics Database includes some revenue and cost savings data, and the survey included questions to confirm the metrics data or collect new information. This approach was similar to the method used for estimating impacts.

Of the 48 projects surveyed, 11 projects (23 percent) reported that they generated revenues. As shown in Tables 4-7 and 4-8, five projects (10 percent) were able to estimate revenue figures and reported that a total of \$11,190,000 was generated to date. This figure is mostly due to two projects that reported \$2.8 million and \$8 million each in sales revenue. This type of revenue distribution is typical for R&D portfolios, where one or two successful projects often account for the majority of the portfolio's financial benefits.

Table 4-7. Summary of Revenue Generated from Demonstration Projects, by NYSERDA Project Category

NYSERDA Project Category	Number of Surveyed Projects	Number of Projects with Quantified Revenues
Product Demonstration	45	4
On-Site Process Improvement	3	1
Total	48	5

Table 4-8. Summary of Revenue Generated from Demonstration Projects, by Project Type

Project Type	Number of Surveyed Projects with Estimated Revenue	Revenue Generated
Transportation	2	\$2,850,000
Biofuel	1	\$8,000,000
Waste Management	1	\$300,000
Server Efficiency	1	\$40,000
Total	5	\$11,190,000

Out of the 48 projects, 28 projects (58 percent) reported that they realized cost savings. As shown in Tables 4-9 and 4-10, 11 projects (23 percent) were able to estimate their cost savings.¹⁴ These 11 projects estimated total cost savings of \$21,068,716. This figure includes energy cost savings as well as cost savings resulting from enhanced productivity and efficiency.

Table 4-9. Summary of Cost Savings from Demonstration Projects, by NYSERDA Project Category

NYSERDA Project Category	Number of Surveyed Projects	Number of Projects with Quantified Cost Savings
Product Demonstration	45	10
On-Site Process Improvement	3	1
Total	48	11

Table 4-10. Summary of Cost Savings Generated from Demonstration Projects, by Project Type

Project Type	Number of Surveyed Projects with Estimated Cost Savings	Cost Savings Generated
Solar	2	\$20,448
Heating/Cooling	2	\$55,900
Server Efficiency	2	\$477,485
Transportation	2	\$20,324,283
Biofuel	1	\$31,000
Lighting	1	\$3,600
Waste Management	1	\$156,000
Total	11	\$21,068,716

Of the 11 projects that were able to estimate cost savings, one project reported that cost savings occurred from a change in fuel type used. This project reported that approximately \$31,000 of cost savings resulted from replacing the use of propane.

It is important to note that the tables above only capture revenues and cost savings achieved at the time the survey was conducted. Several respondents indicated that revenues and cost savings are expected to

¹⁴ Two projects reported revenues and cost savings.

continue. Therefore, total revenues and cost savings should continue to grow over time. In addition, the aforementioned project for which a final report was submitted, but a survey was not conducted, reported annual cost savings of \$12,614. While these results could not be verified, the nature of the project indicates that the project is ongoing and cost savings continue to be realized.

4.4 NYSERDA INFLUENCE ON DEMONSTRATION PROJECTS

The survey included a number of questions to assess NYSERDA’s influence on the demonstration projects. An initial question aimed to establish the chronology of events by documenting when respondents first learned about NYSERDA’s R&D Program. The earlier in the project respondents learned about the program, the more likely it is that NYSERDA influenced the design of the project. As shown in Table 4-11, 37 projects (77 percent) learned about the program prior to planning their demonstration projects, and six projects (13 percent) learned about it during the planning phase. Only two projects (four percent) learned about the program after starting implementation. While these figures do not by themselves establish NYSERDA’s influence, the timing is consistent with NYSERDA contributing to the development of the projects.

Table 4-11. When Firms Learned About NYSERDA R&D Program

Response	Number of Projects (n=48)	Percent of Projects
Prior to Planning	37	77%
During Planning	6	13%
After Finalizing Plans	0	0%
After Starting Implementation	2	4%
Don’t Know/Unable to Answer	3	6%
Total	48	100%

Respondents were asked to rate the importance of NYSERDA’s financial and technical assistance in their decision to undertake the demonstration project on a scale of zero to five, with zero being “not at all important” and five being “very important.” As shown in Table 4-12, 38 projects (79 percent) rated NYSERDA’s financial assistance five out of five in terms of importance, and 44 projects (92 percent) rated it at least four out of five. The average rating for this question was 4.7 out of 5.0. The responses indicate that NYSERDA’s financial assistance was influential in respondents’ decisions to develop the demonstration projects.

Table 4-12. Importance of NYSERDA’s Financial Assistance in Decision to Undertake the Project

Rank	Did Not Answer the Question	Not At All Important 0	1	2	3	4	Very Important 5
Number of Projects (n = 48)	1	0	0	2	1	6	38
Percentage of Projects	2%	0%	0%	4%	2%	13%	79%

Out of 47 projects (one did not answer the question), 13 respondents indicated that they received NYSERDA’s technical assistance. As shown in Table 4-13, the perceived importance of NYSERDA’s technical assistance was slightly more varied than financial assistance, with 77 percent of the 13 respondents rating technical assistance a four or five on the same zero-to-five importance scale. The average score for respondents who answered the question was 4.1.

Table 4-13. Importance of NYSERDA’s Technical Assistance in Decision to Undertake the Project

Rank	Not At All Important 0	1	2	3	4	Very Important 5
Number of Projects (n = 13)	0	1	0	2	4	6
Percentage of Projects	0%	8%	0%	15%	31%	46%

To provide a broader context for assessing NYSERDA’s influence on the demonstration projects, respondents were asked to consider other organizations that provided funding and technical assistance. As shown in Table 4-14, 27 projects (56 percent) received funding from other sources, in combination with technical assistance or alone. Respondents received nearly \$3.7 million in funding from a variety of sources, including non-profits, state agencies, institutions, and corporations. An even higher percentage of respondents (75 percent) received technical assistance from other organizations, either alone or in combination with financial assistance. Technical assistance providers included engineering firms, state agencies, utilities, universities, manufacturers, and other entities. While these findings indicate that NYSERDA was not the only contributor, they do not indicate the extent to which NYSERDA’s contribution mattered. By design, NYSERDA’s R&D Program aims to be a catalyst rather than the sole actor; therefore, the program’s overall influence may not be directly proportional to the share of funding or other assistance provided by NYSERDA.

Table 4-14. Non-NYSERDA Funding and Technical Assistance

Assistance Type	Number of Projects (n = 48)	Percent of Projects
Funding Only	5	10%
Technical Assistance Only	14	29%
Both Funding and Technical Assistance	22	46%
No Additional Funding or Technical Assistance	4	8%
Don’t Know*	3	6%
Total**	48	100%

Note: (*) “Don’t Know” includes one respondent who did not receive funding but did not know if other sources provided technical assistance, plus two respondents who did not receive technical assistance and were unsure if they received funding.

(**) Figures do not sum exactly to 100% due to rounding.

To better understand NYSERDA’s influence on the demonstrations, respondents answered questions about the likelihood that they would have completed the project in New York State without NYSERDA. As shown in Table 4-15, 36 projects (75 percent of respondents) rated the likelihood of completing the project in New York without NYSERDA’s assistance a zero or one out of five, on a scale where zero represents “not at all likely” and five represents “very likely.” The average rating was 0.8. This suggests that NYSERDA’s financial assistance was an important factor in developing the demonstrations in New York. As shown in Table 4-16, the likelihood of completing the project in New York State without NYSERDA’s technical assistance was more varied, with 46 percent of respondents out of the 13 that received technical assistance giving a rating of zero or one. The average rating was 2.0.

Table 4-15. Likelihood of Completing the Project in New York State without NYSERDA’s Financial Assistance

Rank	Did Not Answer the Question	Not At All Likely 0	1	2	3	4	Very Likely 5
Number of Projects (n = 48)	2	29	7	6	2	0	2
Percentage of Projects*	4%	60%	15%	13%	4%	0%	4%

Table 4-16. Likelihood of Completing the Project in New York State without NYSERDA’s Technical Assistance

Rank	Not At All Likely 0	1	2	3	4	Very Likely 5
Number of Projects (n = 13)	3	3	1	4	1	1
Percentage of Projects*	23%	23%	8%	31%	8%	8%

Note: (*) Figures do not sum exactly to 100% due to rounding.

Next, respondents answered questions about how NYSERDA affected the magnitude of project impacts and project timing. As shown in Table 4-17, 90 percent of respondents stated that projects would have happened on a smaller scale (44 percent) or not at all (46 percent) without NYSERDA. As shown in Table 4-18, a similar percentage of respondents (83 percent) indicated that their projects would have happened later (25 percent) or not at all (58 percent) without NYSERDA. Respondents who stated that the project would have happened later were asked to estimate how much later; the average response was 2.6 years. These responses suggest that NYSERDA played an important role in accelerating the projects and enhancing their impacts.

Table 4-17. Estimated Project Impacts Without NYSERDA

Response	Number of Projects (n = 48)	Percent of Projects
Same without NYSERDA	3	6%
Smaller without NYSERDA	21	44%
Larger without NYSERDA	1	2%
Project Would Not Have Happened without NYSERDA	22	46%
Did Not Answer the Question	1	2%
Total	48	100%

Table 4-18. NYSERDA's Effect on Project Timing

Response	Number of Projects (n = 48)	Percent of Projects
Earlier	0	0%
About the same time	7	15%
Later (Average: 2.6 Years Later)	12	25%
Project would not have happened without NYSERDA	28	58%
Did Not Answer the Question	1	2%
Total	48	100%

4.5 NYSERDA CONTRIBUTION TO R&D DEMONSTRATION PROJECTS

Using the answers to the influence questions in Section 4.4, and experience with prior demonstrations, a contribution score was derived for each demonstration project. The score is a composite of five factors that reflect NYSERDA's influence.¹⁵ The average contribution score across demonstration projects was 4.7 out of 6.0.¹⁶ The contribution score for each project was converted to a percentage and applied to the impacts reported for each project. For example, a contribution score of 4.7 translates to 75 percent.

Tables 4-19 and 4-20 show NYSERDA's contribution to the direct and indirect benefits that survey respondents were able to quantify. Given the uncertainties inherent in this type of analysis, the results are best interpreted as indicating the general scale of NYSERDA's contribution rather than a precise quantification of impacts that can be directly attributed to NYSERDA.

¹⁵ The five factors are: novelty, importance, likelihood, magnitude, and timing. The method used to calculate the contribution score is described in Appendix C.

¹⁶ This is the simple average across projects and is shown for illustrative purposes only. It does not account for the relative size of benefits reported by each project, and therefore cannot be applied to total reported benefits. Instead, the analysis calculates the contribution separately for each project based on the project's reported benefits and the project's individual contribution score.

Table 4-19. NYSERDA's Contribution to Quantifiable Direct Benefits

Direct Benefit Type	Amount	NYSERDA Contribution
Electricity Produced (kWh)	157,767	118,325
Electricity Saved (kWh)	2,342,192	1,838,347
Diesel Fuel Saved (gallons)	51,958	38,969
Heating Fuel Saved (gallons)	4,000,000	3,000,000
Gasoline Saved (gallons)	1,494,081	70,560
CO ₂ Emissions Offset (lbs.)	82,208,511	41,775,969
SO ₂ Emissions Offset (lbs.)	168	126
NO _x and PM Emissions Offset (lbs.)	58,860	60
Vehicle Miles Traveled Avoided	34,199,759	1,284,964
Natural Gas Displaced (therms)	1,080	810
Propane Displaced (gallons)	1,014	761

Table 4-20. NYSERDA's Contribution to Quantifiable Indirect Benefits

Indirect Benefit Type	Amount	NYSERDA Contribution
CO ₂ Emissions Offset (lbs.)	1,461,240	1,320,345
Electricity Produced (kWh)	48,000	36,000

Using the same project contribution scores and percentages derived above, the study estimated NYSERDA's contribution to demonstration revenues and cost savings. Table 4-21 shows that NYSERDA contributed to approximately \$8.3 million in revenues. As discussed in Section 4.3, the revenues are mostly attributable to two projects. Table 4-22 shows that NYSERDA contributed to \$719,406 in cost savings, \$23,250 of which was due to a change in fuel type.

Table 4-21. Summary of NYSERDA's Contribution to Revenue Generated from Demonstration Projects

Project Type	Number of Surveyed Projects with Estimated Revenue	Revenue Generated	NYSERDA Contribution
Transportation	2	\$2,850,000	\$2,100,000
Biofuel	1	\$8,000,000	\$6,000,000
Waste Management	1	\$300,000	\$150,000
Server Efficiency	1	\$40,000	\$15,000
Total	5	\$11,190,000	\$8,265,000

Table 4-22. Summary of NYSERDA's Contribution to Cost Savings Generated from Demonstration Projects

Project Type	Number of Surveyed Projects with Estimated Cost Savings	Cost Savings Generated	NYSERDA Contribution
Solar	2	\$20,448	\$15,336
Heating/Cooling	2	\$55,900	\$41,925
Server Efficiency	2	\$477,485	\$377,799
Transportation	2	\$20,324,283	\$141,396
Biofuel	1	\$31,000	\$23,250
Lighting	1	\$3,600	\$2,700
Waste Management	1	\$156,000	\$117,000
Total	11	\$21,068,716	\$719,406

SECTION 5:

REPLICATIONS, IMPACTS, AND DEMONSTRATION INFLUENCE

Replications are a primary goal of NYSERDA’s R&D demonstration projects. This section covers the survey questions regarding the number and type of demonstration projects that were replicated, number of replications, impacts associated with the replications, and the contribution of the demonstration projects to developing the replications. This section also examines the number of replication projects reporting additional replications.

5.1 NUMBER AND TYPES OF REPLICATIONS

The definition of replication varies by market actor. As discussed in Section 1.4, the survey defined replications for integrators and site owners as additional installations or scaling up of the technology or process used in the NYSERDA-funded demonstration project. Replications could be at the same site as the NYSERDA demonstration project or at another site, and may be carried out by the same firm or a different firm than the original demonstration. For vendors, replications are defined as additional sales of the same technology or services that were used in the demonstration project. The sales could be to the same buyer that participated in the demonstration project or to a different buyer.

Thirty-six of the 48 surveyed projects (75 percent) reported replications. Respondents were asked whether their firm or another firm replicated the NYSERDA demonstration project in a similar application or different application. As shown in Table 5-1, 34 projects (71 percent) reported replications for similar applications alone or in combination with different applications. Another two projects (four percent) reported replications for different applications only. Eight projects (17 percent) reported no replications, and the other four (eight percent) did not know.

Table 5-1. Comparison of NYSERDA-Funded Demonstrations to Replications by Application

Replication Market and Application	Number of Projects (n = 48)	Percent of All Projects (n=48)	Percent of Replicated Projects (n=36)
Similar Application Only*	28	58%	78%
Different Application Only	2	4%	6%
Both Similar and Different Applications	6	13%	17%
No Replications	8	17%	-
Don't Know	4	8%	-
Total**	48	100%	100%

Notes: (*) Eight respondents answered “Yes” for similar applications and “Don’t Know” for different applications.

(**) Percentages do not sum to 100% due to rounding.

Respondents who reported different applications were asked to describe how the applications differed from the original demonstration project. Answers varied and included the following:

- Different markets or technologies;
- Different uses;
- Modified the design for particular sites; and
- Applied some parts of the model but not others.

Respondents who reported at least one similar replication were asked about replications in New York State. Twenty-five of the 48 projects surveyed (52 percent) reported at least one replication in New York.

Of these 25 projects, six reported that NYSERDA provided funding for one or more replications, while the other 19 projects indicated that NYSERDA did not provide funding. Table 5-2 below shows the number of replications by project type. Overall, respondents reported 493,605 replications in New York; however, 400,000 of these replications were individual sales (units sold) from one project. The respondent who reported the 400,000 units sold was not able to provide the sales volume in dollars.¹⁷ This project did not report any quantitative benefits, so the benefit figures reported throughout the rest of this section do not include these 400,000 replications.

Table 5-2. Replications in New York State by NYSERDA Project Category

NYSERDA Project Category	Number of Projects Surveyed (n=48)	Demonstration Projects with Replications in NYS				
		Total (n=25)	Without NYSERDA Funding (n=19)	With NYSERDA Funding (n=6)	Percentage of Projects Replicated (n=48)	Number of Replications
Product Demonstration	45	23	17	6	92%	493,602*
On-Site Process Improvement	3	2	2	0	8%	3
Total	48	25	19	6	100%	493,605

Notes: (*) 400,000 of these replications were from individual sales (units sold) from one project in the transportation sector.

The 23 respondents who had not replicated their demonstration project in New York were asked whether they expected their projects to be replicated in the state in the future. As shown in Table 5-3, six respondents (26 percent) expected that their projects will be replicated in New York in the future.

Table 5-3. Expectation that Projects will be Replicated in New York State in the Future

	Number of Projects (n=23)	Percent of Projects (Out of 23)
Yes	6	26%
No	5	22%
Don't Know	12	52%
Total	23	100%

5.2 SUPPORTING FACTORS AND BARRIERS TO REPLICATIONS IN NEW YORK

Respondents whose projects were replicated in New York State provided a range of reasons for being able to replicate the NYSERDA-funded demonstration projects in the state. As shown in Table 5-4, the most frequently mentioned supporting factors were demonstrable savings achieved by demonstration projects (14 projects; 56 percent) and technical expertise gained from demonstration projects (13 projects; 52 percent). Just under one-third of respondents cited financing as a factor. Four respondents (16 percent) mentioned other factors, including: the demonstration proved the technical functionality of the product or service; market demand for the product or service was strong; and the demonstration enhanced the reputation of the demonstrated technology or firm.

¹⁷ None of the vendors surveyed was able to provide replication sales in dollars.

Table 5-4. Reasons for Replications

	Number of Projects (n=25)*	Percent of Projects (Out of 25)*
Demonstrable Savings Were Achieved	14	56%
Technical Expertise Gained	13	52%
Financing Available	8	32%
Operating Conditions Were Right	7	28%
Requested by Building Owner	6	24%
Location Available	5	20%
Other	4	16%

Notes: (*) Respondents were allowed to select more than one answer.

Respondents who have not replicated their projects in New York State were asked to identify the barriers to replications in the state. As shown in Table 5-5, the two most commonly cited barriers to replication were cost and absence of a market to take advantage of the demonstrated technology. Cost was cited by six respondents (26 percent) and absence of a market was cited by four respondents (17 percent).

Table 5-5. Barriers to Project Replication

Barriers to Replications	Number of Projects (n=23)	Percent of Projects
Cost	6	26%
Absence of market to take advantage of the demonstrated technology	4	17%
Unable to identify barriers to replication	13	57%
Total	23	100%

5.3 REPLICATION IMPACTS

One of the study objectives was to estimate the impact of the replication projects. Because replication projects are often implemented by a different firm than the original demonstration project, quantifying the impacts of replication projects can be challenging. Therefore, as a first step, respondents were asked to consider the size of the replication impacts relative to the original demonstrations.

As shown in Table 5-6, a majority of respondents (67 percent excluding “Don’t Know”) characterized the replication impacts as the same or higher compared to the original demonstration. Similarly, more than half of respondents (62 percent excluding “Don’t Know”) stated that revenues or cost savings from the replications were the same or higher compared to the demonstrations. On this basis, the study conservatively estimates replication impacts assuming they are the same size as the original demonstration impacts for projects where quantifiable data from replication projects were not provided.¹⁸

¹⁸ The method for estimating replication impacts is described in Appendix C.

Table 5-6. Scope of Replications in Comparison to NYSERDA Demonstration Project

	Comparison of Impact Benefits to Original Demonstration			Comparison of Revenue Generation and Cost Savings to Original Demonstration		
	Number	Percentage	Percentage Excluding “Don’t Know”	Number	Percentage	Percentage Excluding “Don’t Know”
Lower than Original Demo	2	3%	5%	9	13%	35%
The Same Size	19	28%	49%	14	21%	54%
Higher than Original Demo	7	10%	18%	2	3%	8%
Not Comparable	11	16%	28%	1	1%	4%
Don’t Know	29	43%	-	42	62%	-
Total*	68	100%	100%	68	100%	100%

Note: (*) Respondents who reported at least one replication in New York were asked the questions for their *five most recent* replications. Because some respondents had more than five replications, the number of responses shown in the table (n=68) is less than the total number of replications in New York.

Table 5-7 shows the estimated impacts of the replication projects by benefit type. Estimated impacts include 196,560 kWh in electricity produced; 2,169,222 kWh in electricity saved; 10,000 gallons in fuel oil saved; 720,000 gallons in diesel fuel saved; 182,513 gallons in gasoline saved; 22,463,771 pounds in CO₂ emissions offset; and 489,510 vehicles miles traveled avoided. While not directly reported, CO₂ emissions offset benefits were calculated for replication projects that reported quantifiable, energy-related benefits.

Eight of 25 projects that reported replications were able to provide quantifiable benefits. This does not mean that the remaining projects lacked benefits; however, the survey respondents were unable to quantify them.

Table 5-7. Benefits from Replications in New York

Benefit Type	Number of Projects Surveyed (n=48)*	Number of Projects with Replications in NYS (n=25)*	Number of Projects with Replications and Quantifiable Benefits (n = 8)**	Amount
Electricity Produced (kWh)	5	2	1	196,560
Electricity Saved (kWh)	18	13	3	2,169,222
Fuel Oil Saved (gallons)	3	1	1	10,000
Gasoline Saved (gallons)	6	4	2	182,513
Diesel Fuel Saved (gallons)	2	1	1	720,000
CO ₂ Emissions Offset (lbs.)	33	18	8	22,463,771
Vehicle Miles Traveled Avoided	2	1	1	489,510

Notes: (*) Projects reported multiple benefit types and not all demonstration projects with direct benefits reported replications.

(**) For replication projects that did not have quantitative benefits data, the evaluators attempted to estimate replication impacts assuming they were the same size and scale as the original demonstration impacts. However, if the survey respondent did not provide a start date for the replication project, replication impacts were not estimated.

Tables 5-8 and 5-9 estimate the revenues and cost savings for replication projects in New York. The estimated revenue for the replications totals \$806,667. The project types of the two replication projects with estimated revenue fell in the server efficiency and transportation categories. Estimated cost savings total approximately \$3.7 million. Three of the replication projects that were able to estimate cost savings fell in the transportation category, two in solar, two in server efficiency, and one in biofuel.

Table 5-8. Revenue from Replications in New York, by NYSERDA Project Category

NYSERDA Project Category	Number of Projects Surveyed (n=48)	Number of Projects with Replications in NYS (n = 25)	Number of Projects with Replications and Estimated Revenue (n = 2)	Replication Revenue
Product Demonstration	45	23	2	\$806,667
On-Site Process Improvement	3	2	--	--
Total	48	25	2	\$806,667

Table 5-9. Cost Savings from Replications in New York, by NYSERDA Project Category

NYSERDA Project Category	Number of Projects Surveyed (n=48)	Number of Projects with Replications in NYS (n = 25)	Number of Projects with Replications and Estimated Cost Savings (n = 8)	Amount
Product Demonstration	45	23	8	\$3,678,499
On-Site Process Improvement	3	2	--	--
Total	48	25	8	\$3,678,499

5.4 DEMONSTRATION INFLUENCE ON REPLICATIONS

The survey included a series of questions to assess the influence of the NYSERDA-funded demonstrations on the replication projects. Respondents who reported replications in New York State were asked to express the extent of their agreement or disagreement with the statement: “Overall, the NYSERDA-funded demonstration project was critical for developing the replication project(s).” As shown in Table 5-10, 60 percent of respondents gave a rating of four or five out of 5.0. For those respondents that provided a rating, the average rating was 4.3 out of 5.0, indicating strong agreement that the demonstration projects were influential. No respondents gave a rating of less than three.

Table 5-10. Influence of NYSERDA Demonstration Projects on Replications in New York

	Don't Know	Strongly Disagree 0	1	2	3	4	Strongly Agree 5
Number of Projects (n = 25)	4	0	0	0	6	3	12
Percentage of Projects	16%	0%	0%	0%	24%	12%	48%

Respondents were asked to describe how NYSERDA’s assistance with the demonstration project influenced the ability to develop the replication projects. Responses included:

- The demonstration proved that it is possible to do this type of project;
- The knowledge and expertise gained from the demonstration project helped with the replications;
- The demonstration resulted in improved marketing, which led to increased sales of the technology; and
- The demonstration provided the technical underpinnings for future projects.

Respondents were asked how the NYSERDA demonstration project affected the likelihood that the replications occurred. As shown in Table 5-11, 40 percent of respondents rated the likelihood as a zero or one out of five. Of the respondents who provided a rating, the average rating was 1.9 out of five, indicating general agreement about the influence of the demonstration projects. However, 20 percent of respondents who answered this question rated the likelihood that replications would have occurred without NYSERDA’s demonstration project as four or five (very likely).

Table 5-11. Likelihood that Replications Would Have Occurred in New York without NYSERDA’s Demonstration

	Don't Know	Not At All Likely 0	1	2	3	4	Very Likely 5
Number of Projects (n = 25)	3	7	3	4	3	3	2
Percentage of Projects (n = 25)	12%	28%	12%	16%	12%	12%	8%

To further assess how the demonstration projects influenced the replications, respondents were asked how the demonstrations affected the magnitude of the replication impacts and the timing of the replications. As shown in Table 5-12, 71 percent of respondents indicated that the impacts would have been smaller (33 percent excluding “Don’t Know”) or the replications would not have happened at all (38 percent excluding “Don’t Know”) without the NYSERDA demonstration project, while 29 percent indicated the impacts would have been the same.

Table 5-12. Estimated Magnitude of Replication Impacts Without the NYSERDA Demonstration Project

Magnitude of Replication(s) without NYSERDA Project	Number of Projects	Percent of Projects	Percentage Excluding “Don’t Know”
Same	6	24%	29%
Smaller	7	28%	33%
Larger	0	0%	0%
Replication(s) Would Not Have Happened without NYSERDA	8	32%	38%
Don’t Know	4	16%	--
Total	25	100%	100%

The findings also suggest that the demonstration projects accelerated the development of the replication projects. As shown in Table 5-13, 86 percent of respondents stated that the replications would have happened later (41 percent excluding “Don’t Know”) or not at all (45 percent excluding “Don’t Know”) without the NYSERDA demonstration project. Respondents who reported that replications would have occurred later estimated that the demonstrations accelerated the replications by an average of 2.6 years.

Table 5-13. Estimated Timing of Replications Without the NYSERDA Demonstration Project

Timing without NYSERDA Demonstration Project	Number of Projects	Percent of Projects	Percentage Excluding “Don’t Know”
Earlier	0	0%	0%
About the Same Time	3	12%	14%
Later (average: 2.6 years)	9	36%	41%
Replication(s) Would Not Have Happened without NYSERDA	10	40%	45%
Don’t Know	3	12%	--
Total	25	100%	100%

Based on the answers to the previous questions, replication contribution scores were derived using a similar method as the demonstration contribution scores in Section 4. The average replication contribution score was 3.8 out of 6.0.¹⁹ The contribution scores were converted to percentages and applied to the estimated replication impacts to estimate NYSERDA’s contribution.

Table 5-14 summarizes NYSERDA’s contribution to replication project impacts. Among other benefits, the table shows that NYSERDA demonstration projects contributed to 1.16 million kWh of electricity saved.

¹⁹ This is the simple average across projects and is shown for illustrative purposes only. It does not account for the relative size of benefits reported by each project, and therefore cannot be applied to total reported benefits. Instead, the analysis calculates the contribution separately for each project based on the project’s reported benefits and the project’s individual contribution score.

Table 5-14. Demonstration Contribution to Quantifiable Benefits from Replications

Benefit Type	Number of Projects Surveyed (n=48)*	Number of Projects with Replications in NYS (n=25)*	Number of Projects with Replications and Quantifiable Benefits (n = 8)**	Amount	NYSERDA Demonstration Contribution
Electricity Produced (kWh)	5	2	1	196,560	147,420
Electricity Saved (kWh)	18	13	3	2,169,222	1,163,306
Fuel Oil Saved (gallons)	3	1	1	10,000	7,500
Gasoline Saved (gallons)	6	4	2	182,513	136,885
Diesel Fuel Saved (gallons)	2	1	1	720,000	540,000
CO ₂ Emissions Offset (lbs.)	33	18	8	22,463,771	16,310,039
Vehicle Miles Traveled Avoided	2	1	1	489,510	367,133

Notes: (*) Projects reported multiple benefit types. Not all demonstration projects with direct benefits reported replications.

(**) For replication projects that did not have quantitative benefits data, the evaluators attempted to estimate replication impacts assuming they were the same size and scale as the original demonstration impacts. However, if the survey respondent did not provide a start date for the replication project, replication impacts were not estimated.

Tables 5-15 and 5-16 show NYSERDA’s estimated contribution to replication revenues and cost savings. The tables show that NYSERDA demonstration projects contributed to \$601,667 in replication revenues and \$2,510,717 in cost savings. Cost savings include energy cost savings as well as cost savings resulting from improved productivity and efficiency.

Table 5-15. Demonstration Contribution to Revenue from Replications in New York, by NYSERDA Project Category

NYSERDA Project Category	Number of Projects Surveyed (n=48)	Number of Projects with Replications in NYS (n = 25)	Number of Projects with Replications and Estimated Revenue (n = 2)	Replication Revenue	NYSERDA Demonstration Contribution
Product Demonstration	45	23	2	\$806,667	\$601,667
On-Site Process Improvement	3	2	--	--	
Total	48	25	2	\$806,667	\$601,667

Table 5-16. Demonstration Contribution to Cost Savings from Replications in New York, by NYSERDA Project Category

NYSERDA Project Category	Number of Projects Surveyed (n=48)	Number of Projects with Replications in NYS (n = 25)	Number of Projects with Replications and Estimated Cost Savings (n = 8)	Amount	NYSERDA Demonstration Contribution
Product Demonstration	45	23	8	\$3,678,499	\$2,510,717
On-Site Process Improvement	3	2	--	--	
Total	48	25	8	\$3,678,499	\$2,510,717

5.5 ADDITIONAL REPLICATIONS OF REPLICATION PROJECTS

To understand the full scope of replication impacts from demonstration projects, respondents were further asked whether their firm or another firm replicated the replication project(s). Eight projects reported to have replications of their original replication project, applied in a similar application. Two of these projects had additional replications of replication projects in New York that were replicated without NYSERDA or external funding. These two projects produced a total of 2,019 additional replications in New York, and 2,000 of these replications were from individual sales of one project. Reasons for the successful extension of replication projects included:

- Technical expertise gained;
- Operating conditions were right; and
- Demonstrable savings were achieved

These additional replications of replication projects were not able to quantify their benefits, revenues, or cost savings, but they were able to share insight on the role their original replication project played on further replications. On a scale from zero to five, where zero represents strongly disagree and five represents strongly agree, the two projects, with an average score of four, agreed with the statement that “Overall, the original replication project was critical for developing the additional replication project.”

CHAPTER 6:

PROCESS ANALYSIS

While impact assessment was the study's primary purpose, the survey also included some questions about NYSERDA's processes. This section covers survey questions about overall satisfaction and satisfaction with specific aspects of NYSERDA's R&D Program.

6.1 PROGRAM AWARENESS AND COMMUNICATION

Respondents were asked how they first learned about the potential for NYSERDA assistance. As shown in Table 6-1, the four most common methods to learn about NYSERDA R&D were: prior participation in the NYSERDA R&D Program (49 percent); word of mouth from business colleagues or clients (23 percent); prior participation in another NYSERDA program (13 percent); and advertising (13 percent).

Table 6-1. Sources of NYSERDA Program Awareness

Source of Program Awareness	Number of Projects (n=47)*	Percent of Projects
Prior Participation in NYSERDA R&D Program	23	49%
Word of Mouth – Business Colleague/Client	11	23%
Prior Participation in another NYSERDA Program	6	13%
Advertising	6	13%
Contacted by NYSERDA Program Representative	2	4%
Word of Mouth – Friend/Relative	1	2%
Visited a Demonstration Site	0	0%
Other	4	9%
Don't Know	3	6%

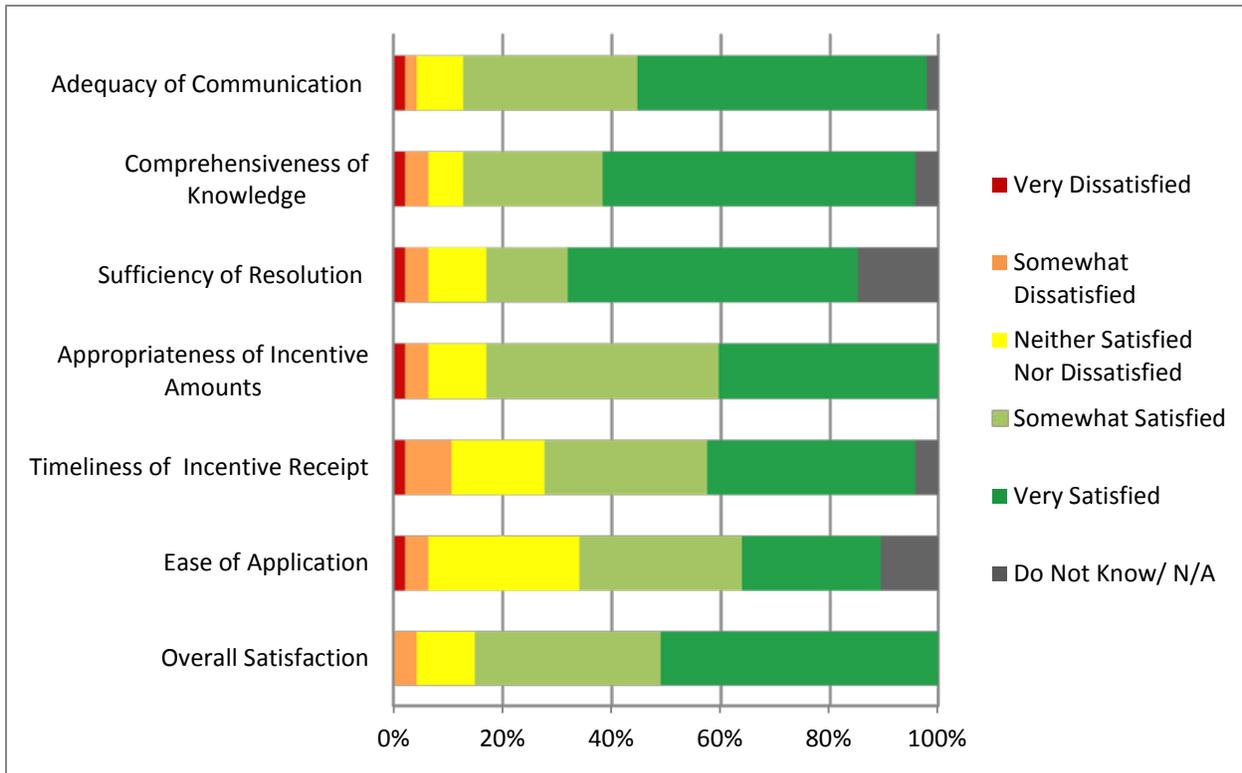
Notes: (*) Multiple responses were allowed. One of 48 surveyed respondents declined to respond to this section of the survey.

6.2 SATISFACTION WITH PROGRAM ASSISTANCE

The survey included a set of questions designed to assess satisfaction with NYSERDA's assistance. Respondents were asked to indicate their agreement or disagreement with a series of statements relating to program participation, including ease of application, communication, qualifications of program staff, and other aspects of NYSERDA's assistance, as shown in Figure 6-1.

Overall satisfaction with NYSERDA's R&D Program was high, with 85 percent of respondents agreeing or strongly agreeing (a 4 or 5 rating out of 5) that they were satisfied overall with the R&D Program. Respondents also gave very high ratings (greater than 80 percent gave a rating of 4 or 5) for NYSERDA staff's adequacy of communication with participants and comprehensiveness of knowledge.

Figure 6-1. Respondent Feedback on NYSERDA’s R&D Program Characteristics (n=47*)



Notes: (*) One of 48 surveyed respondents declined to respond to this section of the survey.

As can be seen in Table 6-2, mean satisfaction ratings for all categories were between 3.8 and 4.4, with mean overall satisfaction at 4.3. The majority of respondents stated that they were satisfied with every characteristic of NYSERDA’s R&D Program with more than 50 percent of respondents stating they were very satisfied with NYSERDA’s adequacy of communication, comprehensiveness of knowledge, and sufficiency of resolution.

Table 6-2. Average Feedback on NYSERDA’s R&D Program Characteristics

Category	Adjusted N*	Mean**	Median**	Mode**
Adequacy of Communication	47	4.35	5	5
Comprehensiveness of Knowledge	46	4.38	5	5
Sufficiency of Resolution	42	4.33	5	5
Appropriateness of Incentive Amounts	47	4.15	4	4
Timeliness of Incentive Receipt	47	3.98	4	5
Ease of Application	46	3.81	4	4
Overall Satisfaction	47	4.32	5	5

Notes: (*) One of 48 surveyed respondents declined to respond to this section of the survey.

(**) On a 1-5 scale, where 1 = “Very Dissatisfied,” 2 = “Dissatisfied,” 3 = “Neither Satisfied Nor Dissatisfied,” 4 = “Satisfied,” and 5 = “Very Satisfied.”

6.3 POTENTIAL IMPROVEMENTS RECOMMENDED BY SURVEY RESPONDENTS

Respondents were asked a series of open-ended questions about potential improvements that NYSERDA could undertake to encourage more demonstrations and replications. Response counts are shown in parentheses next to each suggestion.²⁰

Suggestions for how NYSERDA could encourage more **demonstration** projects included the following:

- Provide more technical assistance from the solicitation phase through the project's end (10).
- Advertise funding opportunities at entrepreneurial events, via the internet, and by sending solicitations directly to potential candidates (10).
- Target technologies that are actively emerging in the marketplace (6).
- Post project reports online and offer an online database of project results (5).
- Broaden the range of eligible projects to include more technologies and services (5).
- Increase flexible funding and better distribute grants (4).
- Streamline the solicitation and application processes (4).
- Ease reporting requirements (2).
- Partner with other agencies when developing and implementing projects (1).
- Create more fellowship programs. (1)

Suggestions for how NYSERDA could encourage more **replication** projects included the following:

- Post project reports online and offer an online database of project results (13).
- Advertise funding opportunities at entrepreneurial events, via the internet, and by sending solicitations directly to potential candidates (6).
- Provide more technical assistance from the solicitation phase through the project's end (5).
- Bring market actors together to develop and implement projects (5).
- Target technologies that are actively emerging in the marketplace (3).
- Broaden the range of eligible projects to include more technologies and services (3).
- Increase flexible funding and better distribute grants (2).
- Advertise an interest in completing replication projects specifically (2).
- Streamline the solicitation and application processes (1).
- Ease reporting requirements (1).
- Encourage greater stakeholder participation in R&D projects (1).

²⁰ Multiple responses were allowed.

CHAPTER 7:

COST EFFECTIVENESS

This section assesses the cost effectiveness of the 48 demonstration projects surveyed. The first part of the section calculates cost effectiveness in terms of revenues and cost savings achieved per NYSERDA dollars spent. The second part calculates electricity and fuel savings per NYSERDA dollars spent.

Calculations are presented separately for demonstration projects, replication projects, and the combined effects of demonstration and replication projects. The last part of this section is a qualitative assessment of whether participants consider the demonstrations to be worthwhile investments.

The benefit figures in this section are taken from Chapters 4 and 5.²¹ It should be noted that the revenue and cost savings figures represent the totals achieved through 2015, and not the total revenue and cost savings to be accrued over the entire lifespan of individual demonstration projects. Determining the lifespan of individual demonstration projects and projected revenues and costs is difficult as many unpredictable factors (e.g., market demand, technology viability, maintenance and upkeep conditions, etc.) can influence project lifespan. As such, the cost effectiveness figures in this section represent conservative cost effectiveness estimates as benefits will continue into the future for several projects and benefits per NYSERDA dollar will grow over time.

In total, NYERSERDA invested \$12.3 million in the 48 projects surveyed; this will herein be referred to as NYERSDA's investment. The evaluators calculated cost effectiveness by dividing the reported benefits of the 48 projects by NYSERDA's investment in those same projects.

7.1 NYSERDA'S COST EFFECTIVENESS: REVENUES AND COST SAVINGS

The following metrics were calculated by dividing reported benefits by NYSERDA's investment for all project types:

- Demonstration project revenues per NYSERDA investment;
- Demonstration project cost savings per NYSERDA investment;
- Demonstration project total dollars (revenues and cost savings) per NYSERDA investment;
- All of the previous calculations for replication projects; and
- All of the previous calculations combining demonstration and replication projects.

Table 7-1 shows the dollars saved and generated by the demonstration projects for every dollar of NYSERDA investment.²² The demonstrations generated approximately \$0.67 in revenues and generated approximately \$0.06 in cost savings for every dollar that NYSERDA spent. Overall, each dollar of NYSERDA investment yielded approximately \$0.73 in reported revenues and cost savings.

²¹ Determining the cost effectiveness for all funds spent on these projects including, NYSERDA contributions and firm costs, is not possible because many firms are unable to accurately report funds spent on specific projects. Therefore, this section reports the cost effectiveness of NYSERDA's costs using the benefits attributable to NYSERDA. Section 2.5 describes the method for estimating NYSERDA's contribution.

²² Some portion of the revenues and cost savings may include the benefits of electricity and fuel savings presented below.

Table 7-1. Cost Effectiveness for Demonstration Benefits

Benefit Type	Cost Effectiveness
Demonstration Project Revenues per NYSERDA \$	\$0.67
Demonstration Cost Savings per NYERDA \$	\$0.06
Total Demonstration Dollars (Revenues Plus Cost Savings) per NYSERDA \$	\$0.73

Table 7-2 presents similar calculations for the replication projects. Overall, the replications generated \$0.25 for each dollar that NYSERDA invested in the original demonstration projects. Note that the figures in Table 7-2 only account for the \$12.3 million that NYSERDA invested in the surveyed demonstration projects; they do not reflect the costs incurred by NYSERDA for replication projects, because these data were not available in a comprehensive or consistent way.²³

Table 7-2. Cost Effectiveness for Replication Benefits

Benefit Type	Cost Effectiveness
Replication Project Revenues per NYSERDA \$	\$0.05
Replication Cost Savings per NYSERDA \$	\$0.20
Total Replication Dollars (Revenues and Cost Savings) per NYSERDA \$	\$0.25

Table 7-3 presents the cost-effectiveness figures for combined demonstration and replication benefits. Overall, the demonstration and replication projects saved or generated \$0.98 for every NYSERDA dollar invested in the surveyed demonstration and replication projects. It should also be noted that total savings and revenues are likely understated as a result of some respondents not being able to quantify their energy savings or revenues. On the other hand, as noted above, the figures also do not include costs that NYSERDA incurred on replication projects.

Table 7-3. Cost Effectiveness for Combined Demonstration and Replication Benefits

Benefit Type	Cost Effectiveness
Demonstration and Replication Project Revenues per NYSERDA \$	\$0.72
Demonstration and Replication Cost Savings per NYSERDA \$	\$0.26
Demonstration and Replication Total Dollars (Revenues and Cost Savings) per NYSERDA \$	\$0.98

7.2 NYSERDA’S COST EFFECTIVENESS: ELECTRICITY AND FUEL SAVINGS

As discussed in Section 1.3, NYSERDA’s R&D Program supports projects that are designed to deliver public benefits. These benefits range from improved system reliability to health and environmental improvements. While some demonstration projects may result in lower energy costs, cost-effective

²³ Respondents were asked to describe the sources of funding for up to five of the most recent replications associated with their demonstration project. However, some respondents did not know if NYSERDA provided funding (many replications were carried out by different firms than the original demonstration), and others did not know the amounts. Moreover, given the limited time available for telephone surveys, the survey did not collect information on funding sources for replications beyond the most recent five.

energy savings is not the main reason for NYSERDA funding these projects. Nonetheless, it can be useful to consider energy-cost savings within the context of the overall cost-effectiveness analysis.

This section analyzes NYSERDA's cost effectiveness in terms of electricity savings (MWh) and fuel savings (therms). Many respondents indicated that savings will continue in years to come – i.e., only a fraction of the expected benefits have been realized to date. However, all of NYSERDA's demonstration project costs were incurred upfront. Therefore, to compare the benefits and costs on equal terms, the analysis estimates the value of future energy savings.²⁴

This type of analysis is complicated by the uncertainties inherent in predicting future energy prices and energy savings. It is also uncertain how long the technologies or processes resulting in the energy savings will continue into the future. To reflect these uncertainties, the analysis calculates NYSERDA's cost-effectiveness under a variety of scenarios. The scenario analysis considers two variables that determine the value of future energy savings: energy prices and technology lifespan.

This analysis is further complicated by the fact that projects have been producing benefits for varying amounts of time. As such, first, the cost savings of already accrued energy and fuel savings were calculated. As described in Sections 4 and 5, respondents reported direct benefits. Associated electricity and fuel savings were either reported in aggregate or annually. Aggregate savings were annualized to MWh/year and therms/year, respectively, using the assumption that benefits began to accrue one year after the contract sign date. Annual savings were then multiplied by energy prices for that year. Past energy prices are taken from the U.S. Energy Information Administration (EIA) *Annual Energy Review 2011*.

Next, future cost savings were estimated. Forecasted energy prices are taken from the EIA's *Annual Energy Outlook 2015* for the U.S. Middle Atlantic region, which includes New York State. The "medium" energy prices represent the EIA's reference case; the "low" and "high" cases represent the EIA's forecast under a lower-economic growth scenario and higher-growth scenario, respectively. Finally, already accrued and future benefits were summed.^{25 44}

The benefits also reflect whether the systems or processes demonstrated in the NYSERDA projects operate for five years, 10 years, 15 years, or 20 years. NYSERDA's experience has shown that many projects stay online longer than one year, while a 20-year lifetime might be longer than average. Note that all cost savings in the following figures are a mixture of already accrued benefits and projected future benefits.²⁶

Tables 7-4, 7-5, and 7-6 estimate the electricity savings for demonstration projects, replication projects, and the combined benefits of demonstrations and replications. For example, as shown in Table 7-4, if

²⁴ The results from sections 7.1 and 7.2 are not additive, as some but not all of the cost savings associated with energy and fuel savings were reported in section 7.1. This section aims to quantify the cost savings associated with all energy and fuel savings.

²⁵ *Annual Energy Outlook 2013* expresses all energy prices in 2013 dollars, unless otherwise noted. Past energy prices in the EIA *Annual Energy Review 2011* reflect cross-sector averages and are reported nominally. Nominal pricing was converted to 2013 dollars for consistency, using the Bureau of Labor Statistics online CPI Inflation calculator. Expressing all savings in current dollars adjusts for the effects of inflation on energy prices in later years, and therefore represents a reasonably accurate assessment of the world from NYSERDA's point of view. It does not, however, account for the firm's opportunity cost of capital – i.e., other investments the firm could have made instead of investing in the project. If a private firm were considering the investments described in this section, it would further discount the future energy savings by its weighted average cost of capital – i.e., the cost required to finance the firm's mix of debt and equity – thereby reducing the present value of the savings.

²⁶ For instance, year 5 values are inclusive of the first five years of accrued savings for all projects that have been accruing benefits for more than 5 years, and a mixture of accrued and projected savings for all projects that have been operational for less than 5 years.

demonstration projects operate for ten years under the medium scenario, they will save an estimated \$268,509 in electricity costs. If they operate for a shorter time, the benefits will be smaller (holding all else equal); if they operate longer than five years, the benefits will be larger. Similarly, the benefits depend on electricity prices, which vary across the “low,” “medium,” and “high” scenario. For example, if the projects operate for 20 years, they will have estimated savings of \$419,904 in the low scenario and \$435,308 in the high scenario. Overall, the estimated combined demonstration and replication savings vary from \$270,466 to \$716,626, depending on electricity prices and lifespan.²⁷

Table 7-4. Estimated Electricity Savings from Demonstration Projects

Lifespan (Years)	Energy Prices		
	Low	Medium	High
5	\$132,192	\$132,194	\$132,194
10	\$267,092	\$268,509	\$269,297
15	\$304,004	\$310,493	\$314,934
20	\$419,404	\$429,565	\$435,308

Table 7-5. Estimated Electricity Savings from Replication Projects

Lifespan (Years)	Energy Prices		
	Low	Medium	High
5	\$138,274	\$138,630	\$138,856
10	\$180,075	\$182,081	\$183,562
15	\$225,968	\$229,837	\$232,231
20	\$273,689	\$278,854	\$281,318

Table 7-6. Combined Estimated Electricity Savings

Lifespan (Years)	Energy Prices		
	Low	Medium	High
5	\$270,466	\$270,824	\$271,050
10	\$447,167	\$450,590	\$452,859
15	\$529,973	\$540,330	\$547,165
20	\$693,093	\$708,419	\$716,626

²⁷ Please refer to Appendix C for further details about the methodology for this analysis.

Tables 7-7, 7-8, and 7-9 show the same type of analysis for fuel savings. As shown in Table 7-9, estimated fuel savings from demonstration and replication projects ranges from approximately \$8.8 million to \$33.9 million, depending on assumptions about lifespan and energy prices.

Table 7-7. Estimated Fuel Savings from Demonstration Projects

Lifespan (Years)	Energy Prices		
	Low	Medium	High
5	\$6,451,113	\$6,468,352*	\$6,452,289*
10	\$12,200,384	\$12,255,099	\$12,257,704
15	\$18,084,026	\$18,223,505	\$18,274,556
20	\$24,478,609	\$24,760,887	\$24,916,386

Table 7-8. Estimated Fuel Savings from Replication Projects

Lifespan (Years)	Energy Prices		
	Low	Medium	High
5	\$2,306,981	\$2,306,843	\$2,307,469
10	\$4,309,768	\$4,339,043	\$4,339,876
15	\$6,478,022	\$6,540,051	\$6,558,250
20	\$8,842,391	\$8,955,021	\$9,008,548

Table 7-9. Combined Estimated Fuel Savings

Lifespan (Years)	Energy Prices		
	Low	Medium	High
5	\$8,758,094	\$8,775,195*	\$8,759,757*
10	\$16,510,152	\$16,594,142	\$16,597,580
15	\$24,562,048	\$24,763,556	\$24,832,806
20	\$33,321,000	\$33,715,908	\$33,924,934

*Note: Estimated fuel savings are actually lower in the high economic growth case when compared to the reference case. This is because higher economic activity leads to short-term reduced energy prices due to a number of interacting market factors (e.g., renewable energy production, immigration, labor force, capital stock, and productivity changes, etc.) For more information, see: [http://www.eia.gov/outlooks/aeo/pdf/0383\(2015\).pdf](http://www.eia.gov/outlooks/aeo/pdf/0383(2015).pdf)

The estimated electricity and fuel savings were summed to derive aggregate savings, and the aggregate savings were divided by NYSERDA's investment to calculate cost effectiveness.²⁸ Tables 7-10, 7-11, and 7-12 present the results of the analysis. As shown in Table 7-12, the demonstration and replication projects could together save between \$0.73 and \$2.82 for every dollar that NYSERDA invested in the demonstration projects, depending on project lifespan and future energy prices. Given the uncertainties and limitations of this analysis, the figures should be interpreted as a general indication, rather than a precise estimate, of energy-cost savings. It should also be noted that total savings (and therefore, cost

²⁸ The report does not show this intermediate step of adding electricity and fuel savings.

effectiveness) may be understated as a result of some respondents not being able to quantify their energy savings. Therefore, the actual savings and cost effectiveness are likely higher than the figures suggest.

Table 7-10. Cost Effectiveness of Electricity and Fuel Savings from Demonstrations

Lifespan (Years)	Cost Effectiveness		
	Low	Medium	High
5	\$0.54	\$0.54	\$0.54
10	\$1.01	\$1.02	\$1.02
15	\$1.50	\$1.51	\$1.51
20	\$2.03	\$2.05	\$2.06

Table 7-11. Cost Effectiveness of Electricity and Fuel Savings from Replications

Lifespan (Years)	Cost Effectiveness		
	Low	Medium	High
5	\$0.20	\$0.20	\$0.20
10	\$0.37	\$0.37	\$0.37
15	\$0.55	\$0.55	\$0.55
20	\$0.74	\$0.75	\$0.76

Table 7-12. Cost Effectiveness of Combined Electricity and Fuel Savings

Lifespan (Years)	Cost Effectiveness		
	Low	Medium	High
5	\$0.73	\$0.74*	\$0.73*
10	\$1.38	\$1.39	\$1.39
15	\$2.04	\$2.06	\$2.06
20	\$2.77	\$2.80	\$2.82

*Note: Estimated fuel savings are actually lower in the high economic growth case when compared to the reference case. This is because higher economic activity leads to short-term reduced energy prices due to a number of interacting market factors (e.g., renewable energy production, immigration, labor force, capital stock, and productivity changes, etc.) For more information, see: [http://www.eia.gov/outlooks/aeo/pdf/0383\(2015\).pdf](http://www.eia.gov/outlooks/aeo/pdf/0383(2015).pdf)

7.3 PARTICIPANT PERSPECTIVES OF COST EFFECTIVENESS

The study also sought to assess the project's cost effectiveness from the firm's perspective. The survey included questions about resources committed by participants and their perceptions of whether their investment was worthwhile.

Out of 48 respondents, 11 contributed staff time to the project and 32 contributed project expenses ranging from approximately \$1,000 to \$9 million, with an average contribution of \$3,050,000, or \$100,000 excluding the \$9 million investment. These figures include cash and in-kind contributions. Moreover, the figures are partial and only represent what respondents reported. Many respondents reported that they did not know or could not remember their level of contribution. Therefore, while the numbers give some indication of the level of the firm's investment, they cannot be used to quantitatively assess cost effectiveness.

Therefore, the study used a qualitative approach to assess the value of the investment using the project's cost-effectiveness from the firm's perspective. A series of questions asked respondents about other investments the firm was considering when it began the demonstration project and how those alternatives compared. As shown in Table 7-13, 13 out of 48 projects (27 percent) stated that they had considered alternatives to the demonstration project. As shown in Table 7-14, 10 of these 13 respondents (77 percent) indicated that the demonstration was the best choice relative to the alternatives.

Table 7-13. Alternatives Considered at the Time of the Demonstration Project

	Number of Projects	Percent of Projects	Adjusted Percent of Projects
Yes	13	27%	28%
No	33	69%	72%
Don't Know/Refused	2	4%	--
Total	48	100%	100%

Table 7-14. Value of Demonstration Relative to Alternatives

	Number of Projects	Percent of Projects
Yes	10	77%
Don't Know/Refused	3	23%
Total	13	100%

The survey asked respondents if they considered the demonstration project to be a good investment, and whether their return on investment was positive, negative, or neutral. As shown in Table 7-15, 46 respondents out of 48 (96 percent) indicated that the demonstration was a good investment.

Table 7-15. Assessment of Whether the Demonstration was a Good Investment

	Number of Projects	Percent of Projects
Yes	46	96%
No	2	4%
Total	48	100%

As shown in Table 7-16, 71 percent of respondents indicated that their return on investment was positive, 17 percent breakeven, and eight percent indicated that their return was negative.

Table 7-16. Firm's Return on Investment

	Number of Projects	Percent of Projects	Adjusted Percent of Projects
Positive	34	71%	74%
Breakeven/Neutral	8	17%	17%
Negative	4	8%	9%
Don't Know/Refused	2	4%	--
Total	48	100%	100%

CHAPTER 8:

PREVIOUSLY SURVEYED PROJECT RESULTS

This section describes the types of impacts reported by previously surveyed respondents of NYSERDA demonstration projects from 2008 to 2010. IEC reviewed the 2014 R&D Demonstration Survey to identify 10 “successful” projects and five “unsuccessful” projects in terms of benefits and replications. The “successful” projects typically reported both quantifiable benefits and replications when surveyed in 2014. Some “unsuccessful” projects reported neither benefits nor replications, while others reported benefits, but not replications. The reason the latter set of projects were identified as “unsuccessful” was because replications would be expected for projects that produced benefits.

8.1 SUCCESSFUL VS. UNSUCCESSFUL PROJECTS

Of the 15 previously surveyed respondents, 13 agreed to be re-surveyed. These 13 projects included nine projects identified as “successful” demonstrations based on the previous survey and four projects identified as “unsuccessful.” The unsuccessful projects included two projects that reported neither benefits nor replications, and two projects that reported quantifiable benefits, but not replications in 2014.

Seven of the nine successful projects were still in use at the time of their 2016 survey. These projects were able to report additional quantifiable benefits from 2014, including electricity saved, natural gas saved, electricity produced, and others.

Both unsuccessful projects that reported quantifiable benefits stated that the benefits reported in 2014 have not changed. One of these projects reported that the benefits were annual and that these benefits are still ongoing. Both unsuccessful projects that did not report quantifiable benefits in 2014 were still unable to report quantifiable benefits. However, both of these projects are still in use.

The successful projects reported one additional replication since the 2014 survey, while the unsuccessful projects did not report any replications.

The remainder of this chapter reports the results of the previously surveyed projects in aggregate, without regard to whether the project was originally classified as successful or unsuccessful.

8.2 TYPES OF IMPACTS

Table 8-1 shows the distribution of benefits among the re-surveyed demonstration projects with some projects producing multiple benefits. The single most commonly identified benefit was electricity saved (39 percent). Electricity produced was the second most commonly identified benefit (23 percent). CO₂ emissions offsets were considered a direct benefit for all project types that reported energy-related benefits (69 percent).

Table 8-1. Direct Benefits Reported by Re-Surveyed Respondents

Direct Benefit Type	Number of Projects (n = 13)*	Percent
CO ₂ Emissions Offset	9	69%
Electricity Saved	5	39%
Electricity Produced	3	23%
Improvement to Operations and Management	2	15%
Material Waste Reduction	2	15%
Installed Capacity	1	8%
Natural Gas Saved	1	8%
SO ₂ Emissions Offset	1	8%
NO _x Emissions Offset	1	8%
Improved Productivity	1	8%

Note: (*) Multiple responses were allowed. Percentages were calculated out of the 13 projects.

All respondents who reported benefits noted that no additional types of benefits were experienced since the original demonstration project, even after considering technological upgrades to existing projects.

8.3 QUANTIFIABLE IMPACTS OF RE-SURVEYED PROJECTS

Re-surveyed respondents confirmed that the benefits reported for their projects through 2014 in the previous survey (Round 2) were correct.

Ten of the 13 re-surveyed respondents noted that their original demonstration project is still in operation. As shown in Table 8-2, the projects still in operation produced additional energy saving, energy production, installed capacity, and environmental benefits since the previous survey was conducted through the end of 2014. CO₂ emissions offsets were calculated by the evaluators for projects that reported energy-related benefits.

Table 8-2. Quantifiable Benefits Achieved Through and Since 2014 by Impact Category

Benefit Type	Amount Through 2014	Amount Since 2014
Electricity Saved (kWh)	28,090	11,236
Natural Gas Saved (therms)	10,525	4,210
Electricity Produced (kWh)	147,008	30,803
Installed Capacity (kW)	130	130
CO ₂ Emissions Offset (lbs.)	326,467	98,106
SO ₂ Emissions Offset (lbs.)	1,539	513
NO _x Emissions Offset (lbs.)	378	126

8.4 REVENUES AND COST SAVINGS OF RE-SURVEYED PROJECTS

Re-surveyed respondents were also asked to confirm that the revenues and cost savings reported for their projects through 2014 in the previous survey (Round 2) were correct. Of the 13 re-surveyed projects, one respondent reported a change in revenue due to a change in market conditions. Table 8-3 shows the original figure reported in 2014 and the revised figure reported in the current round of the survey. Overall, this project revised its initial estimated annual revenue from \$60,000 to \$40,000, a decrease of \$20,000 annually. As shown in the final column, NYSERDA's estimated contribution to this revenue generated is \$30,000, based on the contribution scores calculated in the previous round of the survey.

Table 8-3. Revised Estimate for Annual Revenue Generated through 2014

Previously Reported Revenue through 2014 (Annual)	Currently Reported Revenue through 2014 (Annual)	Difference (Annual)	NYSERDA contribution
\$60,000	\$40,000	-\$20,000	\$30,000

To put this in perspective, the previous round reported total revenue for all 61 projects surveyed in Round 2 of approximately \$1.14 billion after adjusting for NYSERDA's contribution factor. Thus, these newly reported figures represent a 0.003 percent decrease of those revenues generated on an annual basis.

Of the 13 re-surveyed projects, one respondent revised their initial estimate for cost savings. The project attributed the change to a technological upgrade to their project resulting in greater cost savings than they had estimated in the previous survey. Table 8-4 shows the original figures reported in 2014 and the revised figures reported in the current round of the survey for the project. Overall, the project revised its initial estimated annual cost savings from \$360,000 to \$6,624,000, an increase of approximately \$6.3 million annually. As shown in the final column, NYSERDA's estimated contribution to these cost savings is \$4,140,000, based on the contribution scores calculated in the previous round of the survey.

Table 8-4. Revised Estimate for Annual Cost Savings through 2014

Previously Reported Cost Savings (Annual)	Currently Reported Cost Savings (Annual)	Difference (Annual)	NYSERDA Contribution
\$360,000	\$6,624,000	\$6,264,000	\$4,140,000

To put this in perspective, the previous round reported total cost savings for all 61 projects surveyed of approximately \$65.7 million after adjusting for NYSERDA's contribution factor. Thus, these newly reported figures represent an additional six percent of those cost savings on an annual basis.

As noted above, of the 13 respondents, 10 re-surveyed respondents noted that their original demonstration project is still in operation. Two projects were able to estimate revenues generated since 2014 and three projects were able to estimate cost savings generated since 2014. Tables 8-5 and 8-6 detail total new revenue and cost savings generated since these projects were previously surveyed in 2014.

Table 8-5. Total Revenue Generated Since 2014

Benefit Reported	Number of Re-Surveyed Projects with Estimated Revenue since 2014	Revenue Generated	NYSERDA Contribution
Electricity Produced	1	\$80,000	\$60,000
Electricity Saved	1	\$1,750,000	\$1,531,250
Total	2	\$1,830,000	\$1,591,250

Table 8-6. Total Cost Savings Generated Since 2014

Benefit Reported	Number of Re-Surveyed Projects with Estimated Cost Savings since 2014	Cost Savings Generated	NYSERDA Contribution
Installed Capacity	1	\$140,000	\$105,000
Electricity Saved	2	\$13,348,000	\$8,355,000
Total	3	\$13,488,000	\$8,460,000

After adjusting for NYSERDA’s contribution (calculated when these projects were initially surveyed in 2014), total revenues attributable to NYSERDA are approximately \$1.6 million. The total cost savings considering NYSERDA’s contribution are approximately \$8.5 million.

It is important to note that re-surveyed respondents who reported additional revenue and cost savings since 2014 expected these benefits would continue into the future. Therefore, total revenues and cost savings should continue to grow over time.

8.5 REPLICATIONS

Replications are defined as an additional installation or scaling up of the technology or process demonstrated under the NYSERDA-funded project or additional sales of the technology that was used in the demonstration. Of the 13 re-surveyed respondents, no additional replications since 2014 were reported for similar applications. One project respondent reported a replication for a different application where the technology is now used for a different purpose than intended from the original demonstration project.

8.6 COST EFFECTIVENESS

NYSERDA invested approximately \$3.3 million dollars in the 13 previously surveyed projects. These projects reported \$1.05 billion in revenues and approximately \$21.2 million in cost savings in the previous round for a total cost effectiveness of \$323.03 per NYSERDA dollar invested.²⁹ As reported above, these projects reported an additional \$1.6 million in revenue and \$8.5 million in cost savings since 2014, a 0.94 percent improvement in cost effectiveness since the last time the projects were surveyed.

8.7 PARTICIPANT PERSPECTIVES OF COST EFFECTIVENESS

The original 2014 survey and current 2016 survey asked respondents if they considered their project a good investment. In 2014, all 13 respondents (100 percent) answered that they believed their project was a good investment. Upon re-survey, respondents were asked if they still felt that the project was a good investment. All 13 respondents agreed with their previous answer, and still consider their project a good investment.

In both surveys, respondents were also asked to describe the economic return on their project as positive, negative, or neutral. In the current survey round, all 13 respondents agreed with their 2014 survey answers, summarized in Table 8-5. Eleven of the 13 projects (85 percent) reported a positive return. The remaining two (15 percent) reported a neutral return.

²⁹ All cost and revenue figure reflect NYSERDA’s contribution. Note that this survey selected some particularly successful projects so this cost effectiveness was much higher than the average for all projects surveyed in 2014.

Table 8-5 Firm's Return on Investment

	Number of Projects	Percent of Projects
Positive	11	85%
Neutral	2	15%
Negative	0	0%
Total	13	100%

CHAPTER 9:

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings in the previous chapters, Chapter 9 summarizes the study’s conclusions and provides recommendations for future rounds of the R&D demonstration survey.

9.1 CONCLUSIONS

The evaluation has many similar high-level conclusions as the previous study, as respondents provided similar answers, in aggregate, to several qualitative questions. In both surveys, the majority of projects reported: (1) meeting all or most of their objectives, (2) at least one replication of the original demonstration project, and (3) overall satisfaction with the program and NYSERDA. Furthermore, projects reported similar factors that support the development of replication projects. However, the projects in the current round reported fewer electricity benefits, cost savings, and revenues compared to the previous round of the survey.

The evaluation has the following major conclusions:

NYSERDA’s R&D demonstrations have mostly achieved their objectives and have generated substantial impacts. Ninety-one percent of survey respondents reported meeting “all” or “most” of their objectives, with over half of all projects meeting all of their objectives. Given the broad range of projects and benefits, and the challenges of recalling savings from two or more years ago, many benefits could not be quantified. However, the benefits that could be quantified are impressive, as shown in Table 9-1.

Table 9-1. Summary of NYSERDA Contribution to Demonstration Impacts

Direct Benefit Type	Amount	NYSERDA Contribution
CO ₂ Emissions Offset (lbs.)	82,208,511	41,775,969
Electricity Produced (kWh)	157,767	118,325
Electricity Saved (kWh)	2,342,192	1,838,347
Diesel Fuel Saved (gallons)	51,958	38,969
Heating Fuel Saved (gallons)	4,000,000	3,000,000
Gasoline Saved (gallons)	1,494,081	70,560
SO ₂ Emissions Offset (lbs.)	168	126
NO _x and PM Emissions Offset (lbs.)	58,860	60
Vehicle Miles Traveled Avoided	34,199,759	1,284,964
Natural Gas Displaced (therms)	1,080	810
Propane Displaced (gallons)	1,014	761

Demonstration projects were typically replicated and these replications generated additional benefits. Seventy-five percent of demonstration projects surveyed reported at least one replication, and 52 percent of projects reported at least one replication in New York. Table 9-2 summarizes the benefits generated by the replications in New York.

Table 9-2. Benefits from Replications in New York

Benefit Type	Number of Projects Surveyed (n=48)*	Number of Projects with Replications in NYS (n=25)*	Number of Projects with Replications and Quantifiable Benefits (n = 8)**	Amount	NYSERDA Demonstration Contribution
Electricity Produced (kWh)	5	2	1	196,560	147,420
Electricity Saved (kWh)	18	13	3	2,169,222	1,163,306
Fuel Oil Saved (gallons)	3	1	1	10,000	7,500
Gasoline Saved (gallons)	6	4	2	182,513	136,885
Diesel Fuel Saved (gallons)	2	1	1	720,000	540,000
CO ₂ Emissions Offset (lbs.)	33	18	8	22,463,771	16,310,039
Vehicle Miles Traveled Avoided	2	1	1	489,510	367,133

Notes: (*) Because projects spanned multiple impact categories, the column does not sum to 48.

(**) Because projects spanned multiple impact categories, the column does not sum to 25.

Demonstrable savings and technical expertise are important factors for developing replication projects in New York. Demonstrable savings achieved by demonstration projects (56 percent) and technical expertise gained from demonstration projects (52 percent) were the most frequently mentioned factors that supported the development of replication projects in New York. This finding is consistent with Round 2 of the survey, which identified technical expertise and demonstrable savings achieved as the two most important factors for replication of demonstration projects.

NYSERDA's R&D demonstration projects surveyed did not report quantifiable cost savings and revenues in excess of NYSERDA's investment in the projects. Tables 9-3 and 9-4 summarize NYSERDA's cost effectiveness in terms of demonstration and replication benefits achieved per dollar spent on demonstration projects. The projects reported total quantifiable cost savings and revenues of \$0.98 cents per NYSERDA dollar spent. However, the actual revenues and cost savings may be greater than reported as many projects were unable to quantify revenues or cost savings. Additionally, some of these projects are expecting revenues and cost savings to continue in future years, which will further drive down the cost of NYSERDA's investment relative to the benefits. IEc estimates that the benefits of electricity and fuel savings will exceed NYSERDA's investment in the demonstration if projects continue to accrue benefits for at least 10 years, but not if they accrue benefits for just five years. It is important to note that NYSERDA funds R&D demonstrations to achieve public policy goals that are not uniformly centered on cost-effective energy savings. Survey responses suggest that participants generally found the demonstration projects to be worthwhile investments.

Table 9-3. Cost Effectiveness for Combined Demonstration and Replication Benefits

Benefit Type	Cost Effectiveness
Demonstration and Replication Cost Savings per NYSERDA \$	\$0.26
Demonstration and Replication Revenues per NYSERDA \$	\$0.72
Demonstration and Replication Dollars (Revenues and Cost Savings) per NYSERDA \$	\$0.98

Table 9-4. Cost Effectiveness of Electricity/Fuel Savings from Demonstrations and Replications

Lifespan (Years)	Energy Prices		
	Low	Medium	High
5	\$0.73	\$0.74*	\$0.73*
10	\$1.38	\$1.39	\$1.39
15	\$2.04	\$2.06	\$2.06
20	\$2.77	\$2.80	\$2.82

*Note: Estimated fuel savings are actually lower in the high economic growth case when compared to the reference case. This is because higher economic activity leads to short-term reduced energy prices due to a number of interacting market factors (e.g., renewable energy production, immigration, labor force, capital stock, and productivity changes, etc.) For more information, see: [http://www.eia.gov/outlooks/aeo/pdf/0383\(2015\).pdf](http://www.eia.gov/outlooks/aeo/pdf/0383(2015).pdf)

Participant satisfaction with NYSERDA’s R&D Program appears high. Overall satisfaction with NYSERDA’s R&D Program was high, with 85 percent of respondents agreeing or strongly agreeing (a 4 or 5 rating out of 5) that they were satisfied overall with the R&D Program. Respondents also gave very high ratings (greater than 80 percent gave a rating of 4 or 5) for NYSERDA staff’s adequacy of communication with participants and comprehensiveness of knowledge. Though generally satisfied, respondents offered several suggestions for ways in which NYSERDA could further promote demonstration and replication projects in New York. These suggestions include, among others: provide more technical assistance; advertise funding opportunities; target technologies that are actively emerging in the marketplace; make project reports publicly available; and broaden the range of eligible products.

Previously surveyed projects have reported substantial additional benefits since last surveyed in 2014. IEC and APPRISE surveyed 13 projects previously surveyed in 2014. Table 9-5 and 9-6 show the additional benefits achieved by these projects between 2014 and 2016.

Table 9-5. Total Revenue Generated by Re-Surveyed Projects Since 2014

Benefit Reported	Number of Re-Surveyed Projects with Estimated Revenue since 2014	Revenue Generated	NYSERDA Contribution
Electricity Produced	1	\$80,000	\$60,000
Electricity Saved	1	\$1,750,000	\$1,531,250
Total	2	\$1,830,000	\$1,591,250

Table 9-6. Total Cost Savings Generated by Re-Surveyed Projects Since 2014

Benefit Reported	Number of Re-Surveyed Projects with Estimated Cost Savings since 2014	Cost Savings Generated	NYSERDA Contribution
Installed Capacity	1	\$140,000	\$105,000
Electricity Saved	2	\$13,348,000	\$8,355,000
Total	3	\$13,488,000	\$8,460,000

These projects reported additional revenue of approximately \$1.8 million, of which NYSERDA contributed an estimated \$1.6 million, since 2014; and approximately \$13.5 million in cost savings, of which NYSERDA contributed an estimated \$8.5 million, since 2014. This is evidence that some R&D demonstration projects continue to accrue substantial benefits for many years after NYSERDA’s involvement in the project concludes.

NYSERDA’s record keeping has improved, but data limitations remain. NYSERDA was able to provide final project reports for the majority of demonstrations prior to survey implementation for the current round of the survey. This greatly facilitated the survey process, especially in terms of asking about demonstration benefits. However, NYSERDA was not able to provide final reports for all projects. Furthermore, IEC was still reliant on the “ClosedDate” field in the R&D Metrics Database to determine when projects ended. Since this field is used to track when the project was closed from an accounting perspective and not an operations perspective, several projects had actually concluded operations many years prior to the official closed date. This led to many instances where the Principal Investigator was no longer available for a survey or the respondent was unable to remember key details from the project.

9.2 RECOMMENDATIONS

NYSERDA has committed to repeating the R&D demonstration survey at regular intervals to ensure the existence of a regularly updated, comparable set of information about NYSERDA’s demonstration projects and associated replications. This survey and the previous rounds provided valuable information that can guide future survey efforts. Recommendations to enhance future rounds of the R&D Demonstration Survey include the following:

Continue to utilize the electronic survey instrument developed in this round. Previous R&D demonstration surveys have used paper survey instruments to conduct the phone survey, and transferred the data from the paper survey to an electronic database following survey administration. For the current round, IEC developed a Microsoft Access-based electronic survey database to enter, store, and sort survey data. While this database required an initial development investment, it eliminated the data entry step required in previous rounds. Future rounds of the R&D survey should continue to leverage this electronic survey instrument as there will not be an upfront cost to develop the database, but there will continue to be substantial data entry savings.

Continue to re-survey demonstration projects from prior rounds. IEC and APPRISE surveyed select projects from 2008-2010 that were surveyed in the previous round. These surveys were able to quantify additional benefits. Not only do these surveys allow for additional quantification of benefits, but they provide evidence to support a primary theory driving the R&D demonstration program – that projects may continue to provide benefits for many years after NYSERDA’s involvement in the project has ended.

Continue to survey replication projects identified during the primary survey. The first two rounds only surveyed demonstration participants, and asked if they were aware of any replication projects. In this round, the evaluators specifically asked for contact information of project managers at replication

sites and followed up directly with the replicators. These follow-up surveys helped to verify the number of replications, quantify benefits, and identify new replication projects.

Provide definitions to survey respondents. The previous round of the survey (March 2014) asked respondents whether they produced 15 specific types of benefits. The evaluators found that asking respondents about each of these 15 benefits was time-consuming and unnecessary, as most benefits coalesced around a smaller number of benefit types. Therefore, in the current survey, we condensed these questions to ask for the three most common specific benefits reported from the previous round: power production, demand reduction, and energy efficiency. The evaluators then asked respondents to provide all other benefits produced by the project to ensure all energy and environmental benefits were reported. However, there was some concern that the benefits were not uniformly defined to the respondents. Prior to the next round, the evaluators and NYSERDA should work together to develop definitions for each benefit type to read to the respondent.

Calculate CO₂ benefits solely based on energy benefits. A few projects this round reported CO₂ benefits, but did not report energy benefits. Asking respondents to report CO₂ offsets directly led to some gaps and inconsistencies. Going forward, we recommend that instead of asking respondents to estimate their CO₂ savings, the evaluators should calculate CO₂ savings solely based on energy savings reported by respondents using NYSERDA's emission factors.

Focus surveys on the Principal Investigator if at all possible. This round of the survey attempted to survey multiple project team participants, particularly in cases where the PI was a vendor. The previous survey had found vendors were not able to sufficiently answer many of the survey questions. IEC and APPRISE were not able to locate secondary contacts for any of the eight projects surveyed where the PI was a vendor. In each case the vendor was unable to provide any contact that would be able to answer the survey questions. However, the eight vendor surveys did not stand out as lower quality surveys this round. Overall, we found that the most important determinant of the quality of the interview was not the type of participant (integrator, site owner, or vendor), but whether the respondent was the NYSERDA PI for the project. PIs are responsible for reporting to NYSERDA so they often remember or can locate key project data. Furthermore, these respondents are often the only project team members interacting with NYSERDA R&D staff, and can most accurately answer questions regarding NYSERDA's R&D demonstration process.

The next survey should include additional questions to determine overall project success. The current survey reports total benefits and cost effectiveness of demonstrations and their replications. However, many projects are unable to quantify benefits. Furthermore, the cost effectiveness figure relies on revenues and cost savings that do not necessarily reflect increases in profit. For example, a product demonstration may lead to the formation of a company with \$20 million in annual revenues, but \$30 million in expenses. The current cost effectiveness measure would only include the revenues. Similarly, a product may cost 95 percent less to produce after the NYSERDA demonstration, but it may still cost more to make than existing alternatives. The current cost effectiveness measure would capture all of the cost savings, but would not reflect the fact that the technology is not economically viable. One way to deal with the revenue issue would be to ask questions about profitability, such as: "Do your revenues exceed your costs currently? If so, by how much do revenues exceed cost? If not, do you anticipate that your revenues will exceed your costs in the future?" The next round of the survey could also include a number of more qualitative questions to understand whether the project produces a new technology or process that produces environmental benefits or energy savings. Some examples of such questions might include, "Are there existing alternatives to this technology or process being offered by your competitors that are more cost effective or produce additional benefits compared to your technology or process?," or for projects that have been replicated, "Do you believe this process or technology will continue to be replicated in the future?" The answers to these questions could be compiled into a score similar to the

NYSERDA contribution score featured in this report. The score could then be used to assess project success.

NYSERDA should require demonstration projects to report to NYSERDA when operations cease.

As explained in the Conclusions section above, NYSERDA does not currently track when project operations conclude. The proxy for this information is the “ClosedDate” field in the R&D Metrics Database, which tracks when projects are financially closed in NYSERDA’s accounting system. This date is often many years after operations conclude. The ideal time to survey R&D demonstration projects is two to five years after the project operations are completed – enough time for benefits to accrue and for replications to occur, but not so long that companies dissolve, contact information changes, or project participants forget key details about the project. In order to ensure that all survey participants fall within that two to five year window, NYSERDA should track the actual date that each demonstration concludes its operations.