Early Stage Process Evaluation of the NYSERDA Electric Power Transmission & Distribution Program

Final Report

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Summary

Navigant performed an early stage process evaluation of the Electric Power Transmission & Distribution (EPTD) program. The evaluation included the following tasks:

1. **Program and Stakeholder Review**: Navigant conducted a review of program materials and in-depth interviews with program staff to document the program design and objectives, explore the alignment of expectations across program staff, evaluate internal communication and collaboration pathways, and identify areas for internal program improvement. In addition, Navigant completed in-depth interviews with 14 external stakeholders relevant to NYSERDA Smart Grid activities to examine stakeholder awareness of EPTD program activities, explore alignment of the program with stakeholder objectives, identify issues for further investigation; and evaluate stakeholder perception of program funding strategies.
2. **Benchmarking**: Navigant reviewed EPTD projects to identify technologies that are well-supported by the program and to identify any program funding gaps. Navigant then benchmarked the EPTD program against American Recovery and Reinvestment Act (ARRA) investments in Smart Grid transmission and distribution (T&D) programs across North America. The EPTD program is more focused on grid-based (that is, T&D) modernization than on end-use applications (such as advanced metering infrastructure [AMI] and smart appliances), and EPTD staff noted that a key driver of program activity is the desire to fill technology gaps within the Smart Grid domain, particularly in the grid-based aspect of the domain. Navigant used this program context to focus its benchmarking efforts.
3. **Infographic**: Navigant used observations made during the benchmarking assessment to create an infographic that depicts the spectrum of Smart Grid T&D technologies within the larger electric grid topography. The infographic depicts the categorical investment allocation – by both EPTD and ARRA-funded Smart Grid programs – by technology class to help EPTD staff compare their investment decisions to those made on a national scale, while providing a graphical context for the investment decisions.

High-level Findings

Navigant identified the following findings as a result of the Program and Stakeholder Review and Benchmarking efforts.

Stakeholders Desire Increased Communication Regarding Program Activity: Internal and external stakeholders noted that the EPTD program could improve its communications with stakeholders. Interviewees stated that increased communication of Program Opportunity Notice (PON) awards, as well as participating project progress updates and results, would add value to program efforts and promote stakeholder awareness of and involvement in program activities.

Stakeholders Agree That EPTD's Portfolio Investment Strategy Is Prudent: Given the scope of the T&D technology spectrum, stakeholders considered the EPTD program's strategy of making small investments across multiple technologies the most appropriate way to achieve program objectives. In addition, stakeholders felt that program investments, which are currently distributed among research studies, engineering studies, product development, and demonstration projects, are appropriately aligned with the investment needs of each of these project types. Demonstration projects, for example, receive a higher proportion of investment dollars than

engineering or research studies or product development. This strategy, which is aligned with the expectations and needs of many external stakeholders, reflects a rational distribution of research and development (R&D) dollars, as demonstration projects tend to require greater investments in hardware and implementation. Stakeholders noted, however, that there appears to be a need to identify transitional funding for projects or technologies that have successfully completed the demonstration phase and are ready for scaling.

EPTD Investments Are Aligned With Broader Market Trends: Navigant's assessment of the EPTD program's technology investments shows strong alignment with national trends in Smart Grid technology investments within the T&D domain. This alignment confirms that the EPTD program is effectively focusing its resources to fill technology gaps identified by program staff and the stakeholder community. This alignment may help spur broader economic development from program investments (such as broader use of existing technologies, commercialization of new technologies, and development of new business models in the T&D domain) as private investors respond to program accomplishments.

Evaluation Recommendations

Navigant identified the following recommendations for EPTD program staff based on the tasks completed in this evaluation.

Recommendation 1: Work collaboratively to develop a formal definition of Smart Grid – EPTD staff and external stakeholders would like a more formal definition of the term Smart Grid in New York State. All stakeholders agreed that a consistent definition would help the EPTD program and Smart Grid initiatives promoted by other organizations throughout the state be more strategic in terms of funding specific types of projects, technologies, and strategies. Stakeholders felt that a collaborative process involving EPTD staff, energy regulators, and other relevant stakeholder groups was needed to better articulate Smart Grid policy framework for the state. Stakeholders viewed this as an essential task and agreed that the impact of EPTD projects would likely be increased if the EPTD program had a clearly articulated vision for how individual projects fit into a comprehensive Smart Grid policy framework.

Recommendation 2: Enhance external communications and project information-sharing – EPTD program staff currently make a number of efforts to communicate the program to interested external stakeholders. These efforts include presenting project information on the NYSERDA website and meeting annually with program stakeholders to discuss EPTD projects and the program's direction. External stakeholders felt that the EPTD information dissemination process could be improved, however. Based on this feedback, as well as an examination of best practices, Navigant recommends enhancing the information dissemination processes used by the EPTD program to improve stakeholder awareness of program activities and the details of specific projects within the program. Examples include providing case summaries of participating projects and corresponding lessons learned,

improving access to project information including technology advancements and performance characteristics, and scheduling events (such as webinars and stakeholder meetings) to share project information. These efforts will foster stakeholder awareness of and enthusiasm for EPTD activities and projects and will strengthen existing relationships and feedback loops between stakeholders, project representatives, and the program.

Recommendation 3: Consider developing metrics for measuring the economic impacts of EPTD investments – As noted in the EPTD program logic model, objectives of the program include increasing private investment and promoting the adoption of new business models in the T&D domain.[1] Navigant recommends that EPTD staff consider expanding their existing project review process by capturing three types of economic metrics at the conclusion of each project to serve as tracking mechanisms for the projects. The metrics include benefits resulting – either directly or indirectly – from NYSERDA's investment in a particular project. Suggested metrics categories include: **system benefits** (such as improved statewide T&D system condition monitoring), **state economic benefits** (such as private investment generated by program activity), and **business growth** (such as new technologies commercialized by companies that received EPTD funding). EPTD staff should track these metrics beyond the lifecycle of the Program Opportunity Notice (PON) awards to assess EPTD investments over a broader time horizon.

[1] Navigant and Research Into Action, *Electric Power Transmission and Distribution (EPTD) Smart Grid Program, Final Program Theory and Logic Model Report*, December, 2013.

1 Introduction

NYSERDA's Electric Power Transmission & Distribution (EPTD) Smart Grid initiative promotes the systematic modernization of the electric grid by designing and managing programs focused on improving the reliability, efficiency, security, and overall performance of the electric power delivery system in New York State.[2] Program offerings provide opportunities for sharing risks associated with research, development, and demonstration (together, RD&D), and validation of innovative Smart Grid technologies and applications that improve asset utilization, improve efficiency, maintain strict security, lower consumer costs, and lower the carbon intensity of the electric-power sector. The initiative's focus includes efforts to expand grid functionality, such as through advanced energy storage, advanced monitoring, automation, management and controls, innovative demand response, integration of renewable resources, and electric vehicles. NYSERDA funds its projects through competitive solicitations issued throughout the year.

NYSERDA works with organizations active in the Smart Grid domain, such as the New York State Smart Grid Consortium, to coordinate the efforts of key energy stakeholders to help realize program goals. NYSERDA also coordinates with other state and federal organizations on transmission- and distribution-related research. NYSERDA's programs fund research studies, engineering studies, product development, and demonstration projects focused on Smart Grid technologies and applications that provide economic growth opportunities.

The Electric Power Transmission & Distribution (EPTD) program is one of three programs within NYSERDA's overarching Smart Grid initiative. The EPTD program focuses on technologies specific to "smart wires," within the transmission and distribution (T&D) domain. The other two programs are focused on smart buildings and transportation. In particular, the EPTD program is designed to promote the development of a Smart Grid that accommodates a diverse set of electrical generation resources, enhances overall grid performance, and enables customers to reduce costs, energy consumption, and their environmental impacts.

1.1 Research Objectives

The primary objective of this research was to conduct an early stage process evaluation of the EPTD program. Navigant used three primary tasks to complete the project: 1) program and stakeholder review; 2) benchmarking assessment; and 3) Smart Grid ecosystem infographic. The activities performed for each of these three tasks are summarized below.

[2] NYSERDA's Advanced Building Systems and Electric Vehicle Infrastructure programs are related to the EPTD program.

1.1.1 Task 1: Program and Stakeholder Review

The goal of this task was to document the primary internal and external processes related to EPTD program activities.

Internal Processes – Navigant conducted a review of program materials and in-depth interviews with program staff to document the program design and objectives, explore the alignment of expectations across program staff, evaluate internal communication and collaboration pathways, and identify areas for internal program improvement.

External Processes – Navigant completed in-depth interviews with 14 external stakeholders relevant to NYSERDA Smart Grid activities to examine stakeholder awareness of EPTD program activities, explore alignment of the program with stakeholder objectives, identify issues for further investigation; and evaluate stakeholder perception of program funding strategies. Stakeholders were selected to represent broad categories of individuals and organizations affected by or in a position to affect NYSERDA Smart Grid programs. Interviews were completed with representatives of the following organizations:

- New York Independent System Operator (NYISO)
- The New York State Smart Grid Consortium
- New York Power Authority (NYPA)
- New York Public Service Commission (PSC)
- Investor-owned and public utilities
- Academic and nonprofit research institutions
- Smart Grid finance and investment community[3]
- PON awardees (participating projects)

1.1.2 Task 2: Benchmarking Assessment

Navigant conducted a benchmarking analysis to help assess the focus, approach, and results of the EPTD program relative to similar initiatives across North America. The EPTD program is more focused on grid-based (that is T&D) modernization than on end-use applications (such as advanced metering infrastructure [AMI] and smart appliances), and a key driver of program activity is staff's desire to fill technology gaps within the Smart Grid domain. Navigant used this context to focus its benchmarking efforts. Navigant augmented the benchmarking exercise by identifying key grid-level market trends in the Smart Grid domain by reviewing relevant secondary sources.[4]

Navigant benchmarked the EPTD program's project portfolio (Appendix B) against federal Smart Grid investments made through the United States Department of Energy's (DOE) Smart Grid Investment Grant (SGIG) program, Smart Grid Demonstration Program (SGDP), and Renewable and Distributed Systems Integration (RDSI) program.[5]

[3] Navigant was unable to gain access for interviews with private T&D investors, distribution equipment manufacturers, and the United States Department of Energy.
[4] The secondary sources reviewed by the Navigant team are cited throughout this report.
[5] As reported by the DOE on SmartGrid.gov for technology assets deployed as of December 31, 2013.

Navigant examined the EPTD and DOE funding allocations across comparable technology categories to understand technology prioritization decisions and identify investment gaps. The DOE projects served as a meaningful basis for comparison due to the breadth of the Smart Grid technology landscape these projects covered.

1.1.3 Task 3: Smart Grid Ecosystem Infographic

Navigant used the observations made during the benchmarking assessment to create an infographic that depicts the spectrum of Smart Grid T&D technologies within the larger electric grid topography. The infographic depicts the categorical investment allocations made by EPTD and DOE by technology category to help EPTD staff compare their investment decisions to those made on a national scale, while providing a graphical context for the investment decisions.

1.2 Report Organization

The remainder of this report is organized in the following manner:

Section 2 presents the interview methods used by the Navigant team including discussion of the research objectives, the sample selection process, and the interview process.

Section 3 presents the results of the program and stakeholder review task including findings and recommendations developed as a result of stakeholder feedback.

Section 4 presents the results of the benchmarking task including a comparison of EPTD program investments against American Recovery and Reinvestment Act (ARRA) investments in Smart Grid transmission and distribution (T&D) programs.

Section 5 presents the infographic developed by the Navigant team that depicts the spectrum of Smart Grid T&D technologies within the larger electric grid topography.

Section 6 presents the findings and recommendations identified by Navigant over the course of the project.

2 Interview Methods

This section discusses the methods Navigant used to conduct the program staff and external stakeholder interviews.

2.1 Research Objectives

Navigant conducted in-depth interviews with program staff and external stakeholders to document EPTD program design and objectives, explore the alignment of expectations across program staff and external stakeholders, evaluate internal and external communication pathways, and identify suggested areas for program improvement. Table 1 summarizes the key themes explored in the interviews.

Table 1. Interview Themes

Theme	Key Questions	Objectives
Perspectives of NYSERDA Smart Grid programs	How have you interacted with NYSERDA on Smart Grid programs? Describe for me these interactions.	Examine stakeholder awareness of program activities. Document program design and objectives, explore the alignment of expectations across program staff, evaluate internal communication and collaboration, and identify areas for internal program improvement.
Interactions with other organizations	Have you heard of the Smart Grid Consortium? Tell me about your participation in that organization. How does participation in the Smart Grid Consortium fit with your organization's long-term vision for Smart Grid technology?	Explore alignment across stakeholder objectives and programs, identify issues for further investigation, and evaluate stakeholder perception and alignment of NYSERDA funding strategy.
Role(s) of the EPTD Program	What do you see as the EPTD program's role in the Smart Grid space? How might you suggest that EPTD staff change their role?	Explore alignment across stakeholder objectives and programs, identify issues for further investigation, and evaluate stakeholder perception of EPTD funding strategy.
Program staff (internal processes)	What are some challenges your group has encountered in interacting with the EPTD program?	Explore alignment across stakeholder objectives and programs.
Private research lab-specific themes	How does the work that the EPTD program funds in the Smart Grid space affect the research that you are performing at your facility?	Examine stakeholder awareness of program activities, explore alignment across stakeholder objectives and programs, identify issues for further investigation, and evaluate stakeholder perception of EPTD funding strategy.
University-/Government lab-specific themes	How well does the EPTD program's technology strategy align with your research priorities?	Examine stakeholder awareness of program activities, explore alignment across stakeholder objectives and programs, identify issues for further investigation, and evaluate stakeholder perception of EPTD funding strategy.
Utility-specific themes	How well does the EPTD program's technology strategy align with your utility's technology roadmap for building a Smart Grid? Where do you see Smart Grid technology, in general, evolving in the next ten years? What role do you think utilities will play in that evolution?	Examine stakeholder awareness of program activities, explore alignment across stakeholder objectives and programs, identify issues for further investigation, and evaluate stakeholder perception of EPTD funding strategy.

2.2 Sample Selection

Navigant worked with EPTD staff to develop a sample of 25 organizations representing stakeholders (both internal and external) to EPTD program activities. Navigant identified the initial list of stakeholder organizations and EPTD staff provided contact information for these organizations as needed.[6] This process, known as targeted sampling, ensured that the sample included a broad selection of stakeholder organizational types. Navigant selected individual interviewees within each organization based on their involvement with the EPTD program. As shown in Table 2, Navigant conducted interviews with representatives from 17 of the 25 targeted stakeholder organizations. This number was not intended to achieve any predetermined degree of statistical precision; it was Navigant's estimate of the number of interviews needed to reasonably represent a cross-section of stakeholder types.

Table 2. Interviews Conducted

#	Respondent Organization
1	NYSERDA Program Manager #1
2	NYSERDA Program Manager #2
3	NYSERDA Program Manager #3
4	Central Hudson Gas & Electric
5	New York Power Authority
6	New York Independent System Operator
7	New York State Smart Grid Consortium
8	Rensselaer Polytechnic Institute
9	New York Battery and Energy Storage Technology Consortium
10	New York State Department of Public Service
11	Electric Power Research Institute
12	Stanford University Steyer-Taylor Center for Energy Policy and Finance/National Renewable Energy Laboratory
13	Orange & Rockland
14	New York State Electric and Gas Corporation
15	Clarkson (PON Awardee)
16	American Vanadium (PON Awardee)
17	NYSEG (PON Awardee)

2.3 Interview Process

Navigant technical staff conducted interviews over the phone between November 2013 and February 2014. Interview length ranged from 35 minutes to more than one hour. Most interviews were conducted with two members

[6] EPTD staff but did not identify the specific stakeholders to be interviewed by Navigant. Rather, staff provided contact information and relevant details regarding participating projects (e.g., the level of project development and status of program participation) on an as needed basis.

of the Navigant team present. This allowed one member of the team to stay engaged and focused on the interview while the other could record detailed notes for review.

Navigant adhered to the "Interview Guide Approach" outlined by Patton.[7] This approach explores topics and issues determined in advance (as noted by the interview themes shown in Table 1). Each interview was adjusted (sequence and wording) depending on the interviewee to help increase the comprehensiveness of the data collected, while maintaining a systematic process to support effective exploration of similar themes across different stakeholder types. The completed interviews were conversational in nature, which yielded more candid and valuable responses.

[7] Patton, M. Q. (1987) How to Use Qualitative Methods in Evaluation. California: Sage Publications, Inc.

3 Program and Stakeholder Review

This section presents findings from interviews the Navigant team completed with internal stakeholders (EPTD program managers and staff) and external stakeholders (regulators and those engaging with or seeking funding from NYSERDA programs).

3.1 Internal Stakeholders

Navigant conducted interviews with three EPTD program staff (internal stakeholders) to elicit their perceptions of internal communication and collaboration processes, definitions of the Smart Grid, and the prevailing R&D funding strategy.

3.1.1 Internal Communication and Collaboration Processes

EPTD staff noted that internal communication and collaboration processes are informal yet effective. Program staff work closely with one another and have solid working relationships. Staff noted that a formal process for identifying and communicating with NYSERDA subject-matter experts does not exist but that they are able to leverage their internal networks to directly contact subject-matter experts as needed.

The primary formal mechanism staff identified for communicating strategy or coordinating projects across group lines was through Technical Evaluation Panels (TEP). TEPs provide opportunities for NYSERDA staff (across groups) and external experts to review PON applications, provide feedback, and help promote (or reject) projects that fit within their group's and NYSERDA's objectives.

Interviewees stated that certain groups within NYSERDA's R&D department focus on technology development, while the Smart Grid programs tend to focus on demonstration projects. EPTD staff provide their unique perspective on candidate projects by serving on TEPs for other groups. By serving on TEPs, EPTD staff can advise selected projects during the technology development phase to increase the likelihood of the projects' success during a subsequent demonstration phase. TEPs also create opportunities for EPTD staff to communicate the value of T&D improvements to other NYSERDA staff during the project selection process.

3.1.2 Definition of Smart Grid

EPTD staff indicated that internal and external stakeholders did not share an understanding of the term Smart Grid and the value of the Smart Grid to NYSERDA or to external organizations. Part of the reason for this lack of clarity may be due to an imprecise definition of the term Smart Grid. There was no consensus among EPTD staff regarding the definition of Smart Grid and staff agreed that the definition likely differs across external stakeholder groups as

well. Staff expressed optimism that state regulators are aware of this situation and are working with multiple stakeholder groups to better articulate a Smart Grid policy statement for the state.

3.1.3 R&D Funding Strategy

EPTD staff generally favored a portfolio-based approach to R&D—in terms of project size (dollar amount) and diversity of technologies. Staff noted that the broad scope of the T&D technology spectrum was a key factor driving the EPTD program's strategy of making small investments across multiple technologies. Staff also noted that they try to avoid investing in projects that might have happened anyway—the free rider phenomenon. This philosophy aligns with staff's stated desire to identify and fill technological gaps within the Smart Grid domain. In addition, EPTD staff noted that the uncertain nature of an evolving Smart Grid created investment risks that were best managed through the use of a broad and diverse portfolio strategy that generally avoided high-budget, large-scale projects.

Table 3 summarizes the key findings generated from the internal stakeholder interviews.

Table 3. Summary of Internal Stakeholder Key Findings

Key Finding	Exemplary Quote
EPTD staff leverage informal mechanisms for coordination, collaboration, and communication	*It's not hard. We're not a large department and all the colleagues here are close… so when you talk about [coordination across] groups we're talking about three guys. I don't think we have any challenges internally…we kind of know who's doing what…I don't think there are any organizational challenges.*
EPTD's primary formal mechanism for coordination with other groups is through TEPs.	*Smart Grid representatives will sit on review boards. This allows input at the technology development phase that can help shepherd a project to the demonstration phase later.*
EPTD staff believe a clear definition of Smart Grid is needed to help establish regulatory priorities and program strategies	*We're still defining what Smart Grid means…we recognize that Smart Grids could either be how the grid itself is smarter or how the grid is smarter when it is interacting with customers better. Those are two different angle[s] of 'smarts.'*
EPTD staff generally support a broad and diverse portfolio of projects.	*There's a high rate of uncertainty and complications in the process…business complications, technology complications… so having a broad and diverse portfolio is the smart way to go.*

3.2 External Stakeholders

External stakeholders represented organizations outside of NYSERDA, including regulators and those engaged with or seeking funding from the EPTD program. Navigant conducted interviews with 14 external stakeholders to elicit their perceptions regarding the definition of Smart Grid, the EPTD program's information-sharing process, their experience with EPTD program managers, and the program's project funding strategy.

3.2.1 Definition of Smart Grid

Like internal stakeholders, external stakeholders agreed that the term Smart Grid does not have one fixed definition across stakeholders. In general, stakeholders affiliated with utilities that focus on generation and transmission (with little customer interaction) tended to define Smart Grid in terms that excluded customer-side improvements. Alternatively, stakeholders affiliated with organizations that provide services beyond T&D conceived of a broader definition, including technologies (such as phasor measurement units [PMUs], switches, control devices, and power technologies), communications with the grid, integration of smart buildings with the grid, managing customer loads, and educating a new generation of engineers to run the future system. External stakeholders agreed that a consistent definition was needed to clarify the types of projects, technologies, and strategies that deployed by the EPTD program and Smart Grid initiatives promoted by other organizations throughout the state including strategic interaction across the various initiatives. Most external stakeholders shared EPTD staff's perception that state regulators were aware of the need for a formal definition of Smart Grid and were making progress toward developing such a definition.

Many external stakeholders expressed their opinion that NYSERDA should articulate a long-term strategic vision for the Smart Grid in New York State. In general, external stakeholders shared a perception that EPTD staff focus on managing individual participating projects rather than on developing a more strategic long-term plan based on or incorporating a viable Smart Grid strategy. These external stakeholders expressed that NYSERDA may be able to lead a facilitated process to better articulate a Smart Grid policy framework for the state. Given the perceived lack of a state-level Smart Grid policy framework, many external stakeholders were unclear about how EPTD participating projects might fit together in a long-term strategy.

Many external stakeholders said the EPTD program has had positive statewide impacts. According to these external stakeholders, getting an award from NYSERDA gives legitimacy to a project or technology, because the EPTD program is funding projects that wouldn't normally be done by the utilities or the private sector. Stakeholders viewed project validation as a primary benefit of participating in the EPTD program, but said the impact of their projects could be increased if the EPTD program had a well-articulated vision for how individual projects fit into a long-term vision for the state.

3.2.2 Information-sharing Process

A minority of external stakeholders stated their perception that NYSERDA's Smart Grid programs were somewhat insular and available only to a small group of invited organizations. These stakeholders noted that they were not invited to Smart Grid meetings facilitated by NYSERDA and suggested that NYSERDA and other stakeholders would benefit from a more open process. In addition, several external stakeholders were frustrated that EPTD program staff did not regularly inform them about program developments and project outcomes (successes or failures) associated with EPTD activities. These stakeholders expressed a desire for NYSERDA to institute a more

formal process for communicating with the Smart Grid community. Stakeholders expressed that there is no process or dashboard to help relevant parties share lessons learned from participating projects, particularly recommendations about how external parties could build upon the outputs of each participating project.

Many external stakeholders suggested that EPTD program staff may want to institute a reporting process similar to one used by the DOE, which reports projects that have received program funding, including summaries of participating projects' successes and lessons learned. Stakeholders reported that they benefited tremendously from this type of reporting. In addition, external stakeholders said the outputs of existing participating projects should be used as inputs for future participating projects to the extent possible to build upon preceding program investments. External stakeholders expressed their belief that opportunities for expanding program outputs beyond individual projects would likely be increased if the EPTD program enhanced its formal information-sharing process.

3.2.3 EPTD Project Management Expertise

External stakeholders held generally positive opinions of EPTD staff's management of participating projects. They described EPTD staff as knowledgeable and involved throughout the PON process, including proactively helping them understand the process. Nearly every stakeholder reported that EPTD staff gave (and continues to give) participating projects the flexibility to implement projects in a manner that is appropriate for their organization. The stakeholders also indicated that EPTD staff encourages utilities and other organizations to participate in the PON process. A minority of external stakeholders noted that EPTD contractors were assigned to projects that were outside of their areas of technical expertise, and that this created inefficiencies in their projects. These stakeholders would like to see better alignment between contractor technical knowledge and the projects they manage.

3.2.4 Perceptions of the New York State Smart Grid Consortium

Stakeholder perceptions of and ideas about the Consortium are important to the overall understanding of NYSERDA's position and objectives for Smart Grid in the state. Although many external stakeholders had hoped that the Consortium would serve as a centralized information sharing organization, most external stakeholders said they were uncertain about the Consortium's goals, objectives, and outcomes. These stakeholders stated that the Consortium had not sufficiently communicated its overarching goals or the problems it would address.

Not all external stakeholders shared this perspective, however. Some external stakeholders reported that the Consortium provides an opportunity to develop relationships across the industry. These stakeholders also said the Consortium has the potential to assist New Yorkers in learning from the experience of experts from other jurisdictions and areas of expertise. Further, these stakeholders noted that since the EPTD program tends to focus on the technical aspects of the Smart Grid, the Consortium could enhance the program's efforts through regular communications and information-sharing regarding program activities and outcomes.

3.2.5 EPTD Program Funding Strategy

External and internal stakeholders agreed that the EPTD program's portfolio-based funding approach – which supports a diverse mix of projects and technologies – is the optimal strategy, especially since T&D projects tend to cost significantly more than other types of projects. Most external stakeholders supported the types and size of projects funded by the program. In addition, many external stakeholders saw the EPTD program's role as funding applied Smart Grid research, rather than conducting true R&D. These stakeholders stated that the program supports development of products that can be demonstrated in the field and can subsequently be deployed by utilities or other organizations. However, as discussed previously, external stakeholders would like the EPTD program to implement more effective communication strategies regarding program activities. This information would enable external stakeholders to remain aware of program accomplishments and build upon successful project outcomes.

External stakeholders involved more heavily in applied research (rather than technology development or deployment) were concerned about the EPTD program's potential investments in much larger projects. For instance, many academic institutions cannot compete with utilities for PON awards because they cannot provide the matching funds that are often required to respond to an EPTD PON. This barrier would become a greater challenge for such stakeholders if the program moves toward funding larger projects. To mitigate this potential issue, external stakeholders suggested that the EPTD program continue to encourage and support partnerships between academic institutions and the utilities. These partnerships effectively integrate cutting-edge knowledge with relevant technical expertise, existing system infrastructures, and available capital to develop projects that are likely to generate positive impacts statewide.

Table 4 summarizes the key findings from the external stakeholder interviews.

Table 4. Summary of External Stakeholder Findings

Key Finding	Exemplary Quote
External stakeholders struggle to consistently define Smart Grid	*The definition of Smart Grid seems to depend on where you're coming from…what your business goals are…perhaps what your ideals are…It's a little bit of a slippery topic because the interpretation has been moving around.*
External stakeholders support a diverse mix of participating projects and technologies	*When you start out, you have to spread the research money wide…see what starts to pop up as things that really make sense.*
External stakeholders felt the EPTD information dissemination process could be improved	*The purpose [of PON awards] should be so that others look at this and say, 'I can take this and I can use it.' I just don't know where that information might be.*

3.3 Recommendations Based on the Program and Stakeholder Review

Navigant developed the following recommendations based on the program and stakeholder review.

Recommendation 1: Work collaboratively to develop a formal definition of Smart Grid

EPTD staff and external stakeholders would like a more formal definition of the term Smart Grid in New York State. All stakeholders agreed that a consistent definition would help the EPTD program and Smart Grid initiatives promoted by other organizations throughout the state be more strategic in terms of funding specific types of projects, technologies, and strategies. Stakeholders felt that a collaborative process involving EPTD staff, energy regulators, and other relevant stakeholder groups was needed to better articulate a Smart Grid policy framework for the state. Stakeholders viewed this as an essential task and agreed that the impact of EPTD projects would likely be increased if the EPTD program had a clearly articulated vision for how individual projects fit into a comprehensive Smart Grid policy framework.

Recommendation 2: Enhance External Communications and Project Information-sharing

EPTD program staff currently make a number of efforts to communicate the program to interested external stakeholders. These efforts include presenting project information on the NYSERDA website and meeting annually with program stakeholders to discuss EPTD projects and the program's direction. External stakeholders felt that the EPTD information dissemination process could be improved, however. Based on this feedback, as well as an examination of best practices, Navigant recommends enhancing the information dissemination processes used by the EPTD program to improve stakeholder awareness of program activities and the details of specific projects within the program.

In particular, EPTD staff can take the following three actions to address the information-sharing challenges noted by external stakeholders:

1. **Improve access to program and project information:** Navigant recommends enhancements to the EPTD program website that facilitate navigation of the site, as well as more prominent promotion of the website address, to allow external stakeholders to more easily find and access the program and project information they are seeking.
2. **Expand project information reporting requirements:** EPTD staff should consider expanding PON reporting requirements to provide external stakeholders with additional information regarding funded projects. As an example, EPTD staff might consider asking participating projects to obtain and share the following information, which DOE captures for each of their Smart Grid Investment Grant (SGIG) projects:

    - Project description

- Goal/Objectives
- Key Milestones
- Benefits
- Contact information
- Partners
- Project duration
- Total budget
- Equipment
- Demonstration sites
- Equipment costs
- Equipment quantities
- Customers enrolled
- Distributed generation capacities
- Other system data

3. **Host quarterly EPTD events:** EPRI hosts quarterly events or webinars to update stakeholders on Smart Grid project developments. Navigant recommends EPTD staff consider a similar approach to keep EPTD program stakeholders up-to-date and engaged in program activities throughout the calendar year. These events (such as conferences and webinars), which would involve internal and external stakeholders including representatives from participating projects and EPTD staff, would serve as opportunities to present "state of the EPTD" program reports. This effort would increase stakeholders' awareness of and enthusiasm for EPTD activities and increase the likelihood that external parties could build upon the outputs of successful EPTD projects.

Recommendation 3: Develop Metrics for Measuring the Economic Impacts of EPTD Projects on the New York State Economy

Since NYSERDA's Smart Grid investment goals include delivering ratepayer benefit through system improvements, as well as promoting business and market development and helping to build the "expansion" link in the innovation chain, EPTD staff should consider developing and tracking performance metrics (supplemental to existing program performance metrics) relative to these goals. These metrics could be used to verify goal achievement or identify areas for program refinement. NYSERDA already has identified metrics for assessing cleantech innovation.[8] Many of these metrics could be applied to the EPTD program including the following examples:

- Patents registered
- University research expenditure
- Industry-sponsored university research expenditure
- Value of competitive DOE awards (or other, such as small business innovation research/small business technology transfer)
- Venture capital investments
- Private-sector jobs created
- Industry development
- Number of Smart Grid companies

[8] NYSERDA, *Clean Energy Innovation Metrics*, 2012.

Furthermore, while the EPTD program captures system impact metrics on a project-by-project basis, including efficiency gains, avoided cost and other technology-related system impacts, EPTD staff has not yet implemented a process to track these metrics after participating projects are completed. Navigant recommends that EPTD staff consider tracking at the state level the subsequent deployment of completed projects that have successfully validated a technology or application. By applying the benefits identified within the context of the EPTD program, EPTD staff could estimate the downstream system benefits of their investments as technology deployment is expanded throughout the state. The estimated benefits could then be applied to avoided costs or deferred T&D investments and be extrapolated into ratepayer cost savings over time.

4 Benchmarking Assessment

Navigant conducted a benchmarking analysis to assess the breadth and depth of the EPTD program. As noted previously, the program is focused on grid-based modernization (transmission, distribution, and energy storage), as opposed to end-use applications (such as AMI and smart appliances), and a key driver of program activity is staff's desire to fill technology gaps within the Smart Grid domain. Navigant conducted the benchmarking assessment within this context by identifying grid-level market trends, and by mapping those trends to the EPTD program's current investment profile with the objective of identifying promising areas for future program investment.

This section presents an overview of the current EPTD investment profile, as categorized by Navigant, followed by a comparison with the current grid-based investment profile nationally and a discussion of identified national market trends in grid-based technologies.

4.1 Existing EPTD Investments

Figure 1 and Figure 2 show the percentage of EPTD project types by funding level (Figure 1) and by number of projects (Figure 2). The majority (68%) of program funding was allocated toward various Smart Grid Demonstration projects, followed by Engineering Studies (16%) and Research Studies/Product Development (8%). This distribution suggests that the EPTD program is in a strong position to identify successful Demonstration projects and steer subsequent investment to those projects as they are deployed in the marketplace.

Figure 1. Funding Percentage of EPTD Investments by Project Type

Source: EPTD Program records

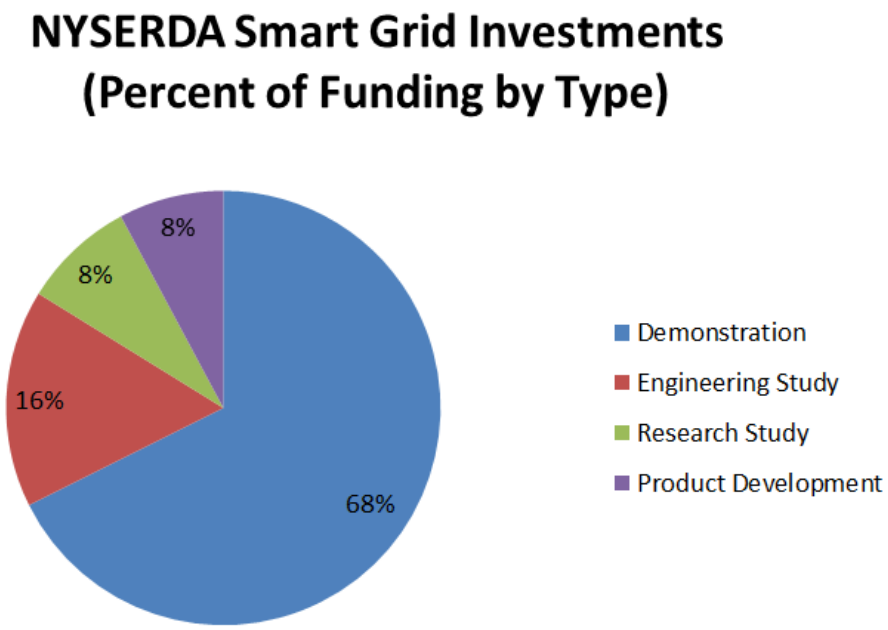
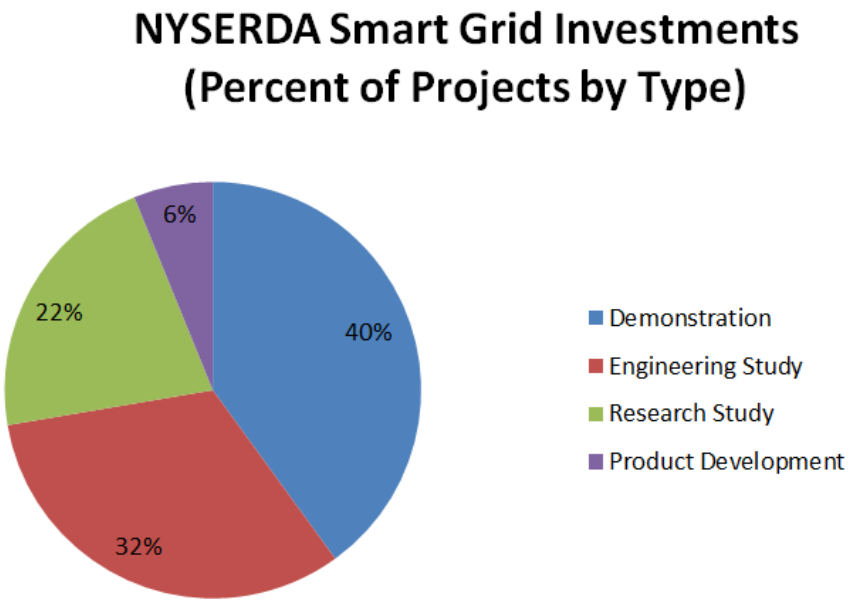


Figure 2. Percentage of EPTD Projects by Project Type

Source: EPTD Program records



Navigant also characterized EPTD projects by technology category. The following technology categories were used (adapted from technology categories in the IEA Technology Roadmap, 2011[9]):

- **Flexible Alternating Current Transmission Systems (FACTS).** This category includes technologies that enhance the controllability of transmission networks in order to maximize power transfer capability and may also include power system sensing and automating equipment. Some of these technologies include: fixed series capacitors (FSCs), thyristor controlled series capacitors (TCSCs), thyristor protected series capacitors (TPSCs), static synchronous compensators (STATCOM), static volt-ampere reactive (VAR) compensators, and variable frequency transformers.
- **Phasor Measurement Units (PMU).** PMUs, also known as synchrophasors, measure the frequency, voltage, and current magnitudes and phasor angle contours in transmission lines. PMUs generate data to inform decision making, mitigate wide-area disturbances, and improve transmission capacity and reliability via wide-area situational awareness (WASA), wide-area monitoring systems (WAMS), wide-area adaptive protection, control and automation (WAAPCA), and supervisory control and data acquisition (SCADA), as well as dynamic line rating (DLR).
- **High-temperature Superconductors (HTS).** HTS can significantly reduce transmission losses and enable economical fault-current limiting with higher performance.
- **Distribution System Sensing and Automation.** This category consists of a set of intelligent sensors, processors, and communication technologies that enable an electric utility to remotely monitor and coordinate its distribution assets and operate these assets in an optimal manner with or without manual intervention. Some of these technologies include: volt-VAR optimization (VVO);[10] fault location, isolation, and service restoration (FLISR); digital protection and control automation (including feeder load balancing) with auto-reclosers and sectionalizers; and general monitoring/diagnostics applications and technologies that leverage supervisory control and data acquisition (SCADA) and other monitoring systems.
- **Energy Storage.** This category includes technologies that can enhance transmission and distribution reliability and effectiveness by utilization of short-term and long-term energy storage. Some of these technologies include batteries, flywheels, and compressed air.
- **Distributed Generation (DG).** This category includes technologies and systems that allow for two-way flow of electricity in order to integrate small distributed generation sources to the grid.
- **Demand Response (DR).** This category includes technologies and systems that allow for real-time reductions in end-use loads in response to utility signals (such as interrupter control, curtailment signals, or price signals).
- **Microgrids.** This category includes systems that allow for local generation, distribution, and regulation of the flow of electricity to customers.
- **Other Technologies.** This category includes other EPTD projects related to transmission, distribution, or energy storage that spanned multiple categories as a cross-cutting project, had insufficient information available for categorization, or fell outside the categories listed above.

Figure 3 and Figure 4 show the percentage of EPTD program investment by technology category. These percentages were generated using only NYSERDA's investment portion of the projects' total costs. About 25% of EPTD investments were allocated to distribution sensing and automation technologies, 21% toward energy storage, and 16% toward PMU-related infrastructure and applications.

[9] http://www.iea.org/publications/freepublications/publication/smartgrids_roadmap.pdf
[10] VVO combines Conservation Voltage Reduction (CVR) and VAR control.

Figure 3. EPTD Investments (Percent of Funding by Technology Category)

Source: EPTD Program records

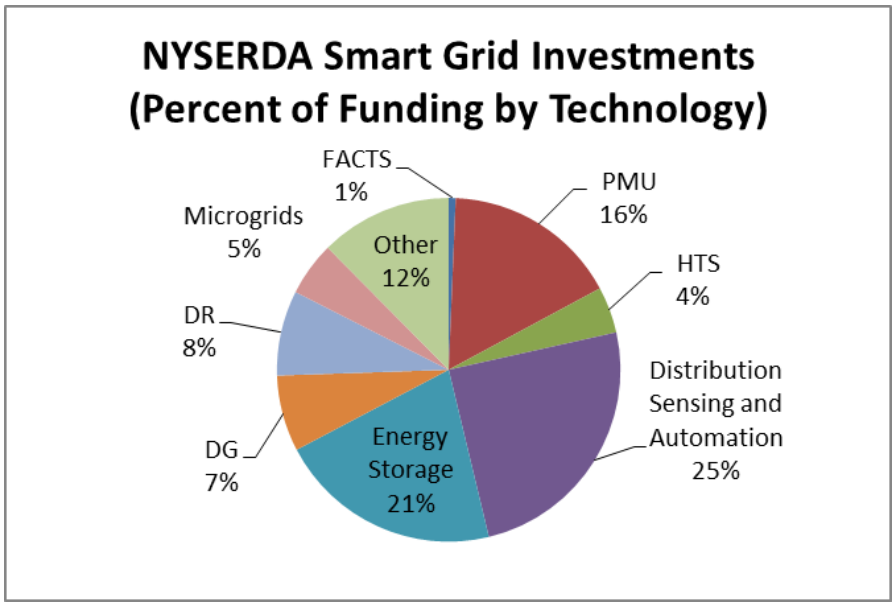


Figure 4. Funding of EPTD Investments by Technology Category, Considering Only NYSERDA's Portion Project Costs

Source: EPTD Program records

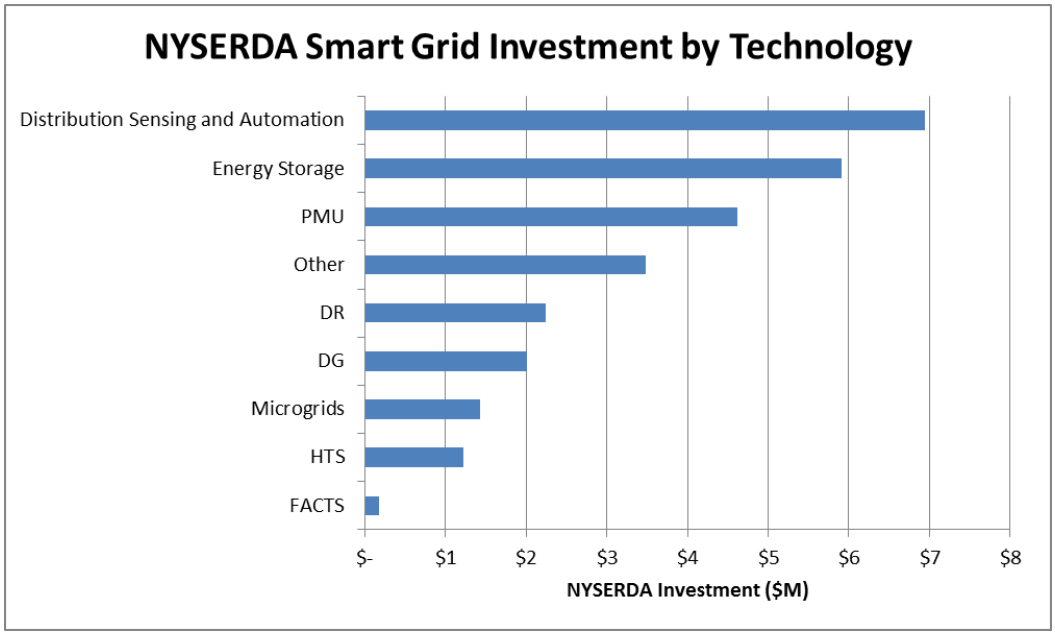


Table 5 summarizes the mapping of Smart Grid technologies to the broader categories emphasized in the EPTD program: Electric Transmission System, Electric Distribution System, and Energy Storage technologies.[11] Navigant

[11] It is important to note that national Smart Grid projects and investments extend well beyond these categories. These categories were selected in order to provide a more focused benchmarking and comparison of the EPTD program.

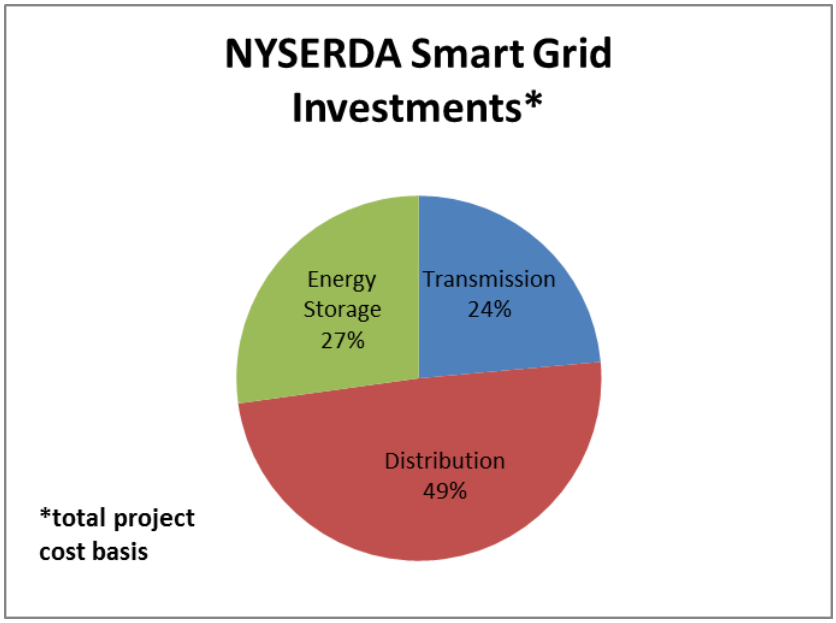
used this mapping to allocate total EPTD project investment to broader categories, as shown in Figure 5. Nearly 50% of EPTD investments were allocated to distribution technologies, 27% toward energy storage, and 24% toward transmission-related infrastructure and applications.

Table 5. Smart Grid Technologies to Category Mapping

Technology	Electric Transmission	Electric Distribution	Energy Storage
FACTS	X		
PMU	X		
HTS	X		
Distribution system sensing and automation		X	
Energy storage			X
Distributed generation		X	
Demand response		X	
Microgrids		X	
Other technologies	X	X	X

Figure 5. EPTD Investments (in Total Project Costs) in Transmission, Distribution, and Energy Storage Technologies

Source: EPTD Program records



4.2 Comparison with National Smart Grid Program Investments

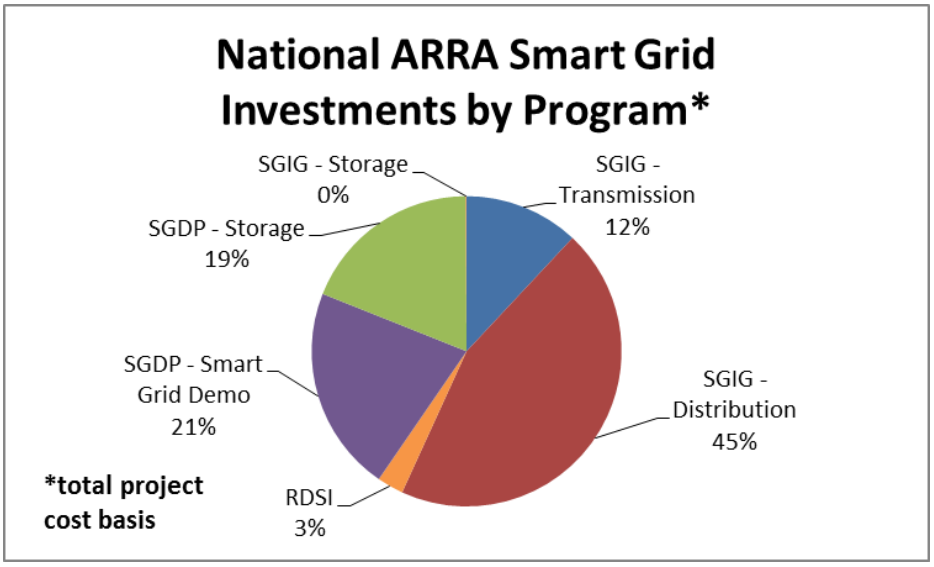
Navigant benchmarked EPTD program activities, presented above, against a current view of national Smart Grid investments, presented below. This section compares EPTD program investments with a snapshot of the current

investments made through DOE's Smart Grid Investment Grant (SGIG) program, Smart Grid Demonstration Program (SGDP), and Renewable and Distributed Systems Integration (RDSI) program implemented through the American Reinvestment and Recovery Act (ARRA).[12] The investments made through the SGIG program generally represent more mature, market-ready technologies than the projects in the SGDP and RDSI programs.

Figure 6 and Figure 7 show relative and absolute national Smart Grid investment proportions through ARRA, respectively, in terms of overall project dollars.[13] It is important to note that SGDP and RSDI projects are generally cross-cutting and include investments in transmission, distribution, and energy storage.

Figure 6. Relative Proportion of National Smart Grid Investments (in Total Project Costs) for ARRA-Funded Programs

Source: DOE Program records



[12] As reported by the DOE on SmartGrid.gov for technology assets deployed as of December 31, 2013.

[13] Two projects participating in the EPTD program (Consolidated Edison's Super Conductor Demo and NYSEG's Compressed Air Energy Storage Demo) receive a relatively small portion of their funding from NYSERDA (ConEd: $1,000,000 from NYSERDA and $36,500,000 from the awardee; NYSEG: $1,000,000 from NYSERDA and $124,000,000 from the awardee). These projects were removed from the analysis to avoid skewing the results.

Figure 7. Absolute Proportion of Smart Grid Investments (in Total Project Costs) for ARRA-Funded Programs

Source: DOE Program records

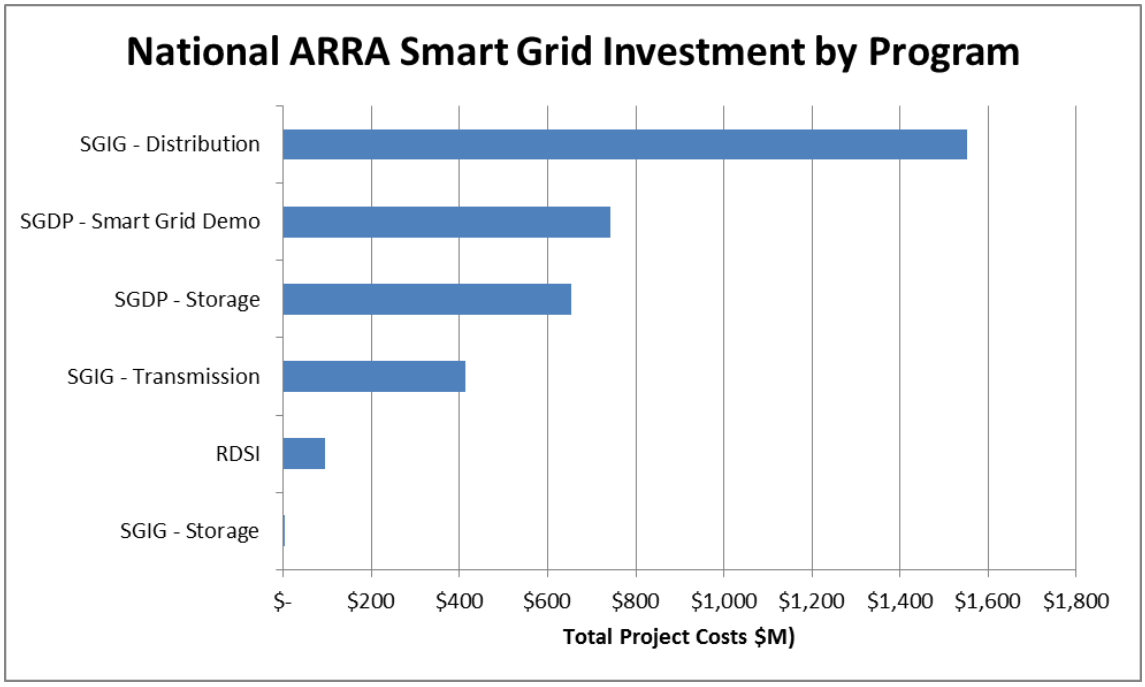


Figure 8 and Figure 9 provide additional detail regarding the breakdown of T&D system assets deployed under the SGIG funding. It is important to note that the values in Figure 8 and Figure 9 do not necessarily reflect the full rollout of technologies planned through the SGIG program for assets deployed as of December 31, 2013.

Figure 8. SGIG Program Electric Distribution Asset Expenditures

Source: DOE Program records

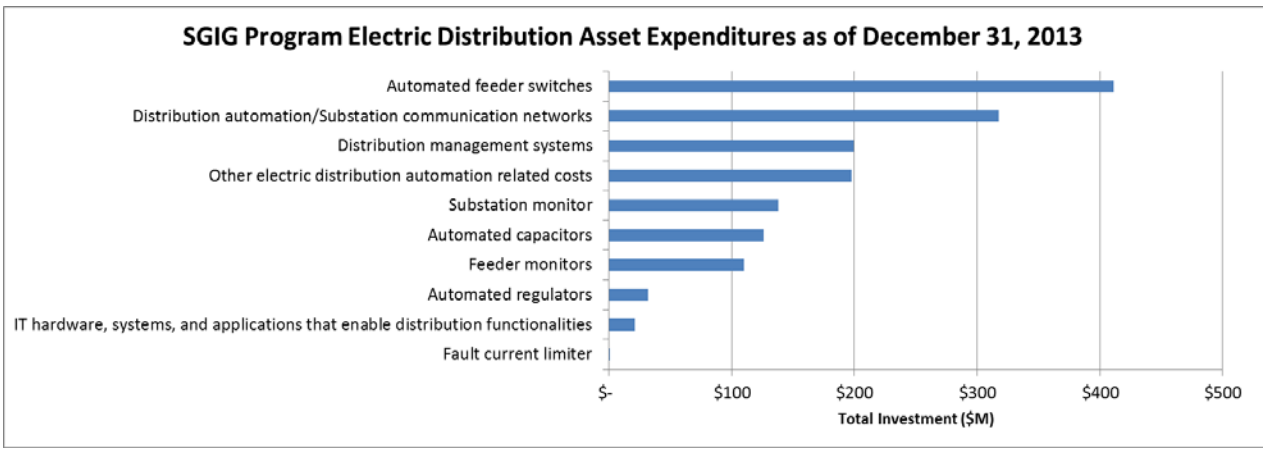
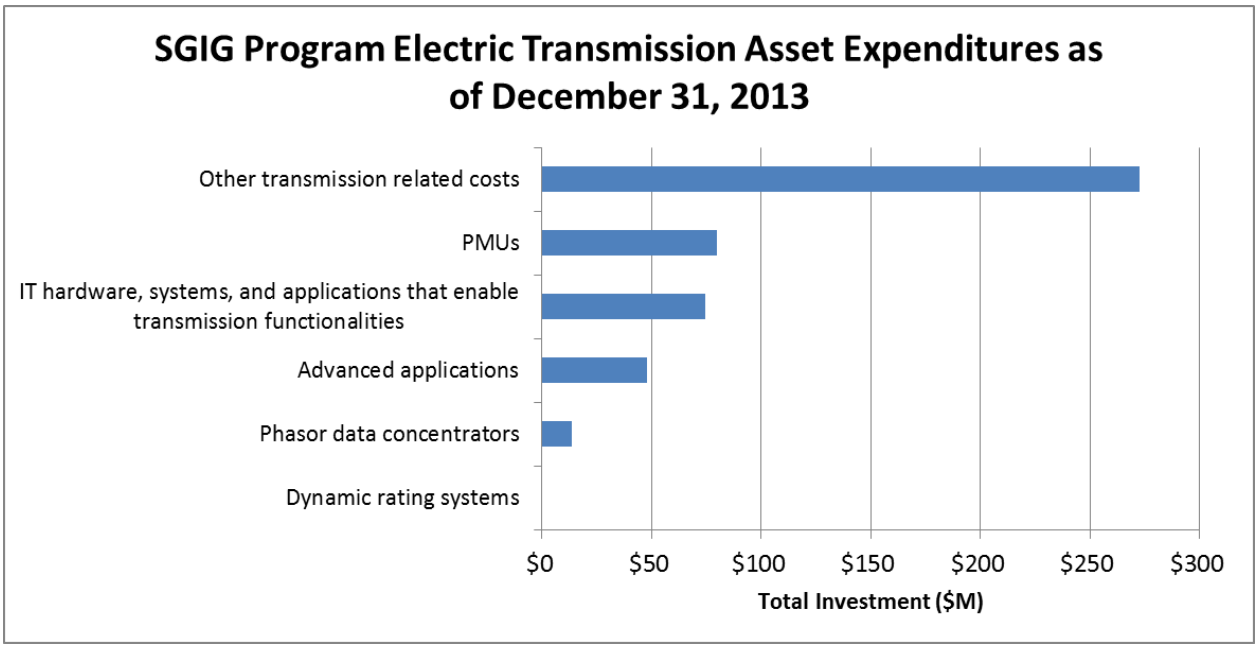


Figure 9. SGIG Program Electric Transmission Asset Expenditures

Source: DOE Program records



4.3 Findings from the Benchmarking Assessment

EPTD program investments in the transmission, distribution, and storage categories are relatively similar to those made through the DOE programs, with the most significant investment occurring in distribution technologies and approximately one-quarter of funding going towards energy storage technologies. It is important to note that the national SGDP and RDSI programs are cross-cutting, and therefore the allocation of these programs' funds to these categories is unknown.

Nationally, investment in electric distribution system reliability and efficiency improvements has grown more significantly recently than most other grid-based measures, and this level of growth is expected to continue. For instance, Navigant Research estimated almost $0.9 billion in revenue from low-voltage distribution automation (DA) and more than $1.6 billion in revenue from medium-voltage DA in 2012, with revenue growth expected to continue at more than a 6% over the next nine years.[14] The emphasis on distribution-related investments on a national basis mirrors the emphasis in the EPTD program, as shown in the previous figures. Some of the key technologies and applications driving these grid-based distribution investments nationally include the following:

- **Automated Feeder Switches.** Automated switches are being widely deployed on the distribution grid to support applications like Fault Location, Isolation, and Service Restoration (FLISR) for improved grid reliability. More investment has been made in automated feeder switches than in any other T&D technology in the SGIG program, with more than $400 million invested nationally. This investment represents almost 8,000 switches installed by 49 entities.

[14] Navigant Research, Navigant Inc. Smart Grid Technologies Published Q1 2012

- **Automated Capacitors.** Automated capacitors can be used for Volt-VAR optimization (VVO) to improve the efficiency of the distribution network. Almost 12,000 automated capacitors were installed by 45 different reporting entities as part of the SGIG program from 2010 to 2013.
- **Distribution Automation/Substation Communication Networks.** Although communication technologies are not an explicit focus of the EPTD program, communication networks are often a sizeable component of Smart Grid integration costs, encompassing more than $300 million in investment through the SGIG program from 2010 to 2013.
- **PMUs.** As reported by DOE, more than 1,000 PMUs have been deployed as part of the SGIG program since 2010. Navigant Research predicts a 2% compound annual growth rate (CAGR) in PMU-related revenue that will continue over the next nine years.[15] The longer-term challenge with PMUs is to begin integrating PMUs into the planning and operating procedures of transmission operators. By 2015, DOE has set a goal that 50% of transmission operators will have, to some degree, planning or operating procedures in place that incorporate measurements from PMUs.[16]

The benchmarking analysis also indicated that EPTD program funding seems to be in line with developments in energy storage. It is important to note, however, that energy storage remains a less mature technology category and will require more investment in continued R&D and demonstration efforts than broad-scale deployment in the near- to intermediate-term.

[15] Navigant Research, Navigant Inc. Smart Grid Technologies Published Q1 2012

[16] U.S. Department of Energy, *Synchrophasor Technologies and their Deployment in the Recovery Act Smart Grid Programs*, August 2013.

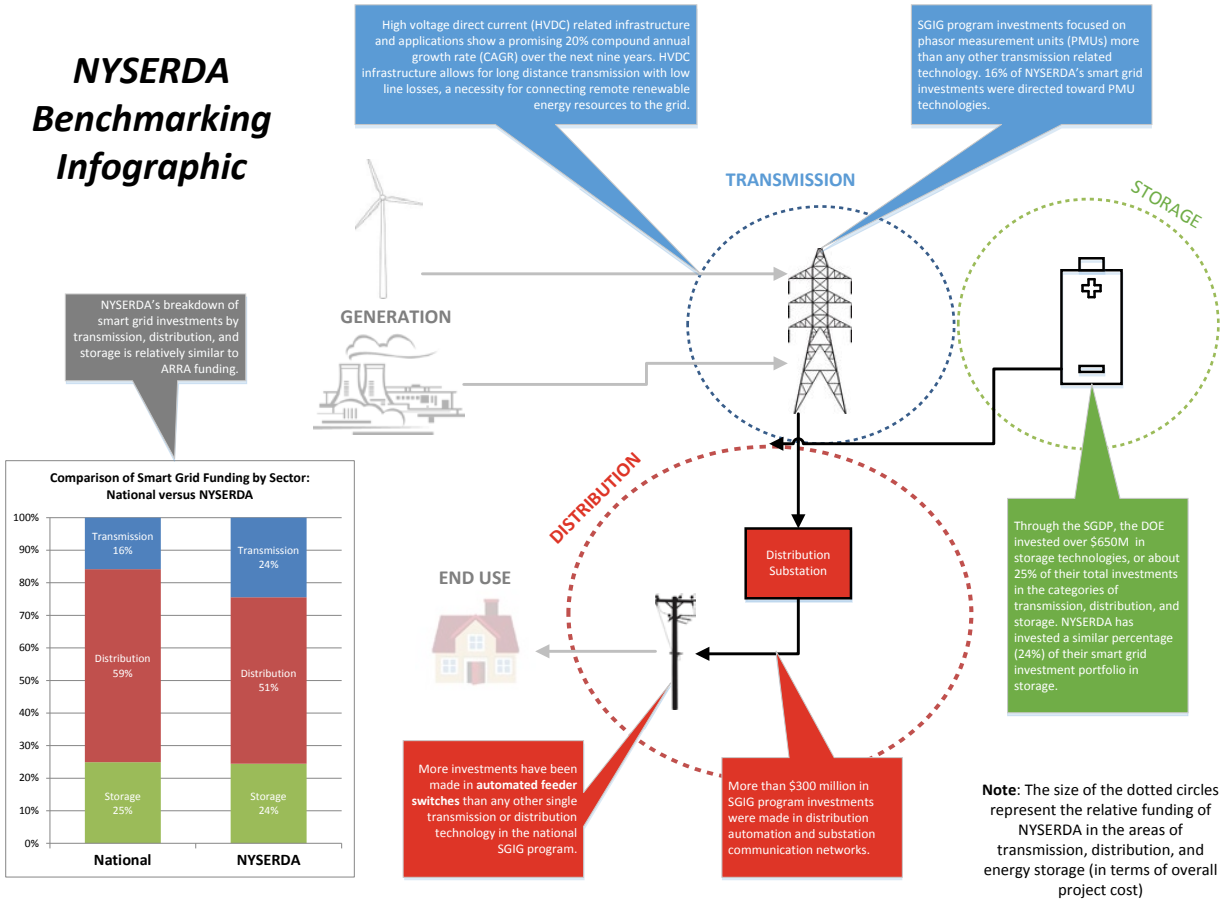
5 Smart Grid Ecosystem Infographic

Navigant used the observations made during the benchmarking assessment to create an infographic that depicts the spectrum of Smart Grid T&D technologies within the larger electric grid topography (Figure 10). The infographic depicts the categorical investment allocation – by both EPTD and DOE – by technology class to help EPTD staff compare their investment decisions to those made on a national scale, while providing a graphical context for the investment decisions. The infographic is color-coded by transmission (blue), distribution (red), and storage (green), with the remaining system components of generation and end-use color-coded in gray to focus attention on the EPTD program's technology focus.

The areas of the dotted circles represent EPTD's relative investments in transmission, distribution, and energy storage (based on total project costs). The bar graph in the bottom left compares the relative spending of ARRA-funded programs and EPTD's investments in these three sectors. As noted in the benchmarking assessment section, EPTD program investments in the transmission, distribution, and storage categories are relatively similar to those made through the DOE programs, with the most significant investment occurring in distribution technologies and approximately one-quarter of funding going towards energy storage technologies. Additional findings from Navigant's benchmarking efforts are highlighted in the call-outs throughout the infographic.

Figure 10. Smart Grid Ecosystem Infographic

Source: Navigant analysis



6 Findings and Recommendations

Navigant performed an early stage process evaluation of the Electric Power Transmission & Distribution (EPTD) program within NYSERDA's Smart Grid initiative. The evaluation included the following tasks:

Program and Stakeholder Review: Navigant conducted a review of program materials and in-depth interviews with program staff and external stakeholders to document the program design and objectives, explore the alignment of expectations across program staff and stakeholders, evaluate internal and external communication and collaboration pathways, and identify potential areas for program improvement.

Benchmarking: Navigant reviewed EPTD projects to identify technology areas that are well-supported by the program and to identify any program funding gaps. Navigant then benchmarked the EPTD program against American Recovery and Reinvestment Act (ARRA) investments in Smart Grid transmission and distribution (T&D) programs across North America.

Infographic: Navigant used the observations made during the benchmarking assessment to create an infographic that depicts the categorical investment allocation – by both EPTD and ARRA-funded Smart Grid programs – by technology class to help EPTD staff compare their investment decisions to those made on a national scale, while providing a graphical context for the investment decisions.

Key findings and recommendations identified by the Navigant team are presented in this section.

6.1 Findings

Navigant identified the following findings as a result of the Program and Stakeholder Review and Benchmarking efforts.

Stakeholders Desire Increased Communication Regarding Program Activity: Internal and external stakeholders noted that the EPTD program could improve its communications with stakeholders. Interviewees stated that increased communication of Program Opportunity Notice (PON) awards, as well as participating project progress updates and results, would add value to program efforts and promote stakeholder awareness of and involvement in program activities.

Stakeholders Agree That EPTD's Portfolio Investment Strategy Is Prudent: Given the scope of the T&D technology spectrum, stakeholders considered the EPTD program's strategy of making small investments across multiple technologies the most appropriate way to achieve program objectives. In addition, stakeholders reported that program investments, currently distributed among research studies, engineering studies, and demonstration

projects, are appropriately aligned with the investment needs of each of these project types. Demonstration projects, for example, receive a higher proportion of investment dollars than engineering or research studies. This strategy, which is aligned with the expectations and needs of many external stakeholders, reflects a rational distribution of research and development (R&D) dollars, as demonstration projects tend to require greater investments in hardware and implementation. Stakeholders noted, however, that there appears to be a need to identify transitional funding for projects or technologies that have successfully completed the demonstration phase and are ready for scaling.

EPTD Investments Are Aligned With Broader Market Trends: Navigant's assessment of the EPTD program's technology investments shows strong alignment with national trends in Smart Grid technology investments within the T&D domain. This alignment confirms that the EPTD program is effectively focusing its resources to fill technology gaps identified by program staff and the stakeholder community. This alignment may help spur broader economic development from program investments (such as broader use of existing technologies, commercialization of new technologies, and development of new business models in the T&D domain) as private investors respond to program accomplishments.

6.2 Recommendations

Navigant identified the following recommendations for EPTD program staff based on the tasks completed in this evaluation.

Recommendation 1: Work collaboratively to develop a formal definition of Smart Grid – EPTD staff and external stakeholders would like a more formal definition of the term Smart Grid in New York State. All stakeholders agreed that a consistent definition would help the EPTD program and Smart Grid initiatives promoted by other organizations throughout the state be more strategic in terms of funding specific types of projects, technologies, and strategies. Stakeholders felt that a collaborative process involving EPTD staff, energy regulators, and other relevant stakeholder groups was needed to better articulate a Smart Grid policy framework for the state. Stakeholders viewed this as an essential task and agreed that the impact of EPTD projects would likely be increased if the EPTD program had a clearly articulated vision for how individual projects fit into a comprehensive Smart Grid policy framework.

Recommendation 2: Enhance external communications and project information-sharing – EPTD program staff currently make a number of efforts to communicate the program to interested external stakeholders. These efforts include presenting project information on the NYSERDA website and meeting annually with program stakeholders to discuss EPTD projects and the program's direction. External stakeholders felt that the EPTD information dissemination process could be improved, however. Based on this feedback, as well as an examination of best practices, Navigant recommends enhancing the information dissemination processes used by the EPTD program to improve stakeholder awareness of program activities and the details of specific projects within the

program. Examples include providing case summaries of participating projects and corresponding lessons learned, improving access to project information including technology advancements and performance characteristics, and scheduling events (such as webinars and stakeholder meetings) to share project information. These efforts will foster stakeholder awareness of and enthusiasm for EPTD activities and projects and will strengthen existing relationships and feedback loops between stakeholders, project representatives, and the program.

Recommendation 3: Consider developing metrics for measuring the economic impacts of EPTD investments – As noted in the EPTD program logic model, objectives of the program include increasing private investment and promoting the adoption of new business models in the T&D domain.[17] Navigant recommends that EPTD staff consider expanding their existing project review process by capturing three types of economic metrics at the conclusion of each project to serve as tracking mechanisms for the projects. The metrics include benefits resulting – either directly or indirectly – from NYSERDA's investment in a particular project. Suggested metrics categories include: **system benefits** (such as improved statewide T&D system condition monitoring), **state economic benefits** (such as private investment generated by program activity), and **business growth** (such as new technologies commercialized by companies that received EPTD funding). EPTD staff should track these metrics beyond the lifecycle of the Program Opportunity Notice (PON) awards to assess EPTD investments over a broader time horizon.

[17] Navigant and Research Into Action, *Electric Power Transmission and Distribution (EPTD) Smart Grid Program, Final Program Theory and Logic Model Report*, December, 2013.

Appendix A: American Recovery and Reinvestment Act Distribution, Transmission, and Energy Storage Smart Grid Investments

The following tables identify the national Smart Grid projects presented in Section 4. These projects were funded, in part, by the federal government through the American Recovery and Reinvestment Act (ARRA)[18] and by the grant recipient.

Table 6. ARRA Smart Grid Projects

Source: Navigant analysis; data from www.SmartGrid.gov

Project	State	Award Amount	Total Project Value
Amber Kinetics, Inc. (Flywheel Energy Storage Demonstration)	California	$3,694,660	$7,457,591
American Transmission Company (Enhanced SCADA and PMU Communications Backbone Project)	Wisconsin	$11,444,180	$22,888,360
American Transmission Company (Phasor Measurement Unit Project)	Wisconsin	$1,330,825	$2,661,650
Aquion Energy (Sodium-Ion Battery for Grid-level Applications)	Pennsylvania	$5,179,000	$10,359,827
Atlantic City Electric Company (SGIG Distribution Automation Project)	New Jersey	$18,700,000	$37,804,712
Avista Utilities (Spokane Smart Circuit)	Washington	$20,000,000	$40,048,996
Baltimore Gas and Electric Company (Smart Grid Initiative)	Maryland	$200,000,000	$451,814,234
Beacon Power (20 MW Flywheel Frequency Regulation Plant)	Massachusetts	$24,063,978	$52,415,000
Burbank Water and Power (Smart Grid Program)		$20,000,000	$62,650,755
CenterPoint Energy Houston Electric, LLC (Smart Grid Project)	Texas	$200,000,000	$639,187,435

[18] http://www.smartgrid.gov/recovery_act/deployment_status/program_investments

Project	State	Award Amount	Total Project Value
Central Lincoln People's Utility District (Smart Grid Team 2020 Program)	Oregon	$9,936,950	$19,873,900
City of Anaheim (Model for Small and Midsize Utility Districts around the United States)		$5,896,025	$12,167,050
City of Auburn, IN (SmartGRID Project)	Indiana	$2,075,080	$4,150,160
City of Fort Collins Utilities (Front Range Smart Grid Cities)	Colorado	$18,101,263	$36,202,526
City of Glendale (AMI Smart Grid Initiative)	California	$20,000,000	$51,302,425
City of Leesburg, FL (Leesburg Smart Grid Investment Grant Project)	Florida	$9,748,812	$19,497,625
City of Naperville, IL (City of Naperville Smart Grid Initiative)	Illinois	$10,994,110	$21,988,220
City of Painesville, Ohio (Vanadium Redox Battery Demonstration Program)	Ohio	$4,243,570	$9,462,623
City of Quincy, FL (Smart Grid Project)	Florida	$2,471,041	$4,942,082
City of Ruston, Louisiana (Advanced Metering Infrastructure and Smart Grid Development Program)	Louisiana	$4,331,650	$8,663,300
City of Tallahassee, FL (Full-Scale Implementation of Automated Demand Response)	Florida	$8,890,554	$17,781,108
City of Wadsworth (Connected Grid Project)	Ohio	$5,411,769	$10,823,539
Consolidated Edison Company of New York, Inc. (Smart Grid Deployment Project)	New Jersey, New York	$136,170,899	$272,341,798
Denton County Electric Cooperative, Inc. (CoServ Advanced Metering Project)	Texas	$17,205,844	$40,966,296
Detroit Edison (Advanced Implementation of Energy Storage Technologies)	Michigan	$4,995,271	$10,877,258
Detroit Edison Company (SmartCurrents)	Michigan	$83,828,878	$167,657,756

Project	State	Award Amount	Total Project Value
Duke Energy Business Services (Notrees Wind Storage Demonstration Project)	North Carolina	$21,806,226	$43,612,464
Duke Energy Business Services (Smart Grid Deployment)	Indiana, North Carolina, Ohio, South Carolina	$200,000,000	$555,706,307
Duke Energy Carolinas, LLC (PMU Deployment in the Carolinas with Communication System Modernization)	North Carolina, South Carolina	$3,927,899	$7,855,797
East Penn Manufacturing Co. (Grid-Scale Energy Storage Demonstration Using UltraBattery Technology)	Pennsylvania	$2,543,523	$5,087,269
Eastern Nebraska Public Power District Consortium (Smart Grid Initiative)	Nebraska	$1,874,994	$3,749,988
El Paso Electric Company (Distribution Automation Project)	New Mexico, Texas	$1,014,414	$2,196,187
Entergy Services, Inc. (Deployment and Integration of Synchro Phasor Technology)	Arkansas, Louisiana, Mississippi, Texas	$4,611,201	$9,222,402
EPB (Smart Grid Project)	Georgia, Tennessee	$111,567,606	$226,707,562
Florida Power & Light Company (Energy Smart Florida)	Florida	$200,000,000	$578,963,314
Georgia System Operations Corporation (Energy Management Infrastructure Project)	Georgia	$6,456,501	$12,913,003
Golden Spread Electric Cooperative, Inc. (Smart Grid Project)	Texas	$17,263,115	$43,157,788
Guam Power Authority (Smart Grid Project)	Guam	$16,603,507	$33,207,014
Hawaiian Electric Company (East Oahu Switching Project)	Hawaii	$5,347,598	$10,695,196
Idaho Power Company (IPC Smart Grid Program)	Idaho, Oregon	$47,000,000	$98,270,405
Indianapolis Power & Light Company (Smart Energy Project)	Indiana	$20,000,000	$48,900,000
ISO-New England (Synchrophasor Infrastructure and Data Utilization (SIDU) in the ISO New England Transmission Region)	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	$7,993,714	$18,087,427

Project	State	Award Amount	Total Project Value
Knoxville Utilities Board (Knoxville Smart Grid Community Project)	Tennessee	$3,585,022	$7,170,043
Ktech Corp (Flow Battery Solution for Smart Grid Renewable Energy Applications)	New Mexico	$4,764,284	$9,528,568
Lafayette Consolidated Government (Lafayette Utilities System Smart Grid Project)	Louisiana	$11,630,000	$23,260,000
Madison Gas and Electric Company (Customer Driven Design of Smart Grid Capabilities)	Wisconsin	$5,550,941	$11,101,881
Memphis Light, Gas and Water Division (Implementation of Smart Grid Technology in a Network Electric Distribution System)	Tennessee	$5,063,469	$13,112,363
Midwest Energy (Relay Replacement for Knoll Substation)	Kansas	$712,257	$1,424,514
Midwest Independent Transmission System Operator (Midwest ISO Synchrophasor Deployment Project)	Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Montana, North Dakota, Ohio, Pennsylvania, South Dakota, Wisconsin	$17,271,738	$34,543,476
Minnesota Power (Smart Grid Advanced Metering Infrastructure Project)	Minnesota	$1,544,004	$3,088,008
Modesto Irrigation District (Smart Grid Deployment and Installation Project)	California	$1,493,149	$2,986,340
Municipal Electric Authority of Georgia (MEAG Smart Grid Distribution Automation Project)	Georgia	$12,267,350	$24,534,700
New York Independent System Operator, Inc. (New York Capacitor/Phasor Measurement Project)	New York	$37,828,825	$75,710,733
New York State Electric and Gas (Advanced Compressed Air Energy Storage)	New York	$1,394,453	$2,942,265
Northern Virginia Electric Cooperative (Electric Distribution System Automation Program)	Virginia	$5,000,000	$10,000,000
NSTAR Electric Company (Grid Self-Healing and Efficiency Expansion)	Massachusetts	$10,061,883	$20,123,766
NV Energy, Inc. (NV Energize)	Nevada	$138,877,906	$277,755,812

Project	State	Award Amount	Total Project Value
Oklahoma Gas & Electric (Positive Energy Smart Grid Integration Program)	Arkansas, Oklahoma	$130,000,000	$357,376,037
Pacific Gas and Electric Company (Advanced Underground Compressed Air Energy Storage)	California	$25,000,000	$355,938,600
PECO (Smart Future Greater Philadelphia)	Pennsylvania	$200,000,000	$415,118,677
Pepco Holdings, Inc.-DC (Smart Grid Project)	District of Columbia	$44,580,549	$92,753,369
PJM Interconnection, LLC (PJM SynchroPhasor Technology Deployment Project)	Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Virgin Islands, West Virginia	$13,698,091	$228,203,511
Potomac Electric Power Company (Maryland) (Smart Grid Project)	District of Columbia	$104,780,549	$213,354,494
Powder River Energy Corporation (Powder River Innovation in Energy Delivery Project)	Montana, Wyoming	$2,554,807	$5,109,614
PPL Electric Utilities Corporation (PPL Smart Grid Project)	Pennsylvania	$19,054,800	$38,109,316
Premium Power (Distributed Energy Storage System)	Massachusetts	$6,062,552	$12,514,660
Primus Power Corporation (Wind Firming EnergyFarm)	California	$14,000,000	$46,700,000
Progress Energy Service Company (Optimized Energy Value Chain)	Florida, North Carolina, South Carolina	$200,000,000	$520,000,000
Public Service Company of New Mexico (PV Plus Battery for Simultaneous Voltage Smoothing and Peak Shifting)	New Mexico	$2,305,931	$6,113,433
Public Utility District No. 1 of Snohomish County (Smart Grid Infrastructure Modernization of Electrical Distribution System)	Washington	$15,825,817	$31,651,634
Rappahannock Electric Cooperative (Smart Grid Initiative)	Virginia	$15,694,097	$31,388,194
Sacramento Municipal Utility District (SmartSacramento)	California	$127,506,261	$308,406,477

Project	State	Award Amount	Total Project Value
San Diego Gas & Electric Company (SDG&E Grid Communication System)	California	$28,115,052	$59,427,645
Seeo Inc (Solid State Batteries for Grid-Scale Energy Storage)	California	$6,196,060	$12,392,120
Southern California Edison Company (Tehachapi Wind Energy Storage Project)	California	$24,978,264	$54,856,495
Southern Company Services, Inc. (Smart Grid Project)	Alabama, Florida, Georgia, Mississippi	$164,527,160	$330,130,420
SustainX Inc. (Isothermal Compressed Air Energy Storage)	New Hampshire	$5,396,023	$13,046,588
Talquin Electric Cooperative (SmartGrid Program)	Florida	$8,100,000	$16,200,000
Town of Danvers, MA (Smart Grid Implementation Program)	Massachusetts	$8,476,800	$16,953,600
Vermont Transco, LLC (eEnergy Vermont)	Vermont	$68,928,650	$137,857,302
Westar Energy (SmartStar Lawrence Project)	Kansas	$19,041,565	$39,290,749
Western Electricity Coordinating Council (Western Interconnection Synchrophasor Program)	Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Texas, Washington	$53,890,000	$107,780,000
Wisconsin Power and Light Company (Smart Grid Distribution Automation)	Wisconsin	$3,165,704	$6,378,509

Appendix B: NYSERDA Smart Grid Program Projects

Table 7. NYSERDA Smart Grid Program Projects

Company/ Contract	Project	Project Type	NYSERDA ($)	Total Cost ($)	Project Category
Premium Power 11008	Zn-Br Flow Battery Demonstration	Demonstration	231,688	463,376	Energy Storage
NYPA 8718	Na-S Stationary Battery Demonstration	Demonstration	1,000,000	4,700,000	Energy Storage
NY Presbyterian Hospital 10466	Ground Fault Protector Demonstration	Demonstration	110,000	220,000	Distribution Sensing and Automation
EPRI 10470	Real-Time Applications of Phasor Measurement Units	Demonstration	744,120	1,495,302	FACTS
EPRI 10471	Fast Fault Screening Tool for Real-Time Transient Stability Assessment	Demonstration	250,000	500,000	FACTS
Orange & Rockland 10474	Smart Grid Pilot Project	Demonstration	1,000,000	4,422,000	Distribution Sensing and Automation
Consolidated Edison 10674	Super Conductor Demonstration	Demonstration	1,000,000	37,500,000	HTS
Innoventive Power 10676	Use of Demand Response to Support NYS Transmission and Distribution Circuits	Demonstration	999,665	2,451,934	Other
NYSEG 10467	Compressed Air Energy Storage Study	Engineering Study	200,000	373,923	Energy Storage
Alcoa 10468	NYISO Demand Response Capability Assessment	Engineering Study	165,000	215,000	Other
Clarkson University 10677	Design Methodology for Electric Power Distribution Systems	Engineering Study	190,079	258,209	Distribution Sensing and Automation
General Electric 10465	Analysis of the Impact of Proposed Greenhouse Gas Policies on the NY Power Grid	Research Study	200,000	350,250	Other
Pace University 10472	Identification and Development of More Effective Approaches for Engaging Distribution Utilities in the Deployment of DG as T&D Resources	Research Study	148,650	203,003	Other
NETSS 10476	Voltage Dispatch and Pricing Support of Efficient Real Power Dispatch	Research Study	150,000	150,000	FACTS
JWD Consulting 10477	Installing Flexible Alternating Current Transmission System Devices on the Electric Transmission System Grid	Research Study	182,500	351,000	FACTS

Company/ Contract	Project	Project Type	NYSERDA ($)	Total Cost ($)	Project Category
Columbia University 10675	Micro-grids: Benefits of Small Scale Electricity Networks in NYS	Research Study	134,958	179,944	Distribution Sensing and Automation
Beacon Power 11007	Interconnection of a 20 MW Flywheel Regulation Plant to a High Voltage Grid	Demonstration	500,000	4,206,000	Energy Storage
NYSEG 11052	Compressed Air Energy Storage Demonstration	Demonstration	1,000,000	125,000,000	Energy Storage
Brookfield Power 11054	Dispatchable Green Energy Integration with Intermittent Wind Resources	Demonstration	1,000,000	2,975,725	Other
Central Hudson Gas & Electric 11058	Utilization of Micro-grids for Reliability Improvement and System Reinforcement	Demonstration	371,000	800,000	Distribution Sensing and Automation
Clarkson University 11053	Surface-Textured High Voltage Insulators with Super Hydrophobicity	Product Development	200,000	400,401	Other
EPRI 11051	Conceptual Design and Assessment for a Green Urban Network	Engineering Study	194,280	259,280	Other
6-Nines Power 11057	Public Ownership of Energy Storage Systems in NYS	Research Study	76,500	149,365	Energy Storage
Power Factor Correction 11059	Local Distribution System Power Factor Correction	Demonstration	200,000	240,950	Distribution Sensing and Automation
SMRT Line 11060	Commercial and Regulatory Models for Non-Utility Transmission Infrastructure	Research Study	200,000	430,000	Other
NYISO 15467	New York State Phasor Measurement Network	Demonstration	400,000	800,000	FACTS
V&R Energy Systems 15468	Prevention of Occurrence of Major Catastrophic Events: Demonstration for Electrical System	Demonstration	300,000	1,250,000	FACTS
EPRI 15466	Transmission Grid Operation Risk Assessment using Advanced Sensor Technologies	Engineering Study	199,400	349,400	FACTS
EPRI 15464	Energy Assessment of T&D Losses	Engineering Study	187,500	250,062	Other
NYPA 21083	Increased Reliability and Efficiency Using Combined Phasor Measurement Units (PMU), Dynamic Line Rating and Optimized Equipment Management Technologies	Demonstration	1,683,494	3,366,988	FACTS
National Grid 21086	Assessment of Microgrid Powered by Renewables	Engineering Study	106,624	195,468	Distribution Sensing and Automation

Company/ Contract	Project	Project Type	NYSERDA ($)	Total Cost ($)	Project Category
National Grid 21085	Advanced Distribution Protection, Automation, and Control for the Smart Grid	Engineering Study	246,045	416,432	Distribution Sensing and Automation
Energy Storage and Power 21087	Small Compressed Air Energy Storage	Engineering Study	250,000	393,234	Energy Storage
Central Hudson Gas & Electric 21082	Distribution Smart Grid	Demonstration	1,599,450	4,849,450	Distribution Sensing and Automation
Consert Inc. 21084	Central Hudson Virtual Peak Plant	Demonstration	114,955	282,360	Other
Delaware County Electric Co-op 21081	Smart Grid Demonstration Project	Demonstration	869,633	1,739,266	Other
KEMA 28813	Markets & System Dynamics * buildings program budget	Research Study	96,070	127,903	Other
Stony Brook University 28814	Enhanced Power System and Control Through High Performance Computing	Engineering Study	250,000	359,928	FACTS
RPI 28815	State Estimation and Situational Awareness	Engineering Study	212,429	283,381	Distribution Sensing and Automation
Ceralink Inc. 28816	Elimination of Transmission & Distribution Line Losses through use of Line Arrestors	Engineering Study	249,988	365,802	Other
EPRI 28817	Determine Effectiveness of Smart Grid Inverters to Support PV in NY Electric Distribution System	Engineering Study	250,000	350,000	Distribution Sensing and Automation
Utility Systems Technologies 28819	Optimizing Supply Voltage Support to Minimize Energy Consumption	Product Development	250,000	381,000	FACTS
Triple Point Energy 28820	Thermal Power Plant Energy Storage System	Engineering Study	146,962	197,801	Energy Storage
V&R Energy Systems 28821	Advanced State Estimation to Improve Reliability of Con Edison's Network	Demonstration	500,000	1,000,000	Distribution Sensing and Automation
NYPA 28822	Above Ground Compressed Air Energy Storage Plant	Engineering Study	250,000	500,000	Energy Storage
Orange & Rockland 28823	Advanced Smart Grid System Applications	Demonstration	2,000,000	7,316,188	Other
Central	Advanced Distribution Smart	Demonstration	967,800	2,066,100	Distribution

Company/ Contract	Project	Project Type	NYSERDA ($)	Total Cost ($)	Project Category
Hudson Gas & Electric 28824	Grid – Phase II				Sensing and Automation
Electrovaya 28825	Utility Scale Transportable Energy Storage System	Demonstration	1,324,210	2,975,996	Energy Storage
Urban Electric Power 30366	Grid Scale Energy Storage Ni Zn Flow Battery	Product Development	1,000,000	2,000,000	Energy Storage
Applied Materials 30730	Superconducting Fault Current Limiter	Demonstration	1,221,574	2,443,148	HTS
Binghamton University 30733	Electric Grid Reliability Improvements Utilizing Security Profile and Control Effectiveness Analysis	Research Study	100,000	133,580	FACTS
RIT 30732	Improving Operator Situational Awareness Wide Area Geographic View of Electric Grid	Research Study	75,000	100,000	FACTS
Pareto Energy 30731	Micro Grid Power Electronics	Engineering Study	150,000	275,000	Distribution Sensing and Automation
Enernex 36651	Major Disturbance Mitigation	Research Study	210,000	285,000	FACTS
RPI 36653	State Estimation using PMU's	Research Study	150,048	199,960	FACTS
Georgia Tech 36654	Dynamic Resilience Measurements of Electric Service Under Severe Weather Conditions	Research Study	90,000	120,000	FACTS
EPRI 36655	Application of Super Hydrophobicity and Icephobicity	Research Study	700,000	1,100,000	Other
Con Ed 36656	Integration of Microgrids and Distributed Energy Resources	Engineering Study	663,094	884,125	Distribution Sensing and Automation
Bigwood Systems 36657	Continuous Distribution Power Flow	Engineering Study	90,634	120,846	Distribution Sensing and Automation
NYPA 36658	Improved Performance of NYS Power Grid	Engineering Study	250,000	668,468	FACTS
Brookhaven National Lab 36659	Impacts of Utility Scale Solar Photovoltaic	Engineering Study	280,000	350,000	Other
EPRI 36660	Assessment of Urban Microgrid	Engineering Study	334,990	734,990	Distribution Sensing and Automation
Georgia Tech 36661	Setting-less Protection System	Product Development	897,994	1,838,235	FACTS
NYPA	Demonstration of Energy Storage System at SUNY	Demonstration	424,998	969,976	Energy Storage

Company/ Contract	Project	Project Type	NYSERDA ($)	Total Cost ($)	Project Category
36663	Canton				
American Vanadium 36664	Vanadium Redox Flow Battery Demonstration * buildings program budget	Demonstration	500,000	2,091,830	Energy Storage

Appendix C: Summary of Interview Protocol

C.1 Stakeholder Themes: Interview Protocol

Your Role & Your Organization's Role

- Tell me briefly about your organization.
- Tell me about the team of individuals that you work with specifically on Smart Grid issues.

Perspectives on NYSERDA & Perspectives on NYSERDA Smart Grid Programs

- Have you interacted with NYSERDA on any energy-related programs?
- How about interactions with NYSERDA on Smart Grid programs?
- Describe for me these interactions.
- What were your objectives for participation/engagement with NYSERDA? Have these objectives been met? How have they changed? How do you measure progress in achieving these objectives?
- How has your organization benefited from these interactions? New knowledge? Technology?
- Where have you struggled in your interactions with NYSERDA's Smart Grid programs? How have you resolved those issues? Do you have recommendations to improve these interactions?
- What would you say are the greatest strengths of NYSERDA's Smart Grid programs? Weaknesses?
- How does your organization use Smart-Grid -ated data? What is NYSERDA's role in data collection? Analysis and application? How could they play a better role in facilitating the use of data for Smart Grid?

Interactions with Other Organizations

- Tell me about some of the particular Smart Grid programs in which your organization participates.
- What are some of the activities involved in participation? How long has your organization participated in each of these programs?
- What are your objectives for each of these programs? Have they been met? Have they changed? How do you measure progress against these objectives?
- Have you heard of the Smart Grid Consortium? Tell me about your participation in that organization. What are some key interactions or outcomes that have resulted from participation in the Smart Grid Consortium? How does participation in the Smart Grid Consortium fit with your organization's long-term vision for Smart Grid technology? How does it fit with your organization's goals or priorities?

Role of NYSERDA

- What do you see as NYSERDA's biggest role in Smart Grid deployment? How do you see that changing? Do you have recommendations for a better role they may be able to play in Smart Grid programming?
- How knowledgeable are you about NYSERDA's funding process? How would you evaluate their strategy for investment in various Smart Grid projects or programs? Do you have some specific examples that illustrate this at all?

C.2 Questions for Specific Stakeholder Types

Private Research Labs (IBM/General Electric)

- How does the work that NYSERDA funds in the Smart Grid space affect the research that you are performing at your facility? How does it support your work? Inhibit? Do you have examples that show how NYSERDA-funded work has lent credibility to your efforts? How does it shape the direction of your research?
- Where do you see Smart Grid technology, in general, evolving in the next ten years? What role do you think privately funded research will play in that evolution?

University and Governmental Research Labs

- How familiar are you with the funding opportunities through NYSERDA? Specifically, the funding opportunities related to the technologies that these opportunities focus on?
- How well does NYSERDA's technology strategy align with your research priorities?
- Where do you see Smart Grid technology, in general, evolving in the next ten years? What role do you think university- and government-funded research will play in that evolution?

Utilities

- How familiar are you with the funding opportunities through NYSERDA? Specifically, the funding opportunities related to the technologies that these opportunities focus on?
- How well does NYSERDA's technology strategy align with your utility's technology roadmap for building a Smart Grid?
- Where do you see Smart Grid technology, in general, evolving in the next ten years? What role do you think utilities will play in that evolution?