ELECTRIC POWER TRANSMISSION AND DISTRIBUTION (EPTD)
SMART GRID PROGRAM

Final Program Theory and Logic Model Report

Prepared for

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Todd French
Project Manager

Prepared by

Research Into Action, Inc.
P.O. Box 12312
Portland, Oregon 97212
503 / 287-9136

Principal Investigator:
Jane S. Peters
Research Into Action, Inc.

Project Staff:
Robert Russell
Brent Barkett
Kirsten Midura
Navigant, Inc.

Project Number 9835

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INTRODUCTION

The electric power transmission and distribution (EPTD) system is widely regarded as an enabling infrastructure ripe for systematic improvements, which could produce and ensure higher levels of efficiency, reliability, security, and resiliency for all consumers. Systematic grid modernization offers an opportunity to promote improved asset utilization, while lowering the carbon intensity of the electric-power sector. These modernized, automated grid developments are often referred to colloquially as the "Smart Grid." Although there is no standardized definition of the Smart Grid, this term can often refer to "a combination of enabling technologies, hardware, software, or practices that collectively make the delivery infrastructure or the grid more reliable, more versatile, more secure, more accommodating, more resilient, and ultimately more useful to consumers."[1]

New York State Energy Research and Development Authority (NYSERDA)'s involvement with Smart Grid development dates back to 2007, when it issued the first of three competitive solicitations designed to support EPTD projects aimed at improving the reliability, efficiency, security, and overall performance of the electric power delivery system in New York State. Using funding authorized by the Commission under the System Benefits Charge program (SBC3), NYSERDA is currently supporting more than 30 projects that have made advancements in such areas as establishing uniform, statewide diagnostics to assess system reliability; integrating advanced communication; controlling and monitoring technologies, developing power electronics and remote sensing for continuous monitoring of infrastructure; conducting real-time monitoring of real and reactive power, voltage conservation; offering demand-side ancillary services and facilitating the integration; and delivering electricity from renewable and distributed generation resources.

The Public Service Commission (PSC)'s October 2011 Order regarding the fourth round of System Benefit Charge (SBC4) funding allocated $37.5 million for the NYSERDA EPTD Smart Grid Program. The Order specifically stated that the EPTD Smart Grid program could provide enhancements that ensure higher levels of security, quality, reliability, and availability of electric power; improve economic productivity; and minimize environmental impacts while maximizing sustainability.[2]

The purpose of this document is to present the logic model for the EPTD Smart Grid Program. This document is organized into the following segments:

1. **Program Context, Stakeholders, Intent and Design:**
    a. The problem(s) the program is attempting to solve and the issue(s) it will address.
    b. All entities (the stakeholders) with responsibility for installing and maintaining reliable, safe and secure operation of the electric power delivery system (the environments/context within which the program is working).
2. **Program Objectives**: The program's ultimate purpose and targets.

[1] Sioshansi, Fereidoon P., 2012, *Smart Grid: Integrating Renewable, Distributed, & Efficient Energy.* Associated Press.

[2] NYSERDA, *Operating Plan for Technology and Market Development Programs (2012-2016), System Benefits Charge*, February 15, 2013 (Second Revision).

3. **Program Resources**: The dollars, staffing and partnership, etc. resources the program is providing.

4. **Program Activities**: The various research and engineering studies, product development, demonstration and commercialization progress support activities and strategies being delivered through the program.

5. **Program Outputs**: The anticipated immediate results associated with program activities.

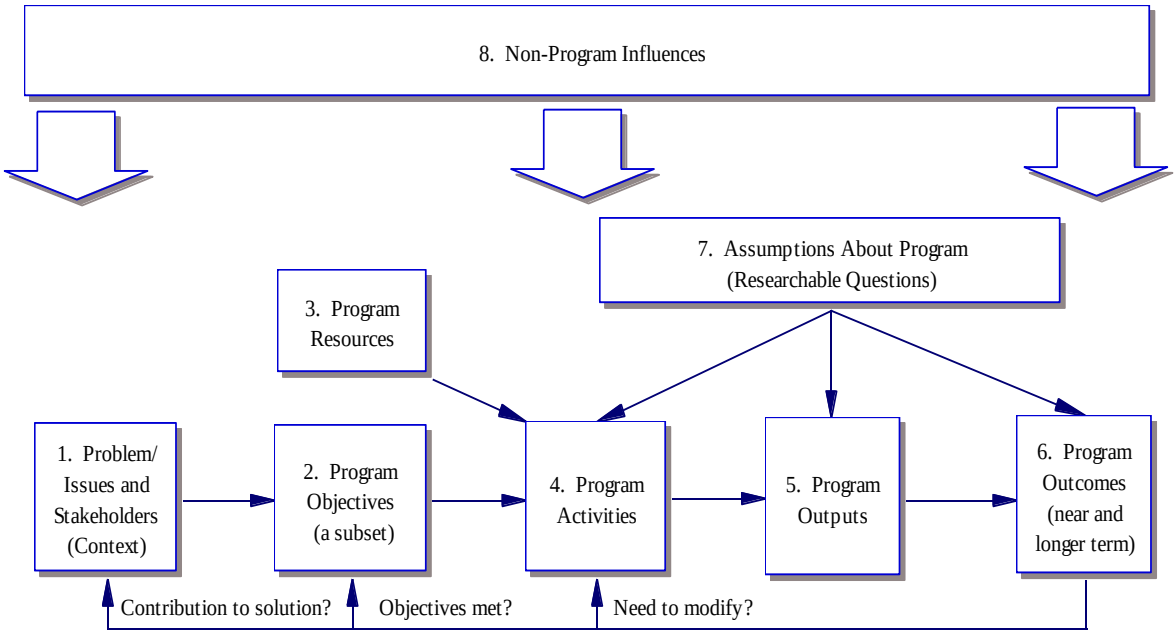
6. **Program Outcomes and Logic Diagram**: What is expected to be achieved in the near, intermediate and longer term. Also shows in diagram form, the linkages between key activities, outputs, outcomes, and external/non-program influences.

7. **Assumptions**: The assumptions about how program activities and outputs will lead to the desired near, intermediate, and longer-term outcomes.

8. **Non-Program External Influences**: Factors outside the program that may drive or constrain the achievement of outcomes.

The relationship among these eight items is presented in Figure T-1. A program-specific logic model diagram is presented later in this document as Figure 6-1.

Figure T-1: Program Design Template



Section 1:

PROGRAM CONTEXT, STAKEHOLDERS, INTENT, AND DESIGN

1.1 TARGETED PROBLEM

Recent advancements in technology, as well as continuing increases in electricity demands, have led utilities to consider the Smart Grid and its role in the modernization of the electric grid. As part of the ongoing process of upgrading and replacing our aging transmission and distribution (T&D) systems, utilities are increasingly employing Smart Grid technologies, which, if utilized properly, have the potential to make electric power systems more reliable, robust, efficient, and economical. Smart Grid technologies can also enable integration of increased levels of renewable and distributed energy resources and increased energy efficiency and demand response.

Currently, New York State faces a range of T&D system security, efficiency, reliability, and power quality issues that affect the country's entire northeast region and in some cases, much of the Eastern Interconnection.[3] Some of these issues will be addressed by the marketplace, and others clearly have public benefit implications and could be addressed through public/private partnerships. To help remedy these issues, NYSERDA's EPTD Smart Grid 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.

NYSERDA is just one of several market actors impacted by, or involved in, addressing these challenges. Compared to other entities that may also be investigating and investing in solutions for the multi-billion dollar embedded electricity grid infrastructure, NYSERDA has relatively few dollars invested ($37.5 million over the five year period 2012 – 2016. The focus of NYSERDA's EPTD Smart Grid program, therefore, will be on projects addressing both T&D issues with public benefit implications. NYSERDA's program is intended to address both upstate and downstate electricity needs, support underground and overhead power delivery systems, and support both central and distributed generation infrastructure. Specific program areas will include grid scale energy storage; T&D automation and management; renewable and distributed energy integration; advanced monitoring and controls; advanced sensors, devices and systems; microgrids; advanced cables and conductors; and advanced system modeling and applications

1.2 PROGRAM GOALS AND DESIGN

The EPTD Smart Grid Program aims to improve T&D infrastructure and monitoring through increased investment, integrate advanced communication, automation, and control technologies, improve system efficiencies and reduce system losses, and improve reliability of the grid, among other goals. To achieve the overall program goals, The EPTD Smart Grid Program includes the following four project categories:

- **Research Studies** aimed at exploring new policy, business, regulatory models, advanced concepts, and innovative product or technology development opportunities.
- **Engineering Studies** that assess the feasibility and effectiveness of demonstrating new or under-utilized technologies at a New York site. The studies are intended to support project development

[3] The Eastern Interconnection refers to one of the two major alternating current power grids in North America. The other major interconnection is the Western Interconnection.

activity, such as site assessment, economic analysis, interconnection, and permitting issues associated with potential demonstration projects that improve the reliability, quality, and efficiency of the electric power delivery system.

- **New Product Development** and commercialization of products for improving the performance of the electrical power delivery system.
- **Demonstration Projects** of new or under-utilized technologies that improve the performance of the electrical power delivery system and are past the "proof-of-concept" stage, but that are not yet commercially ready or certified.

1.3 STAKEHOLDERS

NYSERDA's EPTD Smart Grid Program continues to seek input from a broad range of stakeholders. In turn, NYSERDA provides these stakeholders with ongoing feedback about program achievements and milestones. Following is a listing relevant stakeholder groups. Table 1-1 provides more information regarding the context within which these and other stakeholders reside.

- New York State Utilities (Investor Owned, Public, Municipal and Cooperatives)
- New York Power Authority (NYPA), Long Island Power Authority (LIPA)
- New York Independent System Operator (NYISO)
- New York State Reliability Council (NYSRC)
- Northeast Power Coordinating Council (NPCC)
- New York State Public Service Commission (PSC)
- New York State Smart Grid Consortium (NYSSGC) – Specifically Rochester Polytechnic Institute and Brookhaven National Laboratory
- New York Battery and Energy Storage Technology Consortium (NY-BEST)
- New York State Department of Environmental Conservation (NYSDEC)
- New York State Department of Public Service (NYSDPS)
- Private T&D Investors
- Independent Power Producers (IPPNY)
- Equipment Manufacturers
- Department of Energy (DOE)
- Research Organizations (Electric Power Research Institute [EPRI], NY-BEST, NYSSGC, etc.)

Table 1-1: Stakeholder Context

Utilities
• Support from utilities is sought to advance improvements to the T&D system. • Needs include superconducting cables, fault current management, improved fault location capabilities, higher capacity distribution cables, distribution automation capabilities, effective integration of renewable and distributed resources into the distribution system, worker and public safety, cost reduction, and reliability. Various utilities in New York State are already conducting a substantial amount of work in these areas.[4] • Con Edison predominantly uses a network system and wires are underground (New Rochelle uses a radial system). The rest of the state predominantly uses a radial system (Albany, Rochester, Buffalo, etc. downtowns have network systems). These differences will require different T&D research. • Orange & Rockland and Central Hudson are looking to integrated system models for their systems. • Although the distribution system is regulated, the transmission system is not. Most of the transmission system is currently owned by the regulated utilities.
Power Plant Owners/Operators (including Renewables and Distributed Generation)
• Changes to the transmission system should accommodate all types of power generation. • Investments in generation capacity must be coordinated with investments in transmission capacity.[5]
Regulatory Agencies and Policy Advocates
• The Federal Energy Regulatory Commission (FERC) has entrusted independent system operators (ISOs), such as the NYISO with significant regional planning responsibilities.[6] • The Energy Policy Act of 2005 has made fundamental changes to the investment incentives related to many types of energy resources and the T&D infrastructure.[7] • Governmental units, policy makers, DPS Staff, and electric customer advocacy groups are also involved.
NYISO
• Responsibility for system reliability and the economic dispatch of generation within New York State and imports and exports of power from/to other Regional Transmission Operators (RTOs) lies with the NYISO.

[4] NYSERDA, *Operating Plan for Technology and Market Development Programs (2012-2016), System Benefits Charge*, February 15, 2013 (Second Revision).

[5] Ibid.

[6] Ibid.

[7] Ibid.

Private Sector Investors
• Transmission system projects are being considered and have been funded through the private sector.
Other Mid-Market (Infrastructure) Entities
• T&D equipment manufacturers, distributors, system engineers, designers, and installation contractors are becoming aware of issues, opportunities and implications associated with new technologies and have begun to achieve financial benefits from promotion/involvement.
Research Organizations
• National government and private industry research organizations, including the Department of Energy's Brookhaven, Sandia, and Oak Ridge National Labs and the Electric Power Research Institute, are well suited and currently involved in various research projects addressing security, reliability and power quality issues associated with the electric utility T&D system. • University-based and other non-profit research centers within and outside of New York State provide a valuable T&D research and development source. • NYSERDA provides another resource for advancing T&D technologies and policy solutions with a focus on more local (New York State) and regional public benefit-oriented activities.

1.4 PROGRAM BARRIERS

The EPTD Smart Grid Program works to overcome a variety of market barriers. Table 1-2 highlights some of the key barriers (and associated stakeholder groups) that NYSERDA has identified for potential targeting within the larger grid-related problems that New York State may face. Depending on proposals received in response to the EPTD Smart Grid Program Opportunity Notices (PONs), some or all of these barriers may be addressed through program activities:

Table 1-2: Potential Problems and Key Stakeholders

Problem Area and Barrier Details	Stakeholders Impacted and/or Involved
1. Lack of new technology solutions and limited willingness to demonstrate or adopt existing solutions	
a. Advances in transmission system technologies are not likely to be implemented unless private investors can benefit from the technology. b. Diagnostic tools for early-warning detection of T&D failures are needed. c. The NYISO needs systems to monitor the performance of its own transmission lines as well as those of the systems with which it is interconnected, to increase situational awareness, to improve early detection of dangerous situations, and to monitor weather-related issues. d. There is currently no system available for quantifying transmission system performance. System/Customer Average Interruption Duration Indices are available, yet these systems only track frequency and duration of system outages rather than overall performance. e. Reliability performance is often measured as the average total duration of interruptions (i.e., "minutes lost") experienced by a consumer in a year. Using this measure, over 90% of the minutes lost for consumers are attributable to distribution events. Hence, investments in the distribution system are required to achieve higher levels of reliability and quality.[8] f. Increased use of intermittent renewable and distributed energy resources. g. Improved grid monitoring/assessment/control tools are needed to enhance real-time performance of the power delivery system. h. Critical need for hardening of the grid to resist both natural and manmade disturbances. i. Better diagnostic indicators are necessary to quantify grid performance. j. Historical congestion points on the electric grid need to be alleviated to improve reliability and reduce energy costs. k. Power system operational issues, such as the need to improve situational awareness of operators, also cut across New York State's boundaries. l. An increasing need for reactive power reserves and voltage support, and a need for improved power system integrity protection m. The adoption of the RPS and RGGI may require changes in the transmission system to accommodate for increased renewable power.	Private Sector Investors, Research Organizations, Other Mid-Market (infrastructure) Entities, Power Plant Owners/Operators, Utilities, NYISO, Regulatory Agencies

[8] Ibid.

Problem Area and Barrier Details	Stakeholders Impacted and/or Involved
2. Limited interest and weak market infrastructure to support public benefits-type projects	
a. Collaboration is needed to leverage financial investment to solve critical problems that are common to multiple entities b. T&D encompasses a diverse group of loosely coupled entities. Coordination of these entities is essential to reach stated public goals. c. Electric power flows that are significantly different compared with historical energy delivery characteristics when the industry was fully regulated. d. Increasing energy and peak demand requirements place a heavy burden on the grid. e. De-regulation has decoupled ownership of power generation and electric power delivery infrastructure. This has resulted in less coordinated resource planning. f. New York State is importing more electricity and exporting less electricity. At the same time, New York State has a desire to be less dependent on other states for its power. g. The FERC has entrusted ISOs/RTOs, such as the NYISO, with significant regional planning responsibilities.[9] h. The importance of maintaining high T&D system reliability will increase with the formation of the Electricity Reliability Organization (ERO), which will have legal authority.[10] i. As the industry continues to change, research plans must be developed and implemented to address these issues and must adapt to the changing conditions.	Utilities, Research Organizations, Other Mid-Market (infrastructure) Entities, Private Sector Investors, Power Plant Owners/Operators, NYISO

[9] After transmission developers obtain approvals from the NYISO, these developers must also apply for approval from the New York State PSC under Article VII of the Public Service Law [1].

[10] With the adoption of the U.S. Energy Policy Act in 2005, a new ERO is charged with developing and enforcing continent-wide reliability standards. The FERC has certified the North American Electric Corporation as the ERO in the United States.

Problem Area and Barrier Details	Stakeholders Impacted and/or Involved
3. Limited private investment in T&D due to inconsistent policy/regulatory issues, conflicting incentives, and inadequate business models	
a. Energy security and reliability is a public benefit and therefore, private sector investment is unlikely without public support. b. Excess generation capacity exists in Upstate New York whereas congestion exists in Downstate areas. c. Lack of cost recovery and benefit sharing mechanisms that promote investment in/application of smart technologies stymie early stage investment/testing of smart devices/business processes. d. Lack of investment (both private and public) in T&D infrastructure has increased system vulnerability.	Regulatory Agencies, NYISO, Power Plant Owners/Operators, Utilities, Private Sector Investors, Other Mid-market (infrastructure) Entities
4. Limited recognition of T&D system benefits associated with closer/strategic coordination with load management, energy efficiency and distributed generation efforts	
a. Elimination of utility-led/regulatory-mandated integrated resource planning has reduced careful assessment of non-traditional solutions to technical T&D problems and constraints. b. Targeted demand response, energy efficiency, and renewable and distributed generation options, in addition to new T&D technologies, are more regularly being considered as cost-effective solutions to T&D system security, reliability, and power quality problems. c. High technical and financial risk associated with demonstrating/developing new technologies. d. Need to accurately quantify public reliability and security benefits associated with T&D system upgrades to encourage additional investment.	Utilities, Regulatory Agencies, Private Sector Investors, Power Plant Owners/Operators, Research Organizations, NYISO

Section 2:

PROGRAM OBJECTIVES (HIGH LEVEL)

The EPTD Smart Grid Program seeks to support appropriate policy, planning, and coordination efforts that collectively will lead to the following objectives:

2.1 SHORT-TERM/INTERMEDIATE-TERM (1-4 YEARS)

- Influence policies and regulations to support T&D infrastructure, or their adoption more quickly (as a result of white papers, etc.) while balancing stakeholder needs
- Increase private investment to promote the adoption of new business models
- Dissemination of lessons learned and best practices
- Respond to changing stakeholder priorities in the face of weather related or economy (expansion or contraction) realities
- Commercialize new technologies and achieve broader use of existing technologies to improve reliability, security and power quality, with more people adopting them due to funded R&D, demonstrations and dissemination of same

2.2 LONG-TERM (5+ YEARS)

- Improve T&D infrastructure through increased investment
- Improve statewide system condition monitoring (deployment and validation of remote sensing devices) and develop advanced diagnostics to assess T&D system reliability (e.g., advanced monitoring and control systems and subsystems)
- Integrate advanced communication, control, automation, and management technologies, power electronics, and innovative T&D technologies
- Aid adoption of new and under-utilized technologies that improve system efficiencies and reduce system losses (e.g., innovative grid scale energy storage technologies including, but not limited to, stationary batteries, flywheels, ultra-capacitors, flow batteries, compression systems and superconducting magnetic energy storage)
- Improve power reliability in terms of reduced number and duration of power outages in New York State (e.g., advanced sensors, devices, control systems and other equipment innovations that improve T&D system performance and reliability)
- Improve power quality by reducing voltage sags, flicker, etc. which currently require customers to install systems to protect against power anomalies
- Improve power security
- Preparing the grid for the delivery of electricity from large-scale and distributed renewable generation resources including wind and solar as these resources become available
- Enhance economic development by reducing congestion charges (e.g., advanced conductor and cabling technologies to improve throughput and reduce losses)

- Confirm that focused R&D portfolios, developed by NYSERDA and other entities, are helping to make these advances

Section 3:

PROGRAM RESOURCES

As shown in Table 3-1, NYSERDA's EPTD Smart Grid Program will take advantage of numerous resources.

Table 3-1: Program Resources

SBC Funding
• $37.5 million commitment over the five year period (2012 – 2016) • This funding will be leveraged with other SBC4 funding targeted for advancing electric vehicle and energy storage technology under the broader Power Supply and Delivery Initiatives
NYSERDA Staff Resources
• Program administration and implementation oversight support
External Resources
• Utilities, Independent Power Plant Owners/Operators • Regulatory Agencies and Policy Advocates, NYISO • Private Sector Investors, Other Mid-Market (Infrastructure) Entities, Research Organizations, such as EPRI, NY-BEST, and the NYS Smart Grid Consortium
Intangible Resources
• NYSERDA's credibility and relationship with key stakeholders, policy makers and key market actors • NYSERDA's experience with product development and demonstration projects

Section 4:

PROGRAM ACTIVITIES

To achieve its program objectives, NYSERDA seeks to fund a combination of research and engineering studies and product development and demonstration projects that improve the reliability, efficiency, resiliency, quality, and overall performance of the electric power delivery system in New York State. The EPTD Smart Grid Program will offer competitive solicitations, funding, project management, and technology transfer support for specific technology areas. The program will target market actors across the continuum of supply, infrastructure, and demand chain. In addition, the program will coordinate closely with various stakeholders to ensure that projects are selected and implemented in a way that maximizes statewide benefits for New York State's electric ratepayers.[11]

EPTD Smart Grid Program staff will utilize the following tactics when implementing the program:

- Support projects that demonstrate significant statewide benefits (e.g., emissions reductions, job creation, product manufacturing and sales, increased reliability, higher efficiency, and reduced power costs)
- Coordinate the efforts of all New York State T&D stakeholders
- Leverage external funding to further supplement in-state resources (e.g., project cost sharing and coordination with EPRI, DOE, etc.)

NYSERDA program activities can be grouped into the following two major categories:[12]

1. **T&D Policy, R&D Planning and Coordination**

   Activities in this area are designed mainly to address ineffective policy/regulatory issues, conflicting incentives, and inadequate business models that limit private investment in T&D. The program's coordination activities are intended to support public benefit-type projects by addressing problems of limited interest and weak market infrastructure. These activities focus mainly on:

   a. Funding studies on and coordinating policy efforts,

   b. Funding pre-deployment studies about infrastructure, and

   c. Planning/coordinating funding of specific R&D efforts.

[11] The NYISO and the NYSRC have substantial roles in managing the wholesale markets and establishing/enforcing stringent grid reliability standards.

[12] Additional detail can be found in PONs 2474 (closed) and 2715 (active).

Approximately 25% of NYSERDA program resources are dedicated to these activities. Examples include research resulting in the publication of the following reports:[13]

- *Assessment of Transmission and Distribution Losses in New York State*
- *Microgrids: An Assessment of the Value, Opportunities, and Barriers to Deployment in New York State*
- *Fast Fault Screening for Real-Time Transient Stability Assessment*

Competitive solicitations for research studies to address the following issues also fall into this program activity category:

- Defining effective business models that promote private investment in electric power delivery infrastructure
- Identifying and resolving regulatory barriers that can delay the implementation of an advanced grid network
- Addressing wholesale market equity issues associated with increasing the capacity of electric energy flow from upstate to downstate communities
- Ensuring grid reliability, efficiency, quality, and performance as the delivery network accommodates clean energy technologies, such as renewable power generation, electric vehicles, and efficient distributed generation systems
- Developing a comprehensive strategy for "hardening" the T&D system to withstand potential threats and outages

2. **Technology Development, Demonstration, and Information Dissemination**

Activities in this area are designed mainly to address lack of new technology solutions and limited willingness to demonstrate or adopt existing solutions and - through information dissemination activities - limited interest and weak market infrastructure to support public benefits-type projects. These activities focus mainly on:

a. Funding product development

b. Funding demonstrations of new technologies

c. Disseminating results

Approximately 75% of NYSERDA's program resources are dedicated to these activities. Examples include the following:

- Competitive solicitations for R&D technology demonstration and product development projects that address one or more of five technology categories critical to the development of an advanced electric power delivery system:

[13] The complete set of reports recently completed through the program can be found at the following website: http://www.nyserda.ny.gov/Publications/Research-and-Development-Technical-Reports/Electric-Power-Delivery-Reports.aspx.

1. Monitoring and Diagnostics: Deploy innovative sensors to measure critical grid parameters (e.g., voltage, frequency, reactive power).
2. Data Processing and Analysis: Demonstrate advanced modeling tools and analytical algorithms to predict grid performance.
3. Optimized Visualization: Implement innovative graphical user interfaces that improve the situational awareness of grid operations in real-time.
4. Secure Communication: Incorporate secure communication technologies to enhance the flow and accuracy of information shared among regional control areas (i.e., NYISO, PJM Interconnection, LLC, Independent System Operator-New England).
5. Improved Control and System Performance: Provide grid operation staff with effective output control options to improve grid reliability, security, and overall performance. Demonstrate innovative technologies (e.g., advanced cables, power electronics, reactive power resources) that reduce system power losses and congestion.

Conducting feasibility studies for specific technology demonstration and product development projects to identify, quantify, and/or validate reliability and performance benefits for the electric power delivery system.

Collectively, these feasibility studies, technology demonstration, and product development projects will target a majority of the stakeholder groups (market actors) identified in Table 1-1. In addition, NYSERDA will reach out to the NYISO and the NYSRC to ensure that selected projects are consistent with their plans.[14]

Information dissemination is an essential element of the EPTD Smart Grid Program. Results of completed projects will be shared with stakeholders, including the electric utilities, NYISO, NYSRC, and the New York PSC. Information about projects will be shared though stakeholder participation on technical evaluation panels, conferences, meetings, articles, reports, and the NYSERDA web site. EPRI may provide technology transfer assistance at the national level.

[14] The NYISO and the NYSRC have substantial roles in managing the wholesale markets and establishing/enforcing stringent grid reliability standards.

Section 5:

PROGRAM OUTPUTS

Table 5-1 identifies specific outputs anticipated to come directly from NYSERDA's EPTD Smart Grid Program activities. Associated measurement indicators are also presented. Table 5-1, included in the following Section, presents similar information for anticipated short-term and longer-term program outcomes.

Table 5-1: EPTD Smart Grid Program Outputs, Associated Indicators, and Potential Data Sources

Outputs (<1 year)	Indicators	Data Sources and Potential Collection Approaches
Outputs from Policy, Planning and Coordination Activities		
Meetings with stakeholders and recommendations made White papers written/published	Number, dates and locations of meetings Names of meeting participants and organizations represented Summary of topics discussed and recommendations made Number and summaries of white papers and planning documents created/published	Program files, project reports Any particular organizational data, such as NYISO? Utilities? Same for this column all the way down. . Look for other potential data sources
Business models developed Papers/reports on regulatory and equity issues published Strategies for "hardening" the T&D system	Number and description of business models developed Number and summaries of papers/reports written and where published/posted Number and description of "hardening" strategies developed	Program files, project reports
Technology and research gaps identified T&D R&D priorities specified Targeted projects pursued and leveraged	Number and description of gaps identified Summary of priorities specified Number of projects initiated and completed by type (i.e., Research Studies, Engineering Studies, New Product Development, and Demonstration Projects) Amount and types of leveraged resource and funding provided	Program files, project reports, PONs, RFPs, Program Planning Requests

Outputs (<1 year)	Indicators	Data Sources and Potential Collection Approaches
Outputs from Technology Development and Demonstration Activities		
Demonstrations of new or under-utilized technologies	Number and description of technology advances (by technology area and accomplishment type) Number, description, and results of technology demonstrations Number of demonstration sites located within New York State Number of funded demonstration projects commissioned within 36 months Number and description of commercialized products	Program files, project reports
Outputs from Technology Transfer and Information Dissemination Activities		
Credible data on technology performance, cost and impacts created and disseminated Synthesis and translation of results into forms useful for a broad audience Data and technical findings made accessible to the public including policy makers	Quantity, types and summary of data created Number and summary of magazine articles, conference presentations, websites and other technology transfer and information dissemination sources/events used to share data Number and types of target audiences and stakeholders informed (by topic area and dissemination source)	Program files, project reports

Section 6:

PROGRAM OUTCOMES AND LOGIC DIAGRAM

Table 6-1 details the initiative's expected achievements (i.e. outcomes), as well as the observable indicators that would signify the presence of these achievements. In addition, the table shows the data sources and potential collection approaches that an evaluation effort might undertake to determine the achievement of the expected outcomes.

Table 6-1: EPTD Smart Grid Outcomes, Associated Indicators, and Potential Data Sources

Outcomes	Indicators	Data Sources and Potential Collection Approaches
Short-Term and Intermediate Outcomes Associated with Policy, Planning, and Coordination Activities		
Supportive rulings issued Stakeholder needs balanced	Number, source and description of policy statements (documented and summarized by key policy areas) that cite NYSERDA papers/activities including: - Policy documents addressing development of a Smart Grid - Policy documents addressing delivery of electricity from renewable, DG and CHP - Policy documents addressing grid performance including system losses and customer down time - Policy documents addressing increasing private investment in T&D - Policy documents addressing the economic impact of congestion relief Number and description of rulings issued (summarized by key policy areas) that cite NYSERDA papers/activities	Review of policy documents Review/assessment of rulings Interviews with key stakeholders
Increased private/utility investment in infrastructure	Number of private firms adopting business models defined by studies Amount of private sector investment in T&D infrastructure Development and deployment of products and policies that increase private sector investment in T&D as well as market development in New York (e.g., manufacturing in New York State).	Program records, project reports Survey of companies
Higher quality, more relevant R&D Better R&D management	Number and description of R&D projects being implemented that align with identified and recognized high priority T&D issues Timely/effective project selection, management and targeted research implementation processes Development and deployment of uniform statewide diagnostics systems for assessing T&D system reliability.	Program records, project reports Process and impact evaluations (including comparison against policy objectives and priorities)

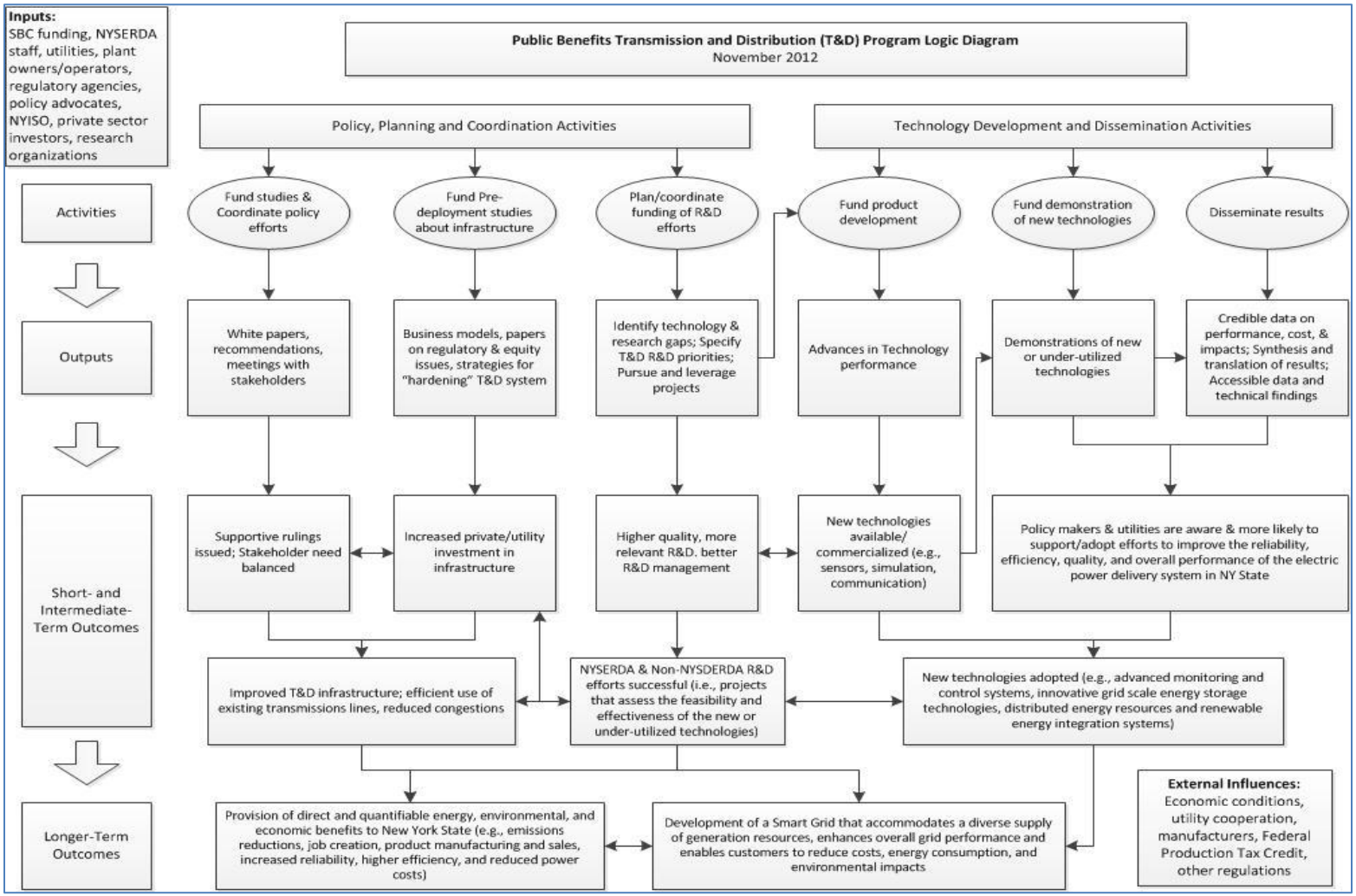
Outcomes	Indicators	Data Sources and Potential Collection Approaches
Short-Term and Intermediate Outcomes from Technology Development Activities		
New technologies available/ commercialized (e.g., sensors, simulation, communication)	Number and description of technologies made available/commercialized (by technology type and policy/priority area, and stakeholder groups involved/impacted) including: - Number of new diagnostics systems for assessing T&D system reliability that are commercialized - Number of new remote sensor products for continuous monitoring of T&D infrastructure with real-time monitoring of real and reactive power that are commercialized - Number of new products decreasing customer down time that are commercialized - Number of new products to reduce system losses that are commercialized - Number of new products to facilitate delivery of electricity from DG and CHP that are commercialized Reduced barriers to the deployment of advanced technologies that improve the reliability, quality and efficiency of the electrical power delivery system - Development and deployment of remote sensors for continuous monitoring of T&D infrastructure with real-time monitoring of real and reactive power.	Program records, project reports U.S. Patent Office Interviews with project participants and other key stakeholders
Short-Term and Intermediate Outcomes from Technology Transfer and Information Dissemination Activities		
Policy makers and utilities are aware and more likely to support/adopt efforts to improve the reliability, efficiency, quality, and overall performance of the electric power delivery system in New York State	Change in awareness/level of understanding of the electricity grid and associated technologies and how they can be used to improve grid performance (documented by specific priority awareness areas and stakeholder groups) Number and types of decisions that have been made based on this information and enhanced understanding (by priority area and stakeholder group) Development and deployment of products and policies that address the economic impact of congestion relief.	Bibliographic data, website hit records, etc. Interviews with policymakers, utilities and other key stakeholders Similar sources as noted in Outcomes from Policy, Planning and Coordination Activities above

Outcomes	Indicators	Data Sources and Potential Collection Approaches
Longer-Term Outcomes		
New technologies adopted (e.g., advanced monitoring and control systems, innovative grid scale energy storage technologies, distributed energy resources and renewable energy integration systems)	Deployment of T&D system improvement technologies including: - Number and description of new technologies deployed to improve the reliability, efficiency, quality, and overall performance of the electric power delivery system in New York State - Number and description of new products deployed to reduce system losses through T&D infrastructure -Number and description of new technologies deployed to increase the role of renewable, DG and CHP in T&D infrastructure - Number and description of new technologies deployed to maximize the economic impact of T&D infrastructure changes Documented in-state and out-of-state sales revenues and jobs created from these new technologies (by technology type) Recoupment funds paid to NYSERDA (applicable to commercialized technologies that received more than $100K from NYSERDA) Development and deployment of products and policies that ensure grid reliability, efficiency, quality, and performance as the delivery network accommodates clean energy technologies, such as renewable power generation, electric vehicles, and efficient distributed generation systems.	Program records, project reports Survey of companies Process and Impact analyses NYSSGC, utilities, NYISO
NYSERDA & Non-NYSERDA R&D efforts successful (i.e., projects that assess the feasibility and effectiveness of new or under-utilized technologies)	Number and types of R&D projects that make up NYSERDA's EPTD Smart Grid Program portfolio Number and types of R&D projects targeting T&D technologies and policies being conducted by other organizations Technology and policy advancement impacts associated with NYSERDA's and other organizations' R&D projects Synergies with national electricity grid initiatives/research needs	Review of program records and NYSERDA/non-NYSERDA project reports Interviews with key stakeholders Process and Impact analyses

Outcomes	Indicators	Data Sources and Potential Collection Approaches
Development of a Smart Grid that accommodates a diverse supply of generation resources, enhances overall grid performance and enables customers to reduce costs, energy consumption, and environmental impacts Improved T&D infrastructure, efficient use of existing transmission lines, reduced congestion Provision of direct and quantifiable energy, environmental, and economic benefits to New York State (e.g., emissions reductions, job creation, product manufacturing and sales, increased reliability, higher efficiency, and reduced power costs)	Amount of renewable or distributed energy resources and electric energy storage technologies integrated into New York State's T&D system Number and duration of power outages Number of power quality problems Number of customers installing equipment to address power quality Dispersal/alternate paths for T&D Miles of new transmission lines built since program inception Ratio of T&D capacity to peak load demand in New York City Amounts of congestion charges in New York City Prices paid for power in New York State Amount of environmental and economic benefits that accrue to New York State Development and deployment of products and policies that improve system efficiencies, reduce system losses, and decrease customer downtime.	Surveys of end-users Interviews with key stakeholders Reports to NYISO, PSC, utilities, etc. Reports from utilities Impact analysis

The following page shows, in diagram form as Figure 6-1, the linkages between activities, outputs, and anticipated outcomes associated with the NYSERDA EPTD Smart Grid Program. This logic model diagram also presents key features of the program including Program Resources (Inputs) and potential Non-Program (External) Influences, which are discussed in more detail in Section 8.

Figure 6-1: Electric Power Transmission and Distribution (EPTD) Smart Grid Program Logic Diagram



Section 7:

ASSUMPTIONS ABOUT STRATEGIES

Based on this program logic document, a number of assumptions have been identified and are noted below.

- Information from program activities (i.e., Research Studies, Engineering Studies, New Product Development Initiatives, and Technology Demonstrations) is successfully disseminated to policy makers, utility actors, manufacturers, investors, and other key stakeholders
- Information from program activities will result in adoption of critical technologies by the NYISO, utilities, and others
- Demonstrations of new and under-utilized technologies will inform and change behavior because key firms are involved and data is widely disseminated to influential actors
- Studies on infrastructure issues will lead to increased investment in T&D infrastructure because they are targeted at key barriers, disseminated to the right people and influence specific policies
- R&D will be incorporated into new technologies because NYSERDA selects projects well and communicates with people who will take up the technology, and new technologies will be adopted because polices will provide incentives and regulations will require it
- There are synergies: (1) among NYSERDA's program strategies, (2) between policy and improved infrastructure, and (3) between technology and infrastructure, and across all three of these areas

Section 8:

NON-PROGRAM INFLUENCES ON OUTCOMES

External influences can help to enhance or hamper achievement of desired outcomes. Several of these potential external influences are noted below:

1. Economic conditions may improve, leading to load growth. Alternatively, economic conditions may decline, leading to a reduction in load on the system. Political priorities might result in lack of interest or heightened, but narrower, interest in T&D issues.

2. Utilities may be willing or unwilling to adopt new technologies and time to adoption may be long.

3. Manufacturers may view new products as being too risky for investment.

4. Elimination or renewal of the Federal Production Tax Credit or other regulations may reduce or increase need for renewable energy generation, requiring changes to the T&D system.

Section 9:

REFERENCES

Program Opportunity Notice (PON) 1913, Electric Power Transmission and Distribution (EPTD) Program, NYSERDA, 2010.

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