Exhibit “8a-A”

STRATEGIC INITIATIVE BUSINESS PLAN for

Smart Generation & Transmission

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Initiative Start	4th Quarter 2014
Initiative End	4th Quarter 2025

TABLE OF CONTENTS

LIST OF FIGURES & TABLES

Figures

Tables

EXECUTIVE SUMMARY

Strategic rationale and drivers of the initiative

To facilitate New York's renewed energy vision to reimagine the grid and to facilitate the increasing pace of industry transformation, NYPA believes that an investment in smart grid technology across their Generation and Transmission infrastructure is an important and necessary step. This ambitious strategic initiative is part of NYPA's Strategic Vision 2014-2019 and is aimed at providing both NYPA and New York State with the most advanced grid in the industry and to ensure that the most modern industry solutions are leveraged to deliver capability in key areas. Ultimately, the investments outlined in this initiative will pave the way for increased benefits to customers by providing the State with a market leading platform for future technologies and services, better management of bulk and distributed renewable generation and storage sources, near-real-time access to information, improved outage management and overall reduced electrical losses and increased system efficiency. In this business plan, we have highlighted the many benefits of this initiative both at a NYPA and NYS level, and combined, these benefits make for a positive investment.

In the context of the New York Energy landscape, the objectives of this initiative align with the Blueprint for Governor Cuomo's Energy Highway ("EH"), issued in 2012 and the 2014 launch of the New York Public Service Commission, Reforming the Energy Vision (REV). The REV initiative aims to ensure that the New York electricity market transforms to accommodate the changing nature of the market, and the actions in this Smart Generation and Transmission roadmap will be entirely complementary of this vision, which states; "The energy industry is in transition. Technological innovation and increasing competitiveness of renewable energy resources, combined with aging infrastructure, extreme weather events, and system security and resiliency needs, are all leading to significant changes in how electric energy is produced, managed and consumed. NewYork State must lead the way to ensure these trends benefit the State's citizens, whose lives are so directly affected by how electric energy is manufactured, distributed, and managed" - New York State Public Service Commission, 2014.

Indeed, NYPA's Smart Generation and Transmission journey has already begun and a foundation has been built by ongoing work, including Life Extension and Modernization (LEM) Upgrades, Generation Automation Control deployments, sensor deployment continuation, Supervisory Control and Data Acquisition (SCADA) upgrades, etc. This initiative proposes to build on that foundation through the advancement of a progressive R&D schedule and deployment of a number of recommended projects. Through the deployment of advanced components, advanced control methods, sensing and measurement, improved interfaces and support (analytics and big data), and integrated communications, NYPA will achieve its goals to both lead the market and support the transition in the NY state marketplace.

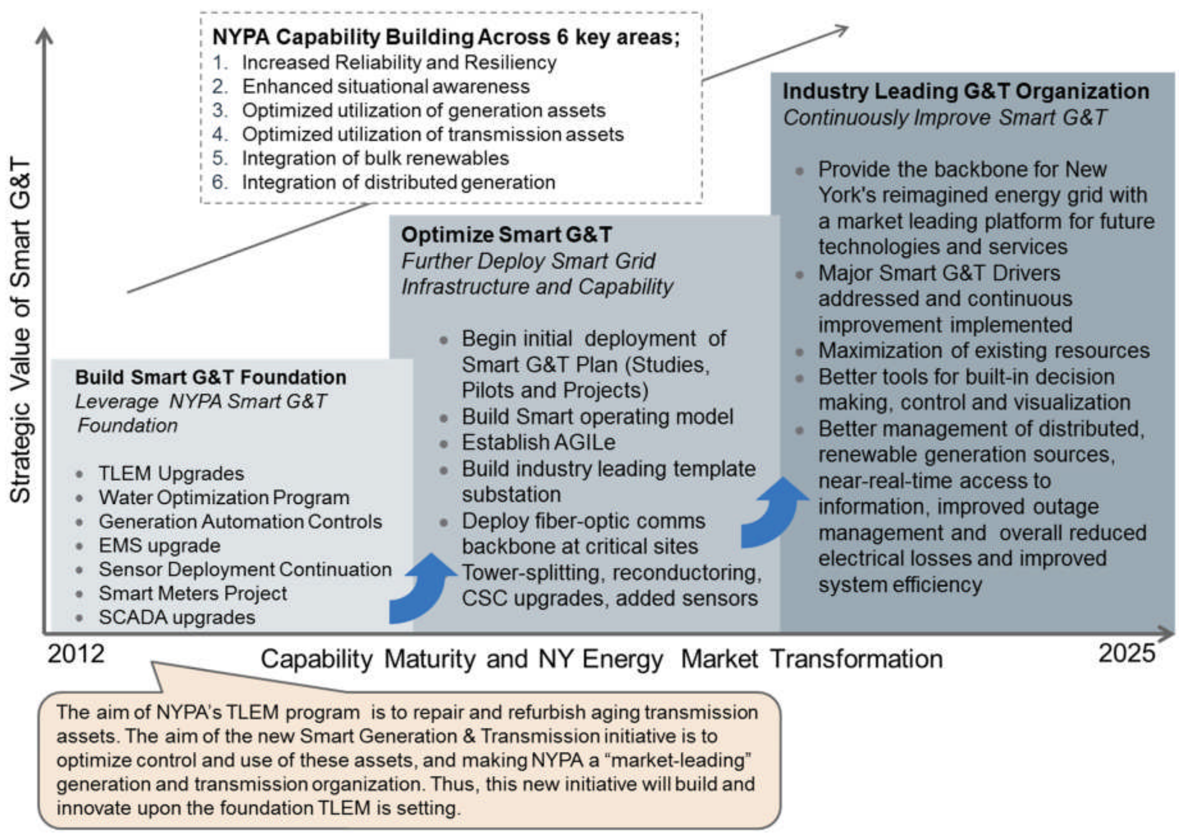
As Figure 1 below outlines, NYPA's smart grid journey will largely fall into three major steps, and as noted in step one, building a smart grid foundation has already begun at NYPA with the Transmission Life Extension and Modernization (TLEM) program, annual research and development schedules, and the proactive and continuous maintenance and improvement programs across the NYPA's grid. Building on this foundation the Smart Generation & Transmission initiative will look to develop capability in a series of areas including;

- Increased reliability and resiliency
    - Advanced transmission monitoring, control and protection systems to decrease likelihood of cascading failures and wide-area blackouts.
    - Robust security measures to reduce likelihood of catastrophic bulk system failures from human-caused and natural disasters.
- Enhanced situational awareness
    - Advanced analytical tools to convert data from grid sensors into insight, leading to wide-area situational awareness and control capabilities.

- Improving operator effectiveness and enhance system protection and restoration.
- Optimize transmission assets
  - Ensure flexibility and efficiency by optimizing the utilization of transmission assets.
  - Reduced congestion and bottlenecks, Reduced costs for operation and maintenance tasks,
  - Reduced risk due to old equipment or necessary downtime, Increased system efficiency.
- Optimize generation assets
  - Automatic controls, predictive maintenance cycles on existing generation facilities to maximize hydro flow and other generation capabilities.
- Integration of bulk renewables
  - Develop bulk renewables to meet environmental policy demands, using intelligent monitoring, climate micro-forecast, protection and control technology, storage tech, and advanced information and operational technology integrated with the underlying assets.
- Integration of distributed generation
  - Ability to manage distributed generation and storage to help balance the intermittency of renewable resources and provide grid support.
  - Advanced system protection to manage intermittency and bidirectional power flow.
  - Advanced energy management system to truly integrate distributed with central resources

NYPA's Smart G&T Journey

Figure 1: NYPA's 2014-2025 Smart Generation & Transmission journey of transformation



Ultimately, this business plan is intended to give customers, regulators and other interested stakeholders a detailed look at how smart generation and transmission will work at NYPA, how NYPA plans to deploy grid technology across its network, and why this approach makes sense for the Authority's customers and the state as a whole. As the energy market is rapidly changing and the evolution of smart grid technologies is maturing at various speeds, this plan and its underlying assumptions will periodically be reassessed in a formal capacity throughout the life-cycle of the intiative. Such an assurance model will be part of the governance and operating model build of this initiative. In addition, NYPA will ensure that this solution is presented to the other TOs in New York and to the NYISO for review and refinement where necessary. While the plan has identified benefits accruing to NYPA and NYS, there are opportunities for further collaboration and business benefits that will be explored as part of the first phase of implementation analysis. NYPA's aim is to lead the industry in smarter generation and transmission adoption and capabilities, and these external stakeholder considerations will be built into the design and chartering phase of each project of this initiative.

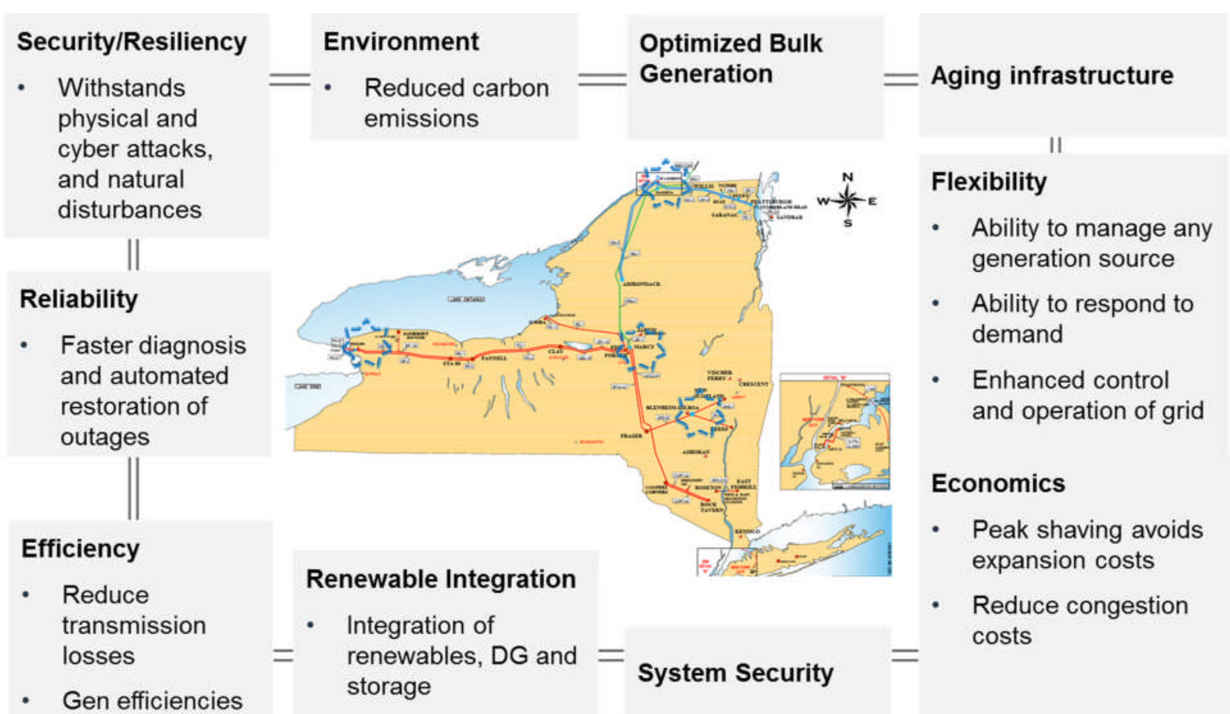
Benefits for New York State

Implementing NYPA's Smart Generation and Transmission initiative will deliver benefits to both NYPA and New York State across a range of financial and non-financial categories. Some of these benefits that smart grid technologies will deliver to the state include;

- Economic development
- Reduced congestion
- Generation savings
- Asset optimization
- Reduced transmission losses
- Integration of renewables
- Ability to support customer choice
- Fuel diversity
- Increased reliability
- Maintaining system security
- Maximizing energy efficiency
- Reducing GHG emissions
- Reliability improvements
- Increased proliferation of renewables
- Enhanced system control
- Increased safety

Indeed by examining the drivers of this initiative, it can be gleaned that the Smart Generation & Transmission capabilities that NYPA plan to deliver will contribute to the solution of many of these, as outlined in Figure 2.

Figure 2: Drivers across the NY state grid influencing NYPA's Smart Generation & Transmission journey



Financial Summary

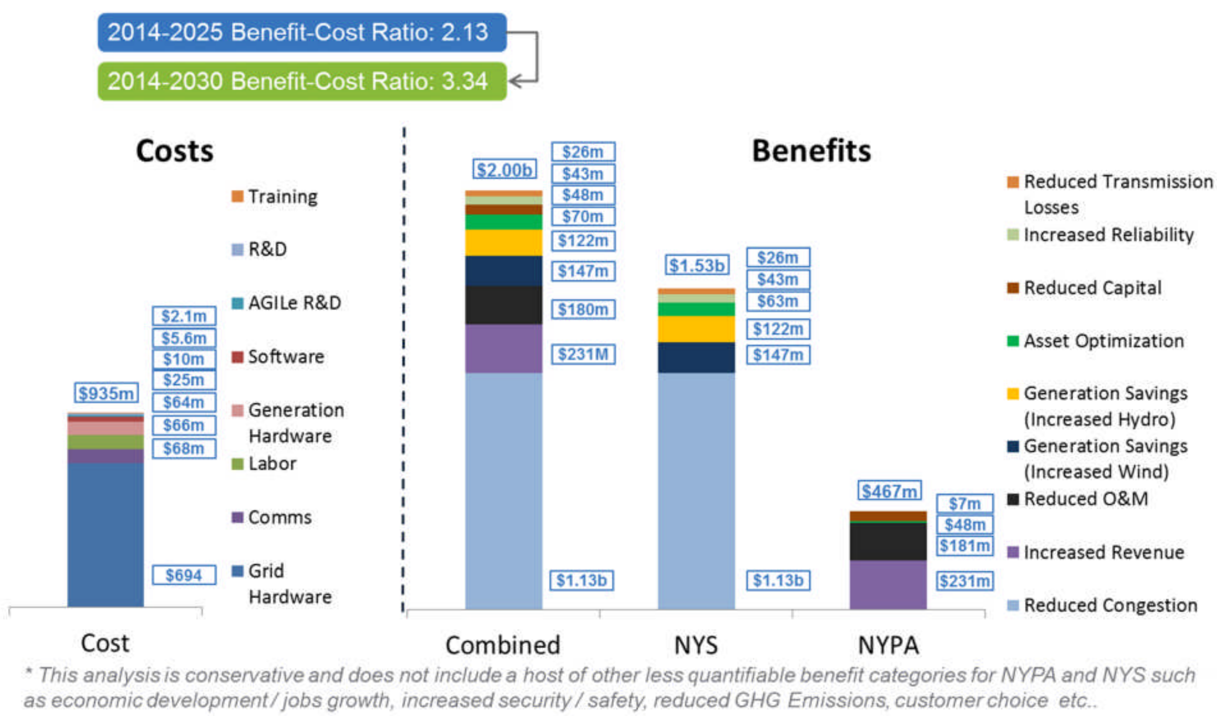
Across the six identified capability areas that NYPA will target, the Smart Generation & Transmission business case analysis shows a positive and improving total benefit-to-cost ratio over time (see Table 1 and Figure 3). While the formal proposed timeline of the initiative's efforts and financial costs will extend from 2014 to 2025 in subsequent sections of this business plan, it is important to note upfront that incremental, ongoing benefits continue to accrue significantly to 2030 and beyond. In both scenarios (to 2025 and 2030), benefit-cost ratios are net positive for NYS and NYPA combined. The lion share of the benefits accrue to NY state, which is in line with NYPA's mission, as well as the drivers and strategic rationale of the initiative as outlined in this document.

Table 1: Initiative Benefit to Cost Ratio to NYPA and NYS combined, by 2025 and by 2030

Year	Benefit-Cost Ratio	Cost	Benefits (to NYS & NYPA)
2025	2.13	$0.93b	$2.00b
2030	3.34	$0.93b	$3.12b

To put this in an external context with other related smart grid investments in the US, the Electric Power Research Institute (EPRI, March, 2011) generally estimated smart grid benefits to be between 2 to 6 times the costs of the investment. According to this and similar studies, smart grid investments are a perfect application of new technologies to reduce costs, transform utility business practices , provide grid control capabilities and provide utility cost savings sufficient to pay interest and principal and even provide some rate relief. The analysis completed in this business plan is consistent with these findings.

Figure 3: Initiative summary benefit-cost breakdown 2014-2025



As we look at the six individual capability areas that roll up to the view in Figure 3, we see that benefit-to-cost ratios may vary for each capability because of different operating cost structures, implementation scale and market maturity. One of the first steps post submission of this business plan is to further design and analyze project implementation plans, so financials will be further refined before projects are submitted for approval on an individual basis. That said, there are some common benefit and cost categories that exist across all the initiatives and that are displayed in the summary chart above.

Benefit Categories

Across the six capability areas there are individual benefits, however, many of these can be aggregated into common categories. The table below highlights these major categories.

Figure 4: Major benefit area descriptions

Benefit Category	Description
Reduced Congestion	Reduction in constraints on the economic operation of the power system, such that the marginal price of energy to serve the next increment of load is optimized.
Generation Savings (Increased Hydro)	Increased flows of low-cost hydro and ISO revenue from additional hydro resulting from upgrades and enhancements from this initiative
Reduced O&M	Reduced operations and maintenance costs, improved reliability and efficiency gains resulting from generation upgrades.
Generation Savings (Increased Wind)	Reduced energy costs due to statewide customer fuel-costs savings from enabling additional wind generation.
Asset Optimization	Reduction in wear and tear and reduced cost of failure
Reduced Capital	Deferred investment (new conductors, new lines, etc.) and other capital savings
Reduced Transmission Losses	Reduction in estimated annual cost of T&D losses in NYS
Increased Reliability	Reduction in outages that cause overall state energy costs to be higher due to a re-dispatch in real-time and deployment of more expensive generation
Increased Revenue	New revenue from increased NYPA hydro flows, CSC and micro-grid pilots

Cost Categories

Similarly, across all of the capability areas there are individual cost categories, however as with the benefits of the Smart Generation & Transmission initiative many of these can be aggregated into common cost areas. The table below highlights the major areas represented in the Benefit-Cost ratio chart.

Figure 5: Major cost area descriptions

Cost Category	Description
Grid Hardware	Tower splitting, STATCOM, CSC upgrades, physical hardware for development system, incremental cost to TLEM, instrumentation and micro-grid pilot installation cost
Communications	Fiber optics communications backbone build-out at most critical sites
AGILe	Setting the AGILe R&D agenda and directing the studies/activities (AGILe is NYPA’s proposed advanced grid innovation laboratory for energy)
Labor	Smart grid enterprise architecture, project / implementation plan, smart G&T initiative, project delivery, resources to oversee studies

High Level Timeline

Across the Smart Generation & Transmission initiatives there are a number of categories of projects that have been identified. In further sections we will detail each of the capability areas and the individual projects, pilots and areas of study that align to these groups. However, in general there are four areas of deployment that exist across the initiative over the next 10-15 years. These can be largely grouped into the following;

a) Work that is inflight already and needs to be completed as per schedule
b) Projects that can be integrated right away
c) Projects that will need to be piloted
d) Further R&D Studies and evaluation

In terms of work that is inflight, the $726 million Transmission Life Extension and Modernization (TLEM) program is a key initial step for creating a smart generation and transmission grid at NYPA as this initiative is replacing and upgrading existing transmission system components that are at the end of service life or at a high risk of failure due to condition.

In addition to the TLEM program, other ongoing efforts include around $1 million in annual research and development, the proactive and continuous maintenance and improvement of its generating assets with $1.1 Billion on major bulk generation efficiency/reliability/operational improvements at the Blenheim-Gilboa, St. Lawrence, and Niagara facilities, and is currently implementing a $470 million upgrade at its Niagara Lewiston Pump Storage Plant over the past several years. Completing the above ongoing projects provides NYPA with the necessary foundation to further build out its Smart Generation & Transmission capabilities.

In late 2014, NYPA will begin its overall Smart Generation & Transmission solution (further outlined in this document), which is meant to innovate incrementally on top the work that has already been done. Figure 6 highlights the high-level initiative deployment timeframe. The roadmap builds upon the early phase Smart Generation & Transmission work already underway, while looking to kick off the majority of the initiative's capability roadmaps by 2015 and implementation by 2016.

Figure 6: High-Level Smart Generation & Transmission Initiative Deployment Timeline

Risks of the initiative

At the highest level, risks associated with the overall initiative and appropriate planned mitigation actions can be grouped into the following key areas:

1. **Resource and Capability Constraints:** Implementing and sustaining smart grid technologies at NYPA will require a host of new skills sets and organizational capability. While this initial roadmap identifies between 40 – 60 new resources that will need to be filled to implement this roadmap, many of these skill-sets are new and unique to this initiative. To mitigate this risk, the initiative will ensure that a holistic operating model and post implementation governance plan is created.
2. **Changes in market conditions:** Changes in wholesale power cost structure, uncertainty over customer market participation, and many other factors can result in considerable uncertainty over estimated returns on smart grid investments. To mitigate this risk, the initiative will track changes in wholesale power cost structure, customer market participation, and many other factors to ensure certainty over estimated returns on smart grid investments.
3. **Inadequate post-implementation strategies:** Many smart grid business plans rely heavily on post-installment benefits (e.g. the implementation of control algorithms). However, program development and implementation details are often not considered until later, resulting in benefits that are often delayed for years. To mitigate this risk, the initiative will ensure adequate post implementation plans and organization structure are developed to track benefits and ensure optimization of new infrastructure.
4. **Vendor Product Maturity:** Many of the Smart Generation & Transmission capability areas in this roadmap will rely on software/IT performance, however, some Grid software/IT capabilities have not been widely deployed and there may be a level a market immaturity across products, adding initiative risk. To mitigate this risk, the initiative will partner with vendors, align products with roadmaps and conduct holistic vendor and market analyses.
5. **Cost Recovery:** A portion of the costs associated with this initiative is expected to be recoverable, but that is not guaranteed and thus poses a risk to the financial prudence and on-time delivery of the projects**.** To mitigate this risk, the initiative team will partner with Finance to ensure that, whenever possible, adequate cost recovery actions are taken in the planning process for individual projects in this initiative.
6. **Stranded assets:** As grid technologies continue to evolve, old technologies become obsolete, and market conditions change, there is the possibility that certain assets are stranded due to implementation of this initiative. The risk of these scenarios occurring is the key risk “as result” of the initiative rather than “to” the initiative, and will need to be mitigated during implementation. To mitigate this risk, the initiative will ensure that at each stage of product development that the risk of new technology or changing market conditions don’t allow for a stranded asset scenario

It is important to also note that there are several new Strategic Initiatives at NYPA, including Asset Management, Customer Solutions, and Workforce Planning that will have significant interfaces with the Smart Generation & Transmission initiative. Management of dependencies across the NYPA Strategic Vision 2014-2019 will be critical to the success of this initiative.

STRATEGIC RATIONALE

Approach and rationale

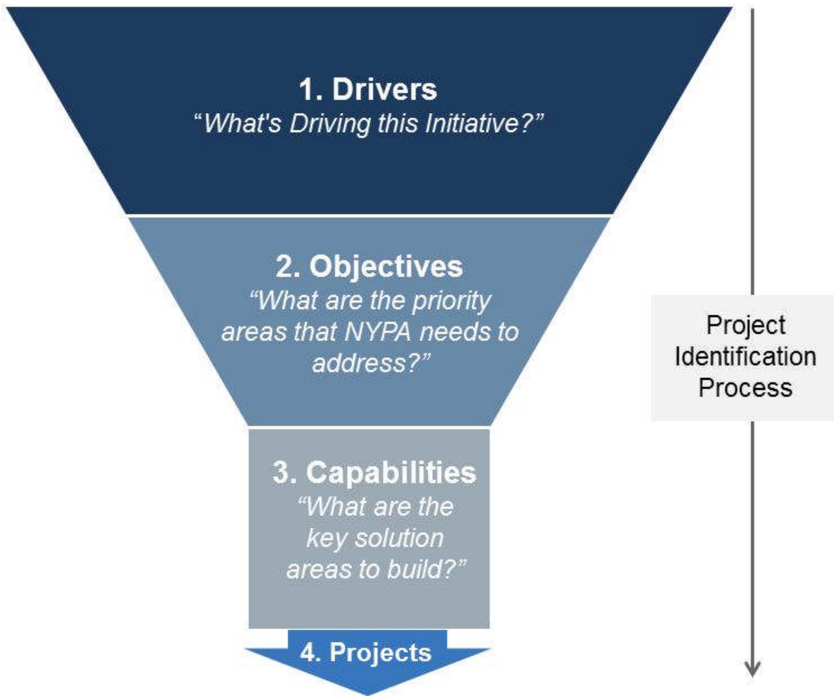
As aforementioned, it is NYPA's ambition to be an industry leading Generation and Transmission organization both in terms of capability and technology. Over the next 10 years this initiative aims to provide the backbone for New York's reimagined energy grid with a market leading platform for future technologies and services.

In the context of New York Energy landscape, the objectives of this initiative align with the Blueprint for Governor Cuomo's Energy Highway ("EH"), issued in 2012, as well as the 2014 launch of the New York Public Service Commission "Reforming the Energy Vision (REV)." The key technology objectives of REV include ensuring system reliability, increasing system resiliency and efficiency, maintaining system security, maximizing energy efficiency and promoting fuel diversity. Aligning to this vision, NYPA will play a key role in helping the State achieve these market reforms, while also addressing some of the pressing needs that exist in NY's energy market including the need to reduce congestion, increase efficiency and provide a flexible resource for managing new generation sources.

Ownership of over 1400 circuit miles of transmission throughout NYS also means that the modernization of its infrastructure to provide NYS with the flexibility it needs to meet this energy transition fits naturally into NYPA's mission and capabilities. This mission includes the stewardship of NYS natural resources, particularly the hydro-power resources of the St. Lawrence River and Niagara Falls, in collaboration with international treaties with Canada. NYPA's mission statement "Power the economic growth and competitiveness of New York State by providing customers with low-cost, clean, reliable power and the innovative energy infrastructure and services they value" is accomplished through NYPA's continuous improvement and modernization programs and by its leadership and collaboration in programs such as the NY Energy Highway initiative, energy efficiency programs, and public/private partnerships.

Aligning to these considerations and working in cross-functional teams, NYPA undertook a 4 step scoping approach (see Figure 7) to identify the most critical projects that the Authority needs to undergo over the next 10-15 years. This process allowed NYPA to examine and benchmark their infrastructure, the markets and the overall initiative from an end-to-end value chain perspective. To that, having identified Smart Generation & Transmission drivers across the marketplace that are driving this initiative (as outlined in the "Benefits to NY State" section) and building on the findings from the strategic planning process undertaken in 2013, NYPA was able to develop a series of objectives.

Figure 7: 4-Step approach to scoping the initiative



Once these objectives were identified, they were grouped into six key capability areas that NYPA will implement over the next 10-15 years (Figure 8). By going through this approach, NYPA was able to identify the most critical work that needs to be implemented by this initiative but also was able to ensure that solutions were designed holistically and in a scalable manner.

Figure 8: Mapping NYPA Smart Generation & Transmission objectives to desired capabilities

ID	NYPA Smart G&T Initiative Objective
A	Maintain current reliability given future challenges and improve where possible
B	Repair and replace critical existing assets
C	Ensure efficient compliance to NERC standards in existing and future projects
D	Maintain reliability in the face of increasing amounts of intermittent renewable resources and changing customer demands
E	Not only save costs for NYPA but for NY state, and support economic growth & business development in NY
F	Optimize the utilization of existing generation resources
G	Optimize the utilization of existing grid assets
H	Accommodate the integration of any type of generation anywhere on the grid, and support for other NY energy initiatives
I	Reduce green-house gas emissions and support NY environmental policy initiatives

Smart G&T Capability Map
Increased reliability & resiliency (A, B, C)
Enhanced situational awareness (A, B, D, F, G, H)
Optimizing aging transmission assets (B, G)
Optimizing aging generation assets (B, F)
Integration of bulk renewables (D, H, I)
Integration of distributed generation (D, H, I)

Following the above approach, NYPA aims to establish a modern, flexible, and efficient grid that maximizes reliability and resiliency while accommodating increasing amounts of power from clean and distributed generation, reducing congestion and bottlenecks, and enhancing situational awareness and grid control. This initiative will ensure flexibility and efficiency in the face of increasing demands on an aging grid by optimizing the utilization of NYPA's assets. By optimizing both the flow of power through existing and potential new infrastructure and modernizing the maintenance and operation of our transmission assets, we will increase:

- Flexibility: a flexible system will be able to accommodate changing load and generation profiles, whether due to increased penetration of renewables or distributed energy resources, energy efficiency, or increased demands on the system in extreme weather events. The system will be operated in real time, incorporating information from devices deployed throughout the network that provide information on current operating condition, operating limits, equipment health, weather conditions, etc., and will ensure minimized congestion through maximized utilization of assets.

- Efficiency: the efficient grid will minimize losses throughout the system and deploy capital and labor in the safest and most efficient ways possible. By operating to real time equipment limits, we will continue to reduce bottlenecks, and by examining and planning toward maximized asset utilization, we can reduce losses from over- or under-sizing certain system components. We will explore autonomous maintenance planning and practice to continue to reduce the risk to our employees involved in operating and maintaining the system while reducing downtime required to prevent or correct failures. The seamless integration of distributed energy resources into the grid will also facilitate customer control over their use and enable expanded energy management of buildings and industrial facilities.

- Modernity: the modern, or "smart," future for our transmission assets will incorporate cutting-edge sensing, control, material, design, and maintenance technologies to move toward a self-healing (or, at least, "self-alerting") grid. We will build upon NYPA's position as a technology, research, and innovation leader in this area and continue to scale our pilot research projects in these areas to full-scale deployment as assets. Where necessary, we will collaborate with institutional research and private sector institutions to develop new technology.

INITIATIVE OVERVIEW

Description of the opportunity

The New York energy market is changing rapidly and is driving a need for industry transformation and requirements to modernize existing infrastructure. The opportunity for NYPA to invest in smart-grid technology across their Generation and Transmission infrastructure is an important step to facilitate this energy transformation. The investments proposed in this initiative will pave the way for increased benefits to customers by providing the State with a market leading platform for future technologies and services, better management of distributed, renewable generation sources, near-real-time access to information, improved outage management and overall reduced electrical losses and increased system efficiency.

Identifying Capability Requirements and Projects

There are many major markets of smart grid technologies, services and products that sit across existing, new and modernized elements of the energy value chain. In addition, there are many working definitions of a Smart Grid and many examples of initiatives under way that could be considered Smart Grid projects. It is also important to note that the definition of a Smart Grid depends on what perspective you are coming from – generation, transmission, or distribution. While there are common elements, and interaction between them, they are at different stages of development and therefore focusing on different challenges and technological solutions. Increasingly however, there are some global similarities emerging in smart grid deployments, and we can broadly say that there may be five steps to realizing a truly intelligent utility:

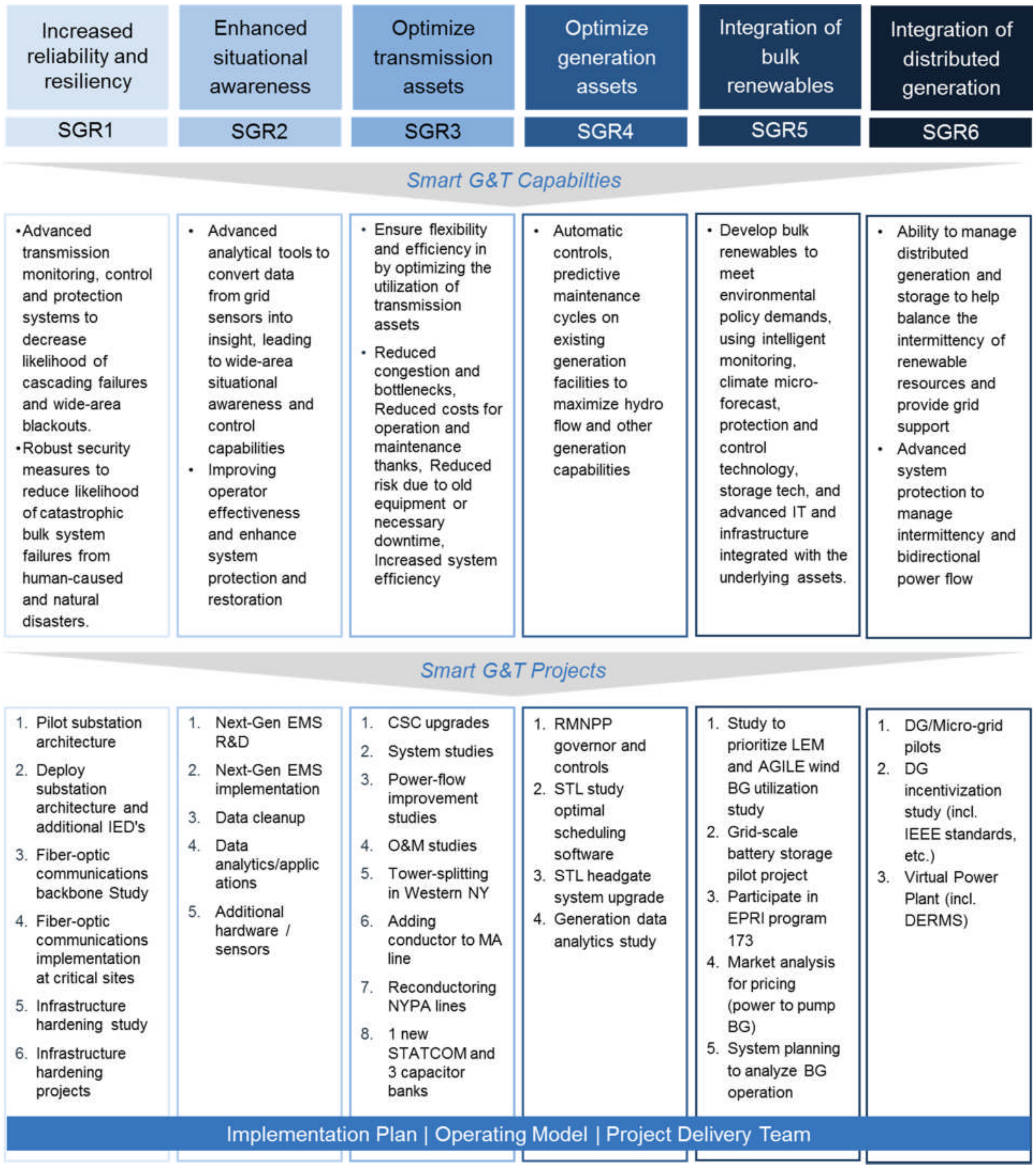
1. Deploying an advanced communications platform
2. Deploying intelligent endpoint devices across the grid
3. Effectively using analytics, software and simulation
4. Rolling out controls and security
5. Ultimately deploying dynamic devices/smart appliances

Within these five areas, NYPA can deploy a whole host of technical solutions that will create a range of benefits for both NYPA and NYS. However, in order to prioritize the most beneficial and cost worthy elements of smart grid technologies and capabilities that exist in the marketplace today and ensure that the investments made by NYPA will be saleable, sustainable and truly address the drivers identified by this initiative, NYPA first identified the capability areas that it needs to build and then identified technical solutions under those areas. This approach will allow NYPA to develop a business and organizational response and well as a technical response to changing market needs. With that said, and as outlined by in the Approach and rationale section, NYPA has identified six key capability areas that projects and ultimately this business plan were designed and centered on. These six capability areas include;

1. Increased reliability & resiliency
2. Enhanced situational awareness
3. Optimized utilization of generation assets
4. Optimized utilization of transmission assets
5. Integration of bulk renewables
6. Integration of distributed generation

In Figure 9 below, each of the capability roadmap area definitions are highlighted as well as the correlating projects in each area.

Figure 9: Summary view of Smart Generation & Transmission capability and project areas

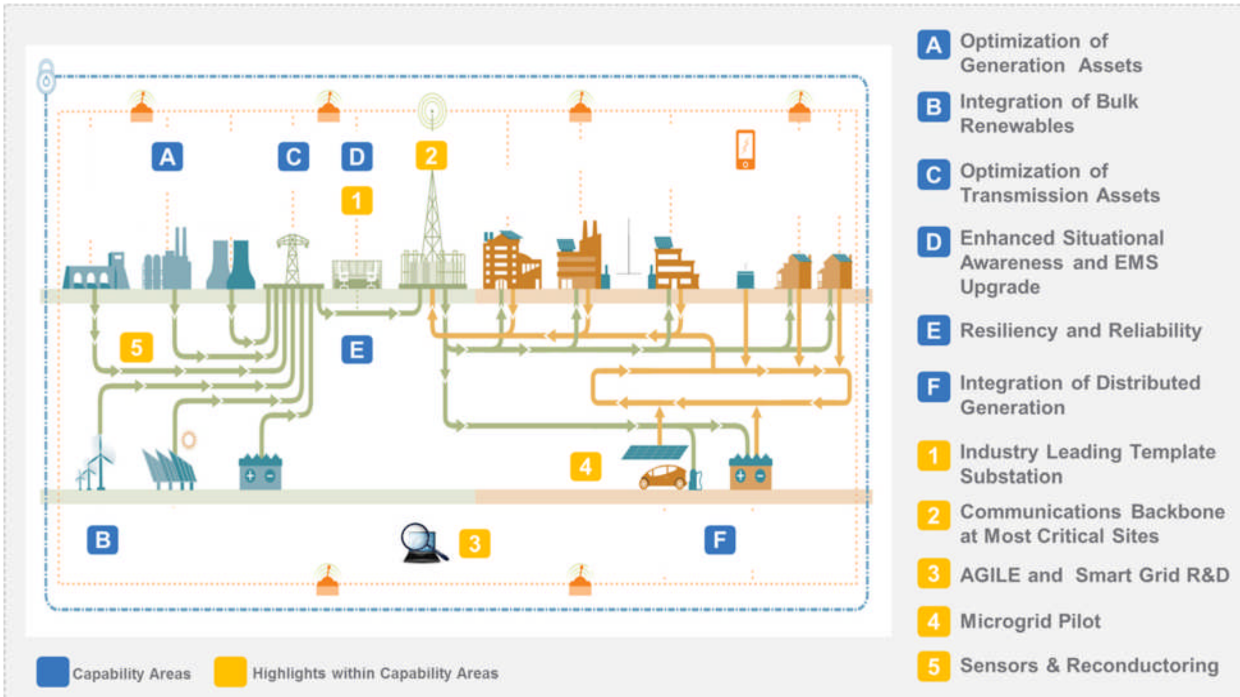


SOLUTION

Proposed solution

NYPA's Smart Generation & Transmission initiative is a holistic deployment of capabilities across the entire value chain. The projects and capabilities identified represent a response to both the challenges facing NYPAs current infrastructure as well as the need to modernize in light of a transformation across the energy sector. Figure 10 below highlights the end to end scope of this initiative mapped onto the existing value chain.

Figure 10: NYPA's end-to-end Smart Generation & Transmission focus areas



While each of the six capability areas identified will have its own discreet roadmap (as detailed in the appendix), below are some of the key objectives they're meant to address;

- Implementation of technologies to improve the flexibility of our system and the efficiency of our maintenance and operations. These include those that have been proven already in the NYPA system - for example, phasor-measurement units (PMU's) or flexible alternating current transmission system (FACTS) devices – and those that have not, such as robotic inspection, new conductor technology, dynamic thermal rating, some of which have been piloted, but not scaled fully.

- Resiliency and reliability projects including the Emergency Energy Control Center (ECC) construction and the MV90 system rebuild. The Emergency ECC will significantly improve the resiliency of NYPA's operations by providing a backup control center offsite with full capabilities in the event that system operations staff could not occupy the ECC at CEC. Presently the project is in the study phase to select the site and define the scope. The second smart gird improvement project for resiliency and reliability is the build out of the MV90 Meter Data collection system which presently resides at the Poletti Admin building. For improved support, and reliability, a second MV90 system will be built and tested in the WPO datacenter with the eventual goal of retiring the system at Poletti.

- System-wide improvements using capital investments in all of our technologies for increasing power flow. The options to be studied range from eliminating unnecessary equipment constraints on power flow (for example, undersized wave guides, current transformers, or connectors) to the construction or purchase of new lines. Following the studies, leveraging and further developing AGILe R&D lab capabilities, we will design a program for investment that will most likely include some combination of reconductoring, dynamic rating, FACTS deployment, or new construction.

- Bulk power storage plants program to provide a valuable benefit to the efficient operation of the electric grid. The goal is to develop advanced modeling techniques that utilize the flexibility of pumped storage, being a generation and demand-response asset, and its numerous capabilities to provide ancillary services, and have a prototype that can eventually be adapted in ISO/RTO system operations and its market software. The analysis and potential enhancements to how pumped storage is utilized will range from the bidding process, to the optimization engine, all the way to prices and settlements.

- The encouragement and incentivization of third party bulk renewable developers to interconnect to the NYPA transmission system. This goal is in line with NYS initiatives for clean power and takes advantage of NYPA's expertise in implementing reliable interconnections as demonstrated with other wind farm developers. NYS currently has approximately 20% generation in the form of bulk renewable (15% hydro, 5% wind and other). The PSC has established a target that approximately 30% energy used (GWH) in NYS by 2015 comes from renewable sources. Grid can operate reliably with a high percentage of bulk and distributed renewable generation. Identify locations in NYS where NYPA's transmission system substations provide good interconnection for additional bulk renewables – such as mapping wind studies with TLEM to prioritize system improvements.

In addition, while Figure 10 above highlights the six key capability areas of focus, within these there are a number of key highlights including the development of an industry leading substation, further build-out of a communications backbone, the development of AGILe and a microgrid pilot.

- **Industry Leading Template Substation:** Develop the use of substation intelligent electronic devices to provide high resolution data on power system equipment condition both for real time operations for enhanced clarity, for improving restoration times following an event by better retrieving data for decision making and for long term trending for asset management. This mainly leverages equipment that will be installed under other programs but needs to be better leveraged by fully realizing the capabilities on board in these devices.

- **Next-generation Energy Management System (EMS):** A system operating architecture is proposed that allows for a comprehensive fully coordinated operation of power systems. This architecture is completely based on sensing and feedback to a central location. Therefore, increased sensors installations and redundant, highly reliable communications links are central staples of such architecture. NYPA will work within its R&D division and with external vendors and organizations as necessary to design and implement the next-generation EMS.

- **Communications backbone at most critical sites:** A significant challenge of integrating Smart Grid technologies, particularly over a wide geographic area for transmission, is for reliable, secure communications systems. Often utilities relied on power line carrier analog communications over the power conductor, direct point to point microwave or third party telephone circuits. As technology has advanced, the required bandwidth has increased significantly, as well as the need for security to ensure reliable system operation and to fully enable the capabilities of the smart IEDs installed at the substations. To enable this NYPA will complete fiber optic programs at its most critical sites.

- **AGILe and Smart G&T R&D:** While the Smart G&T initiative assumes that the physical build of the AGILe R&D lab, as well as the incremental FTE's will be covered under the AGILEe business case, setting the R&D agenda and directing the studies/activities in parallel to AGILe are a significant undertaking in the near term for this initiative. Examples of further studies to conduct include;
    - Next-Gen EMS R&D as detailed above
    - System studies
    - Power-flow improvement studies
    - O&M studies
    - Generation data analytics R&D study
    - Study to prioritize LEM efforts based on increased wind sites
    - Study to prioritize AGILE efforts based on increased wind sites
    - Market analysis for pricing re: purchasing power to pump BG
    - System planning study to analyze new modes of BG operation
    - DG incentivization study

- **Microgrid Pilot:** This initiative will demonstrate a microgrid installation and serve as an example of the benefits that are included in distributed generation technologies. While there are microgrids located within New York State, the uniqueness of the proposed pilot is that NYPA would like to integrate these assets into their internal Virtual Power Plant software. An advanced controller would be installed in order to allow remote monitoring and possibly control. Different control algorithms would be tested to determine optimal ways to benefit customer, the distribution company, and generation/transmission supplier. Testing will also include the ability to enhance resiliency by disconnecting from the grid automatically or remotely, and the ability to send excess power back to the grid.

One of the highest cost and benefit drivers of this initiative is the SGR3 roadmap area – Optimization of Transmission Assets – and so it is important to elaborate on its various components:

- We will undertake a full battery of system studies to determine the best course of action for making system-wide improvements using capital investments in all available technologies for improving power flow. The options to be studied range from eliminating unnecessary equipment constraints on power flow (for example, undersized wave guides, current transformers, or connectors), to the application of energy storage and demand response for system support, to the application of capacitors or other FACTS devices like the Convertible Static Compensator, to the construction or purchase of new lines. We aim to substantially reduce congestion in the system and ensure the system can handle a variety of load and generation profiles while taking care to minimize inefficiencies – the goal is a right-sized, not overbuilt, system. Following the studies, which can leverage or help develop eventual capability for the AGILe lab, we will design a program for investment that will most likely include some combination of reconductoring, dynamic rating, FACTS deployment, or new construction.

- Some preliminary projects have already been identified by NYPA Transmission Planning and Engineering. We plan to complete the tower separation efforts in Western New York and continue to explore ways to improve transmission capability in Northern New York, probably involving the addition of a conductor to the Moses-Adirondack corridor. These efforts will increase the amount of low-cost hydropower we can send from Northern and Western NY. We will also complete networks of dynamic line rating installations where applicable and continue our exploration of advanced ice-phobic conductor materials to reduce downtime during storms. The studies to be commissioned will explore efforts including and beyond these projects both in scope and in geographic region, with a particular eye to continuing to reduce congestion at the most problematic interfaces. The work to upgrade the controls on the Convertible Static Compensator, our FACTS device to reduce congestion at our Marcy substation, will be included as part of this initiative.

- Using results from the system study and examining internal data, whether O&M spending, existing technology, operational considerations etc. we will design frameworks for implementing smart O&M - a framework to prioritize sensor deployment and a framework for testing and implementing advanced maintenance technologies and techniques, which we anticipate will include some combination of live work and autonomous maintenance and data collection. Care will be taken to align installations with TLEM work, when possible, to minimize downtime, and to establish the "innovation pipeline" - a method of evaluating new technologies or approaches and smoothing their transition from research to pilot to full system deployment. To correlate with existing TLEM work, we will commission a final study, whether to be completed internally or by a third party, to ensure that our TLEM work is as modern as it can be and helps to achieve the goals of this initiative.

Solution Design Principles

While the list of capabilities and projects proposed under this initiative is comprehensive and touches many aspects of NYPA's system, for the entire Smart Generation & Transmission solution, a number of common solution design principles will be applied to ensure designed are scalable, readily compatible with changes in technology and cost effective. Categories of NYPA design principles include;

- Cyber Security: Architecture must incorporate the latest cyber security techniques and adhere to NERC CIP (Critical Infrastructure Protection) and other cyber security standards.
- Scalable Solutions: The Smart Generation & Transmission infrastructure should allow for the management of hundreds of thousands of endpoint devices and loads.
- Leverage Industry Protocols: The infrastructure should leverage open standards and industry best practices, establish repeatable processes and patterns, and provide a template for all demand response solutions
- Interoperability: Smart Generation & Transmission technology solutions and requirements should be both vendor and platform independent; "plug and play" architectures should be leveraged as much as possible to allow for the deployment of scalable and interoperable solutions.
- Top-down approach: Roadmaps and projects in this initiative will be carried out with the necessary amount of coordination and oversight to ensure a comprehensive and seamless solution. Ample consideration will be given to NYPA's bottom-up capital budgeting process in the planning of each individual project within the broader solution, so that confirmed projects are funded and executed in a timely manner.

Roll-out plan

The table below represents the delivery categories of each of NYPA's proposed Smart Generation & Transmission Projects. Depending on the categorization, the level of effort will vary across the deployment plan.

Table 2: High-level Smart Generation & Transmission roll-out plan

Roadmap	Project Name	R&D	Pilot	Implementation
SGR0	Initiative implementation plan			●
SGR0	Operating model / Project delivery team set-up			●
SGR0	Smart G&T Enterprise Architecture			●
SGR1	Pilot substation architecture		●	
SGR1	Deploy substation architecture and additional IED's		●	●
SGR1	Fiber-optic communications backbone study	●		
SGR1	Fiber-optic communications backbone implementation		●	●
SGR1	Infrastructure hardening study	●		
SGR1	Infrastructure hardening projects			●
SGR2	Next-Gen EMS R&D	●		
SGR2	Next-Gen EMS implementation		●	●
SGR2	Data cleanup			●
SGR2	Data analytics/applications			●
SGR2	Additional hardware/sensors			●
SGR3	CSC upgrades			●
SGR3	System studies	●		
SGR3	Power-flow improvement studies	●		
SGR3	O&M studies	●		
SGR3	Tower splitting at Western NY			●
SGR3	Replacing conductors on MA line			●
SGR3	Adding conductor to MA line			●
SGR3	Reconductoring 20% of NYPA lines			●
SGR3	Additional transmission instrumentation			●
SGR3	Construction of 1 new STATCOM			●
SGR3	3 new capacitor banks			●
SGR4	RMNPP governor and controls upgrade			●
SGR4	St. Lawrence study optimal scheduling software replacement			●
SGR4	STL headgate system upgrade			●
SGR4	Generation data analytics R&D Study	●		
SGR5	Study to prioritize LEM efforts based on wind sites	●		
SGR5	Study to prioritize AGILe efforts based on wind sites	●		
SGR5	Grid-scale battery storage pilot project		●	
SGR5	Participate in EPRI program 173	●		
SGR5	Market analysis for pricing re: purchasing power to pump BG	●		
SGR5	System planning study to analyze new modes of BG operation	●		
SGR6	DG/Micro-grid pilots		●	
SGR6	DG incentivization study (incl. IEEE standards, etc..)	●		
SGR6	Virtual Power Plant (incl. DERMS)		●	●

Suggested business model

In order to deliver an initiative on this scale, a clear and defined initiative operating model will need to be designed. Across all of the capability areas NYPA will need to significantly add not only skill sets but also incremental FTEs. The delivery strategy and sourcing of resources will depend in each case on the solution being developed however at this stage the requirement for an additional 40 to 60 FTE resources has been identified. In all subsequent tables, "Post-2020" indicates final years 2021-2025 of this initiative.

Table 3: Range of anticipated FTE's needed by capability roadmap area, ro be ramped between 2014-2025

ID	**Capability**	**FTE Requirements**	**Range**
SGR0	Initiative management	Low	~2-5
SGR1	Increased reliability & resiliency	Medium	~6-8
SGR2	Enhanced situational awareness	Medium	~6-8
SGR3	Optimized utilization of transmission assets	High	~18-20
SGR4	Optimized utilization of generation assets	Low	~3-4
SGR5	Integration of bulk renewables	Low	~2-3
SGR6	Integration of distributed generation	Medium	~6-8
		Total	**~40-60**

**FTE requirements 2014-2025. FTE ramp rate and overall FTE requirements will depend on project delivery model.*

Table 3 above is a summary of estimated NYPA FTE counts, either reallocated or incrementally hired, that will be needed to roll out the Smart G&T initiative. As the initiative progresses, new incremental resources will need to be absorbed and trained up for new roles. Cumulatively, this adds up to a total range of 40-60 roles, either incremental or reallocated, resulting from the implementation of this initiative and inevitably comprises a significant transformation within NYPA's operational units. The FTE counts above do not include contractors directly associated with implementation projects – those contractor costs however are included in the initiative's costs summarized in the next section.

Incremental FTE's will sit across various domains including engineers, linemen, technicians, data scientists (IT), and business (ERM, R&D). For example;

- Implementation of smart grid technology will require the development of additional skill sets within NYPA's G&T organization. For example, the implementation of advanced transmission line inspection equipment such as robots ot unmanned aircraft will require new skills to operate and manage. Through a close link with future asset management data functions, the ability to operate on data-driven recommendations will also need to be developed.

- The deployment of Smart Grid technology and increased use of IEDs for data reporting will require significant increased support for highly skilled engineers and technicians. It should be noted that there can be a steep learning curve associated with deployment of new technologies used in NYPA's core business. These types of systems are a unique skill sets combining power system theory, communications, and computer analysis, which will require internal training, and retention to ensure NYPA has qualified personnel to work on these systems. Skilled engineering personnel will also be required to analyze condition monitoring data to assist operation personnel to make maintenance decisions, and Operations staff will require additional training and resources to be able to utilize these technologies to support the reliable operation of the power system.

- Deployment of these technologies, in a reliable manor unto themselves will require separate development systems to verify the IED and data concentrator functions and capabilities, prior to deployment at a substation. Such a development system will ensure efficient and effective commissioning and operation of these systems in the field, allow of testing of future expansion and upgrades, and provide a training system for end users.

Categories of resources identified by this initiative include a) internal, b) external and c) internal incremental. While category b) and c) above will be new and incremental FTEs, for category a) there will be significant retraining efforts that need to be considered. Overall however there are a number of key next steps to define the future Smart Generation & Transmission delivery model including;

- Design new Smart G&T operating model and detailed organizational sizing requirements
- Identify roles and responsibilities and KPI's

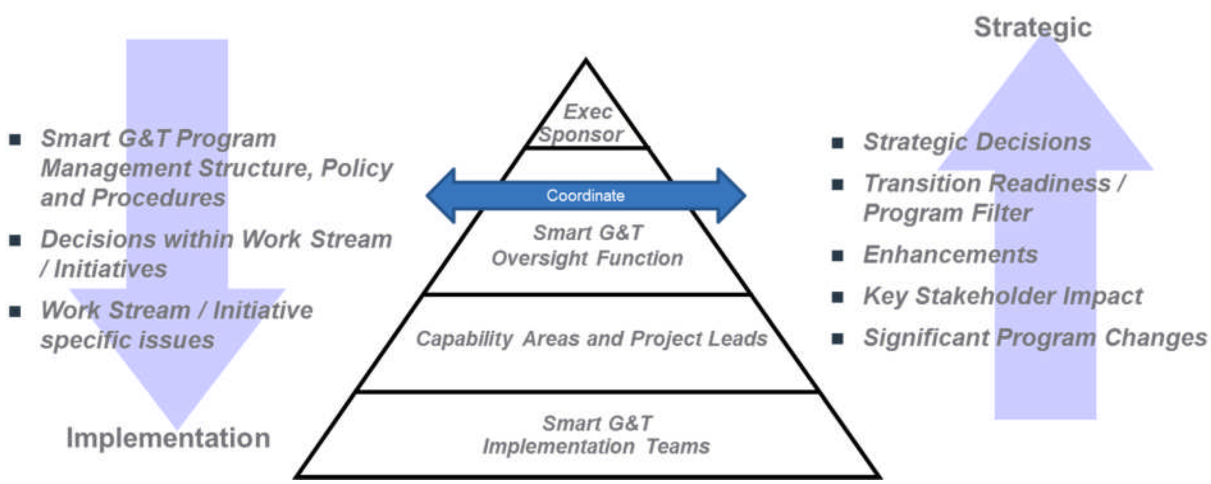
- Implement Smart G&T Governance
- Stabilize operations around identified organizational groups
- Enforce and orchestrate activities

Suggested governance structure

A Smart Generation & Transmission organization is proposed in order to deliver the program of work identified. While the additional resource requirements have been identified at a high-level to date, additional organizational support structures are also being considered. New roles will need to be created in the organization including dedicated levels of responsibility across;

- Executive Sponsor
- Smart Generation & Transmission Oversight Function
- Capability Areas and Project Leads
- Smart Generation & Transmission Implementation Teams

Figure 11: Smart Generation & Transmission Governance Structure (Illustrative)



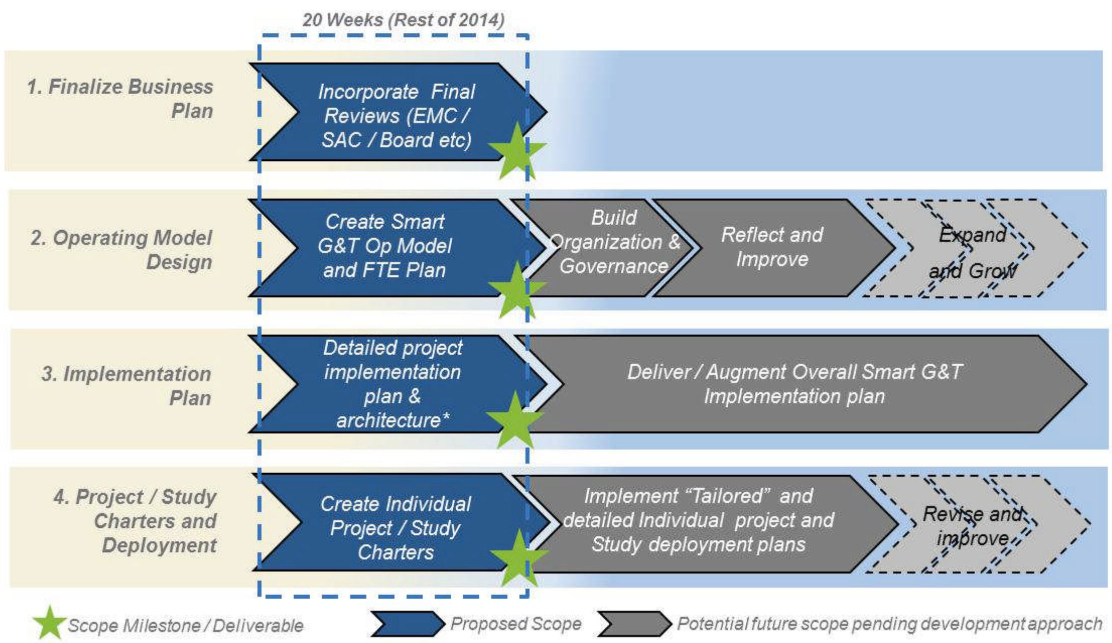
For 2015 NYPA has identified the need to add twelve FTE's to create the Smart Generation & Transmission governance function. This team will be responsible for overseeing the implementation of the organizational structure required to deliver this initiative. While 40-60 FTEs have been identified at this stage for incremental work throughout the initiative years, one of the first tasks for this core team upon board approval of this business plan will be to finalize project implementation plans and understand the ramping of these resources across the initiative. This core team will also be responsible for taking subsequent, detailed project plans and resource requests to the board for approval on a per-project basis. At this stage, a decision will be made on what resources will be embedded to this new team and what resources will be part of the overall transition Smart Generation & Transmission organizations. Throughout the design, a range of Smart Generation & Transmission Operating Model principles will be applied;

- NYPA's Smart Generation & Transmission organization will be designed to efficiently develop and deliver new customer, operational and technology focused capabilities
- New governance structures will enable the type of communication and potential for cooperation with key Smart Generation & Transmission Stakeholders
- The new organization will be conscious of short-term goals, and long-term objectives

- Existing NYPA functions will provide transitional operational support to the business and assist in the transition of these responsibilities to core operations.
- Planned initiatives such as Asset Management and AGILe will provide operational support
- Smart Generation & Transmission will be an evolving organization that is focused on continuous improvement that needs to be agile, resilient, and responsive to iterating.

Initiative Implemenation Planning

As part of the next phase of implementation planning, the Smart G&T initiative team will work on four key areas throughout the remainder of 2014. Each of these four areas will ultimately provide the bottom up business case validation, operating model and detailed project plans needed to finalize the initiative. While the first area recommends a continuation of refining this document, the subsequent three workstreams will validate the content proposed here and set forth a delivery structure, as outlined further below.



*Overall Enterprise Architecture approach still TBD

Operating Model Design

Building on the content in this document, the main purpose of this stream is to create a Smart Generation & Transmission team, operating model, sourcing strategy and overall governance structure to deliver the initiative. It is also to conclude the top-down estimate of resource needs and launch a more detailed bottom-up approach.

Key Activities:

- Develop functional operating model
- Conduct role analysis
- Create the organizational structure and develop organizational staffing plan
  - Smart Generation & Transmisison Oversight Function
  - Capability Areas and Project Leads
  - Smart Generation & Transmission Implementation Teams
- Launch Smart Generation & Transmission organization and implement governance

Detailed Implementation Plan

This stream will create an overarching implementation plan and system architecture. The implementation plan will be a detailed project plan that aligns to the top-down Smart Generation & Transmission approach and overall charter development efforts, with milestones, dependencies and project management tools defined.

Key Activities:

- Implementation Plan
- Create end-to-end project plan with deliverables and milestones
- Align individual project charter with end-to-end timeline
- Detailed Project Plans for prioritized projects
- Enterprise Architecture (final scope to be added to this approach)
- System Blueprint
- Technical Requirements analysis (include data model requirements)

Project / Study Charters and Deployment

The purpose of this stream is to create individual project / study charters and definition of the business solution as prerequisites for the funding approval of individual projects. Any business case unknowns should be resolved here (or a plan put in place to resolve them). Detailed project costs and schedule estimates for the entire project should be significantly increased in accuracy. In addition, evaluation and deployment of quick wins will be part of this workstream.

Key Activities:

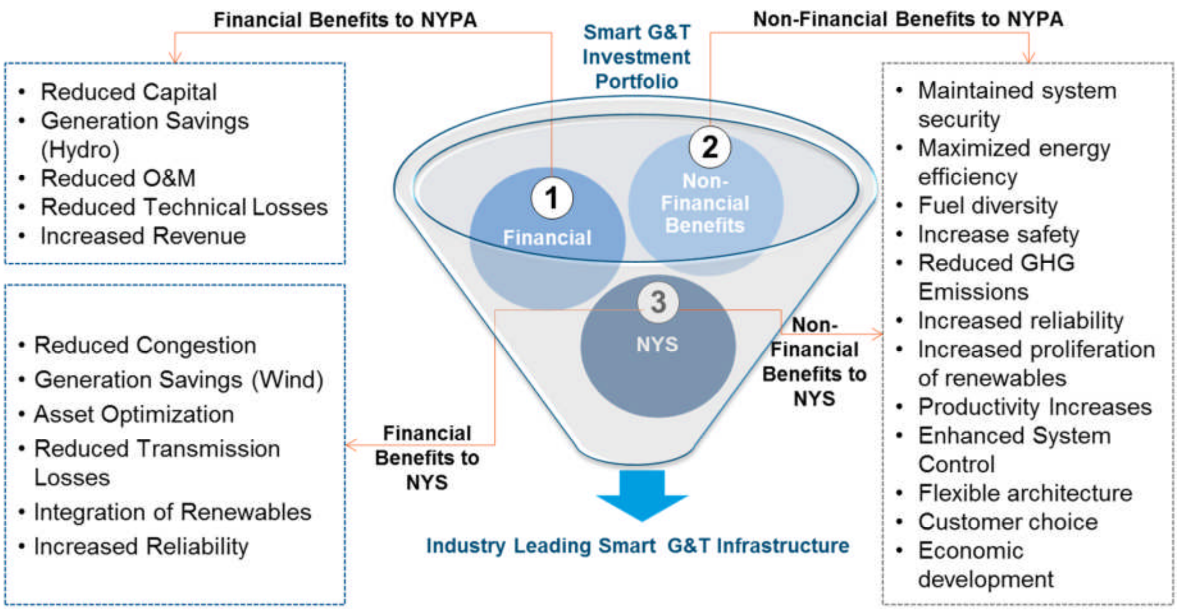
- Complete individual project / study charters
- Project / Study overview (Detailed description and project justification)
- Project scope (Requirements & Deliverables)
- Project / study plan (Timeline and project / study plan including executive milestones)
- Detailed financials (Detailed estimates and funding sources)
- Project organization charter approval (Roles & responsibilities and governance)
- Implement quick wins where applicable

BENEFITS AND REVENUE

High-level benefits description

This section outlines the many benefits that are expected as a result of rolling out this initiative. As Figure 12 below suggests, there are three large buckets of benefits – financial to NYPA, financial to NYS and non-financial – as well as various categories of benefits that fall within those buckets.

Figure 12: Summary of initiative financial and non-financial benefit categories



While financial benefits and the positive benefit-cost ratio form the investment-grade foundation of this business plan, non-financial benefits are equally as important. Below highlights some of the key non-financial benefits listed above:

- **Maintained system security for NYPA –** By following NERC-CIP requirements and design guidelines, this initiative will maintain system security at NYPA in the face of growing new advanced hardware and software installations.
- **Increased safety for NYPA –** By automating as much of grid controls and maintenance as possible, NYPA will reduce the number of man-hours needed to perform often dangerous activities, and thus raise overall safety at NYPA.
- **Higher % penetration of renewables for NYS –** Through efforts such as studies to better facilitate interconnection of bulk wind power sites to NYPA's system, as well as distributed generation/micro-grid piloting, this initiative will encourage a higher % of bulk and distributed renewable penetration in NY State.
- **Reduced greenhouse gas emissions for NYS –** By efforts such as reducing technical losses on transmission lines, increasing flow of hydro power and higher integration of renewables, this initiative will help NY state reduce greenhouse gas emissions
- **Reliability improvements for NYPA and NYS –** By efforts such as upgrading lines, strengthening transmission capacity, and adding sensor/remote monitoring capabilities, this initiative will help both NYPA and NY state improve system reliability
- **Enhanced system control for NYPA and NYS –** By setting up and proliferating use of advanced monitoring and control capabilities in both generation and transmission assets, NYPA will be able to better manage load and supply throughout its system in real-time.

Table 4 below presents a complete list of the projects under this initiative are mapped to the appropriate benefit categories, both financial and non-financial.

Table 4: Smart Generation & Transmission projects mapped to financial and non-financial benefit categories

Benefits			Pilot Substation Architecture	Deploy substation architecture and additional IED's	Communications Backbone Study	Communications Backbone Implementation	Infrastructure Hardening Study	Infrastructure Hardening Projects	Next-Gen EMS R&D	Next-Gen EMS Implementation	Data cleanup	Data analytics/applications	Additional hardware/sensors	System studies	Power-flow improvement studies	O&M studies	CSC Upgrades	Tower Splitting at Western NY	Adding conductor to MA line and replacing MA lines	Reconductoring 20% of NYPA's lines	Additional transmission instrumentation	Installation of one new STATCOM	Construction of 3 new capacitor banks	RMNPP Governor and Controls Upgrade	STL Study Optimal Scheduling Software Replacement	STL Headgate System Upgrade	SCADA/Diversion Flow Measurement Sys Interface	TBD Generation Technology R&D Study	Study to prioritize LEM efforts based on wind sites	Study to prioritize AGILE efforts based on wind sites	Grid-scale battery storage pilot project	Participate in EPRI program 173	Market analysis for pricing (purchasing power to pump BG)	System planning study to analyze BG operation	DG/Micro-grid pilots	DG incentivization study (incl. IEEE standards, etc)	Virtual Power Plant (incl. DERMS)
		Smart G&T Projects	Reliability and Resiliency						Situational awareness					Optimize Transmission										Optimize Generation					Int. of Bulk Renewables						Int.of DG		
Financial	NYPA	Reduced O&M	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
	NYPA	Reduced Capital	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
	NYPA	Asset Optimization							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
	NYPA	Generation Savings (Hydro)																						●	●	●	●	●									
	NYPA	Increased Revenue															●	●	●	●	●	●	●												●	●	●
	NYPA	Increased Reliability	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●								●				●	●	●
	NYS	Reduced Congestion							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●								●	●	●
	NYS	Generation Savings (Wind)							●	●	●	●	●	●	●	●	●																				
	NYS	Asset Optimization							●	●	●	●	●	●	●	●	●																				
	NYS	Reduced Transmission Losses							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●
	NYS	Generation Savings (Hydro)							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
Reliability	NYPA / NYS Reliability	Increased Reliability	●	●	●	●	●	●										●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Environmental	NYPA / NYS Envirn	Reduced CO2 Emissions																●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Safety	NYPA	Increased Safety	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Security	NYPA / NYS Security	Reduced Widecasle Blackouts	●	●	●	●	●	●										●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Financial benefits

Table 5 below is a summary of the financial benefits anticipated from rolling out the Smart Generation & Transmission initiative. Subsequent material presents detail on how these benefits were estimated from a bottom-up examination of each roadmap area and potential benefit categories.

Table 5: Summary of projected benefits from implementing the Smart Generation & Transmission initiative

Benefits to New York State ($ '000)								
Category	2014	2015	2016	2017	2018	2019	2020	Post 2020
Savings from								
Reduced Congestion	$ -	$ -	$ -	$ 41,000	$ 43,000	$ 150,000	$ 126,000	$ 153,000
Generation Savings (Increased Wind)	$ -	$ -	$ -	$ -	$ -	$ 21,000	$ 21,000	$ 21,000
Asset Optimization	$ -	$ -	$ -	$ -	$ -	$ 9,000	$ 9,000	$ 9,000
Reduced Transmission Losses	$ -	$ -	$ 1,400	$ 1,400	$ 1,400	$ 3,050	$ 3,100	$ 3,150
Increased Reliability	$ -	$ -	$ -	$ 4,100	$ 4,300	$ 5,000	$ 4,200	$ 5,100
Generation Savings (Increased Hydro)	$ -	$ -	$ -	$ -	$ 5,000	$ 9,000	$ 18,000	$ 18,000
Total ($ '000)	**$ -**	**$ -**	**$ 1,400**	**$ 46,500**	**$ 53,700**	**$ 197,050**	**$ 181,300**	**$ 209,250**

Total NYS benefits ($ '000)	**$ 1,526,200**

Cost savings for NYPA ($ '000)								
Category	2014	2015	2016	2017	2018	2019	2020	Post 2020
Reduced O&M	$ 1,183	$ 1,422	$ 13,695	$ 18,525	$ 17,332	$ 20,520	$ 21,142	$ 17,348
Reduced Capital	$ -	$ -	$ -	$ 6,000	$ -	$ 6,000	$ 6,000	$ 6,000
Asset Optimization	$ -	$ -	$ -	$ -	$ -	$ 1,000	$ 1,000	$ 1,000
Total ($ '000)	**$ 1,183**	**$ 1,422**	**$ 13,695**	**$ 24,525**	**$ 17,332**	**$ 27,520**	**$ 28,142**	**$ 24,348**

Incremental revenue to NYPA ($ '000)								
Category	2014	2015	2016	2017	2018	2019	2020	Post 2020
Customer revenue	$ -	$ -	$ 969	$ 1,938	$ 2,907	$ 3,876	$ 4,845	$ 5,814
CSC Revenue	$ -	$ -	$ 11,807	$ 11,962	$ 12,121	$ 12,283	$ 12,450	$ 12,621
ISO revenue	$ -	$ -	$ -	$ -	$ 8,000	$ 8,000	$ 8,000	$ 8,000
Total ($ '000)	**$ -**	**$ -**	**$ 12,776**	**$ 13,900**	**$ 23,028**	**$ 24,159**	**$ 25,295**	**$ 26,435**

Total savings & revenue to NYPA ($ '000)	**$ 466,893**

Benefit assumptions

The initiative-level benefits summary above was compiled by rolling up estimate calculations by benefit category made within each of the six roadmap areas. The following Table 6 shows which benefit categories were realized in which roadmap areas and provides a high-level description of how those benefits are expected to be realized in that area. For more detailed documentation of the calculations behind each roadmap area's benefit categories, please see appendix items as referenced in each line below.

Table 6: Benefit category detail and assumptions by capability roadmap area

ID	Roadmap Name	Projects	Benefit Category	Category Detail	# in Appendix Table
SGR1	Increase Reliability / Resiliency	• Pilot Substation Architecture • Deploy substation architecture and additional IED's • Fiber-optic comms backbone study • Fiber-optic comms backbone imp • Infrastructure Hardening Study • Infrastructure Hardening Projects	Increased Reliability	Reduced congestion costs due to avoided transmission failures	1
			Reduced O&M	Reduced O&M - Maintenance	2
			Reduced O&M	Reduced O&M to NYPA due to improved reliability	3
			Reduced Capital	Reduced Capital - Installation of MA fiber if MA line rebuild proceeds	4
			Reduced Capital	Comms lease savings to NYPA	5
SGR2	Enhance Situational Awareness	• Next-Gen EMS R&D • Next-Gen EMS Implementation • Data cleanup • Data analytics/applications • Additional hardware/sensors?	Reduced Congestion	20% reduction in NYS congestion	6
			Generation Savings (Increased Wind)	Reduced energy costs due to additional 300MW wind savings to NYS	7
			Asset Optimization	Economy (reduction in wear & tear) savings to NYS	8
			Asset Optimization	Safety (equipment damage only) to NYS	9
			Reduced O&M	Economy (O&M reduction)	10
			Reduced Transmission Losses	Efficiency (1% technical loss reduction) savings to NYS	11
			Reduced O&M	FTE O&M savings to NYPA	12
			Asset Optimization	Economy (reduction in wear & tear) savings to NYPA	13
SGR3	Optimizing Transmission Assets	• System studies • Power-flow improvement studies • O&M studies • CSC Upgrades • Tower Splitting at Western NY • Replacing conductors on MA line • Adding third conductor on MA line • Additional instrumentation • Reconductoring 20% of NYPA's lines • Installation of one new STATCOM • Construction of 3 new capacitor banks	Generation Savings (Increased Hydro)	Incr flows of low-cost hydro	14
			Increased Revenue	ISO revenue from additional hydro	15
			Increased REvenue	CSC revenue from CSC upgrades	16
			Reduced Congestion	10% reduced congestion to NYS	17
			Reduced Capital	Capital – investment savings	18
			Reduced Transmission Losses	Reduced transmission line losses	19
			Reduced O&M	O&M – maintenance savings	20
SGR4	Optimizing Generation Assets	• RMNPP Governor and Controls Upgrade • St. Lawrence Study Optimal Scheduling Software Replacement • STL Headgate System Upgrade • TBD Generation Technology R&D Study	Reduced O&M	Reduced maintenance, labor and down-time	21
SGR5	Integration of Bulk Renewables	• Study to prioritize LEM efforts based on increased wind sites • Study to prioritize AGILE efforts based on increased wind sites • Grid-scale battery storage pilot project • Participate in EPRI program 173 • Market analysis for pricing re: purchasing power to pump BG • System planning study to analyze new modes of BG operation	N/A	Depending on the outcome of the studies, there is potential but as yet unquantified benefits from: - reduced greenhouse gas emissions to NY state - increase to NY state renewable portfolio - additional revenue to NYPA from optimized BG operations and financial savings to NY state from higher wind penetration	N/A
SGR6	Integration of Distributed Generation	• DG/Micro-grid pilots • DG incentivization study (incl. IEEE standards, etc) • Virtual Power Plant (incl. DERMS)	Increased Revenue	Revenue from customer based on distributed generation revenue and build / maintenance fees and revenue sharing	22

Confidence level of benefit realization

Across the initiative project portfolio we have identified projects and associated benefits through the employment of assumptions, market knowledge and NYPA specific data points.

While we believe the benefit assumptions are directionally correct and provide a positive state-wide benefit-cost ratio for NYPA to proceed with investment, more work is needed to assess the viability of many of these projects. For that reason, a lot of studies and R&D work is frontloaded in the initiative. Also, we suggest each project create a charter and implementation plan along with a detailed cost benefit analysis as a next step from this initiative. This staged gate process will ensure that only the viable projects are executed and an accurate benefits tracking process will be followed.

The following represents the overall confidence that the specified revenue and benefits will be realized, using the scale that follows.

Confidence level of benefit realization

Please indicate the overall confidence that the specified revenue benefits will be realized, using the scale specified to the right. Using the specified confidence level, a confidence-adjusted revenue and benefit range is then estimated.

Benefits	**Low**
Revenue	**Low**

Confidence level	Benefit/revenue realization range
Very high	+/- 5% of expected benefits
High	+/- 10% of expected benefits
Medium	+/- 20% of expected benefits
Low	+/- 30% of expected benefits
Very low	+/- 50% of expected benefits

	Low	High
Total NYS benefits ($ '000)	**$ 1,068,340**	**$1,984,060**
Total savings and revenue to NYPA ($ '000)	**$ 326,825**	**$ 606,961**

Revenue and Cost recovery plan and assumptions (if applicable)

FUNDING FOR THE INITIATIVE

Intended sources of funding

The Smart Generation & Transmission initiative will be funded via a combination of NYPA's O&M and Capital budgets, as well as debt. Several high-cost projects adding up to around $360 million, including a $275 million replacement of conductors on the Moses-Adirondack line and a $41 million Robert Moses governor and controls upgrade, have been proposed in NYPA's long-term capital plans already and specific cost recovery mechanisms have been identified. These and other potential cost recovery avenues for the remaining $570 million of planned spend are listed below and will be explored as part of this initiative:

- NYPA Transmission Adjustment Charge (NTAC): This tariff allows cost recovery for "replacement in kind" investments, such as the planned project to replace conductors on the Moses-Adirondack line
- NYISO Open Access Transmission Tariff (OATT): This tariff includes the Reliability Facilitation Charge recovery mechanism, as well as the congestion cost recovery mechanism under the Congestion Assessment and Resource Integration Study (CARIS).
- Hydro rate recovery: This mechanism allows cost recovery for certain hydroelectric upgrade investments, such as the planned Robert Moses controls upgrade
- NYISO Transmission Congestion Contracts (TCC): This mechanism allows cost recovery for TCC-related projects such as the planned Convertible Static Compensator (CSC) upgrades

To further illustrate, below is a table of the top ten costly projects in the Smart Generation & Transmission initiative and potential rate recovery mechanisms.

Table 7: Rate recovery potential of top ten highest-cost Smart Generation & Transmission projects

Roadmap	Project Name	Cost ($'000)	Cost Recovery Mechanism
SGR3	Replace conductors on MA line	$273,980	NTAC
SGR3	Reconductoring additional 20% of NYPA lines	$147,000	Potential through NYISO-OATT
SGR3	Adding conductor to MA line	$100,000	Potential through NYISO-OATT
SGR1	Fiber-optics comms backbone build-out	$67,790	Potential through NYISO-OATT
SGR3	Additional transmission instrumentation	$59,482	Potential through NYISO-OATT
SGR4	RMNPP governor & controls upgrade	$41,261	Hydro-rate recovery
SGR3	Construction of 1 new STATCOM	$35,000	Potential through NYISO-OATT
SGR3	3 new capacitor banks	$30,000	Potential through NYISO-OATT
SGR4	STL headgate system upgrade	$23,230	Hydro-rate recovery
SGR3	Tower splitting at Western NY	$16,000	Potential through NYISO-OATT
SGR3	CSC upgrade	$15,000	TCC

However, it remains to be seen whether these recovery possibilities are fully realized. As a very preliminary estimate for the purposes of this business plan, a two-thirds of the initiative's costs are assumed to be funded by NYPA equity and the rest by debt. The funding breakdown is laid out in Table 8 below. This level of equity-to-debt funding could change depending on cost receovery mechanism, NYPA's overall capex plan and financial market conditions. It should also be noted that timing of a project may be affected if it is going through a regulatory cost recovery process.

Table 8: Initiative funding sources

Intended total funding sources			
Source	Selected	Value ($ '000)	Percentage of funds
Bond issuance	Yes	$ 311,816	33%
Cash reserves	Yes	$ 623,631	67%
Third-party funds	No	$ -	0%
Other	No	$ -	0%
Total		**$ 935,447**	100%

Any values that have been entered for one or more subinitiatives will be automatically included in the table below at the aggregate level.

Expected annual funding profile								
Category	2014	2015	2016	2017	2018	2019	2020	Post 2020
Bond proceeds	$ 919.39	$ 5,929	$ 32,945	$ 50,702	$ 61,767	$ 55,296	$ 37,677	$ 13,316
Third-party funds								
Total external funds	**$ 919**	**$ 5,929**	**$ 32,945**	**$ 50,702**	**$ 61,767**	**$ 55,296**	**$ 37,677**	**$ 13,316**
Interest payments								
Debt retirement								
Other								
Net external funds impact	**$ 919**	**$ 5,929**	**$ 32,945**	**$ 50,702**	**$ 61,767**	**$ 55,296**	**$ 37,677**	**$ 13,316**
NYPA cash	***$ 1,839***	***$ 11,858***	***$ 65,890***	***$ 101,404***	***$ 123,533***	***$ 110,592***	***$ 75,353***	***$ 26,632***
Total annual cost	*$ 2,758*	*$ 17,787*	*$ 98,835*	*$ 152,106*	*$ 185,300*	*$ 165,888*	*$ 113,030*	*$ 39,949*

Total external funding ($ '000)	**$ 311,816**
Total NYPA cash ($ '000)	**$ 623,631**

Confidence level of external funding

Please indicate the overall confidence that the indicated external funding levels will be realized, using the scale specified to the right. Using the specified confidence level, a confidence-adjusted range of external funding is then estimated.

Confidence level	**Low**

Confidence level	External funding range
Very high	+/- 5% of expected funding
High	+/- 10% of expected funding
Medium	+/- 20% of expected funding
Low	+/- 30% of expected funding
Very low	+/- 50% of expected funding

	Low	High
External funding ($ '000)	**$ 218,271**	**$ 405,360**
Residual NYPA cash funds ($ '000)	***$ 717,176***	***$ 530,087***

COSTS

Initiative cost (i.e. costs associated with implementing the initiative)

Table 9 below is a summary of financial cost estimates needed to roll out the Smart G&T initiative at NYPA. Subsequent material offer detail on how these cost estimates were derived from a bottom-up examination of each roadmap area and its cost categories. At this early stage, without knowing the exact split of O&M costs between headquarters and sites, half of O&M costs are assumed in one and half in the other.

Table 9: Summary of cost estimates for implementing the Smart Generation & Transmission initiative

O&M costs - Site ($ '000)								
Category	2014	2015	2016	2017	2018	2019	2020	Post 2020
Grid Hardware	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Generation Hardware	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Comms	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
AGILE	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Labor	$ 238	$ 988	$ 2,294	$ 2,481	$ 2,613	$ 2,788	$ 2,788	$ 2,263
Software	$ -	$ -	$ -	$ -	$ -	$ 5,250	$ 250	$ 250
R&D	$ -	$ 613	$ 438	$ 175	$ 175	$ 175	$ 175	$ 175
Training	$ -	$ -	$ 88	$ 28	$ 15	$ 15	$ 15	$ 15
Total annual Site O&M	**$ 238**	**$ 1,600**	**$ 2,819**	**$ 2,684**	**$ 2,803**	**$ 8,228**	**$ 3,228**	**$ 2,703**

Total initiative Site O&M costs ($ '000)	**$ 35,110**

O&M costs Headquarters, Overhead and Other								
Category	2014	2015	2016	2017	2018	2019	2020	Post 2020
Grid Hardware	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Generation Hardware	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Comms	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
AGILE	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Labor	$ 238	$ 988	$ 2,294	$ 2,481	$ 2,613	$ 2,788	$ 2,788	$ 2,263
Software	$ -	$ -	$ -	$ -	$ -	$ 5,250	$ 250	$ 250
R&D	$ -	$ 613	$ 438	$ 175	$ 175	$ 175	$ 175	$ 175
Training	$ -	$ -	$ 88	$ 28	$ 15	$ 15	$ 15	$ 15
Total annual HQ/OH/Other costs	**$ 238**	**$ 1,600**	**$ 2,819**	**$ 2,684**	**$ 2,803**	**$ 8,228**	**$ 3,228**	**$ 2,703**

Total HQ/OH/Other initiative costs ($ '000)	**$ 35,110**

Capital expenses ($ '000)								
Category	2014	2015	2016	2017	2018	2019	2020	Post 2020
Grid Hardware	$ 1,100	$ 8,690	$ 71,663	$ 116,713	$ 138,338	$ 114,638	$ 86,658	$ 31,270
Generation Hardware	$ 948	$ 2,192	$ 7,441	$ 12,125	$ 10,682	$ 11,620	$ 9,742	$ 1,948
Comms	$ -	$ 600	$ 6,940	$ 12,350	$ 25,500	$ 18,000	$ 5,000	$ -
AGILe R&D	$ -	$ -	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ -
Labor	$ -	$ 625	$ 1,575	$ 1,575	$ 1,575	$ 1,575	$ 1,575	$ 1,225
Software	$ 236	$ 1,201	$ 2,725	$ 1,975	$ 1,600	$ 1,600	$ 1,600	$ 100
R&D	$ -	$ 425	$ -	$ -	$ -	$ -	$ -	$ -
Training	$ -	$ 854	$ 854	$ -	$ -	$ -	$ -	$ -
Total annual Capex	**$ 2,283**	**$ 14,587**	**$ 93,198**	**$ 146,738**	**$ 179,695**	**$ 149,433**	**$ 106,575**	**$ 34,544**

Total initiative Capital expenses ($ '000)	**$ 865,227**

Total initiative costs ($ '000)	**$ 935,447**

Initiative cost assumptions

The initiative-level cost estimates summary above was compiled by rolling up calculations by cost category made within each of the six roadmap areas. The following table shows which cost categories were incurred in which roadmap areas and offers a high-level description of how those costs are expected to be incurred in that area. For more detailed documentation of the calculations behind each roadmap area's cost categories, please see appendix items as referenced in each line below.

Table 10: Cost category detail and assumptions by capability roadmap area

ID	Roadmap Name	Projects	Cost Category	Category Detail	# in Appendix Table
SGR0	Smart G&T Initiative Delivery	• Smart Grid Enterprise Architecture • Project / Implementation Plan • Smart G&T Initiative Project Delivery	Labor	Smart G&T Initiative Project Delivery	23
			Labor	Smart Grid Enterprise Architecture	24
			Labor	Project / Implementation Plan	25
SGR1	Increase Reliability / Resiliency	• Pilot Substation Architecture • Deploy substation architecture and additional IED's • Fiber-optic comms backbone study • Fiber-optic comms backbone imp • Infrastructure Hardening Study • Infrastructure Hardening Projects	Comms	Fiber Optics Comms Backbone Build-Out	26
			Labor	Labor for Smart Substation Architecture and Comms buildout internal and incremental to LEM	27
			Grid Hardware	Physical assets	28
			Grid Hardware	Incremental Cost to TLEM (2.6M)	29
			Software	IT - Redundant MV90	30
			Comms	Fiber Optics Comms Backbone Preliminary Engineering	31
			Grid Hardware	Physical Hardware for Development system	32
			Labor	3rd Party Labor to Build Development system	33
SGR2	Enhanced Situational Awareness	• Next-Gen EMS R&D • Next-Gen EMS Implementation • Data cleanup • Data analytics/applications • Additional hardware/sensors	Software	Next-gen EMS upgrade/licenses	34
			Labor	Internal support work interface with AGILe	35
			AGILE	AGILE R&D Requirements for next-gen EMS	36
			Software	Transfer and collection of sensor data	37
			Training	Training	38
SGR3	Optimizing Transmission Assets	• System studies • Power-flow improvement studies • O&M studies • CSC Upgrades • Tower Splitting at Western NY • Replacing conductors on MA line • Adding third conductor on MA line • Additional instrumentation • Reconductoring 20% of NYPA's lines • Installation of one new STATCOM • Construction of 3 new capacitor banks	Grid Hardware	Physical Assets	39
			Grid Hardware	Physical Assets	40
			Grid Hardware	Physical Assets	41
			Grid Hardware	Instrumentation	42
			Grid Hardware	Physical Assets	43
			Grid Hardware	Physical Assets	44
			Labor	Labor	45
			Grid Hardware	Physical Assets	46
			Grid Hardware	Physical Assets	47
			R&D	R&D	48
			Software	IT	49
			Training	Training	50
SGR4	Optimizing Generation Assets	• RMNPP Governor and Controls Upgrade • St. Lawrence Study Optimal Scheduling Software Replacement • STL Headgate System Upgrade • Generation Data Analytics R&D Study	Generation Hardware	RMNPP Governor and Controls Upgrade	51
			Generation Hardware	STL Headgate System Upgrade	52
			Training	Training	53
			R&D	St. Lawrence Study Optimal Scheduling Software Replacement	54
			R&D	Generation Data Analytics R&D Study	55
SGR5	Integration of Bulk Renewables	• Study to prioritize LEM efforts based on increased wind sites • Study to prioritize AGILE efforts based on increased wind sites • Grid-scale battery storage pilot project • Participate in EPRI program 173 • Market analysis for pricing re: purchasing power to pump BG • System planning study to analyze new modes of BG operation	R&D	6 studies to incentivize bulk renewables and optimize BG	56
			Labor	Resources to oversee studies below	57
			Training	Training	58
SGR6	Integration of Distributed Generation	• DG/Micro-grid pilots • DG incentivization study (incl. IEEE standards, etc) • Virtual Power Plant (incl. DERMS)	Labor	Labor	59
			Grid Hardware	Microgrid Pilot installation	60
			Grid Hardware	Virtual Power Plant	61
			Software	Virtual Power Plant	62
			R&D	Study - optimal placing and sizing for DG	63

Confidence level of costs

The following represents the overall confidence that the cost levels will be met.

Confidence level of initiative and post-implementation costs	
Please indicate the overall confidence that the indicated cost levels will be met. Based on the indicated level of confidence, a confident-adjusted range of both initiative and post-implementation costs will be established.	
Initiative costs	Low

Confidence level	Cost range
Very high	+/- 5% of expected costs
High	+/- 10% of expected costs
Medium	+/- 20% of expected costs
Low	+/- 30% of expected costs
Very low	+/- 50% of expected costs

	Low	High
Total initiative costs ($ '000)	$ 654,813	$ 1,216,081

These cost estimates are preliminary at this stage. There are significant R&D activities and studies in the early years of the initiative, which may reduce or increase the size of subsequent efforts beyond what is anticipated today. Also, the cost and effort for many proposed projects will depend on the maturity of various technologies in the next few years. For example, the proposed pursuit of a next generation EMS will highly depend on co-development efforts with vendors. However, the business planning team has made its best effort to be comprehensive in its cost considerations.

IMPACT TO MARKET

Overview of marketing approach

In April of 2014, Governor Andrew M. Cuomo unveiled plans for an energy modernization initiative that will fundamentally transform the way electricity is distributed and used in New York State. Under the Reforming Energy Vision (REV) initiative, utilities will actively manage and coordinate a wide range of distributed resources, or generate electricity from many small energy sources and link them together. While this initiative is primary focused at distribution level utilities, many of the capability areas and projects identified by this Smart G&T initiative will form a part of an overall effort by the PSC to improve system efficiency, empower customer choice, and encourage greater penetration of clean generation and energy efficiency technologies and practices. This initiative along with the opening of the Green Bank, NY Sun initiative, and future programs will improve the retail and wholesale markets and assure the success of energy efficiency and clean energy programs. NYPA will use this platform of transformation and the drivers addressed in this business plan to launch its Smart G&T to the broader market and to position not only NYPA, but also NYS as a leader in generation and transmission technology adoption and transformation.

NYPA's role in the market

As the owner/operator of three large hydroelectric power generation facilities in NYS, NYPA has the capability and mission to ensure reliable, clean, and affordable power to the people of NYS. This mission includes the stewardship of NYS natural resources, particularly the water resources of the St. Lawrence River and Niagara Falls, in collaboration with international treaties with Canada. With its strong regional control centers controlling 25% of the electric generation capacity in NYS and ownership of over 1400 circuit miles of transmission throughout NYS, the integration of additional power sources in NYS in the form of bulk renewable power such as wind farms and solar photovoltaic farms fits naturally into NYPA's mission and capabilities. NYPA is one of the premier producers of clean bulk power in the US and as result of this initiative aims to be a premier and industry leading generation and transmission utility in the modern grid of the future.

EXTERNAL STAKEHOLDER IMPACT AND MARKETING PLAN

This initiative will improve grid operations in NYS, allowing the state to approach its renewable energy goals and reducing emissions and costs to serve load to customers throughout the system. This initiative will also serve as a model for other NY Transmission Owners who may proceed down similar smart grid paths.

Table 11: Overview of external impacts due to the Smart Generation & Transmission initiative

External impact overview		
Stakeholder	Description of impact	Impact
Customer	Customers will see reduction in energy costs and increase in energy choice in the long term	Positive - Low
Distribution Utilities	Utilities will see reduction in wholesale power prices	Positive - Medium
NYISO	NYISO will have greater insight over grid conditions and market flexibility	Positive - High
Transmission Operators	TO's will have greater insight over grid conditions and control flexibility	Positive - Medium
State Agencies	State agencies will see reduction in energy costs and increase in energy choice in the long term	Positive - Low
Third Party Agencies	Third party agencies will see reduction in energy costs and increase in energy choice in the long term	Positive - Low

Description of marketing strategy

NYPA will need to keep external stakeholders, such as NY State, the NY PSC, other transmission operators and utilities, etc., up to date on progress, lessons learned, significant developments and the overall solution. In addition, internally, there will be several actions taken to ensure the initiative becomes a visible and integral part of the NYPA organization.

- Kick-off event for the new Smart Generation & Transmission team. The event could feature a combination of presentations and workshops that would educate and engage team staff around the scope and content of the Smart Generation & Transmission initiative.
- Smart Generation & Transmission internal website, training registration and research material. Milestone and success stories will be shared as the initiative matures.
- Quarterly newsletter, which details current projects, photos of project owners, and lessons learned

DEPENDENCIES & RISKS

Initiative dependencies

- Strong interdependencies exist between this initiative and the Asset Management initiative. The general rule of thumb agreed to by both initiatives is that Smart Generation & Transmission activities scope is centered around the installation of new generation and transmission assets whereas Asset Management activites scope is centered around the O&M and collection, management and use of the data coming out of those assets. For example, the further deployment of advanced grid sensors, combined with a hardened communications network falls under this initiative, but will feed directly into the development of an advanced, analytic maintenance program under Asset Management by providing the required data. Both initiatives will ensure each other is kept abreast of developments so that these interdependencies are managed in the most beneficial way.
- Achieving actionable results from advanced sensor deployment will require the development of an asset management capability to analyze and interpret data. Though this is in the pipeline, care must be taken to make sure the timeline on that effort is not extended so much that the efforts here cannot be operationalized until a much later date.
- The TLEM project must complete replacement of critical and vulnerable assets and lay some basic infrastructure, so this initiative can focus on improvements not required for base system reliability
- This initiative may alter certain TLEM decisions that are ongoing.
- NY Transco, NY Energy Highway, REV and other state-wide initiatives will have dependencies to be managed by this initiative.
- NERC CIP standards represent a significant dependency and risk for all of the Smart G&T technologies. The benefit of taking advantage of the valuable information available in the IEDs must be weighed against the increased resources that will be required to maintain compliance with CIP standards. There may also be additional resources needed to support the regular O&M associated with CIP compliance and changing CIP standards are a risk to impact the end cost of the Smart Grid Systems.

Risks associated with the implementation of this initiative

1. **Resource and Capability Constraints:** Implementing and sustaining smart grid technologies at NYPA will require a host of new skills sets and organizational capability. While this initial roadmap identifies between 40 – 60 new resources that will need to be filled to implement this roadmap, many of these skill-sets are new and unique to this initiative.
2. **Changes in market conditions:** Changes in wholesale power cost structure, uncertainty over customer market participation, and many other factors can result in considerable uncertainty over estimated returns on smart grid investments.
3. **Inadequate post-installment strategies:** Many smart grid business plans rely heavily on post-installment benefits (e.g. the implementation of control algorithms). However, program development and implementation details are often not considered until later, resulting in benefits that are often delayed for years.
4. **Vendor Product Maturity:** Many of the Smart Generation & Transmission capability areas in this roadmap will rely on software/IT performance, however, some Grid software/IT capabilities have not been widely deployed and there may be a level a market immaturity across products, adding initiative risk.
5. **Cost Recovery:** A portion of the costs associated with this initiative is expected to be recoverable, but that is not guaranteed and thus poses a risk to the financial prudence and on-time delivery of the projects
6. **Stranded assets:** As grid technologies continue to evolve, old technologies become obsolete, and market conditions change, there is the possibility that certain assets are stranded due to implementation of this initiative. The risk of these scenarios occurring is the key risk “as result” of the initiative rather than “to” the initiative, and will need to be mitigated during implementation.

In Table 12, there is a listing of these risks and howthey plan to be mitigated. Ownership of these risk mitigation actions will be assigned to the Smart Generation & Transmission governance function, which will be established after board approval of this business plan.

Table 12: Overview of potential risks associated with this initiative

Risk overview			
Description	Probability	Impact	Suggested actions
Resource and Capability Constraints	Critical	Significant	Ensure that a holistic operating model and post implementation governance plan is created
Changes in market conditions	Medium	High	Track changes in wholesale power cost structure, customer market participation, and many other factors to ensure certainty over estimated returns on smart grid investments.
Inadequate post-smart G&T implementation strategies	Critical	Significant	Ensure adequate post implementation plans and organization structure are developed to track benefits and ensure maximization of new infrastructure
Vendor Product Maturity	Medium	Low	Partner with vendors, align products with roadmaps and conduct holistic vendor and market analysis
Stranded Assets	Low	High	Ensure that at each stage of product development that the risk of new technology or changing market conditions don't allow for a stranded asset scenario
Cost Recovery	Medium	Critical	Partner with Finance to ensure that, whenever possible, adequate cost recovery actions are taken in the planning process for individual projects in this initiative.

Further industry considerations

Looking at the U.S. alone, the utility sector has always been one of the most capital-intensive industries in the country. The electrical power sector invested more than $90 billion in enhancements to generation and T&D systems in 2012 alone, but in terms of R&D spending as a percentage of revenue, the U.S. electric power sector is second from bottom of all major industries, ranked ahead of only the pulp and paper business. This cocktail of capital intensiveness and low R&D expenditure, coupled with the fact that the largest U.S. utilities are investor-owned (and as such are incentivized to maximize shareholder value in the short term while "maintaining" infrastructure), has created an uncertain market for smart grid investments. NYPA however is in a unique position in this regard and in good stead to take advantage of the significant advances in grid modernization technologies.

Appendix

BENEFITS & COSTS DETAILED ASSUMPTIONS

A1. The following assumptions correspond to the benefits Table 6 and costs Table 9 in the main document.

#	Benefit/Cost	Assumptions Description
1	Benefit	A 1% reliability increase would be a reduction of 8760/100= 87.6 hours of less forced outages / non-scheduled outages per year, this would amount to about $3.5M per year for NY State. This reliability saving occurs when the outage is causing congestion, and the overall state energy costs are higher due to a re-dispatch in real-time and deployment of more expensive generation. This congestion saving is on top of that claimed in this roadmap due to use of sensor data.
2	Benefit	Reduced relay maintenacnce based on Adirondack substation last PMs in maximo, using the total hours for each PM, and rated the number of hours times the frequency of the PM over the max interval reflected for an annual average number of hours. That number was doubled since the PM does not include travel time, , or the prep/ support time to perform testing. This total umber of hours was then multiplied out for the number of relays at Adirondack as a percentage of the entire NYPA system to calcullate the average number of hours spent at NYPA a s a whole, multiplied by $90/hr. This number should be revised once actual total man hour allocations to regulatory PMs are submitted. This is a low confidence level.
3	Benefit	Avoided average cost of cleaning up and lost revenue from two 138kv bushing failures at NYPA in 2011 was $3.4m, assuming avoiding one of these a year in 2016 onward. This has a high confidence as to the accuracy of the numbers which were based on the actuals but may vary based on other equipment failures in different LMBP zones.
4	Benefit	During a major line rebuild, the cost of installing fiber optic OPGW goes from $70k / mile to $10k/mile based on an AEP report.
5	Benefit	Currently pay about $1mm, verified with IT
6	Benefit	Based on data retrieved from the annual NYISO 2013 CARIS (congestion assessment and resource integration study). Projected demand congestion beyond 2012 is provided in the report. Projected TCC payments are calculated using linear extrapolation on the historical data from 2008 to 2012, as shown in the graph below. Due to the fact that paid TCCs provide hedging against congestion benefits to customers can be claimed only on the unhedged congestion potion calculated after subtracting TCC payments from demand congestion. A 20% saving of the unhedged congestion is assumed. -The percent congestion cost reduction estimated here is solely due to "enhanced and coordinated operation and control" of the grid. Other "physical" transmission enhancements will provide further congestion cost reductions.
7	Benefit	The total estimated statewide customer fuel-costs savings from enabling 300 MW of additional wind generation is assumed to be solely due to "enhanced and coordinated operation and control" of the grid. Other physical transmission enhancements will result in additional fuel cost savings by enabling even more wind generation. Average cost of fossil plant is $35/MWhr
8	Benefit	Estimated annual wear and tear (repairs, etc) cost of $5 M per utility in NYS. Take credit for 20% of this * 7 utilities = $ 7 M annually.
9	Benefit	Cost of missing a piece of equipment, or catastrophic failure
10	Benefit	Man-hour equivalent of reduced maintenance
11	Benefit	Estimated annual cost of T&D losses in NYS: (From NYSRDA/EPRI report average system losses of 0.04)* (average system loading of 20,000 MW* 8760 hr * average energy costs of $20/MWhr * (taking credit for 1% reduction --0.25) = $1.4 M. 4) 1000 MW*2000 hr*(Ave CC plant fuel Costs $35/MWhr) = $70M
12	Benefit	Due to reduction and productivity increase
13	Benefit	Estimated annual wear and tear (repairs, etc) cost of $5 M per utility in NYS. Take credit for 20% of this * 7 utilities = $ 7 M annually.
14	Benefit	We assume that upgrades and enhancements will provide for the injection of ~700MW additional low cost hydropower throughout the market. Generally used NYPA internal figures (provided by Uzo Enyinna) peg hydropower at about $3/MWh cheaper than the average LBMP. To be consistent with other roadmap assumptions, we assume an average system price of $20/MWh and average system loading of 20,000 MW. Phasing in the cheaper power will reduce costs to the state as presented.
15	Benefit	These figures are based on NYPA internal estimates (provided by Bruce Fardanesh) of revenue curtailment/opportunity cost from not producing as much hydro.
16	Benefit	Projected revenues for the CSC (variable, depending on TCC revenues from congestion in central zones) as presented for controls upgrade business case. The total 20 year NPV for the project was calculated at $61.5 million in 2012 dollars.
17	Benefit	Based on data retrieved from the annual NYISO 2013 CARIS (congestion assessment and resource integration study).
18	Benefit	We conservatively assume that we can account for ~$5m/year in deferred investment (new conductors, new lines, etc.)
19	Benefit	To be consistent with Situational Awareness assumptions, we also assume a conservative reduction in losses at around 1% for the system.
20	Benefit	As programs begin to phase in, we assume a reduction in maintenance costs (outage time, planned and unplanned maintenance) of around $2m/year after an increase in maintenance initially.
21	Benefit	PA assumed equal to cost for now because projects are pre-approved already

#	Benefit/Cost	Assumptions Description
22	Benefit	- Microgrid pilot will be customer funded, NYPA financed and Energy Efficiency will do the project management (12% mark up for project management fee) - cost of MG will be$ 85 million - VPP will take 2 years to complete and savings are TBD - Study will determine potential savings via decrease in system losses via DG installation - TBD
23	Cost	2-4 FTE's
24	Cost	Based on initiative scope and scale
25	Cost	Based on initiative scope and scale
26	Cost	• STL North Country Buildout including OPGW on MA • BG to Marcy • NATL Buildout • SENY Interconnect…assuming $80k/mile and $10k/mile where line rebuild occurs • Small hydro microwave BG • Y49 Direct Fiber cable replacement
27	Cost	Smart Substation Architecture and Comms buildout internal and incremental to LEM
28	Cost	Emergency ECC - Costs based on unknown scope or location, schedule based on CPR1166 which only includes study costs, and does not include construction or lease/ownership costs. Study cost from CPR, the $5M construction costs based on consultation with Project Mgmt.
29	Cost	Smart Substation Architecture - The TLEM incremental costs assume roughly 100k cost increase in hardware costs at each station, assuming some new equipment and upgrade of other equipment is required. A 1.3 multiplier was used for the 10year program to be conservative and account for some escalation, and because the details of the system are not known at this time. The incremental cost assumes 1000 hrs additional engineering per site and 2500 in labor. This cost is mainly in programming equipment, construction drawings, field installation, commissioning and testing. Since these systems are new to NYPA, there is a learning curve built in to the costs.
30	Cost	Redundant MV90 - The MV90 rebuild includes relocation of application to new servers and call stations potentially to WPO servers from the existing POL servers and a backup MV90 system to run on the off site DR server site. Proof of concept testing is planned for 3&4Q 2014 and installation and pruchase of new equipment in 2015.
31	Cost	Initial study and preliminary design
32	Cost	Smart Substation Architecture - Plan assumes a development test bed system will be built using inhouse engineering for specifcaiton, outside labor for furnishing the constructed system. The system hardware costs assume roughly 25 IEDs including relays, meters, monitoring, plus network equipment, HMI and data concentrators. 8 racks/panels are used to permanently mount this equipment and it is assumed to use the exisitng secondary injection test sets already owned by NYPA OR will utilize the RTDS being purchased by Engineeirng. Assumes 1.5 FTE for Spec/scoping. Costs basis for the STL SAMAC IEC61850 development system that followed the same construction plan. No proprietary protocols will be used, DNP3 or 61850 will be used to a data concentrator that does not require annual license costs.
33	Cost	See above
34	Cost	Purchase and use of next-gen EMS software when developed, assume a fraction of anticipated market price
35	Cost	Additional internal support work (2 FTE in protection & control, equipment engineering, metering), total 6 additional internal FTE's ramping from now until 2025
36	Cost	All R&D costs to be incurred for this roadmap are assumed to be in AGILe. Does not include cost of setting up AGILe however (physical space, systems and 10 operating FTE's), which is in AGILE business plan.
37	Cost	Adding sensors, communications, collecting data, including back-office IT systems needed
38	Cost	6 internal support people will need training. Front-loaded in 2016-2017. 20K$/FTE…
39	Cost	- replacing the existing lines/towers on Moses-Adirondack line - based on 2014 RIK cost estimates for replacing MA 1&2 used for Transco - $273m
40	Cost	- reconductoring additional ~20% of NYPA lines as low estimate - NYPA estimates peg reconductoring costs at ~35% total capital cost of building new lines (assumed here to be ~1.5M/mile), so $525K*280 miles = $147M
41	Cost	- adding third conductor to Moses-Adirondack line - based on NYPA R&D and Cost/Scheduling estimates of the cost of adding a 230kv line to existing towers - $100m
42	Cost	This includes figures around making all lines dynamic thermal rating capable (using assumption of $1m/line for 25 lines, estimated by George Stefopoulos based on historical NYPA work), adding additional line instrumentation ($45k/substation, 31 substations), and making existing substations 100% “smart” (currently assumed to be ~40% “smart” - remaining 60% x $45k/substation, by the EPRI methodology - this portion of the costs may be covered in Resiliency roadmap). It also budgets for the installation of 10 more PMUs, at $125k each, to complete the NYPA PMU network.
43	Cost	- STATCOM - assuming construction of 1 new STATCOM ($35M)
44	Cost	- Capacitor banks - assuming construction of 3 new capacitor banks ($10M each). These numbers are highly variable and will change based on results of the to-be-commissioned system study. Any solution that does not require extensive line buildup could be much less capital intensive, but if extensive new lines are required for system maintenance, this could increase capital costs substantially.
45	Cost	Based on our knowledge of FTE constraints due to new PMUs, additional sensor work etc., we’re guessing we’d need about 10 more technicians at the sites – this includes ~2 per site for each of our 5 main transmission facilities. For the duration of the physical infrastructure and line sensor installation work, we’re assuming around 5-6 additional linemen to avoid reducing the availability of regular line staff.
46	Cost	- tower splitting at Western New York to alleviate constraints affecting the Niagara Power Project output. Project estimated at $16 million with a cost estimate range from $13M to $20M. Project schedule estimated from 2016 to 2019.
47	Cost	- CSC Upgrade - $15 million, assumed when doing analysis to be spent in 2015-2017
48	Cost	This cost includes research required around specific technologies or techniques and costs for building frameworks to incorporate them into the NYPA system. R&D costs were based on an estimate of $175k per year for a new study/program, with 1 or 2 R&D studies/projects per year to be added (one in the first year, two each in subsequent years). Additional $500k system study is included in 2014-2015.

#	Benefit/Cost	Assumptions Description
49	Cost	Earmarked but to be decided based on initial studies
50	Cost	New technologies will require ~$20k/y/FTE in training for site and headquarters personnel
51	Cost	Cost primarily based on LPGP LEM. Existing controls and Governor are electromechanical with reduced reliability, high maintenance cost, and minimal monitoring and lack advanced control capabilities. New system significantly improves all fo these areas.
52	Cost	Existing Headgate controls and equipment are obsolete. New controls provide safer remote control and monitoring and faster gate closure in case of emergencies since personnel do not go to headgates.
53	Cost	With replacement of older technologies with new electronic based systems, some staff need training and development on new technologies. Assuming that 1/3 of mechanical and 1/2 of electrical staff change roles - need classroom and OTJ training for 24 employees.
54	Cost	Critical software for optimal scheduling of STL - software is obsolete, poorly documented and inflexible. New software will provide updated, flexible, easy to use software for operations.
55	Cost	NYPA Cost Estimates
56	Cost	6 studies at $175K each
57	Cost	NYPA staff will need to work with consultants to guide and participate in the rresearch and testing. Staff from Engineering, Operations, R&D, and ERM would be expected to provide support for the studies.
58	Cost	$10K/FTE/year
59	Cost	A small team will run the program, estimated cost is $800,000/year with two engineers providing project management to the microgrid pilot project, have the project managers available
60	Cost	NYPA only installs advanced controller. System will be paid for by customer. Customer costs include total project cost of $85 million over three years (10% the first year, 30% the second year, and 60% the last year) and then an operating and maintenance cost of $30k annually. We would only pay for study to get initial customer interest, the study will be conducted in 2014 at an expected cost of $400k.
61	Cost	Cost to set up hardware of virtual power plant - $2 million (based off doubling cost for NY Energy Manager – current initiative to aggregate utility data for public entities)
62	Cost	Cost to set up software of virtual power plant - $2 million (based off doubling cost for NY Energy Manager – current initiative to aggregate utility data for public entities)
63	Cost	Incentivization of DG Assets – Cost would be $200k for study cost, study would be conducted in 2015

A2. Breakdown of the benefits and costs of the Smart Generation & Transmission initiative by roadmap area.

	SGR0		SGR1		SGR2		SGR3	
Benefits	**NYPA**	**NYS**	**NYPA**	**NYS**	**NYPA**	**NYS**	**NYPA**	**NYS**
Reduced O&M	$ -	$ -	$ 74,000	$ -	$ 24,000	$ -	$ 15,750	$ -
Reduced Capital	$ -	$ -	$ 13,000	$ -	$ -	$ -	$ 35,000	$ -
Reduced Congestion	$ -	$ -	$ -	$ -	$ -	$ 694,000	$ -	$ 431,000
Generation Savings (Increased Wind)	$ -	$ -	$ -	$ -	$ -	$ 147,000	$ -	$ -
Asset Optimization	$ -	$ -	$ -	$ -	$ 7,000	$ 63,000	$ -	$ -
Reduced Transmission Losses	$ -	$ -	$ -	$ -	$ -	$ 12,100	$ -	$ 14,000
Generation Savings (Increased Hydro)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 122,000
Increased Reliability	$ -	$ -	$ -	$ 43,100	$ -	$ -	$ -	$ -
Increased Revenue	$ -	$ -	$ -	$ -	$ -	$ -	$ 187,728	$ -
Total	**$ -**	**$ -**	**$ 87,000**	**$ 43,100**	**$ 31,000**	**$ 916,100**	**$ 238,478**	**$ 567,000**
Costs	**NYPA**		**NYPA**		**NYPA**		**NYPA**	
Grid Hardware	$ -		$ 9,190		$ -		$ 676,462	
Generation Hardware	$ -		$ -		$ -		$ -	
Comms	$ -		$ 68,390		$ -		$ -	
AGILe	$ -		$ -		$ 10,000		$ -	
Labor	$ 7,075		$ 14,625		$ 10,500		$ 25,725	
Software	$ -		$ 1,000		$ 21,000		$ 1,000	
R&D	$ -		$ -		$ -		$ 3,600	
Training	$ -		$ -		$ 120		$ 300	
Total	**$ 7,075**		**$ 93,205**		**$ 41,620**		**$ 707,087**	

	SGR4		SGR5		SGR6	
Benefits	**NYPA**	**NYS**	**NYPA**	**NYS**	**NYPA**	**NYS**
Reduced O&M	$ 66,810	$ -	$ -	$ -	$ -	$ -
Reduced Capital	$ -	$ -	$ -	$ -	$ -	$ -
Reduced Congestion	$ -	$ -	$ -	$ -	$ -	$ -
Generation Savings (Increased Wind)	$ -	$ -	$ -	$ -	$ -	$ -
Asset Optimization	$ -	$ -	$ -	$ -	$ -	$ -
Reduced Transmission Losses	$ -	$ -	$ -	$ -	$ -	$ -
Generation Savings (Increased Hydro)	$ -	$ -	$ -	$ -	$ -	$ -
Increased Reliability	$ -	$ -	$ -	$ -	$ -	$ -
Increased Revenue	$ -	$ -	$ -	$ -	$ 43,605	$ -
Total	**$ 66,810**	**$ -**	**$ -**	**$ -**	**$ 43,605**	**$ -**
Costs	**NYPA**		**NYPA**		**NYPA**	
Grid Hardware	$ -		$ -		$ 8,500	
Generation Hardware	$ 64,491		$ -		$ -	
Comms	$ -		$ -		$ -	
AGILe	$ -		$ -		$ -	
Labor	$ -		$ 875		$ 6,825	
Software	$ -		$ -		$ 1,500	
R&D	$ 611		$ 1,050		$ 250	
Training	$ 1,708		$ 50		$ -	
Total	**$ 66,810**		**$ 1,975**		**$ 17,075**	

Smart G&T Capability Roadmap Detail

SGR1: Increased Reliability & Resiliency

Capability Manager: Frank Ronci

CAPABILITY VISION / STRATEGIC RATIONALE

Reliability of the grid can be defined as the capability to provide continuous service to grid-connected users of electricity at constant (within known tolerances) frequency and voltage in face of normal or expected system contingencies. Resiliency of the grid on the other hand can be defined as the capability to withstand extreme events or disturbances. The fast restoration of service upon loss of load is an important component of reliability and resiliency.

The rationale behind this capability is to ensure uninterrupted service to customers. The level of reliability and resiliency is very much dependent on investments in infrastructure and the return on those investments which are a combination of both financial returns as well as maintaining the best possible level of reliable, available transmission and generation. The challenge is to attain maximum outcome with reasonable or minimum investments.

Two key components of the roadmap is to further develop the use of substation intelligent electronic devices to provide high resolution data on power system equipment condition both for real time operations for enhanced clarity, for improving restoration times following an event by better retrieving data for decision making and for long term trending for asset management. This mainly leverages equipment that will be installed under other programs but needs to be better leveraged by fully realizing the capabilities on board in these devices. Secondly, in order to facilitate the IED data back to various users, as well as to ensure highly reliable data communications information flow, a utility owned communications backbone should be built out. In large part this is an expansion of the existing project to upgrade portions of NYPA's point to point digital microwave. By connecting the dots with additional microwave and fibre optic cables, NYPA can ensure its reliable operation of the power system and its smart grid technologies that NYPA is investing in.

SOLUTION

- Current State
    - Transmission Life Extension and Modernization (TLEM) core driver is reliability. In order to maintain the high degree of reliability the NYPA system has realized through today, TLEM is replacing and upgrading existing transmission system components that are at the end of service life or at a high risk of failure due to condition. Replacement of components prior to a catastrophic failure, minimizes outage times, and prevents real time disturbances that pose a risk to the power system as a whole. TLEM is replacing major equipment such as power transformers, circuit breakers and reinforcing structures, as well as replacing electromechanical controls with modern microprocessor based protection, control, metering, indication and communication equipment.
    - The traditional substation design included a Remote Terminal Unit (RTU) which was a device that was wired to many electro mechanical components to receive status contacts or basic analog information with communications capabilities to remote that information back to a control center. Today, the meters, protection relays, annunciators, breaker monitors, controllers, commonly referred to an IED (intelligent electronic devices) are themselves RTUs. Each device is capable of reporting back a wide variety of data about the health of the power system component it's designed to monitor/measure/protect as well as the health of the device itself. By enabling the advanced monitoring features within each of these devices and retrieving the data for use by operations, engineering, and asset management personnel will increase system reliability by better monitoring the status of the power system, enable engineering personnel to make predictive maintenance decisions rather than

interval based, and enable asset management personnel to make maintenance and replacement more informed, analytic decisions based on field data.

  - The solution project plan is to develop a test bed development system as Phase 1 which will allow engineering staff to design and test a smart substation in an offline environment. This process will serve to implement an optimized design, with most of the bugs and issues identified and addressed in an offline environment. The development system will also be used for the life of the production systems as a test bed for new software updates, patches, additional equipment and allow engineers to troubleshoot a problem that may arise. The Phase 2 will be the phased implementation of smart grid architecture within the Transmission LEM, RM controls upgrade, and other ongoing projects.

- Capability gap analysis
  - A significant challenge of integrating Smart Grid technologies, particularly over a wide geographic area for transmission, is for reliable, secure communications systems. Often utilities relied on power line carrier analog communications over the power conductor, direct point to point microwave or third party telephone circuits. As technology has advanced, the require bandwidth has increased significantly, and the need for security to ensure reliable system operation, to fully enable the capabilities of the smart IEDs installed at the substations,

- Activities to address gap
  - Some of the technologies installed at NYPA sites are proven for their core purpose and have in some applications been expanded to provide data to a station RTU. For example the new Astoria 345kV substation, the STL Moses SAMAC project, and the Ryan, Duley and Patnode substations. In order to properly design and select the appropriate devices into a standard substation architecture, a development system will be built in an offline environment to verify the system functionality, interoperability and reliability. The solution should be multivendor using open protocols to ensure future compatibility, expandability and competitiveness for future upgrades. The build out of the development system will also promote the design process to open the door to expanded functions and capabilities not fully realized in the conceptual stage.

  - No R&D is necessary for the build out of NYPA's communication infrastructure. The technology is proven and smaller scale projects have been completed at NYPA. Other utilities have implemented a similar architecture for their transmission backbones which is a benchmark for a project at NYPA. Further preliminary engineering and cost estimates are required.

- Resiliency – Storm Hardening Report Coordination

  - A Quanta prepared report on Storm Hardening and System Resiliency was commissioned following the major storm events that hit all of NYS. Although the report confirmed many of NYPA's assets are well positioned, the report identifies many traditional infrastructure improvements that will further improve the NYPA transmission system and generation assets to perform reliably during another major weather event. These infrastructure improvements are critical to the resiliency of the power system and NYPA's assets. These improvements, along with TLEM investments can be coupled with Smart G&T projects to take advantage of outages, and minimize cost. For example, the MA1&2 line study and potential rebuild would provide an optimal vehicle for Smart Grid Communications. This recommended action and its costs and benefits is captured in the SGR3 roadmap of this business plan. During a major line rebuild, the estimated cost based on an AEP report of installing fiber optic OPGW goes from $70k / mile to $10k/mile. This recommended action and its cost are captured in this SGR1 roadmap along with the other fiber-optic build-outs, while its benefits are shared between the SGR1 and the SGR3 roadmap. A rebuild or major replacement of the Moses-Adirondack lines may also be a significant opportunity to install advanced transmission line sensors for dynamic line ratings, and remote monitoring. These additional recommended actions and costs and benefits are captured in the SGR3 roadmap of this business plan. To maintain and improve system resiliency, it is recommended to implement the Quanta Report recommendations as outlined above, incorporating Smart G&T technologies within the project scope.

Emergency Energy Control Center (ECC) and Rebuild of MV90 Meter Data Systems

- Additional resiliency and reliability projects that are in the early planning stages at NYPA include the emergency ECC construction and the MV90 system rebuild. The emergency ECC will significantly improve the resiliency of NYPA's operations by providing a backup control center offsite with full capabilities in the event that system operations staff could not occupy the ECC at CEC. Presently the project is in the study phase to select the site and define the scope. The second smart gird improvement project for resiliency and reliability is the build out of the MV90 Meter Data collection system which presently resides at the Poletti Administration building. For improved support and reliability, a second MV90 system will be built and tested in the WPO datacenter with the eventual goal of retiring the system at Poletti. The project will also replicate the MV90 hardware and software at the Disaster Recovery offsite datacenter with all other IT functionality required for business continuity. This project is in the planning and kickoff stages, expected to be implemented in 2015. The rebuild of the system will maintain the historic reliability, and reduce O&M activities by centralizing the application. Additionally the MV90 Servers that operate at ECC, used for daily Scheduling and Settlements with the NYISO, will be duplicated in the WPO data center to improve reliability and resiliency.

FUNDING

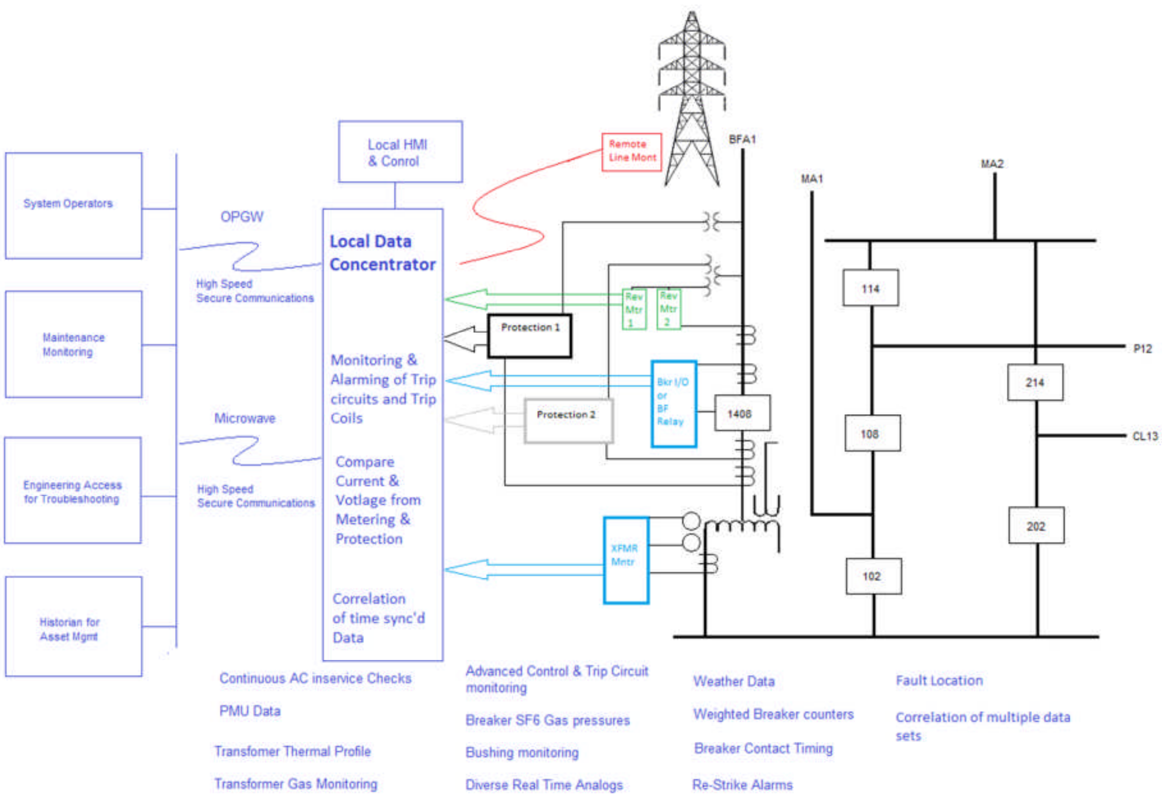
- A large portion of the baseline equipment needed for this roadmap will be procured, designed and installed under T-LEM, deploying IEDs throughout the transmission system. More advanced engineering development and deployment of enabling technologies as stipulated under this roadmap will require additional capital funding, and will also require O&M funding for personnel to maintain, perform upkeep and utilize the systems by analyzing the output data.
- The microwave upgrade program replaced many of the analog microwave sites with digital microwave providing high speed, large bandwidth secure communications between many NYPA Northern region sites. Additional funding will be required to further build out digital microwave to the remaining locations and to implement direct fiber between the most critical sites based on cost/benefit analysis. Strong consideration should be given to include such projects during major physical upgrades of transmission lines such as reconductoring when installing OPGW would be more cost effective.

BENEFITS, COSTS & RESOURCES

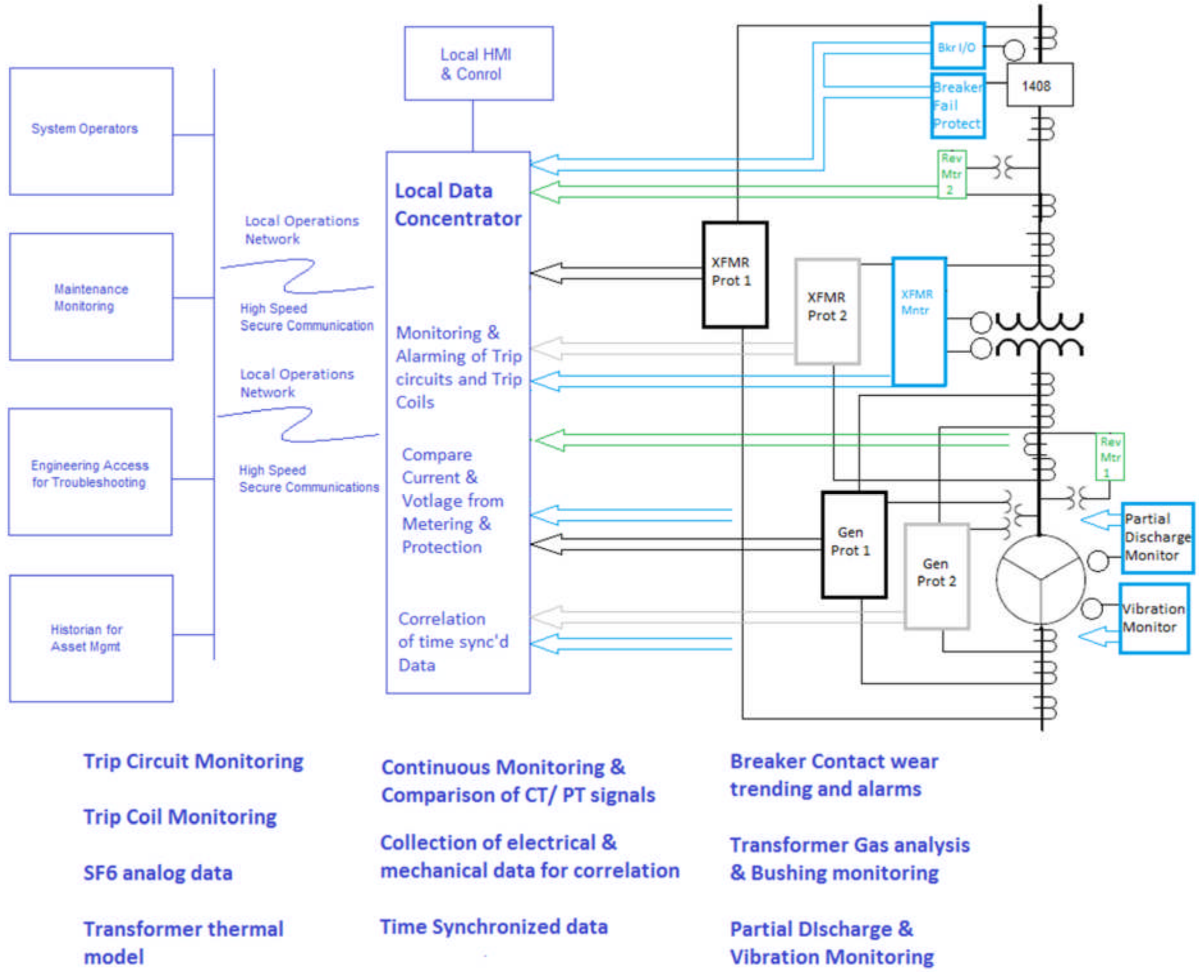
BENEFITS OVERVIEW

- Bushing monitoring – online to predict failures
- Transformer monitoring of thermal model

- The above two benefits are dependent on effective use of monitoring data by efforts conducted under the Asset Management Strategic Initiative
- Circuit breaker wear monitoring using current weighted operation counters to determine when maintenance is required either more or less frequent then the time based maintenance intervals based on actual breaker contact wear, SF6 condition, and restrikes.
- Continuous AC in-service measurement comparison between IEDs to take advantage of NERC condition based maintenance intervals.
- Continuous monitoring of breaker trip coils in addition to trip circuit DC power to take advantage of NERC condition based monitoring.
- Centralize data concentrator improves analysis for synchronized event analysis and long term data profiling.
- Ability to quickly retrieve event data following a system disturbance to analyze fault records within minutes/hours rather than deploying personnel to a substation days later to retrieve relay records.
- NYPA owned communications
  - Longer life expectancy vs a telecom owned system
  - Higher reliability and response is within NYPA control for any problem
  - Better security for critical assets
  - Future expandability with neighboring utilities (example the NIA-BECK link utilized for a more reliable channel for the Packard to Beck tie and Mountain microwave via SONET)



Smart Grid Transmission Substation Architecture



Smart Grid Generation Station Architecture

EXAMPLE COSTS & RESOURCES

Online Continuous Bushing Monitoring

Although some online bushing monitoring systems exist today, they are often less reliable as stand alone systems since they are not monitored and many rely on an alarm to attract an operators attention to a potential problem. Many other factors such as load profile, temperature and humidity data can have influence on the bushing capacitance readings which may cause false alarms making the systems less reliable and thus less are deployed. The desire of having many data sets available at the station data concentrator would combine this information readily available in other smart grid IEDs, providing synchronized data that could be analyzed by engineering and operations personnel and may be able to catch a transformer bushing before it fails catastrophically. The benefit of this smart IED upgrade, as mentioned previously, will depend on effective use of the data by Asset Management Strategic Initiative efforts.

The benefit of such as system can be evaluated first from a system reliability standpoint and a personnel safety standpoint which cannot be represented in a dollar figure. For this analysis, the two example SCPP Generator Step Up transformers (70MVA FA rated 138/13.8kV rated) were selected. Both transformers separately experienced a 138kV bushing failure in Jan 2011 at Harlem River 1 and in June of 2011 at Hellgate

1. In both cases the bushing failed catastrophically, causing a large fire and extensive damage. The cleanup, lost generation energy payments, and replacement equipment, engineering and construction labor costs were collected for the two events. The costs are summarized below:

HR1	O&M	$ 1,059,175.39	
	CAP	$ 1,940,397.00	
	Energy	$ 747,709.00	56 day outage
	ICAP		
	Total	**$ 3,747,281.39**	
HG1	O&M	$ 328,595.04	
	CAP	$ 1,794,149.00	
	Energy	$ 970,550.00	176 day outage
	ICAP		
	Total	**$ 3,093,294.04**	
	Total Cost	**$ 6,840,575.43**	
	Average	**$ 3,420,287.72**	

It should be noted that the capital an O&M and the capital costs are actuals, and the energy revenues are based on the Harlem River 2 and Hellgate 2 unit runtimes and bid prices during the same time period the adjacent unit was in forced outage. This assumes the adjacent unit would be bid the same, with the same gas prices, and same "market opportunity". At the time of this report the ICAP losses are not yet available to the author.

It should be noted that the average cost of a GSU failure due to a bushing failure is $3.4M, the potential unplanned risk avoided by developing advanced monitoring system that will enable Operations and Engineering staff to track data that could remove a major asset for more offline testing to diagnose a problem that may lead to a similar failure. It should be noted that similar GSU bushing failures have recently occurred at Niagara RM3 and RM5 GSUs, which should be analyzed further to determine similar cost data. Also worth noting is the system reliability impact, since Con Edison the local Transmission System Operator, relies on these SCPP units for fast load pickup to ensure their own system reliability. The HR1 failure occurred in January of 2011 and was in forced outage until June 2011. Hellgate 1 was in a forced outage from June 2011 through July 2011, impacting summer peak system reliability.

Continuous AC and Trip Coil Monitoring For Protection Systems

Protection system testing is required under NPCC and NERC enforceable reliability standards, which require either regular maintenance testing of protection assemblies for

1. “Calibration” which verifies the protection assemblies will operate per the specified set point
2. “Functional Testing” which verifies the hardwired inputs, outputs, auxiliary tripping devices, lockouts and wiring is connected to ensure a trip will be executed by the protection system once a relay operates
3. “Breaker Trip Testing” which verifies the trip bus when picked up will actually operate and trip the breaker
4. “AC In-service” testing is designed to verify that the protection system is measuring the appropriate current and voltage signals while the protected element is energized, verifying the instrument transformers are provided the correct signals to the relay.

Current NERC PRC standards requires utilities to perform the above testing within specific time intervals, or allows utilities who have implemented continuously monitored systems to forego time based maintenance since the same signals are continuously monitored, automatically rather than manually and alert operations personnel when there is a problem. Most of the Protection maintenance programs are rooted in the original electro-mechanical devices which did not have the built in diagnostics or ability to alert an operator when there was a problem that may cause the relay to not operate correctly, and therefore required manual intervention to verify by manual testing and perform maintenance adjustments.

As NYPA replaces the older protection systems with microprocessor based protection relays, many onboard diagnostics are utilized to improve individual device reliability and there is the opportunity to deploy continuous monitoring with the additional communication protocols available in the protection relays. Continuous AC monitoring can be implemented by having each relay provide current and voltage information to the station data concentrator which would perform a comparison of each relay’s measured values versus the metering system, also reporting the same current and voltage values as an independent accurate reference. In normal conditions, the system would only see a small percent error difference between the systems, and for example should a PT fuse blow, the system would detect the large different between the measured devices and alert an operator. The operator or engineer could then pull up additional information to remotely troubleshoot and validate the alarm and deploy the appropriate maintenance staff to correct the problem.

The benefit is four fold:

<u>Improved System Reliability</u>:

Since interval maintenance occurs at the time of the report, once every six (6) years, there is one day in six year opportunity for maintenance staff to find a problem that may have existed since just after the prior maintenance. By continuously monitoring protection systems, operations and maintenance staff will be alerted immediately when a problem is detected and can repair immediately, rather than catching it within the next six years.

<u>Maximize Labor Resources</u>:

Electromechanical protection systems typically had a service life or 30-40 years or more when regularly maintained. Microprocessor based protection has a much shorter lifespan and will require more frequent replacement, but less frequent maintenance and testing. Therefore, with continuous monitoring systems, skilled maintenance staff can be deployed to systems when there is actually a problem, freeing up there time to perform more regular replacements, and more advanced testing. The cost benefit example was taken at Adirondack substation which typically requires 1600 hours of testing over the 6 year maintenance interval, to satisfy the regulatory PMs, based on the past Maximo work orders. This does not include travel time, or preparation time, only the actual hours spent maintaining the systems.

Decreased Outage Time: Fewer scheduled outages for protection system testing would be required, and the likelihood of a mis-operation due to personnel testing errors would be minimized with automatic, continuous monitoring systems.

Regulatory Compliance: Under a continuously monitored system, no time based maintenance is required, which eliminates much of the overhead required to provide supporting documentation for compliance audits. Additional benefits include the reduced likelihood that a maintenance interval is missed, or an outage cannot be scheduled risking noncompliance with NERC standard which can result in fines.

Case Study Example – NIA 345kV Circuit Breaker Loss of SF6 pressure

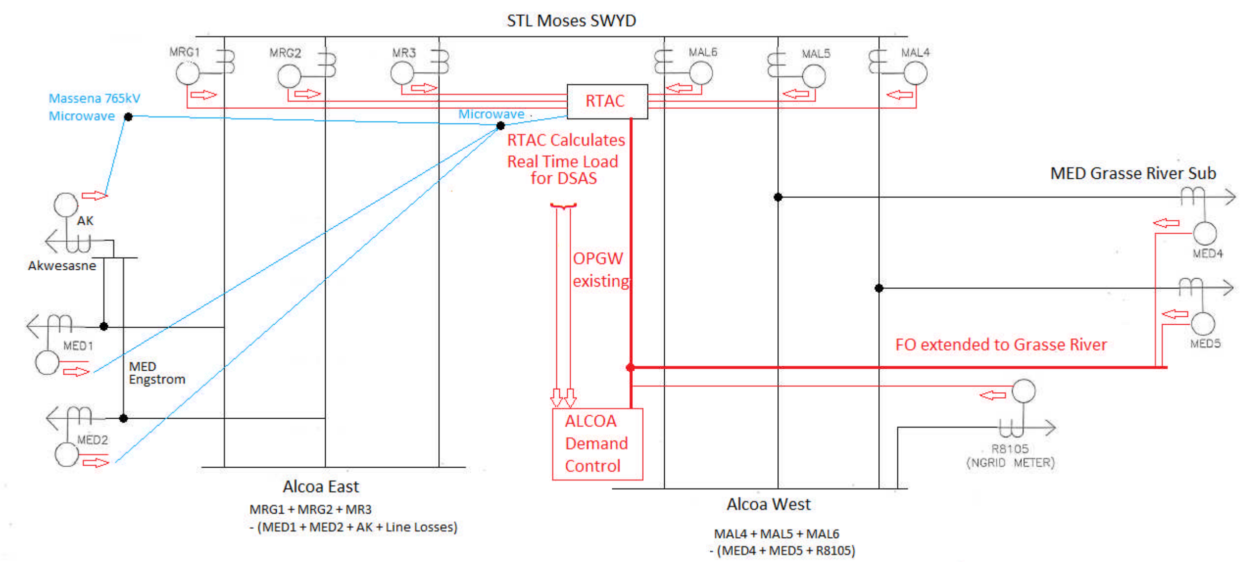
On February 1 2010 there was a major system emergency declared by the NYISO in response to eight 345kV circuit breakers opening without a clearly determined cause in the Niagara switchyard. The root cause was found to be that during switching of station service power, an automatic throw over scheme did not operate correctly and 480V auxiliary power was lost to the circuit breakers in the Niagara switchyard. The SF6 gas breakers rely on auxiliary powered heaters to maintain correct internal pressure in the circuit breaker tanks, and due to the cold temperatures, began to lose pressure until they reached the trip point. A major alarm was received in the control room which required operations personnel to travel to the switchyard to investigate manually. The major alarm is a summary alarm which does not give additional clarity to the remote operator. The first 345kV breaker opened 20mins later and the remaining 345kV breakers continued to open for 28 mins. This caused the NYISO to declare an alert state and system emergency until the Niagara Switchyard was finally restored. Although the efforts of Niagara Operations personnel was commendable in the quick resolution of the problem and restoration of the switchyard, valuable time was spent traveling to the switchyard and then looking through manually looking through targets and annunciators in the switchyard. The advantage of Smart Grid Substation Architecture presented above, would provide the Operators in the Control Room the ability to immediately drill down in the SCADA displays from the "major/minor alarm" resolution level, to viewing the actual gas pressures in the breakers, auxiliary power in each breaker, and detailed station service substation information. Smart G&T architecture will allow the operations and engineering staff the ability to quickly navigate remotely to the IEDs installed in the substations, and gather information critical to decision making in real time. This enhanced situation awareness, and enhanced troubleshooting capability will improve reliability and resiliency by better enabling skilled staff to make decisions based on the data available.

Utility Communications Backbone Network

The benefits of a NYPA owned communications backbones can be realized both in the saved maintenance costs, and capital replacements costs for outside telecom vendors, as secondly in the future resiliency for changing NERC CIP standards to ensure NYPA's compliance for the substation IEDs described above. The installation of a microwave and direct fiber communications link will permit the secure flow of data for both operations, maintenance, asset management and engineering personnel. It will also permit the further deployment of current differential protection systems that rely on direct digital communications channels more reliably protect transmission lines, with better security during system disturbances.

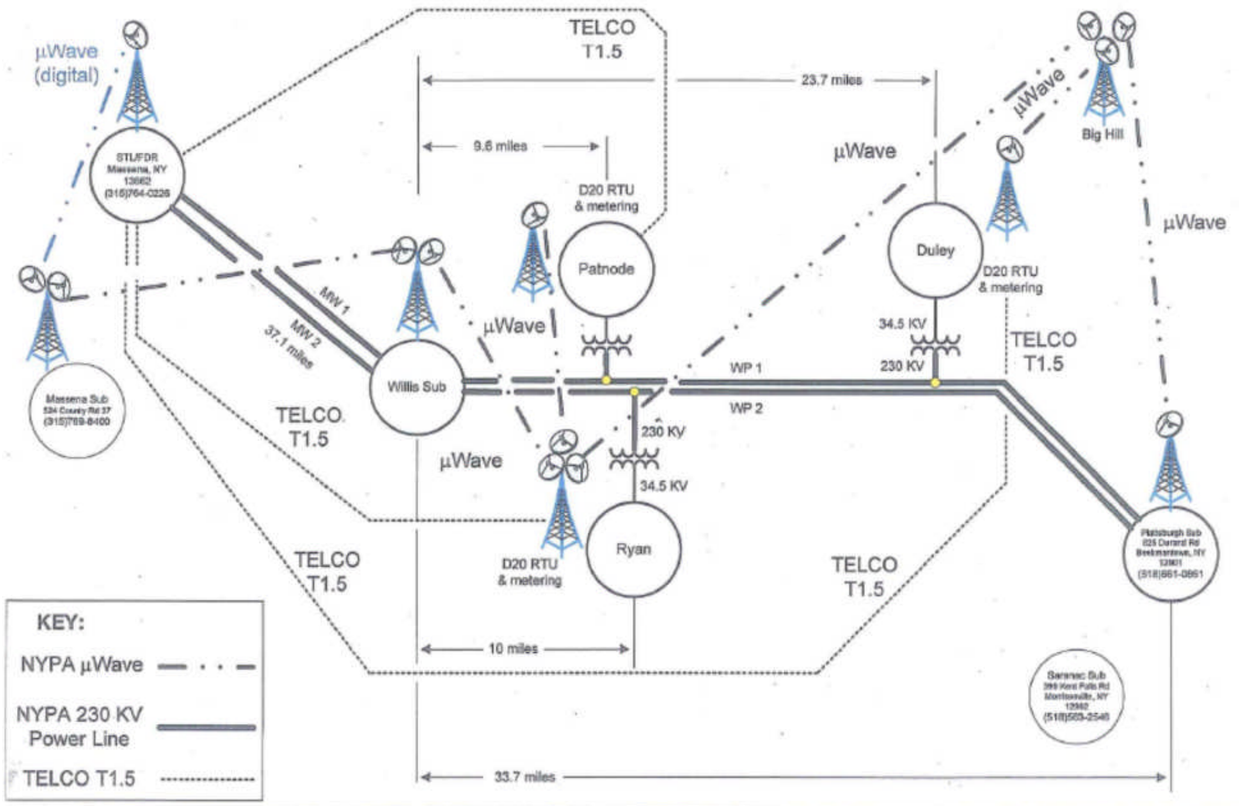
A template project which yielded significant benefits by improving reliability of the monitoring systems was the fiber build out at the NYPA Moses, Alcoa and MED Engstrom substations. A joint project between NYPA and Alcoa, replaced the static line of the MAL6 line with a new Optical ground wire (OPGW) equipped with fiber optics connecting Moses and Alcoa West for protection communications. The fiber has been expanded to include Special Protection systems, and SCADA RTU polling. The benefit of this dedicated communications link was realized when Alcoa, a major NYPA customer entered into the NYISO Demand Side Ancillary Service

Market, (DSAS) which required NYPA's support to provide revenue meter quality data in real time to allow Alcoa to provide feedback for their 6 second base point to the NYISO. Metering systems were upgraded for real time communications; however the total measurement of the Alcoa West load is comprised of 3 meters at Moses, 2 meters at MED Engstrom, and one meter at Alcoa. In order to provide communications between all 6 meters and the RTAC data concentrator, fiber optic cables were extended from the NYPA/ALCOA MAL fiber, to Engstrom creating a small fiber backbone that provided secure, high speed reliable polling of all 6 meters in three separate locations in real time. Although it was not deployed, a similar benefit was realized in order to collect data for the Alcoa East (Reynolds) plant by using the NYPA microwave from Moses to Massena to Akwesasne in order to collect meter data with minimal additional equipment. The demonstrated benefit of the utility own communications backbone infrastructure is the flexibility and ability to quickly adapt to customer needs and power system requirements to deploy new systems/ capabilities.



Example of Rapid Deployment of Smart Grid for Customer Demand Side Participation using existing Utility owned Communications Infrastructure

Example of Digital Communications Network as Cornerstone of Smart Grid Deployment



Existing Northern Region Communications Backbone

IMPACT ON MARKET

Increased reliability will positively impact NYPA market operations seen in the potential reduction of unplanned outages due to equipment failures resulting in reduced generation revenue for energy and capacity payments as well as transmission revenues. Often equipment failures are lengthy, resulting in negative impact to planned revenue streams, and negatively impact O&M and unplanned Capital budgets to cover the cost of cleanup, repairs, restoration and replacement of the failed equipment.

ORGANIZATIONAL IMPACT

- The deployment of Smart Grid technology and increased use of IEDs for data reporting will require significant increased support by highly skilled engineers and technicians. It should be noted that there can be a steep learning curve associated with the deployment of new technologies used in NYPA's core business. These types of systems are a unique skill sets combining power system theory, communications, and computer analysis, which would require internal training, and retention to ensure NYPA has qualified personnel to work on these systems. Skilled engineering personnel will also be required to analyze condition monitoring data to assist operation personnel to make maintenance decisions, and Operations staff would require additional training and resources to be able to utilize these technologies to support the reliable operation of the power system.

- Deployment of these technologies will require separate development systems to verify the IED and data concentrator functions and capabilities, prior to deployment at a substation. Such a development system will ensure efficient and effective commissioning and operation of these systems in the field, allow of testing of future expansion and upgrades, and provide a training system for end users.

EXTERNAL STAKEHOLDER IMPACT

- Development of Smart Grid technologies will be more efficiently and effectively deployed by NYPA's collaboration and participation in industry working groups to learn from other utilities experiences and provide the benefits of NYPA's own learning curve.

DEPENDENCIES & RISKS

- Strong interdependencies exist between this roadmap and the Visualization and Situational awareness roadmap. A significant part of reliability and resiliency will be seen through the increased deployment of synchro-phasors, however to avoid duplication, a detailed explanation can be found in the V&SA roadmap.
- Strong interdependencies exist between this roadmap and the Asset Management initiative. The deployment of station data concentrators, combined with a hardened communications network will feed directly into the development of an advanced, analytic Asset Management program by providing the required data.
- NERC CIP standards represent a significant dependency and risk for all of the Smart G&T technologies. The benefit of taking advantage of the valuable information available in the IEDs must be weighed against the increased resources that will be required to maintain compliance with CIP standards. There may also be additional resources needed to support the regular O&M associated with CIP compliance and changing CIP standards are a risk to impact the end cost of the Smart Grid Systems.

Smart G&T Capability Roadmap Detail

SGR2: Enhanced Situational Awarness

Capability Manager: Bruce Fardanesh

CAPABILITY VISION / STRATEGIC RATIONALE

Operating the power grid in an optimized fashion by developing and utilizing more advanced tools and techniques and moving in the direction of enhanced, fully-coordinated and automated grid controls. The requirements are: higher quality measurements (PMUs), robust and redundant communications links with low latencies (dedicated system-wide fiber backbone), advanced computational and analytical tools (Next-Gen EMS and DMS suite of Apps) as well as high performance computing capabilities (parallel and super-computing).

The rationale behind this capability is safe, reliable, efficient, and economical operation of power systems. This capability can be developed and demonstrated using today's technologies within a 3-4 year time frame and can evolve into even more advanced capabilities.

SOLUTION

- NYPA/NYISO PMU and PDC hardware and Communications network —Very relevant to this capability; feeds the synchrophasor data into this capability
- SAMAC- St Law 61850 based Relay upgrade – Very relevant to this capability -- facilitates protection- and control-related command and control
- CSC Controls Upgrade – Relevant to this capability – Acts as an actuator for the control of 345 kV voltage at Marcy substation as well as control of power flows on two transmission lines exiting Marcy.
- In addition to collecting the data, this solution involes the integration of sensor data with other NYPA data, processed through algorithms and then visualized/alarmed to the various operating personnel
- In the utility industry in general, the current Controls of the grid are not fully coordinated. Relies heavily on operator experience, response, and interventions. Too slow to respond in case of fast cascading contingencies. The narrative in the Appendix details the solution envisioned.

Capability gap analysis

- Highly reliable redundant and dedicated (potentially NYPA owned) communication networks
- System-wide synchronized measurements for robust and fast state and topology feedback
- Determination of appropriate response rates of closed control loops
- Development, testing and implementation of more intelligent system protection schemes (such as Adaptive Reclosure of Transmission Lines—A separate write-up is available for this) for enhanced transient stability of the system.
- Faster computation capability to approach real-time optimization, coordination and control
- System/equipment model identification and validation tools
- Faster algorithms for system topology and state estimation
- Parallel algorithms and faster computers

Activities to address gap:

- A combination of proven technology and R&D is required here. Some existing tools need to be moved to beta testing and demonstration on actual systems.

BENEFITS

- 20% reduction in NYS congestion
- Reduced energy costs due to additional 300 MW wind savings to NYS
- Economy (reduction in wear & tear) savings to NYS
- Safety (equipment damage only) to NYS
- Economy (O&M reduction)
- Efficiency (1% technical transmission loss reduction) savings to NYS
- FTE O&M savings to NYPA

FUNDING

- Since this capability can be developed utilizing AGILe as the platform, the slated funding for this lab would provide for an adequate start. It is envisioned that this development will be done in partnership with one of the large EMS vendors (ABB, GE-ALSTOM, Siemens and others), EPRI and other partners with an appropriate level of cofunding. The funding mechanism(s) for the fiber backbone needs to be determined.

COSTS & RESOURCES

- Once developed, this capability is envisioned to deliver a commercial or at least a pre-commercial product that can be marketed. The cost of a new EMS system today could be in $10 to $20 million range. Permanent on-going costs will be the routine maintenance costs of a typical EMS system (0.5 M to 1.0 M annually).

RISKS

Potential Risks:

1) Ability to partner with other entities such as a major EMS vendor and and their willingness to eventually develop a commercial product.
2) Finding and hiring the right work force with the necessary skills for the AGILe lab.
3) Need for continued installation of additional PMUs or other Phasor data providing IEDs in NYS.
4) Ability to get time-synchronized system topology info (breaker and disconnect switch status)
5) Ensure cooperation from other NY TOs and the NYISO for funding, design, and installation of the fiber optics backbone in NYS.

A Comprehensive Power System Operations and Control Structure--Sensing, Feedback, and Automation

B. Fardanesh

A system operating architecture is proposed that allows for a comprehensive fully coordinated operation of power systems. This architecture is completely based on sensing and feedback to a central location. Therefore, redundant, highly reliable communications links are the central staple of such architecture.

At each generating station or substation, the sensed data are categorized into system electrical quantities, i.e., system voltage and current phasors and breaker status (synchronized measurements) from all IEDs (Relays, DFRs, PMUs, Metering, SCADA, RTUs, and PQ Monitors conforming to IEC61850, IEEE 37-118, IEC61970), as well as all other measurements (which may be dubbed mechanical or equipment monitoring measurements), such as all equipment temperature values (as well as ambient), pressures, transmission line sags, dissolved gas in oil levels, rotation related quantities (vibration, air-gap, etc.), leakage currents, battery monitoring system, PT, CT, equipment response rates, hydro plant head, available water levels, etc., etc.

Local redundant data-bases exist at the local level to store and archive this data. All data will be Common Information Model (CIM) compatible. Cross-correlating application software will continually monitor the health of the equipment and provide operating guidance vis-à-vis the power system operating conditions and generate local and remote alarms when problems do arise. System harmonics and unbalances in conjunction with the mechanical type measurements can help identify system problems. Trending of various quantities will provide advanced warning to the system operator to take remedial and corrective actions. For example, if a disconnect switch is not properly closed in one of the three phases and is introducing a high resistance in that phase, the data from the corresponding heat sensor and the potential unbalance in the system voltages and currents in the vicinity of that disconnect switch may be correlated to detect and pinpoint the source of the problem. As another example, if a critical piece of equipment trips due to a sudden internal failure or a severe contingency occurs, the knowledge of the thermal capability and status of all in service equipment plus the information about the voltage profile in the area will enable the correlation and analysis computer programs to immediately advise the system operator on the immediate actions to be taken to manage MW flows and maintain appropriate voltage levels. Such a system would be extremely helpful to the system operators in coping with emergencies, determining the operating state to go to right after an emergency, and ultimately restoring the system to a normal state, given the situation at hand.

The data from all substations and generating stations will be available over a secure communications backbone at all locations. Authorized access can be issued to various users such as operators, engineering, etc. This communications backbone may be utilized for transmitting the necessary information to the operations/control center.

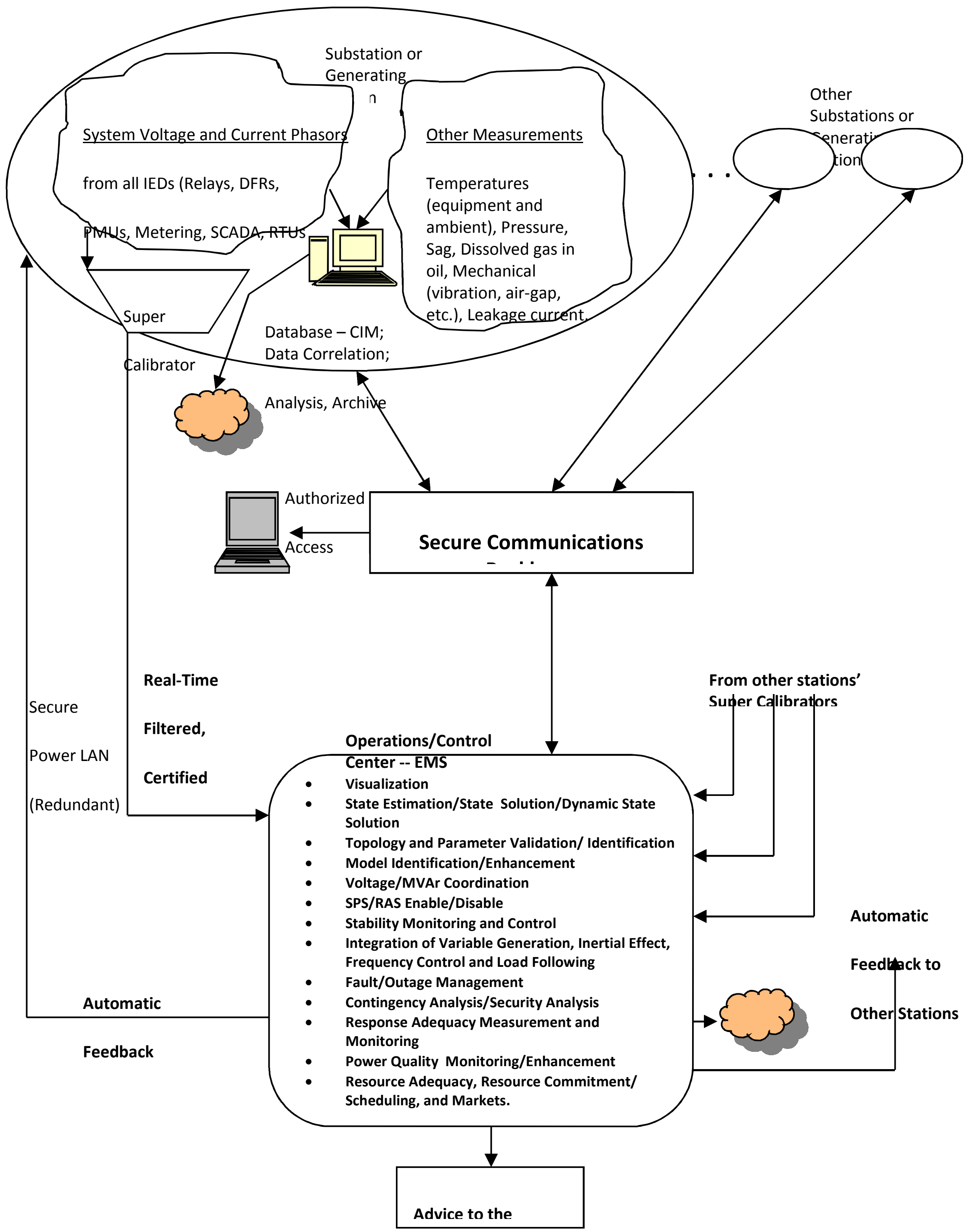
For faster, real-time applications, it is desirable to have a dedicated broad-band communications network--preferably fiber physically owned by the utility such as shield (or ground) wire embedded fiber--linking all HV substations and generating stations to the operations/control center. It would be preferred to implement a "super calibrator" at each site to locally filter the data at each site and provide validated trustable data for transmission to the operations/control center. The super calibrator is a local state estimator that will utilize redundant data and detailed local substation models to identify corrupt data and to ensure the quality and accuracy of the transmitted data. This will considerably increase the confidence level on the data received at the operations/control center and provide the state solver/estimator with highly trustable data.

Once sufficient, synchronized, trustable data (including breaker status or network topology data) with adequate sampling rates are available at the operations/control center, the state solver/estimator, the backbone of all EMS applications can run with a superior performance and as frequently as needed perhaps in the sub-second even cycles time-frame. A centralized system topology and parameter estimation and validation can also be performed if necessary. It is of importance to note that it is possible to perform a direct one-shot (non-iterative) "state solution" as opposed to traditional iterative state estimation, if adequate trustable synchronized data is available at the EMS. Also, contingency ranking and security analysis, both from rotor-angle dynamics and voltage stability points of view, can be done very fast and effectively, providing an optimum action plan to the system operator both under normal and emergency conditions.

It is understood that the visualization and situational awareness, on a wide-area basis, is a natural by-product of such capabilities at the operations/control center.

A distinct example of the benefits of this operating architecture is the coordinated voltage/MVAR control in a control area. Based on sensitivity analysis, the control area may be sub-divided into a number of zones where the voltage profile is most responsive to a designated set of controls. Both during the normal and emergency situations, the sensed voltages are monitored and corrective and/or optimizing actions will be computed (based on a defined set of criteria for the system) and the system operator will be advised on the appropriate actions to be taken. The computations will take into account the desired objective (such as maximizing power flow over a corridor, for example) and the power system topology and equipment availability to determine the best course of action. The recommended actions can be in the form of generator AVR set-points, on-off status of fixed shunt compensation devices, Load Tap Changer settings, as well as the set points for the dynamic voltage control devices such as SVCs, STATCOMs, and synchronous condensers.

Numerous other examples of advantageous utilization of this sensing and feedback based operating structure can be cited. In the immediate future, the development should focus on providing valuable and timely advice to the system operator. In the long run, as confidence is built, some of these actions may be performed automatically via direct feedback from the operations/control center. Ultimately, such closed –loop automated capabilities will be indispensable for operating power systems more reliably, safely, and efficiently, especially in dealing with fast power system phenomenon. This envisioned robust design should however gracefully degrade to a sub-optimal operating regime upon its or its components' failure without jeopardizing system integrity and reliability.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Topology and Parameter Validation/ Identification
Model Identification/Enhancement
Voltage/MVAr Coordination
SPS/RAS Enable/Disable
Stability Monitoring and Control
Integration of Variable Generation, Inertial Effect, Frequency Control and Load Following
Fault/Outage Management
Contingency Analysis/Security Analysis
Response Adequacy Measurement and Monitoring
Power Quality Monitoring/Enhancement
Resource Adequacy, Resource Commitment/ Scheduling, and Markets.
Automatic
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Smart G&T Capability Roadmap Detail

SGR3: Optimizing the Utilization of Transmission Assets

Capability Manager: Alan Ettlinger

CAPABILITY VISION / STRATEGIC RATIONALE

This roadmap supports establishing a modern, flexible, and efficient grid that maximizes reliability and resiliency while accommodating increasing amounts of power from clean and distributed generation, reducing congestion and bottlenecks, and enhancing situational awareness and grid control. Under the auspices of this initiative, flexibility will be ensured and efficiency provided in the face of increasing demands on an aging grid by optimizing the utilization of our assets. By optimizing both the flow of power through existing and potential new infrastructure and modernizing the maintenance and operation of our transmission assets, we will increase:

- Flexibility: a flexible system will be able to accommodate changing load and generation profiles, whether due to increased penetration of renewables or distributed energy resources, energy efficiency, or increased demands on the system in extreme weather events. The system will be operated in real time, incorporating information from devices deployed throughout the network that provide information on current operating condition, operating limits, equipment health, weather conditions, etc., and will ensure minimized congestion through maximized utilization of assets.

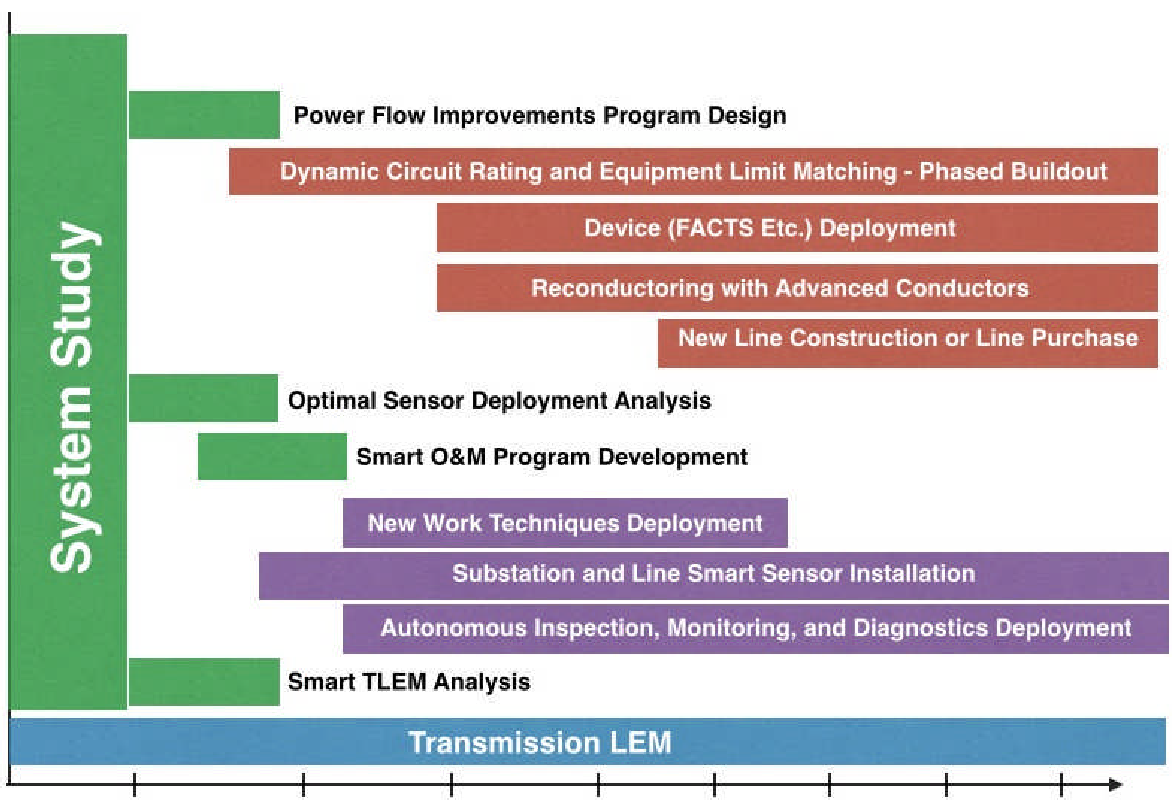
- Efficiency: the efficient grid will minimize losses throughout the system and deploy capital and labor in the safest and most efficient ways possible. By operating to real time equipment limits, NYPA and NYS will continue to reduce bottlenecks, and by examining and planning toward maximized asset utilization, we can reduce losses from over- or under-sizing certain system components. This effort will explore autonomous maintenance planning and practices to continue to reduce the risk to our employees involved in operating and maintaining the system while reducing downtime required to prevent or correct failures.

- Modernity: the modern, or "smart," future for our transmission assets will incorporate cutting-edge sensing, control, material, design, and maintenance technologies to move toward a self-healing (or, at least, "self-alerting") grid. This effort will build upon NYPA's position as a technology, research, and innovation leader in this area and continue to scale our pilot research projects in these areas to full-scale deployment as assets. Where necessary, NYPA will collaborate with institutional research and private sector institutions to develop new technology and simulate its impact on the grid using the capabilities to be developed in the proposed Advanced Grid Innovation Lab (AGILe).

SOLUTION

- Current State
  - Vast amounts of work, from around $1 million annual research and development work in this area to the $725 million Transmission Life Extension and Modernization (TLEM) program, are currently being undertaken in this area.
  - System constraints, whether due to equipment age, system bottlenecks, or changing generation profiles, will continue to impact our operations.
- Capability gap analysis
  - Frameworks for taking new technologies from research to pilot to asset should be developed to ensure optimal system planning.
  - Data-driven operations and maintenance will require the buildout of more sensing and communication infrastructure.
  - Though system constraints are generally known, we have not identified the best way to deploy all of the technologies at our disposal (FACTS, new lines, advanced control techniques, dynamic rating, etc.) to best address problems in the entire system.
- Activities to address gap

- This initiative will study and implement technologies that have both been proven already in the NYPA system (for example, PMUs or FACTS devices) and those that have not (robotic inspection, new conductor technology, dynamic thermal rating, some of which have been piloted, but not scaled fully) to improve the flexibility of the transmission system and the efficiency of maintenance and operations.
- This initiative will undertake a full battery of system studies to determine the best course of action for making system-wide improvements using capital investments in all related technologies for increasing power flow. The options to be studied range from eliminating unnecessary equipment constraints on power flow (for example, undersized wave guides, current transformers, or connectors) to the construction or purchase of new lines. Following the studies, which can leverage or help develop eventual capability for the AGILe lab, program will be signed for investment that will most likely include some combination of reconductoring, dynamic rating, FACTS deployment, or new construction.
- Using results from the system study and examining internal data, whether O&M spending, existing technology, operational considerations etc. design frameworks will be developed for implementing smart O&M - a framework to prioritize sensor deployment and a framework for testing and implementing advanced maintenance technologies and techniques, which we anticipate will include some combination of live work and autonomous maintenance and data collection. Care will be taken to align installations with TLEM work, when possible, to minimize downtime, and to establish the "innovation pipeline" - a method of evaluating new technologies or approaches and smoothing their transition from research to pilot to full system deployment.
- To correlate with existing TLEM work, a final study will be commissioned, whether to be completed internally or by a third party, to ensure that our TLEM work is as modern as it can be and helps to achieve the goals of this initiative.



BENEFITS

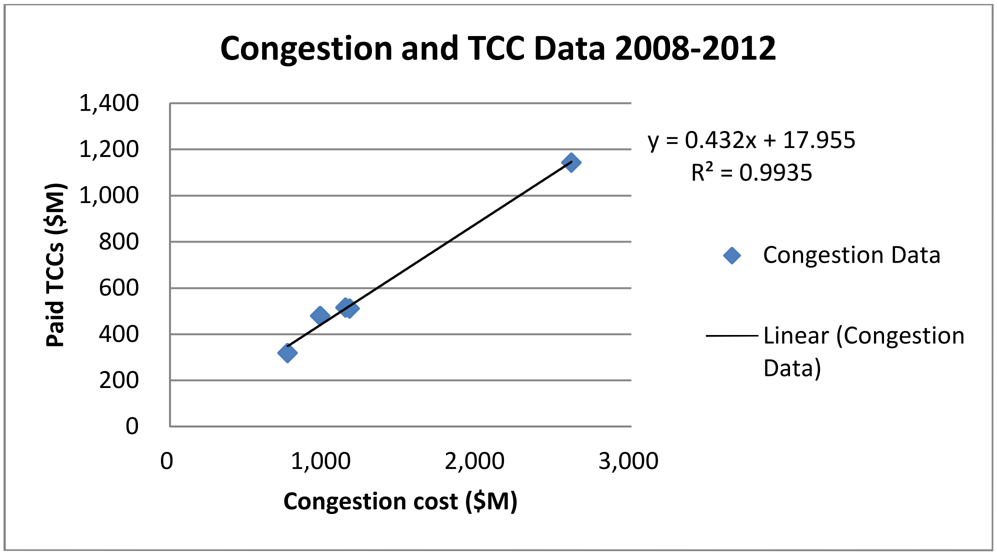
- Reduced congestion and bottlenecks, improving NYPA's ability to move low-cost and clean power throughout the state. Estimates of current congestion costs can be found in the annual NYISO congestion assessment and resource integration study[1]
- Reduced costs for operation and maintenance thanks to autonomous techniques
- Reduced risk due to old equipment or necessary downtime
- Increased system flexibility and resiliency in the face of changing generation, consumption, and climate events
- Increased system efficiency
- Industry leadership

Congestion reduction analysis is presented in the table below based on data retrieved from the annual NYISO 2013 congestion assessment and resource integration study[2]. Projected demand congestion beyond 2012 is provided in the report. Projected TCC payments are calculated using linear extrapolation on the historical data from 2008 to 2012, as shown in the graph below. Due to the fact that paid TCCs provide hedging against congestion benefits to customers can be claimed only on the unhedged congestion potion calculated after subtracting TCC payments from demand congestion. A 10% saving of the unhedged congestion is assumed, totaling $276 million of financial benefits from 2017 to 2022.

	Year	Demand congestion for total NYCA ($M)	TCC Payments ($M)	Unhedged Congestion ($M)	Potential Customer Savings ($M)
Historical Data	2008	2,611	1,143	1,468	
	2009	977	480	497	
	2010	1,141	515	626	
	2011	1,169	511	658	
	2012	765	319	446	
Projected Data	2013	643	*296*	347	
	2014	673	*309*	364	
	2015	749	*342*	407	
	2016	634	*292*	342	
	2017	757	*345*	412	41
	2018	784	*357*	427	43
	2019	906	*409*	497	50
	2020	771	*351*	420	42
	2021	929	*419*	510	51
	2022	907	*410*	497	50
					276

[1] NYISO 2013 Congestion Assessment and Resource Integration Study (p. 34), available online at http://www.nyiso.com/public/webdocs/markets_operations/committees/bic_espwg_iptf/meeting_materials/2013-08-12/2013%20CARIS%20Draft%20Report%20%20rev.pdf.

[2] Ibid



FUNDING

Since much of the initiative focuses on continuing to develop technology that may or may not be commercially ready at this time, significant opportunities for co-funding or research partnerships exist. A target is to achieve between 5 and 10% of annual funding from external sources, whether from institutional research organizations or collaboration with other utilities or private entities, or other governmental sources of funding.

COSTS & RESOURCES

Detailed in the initiative backup Excel spreadsheet.

ORGANIZATIONAL IMPACT

- Implementation of smart grid technology will require the development of additional skill sets within NYPA's G&T organization. Through a close link with future asset management data analytics functions, the ability to interpret and act on data-driven recommendations will need to be developed within the organization. The new technologies will also have a different life cycle than traditional transmission technologies, so developing ability to troubleshoot and manage these new devices will be critical.
- New FTEs will need to be added to the NYPA workforce to facilitate development, implementation, and ongoing operation and maintenance of the proposed projects. We assume that 3 new engineers will be needed at an annual cost of $150,000 (including compensation and benefits). Based on our knowledge of FTE constraints due to maintenance and compliance requirements of new PMUs, additional sensors, other intelligent electronic devices etc., we're estimating we would need about 10 more technicians at the sites – this includes ~2 per site for each of our 5 main transmission facilities (Niagara, St. Lawrence, Blenheim-Gilboa, CEC, SENY), which will be added gradually as 2 per year from 2016 to 2020. Each technician a cost of $100,000 is assumed. For the duration of the physical infrastructure and line sensor installation work, we're assuming around 5-6 additional linemen to avoid reducing the availability of regular line maintenance staff for regular maintenance tasks. An estimated cost of $120,000 per lineman is used. We are assuming that any

FTEs required to implement and maintain communications networks, etc. are being captured in the other roadmaps.

EXTERNAL STAKEHOLDER IMPACT

- This capability will improve grid operations in NYS, allowing the state to approach its renewable energy goals and reducing emissions and costs to serve load to customers throughout the system.
- This capability will also serve as a model for other NY Transmission Owners who may proceed down similar smart grid paths.

DEPENDENCIES & RISKS

- Achieving actionable results from advanced sensor deployment will require the development of an asset management capability to analyze and interpret data. Though this is in the pipeline, care must be taken to make sure the timeline on that effort is not extended so much that the efforts here cannot be operationalized until a much later date.
- Transmission LEM must complete replacement of critical and vulnerable assets and lay some basic infrastructure, so this initiative can focus on improvements not required for base system reliability.
- NY Transco could have an impact on any major new construction funding.

Smart G&T Capability Roadmap Detail

SGR4: Optimizing Generation Assets

Capability Manager: Bohdan Dackow

CAPABILITY VISION / STRATEGIC RATIONALE

- NYPA's bulk generation fleet runs optimally while maintaining the capability to respond to a wide range of system conditions, including, load/generation variability caused by intermittent bulk renewables (i.e. wind, solar, etc.) by:
    - the continuous optimization of water utilizing advanced water optimization algorithms
    - supplying required regulating and reserve capability
    - providing bulk energy storage capabilities to capture excess generation from intermittent bulk renewables through existing pumped storage facilities (i.e. LPGP, BG)
    - Working with all stakeholders in New York, initiate market changes that recognize and properly value bulk energy storage capacity.

CURRENT STATE

- As New York continues to implement Smart Grid technologies at the distribution and transmission levels, NYPA's bulk generation fleet must be prepared to rapidly adapt to the changes.
- At this time, the industry is focused on the high impact areas of transmission and distribution, and not yet evaluating bulk generation. With New York taking a leadership role, this initiative is being proactive and looking at its bulk generation fleet to determine what proactive steps, if any, can be taken to establish New York State as the leader in Smart Grid as it relates to bulk generation.
- With no established definition of Smart Generation, NYPA has made a thorough review of what its bulk generation fleets role can be with Smart Grid and identified two roles for its bulk generation:
    - the ability to quickly and efficiently respond to rapidly changing system conditions (e.g. a large thunderstorm moves through Western New York shutting down 300MW of wind generation)
    - the ability to store excess energy to support the expansion of intermittent bulk renewable generation (e.g. absorbing 300MW of excess wind, or hydro at 3AM)
- Looking at these two roles and the current state of the NYPA generation fleet, NYPA is well prepared to meet these two roles through:
    - The highly flexible nature of NYPA's existing hydro facilities allows these assets to have a substantial surplus of regulation and reserve capability that can be made available quickly and efficiently to the grid as the penetration of bulk renewables increases.
    - The use of NYPA's two large pump storage facilities:
        - BG with 12 GWh
        - LPGP with 4 – 6 GWh
- NYPA has been proactively and continuously maintaining and improving its generating assets to ensure high efficiency and flexibility which fully supports this initiative. Over the last several years NYPA has spent over $1.1 Billion on major bulk generation efficiency/reliability/operational improvements at its Blenheim-Gilboa, St. Lawrence, and Niagara facilities, and is currently implementing a $470 million upgrade at its Niagara Lewiston Pump Storage Plant. These improvements (see Table 1) that have been or are being completed, fully support the two goals of flexibility and energy storage.
- Current Status of Smart Technologies at NYPA Bulk Generation Facilities – Table 1

Plant	Unit Controls	Governor	AVR/Static Exciter	Water Optimization	Regulation & Reserves	Hydro Turbine Efficiency

RMNPP	Planning	Planning	Yes	Yes[2]	Yes	Yes
LPGP	In Progress	In Progress	In Progress	Yes[2]	Yes	Yes
BG	No	Yes	Yes	N/A	Yes	Yes
STL	Yes	Yes	Yes	Yes[2]	Yes	Yes
500	Yes	Yes	Yes	N/A	Yes[1]	N/A
Flynn	Yes	Yes	Yes	N/A	No	N/A
SCPP	Yes[2]	Yes[2]	Yes	N/A	No	N/A

[1] Technical capability for regulation is in place, but currently not utilized since system reliability/operational requirements and market/economic conditions do not warrant its use at present

[2] Technology is already in place but is being upgraded and/or further enhanced

- The major areas and technologies that support the flexible operation of the fleet and the stated goals of this initiative are:
- **Unit Controls** – the use of microprocessor (i.e. PLC or DCS) based control systems provides highly reliable systems that are highly flexible. PLC's were originally developed for the auto industry as a means to quickly modify assembly lines. Prior to PLCs, manufacturers would have to shut down their assembly lines for long outages to allow for the rewiring of their controls. With the advent of PLCs, all of the changes are made through software requiring little to sometimes no outages. This same flexibility allows rapid changes to generator controls.
- **Governor** – prior to the use of microprocessors, generators were controlled with 'dumb' mechanical systems comprised of springs, fly balls, and levers that could only control load and speed. With the application of microprocessors to governors, intelligence could be incorporated to the design. While a mechanical governor would only try to control speed, even when detrimental to the stability of the system, modern governors are smart enough to know when they should not blindly control speed and instead hold back to help stabilize the grid.
- **AVR/Static Exciter** – the use of modern power electronics and microprocessors have enabled the use of advanced control algorithms (i.e. Power System Stabilizer – PSS) that are now able to help stabilize the grid during transient events. Prior to this the system was 'dumb' in that it could only maintain voltage and was unable to determine if something detrimental was happening on the grid. Also, the use of smart controls ensures that machines are better protected and prevent them from being operated outside of their limits.
- **Water Optimization** – using computer algorithms that include stochastic forecasts, determine how best to convert available water to megawatts, while obtaining maximum revenue and while complying with international treaty.
- **Regulation & Reserves** – receive real time (seconds) signals from the NYISO across secure and reliable communication links that continuously change the generator fleets output so as to maintain the continuous balance between load and generation
- **Hydro Turbine Efficiency** – using advanced hydraulic modeling and computer modeling, designing turbines with optimum efficiency for specified head and flow
- **In Progress Projects:**

    - **RMNPP Controls** (CPR-524) – Unit Controls, Governor, AVR/Static Exciter, Regulation & Reserves, and Hydro Turbine Efficiency – replace the existing mechanical governor and electromechanical controls with new microprocessor based controls. This project was started in early 2014 with expected completion in 2022.

- **STL Optimization (CPR-880) –** Water Optimization – replace the existing water/generation optimization program with a new version utilizing current programing technologies providing improved program performance. This project was started in 2014 and is expected to be completed in 2015.
- **NIA Optimization** – Water Optimization – enhances the existing water/generation optimization program to also utilize energy pricing to optimize generation. Expected completion 2014.
- **NIA Diversion Control –** Water Optimization – improves the control algorithm to improve the automatic control of water and generation usage between the Moses and LPGP facility. Currently NYPA uses Flow3D CFD software to simulate flow at Niagara/LPGP. There are ongoing EPRI projects looking to evaluate and improve upon Niagara/LPGP flow measurements and flow simulations so as to optimize the operational performance at Niagara/LPGP. Some of the preliminary EPRI reports generated, along with a demonstration of a simulation package with optimizing algorithms indicates that there could be an opportunity to improve flow control and operational efficiency.
- **SCPP Controls (CPR-1075) –** Unit Controls, Regulation & Reserves – replace the controls at all seven SCPP sites with the latest microprocessor based controls. It was started in 2013 and is scheduled for completion in 2018.
- **LPGP LEM (CPR-555) –** Unit Controls, Governor, AVR/Static Exciter, Regulation & Reserves, and Hydro Turbine Efficiency – replace all major plant equipment including new high efficiency turbines, microprocessor based unit / governor controls and static exciters. The project was started in 2010 and is scheduled for completion in 2020.

- Capability gap analysis
  - As summarized in the Current Status table, the entire NYPA bulk generation fleet is, or is in the process of being upgraded, effectively meeting the stated goals of this initiative. (The one exception to this is BG controls, which is not currently planned for upgrade and is not an impediment to the Smart G&T initiative).

BENEFITS

- Bulk power storage plants provide a valuable benefit to the efficient operation of the electric grid. National Renewable Energy Laboratory (NREL) and Power Systems Engineering Research Center (PSERC) are collaborating on a project to better model pumped storage (as well as eventually other large-volume energy storage resources) in day-ahead and real-time markets. The goal is develop advanced modeling techniques that utilize the flexibility of pumped storage, being a generation and demand-response asset, and its numerous capabilities to provide ancillary services, and have a prototype that can eventually be adapted in ISO/RTO system operations and its market software. The analysis and potential enhancements to how pumped storage is utilized will range from the bidding process, to the optimization engine, all the way to prices and settlements. The team is setting up an advisory board made up of experts from industry on current pumped storage bidding procedures, current utilization of pumped storage in ISO markets, and current settlements procedures for pumped storage. The advisory board will contain members of most of the ISOs in the U.S. as well as numerous utilities or owner/operators of pumped storage facilities.
- The 1200 MW Blenheim-Gilboa (BG) pump storage power plant has the ability to 'store' 12 GWh of energy that can be supplied to the system at 1000 MW for 12 hours. The difficulty of

fully realizing this valuable resource is under current market conditions the energy required to pump the water must be purchased at wholesale LBMP rates and also sold at wholesale LBMP rates; the difference between lower (Off-Peak) LBMP rates for pumping and higher (On-Peak) LBMP rates for generating is typically too small to make its use economically feasible.

- The break-even point for BG is at approximately 70%; for example if power was purchased at $36/MWh for pumping, power would need to be sold, at a minimum, at $52/MWh to break-even, which does not include any additional O&M costs associated with more frequent operation.

DEPENDENCIES & RISKS

- Although NYPA has bulk energy storage capabilities, existing NYISO market rules do not recognize this valuable asset by providing any cost recovery mechanism limiting its utilization. Until the value of large scale energy storage is recognized (e.g. as an ancillary service), it will remain underutilized.

- The definition of Smart Grid itself, by its very nature is dependent on a fully integrated and logically communicated and controlled system that requires coordinated effort and dependent operation amongst all Smart Grid related activities.

- All stakeholders, including NYPA uncontrolled external entities must be coordinated to ensure success. One possible solution is to form a centrally organized committee made up of all entities to ensure a coordinated and organized plan of Smart Grid implementation going forward. To avoid the appearance of any conflict of interests, it is recommended that the NYISO lead such a committee.
- Timeframes for all stated activities have been provided within the body of this report.

Smart G&T Capability Roadmap Detail

SGR5: Integration of Bulk Renewables

Capability Manager: Gerald Mannarino

CAPABILITY VISION / STRATEGIC RATIONALE

As the owner/operator of three large hydroelectric power generation facilities in NYS NYPA has the capability and mission to ensure reliable, clean, and affordable power to the people of NYS. This mission includes the stewardship of NYS natural resources, particularly the water resources of the St. Lawrence River and Niagara Falls, in collaboration with international treaties with Canada. NYPA's mission statement says:

Power the economic growth and competitiveness of New York State by providing customers with low-cost, clean, reliable power and the innovative energy infrastructure and services they value.

This mission is accomplished through NYPA's continuous improvement and modernization programs and by its leadership and collaboration in programs such as the NY Energy Highway initiative, energy efficiency programs, and public/private partnerships.

With its strong regional control centers controlling 25% of the electric generation capacity in NYS and ownership of over 1400 circuit miles of transmission throughout NYS, the integration of additional power sources in NYS in the form of bulk renewable power such as wind farms and solar photovoltaic farms fits naturally into NYPA's mission and capabilities.

Constraints in the transmission system limit the flow of power from the North and Western regions of NYS to the South and East high load centers. At this time the bulk of the wind farm developments are in the North and West regions of NYS. With NYC and LI representing 50% of the NYS load but 63% of the generation is upstate where transmission constraints cause high prices to downstate customers.

Therefore, this roadmap identifies the following target:

- *Encourage and incent third party bulk renewable developers to interconnect to the NYPA transmission system. This goal is in line with NYS initiatives for clean power and takes advantage of NYPA's expertise in implementing reliable interconnections as demonstrated with other wind farm developers. NYS currently has approximately 20% generation in the form of bulk renewable (15% hydro, 5% wind and other). NYS PSC has established a target that approximately 30% energy used (GWH) in NYS by 2015 comes from renewable sources.* Grid can operate reliably with a high percentage of bulk and distributed renewable generation. Identify locations in NYS where NYPA's transmission system substations provide good interconnection for additional bulk – such as mapping wind studies with T-LEM to prioritize system improvements.

With roughly 80% of NYPA's generation capacity in the form of bulk renewable, NYPA is exceptionally positioned within any overall state targets for renewable generation sources. NYPA's B-G Power Project Pumped-Storage hydro facility with 1160MW capacity also provides significant storage capability but is currently utilized as a peaking plant. This roadmap identifies the following target:

- *Develop studies (electrical system, market pricing, operational) and analyze options for increased utilization of B-G as a storage facility with more frequent generation. Additional generation from B-G will result in additional revenue for NYPA and will bring NYS closer to its target of 30% of electricity usage from renewable resources.*

- *The analysis should include options for bilateral agreements with Nuclear plants and/or wind developers in order to avoid market pricing for the pumping costs. This would incorporate large amounts of energy storage that can provide dynamic response and energy shifting capabilities to mitigate the intermittency, ramping, and dump power issues associated with renewable generation*.

The addition of such new power sources must take into consideration the efficiencies that NYPA has built into its hydroelectric power stations for optimal use of water, transmission capability, power delivery to areas where it's needed most, and for the overall benefit to NYS and NYPA's customers.

SOLUTION

NYPA is one of the premier producers of clean bulk power in the US. NYPA owns and operates three (3) large hydro facilities with capability of approximately 4600 MW and four (4) smaller hydro projects with approximately 25MW capability. The total hydro generation of 4450MW represents roughly 80% of NYPA's overall generation resource and 25% of NYS as a whole. Included in the generation capability is approximately 1160 MW from the pumped-storage facility at the BG Power Project. Following is a list of NYPA's bulk renewable generation sources).

Facility	Units	Unit Capability	Avg Availability **Average Plant Availability (% of hours available to produce power/8760vailability**	MW
Niagara Robert Moses Power Project and LPGP	13	225	89.2	2675 (w/LPGP)
St. Lawrence FDR Project	16	55	90.1	800
Blenheim-Gilboa	4	290	86.5	1160
Small Hydro	12	various	59.4	23

In addition to its own bulk renewable generation resources, NYPA has integrated bulk renewables from independent wind farm developers. These include:

<u>Noble Environmental (Ryan & Duley Substation):</u>

Noble Environmental Power is a leading wind energy company and owns four wind farms in North country New York. These four project sites produce about 385 megawatts, enough energy to power about 110,000 homes. The four (4) sites and their capacities are:

- Altona, Clinton County, 97.5 MW wind farm consists 65 GE 1.5 MW turbines
- Chateaugay, Franklin, County, 106.5 MW wind farm consists 71 GE 1.5 MW turbines
- Clinton, Clinton County, 100.5 MW wind farm consists 67 GE 1.5 MW turbines
- Ellenburg, Clinton County, 81 MW wind farm consists 54 GE 1.5 MW turbines.

Interfaces to the NYPA bulk electric system are at:

- Altona wind farm tie in to NYPA transmission system at Duley Substation and Ellenburg,
- Clinton and Chateaugay wind farms tie in to NYPA transmission via Ryan Substation.

<u>Horizon/Marble River Wind farm (Patnode)</u>

Marble River has installed a wind-power electric generating project in the towns of Clinton and Ellenburg in Clinton County, NY. The projects include a total of 72 turbines, comprised Vestas V112 wind turbines with generating capacity of 3.0 MW each. The two (2) sites and their capacities are:

- 56 turbines installed in Town Clinton, 168MW
- 16 turbines installed in town of Ellenburg, 48MW.

The wind farm is capable of producing up to 216 MW of power. These two wind farms tie in to NYPA 230KV transmission line at Patnode substation.

With their interconnections to the Northern Region transmission system, the wind farms receive generation control settings from NYPA's SCADA system at the STL-FDR Power Project.

The interconnections to NYPA's transmission system are coordinated within many NYPA departments. The technical requirements are detailed in NYPA interconnection agreements and the Design Basis Documents established by NYPA Engineering. The Design Basis establishes requirements for interconnection, addresses safety issues, and reliability and resilience for the interconnection. Flexibility is built into the Design Basis so that appropriate options for interconnection can be considered.

<u>Communication and Control of the Wind Farms</u>

Ryan, Duley and Patnode substation are monitored and controlled by STL control room. NYISO uses ECC, SCADA and NYPA local wind farm Remote Terminal Units (RTUs) to pass curtailment flag and load base-points to wind farm control centers.

RTU and data collection and transfer equipment has been installed at each substation to collect instantaneous data to be telemetered to the STL control center. The Local RTU interface with STL SCADA is via two redundant communication circuits. The primary communication link utilizes microwave and secondary communication link uses AT&T T1 frame relay circuit. Smart RTUs support multiple substation protocols that allow easier interface to smart digital Primary and Secondary protection Intelligent Electronic Devices (IEDs) such as Breaker protection, Line protection, Transformer protection, revenue meters etc. Multiple communication ports in the RTU eliminate hardwired I/O connection in RTUs and allow easier interfacing to smart substation sub systems such as Automatic Transfer Switches (ATS), propane generator, digital transducers etc. providing overall situational awareness of the substation and the windfarm.

NYPA measures, via RTU, net power flows including MW and MVAR, MWHR and loss profile data to and from the Marble River Wind farm at the point of interconnection. NYPA also provides wind farm metering and substation quantities in analog and digital form to wind farm over fiber link to their Wind farm Energy management system. Wind farm also provide gross MW and MVAR quantities at each generator terminal.

<u>Microwave Communication System</u>

New digital Microwave towers and communication equipment has been installed in these substations to interface with the existing NYPA digital microwave system. The new microwave system at Duley interfaces with Big Hill microwave Tower. Patnode interfaces with Ryan Tower and Ryan Tower interfaces with Willis substation Tower. The microwave back bone is from Plattsburg to Willis to Massena to Moses substation. Digital Microwave system provides critical and reliable communication path for Line/substation protection and remote substation operation.

Capability gap analysis And Activities to Address Gap (What else is needed?)

Overall, six (6) studies, to be funded by NYPA, are identified for this roadmap.

<u>Target 1: Promote interconnection to NYPA transmission system by third party bulk renewable developers:</u>

NYPA has demonstrated its capability to interconnect and integrate new wind farm facilities as is seen by its connections in Northern NY. This target is largely driven by developers and market conditions. As long as wind farm developers are willing to exploit wind resources and/or solar or other bulk renewables NYPA will be able to accommodate the developers. NYPA's Engineering Design Basis document provides details to developers regarding NYPA's interconnection requirements. NYPA is also in the midst of its multi-year Transmission Life Extension Modernization (T-LEM) projects that will upgrade all of its substations. This will further strengthen NYPA's capability to support additional generation sources upstate. As a multi-year project it may be possible for NYPA to consider wind and solar studies to determine and prioritize the ordering of the substations upgrades to those areas more beneficial to developers of renewables.

In the "2013 Special Reliability Assessment" report issued by NERC in November 2013 with California ISO (CAISO), NERC reports on specific areas to address integration of bulk renewable, these include:

- Reactive Power Control
- Active Power Control
- Inertia and Frequency Response
- Steady-State, Short-Circuit, and Dynamic Generic Model Development
- The recommendations from NERC and CAISO include development of standards, standard designs for reactive power control, flexibility in ramping, and frequency response capabilities. **Utilize transmission <u>studies</u> to determine where constraints are in the transmission system and overlap with wind studies identifying high wind locations in order to prioritize T-LEM upgrades to provide interconnection into the NYPA transmission system where developers want to build;**
- Fund <u>studies</u> on Grid-scale battery storage pilot projects;
- Fund <u>studies</u> and simulation of hypothetical integration of more renewables to prioritize R&D (Agile), the basis for the studies could come from the NERC/CAISO report;
- Negotiate power purchase agreements with bulk renewable developers;
- Regularly review and maintain design basis document and update it to account for new technologies and support for the system capabilities identified in the NERC/CAISO report;

<u>Target 2: Study development of BG as a storage facility for higher utilization and stabilizing variable generation sources:</u>

In the winter months of 2013 – 2014 the BG facility was called in to frequent generation mode due to extremely harsh winter weather resulting from a Polar Vortex. During the January to March period, BG revenue were 5 times budgeted ($3,649,000 budgeted vs $14,645,000 actual). The reason was due to high market prices due to fuel gas shortages that outweighed the cost of pumping BG. Therefore to utilize BG more effectively for increased revenue the following activities are needed:

- Participate in EPRI Program 173, generation and wind/solar studies and modeling is researched;
- Fund studies for market analysis for bilateral agreements vs market pricing for purchasing power to pump BG;
- System Planning studies to analyze new modes of BG operation such as storage control and regulation;
- Continue to participate in NREL – PSERC study;
  - The PSERC project develops new models and algorithms to effectively integrate energy storage technologies within existing energy management systems and market management systems.

Negotiations with a base loaded plant that can reliably provide low cost power to B-G should be explored. Other options include direct transfers from NYPA plants such as Niagara, purchasing power from plants that are financially troubled, or consideration for building new transmission to interconnect directly into regions/zones were BG could sell into more expensive markets.

Another study area for exploration could be development of another generating unit/plant at BG. This unit could be a small unit fueled by the existing reservoir. The unit would be a generator only that would not have the operational and market constraints of the BG plant. The additional unit(s) could provide voltage and frequency support as identified in the NERC/CAISO report as well as additional generation capacity. Environmental impact and geological components would need to be included in the study.

General Commentary

NYPA has demonstrated experience of its capability to integrate bulk renewable generation resources into the power grid through its own hydroelectric projects as well as with its interconnections with 3rd party wind farm developers.

The majority of wind farm sites in NYS are located in the northern and western regions of the state. These are lower load areas compared with the south eastern portions of the state. The excess of the wind farm capacity upstate and the limitations of the transmission system to deliver power to the lower portions of the state due to system constraints and delivery losses on long-haul transmission lines limits suitability for additional wind power sites upstate.

Excess capacity upstate is resulting in NYPA's major hydro resources (arguably the largest and cleanest bulk renewables) to back off generation and thereby its utilization of water from Niagara Falls and the St. Lawrence River. This reduction in generation could result in less efficient operation of existing clean facilities and higher costs to consumers as higher cost generators are dispatched.

NYPA can use its Transmission Planning and Engineering resources to enhance its transmission planning and siting programs to determine where the capacity is needed and the identification of any transmission constraints that should be addressed to ensure efficient delivery. A concept of "build it where it's needed" as opposed to "build it and they will come" is needed.

Improvements to the transmission system so that power from upstate can be delivered downstate without impact to NYPA existing hydroelectric generation should be considered. Projects to update the transmission system through the T-LEM program and NY Energy Highway are important and should address the constraints issue and allow flexibility for a variety of generation sources.

Other areas for possible solutions

Increase transmission capacity or energy storage or aggregated Demand Response programs.

Weather forecasting models, particularly for wind and solar forecasting, are needed to determine proper placement for these renewable sources. With improved forecasting for wind or large solar projects better integration into the markets will result. NYISO has a wind forecasting initiative and NYPA is supporting them on the early stages of a solar forecasting model.

On a more distributed level, that could support the transmission level, is the use of smart inverters for solar or wind power plants. Inverters can work to support voltage or frequency on the grid and may offer functionality to support transmission.

New generating facilities and likely new substations will require expansion of NYPA's communication circuits. Upstate regions utilize a new digital microwave system for their primary communication and T1 for secondary communication paths. An opportunity to begin development of a fully NYPA owned and dedicated communication system using existing rights of way and transmission towers should be explored as part of the modernization efforts.

Timelines

- Studies can begin in 2015 and would be expected to take 1 – 2 years;
- NYS Installed Reserve Margin (IRM) is at 17%
- NYISO projections are that generation will be ahead of load through 2019;
- Generation will match load 2019-2020;
- New generation will be needed by 2021 to stay ahead of the load growth;
- Actively pursue BG option for more utilization of BG generation
- Complete operation system studies
- Negotiate pre-purchase agreements at 50% discount to historic average market prices
- Complete this combination option (1 & 2) by 2019 in order to support load growth;

BENEFITS

Target 1: Encourage third party bulk renewable developers

Promote interconnection to NYPA transmission system by third party bulk renewable developers:For this target area, NYPA has demonstrated its capability by integrating several wind farms into NYPA's Northern Region substations and SCADA system and EMS.

NYPA has demonstrated experience of its capability to integrate bulk renewable generation resources into the power grid through its own hydroelectric projects as well as with its interconnections with 3rd party wind farm developers. Several 3rd party wind farms have been interconnected into NYPA's Northern Region substations and SCADA system and EMS.

This target becomes primarily an initiative to support NYS goals for increased clean power sources such as wind and solar. In 2013, use of renewable in NYS was 22%, the NYS PSC target for 2015 is 30%. The benefits would be intangible to NYPA such as continuing leadership in "green" power and stewardship of the natural resources of NYS which links with the mission statement.

By increasing generation from BG based on the Target 2 outcome then the additional generation will add to the renewable usage target to benefit NYS.

Target 2: Utilization of BG as storage for higher utilization and stabilizing variable generation sources:

In the winter months of 2013 – 2014 the BG facility was called in to frequent generation mode due to extremely harsh winter weather resulting from a Polar Vortex. During the January to March period, BG revenue were 5 times budgeted ($3,649,000 budgeted vs $14,645,000 actual) since gas supplies were restricted and BG was needed to generate. The reason was due to high market prices that compensated for the cost of pumping BG. The project for modeling pumped-storage hydro by PSERC for better utilization should be able to provide quantitative results that could be applied to B-G operation.

Additional benefits include:

- Increased revenue
- stabilizing and reducing wholesale electricity prices
- increasing the spread of renewable energy- reducing the need to expand electricity transmission
- Increased usage of renewable power to help meet the NYS goal of 30%
- improving grid operations
- enhanced bulk energy storage compared to conventional batteries
- Higher utilization of plant capacity (probable increase in O&M)

Based on meeting of 7/31/2014 financials are to be removed from this roadmap.

Assumptions:

Market Price to sell BG generation: $36.00/MWh

Price to buy energy to pump BG: $18.00/MWh

BG generates 8 hours per day

BG does not generate on weekends (generates 365 – 2*52): 261 days

Plant efficiency 69% (Pump = 1.42 * Gen)

Increase in renewable generation value is based on 2013 NYISO Gold Book using 2012 year end totals and the generation values in the tables below. It is assumed that the BG generation will displace Coal.

Gen	Gross Gen MWh/yr	Gross Gen Rev	Gross Pump MWh/yr	Net Gen MWh/yr	Net Revenue	Increase to % NYS renewable generation
250	522,000	$18,792,000.00	741,240	(219,240)	$5,449,680.00	n/c
500	1,044,000	$37,584,000.00	1,482,480	(438,480)	$10,899,360.00	0.5
750	1,566,000	$56,376,000.00	2,223,720	(657,720)	$16,349,040.00	1.0
1000	2,088,000	$75,168,000.00	2,964,960	(876,960)	$21,798,720.00	1.25

Budgeted Net Revenue for BG in 2013 was $5,050,000.

Using the 500MW Generation estimate NYPA would have $18,899,360 Net Revenue which is an incremental benefit of approximately $5.8M.

FUNDING

Funding for this effort would come from NYPA general funds and budgeted annually as needed for research efforts. NYPA already participates in several EPRI research efforts and can provide additional funding for targeted collaboration projects.

As developers and projects are identified to support then capital funding requests would be budgeted.

Additional funding could be developed in partnership with developers.

COSTS & RESOURCES

Initial costs for this effort would include budgeted dollars as well as labor resources to fund the studies as well as NYPA staff to work with the research partners and consultants.

Normal NYPA procurement processes would be followed.

IMPACT ON MARKET

If the studies prove that reliable pre-purchase agreements can be contracted with power producers then the added generation from BG can result in stabilizing and reducing wholesale electricity prices.

As wind power and/or solar expand into the NYS market BG provides a stabilizing factor for the intermittency of variable generation sources.

BG provides large bulk energy storage compared to conventional batteries and other sources that are still immature technologies.

Results from the studies could lead to additional benefit to NYS such as:

- Meet NYS and Federal requirements for clean power in the renewable portfolio
- More availability of clean power, reducing greenhouse gas emissions.
- Identify new renewable resources and how they can be integrated into the NYS grid
- Brings down cost of clean power
- Can retire older fossil plants
- Creation of permanent jobs to operate and maintain the plant
- More jobs during the construction phase

ORGANIZATIONAL IMPACT

Target 1: Encourage third party bulk renewable developers

NYPA has experience with working with bulk renewable developers in the Northern Region and their interconnections into NYPA substations and to the SCADA and EMS. Any project with a bulk renewable developer would follow normal NYPA project management procedures.

Target 2: Utilization of BG as storage for higher utilization

NYPA has operated the B-G facility more frequently in the past under when market pricing has been favorable for generation over pumping. Therefore the organizational impact should be minimal.

EXTERNAL STAKEHOLDER IMPACT

As BG is better utilized as a generation source NYS would be able to encourage more wind, solar, and other renewable sources since BG could provide a stabilizing force in the market with its reliable hydro supply.

Additional impact to stakeholders includes:

- increasing the spread of renewable energy- reducing the need to expand electricity transmission
- Increased usage of renewable power to help meet the NYS goal of 30%
- improving grid operations
- More availability of clean power
- Impact to day-ahead and real-time market pricing

DEPENDENCIES & RISKS

- Identify dependencies between activities
- A high-level risk overview, specifying probability and severity of key risks, risk owners and action plans.
- Determine timeframes for the activities

Target 1: Encourage third party bulk renewable developers

The risk is the continued viability of adding bulk renewables into the NY system. Transmission constraints need to be addressed. Another factor is general economic conditions and tax incentives so that developers and investors would want to continue to build renewable power sources in NYS.

Target 2: Utilization of BG as storage for higher utilization

At this time tariffs and market prices are not favorable to warrant running B-G generation more frequently. As seen in the first quarter with the actual revenue at approximately 5x the projected revenue for B-G, a significant benefit for NYPA is available. However, without pre-purchase agreements or significant differential in pricing between buy and sell (>30% needed) it won't make sense to run B-G more frequently.

Smart G&T Capability Roadmap Detail

SGR6: Integration of Distributed Generation

Capability Manager: Randy Solomon

CAPABILITY VISION / STRATEGIC RATIONALE

Today's energy system is transitioning dramatically. The current macrogrid, made up of large scale power plants generating bulk electricity to be transmitted to substations and then distributed to end users is evolving into a more complex, smarter system. A growing market for end user participation via on-site generation is enabling the development of renewable technologies, small scale power plants and local energy networks. This end user effort is contributing to the need for a holistic approach to the next generation grid, where end user generation will be tied into the macrogrid to benefit the overall system.

As the nation's largest public utility and a leader in innovation, NYPA has the opportunity to aid in the development and integration of distributed generation technologies. With this goal in mind we present the following vision:

1. *Play a leading role in incentivizing the installation of DG assets.*
2. *Provide a control center platform to seamlessly tie in existing and future distributed generation assets for better control and stability of the overall system.*
3. *Demonstrate the benefits and feasibility of local energy networks.*

SOLUTION

Play a leading role in incentivizing the installation of DG assets

- Leverage expertise to help mold industry standards
- Currently standards for interconnecting distributed generation (IEEE1547) are under development. NYPA can expend resources to assist in developing these standards in a way that we can detail how we would be able to communicate with the asset. In addition, the Public Service Commission (PSC) is revising some of their regulations in order to better facilitate the installation of distributed generation technologies. We have been active in the committee meetings in order to aid in the development of less restrictive PSC regulations.
- Provide funding for select distributed generation (DG) assets based on optimizing our transmission assets

  Optimal placement and sizing of DG assets can decrease system losses and reduce power congestion. A study will be proposed to look at ideal locations for DG assets at customer locations. While this is commonly utilized on the distribution side, there may be some implications for power loss reduction via the integration of DG assets along the transmission lines.

NYPA aims to provide a control center platform to seamlessly tie in existing and future distributed generation for better control and stability of the overall system.

- Implement a Virtual Power Plant and DG data monitoring software

  A Virtual Power Plant (VPP) is a controller which utilizes real time data from a cluster of distributed generation assets. The VPP will have built in control modules to ensure all generation sources are running optimally and maximizing economic payback. Savings will be derived from demand response, ancillary services, grid energy curtailment, real time power purchasing, etc. In addition, data will be archived so any irregular behaviors of generation sources will be identified and remediated. Additional data such as weather information and wind information will allow for VPP forecasting. This information will also be tied into our smart generation and transmission controller to optimize DG assets, prioritize clean energy, enable black start of power stations, and enable more accurate power planning/purchasing.

Demonstrate the benefits and feasibility of local energy networks

- Demonstrate a microgrid installation to serve as an example of the benefits that are included in distributed generation technologies

There are microgrids located within New York State, but the uniqueness of the proposed pilot is that we would like to integrate these assets into our internal Virtual Power Plant software. An advanced controller would be installed in order to allow remote monitoring and possibly control. Different control algorithms would be tested to determine optimal ways to benefit customer, distribution company, and generation/transmission supplier.

Current State

1) Incentivization of DG
    a) IEEE in process of developing DG interconnection standards (1547)
    b) Currently no geographic map of where DG placement would be optimized
2) Implement Virtual Power Plant
    a) Currently no hardware/software support for DG assets
    b) NYPA currently has programs to monitor customer usage via smart meters, the capabilities are deficient for what we need but it can act as a template for data center implementation
    c) Currently do not have the proper technology at DG sites to communicate with VPP
3) DG/Micro-grid pilots
    a) Internal MG&DG program established to install one (1) upstate and one (1) downstate CHP/MG project

Capability gap analysis

1) Incentivization of DG
    a) Participate in IEEE 1547 standards
    b) Optimize placement of DG
2) Build 'Virtual Power Plant'
    a) Install Hardware, and design software system
    b) Data centralization and visualization
    c) Enhanced Load Management
    d) Integrate with existing DG control systems
    e) Integrate weather information
    f) Integrate with NYPA power planning/purchasing systems
3) DG/Micro-grid pilots

Activities to address gap

1) Incentivization of DG
    a) NYPA to send resources to IEEE 1547 meetings to aid in establishing standards for DG interconnection
    b) Hire a contractor to perform study
2) Build 'Virtual Power Plant'
    a) Install Hardware, and design software system
    b) Data centralization and visualization
    c) Enhanced Load Management
    d) Integrate with existing DG control systems
    e) Integrate weather information
    f) Integrate with NYPA power planning/purchasing systems
3) DG/Micro-grid pilots

BENEFITS

Quantifiable cost savings were derived from the following methodologies

1) Incentivization of DG – No quantifiable cost savings at this point.

2) Build 'Virtual Power Plant' – Monetary savings via demand response for customer. Possible savings if we plan to set up shared saving agreements. Additional savings can be acquired via building, maintaining, and controlling the DG asset.
3) DG/Micro-grid pilots – Revenue is based on our Energy Efficiency Division project management fee. It is assumed that we will be implementing the project for the customer and potentially financing it, but the customer will cover the implementation cost and receive the savings.

Qualitative savings

1) Incentivization of DG
    a) Enable market penetration of clean, renewable energy technologies.
    b) Increase resiliency via distributed generation as backup power.
2) Build 'Virtual Power Plant'
    a) Coordinate emergency response plans via customer DG assets for when the macrogrid goes down.
    b) Optimize power purchasing due to enhanced forecasting to lower customer energy costs and increase NYPA's flexibility in the energy market.
    c) Real time monitoring of PLM and other demand response programs.
    d) Reinforcing current infrastructure without building additional structures.
3) DG/Micro-grid pilots
    a) Demonstrate the viability and benefits of microgrids to spur private capital investments in microgrids.

FUNDING

1) Incentivization of DG – Assumed no outside funding
2) Build 'Virtual Power Plant' – Assumed no outside funding
3) DG/Micro-grid pilots - Customer will fund DG/Microgrid, NYPA will pay for initial study to spark customer interest. NYPA will provide project management services for installation.

COSTS & RESOURCES

1) Incentivization of DG
    a) Study Cost – $250K
    b) Human resources required are available within NYPA
2) Build 'Virtual Power Plant'
    a) Startup funding - $5M for Hardware/Software
    b) Ongoing funding – 6-8 FTE – $1,500,000k/yr.
3) DG/Micro-grid pilots
    a) Human resources required are available

IMPACT ON MARKET

1) Stimulate Distributed Generation projects within New York State.
2) Allow for market penetration of microgrids.
3) Create a new revenue stream via new business models (I.e. build, own, operate, and maintain DG assets on customer property).
4) Create platform for DG controls for our customer and NYPA
    a) If PSC changes regulations, customer DG assets can assist the macrogrid by exporting energy produced.
5) Optimize power purchasing due to enhanced forecasting to lower customer energy costs and increase NYPA's flexibility in the energy market.

6) Real time monitoring of Peak Load Management and other demand response programs.

ORGANIZATIONAL IMPACT

- Additional staff required to support overall DG effort

EXTERNAL STAKEHOLDER IMPACT

New York State

- Lower energy costs for NYPA customers
    - More diversified portfolio of generation sources
- Reduce GHG emissions
- Reduce Source EUI
- Increased grid resiliency

Investor Owned Utilities

- Platform for next generation smart distribution grid
    - Potential to partner with NYPA and customers to utilize generation data in distribution planning

Customers

- Easy way to tie in existing and proposed DG Assets
- DG assets will increase in savings amount via NYPA control system

DEPENDENCIES & RISKS

- Integration needed with other NYPA initiatives (Customer Energy Solutions & Build Smart, NY Energy Manager) and NYPA departments (IT, Economic Development, Power Purchasing, Operations, & Energy Efficiency)

- Risk Review
    - Cyber security required
    - Economic – medium
    - Safety – medium

- Currently regulatory barriers
- Economic feasibility of distributed generation technologies in varying applications
- Customer commitment
- Market penetration of distributed generation technologies
- Risks of using new cutting edge technology