nationalgrid

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October 31, 2016

VIA ELECTRONIC DELIVERY

Honorable Kathleen H. Burgess
Secretary
New York State Public Service Commission
Three Empire State Plaza, 19th Floor
Albany, New York 12223-1350

RE: Case 14-M-0101 – Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision (REV)

NATIONAL GRID: COMMUNITY RESILIENCE REV DEMONSTRATION PROJECT – Q3 2016 REPORT

Dear Secretary Burgess:

Niagara Mohawk Power Corporation d/b/a National Grid ("National Grid") hereby submits for filing its quarterly update to the Community Resilience REV Demonstration Project Implementation Plan covering the period of July 1, 2016 through September 30, 2016 ("Q3 Report") as required by the REV Demonstration Project Assessment Report filed by the New York State Department of Public Service Staff ("Staff") with the Commission on February 10, 2016 in Case 14-M-0101.

Please direct any questions regarding this filing to:

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National Grid looks forward to continuing to work collaboratively with Staff as it proceeds with the implementation of the Community Resilience REV Demonstration Project.

Respectfully submitted,

/s/ Karla M. Corpus

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Senior Counsel

Enc.

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national**grid**

Community Resilience

REV Demonstration Project

Potsdam, New York

Q3 2016 Report

October 31, 2016

Table of Content

1.0 Executive Summary

Under the New York Public Service Commission's ("PSC") Reforming the Energy Vision ("REV") proceeding, this Community Resilience Demonstration Project (the "Project") focuses on improving the local resiliency during severe weather events in the remote Village of Potsdam ("Potsdam") in Upstate New York with the creation of a community microgrid. Potsdam and surrounding St. Lawrence County have experienced a number of multi-day power outages as a result of microbursts and winter ice storms; most notably the "Ice Storm of 1998" which left over 100,000 customers without power for up to 3 weeks in the North Country and recently, in December of 2013, another ice storm isolated over 80,000 customers for days.

Image 1.1 – Photo of Upstate New York after the 1998 Ice Storm[1]

Niagara Mohawk Power Corporation d/b/a National Grid ("National Grid" or the "Company") has partnered with Clarkson University in order to develop a community resilience microgrid for Potsdam with an underground distribution network and coordination of new and existing distributed energy resources ("DER"). Concurrently, the Company will develop and test new utility services that may be required for further microgrid deployment in New York State.

The four services to be developed and tested are:

1. Tiered recovery for storm-hardened, underground wires;
2. Central procurement for DER;
3. Microgrid control and operations; and
4. Billing and financial transaction services.

[1] Image was taken during the aftermath of 1998 Ice Storm.

While National Grid is leading the Project, this demonstration is actually a close-knit partnership effort between Clarkson University and National Grid. Moreover, it will require significant input from other major Potsdam stakeholders, such as the Village of Potsdam government, the Canton-Potsdam Hospital, and the State University of New York at Potsdam ("SUNY Potsdam").

Image 1.2 – The major stakeholder partners of the Community Resilience demonstration (clockwise, from top left: Clarkson University, SUNY Potsdam, Village of Potsdam Offices, Canton-Potsdam Hospital)

During the third quarter of 2016 the National Grid project management team continued efforts to finalize the Conceptual Design phase of the Project. A draft of the New York State Energy Research and Development Authority ("NYSERDA") Program Opportunity Notice ("PON") 2715 Task 4 report was received from partners Clarkson University and GE Energy Consulting containing the basis for the microgrid cost estimates as well as a societal benefit-cost analysis ("BCA").

In addition, the Project team continued to receive updates on the National Science Foundation ("NSF") Partnerships for Innovation: Building Innovation Capacity ("PFI:BIC") and the U.S. Department of Energy's ("DOE") Office of Electricity Delivery and Energy Reliability Enhanced Microgrid Control System ("eMCS") projects while meeting regularly to discuss RFP 3044 NY Prize Community Grid Competition - Stage 2: Detailed Engineering Design and Financial and Business Plan RFP ("NY Prize Stage 2 RFP").

2.0 Highlights Since Previous Quarter

National Grid and the key Project partners have made substantial progress in the third quarter of 2016, with all parties continuing to push for expected outcomes laid out in the Project Implementation Plan.[2] For a reference timeline emphasizing the major milestones and accomplishments, please see Figure 2.1. Changes and additions are highlighted in yellow and are described in more detail in Section 3.1.

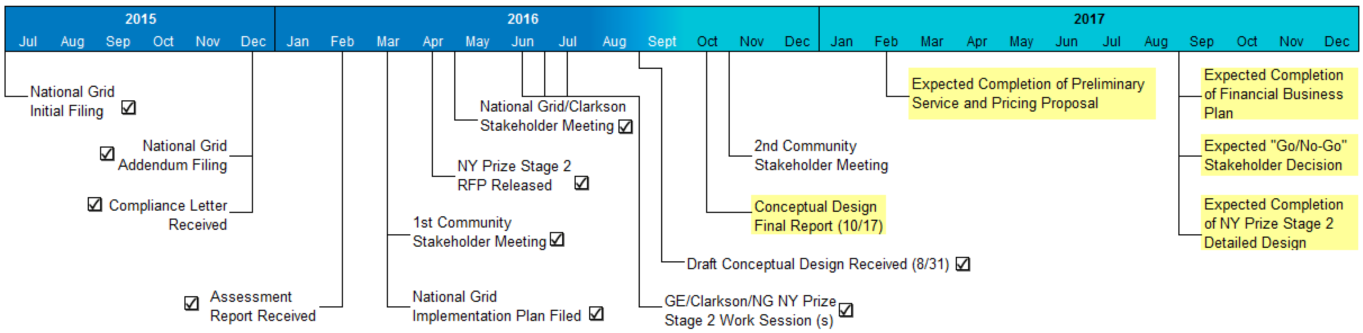

Figure 2.1 – Achievements and Milestones Timeline

2.1 Major Task Activities

1. **Conceptual Design Draft (NYSERDA PON Task 4)**
   Originally due June 30, 2016, GE Energy Consulting delivered a draft of the NYSERDA PON Task 4 report to National Grid and Clarkson University on August 31, 2016. The draft report contains the basis for the microgrid cost estimates, a detailed one-line diagram (see attached Appendix D), as well as a societal BCA.

   The final of the four-part PON series, this report quantifies the major equipment items, their general ratings and specifications, and their associated costs. It also examines the overall societal BCA of the proposed microgrid using NYSERDA's approach to the NY Prize Stage 1 competition.

   a. **Cost Breakdown**
      The cost estimates found within the report were developed by GE Energy Consulting from actual equipment quotes, historical pricing, or raw estimations. It is intended to capture only the major equipment items; minor items have not been included and have been lumped into the miscellaneous costs total.

      A detailed material list was included in the report with quantities, descriptions, specifications, and potential suppliers, but did not include specific costs by equipment item. Further material cost breakdowns will be

[2] Case 14-M-0101-*Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision*, National Grid Implementation Plan for Community Resilience REV Demonstration Project, Potsdam, New York (filed March 11, 2016).

included in the detailed engineering design during the next phase of the Project.

The proposed microgrid requires 4 MW of additional generation in order to serve the participant load during island mode. The cost estimate included three (3) new generation equipment options and two (2) distribution equipment options. The generation options include dual fuel, natural gas only, and a GE hybrid fuel cell/natural gas option, all with varying cost estimates. The choice of generation equipment will ultimately lie with the generation owners and not with National Grid unless an alternative business model, as conceptually laid out later in this report, was to be adopted for the Project.

The two (2) distribution equipment options are distinguished between the number of circuit breakers needed for adequate protection and flexibility of the microgrid. With forty-nine (49) circuit breakers, the first option would offer the maximum level of flexibility as it would be capable of isolating system faults affecting the minimum possible number of loads. The second option would offer the same level of protection with a slightly lower capacity to isolate faults resulting in lower costs. This would be accomplished by substituting some of the circuit breakers with fused switches. After reviewing the cost information and one-line diagram, the Project team is requiring an additional option be included that would reduce the number of circuit breakers and utilize additional fused-switches to provide a strong level of protection and flexibility at a potentially lower cost.

Table 2.1 details the estimated costs of the major components of the proposed microgrid.

Category	Equipment Costs	Installation Costs	Total
Generation			
Option 1 (Dual Fuel Option)	$4,000,000[1]	$1,500,000	$5,500,000
Option 2 (Natural Gas Only Option)	$2,700,000	$1,500,000	$4,200,000
Option 3 (GE Hybrid Fuel Cell/Natural Gas Option)	$25,000,000[2]	$3,500,000	$28,500,000
Distribution (Includes Interconnection Cable, Breakers, and Switches)			
Option 1 (Breakers Only)	$11,813,000	$11,705,000	$23,517,000
Option 2 (Breakers and Fused Switches)	$11,272,000	$11,185,000	$22,456,000
Protection	$1,941,000	$630,000	$2,571,000
Control and Communications	$2,783,000	$1,450,000	$4,233,000
Energy Storage Equipment Option	TBD	TBD	TBD
Gas Extension and Connections	n/a	n/a	$150,000
Gas Extension, Diesel Storage, and Connections	n/a	n/a	$200,000
Miscellaneous Equipment	n/a	n/a	$750,000
Engineering and Design	n/a	n/a	$1,000,000
Testing and Commissioning	n/a	n/a	$250,000

[1] Dual Fuel Engine cost is a conceptual estimate only; no quote was received from supplier.
[2] GE Hybrid Fuel Cell/Natural Gas Engine cost is still in development.

Table 2.1 – Conceptual Design Cost Information

b. Benefit-Cost Assessment

GE Energy Consulting used the societal BCA model promulgated by Industrial Economics, Inc. (“IEc”). IEc was retained by NYSERDA to provide a uniform and consistent methodology for comparing the benefits and costs of different NY Prize Stage 1 projects, and the model was deemed a useful tool to analyze the Potsdam microgrid.

While an economic BCA is important in any investment, a societal-based BCA is required for resilient community microgrids to justify the investment based on the net benefits to the society as a whole. Therefore, the model estimates the costs and benefits of a microgrid from the perspective of society, taking into account the benefits of maintaining operations at the facilities served by the microgrid in the event of a prolonged emergency.

The BCA model analyzes the microgrid’s costs and benefits over a twenty (20) year time horizon applying conventional discounting techniques to calculate the present value of costs and benefits. After the model evaluates the microgrid’s cumulative benefits and costs, it then calculates the ratio of the microgrid’s present value of benefits to its present value of costs, as well as the project’s internal rate of return (“IRR”).

There is a comprehensive list of data required for the BCA model including demographic information, engineering costs and maintenance, fuel consumption, facility descriptions, DER characteristics, environmental impacts and emission allowances, capital investments, and emergency services, to name a few.

The BCA model considers costs and benefits for two scenarios:

- Scenario 1: No major power outages over the assumed 20-year operating period (*i.e*., normal operating conditions only).
- Scenario 2: The average annual duration of major power outages required for project benefits to equal costs, if benefits do not exceed costs under Scenario 1.

The BCA model classifies outages caused by major storms or other events beyond a utility's control as "major power outages".[3]

The BCA results indicate that under current assumptions, assuming no major power outages during a twenty (20) year time horizon, the Potsdam microgrid's societal present value of costs would exceed its present value of benefits, resulting in a societal benefit to cost ratio of 0.81. The results of the Scenario 1 analysis are provided in Table 2.2.

[3] As noted by IEc: "The New York State Department of Public Service ("DPS") requires utilities delivering electricity in New York State to collect and regularly submit information regarding electric service interruptions. The reporting system specifies the information include ten (10) cause categories: major storms; tree contacts; overloads; operating errors; equipment failures; accidents; prearranged interruptions; customers equipment; lightning; and unknown. (There are an additional seven cause codes used exclusively for Consolidated Edison's underground network system, which are inapplicable here.) Reliability metrics can be calculated in two (2) ways: including all outages, which indicates the actual experience of a utility's customers; and/or excluding outages caused by major storms, which is more indicative of the frequency and duration of outages within the utility's control. In estimating the reliability benefits of a microgrid, the BCA employs metrics that exclude outages caused by major storms. The BCA classifies outages caused by major storms or other events beyond a utility's control as "major power outages," and evaluates the benefits of avoiding such outages separately."

Cost or Benefit Category	Present Value Over 20 Years (2014$)	Annualized Value (2014$)
Costs		
Initial Design and Planning	$1,250,000	$110,272
Capital Investments	$36,922,000	$2,780,758
Fixed Operation and Maintenance ("O&M")	$3,926,650	$346,400
Variable O&M (Grid-Connected Mode)	$11,160,556	$984,558
Fuel (Grid-Connected Mode)	$33,362,340	$2,943,148
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$22,697,293	$1,481,179
Total Costs	**$109,318,838**	**$8,646,316**
Benefits		
Reduction in Generating Costs	$42,525,428	$3,751,495
Fuel Savings from Combined Heat and Power ("CHP") Facilities	$0	$0
Generation Capacity Cost Savings	$8,690,644	$766,668
Distribution Capacity Cost Savings	$0	$0
Reliability Improvements	$1,878,695	$165,845
Power Quality Improvements	$6,666,383	$588,093
Avoided Emissions Allowance Costs	$19,071	$1,682
Avoided Emissions Damages	$28,334,071	$1,849,024
Major Power Outage Benefits	$0	$0
Total Benefits	**$88,114,291**	**$7,122,807**
Net Benefits	**-$21,204,547**	**-$1,523,509**
Benefit-Cost Ratio	**0.81**	
Internal Rate of Return	**-0.70%**	

Table 2.2 – Societal BCA Results Scenario 1

However, the Potsdam microgrid is intended to be a resilient microgrid that would provide electric power to the microgrid's critical facilities in the event of a major power outage for an extended period. As expected, avoidance of outages would then increase the societal benefits of the microgrid due to a reduction in the interruption costs of the microgrid facilities.

By incrementally adding fractions of major power outage days to the BCA model, it was determined that with 0.73 days of outages per year, the Potsdam microgrid would achieve a societal BCA of 1.0, with an IRR of 6.50%. The results of Scenario 2 are provided in Table 2.3.

Cost or Benefit Category	Present Value Over 20 Years (2014$)	Annualized Value (2014$)
Costs		
Initial Design and Planning	$1,250,000	$110,272
Capital Investments	$36,922,000	$2,780,758
Fixed O&M	$3,926,650	$346,400
Variable O&M (Grid-Connected Mode)	$11,160,556	$984,558
Fuel (Grid-Connected Mode)	$33,362,340	$2,943,148
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$22,697,293	$1,481,179
Total Costs	**$109,318,838**	**$8,646,316**
Benefits		
Reduction in Generating Costs	$42,525,428	$3,751,495
Fuel Savings from CHP	$0	$0
Generation Capacity Cost Savings	$8,690,644	$766,668
Distribution Capacity Cost Savings	$0	$0
Reliability Improvements	$1,878,695	$165,845
Power Quality Improvements	$6,666,383	$588,093
Avoided Emissions Allowance Costs	$19,071	$1,682
Avoided Emissions Damages	$28,334,071	$1,849,024
Major Power Outage Benefits	$21,161,175	$1,868,125
Total Benefits	**$109,275,466**	**$8,990,933**
Net Benefits	**-$43,372**	**$344,616**
Benefit-Cost Ratio	**1.00**	
Internal Rate of Return	**6.50%**	

Table 2.3 – Societal BCA Results Scenario 2 (with 0.73 Days of Annual Major Power Outages)

While the GE Energy Consulting team was completing the above work on the NYSERDA Task 4 report, the Clarkson University team was given the opportunity to present a paper regarding the Potsdam microgrid at the Innovative Smart Grid Technologies ("ISGT") conference in Minneapolis, Minnesota held in the beginning of September. The paper, entitled *Peak Load Carrying Capability of a Resilient Microgrid in Island Mode*, focused on proposed method utilizing microgrid unavailability criterion evaluating peak load carrying capabilities of a resilient microgrid in the islanded mode. The paper was presented by Thomas Ortmeyer and Amir Enayati, Clarkson University professors.

2. **Business/Governance Plan Analysis**

A major activity during the third quarter was the discussion of possible business models for the proposed microgrid. The collective Project team developed a working document to encapsulate possible scenarios regarding ownership structure, maintenance, governance, DER ownership, market interaction, and regulation.

In addition, GE Energy Consulting's affiliate, Current, hosted a brainstorming session on July 14, 2016 to develop business model ideas for National Grid that could possibly be explored and advocated for the Project. The result of that meeting and subsequent correspondence with Project partners produced a list of six (6) possible business models, as summarized below:

a. **National Grid REV Demo Option**
A tiered recovery option as described in the Project Implementation Plan.[4] National Grid would recover the cost of the primary underground system through multiple tiers of surcharges within the community. The model includes an expanded operational role for National Grid by servicing the microgrid controller, providing billing services, and central procurement of DER. The DER would be owned by the microgrid stakeholders or a third party.

b. **DER Provider Option**
Microgrid generation would be owned by several microgrid entities and operated as a single entity. The aggregator could be National Grid, a consortium of local customers, or a third party. DER owners would be able to benefit from market opportunities, combined O&M, and reliability synergies. Load and generation entities would be treated separately for supply billing, demand, and other activities. There could be aggregation of the individual demand charges, with a negotiated fee to National Grid for the service of connecting these customers. Pricing would be based on Location Based Marginal Pricing + DER ("LBMP+D").

c. **DER Energy Service Company ("DESCO") Option**
The microgrid network would be owned and operated as a DER Energy Service Company ("DESCO") by National Grid as a separate, regulated entity. Microgrid generation would be either owned or contracted for and operated by the DESCO utilizing bilateral supplier contracts with microgrid tenants and other customers. The DESCO would meet its supply obligations by optimal scheduling of microgrid generation and/or purchases from the New York Independent System Operator ("NYISO"). National Grid would be a provider of "settlement" services, such as smart metering and billings. Customer rates would reflect the flexibility and cost of participating in the microgrid. Pricing would be based on LBMP+D. The need for or the role of a local community utility board in this option remains to be determined.

d. **Community Special Utility District ("CSUD") Option**
The entire Potsdam overhead distribution system (as well as the proposed underground distribution system) would operate as a Community Special Utility District ("CSUD"). National Grid would own, operate, and maintain the substation and primary distribution system as a separate, regulated entity led by a community utility board which is also accountable the PSC. The CSUD would be responsible for operation, maintenance and capital costs of the utility services within the CSUD and hold the authority to determine rate incentives and procedures for optimizing the performance of the electric power grid within the district.

[4] Case 14-M-0101, s*upra* note 2.

e. **Feeder Special Utility District (“FSUD”) Option**
The Feeder Special Utility District (“FSUD”) would operate similarly to the CSUD. The primary difference would be that FSUD would operate on the single feeder that supplies the microgrid. The FSUD would operate as a single entity from the regulatory and power grid perspective, and would be a Service Classification (“SC”) 3A transmission customer of National Grid. The FSUD would be responsible for its share of National Grid’s Lawrence Avenue substation costs, and for all of the primary distribution costs within the district. It would benefit from operating all of the microgrid generation as a single entity, and it would be billed as a single unit for demand charges. The FSUD would be governed by a board selected from feeder customers.

f. **Innovation or Performance Based Pricing Option**
The microgrid entity would be owned and operated by National Grid and would be subject to a fixed annual revenue recovery or rate of return (adjusted on an annual basis). If the microgrid entity can reduce its costs by innovation of either its microgrid assets or operations, then any savings would be split between the microgrid entity and the microgrid customers. Annual regulated revenue could be reduced by a fraction each year in order to stimulate innovation.

National Grid hosted a working session on September 12, 2016 with Clarkson University and GE Energy Consulting to discuss the above governance models while debating the pros and cons of each option. A summary of the discussion can be found in Appendix C. In general, each option presented opportunities and challenges to both ownership structure and PSC approval. The major conclusions of the discussion were:

- A rational, transparent rate structure is required;
- Participation in day-ahead market and ancillary services is also important;
- Aggregation of demand and generation is equally valuable;
- Possible utility district options must be further analyzed;
- A combination of the above-listed business models will most likely be the best option (*e.g.*, tiered recovery or performance pricing can be applied to other options).

By no means is this list considered all-inclusive or complete, but rather a starting point for discussion regarding possible governance of the microgrid. Additional discussion is required, but the aforementioned activity laid the groundwork for the Project partners to consider further options.

3. Bill Impact Analysis

During the third quarter, the National Grid team continued analyzing the first of four (4) new services to be offered through the Project: tiered recovery of new storm-hardened, underground wires. The conceptual design phase of the Project estimated the highest cost of this capital expenditure to be approximately $11.8M.[5] This figure is based on the build-out of the full microgrid with fully-flexible circuit

[5] The conceptual design includes three (3) distribution equipment options ranging from high to low. The bill impact analysis used the highest priced distribution option.

breakers included throughout. Set out below is a summary of the steps taken by the National Grid Project team.

Process:

1) The National Grid Data & Analytics team gathered appropriate customer accounts based on certain geographic criteria;
2) The National Grid Billing Operations team gathered usage of customer base;
3) The National Grid New York Pricing Electric team set up allocations within each tier based on kWh and kW usage of selected customer base;
4) The National Grid Upstate New York Revenue Requirement team used depreciation rates, average service life ("ASL"), and carrying costs to establish appropriate dollar figure for recovery of investment; and
5) The National Grid Project Management team analyzed data to distribute required revenue amongst tiers within recovery model.

Analysis:

Upon consultation with New York State Department of Public Service Staff, a new approach was developed to rationalize the recovery of the underground wire system from the surrounding area's National Grid electric customers. While the initial approach attempted to establish arbitrary radial zones for recovery, the new approach aims to validate each tier based on access to critical infrastructure and services. The Project team collected data on the territories of each critical service that would potentially offer services through the microgrid during an emergency. Each tier is based on these service territories with decreasing availability as they expand outward from the microgrid itself. Table 2.4 describes the selected criteria for each tier. Table 2.5 identifies the critical services available to each corresponding tier. A map of the multi-tier system can be found in attached Appendix A.

		Participants[1,2]
DIRECT	**Tier 1a**	Generating participants: Clarkson University, SUNY Potsdam, Village Government
	Tier 1b	Load-only participants: Clarkson Inn, Canton-Potsdam Hospital, Key Bank, Kinney Drug Store, Stewarts Gas Station, High School
INDIRECT	**Tier 2**	Village of Potsdam Border
	Tier 3	Town of Potsdam Border
	Tier 4	Village of Potsdam, Village of Norwood, Town of Potsdam, Town of Pierrepont, Town of Colton, Town of Stockholm (portion), Town of Norfolk (portion)[3]
	Tier 5	Zip codes: 13625, 13695, 13639, 13635, 13684, 13652, 13630, 13687, 13672, 13617, 13676, 13699, 13660, 13668, 13696, 13697, 12965, 12967, 13613, 13667, 13621, 13694, 12922, 12927, 13677, 13647, 13678

[1] Colors correspond to map located in Appendix A.
[2] All tiers are exclusive of previous tier's customers.
[3] Tier 4 based on Potsdam Volunteer Rescue Squad's ("PVRS") service territory, which covers portions of the Towns of Stockholm and Norfolk.

Table 2.4 – Tiered Approach Parameters

		Service Offered[1]					
		Police Department	Wastewater Treatment	Water Treatment	Fire Department	PVRS	Hospital
DIRECT	Tier 1a	✓	✓	✓	✓	✓	✓
	Tier 1b	✓	✓	✓	✓	✓	✓
INDIRECT	Tier 2	✓	✓	✓	✓	✓	✓
	Tier 3				✓	✓	✓
	Tier 4					✓	✓
	Tier 5						✓

[1] *Colors correspond to map located in Appendix A.*

Table 2.5 – Tiered Service Availability

In addition, the Project team reevaluated the formula used to calculate the revenue requirements needed to recover the underground wire investment. After some investigation it was determined the likely average service life of the underground conduit and cables to be seventy-five (75) years (see attached Niagara Mohawk Power Corporation d/b/a National Grid Electric Depreciation Rate table, Appendix B).

Results:
With the expanded population figures and adjusted depreciation rates, this second tiered recovery approach has resulted in a smaller bill increase scenario compared to the Project team's previous approach. The percentage monthly bill impact on delivery charges for each tier can be found in Table 2.6. On average, the connected participant would experience an increase of eight (8) percent on their delivery charge, while the surrounding supportive tiers would see decreasing levels of impact ranging from a two (2) to six (6) percent increase on their delivery charges.

	Customer Bill Impact on Delivery Charges (%)[1]					
	Residential	**Sm. Com (Non-Demand)**	**Sm. Com (Demand)**	**Lg. Com (Primary)**	**Lg. Com (Trans)**	
	SC1	**SC-2ND**	**SC-2D**	**SC-3Pri**	**SC-3A Tran**	***AVG***
Tier 1a	N/A	N/A	N/A	7.94%	N/A	7.94%
Tier 1b	N/A	N/A	8.56%	5.85%	N/A	7.48%
Tier 2	4.09%	4.12%	5.97%	6.69%	N/A	5.47%
Tier 3	3.20%	3.22%	4.19%	5.89%	5.52%	4.40%
Tier 4	3.14%	3.16%	4.13%	3.48%	N/A	3.48%
Tier 5	2.12%	2.13%	3.03%	2.16%	4.70%	2.83%

[1] *Colors correspond to map located in Appendix A.*

Table 2.6 – Customer Monthly Bill Impact Percentages

Additional analysis is required to analyze how DER generation and participation in the market could offset the delivery charges and distribution costs for connected participants.

The Project team continues to work with their internal pricing team and Project partners to develop a realistic business model solution for the microgrid. Cost recovery of the underground wires investment is integral part to any successful business model.

4. GE Global Research's eMCS Testing Approval

During this quarter the GE Global Research Project team received approval from the DOE to proceed with testing of the eMCS (Award # DE-OE0000728). The eMCS tests will be conducted in two phases: computer simulation for the Dispatch Module at GE Global Research in Niskayuna, New York and physical system testing of the Protection Module at the National Renewable Energy Laboratory ("NREL") in Golden, Colorado.

This quarter the National Grid Project team had the opportunity to visit the Niskayuna research center to witness the eMCS testing. The test demonstration focused on both aspects of the controller; dispatch and protection. The dispatch demonstration concentrated on how much the optimal dispatch would save over the base case operating scenario. The protection simulation centered on the microgrid's point of interconnection ("POI") adherence to the Institute of Electrical and Electronics Engineers ("IEEE") 1547 standard. Specific information on each aspect of the testing is set forth below.

Dispatch
In order for this rural community microgrid to be successful, the eMCS must have the ability to determine set-points for the microgrid's generation assets to meet local energy demand in the most cost-effective manner. In addition to servicing the base load, the controller will enable the microgrid to participate in the NYISO ancillary service market, including the day-ahead market. Given NYISO size requirements for participation, the controller's aggregation of the microgrid's generation assets allows these microgrid generators the ability to participate in the market.

Numerous data are utilized during the optimal dispatch algorithm including grid energy prices, fuel prices, load profiles, and renewable forecasts. The controller then considers constraints such as operational levels, available generation, ramp rates, black-start capabilities, must-run requirements, and reserves before finalizing a generator schedule.

The testing design uses three (3) scenarios to demonstrate the benefit-cost of optimal dispatch:

- Grid import – assumes no local generation dispatch and energy is purchased from grid;
- Rule-of-thumb dispatch – assumes the efficiency of each generator is fixed; dispatches are made in decreasing order of efficiency and there is no grid import of energy;

- Optimal dispatch – considers asset efficiency as a function of operating point; considers ramp rate limits and assumes the ability to import from grid if economical.

Using historical data from a typical two (2) week period in March, a comparison of operating expenses of the three (3) scenarios found a 28% reduction in cost when using the optimal dispatch system versus the rule-of-thumb approach, and an 11% reduction in cost when using the optimal dispatch system versus the full grid import mode. Figure 2.3 displays the full factorial design with the fuel pricing and grid energy pricing yielding results from 108 test scenarios.

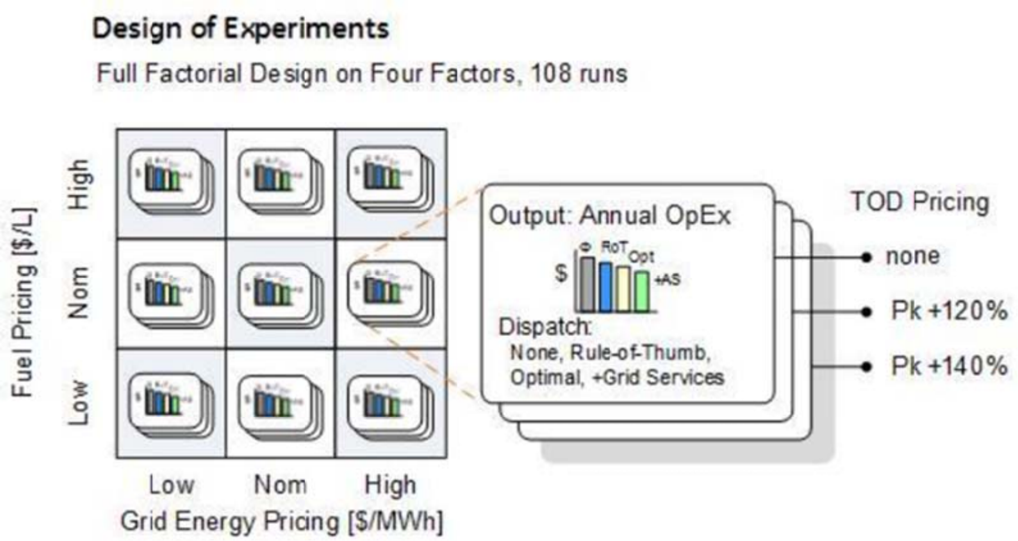

Figure 2.3 – Optimal Dispatch Full Factorial Design

The results of the optimal dispatch study show how the microgrid controller can enhance the economic power of the microgrid during daily operation. The major conclusions are:

- As grid energy price increases, the proportion of the local generation supplying the load increases;
- As fuel price increases, the proportion of the local generation supplying the load decreases;
- As peak energy price increases, the proportion of the local generation supplying the load increases.

In addition to the real-time control described above, the eMCS will allow the microgrid to participate in NYISO day-ahead market and ancillary services. A fourth scenario used an algorithm to determine day-ahead hourly regulation schedule for the microgrid to bid into the regulatory market. The algorithm was optimized with the objective of maximizing the microgrid's expected profit over day-ahead time horizon for providing energy to loads and participating in regulation market.

Regulation price variation, including time of day ("TOD") pricing, impacts the decision on when to participate in the regulated market. The algorithm results mirrored that of the optimal dispatch study, whereas a peak energy price increase resulted in an enhanced reliance on local generation and less on grid purchases.

Protection
In addition to dispatch optimization, the GE Global Research team is in the process of testing protection features, as the eMCS must consider safety measures during islanding events and reconnection thereafter. Using IEEE 1547 standards, the team is utilizing real-time digital simulators ("RTDS") to test frequency, voltage, disconnect times, and phase angle difference during simulated events. Figure 2.4 displays the RTDS platform as displayed on the local user interface.

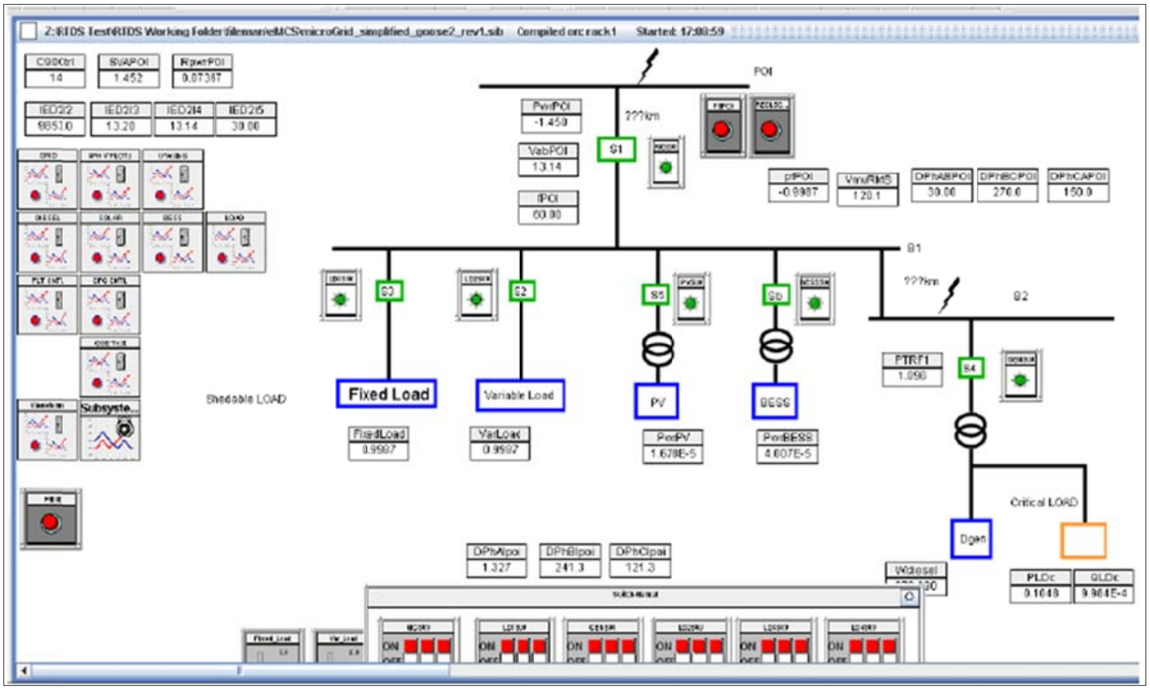

Figure 2.4 – RTDS Display

The GE Global Research Project team used IEEE 1547a-2014 POI relay standards when testing the faults and disconnect/reconnect performance. Clearing times for abnormal frequency and voltage conditions are established by IEEE to control interconnection requirements of distributed generating resources. Thus far the team has completed testing on six (6) disconnect cases: small over-voltage; large over-voltage; small under-voltage; large under-voltage; under-frequency and over-frequency. Team members manually adjusted voltage or frequency to simulate an event while recording the clearing time the eMCS disconnected from the grid. All tests produced positive results well within IEEE 1547 standards.

5. Clarkson University NSF Grant Update
Clarkson University continues their work with the NSF PFI:BIC project. This project focuses on the human-machine operational impacts of the microgrid both during normal operations as well as during disaster response. National Grid organized an instructional tour of the National Grid Syracuse Energy Transmission Control Center ("TCC") for the Clarkson University team to provide information as to the detailed operation of a control center and to illustrate how a disaster may affect the management and functionality of the operations. The tour took place on July 13, 2016.

Image 2.2 – National Grid Transmissions Control Center

The informative session focused on organizational structure of the TCC, main function of the TCC, and regulatory standards that apply to the TCC. The Clarkson University team found the presentation and tour to be very educational and established the need to define responsibility for the operations of the microgrid to incorporate the human factors into the design of the control center.

As noted above, the Clarkson University team also had the opportunity to present a paper at the ISGT conference in Minneapolis in September in reference to the Potsdam microgrid. The paper titled, "*Planning and Design Goals for Resilient Microgrids*" focused on the goals of a resilient microgrid while identifying the challenges that arise in the design and development of these systems. The paper was presented by Thomas Ortmeyer, Lei Wu, and Jie Li, Clarkson University professors.

In addition, two Clarkson University graduate students were recognized at the IEEE Power & Energy Society 2016 general meeting for their papers regarding sustainability and distribution of the proposed microgrid. Funded by the NSF grant, Yikui Liu and Chenxi Dai's selections were featured in the Daily Courier Observer. (See attached Appendix E.)

2.2 Challenges, Changes, and Lessons Learned

Qtr. 2016	Issue or Change	What was the resulting change to Project scope/timeline?	Strategies to resolve	Lessons Learned
Q1	Change in Project Management.	Michael Duschen (Project Manager, Solutions Delivery Team of New Energy Solutions, Michael.Duschen@nationalgrid.com) and Daniel Payares (Project Manager, Solutions Delivery Team of New Energy Solutions, Daniel.PayaresLuzio@nationalgrid.com) replaced Christopher Yee as the Project Managers for the Community Resilience REV Demonstration Project.	Detailed transition task list developed by the former Project Manager to facilitate the transition.	Strong communication between all stakeholders is needed in order to maintain direction.
Q1	National Grid designated Executive Sponsor.	Philip Austen (Director, Solution Delivery Team of New Energy Solutions, PAusten@nationalgrid.com) designated as the Executive Sponsor for the Community Resilience REV Demonstration.	N/A	Corporate project sponsors can often facilitate resources and provide solutions for the development of the project.
Q1	Delayed release for NY Prize Stage 2 RFP.	Project timeline may be modified due to the delayed release of the NY Prize Stage 2 RFP which was originally scheduled to be released in the fall of 2015, but was actually released on April 20, 2016.	Analyze which Project tasks are and are not dependent on the NY Prize Stage 2 RFP release. To ensure minimal delays, National Gird has progressed on independent tasks and will reassess timeline changes for tasks that are dependent.	Delays and changes to the project timeline are still being analyzed due to the delay of the Stage 2 RFP release. Some delays may be unavoidable but with good planning and communication, they may be controlled and minimized. Project delays, if any, will be specified in a subsequent quarterly report.

Qtr. 2016	Issue or Change	What was the resulting change to Project scope/timeline?	Strategies to resolve	Lessons Learned
Q1	Financial and technical issues for the Village of Potsdam: 1. Village under documented financial constraints 2. East Dam hydro plant is currently in disrepair.	The teams from Clarkson University and National Grid have been working together to develop alternative solutions that can be financially viable for the Village.	Looking for strategic partnerships or funding options to repair the East Dam hydro plant without posing a burden for the Village of Potsdam.	It is important to work alongside the different stakeholders, keeping communication channels open and honest.
Q2	Some of the microgrid stakeholders may consider the costs to outweigh the added benefits and opt out.	If the major stakeholders opt out of the microgrid, the Project could not be constructed.	Create and maintain a list of available alternative commercial customers to reach out to if this happens. Another alternative is to scale back the size of the microgrid to make it more affordable.	It is important to be flexible with the design and assumptions of the microgrid design. The Project may need to be scaled back to accommodate fewer stakeholders.
Q2	Some of the major stakeholders do not have local decision-making authority (*e.g.*, SUNY Potsdam, KeyBank, and Kinney Drugs).	Securing approval for capital investments may take a significant amount of time or ultimately be denied, as decision makers are not direct beneficiaries.	Engage decision makers early in the process to help alleviate potential delays. In some cases (*e.g.*, bank, pharmacy), investigate alternative locations that may have more local control.	It is important to engage the appropriate decision makers early to anticipate delays in approvals.
Q2	Capital investment for the 4MW of additional and necessary DER might not provide an acceptable return on investment ("ROI") for potential owners.	If the additional DER necessary to operate the microgrid is not procured, the Project might not be financially/technically feasible.	Have the Company backstop the generation from the additional DER through PPA agreements in order to have an acceptable ROI for the owners.	Contingency plans are needed to adjust microgrid size based on DER procurement.
Q2	Gas station confident with their own resilience provided by back-up generators.	Minor stakeholder may not want to work with microgrid team if they have adequate on-site generation.	Work within National Grid to find alternatives to participation of gas station site and mitigate other stakeholder self-generating alternative(s).	The team must understand each stakeholder's individual resiliency to calculate benefit from microgrid.

Qtr. 2016	Issue or Change	What was the resulting change to Project scope/timeline?	Strategies to resolve	Lessons Learned
Q2	Wires recovery model challenged with current microgrid layout and target population.	May delay delivery of "Preliminary Service Proposals & Pricing" and may increase costs associated with pricing aspect of the Project.	Look for alternate funding sources, expand target population, or eliminate branches of microgrid (or some combination thereof).	It is important to establish target population size early in process. This will affect ability to recover costs.
Q2	Village progressing on possible repair of East Dam Hydro plant turbine gear boxes	The East Dam Hydro plant's gear box damage could be a major risk to the Project. Additional DER is required if this hydro generating facility cannot be returned to service.	Continued communication with the Village to assess timeframe and cost of possible repair.	Contingency plans are needed to account for possible additional DER.
Q3	American Society of Heating, Refrigerating and Air Conditioning Engineers ("ASHRAE") Level II audits are needed for NY Prize Stage 2 and therefore additional funding may be required.	NY Prize Stage 2 requires full ASHRAE Level II energy efficiency audits. This could result in additional cost and cause further delays.	Work with Clarkson University to assess need and establish which loads require full audit.	The team needs to know full cost of detailed design prior to execution.
Q3	Issue discovered in the West Dam Hydro plant generator	The West Dam Hydro plant's generator issue could be a major risk to the Project. Additional DER is required if this hydro generating facility cannot be returned to service.	Continued communication with the Village to assess timeframe and cost of possible repair.	Contingency plans are needed to account for possible additional DER.
Q3	There is ongoing conversation regarding business options for the microgrid, including possible special utility districts that remove assets from National Grid's balance sheet.	There is a risk that partners could decide that a municipal district is more appropriate than proposed REV structure, resulting in a NO-GO decision.	Develop an internal plan that promotes REV demo framework over municipal district and communicate with stakeholders.	All business model options need to be fully analyzed and discussed with stakeholders.
Q3	The estimated energy bill impact figures are considerably higher for commercial accounts than residential accounts due to the fact the analysis is based on usage.	Larger commercial account holders may challenge the tiered-recovery approach.	Create contingency plans within the tiered-recovery calculation to factor in the possible removal of commercial accounts.	Usage might not be the best metric for tiered-recovery approach.

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3.0 Next Quarter Forecast

In Q4 of 2016, the Project team will focus its efforts on commencing the NY Prize Stage 2 phase of the Project with its partners. The Project team expects all parties to finalize terms and conditions in the near future and begin this next phase of the study within the next thirty (30) days. Given the anticipated twelve (12) month timeframe for execution of the full detailed design, the Project team anticipates the Project will continue past the originally planned end date of June 30, 2017.

During the last quarter of this year, as Clarkson University and GE Energy Consulting finalize the NYSERDA PON study and distribute the final Conceptual Design, the National Grid Project team will begin the analysis of possible pricing options for the proposed new services. The Project team will utilize the cost figures presented in the Conceptual Design to analyze different pricing possibilities for service fees related to DER procurement and microgrid control and operations.

As stated in National Grid's Project Implementation Plan,[6] the completion of the Conceptual Design offers an opportunity to engage microgrid stakeholders and inform them on the initial design and cost ranges for the proposed microgrid. In anticipation of the delivery of the final Conceptual Design, National Grid and its partners plan a stakeholder outreach session during the last week of October. This meeting will bring together potential participants of the microgrid, as well as local government officials pivotal to the success of the Project.

National Grid will continue the conversation regarding business model options during the next quarter. A major portion of the NY Prize Stage 2 scope of work focuses on the business plan assessment of the microgrid, including a detailed economic benefit cost analysis, financial viability, and legal viability. This work will begin towards the end of the calendar year as the team launches the next phase of the Project, which will produce additional information to better advise the team on the best approach for governance, ownership, and operation/maintenance.

National Grid also plans to study local economic development benefits of the Project, including jobs created during construction and the economic impact of on-going benefits once the microgrid is complete. On-going benefits include efficiency improvements which reduce energy costs to customers; improved reliability and power quality, which reduces customer outage costs; deferred infrastructure spending, which reduces capital costs passed on to customers and reduced local emissions, which could improve the quality of life and potentially attract more people and businesses to the region. The Company will use the Regional Economic Models, Inc. ("REMI") model to estimate the economic impacts of these benefits. REMI is a regional economic model that can estimate how these cost savings translate into increased investment, consumer spending, and hiring in the Potsdam area and across National Grid's service territory as a whole.[7] REMI also estimates improvements in migration flows result from local emissions reductions.

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[6] Case 14-M-0101, *supra* note 2.

[7] REMI is a dynamic equilibrium model of New York state and local economies based on public data and peer-reviewed methodology. REMI is owned by Regional Economic Models, Incorporated and leased to its clients. REMI is used throughout the United States with over 150 US and international clients including state and local government planning agencies, energy consultants, non-profit research organizations and utilities. Model description, documentation, applications and client lists can be found at www.remi.com.

3.1 Checkpoints/Milestone Progress

	Checkpoint/Milestone	Anticipated Start-End Date	Revised Start-End Date	Status
1	Clarkson University NYSERDA PON Study *(Conceptual Design)*	10/2015 – 6/30/16	10/2015 – 10/31/16	🟡
2	Initial Engineering Design Recovery Plan *(Tiered Recovery Plan)*	4/6/2016 – 7/26/16	5/1/2016 – 9/30/16	🟢
3	Preliminary Service Proposal & Pricing *(Pricing Proposal)*	7/01/16 – 11/01/16	11/01/16 – 01/31/17	🟡
4	NY Prize Stage 2 RFP *(Detailed Engineering Design and Business Plan)*	3/16/16 – 12/1/17	10/1/16 – 8/31/17	🟡

Key

🟢 On-Track

🟡 Delayed start, at risk of on-time completion, or over-budget

🔴 Terminated/abandoned checkpoint

1. Clarkson University NYSERDA PON Study – Task 4 *(Conceptual Design).*

Status: [🟡]
Start Date: 10/2015
End Date: 10/31/2016

GE Energy Consulting presented a draft of the NYSERDA PON Task 4 report to the Project team on August 31, 2016. The report represents the Conceptual Design for the Project and signifies the final technical task of the NYSERDA PON project. It aims to accomplish the following items:

- Detailed cost of all aspects of the microgrid;
- Benefit-Cost analysis for the microgrid;
- Further refinement of microgrid performance.

Throughout the month of September, the Project team provided GE Energy Consulting feedback and suggestions to enhance the report. GE Energy Consulting plans to submit the final version to the Project team on or about October 17, 2016. In addition, the NYSERDA PON grant requires a cumulative report combining the findings of all three (3) tasks noted above. GE Energy Consulting expects to finalize the Executive Summary of the study during the final quarter of 2016.

2. Initial Engineering Design Recovery Plan *(Tiered Recovery Plan)*

Status: [🟢]
Start Date: 5/1/2016
End Date: 9/30/2016

The National Grid Project team conducted additional analysis of the tiered recovery model as described in section 2.1. The new approach aims to validate each tier based on access to critical infrastructure and services. The Project team collected data on the territories of each critical service that would potentially offer services through the microgrid during an emergency. Each tier is based on these service territories, with decreasing availability as they expand outward from the microgrid itself.

With the expanded population figures and revised depreciation rates, this second tiered recovery approach has resulted in a more palatable bill increase scenario. The monthly bill impact percentages for each tier can be found in Table 2.6.

Additional analysis is required to analyze how DER generation and participation in the market could offset the distribution costs for connected participants.

3. Preliminary Service Proposal and Pricing *(Pricing Proposal)*

Status: [●]
Start Date: 11/1/2016
End Date: 1/31/2017

In the Project Implementation Plan,[8] National Grid offered this milestone as an opportunity to present findings of the Conceptual Design along with a preliminary service and pricing offerings to stakeholders. Due to the delays in the Conceptual Design, the pricing options have yet to be analyzed and/or formalized. Thus, a proposal has not yet been made to stakeholders. The adjusted timeline shifts much of this task into the fourth quarter of 2016, with a presentation of findings to stakeholders anticipated to be made in February 2017.

4. NY Prize Stage 2 RFP *(Detailed Engineering Design and Financial and Business Plan)*

Detailed Design Study
Status: [●]
Start date: 10/1/16
End date: 8/31/17

National Grid has agreed to partner with GE Energy Consulting to work on the detailed engineering design and business plan assessment in line with the NY Prize Stage 2. GE Energy Consulting will subcontract with Clarkson University, Nova Energy Solutions, and O'Brien & Gere to perform some of the tasks that are outside of GE Energy Consulting's area of expertise. Although there was a four (4) month delay in the release of the NY Prize Stage 2 RFP, the initial design in the NYSERDA PON study covered some of the requirements of the RFP, which should result in minimal delay to the entire Project.

This phase of the study is expected to begin within the next thirty (30) days. While the original timeline for completion of the Stage 2 audit-grade detailed engineering design study and business plan assessment was twelve (12) months, the Project team now anticipates completion by the end of August 2017.[9]

[8] Case 14-M-0101, *supra* note 2.
[9] The Project partners have met numerous times during Q3 2016 to negotiate contract terms for this phase of the Project. As of September 30, 2016, the parties have not yet finalized the terms and conditions regarding the partnership agreement, but anticipate finalizing such an agreement in the near future.

4.0 Work Plan & Budget Review

4.1 Updated Work Plan

Updated Gantt chart from Project Implementation Plan is below:

	Task Name	Duration	Start	Finish
7	**REV Demonstration**	**445 days**	**Tue 12/15/15**	**Mon 8/28/17**
8	Demonstration Approval	1 day	Tue 12/15/15	Tue 12/15/15
9	**General Project Management**	**335 days**	**Mon 3/21/16**	**Fri 6/30/17**
23	Benefit Analysis for Stakeholder Engagement	3.2 mons	Tue 10/18/16	Fri 1/13/17
24	**Stakeholder engagement and community outreach**	**223 days**	**Wed 12/16/15**	**Mon 10/24/16**
25	Initial Stakeholder Engagement	64 days	Wed 12/16/15	Mon 3/14/16
26	Initial Stakeholder Meeting	0 days	Mon 3/14/16	Mon 3/14/16
27	Second Stakeholder Meeting	0 days	Mon 10/24/16	Mon 10/24/16
28	Conceptual Design Complete Milestone	0 days	Mon 10/17/16	Mon 10/17/16
29	Initial Engineering Design Recovery Plan (Capital Costs)	4 mons	Mon 6/13/16	Fri 9/30/16
30	Initial Tariff Design (Commodity Costs)	2.5 mons	Tue 11/1/16	Mon 1/9/17
31	Preliminary Service Proposals & Pricing Milestone	0 days	Mon 1/9/17	Mon 1/9/17
32	Stakeholder feedback on initial cost estimates and recovery/payment plan & additional community outreach	1 mon	Tue 1/10/17	Mon 2/6/17
33	Coordinate and incorporate stakeholder feedback with Detailed Design Study team	2 mons	Tue 2/7/17	Mon 4/3/17
34	Revise tariffs based on possible changes to NY Prize technical study	2 mons	Tue 4/4/17	Mon 5/29/17
35	Draft contracts for Go/No-Go meeting with refined tariffs and business cases	2 mons	Tue 5/30/17	Mon 7/24/17
36	Financial/Business Plan & Contracting	25 days	Tue 7/25/17	Mon 8/28/17
37	Completion of Financial/Business Plan ("Go/No-Go")	0 days	Mon 8/28/17	Mon 8/28/17

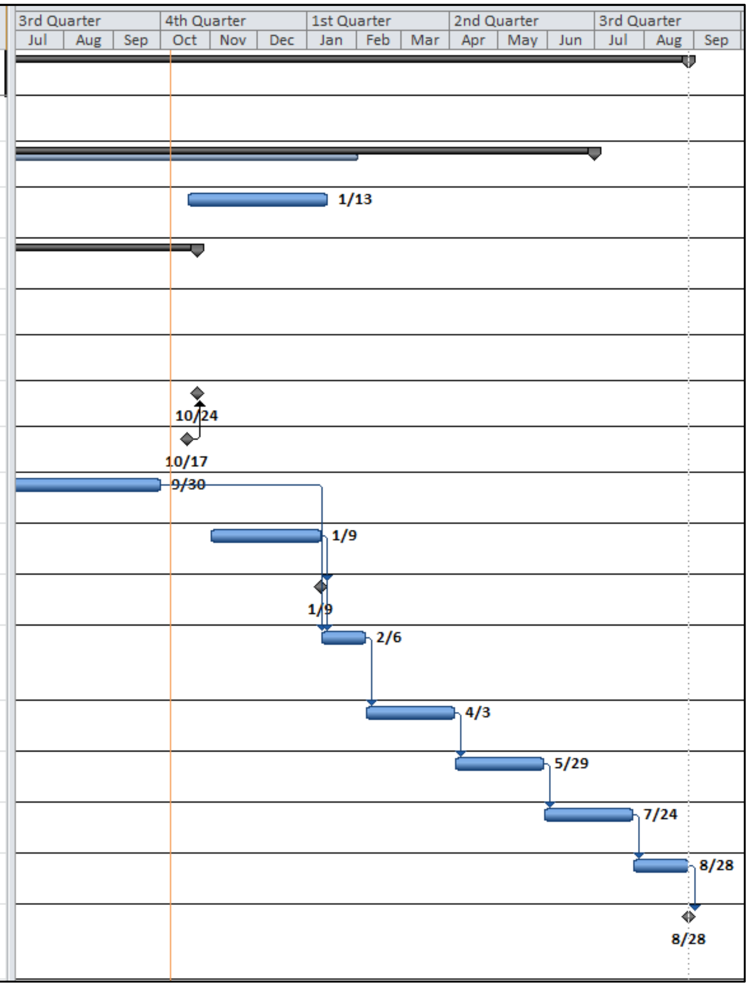


Figure 4.1 – Updated Gantt Chart from Project Implementation Plan.

4.2 Updated Budget

Table 4.1 displays the updated total spent through September 30, 2016.

Task	Budget	Quarterly Spend	Spend to Date	Remaining Balance
Project Administration and Planning	$131,000	$33,969	$130,079	$921
Marketing and Community Engagement	$200,000	$10,351	$55,264	$144,736
Implementation	$275,000	$9,371	$20,106	$254,894
Audit Grade Detailed Engineering Design	$1,000,000	$3,663	$4,457	$995,543
Totals:	**$1,606,000**	**$57,354**	**$209,906**	**$1,396,094**

Table 4.1 – Updated Budget

The incremental costs associated with the Project as of September 30, 2016 total $104,593. Continued monitoring and reporting of incremental costs will be included in subsequent quarterly reports.

As the Project moves out of the initial planning and conceptual design phase and into the detailed design and implementation phase, the budget will shift reliance to the latter's expense line items. While the majority of the Project Administration and Planning budget has been depleted, the Project team will continue to record expenses in this category to track categorical expenses of the Project.

5.0 Progress Metrics

The size and number of participants in the microgrid will dramatically change the projected cost and configuration of the microgrid construction. This section will track the current projected cost range of the microgrid depending on the most recent engineering estimates as well as the projected resiliency duration of the detailed design.

5.1 Total Cost of Microgrid

Metric	As of Q2 2016	As of Q3 2016
Projected Cost Range of Microgrid Construction	$36M[1]	$35M - $60M[2]
Underground Wire Cost Range	$11.3M - $11.8M	$11.3M - $11.8M
Projected Resiliency Duration	14 Days	14 Days

[1] Includes all aspects of microgrid (underground wires, controller, new DER).
[2] Range includes three (3) generation equipment options and two (2) distribution equipment options.

Table 5.1 – Cost of Microgrid

Project Total Estimates with Options	
Dual Fuel Engine with Option 1 Protection	$38,020,000[1]
Dual Fuel Engine with Option 2 Protection	$36,960,000[1]
Natural Gas Engine only with Option 1 Protection	$36,670,000
Natural Gas Engine only with Option 2 Protection	$35,610,000
GE Hybrid Fuel Cell/Natural Gas with Option 1 Protection	$60,970,000[2]
GE Hybrid Fuel Cell/Natural Gas with Option 2 Protection	$59,910,000[2]
Energy Storage Option Adder	TBD

[1] *Dual Fuel Engine cost is an estimate only, as no quote was received from the supplier.*
[2] *GE Hybrid Fuel Cell/Natural Gas Engine is in development.*

Table 5.2 – Project Total Costs

5.2 Tiered Recovery Population

The National Grid team's second approach to the tiered recovery model used the customer counts set out below:

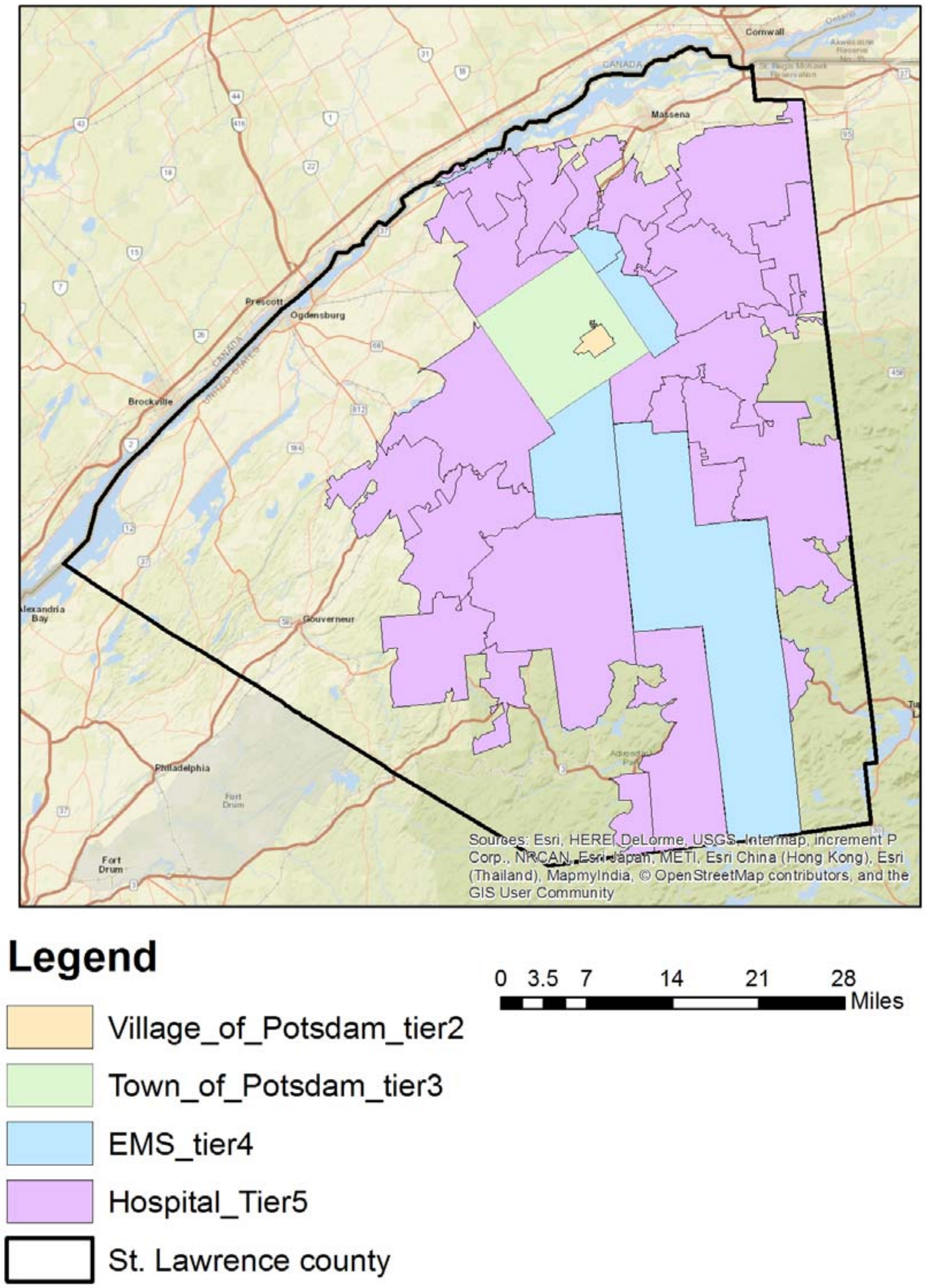
	Commercial	Residential	Total
Tier 1	12	0	12
Tier 2	518	2,239	2,757
Tier 3	463	3,246	3,709
Tier 4	331	3,693	4,024
Tier 5	1,718	14,304	16,022
Total	**3,042**	**23,482**	**26,524**

Table 5.3 – Tiered-Recovery Customers

Other metrics may be added to subsequent quarterly reports as they become more relevant as the Project progresses.

6.0 Appendices

Appendix A: Tiered Recovery Map



Appendix B: Niagara Mohawk Power Corporation d/b/a National Grid Electric Depreciation Rates

Appendix 1
Schedule 3
Page 1 of 2

NIAGARA MOHAWK POWER CORPORATION
Case 12-E-0201 & 12-G-0202
Electric Depreciation Rates
Effective 1/1/2011

Account	Account Name	Average Service Life (ASL)	Curve	Net Salvage	Depreciation Rate
Electric Transmission Plant					
350.40	Land rights	75	H5	1.00%	1.32%
352.00	Structures and improvements	65	H3	-35.00%	2.08%
353.01	Station equipment	45	H0.5	-10.00%	2.44%
353.55	Station equipment - EMS RTU	30	S3	-2.00%	3.40%
354.00	Towers and fixtures	70	H4	-20.00%	1.71%
355.00	Poles and fixtures	65	H4	-30.00%	2.00%
356.00	Overhead conductors, devices	75	H2	-20.00%	1.60%
357.00	Underground conduit	75	H4	0.00%	1.33%
358.00	Underground conductors, devices	75	R3	-12.00%	1.49%
359.00	Roads and trails	75	H4	0.00%	1.33%
Electric Distribution Plant					
360.00	Land Rights	75	H5	0.00%	1.33%
361.00	Structures and improvements	75	R1.5	-25.00%	1.67%
362.00	Station equipment	60	H2	-10.00%	1.83%
362.55	Station equipment - EMS RTU	30	S3	1.00%	3.30%
364.00	Poles, towers and fixtures	65	R1.5	-5.00%	1.62%
365.00	Overhead conductors, devices	50	R4	-25.00%	2.50%
366.00	Underground conduit	75	H4	-10.00%	1.47%
367.00	Underground conductors, devices	75	R3	-15.00%	1.53%
368.00	Line transformers - Bare Costs	45	H0.5	-20.00%	2.67%
368.00	Line transformers - Install Costs	45	R1.5	-20.00%	2.67%
369.10	Services - Overhead	50	H4	-30.00%	2.60%
369.20	Services - Underground-Conduit	75	H4	-1.00%	1.35%
369.21	Services - Underground-Cable	75	H2.5	-5.00%	1.40%
370.10	Small Meters - Bare Cost	20	H0.5	-25.00%	6.25%
370.20	Small Meters - Install Cost	20	H0.5	-25.00%	6.25%
370.30	Large Meters - Bare Cost	20	H3	-1.00%	5.05%
307.35	Large Meters - Install Cost	20	H3	-1.00%	5.05%
371.00	Installs customer premise	40	H1.5	-40.00%	3.50%
373.10	Overhead Street lighting, signal system	50	H1.5	-30.00%	2.60%
373.20	Underground Street lighting, signal system	70	H1	-30.00%	1.86%
Electric General Plant					
390.00	Structures and improvements	55	H0.5	-10.00%	2.00%
391.01	Office furniture and equipment	22	SQ	0.00%	4.55%
391.20	Data processing equipment	5	SQ	0.00%	20.00%
393.00	Stores equipment	22	SQ	0.00%	4.55%
394.00	Tools, shop and garage equipment	22	SQ	0.00%	4.55%
395.00	Laboratory equipment	22	SQ	0.00%	4.55%
396.00	Power operated equipment	22	SQ	0.00%	4.55%
397.10	Communication equipment - Radio	22	SQ	0.00%	4.55%
397.20	Communication equipment - Telephone	8	SQ	0.00%	12.50%
397.50&.60	Communication equipment - Network	22	SQ	0.00%	4.55%
398.00	Miscellaneous equipment	22	SQ	0.00%	4.55%
398.10	Power and Supervisory Control	22	SQ	0.00%	4.55%

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Appendix C: Business Governance Model Analysis

Model 1: REV Filing

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Governance as described in REV filing. NG central procurement through PPA, offer other services such as billing and hosting microgrid controller.

PROS	CONS
▪ PSC has assessed and approved for testing ▪ Could be applied to other models ▪ Rate design for possible full recovery ▪ Supports benefits of each tier ▪ Utility already billing customers, own T&D ▪ Maintains customer relationship with DERs ▪ Possible future financing by Utility ▪ Additional revenue for Utility	▪ How are levels of benefits defined for each tier ▪ Customers' concern with cross subsidized tiers ▪ Trade off of complexity of tiers ▪ Customer bill impact ▪ New revenue for Utility ▪ More entrenched with Utility as main provider ▪ Limited or no aggregation of energy ▪ Manual controller

Critical Success Factors

- Rational, affordable rate structure that is transparent and easily understood
- Clear delineation between tiers
- Understand drivers and reactions of stakeholders to measure tolerance (customer choice, reliability)
- Regulatory approval
- Alignment into the REV framework
- Is there a better long term viability given Utility balance sheet strength?

Model 2: DER Provider

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Generation owned by several microgrid entities and operated as single entity. Aggregator could be NG, consortium, or a third party. Load/generation entities treated separately.

PROS	CONS
▪ Utility owns and maintains T&C ▪ More economically viable that DESCO ▪ Optimizing own generation ▪ Participation in wholesale market, ancillary, DR ▪ Able to market excess capacity ▪ Combining O&M on generation side ▪ Allows Utility additional latitude future services ▪ Lower marginal cost of energy	▪ Regulatory filing complexity ▪ Additional marketing costs, efforts, coordination ▪ Complexity of ownership structure ▪ Need for NOC ▪ Less risk management and control ▪ 3rd party ownership of DER

Critical Success Factors

- Possible aggregation of demand charges in addition to aggregation of generation
- Stakeholder security of relationship amongst members
- Operation of the NOC
- Demonstrate economic viability given parameters

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Model 3: DESCO

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Microgrid network owned and operated as DER Energy Service Company (DESCO). DESCO schedules microgrid generation and/or purchase from NYISO.

PROS	CONS
▪ Utility owns and maintains T&C ▪ More economically viable than conventional ESCO ▪ Optimizing own generation ▪ Participation in wholesale market, ancillary, DR ▪ Able to market excess capacity ▪ Combining O&M on generation side ▪ Allows Utility additional latitude of services ▪ Lower marginal cost of energy (sometimes) ▪ Stakeholder ownership of DER ▪ Risk management advantage	▪ Regulatory filing complexity ▪ Additional marketing costs, efforts, coordination ▪ Complexity of ownership structure ▪ Need for NOC ▪ Qualification in participation in the market (NYISO)

Critical Success Factors

- Possible aggregation of demand charges in addition to aggregation of generation
- Stakeholder security of relationship amongst members
- Operation of the NOC
- Demonstrate economic viability given parameters

Model 4: CSUD

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Entire Potsdam overhead distribution system operates as a special utility district. NG would own, operate, and maintain the substation and primary distribution system.

PROS	CONS
▪ O&M controlled by CSUD, executed by Utility ▪ Utility still involved as separate, regulated company ▪ Incentive for deferred maintenance ▪ Better decision making authority ▪ Community aggregation possibility (ESCO purchase) ▪ Benefit of municipal flexibility ▪ Single authority to control optimization	▪ Stakeholders assume all risk ▪ Increased rate base for Utility ▪ Switching issue with larger grid; switching agreement ▪ Potential lack of choice in energy procurement ▪ Possible issue with tiered recovery of underground ▪ Board member complexity and conflict of interest ▪ Complexity of billing & administrative costs ▪ Set up costs

Critical Success Factors

- Regulation over Utility as separate entity
- Process for selection of Board members clear and transparent
- Stakeholders' acceptance of full risk and responsibilities of MG
- Successful creation of district, including legal framework
- Consideration given to maintaining the distribution system

Model 5: FSUD

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Similar to the CSUD but with single feeder supplying the microgrid. Would operate as a single entity from the regulatory perspective, and would be an SC3A transmission customer of NG.

PROS	CONS
▪ Governance simpler than CSUD due to boundaries (metered separately) ▪ DER ownership flexibility ▪ Deals with demand charge up front ▪ Members control internal rates for demand ▪ Single authority to control optimization ▪ Reduced contingency budget due to hardened system	▪ Stakeholders assume all risk ▪ Increased rate base for Utility ▪ Switching issue with larger grid; switching agreement ▪ Potential lack of choice in energy procurement ▪ Possible issue with tiered recovery of underground ▪ Complexity of billing & administrative costs ▪ Set up costs ▪ Utility role on board

Critical Success Factors

- Consideration given to maintaining the distribution system
- Possible new rate class for "service at substation"
- Regulation over Utility as separate entity
- Clarification of governance and utility role (as customer and member)

Model 6: Performance Based

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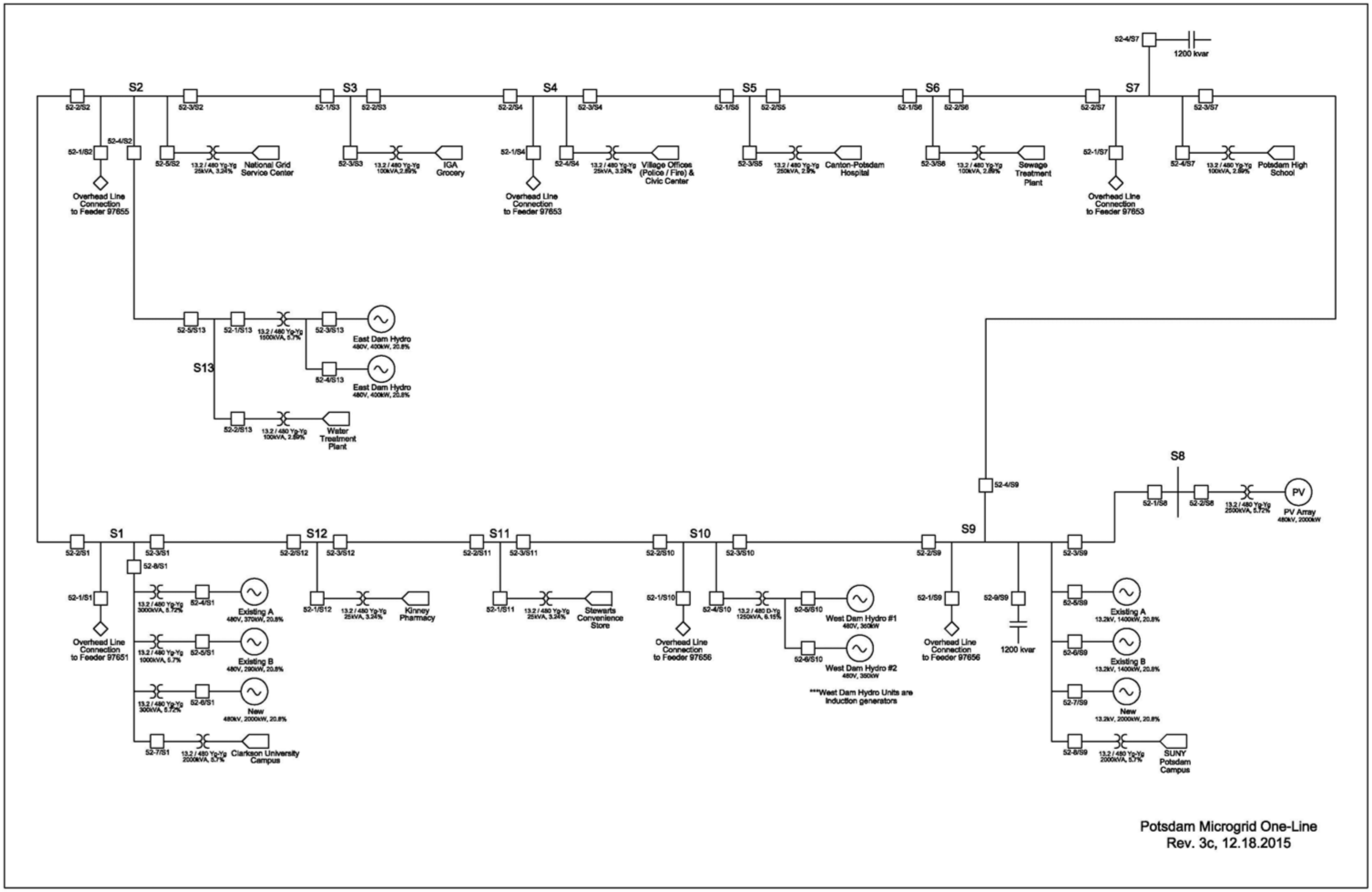
Microgrid Entity owned and operated by NG subject to fixed annual revenue recovery. Savings or cost cutting below the approved rate would be split between the Entity and the customers.

PROS	CONS
▪ Could be applied to other models ▪ NG has found success with the model in UK so we know it has potential to work well for Utility ▪ Profitable at a high level ▪ Aligns the interests of the end customers with Utility by driving the most cost efficient solution ▪ Aligns well with REV goals/PSC goals ▪ Maintains customer relationship with DERs	▪ Big change/departure for Utility typical business and will take some adjustment ▪ Works best in situations with anticipated T&D future needs (Potsdam does not) ▪ Potential regulatory approval issues ▪ Challenge of setting the "right" annual revenue recovery caps, rate structure ▪ Limited or no aggregation of energy

Critical Success Factors

- Correct geography/situation (many technologies, solutions can be applied) efficiency, market, DERs, etc.
- Customers need to be engaged and clearly benefit from new model (can improve resiliency; power quality; reduce costs)
- Upgrade to T&D needed in near future to justify
- Regulatory approval needed due to new model

Appendix D: NYSERDA PON One-Line Diagram



Appendix E: IEEE Article

Daily Courier Observer Thursday, September 1, 2016 A7

Grad students write 2 papers

CLARKSON UNIVERSITY: Electrical, computer engineering research leads to honors

POTSDAM — Research by two Clarkson University electrical and computer engineering graduate students, which was recently recognized at the Institute of Electrical and Electronics Engineers Power & Energy Society 2016 general meeting, could also benefit Potsdam residents in the future.

Electrical and Computer Engineering Assistant Professor Jie Li and Associate Professor Lei Wu collaborated with Ph.D. students Yikui Liu and Chenxi Dai to write two papers.

The titles of the papers and their authors are "Ex-Post Real-Time Distribution LMP Based on State Estimation," by Yikui Liu, Jie Li, Lei Wu, and Qingzhen Liu, and "A Two-Stage Robust Transmission Expansion Planning Approach with Multi-Band Uncertainty Set," by Chenxi Dai and Lei Wu.

One made mathematical calculations related to electrical distribution network and pricing, while the other outlined ways to strengthen the sustainability of power grid by adding more renewable energy. Both papers were selected as Best Conference Papers at the Power & Energy Society meeting in July in Boston.

The microgrid research explored ways to add more green and renewable energy, reduce pollution and make a more efficient system, he adds.

Last fall, the National Science Foundation awarded Clarkson University $999,720 to develop advanced, resilient microgrid technology to improve disaster response capability. The project will complement ongoing projects to plan and design a resilient underground microgrid in Potsdam. The Potsdam microgrid features a unique partnership of generator owners, local government, regulated utility, and critical load entities.

SUBMITTED PHOTO

Clarkson University Electrical and Computer Engineering Assistant Professor Jie Li and Associate Professor Lei Wu recently collaborated with their Ph.D. students to write two papers, which were selected as Best Conference Papers at the Institute of Electrical and Electronics Engineers Power and Energy Society General Meeting. From left are Ph.D. student Chenxi Dai, Li, and Ph.D. student Yikui Liu.