



**Smart City
REV Demonstration Project
City of Schenectady, New York
Case 14-M-0101**

Quarterly Report – Q2 2019

July 31, 2019

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1.0 Executive Summary

Niagara Mohawk Power Corporation d/b/a National Grid (“National Grid” or the “Company”) has partnered with the City of Schenectady (“Schenectady” or the “City”) to demonstrate a smart city solution. Using the Company’s outdoor lighting infrastructure as a platform for advanced outdoor lighting services, the Company and the City are deploying smart city technologies and testing the business models that will animate the advanced outdoor lighting and the smart city markets (the “Project”).



The Project is intended to identify innovative smart city solutions that will help the City expand the breadth and efficiency of the services it provides to its residents. This approach aligns with the Company’s efforts to test, scale, and deploy clean energy solutions in line with its *Northeast 80x50 Pathway*, the Reforming the Energy Vision (“REV”) objectives, and the State’s clean energy agenda. Specifically, the partnership between the Company and the City will test whether the Company’s outdoor lighting infrastructure can facilitate the adoption of smart city technologies by deploying approximately 4,275 efficient light-emitting diodes (“LED”) outdoor lighting fixtures, network lighting control (“NLC”) nodes, and smart-city technologies. The upgrades will effectively turn Schenectady into a smart city, capable of saving energy, more efficiently providing municipal services, and opening the door to further innovation.

During the second quarter of 2019, the Project team continued to build and design the Project for Phase 1 deployment by engaging with the City and partner vendors. In parallel, cross-functional teams supported contract negotiations to ensure vendor agreements and statements of work were consistent with Project needs. The Company also continued to engage with vendors to ensure compliance with data security requirements, as well as the completeness of the proposed solutions. Toward the end of the quarter, this work culminated with the Company reaching an agreement with some vendor partners for Phase 1.¹ The Company also entered into an agreement with the City delineating Project responsibilities. Finally, the City notified the Company to proceed with Phase 1 of the Project and LED conversion for Zones A and B, which will include the installation of 3000 Kelvin (“K”) LED street lights.

2.0 Highlights Since Implementation Plan Filing

The tables included in Sections 2.1 and 2.2 below provide detailed descriptions of the major activities completed in the last quarter, as well as the challenges, lessons learned, and risk mitigation strategies from this work.

¹ Negotiations are ongoing with one vendor.

2.1 Major Task Activities

The Company worked on six major tasks during the second quarter of 2019.

First, the Company engaged with the City to finalize its LED wattage selection. The City took this opportunity to increase the lumen output for approximately 450 street lights. The adjustment provides the City with greater control and convenience once NLC nodes are installed, which could lead to additional energy savings opportunities and carbon reductions through lighting adjustments.

Second, the Company completed the lighting color preference survey mentioned in the previous quarterly report. The survey results showed a preference for 3000 K (as compared to 4000 K) street lights, which helped inform the City's overall deployment strategy. With the color selection made, the Company began to design and procure street light materials.

Third, with the support of partner vendors, the Company continued to build and design a smart-city solution that maximizes the benefit to the City. The City selected use-case applications focusing on public safety, smart infrastructure, and environmental monitoring to test in Phase 1. The use-case applications are a high priority for the City and are expected to deliver value by creating a smarter, safer, and more sustainable city.



Fourth, National Grid completed its solution architect review to ensure the proposed solutions meet architect standards and the Company's service-level requirements. The Company also completed Project requirements to evaluate whether the installed solutions deliver the anticipated benefits and whether the solutions are scalable to other zones of the City after the Phase 1 deployment. Given the complexity of the multipurpose network proposed by one vendor, the Company continued to review the network design to ensure data security and to optimize the solution design. The Company anticipates finalizing the scope early next quarter.

Fifth, contract negotiations continued to be a major effort throughout the quarter. In June, the Company reached an agreement with two vendors and awarded contracts for services in Zones A and B. With use-case applications selected and contracts executed, the Project is officially entering Phase 1 deployment.

Finally, the Company and the City executed an agreement to more clearly define Project responsibilities.

The decisions and lessons learned in Phase 1 will inform efforts to expand the successful solution into Zones C, D, and E during Phase 2. Because Phase 2 relies on the Phase 1 outcomes, the Company now expects the Phase 2 start will be delayed until October 2019 as a result of the extended negotiations mentioned above. The Company is working with the City to adjust the start/end dates and update the timing of the components of each phase. The updates are included as part of the revised work plan included as Appendix A. Also, the Company provides a further description of general Project milestones below:

| Anticipated Start /End Date | Adjusted Start/End Date | Checkpoint/ Milestone | Status | |
|------------------------------------|--------------------------------|--|---------------|---|
| October 2018 to December 2018 | | Install LED (Proof-of-Concept Stage; Max. 20 Fixtures) | Completed |  |
| October 2018 to June 2019 | August 2019 to September 2019 | Install LED & NLC Nodes (Zone A & B; Approx. 2,300 Fixtures) Compare vendor solutions | On Track |  |
| October 2018 to December 2019 | August 2019 to September 2019 | National Grid Install Smart City Sensor Nodes (Zones A & B; Max. 100 nodes) | On Track |  |
| July 2019 to June 2021 | August 2019 to June 2021 | LED and NLC Node Steady State (Evaluate operational capabilities) | On Track |  |
| July 2019 to December 2019 | October 2019 to March 2020 | Install LED and NLC Nodes (Zones C, D, & E; Approx. 2,000 fixtures) | On Track |  |
| June 2019 to March 2020 | December 2019 to March 2020 | National Grid Install Smart City Sensor Nodes (Zones C, D, and E; Max. 100 nodes) | On Track |  |
| October 2018 to June 2020 | January 2020 | City Install Smart City Device Attachments to Smart City Sensor Nodes (All Zones) | On Track |  |
| October 2018 to March 2019 | October 2018 to September 2019 | National Grid Implement Multi-Purpose Internet of Things (“IoT”) Mesh Network | On Track |  |
| October 2018 to December 2019 | September 2019 | National Grid Install IoT Mesh Network, and Smart Sensors (Temperature Sensors; | On Track |  |

| Anticipated Start /End Date | Adjusted Start/End Date | Checkpoint/ Milestone | Status |
|-----------------------------|----------------------------|---|--|
| | | Environmental Sensors; Etc.) | |
| January 2019 to June 2020 | October 2019 to June 2020 | Third-Parties Install Sensors (Smart-Home Devices; Electric Vehicle (“EV”) Chargers; Water Leak Sensors; Water Shutoff Valves; Water Meters; Vacant-Home Sensors; Parking Management Sensors; Etc.) | On Track  |
| September 2019 to June 2021 | December 2019 to June 2021 | Steady State Review and Evaluations | On Track  |

2.2 Challenges, Changes, and Lessons Learned

During the second quarter of 2019, the Company decided to delay the advanced metering infrastructure (“AMI”) component of the multipurpose network scope to Phase 2. The original intent of the multipurpose network for Zone A was to deliver network functionality for advanced street lighting, IoT devices, and AMI meters. However, the Company believes it is prudent to delay testing of AMI functionality while the Company’s AMI deployment proposal is pending with the Commission. Regardless, the Company can still use the AMI meters to help validate the accuracy of NLC node chip meters as part of controlled meter-lab testing. The Company expects to begin lab testing in the third quarter of 2019.

In designing the smart city solution for Phase 1 deployment, the number of smart sensors deployed for the two zones was adjusted to ensure proper technology coverage. Zone A deployment will consist of 75 smart sensors and controls with applications for public safety, roadway monitoring, and environmental monitoring. Zone B deployment will include 250 smart sensors with integrated controls, also focusing on public safety, municipal planning, and environmental monitoring.

As the Company and the City begin deploying LED street lights, NLC nodes, and smart city devices, there will be additional lessons learned. At this initial stage, the Company has identified a few high-level takeaways it will use to inform the ongoing work and future smart city deployments:

- Procuring the smart city solution requires close collaboration between project partners, the Company, and the municipality to design solutions that meet the appropriate support models for the project.

- The smart city market is growing rapidly and an area of interest as more municipalities are demanding advanced LED lighting controls, public safety enhancements, and other smart applications to improve public services.
- Several open-protocol smart city networks are becoming commercially available. The network protocols may offer a more cost-effective option for low-power IoT sensors, possibly reducing deployment costs in the future. Communication networks such as Sigfox, LoRa®, and NarrowBand IoT are emerging low- to moderate-powered networks currently being deployed in the market. The Project can benefit from these market developments in Phase 2.
- Designing the smart city solution requires the cross-functional collaboration of numerous municipal departments such as the police, fire, public works, information technology, and economic development.
- The lighting survey shows Schenectady residents preferred warm white 3000 K LED street lights over the cool white 4000 K option. Because 3000 K LED street lights are not currently offered by the Company, the Project required custom lighting.

The above challenges and lessons learned are also captured in the table below, which identifies the corresponding adjustment to the Zone A and B deployment schedule:

| Issue or Change | Strategies to Resolve | Resulting Change to Project Scope/Timeline? | Lessons Learned |
|--|--|---|---|
| Delayed installation of LED street lights and NLC nodes to customize the solution, review and comply with standards, and finalize agreements for deployment. | The Company is working with vendors and the City to determine core software and functionality needs, as well as IT-related issues, impacting contract negotiations. | Deployment in Zones A and B anticipated in the third quarter of 2019. | Tailoring smart city solutions and negotiating agreements may require additional lead time, given the relative newness of the technology. |
| Delayed deployment of AMI meters using the multipurpose network because the Company's AMI deployment plan is currently pending before the Commission. The Company believes it is prudent to delay and combine efforts once the AMI approach becomes clearer. | The Project team will engage periodically with the AMI team to stay informed on the AMI approval process. Deployment of AMI meters on the multipurpose network will be assessed later. | Defer the deployment of AMI meters on the multipurpose network to be revisited later in 2019. | The Project can maximize the learning opportunity by delaying the standalone AMI deployment and aligning the Project with the Company's AMI deployment. |
| To ensure proper solution coverage, the number of smart sensors | The Project team is tracking and | Change from a maximum of 100 smart sensors per zone to 75 | The number of smart sensors depends on the |

| | | | |
|---|--|--|---|
| for each zone was adjusted. Zone A required 75 smart sensors and controls, and Zone B required 250. This could impact the Project budget. | forecasting Phase 1 deployment cost. | smart sensors in Zone A and 250 Smart sensors in Zone B. | use-case applications and solution requirements. |
| Addressing data risk, data security, and individual responsibility for data breaches was challenging during contract negotiations. | The Company deployed additional legal resources on the Project to support contract negotiations. | Delays to executing contracts. | Identifying risks and the responsibilities of each party during contract negotiations can encourage partners to take responsibility and promote accountability. |

2.3 Stakeholder Engagement and Knowledge Sharing

The Company worked with the City during the second quarter to prepare for the 2019 Global City Teams Challenge in Washington, D.C. The expo brings hundreds of municipal governments and technology innovators from around the world to share lessons learned and best practices. The Company will attend and present with the Schenectady Mayor on July 10 - 12.

3.0 Next Quarter Forecast

In the third quarter of 2019, the Company anticipates completing the following items:

- Finalize statement of work with remaining vendor.
- Host kickoff meetings with the City for each zone.
- Invoice the City for LED conversion in zones A and B.
- Engage vendors for resource planning, scheduling, and the delivery of materials.
- Lab test and install the multipurpose network in one zone.
- Begin full deployment of LED street lights and NLC nodes in Zone A and B.
- Begin installing Smart Sensors in Zone A and B.
- Begin planning work for NLC node and smart city solution deployment in remaining zones.
- Explore additional smart city uses cases to assist in deploying sensors, cameras, etc.

4.0 Work Plan and Budget Review

4.1 Updated Work Plan

The Company made updates to the work plan outlined in the Project Implementation Plan to reflect changes in the status and ongoing workstreams. Given the complexities described above, the Company updated the Project work plan to capture the following components:

1. Finalize color temperature selection by the City;
2. Contract with the City;
3. Customize the smart city solution for the City;
4. Procure street lights, NLC nodes, and smart sensors;
5. Procure, design, and install a multipurpose network;
6. Combine LED street light conversion, installation of NLC nodes, and smart sensors;
7. Evaluate the solution deployed in Phase 1 for the City to determine preferred solution for Phase 2;
8. Lab testing of NLC nodes to validate chip metering accuracy; and
9. Deferred field installation of electric AMI meters.

The updated work plan is included as Appendix A.

4.2 Current Budget

| Project Task | 2 nd Quarter Actual Spend | Project Total Spend to Date | Project Budget | Remaining Balance |
|-----------------------------|--------------------------------------|-----------------------------|--------------------|--------------------|
| CapEx | | | | |
| Smart Lighting | \$0 | \$0 | \$2,170,000 | \$2,170,000 |
| Network | \$43,419 | \$74,072 | \$390,000 | \$315,929 |
| Smart Sensor | \$0 | \$0 | \$3,100,000 | \$3,100,000 |
| Project Support | \$0 | \$158,997 | \$100,000 | (\$58,997) |
| Lighting System Evaluations | \$0 | \$0 | \$150,000 | \$150,000 |
| Smart City Data Analytics | \$0 | \$0 | \$100,000 | \$100,000 |
| Data Platform | \$0 | \$0 | \$250,000 | \$250,000 |
| Network Management | \$0 | \$0 | \$250,000 | \$250,000 |
| OpEx | | | | |
| Smart Lighting | \$41,167 | \$41,167 | \$180,000 | \$138,833 |
| Network | \$0 | \$0 | \$715,000 | \$715,000 |
| Smart Sensor | \$0 | \$0 | \$180,000 | \$180,000 |
| Total | \$84,586 | \$274,236 | \$7,585,000 | \$7,310,765 |

5.0 Quarterly Report Template

| Quarterly Report Template | |
|---|--|
| Milestones: | |
| Project Milestones Accomplished: | The City executed a contract with the Company. The Company executed contracts with Zone A and B vendors. The City approved Phase 1 deployment. |
| Next Project Milestone: | Finalize contract with remaining vendor. Vendor kickoff meetings with the City. Field installation of LED, NLC, and smart sensors in Zones A and B. Install multipurpose network. Lab test NLC chip meters in a lab environment. Evaluate deployed solutions to inform Phase 2 deployment. |
| Tasks/Timeline: | |
| Completed Project Tasks Since Last Quarterly Report: | Finalized survey results and shared with the City. The City approved LED conversion with warm white 3000 K LED street lights, allowing street light conversion design to begin. Solution architect reviews were completed leading to vendor agreements execution for Phase 1 vendors. Finally, the Company entered into an agreement with the City, more clearly defining each party's responsibilities. |
| Changes or Impacts to Schedule Since Last Quarterly Report: | Delayed start of installing LED street lights and NLC nodes in Zones A and B due to ongoing work with vendors to scope the solution and negotiate contracts. |
| Lessons Learned: | Adequate time is needed during contract negotiations to fully describe the specific legal obligations and the associated risk for each party. The Project can maximize the learning opportunity by delaying the standalone AMI deployment and aligning the Project with the Company's pending AMI deployment plan. The number of smart sensors depends on the use-case applications and solution requirements. |
| Work Stream Coordination: | Coordination occurring among the Company's Electric Business Unit and the Customer and IT business functions for purposes of engineering design, review, and deployment. |
| Risks: | |
| Identified Risks: | Phase 1 deployment cost is higher than expected with the increase in smart sensors required to ensure proper solution coverage. The Project team anticipates longer delivery times for smart city technologies because most products are not off-the-shelf and require manufacturing. |
| Risk Mitigation Plan: | The Project team is tracking and forecasting the budget to stay within 50% of the project budget. The Company and the City understand there are high setup costs associated with initial |

| Quarterly Report Template | |
|--|---|
| | <p>deployments and will look for scaling the most cost-effective solution to remaining zones.</p> <p>The Company has requested vendors to prioritize manufacturing and delivery schedules to reduce product lead times. The current forecast shows delivery of more than half of the materials needed for Zone B in early August. Phase 1 deployment will begin in Zone B and then enter Zone A as products arrive. The Project team will continue weekly calls to promote a continuous agile deployment.</p> |
| Finance: | |
| Total Spend to Date: | \$274,235.50 |
| Target Budget Spend: | \$350,164 |
| Actual Incremental Spend: | \$58,997 |
| Variance: | (\$16,931) |
| In-Kind and Grant Support (Specifically for REV Demo): | Estimated \$150,000 from vendors. |
| Additional Notes: | |

Appendix B – Summary One-Pager



Smart City Schenectady REV Demo

Q2 2019

Overall Status (Active)

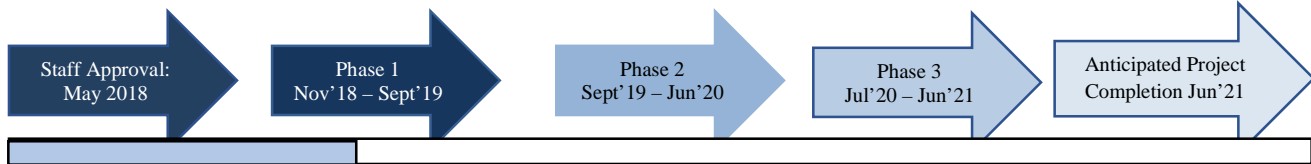
Project Start Date: 05/24/2018

Project End Date: 06/30/2021

Budget: \$7,585,000

Current Quarter Spend: \$84,586

Cumulative Spend: \$274,235.50



Project Summary: The Project is designed to test whether the Company’s outdoor lighting infrastructure can serve as a platform for advanced services, the deployment of Low-Power Wireless Personal Area Networks to enable smart-city technologies, and the business models that will animate the advanced outdoor lighting and smart-city markets.

| Cumulative Lessons Learned | | |
|--|--|--|
| The Customer | Market Partners | Utility Operations |
| <ul style="list-style-type: none"> Cities want more than smart lighting alone. The City of Schenectady intends to improve public services, increase public safety, and find ways to save money in the process. The City and the Company understand the need to engage and inform residents of the project. The project team will develop a community engagement plan with the City in Q3 2019. Conversion to LED street lights provides significant GHG savings that help meet 80 X 50 climate goals. | <ul style="list-style-type: none"> Partners are customizing their solutions to meet the needs of both the City and the Company. Standardization and market advancements would improve network interoperability between smart city devices. First costs are significant. However, the cost of future deployment may be lower as the project expands into other zones. New and disruptive smart city technologies are emerging on the market. The project can benefit from new market entrants to offer greater choice and new products. | <ul style="list-style-type: none"> Smart City is a complex deployment of diverse smart technologies. Utility involvement consolidates smart cities into a single packaged solution. Installation costs are high. Therefore, deployment cost reductions can be achieved through combining smart city installation with LED upgrade. Internal engineering review of smart city solutions is essential. Adequate time is needed to fully ensure the solution meets standard code compliance, data security, and data privacy requirements. |

Application of lessons learned: The Company is reviewing responses submitted from the request for information (“RFI”) for advanced street lighting and smart city products released in Q1 2019. The goal is to identify at-scale solutions that will assist in meeting customer needs, energy efficiency targets, and GHG reduction goals while providing a new “utility of the future” business opportunity.

Issues Identified: The Project team anticipates longer delivery times for smart city technologies because most products are not off-the-shelf and require manufacturing.

Solutions Identified: The Company has requested vendor partners to prioritize manufacturing and delivery schedules to reduce product lead times. The current forecast shows delivery of more than half of the materials needed for Zone B in early August. Phase one deployment will begin in Zone B and then enter Zone A as products start to arrive. The Project team will continue weekly calls to promote a continuous agile deployment.

Recent Milestones/Targets Met: The Company concluded solution architect review and contracted with both Zone A and Zone B vendor partners during Q2 2019. Additionally, the Company established a contractual agreement with the City to organize obligations for each party.

Upcoming Milestones/Targets: The Company will host a kickoff meeting for each zone in early Q3 2019 to create deployment plans to manage product delivery, deployment, and commissioning. In Q3 2019, the Company will also aim to begin LED conversion and installation of smart city technologies for Phase 1 Zones A and B.