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

Quarterly Report – Q2 2020

July 31, 2020

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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, including the Climate Leadership and Community Protection Act ("CLCPA"). 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 2020, the Company advanced several aspects of the Project, including:

- Completed remaining Phase 1 streetlight conversions with NLCs in both zones A and B.
- Installed 23 smart city technologies in Zone B, totaling 239 out of the 250 planned.
- Participated with the City in additional platform technology training.
- Continued to troubleshoot several NLC and smart city technology issues in Zone A.
- Procured additional intelligent data platform services to integrate sensor data.
- Completed cybersecurity testing of Zone B smart city technology to identify new security vulnerabilities.
- Executed a contract with Rensselaer Polytechnic Institute ("RPI") for lighting research.
- Held discovery meetings together with the City for local universities and the medical institution to explore potential use cases of interest for Phase 2.
- Evaluated Phase 2 vendor bid proposals and presentations with the City to identify emerging and more cost-effective technologies.

Finally, the collective effort between the Company and the City during the Phase 2 technology procurement identified the optimal Phase 2 technology solution. The Company notified unsuccessful bidders and began contract negotiations with the presumptive awardee.

2.0 Highlights Since Implementation Plan Filing

The tables 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.

2.1 Major Task Activities

The Company worked on eight significant tasks during the second quarter of 2020. First, the COVID-19 situation presented several construction-related challenges to conclude Phase 1 technology deployment. These challenges included delays resulting from manufacturing plant shutdowns, material shipment, and contractor availability. However, with the situation improving in June, the Company resumed construction on remaining Phase 1 LED streetlight conversions with NLC nodes and smart city technology deployments. The number of streetlights upgraded to LEDs in Zones A and B totaled 2,282. An additional 23 smart city technologies were deployed in Zone B, bringing a total number of devices deployed to 239 out of the 250 planned. The remaining 11 smart city technologies were approved through the make-ready process and are scheduled for installation in the next quarter.

Second, with Zone A smart lighting and smart city technologies deployment complete, vendor partner Cimcon® delivered the smart lighting platform Lighting Gale® and the smart city analytics platform StreetVibe®. Technical user trainings were held for both the Company and City staff. During the training, the Project team identified several NLC node outages due to connectivity or hardware issues. The team also identified data quality issues with the smart city sensors in Zone A. The vendor group resolved several issues through remote troubleshooting; however, the vendor group identified the need to resolve some of these problems in the field in Q3 2020.

Third, the Company procured additional platform services to enhance intelligent analytics delivered by Cisco® Kinetics for Cities. The intelligent internet of things ("IoT") platform will collect, warehouse and analyze both smart lighting and smart city technologies deployed in Zone A. The City will use the Cisco® Kinetics for Cities visualization and analytics platform to better manage multiple software systems and enable interoperability between the lighting and smart city platforms.

Fourth, the Company's information technology ("IT") group began cybersecurity assessment and penetration testing of Phase 1 technologies. The Company tested the Zone B CityIQ® smart city technology and identified minor vulnerabilities that can be improved. The Company plans to share the final report and devise a plan to address those vulnerabilities with Ubicquia® in the next quarter.[1] Due to the COVID-19 situation, vulnerability assessment and penetration testing of smart city technologies in Zone A and smart lighting systems for both zones will be delayed to Q4 2020

Fifth, the Company entered into an agreement with RPI to conduct the lighting research. A kickoff meeting was held to identify potential residential and commercial study areas. With the vast number of smart city technologies deployed across Zones A and B, the study will take advantage

[1] Ubicquia® acquired the CityIQ® smart city technology from Current by GE on May 4, 2020. http://www.ubicquia.com/news/ubicquia_acquire_cityiq

of both pedestrian and vehicle traffic data in its analysis to propose optimal streetlight dimming schemes to maximize energy savings while maintaining safety and security. The Project team expects the study to begin in Q3 2020 and conclude in Q4 2020.

Sixth, at the direction of Mayor Gary McCarthy, the Company held discovery meetings with local universities and the medical institution to explore potential use cases of interest for Phase 2. Individual meetings were scheduled by the Company to identify whether there are areas of collaboration or synergies as the Project team selects the technology solution during the Phase 2 competitive technology procurement process.

Seventh, the Company evaluated Phase 2 bid proposals with the City. City staff members participated in all vendor presentations, technical deep-dives, and bid evaluations to procure the optimal solution that meets the needs of the City and its residents. Towards the end of the quarter, the Project team identified the presumptive awardee (to be announced in Q3 2020). The new vendor will bring a more cost effective NLC solution and innovative smart city technologies poised to deliver value for the City. Selection of the new vendor will introduce a delay of approximately six months in Project implementation because the Project team selected a newer technology version slated for release in Q1 2021. The newer NLC technology version has several advantages, such as enhanced cybersecurity elements and surge protection. The newer smart city technology will deliver multiple concurrent analytics and produce cost reductions compared to its current version. The decision to move forward with the presumptive awardee and choice of technology version were made in agreement between the Company and the City.

Finally, the Company continued to assist the City with city-owned sensors and attachments. The Company will assist the City in a proof-of-concept to attach sensors and Wi-Fi access points to 24 streetlight locations using a power-tap device. The goal is to understand whether there are efficiencies gained by tapping into the streetlight for energy compared to establishing a new service from the secondary powerlines. The stretch goal is to determine whether the NLC nodes can also be used as a metering device to meter these attachments. The City is awaiting application approval with Verizon®. Once the Company receives approval confirmation from Verizon®, the Company will continue to assist the City during the attachment process.

With the COVID-19 situation improving, the Company aims to complete remaining Phase 1 activities to install 11 smart city technologies in Zone B in Q3 2020. The mutual decision to select newer technology versions from the Phase 2 vendor will extend the Project approximately six months. The Company now expects Phase 2 deployment to begin in April 2021. The Company will target contract execution in the next quarter; and begin engineering design work for LED streetlight conversion with smart lighting and smart city technology. 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	

Anticipated Start /End Date	Adjusted Start/End Date	Checkpoint/ Milestone	Status	
October 2018 to June 2019	October 2018 to June 2020	Install LED & NLC Nodes (Zone A & B; Approx. 2,250 Fixtures) Compare vendor solutions	Completed	
October 2019 to June 2020	October 2019 to August 2020	National Grid Install Smart City Sensor Nodes (Zones A & B)	Delayed Completion	
July 2019 to June 2021	January 2020 to September 2021	LED and NLC Node Steady State (Evaluate operational capabilities)	Delayed Completion	
July 2020 to October 2020	April 2021 to May 2021	Install LED and NLC Nodes (Zones C, D, & E; Approx. 2,000 fixtures)	Delayed Start	
July 2020 to October 2020	April 2021 to May 2021	National Grid Install Smart City Sensor Nodes (Zones C, D, and E; Max. 100 nodes)	Delayed Start	
January 2020 to July 2020	January 2020 to September 2021	City Install Smart City Device Attachments to Smart City Sensor Nodes (All Zones)	Delayed Completion	
October 2018 to March 2019	October 2018 to October 2019	National Grid Implement Multi-Purpose IoT Mesh Network	Completed	
September 2019 to October 2020		National Grid Install IoT Mesh Network Sensors, and Meters (Gas ERTs; Temperature Sensors; Environmental Sensors; Etc.)	On Track	
January 2019 to June 2020	June 2021 to December 2021	Explore potential Third-Parties Sensors (Smart-Home Devices; Electric Vehicle (“EV”) Chargers; Water Leak Sensors; Water Shutoff Valves; Water Meters; Vacant-Home Sensors; Parking Management Sensors; Etc.)	Delayed Start	
November 2020 to June 2021	June 2021 to December 2021	Steady State Review and Evaluations	Delayed Start	

2.2 Challenges, Changes, and Lessons Learned

Below is a high-level description of lessons learned which the Company is using to inform its ongoing work and future smart city deployments:

1. Because smart city technologies are non-traditional attachments to utility infrastructure, technology providers must provide product specification drawings and mounting methods for the Company to ensure code compliance before installation.
2. Once the utility provides installation guidelines, a field survey must be conducted on the proposed location to ensure existing conditions can safely accommodate the installation. The NESC H238B-2 requirement for the Current® by GE Digital Infrastructure node added complexity to the Project. However, this important lesson learned is a testament to the Company's strong culture of doing business through safety-by-design principles.
3. After starting to deploy street lights with NLC nodes, the Company and the City recognized the potential benefits offered through the technology. The lighting platform provides the City with greater control, convenience, and the potential to unlock additional energy savings through platform capabilities. The Company also recognized the value the technology can bring to enhance outdoor lighting services, deliver more carbon savings, and increase customer convenience.
4. Some smart city technologies are manufactured abroad, resulting in longer product lead times. This has created approximately three months of delays due to manufacturing and overseas transport. The Company used this lead time to conduct additional due diligence and prepare for the installation process.
5. Depending on the advanced network lighting solution, the installation needs to follow the optimal deployment scheme for the technology. Whether it is a point-to-many-points solution, cellular, or mesh technology, the deployment scheme should involve close communication and guidance with the manufacturer. This allows the technology to function as desired from the start.
6. Currently, there is no approved national metering accuracy standard for NLC nodes. While ANSI standard C136.50 is being designed, the Company believes ANSI standard C12.20 is a reasonable proxy to test NLC nodes for the Project. Additional time will be needed for lab testing of NLC nodes to incorporate the components of both ANSI standards.
7. The initial observations of the Project have identified a variety of NLC technology benefits that provide opportunities to enhance outdoor lighting services and provide operating cost efficiencies.
8. Continued involvement in the ANSI C136.50 NLC industry committee will build on the Company's meter testing experience for preliminary tests. The knowledge gained will enable the Company to formulate business models for various technology applications to provide customers with alternate service options and rate structures.
9. NLC metering accuracy specifications and industry-accepted testing requirements are needed before NLC meter data can be used for billing purposes. In addition, the integration of NLC meter data into the Company's billing system may require system upgrades.

The table below highlights the challenges and lessons learned in Q2 2020, and identifies the corresponding adjustment to the Phase 1 deployment and Phase 2 startup schedule:

Issue or Change	Strategies to Resolve	Resulting Change to Project Scope/Timeline	Lessons Learned
Several NLC network outages were detected for both Zones A and B.	The Company receives outage reports through the lighting platform. Once an outage is triggered, the Company opens a ticket with the lighting platform provider to resolve the issue remotely. Should field technicians be required to resolve the issue, a ticket will be opened within the Company to resolve the issue.	N/A	Both Zone A and Zone B operate on different iterations of low powered mesh networks. Zone A lighting system relies on a multipurpose mesh network managed by a network provider. The architecture involves additional connections between data centers, which makes troubleshooting NLC outages difficult. The root cause for NLC outages has yet to be identified. The Company will continue to work with Zone A vendors to resolve the network issue. Conversely, the Zone B lighting system relies on a lighting only network and issues were resolved within 5 days of opening a ticket with the platform provider.
The presumptive awardee for Phase 2 will be releasing new versions of NLC and smart city technologies in Q1 2021 which have technology benefits and produce cost savings. The City and the Company selected the new versions of the technology and proposed changes to the Project timeline.	The Company and the City propose extending the project for an additional six months to utilize enhanced technology capabilities and cost savings with the new version of NLC and smart city technology.	Delay Phase 2 construction (NLC node and smart city technology deployment) to April 2021 and Project closeout to December 2021	Newer NLC and smart city solutions are being released on the market. Implementing enhanced technologies enables new learning opportunities and provides the City technology benefits.

Issue or Change	Strategies to Resolve	Resulting Change to Project Scope/Timeline	Lessons Learned
Phase 2 bid proposals highlighted the cost of public cellular connectivity for NLC and smart city technologies to be more cost-effective options compared to private low/moderate networks.	The Project will test a public cellular connectivity solution for NLC and smart city technology in Zones C, D, and E.	N/A	The cost of public cellular connectivity solutions for IoT technology has decreased dramatically. Testing a cellular connectivity model will yield new learnings opportunities by comparing it to the technologies deployed in Phase 1. It is important to note that the geographic nature of Zones C, D, and E may have resulted in higher solution costs because the geography may have resulted in the need for additional gateways to connect all endpoints under an RF mesh connectivity solution.
The COVID-19 pandemic continues to present manufacturing and delivery delays. Additional materials are needed to resolve NLC issues in Zone A and smart city technologies in Zone B.	The Company will continue to work closely with vendor partners to understand COVID-19 impacts on materials needed for remaining installation and ongoing maintenance.	Delay Zone B make-ready work for 11 smart city technologies into August 2020.	The Project needs to be agile, given the current public health situation. In these situations, staying in close communication with vendors and internal teams allows components of the project to move forward where possible.
Cross-functional department collaboration between the Company's Regional Account Service (RAS), Engineering Design, and Standards are needed to accurately update internal asset management systems.	Taking the lessons learned from Phase 1 into Phase 2, the Project team will begin updating and validating internal asset management systems once the materials have been confirmed.	N/A	Once the streetlight data has been confirmed with the City, along with the smart city technology selected, cross functional needs to work together to accurately update internal systems. This will ensure that accurate information is communicated to the installation contractor and promote efficiency during construction.

Issue or Change	Strategies to Resolve	Resulting Change to Project Scope/Timeline	Lessons Learned
Field surveys for code compliance identified existing distribution poles to be congested or have existing non-compliance.	The Company will take this learning into Phase 2 and work closely with the technology provider and the City to identify optimal locations for new attachments.	N/A	The Company will actively identify, flag, resolve locations with existing non-compliance in Phase 2. The Company will also work closely with the City to identify optimal locations for new attachments before Phase 2 construction to reduce deployment costs.

2.3 Stakeholder Engagement and Knowledge Sharing

The Company and the City engaged with the New York Civil Liberties Union ("NYCLU") to share technology type, privacy guidelines, and cybersecurity elements deployed in the Project. The Project team offered a partnership opportunity to the NYCLU to achieve optimal Project outcomes while protecting citizen privacy and promoting cybersecurity.

Following the partnership kickoff meeting with local universities and the medical institution in Q1 2020, The Project team continued to engage with these stakeholders to explore use cases of interest for the City to consider when selecting the optimal Phase 2 technology solution. The Company and the City have identified areas of collaboration with local universities and will continue to explore innovation opportunities available on the Project. During these engagements, the Project team identified the interest of the stakeholders to explore medical use cases and technology under smart cities. The Project looks to bring on an external consultant specializing in this field to help the City investigate potential solutions and develop a technology roadmap.

Lastly, the Company shared high level challenges and lessons learned with Ameren. Engagements with other utility partners provide learning opportunities for the Company to inform best practices and future smart city deployments.

3.0 Next Quarter Forecast

The COVID-19 situation presents several challenges to completing the remaining Phase 1 tasks. Assuming the situation continues to improve and field activities can continue, the Company will focus on completing the outstanding construction activities in Phase 1 and starting Phase 2 activities.

In the third quarter of 2020, the Company expects to perform the following tasks:

- Deploy 11 remaining smart city technologies in Zones B through make-ready work;
- Resolve remaining connectivity and outage issues in Zone A;
- Conduct light output measurements in Zone A and compare values with Zone B;
- Complete cybersecurity penetration testing;
- Evaluate the deployed technologies in Phase 1;
- Execute a contract with the presumptive awardee for Phase 2;
- Issue LED streetlight conversion letter and provide an invoice to the City;
- Begin Phase 2 engineering design work; and
- Resume lab testing of NLC nodes to also include NLC technology planned for Phase 2.

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 encountered on the Project, the Company updated the Project work plan to capture the following components:

1. Extend remaining Phase 1 activity into September 2020;
2. Extend lab test NLC nodes into September 2020;
3. Extend Procurement, Planning, and Design of Phase 2 technologies into March 2021;
4. Extend Phase 2 deployment into May 2021;
5. Continue to assist the City with City-owned attachments into September 2020; and
6. Delay Phase 3 steady-state evaluations to begin in July 2021

The updated work plan is included in Appendix A.

4.2 Current Budget

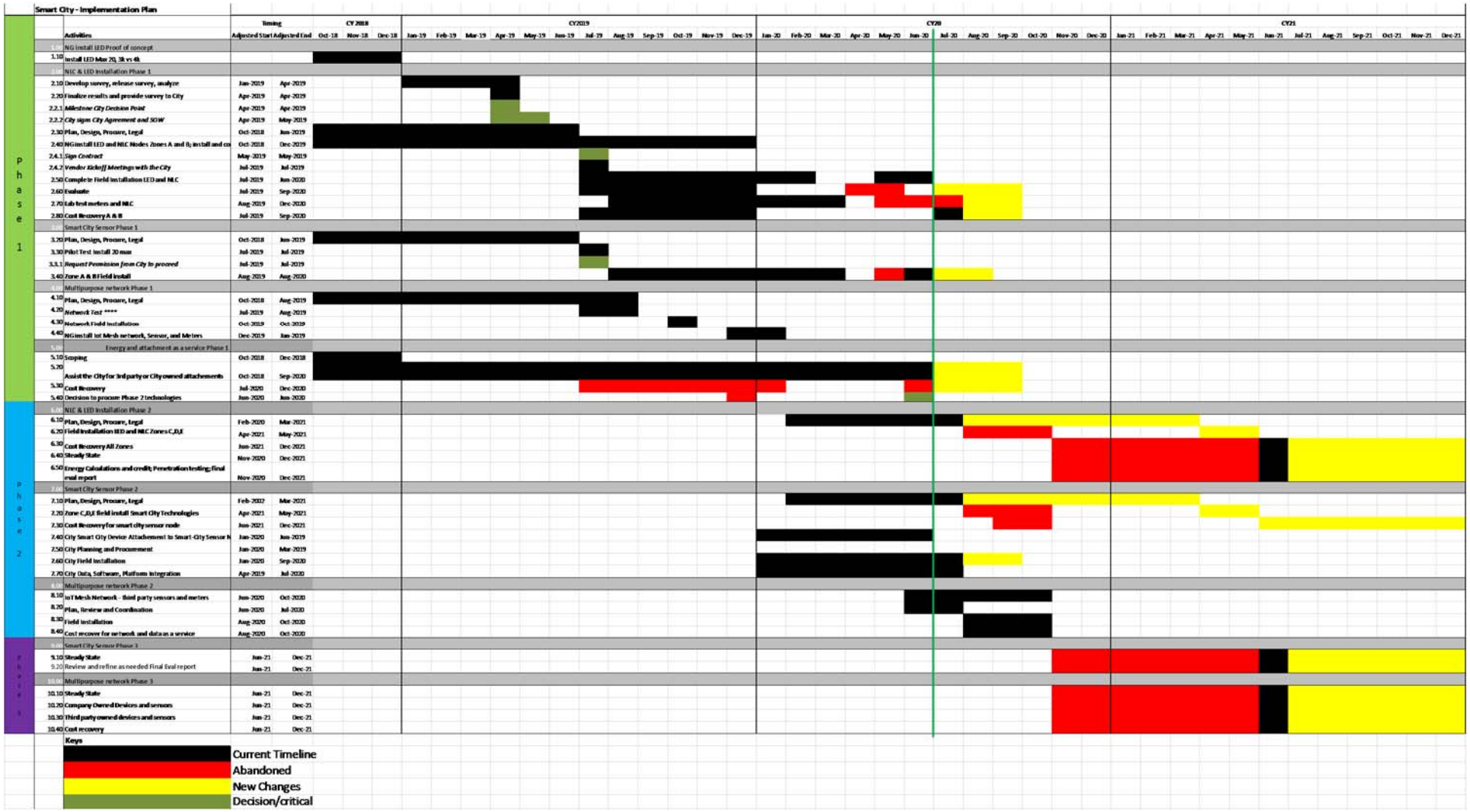
Project Task	**Quarter Actual Spend**	**Project Total Spend to Date**	**Project Budget**	**Remaining Balance**
CapEx				
Smart Lighting		$408,939	$2,170,000	$1,761,061
Network		$235,180	$390,000	$154,820
Smart Sensor	$109,481	$1,708,404	$3,100,000	$1,391,596
Project Support		$158,997	$100,000	($58,997)
Lighting System Evaluations		$9,463	$150,000	$140,537
Smart City Data Analytics		$0	$100,000	$100,000
Data Platform		$239,088	$250,000	$10,912
Network Management		$153,406	$250,000	$96,594
Capital Overhead	$132,496	$665,022	$0	($665,023)
OpEx				
Smart Lighting		$0	$180,000	$180,000
Network		$0	$715,000	$715,000
Smart Sensor		$0	$180,000	$180,000
Total	**$241,977**	**$3,578,500**	**$7,585,000**	**$4,006,500**

5.0 Quarterly Report Template

Quarterly Report Template	
Milestones:	
Project Milestones Accomplished:	1. Completed remaining streetlight conversions in Zones A and B with NLC nodes.
Next Quarter Project Milestones:	1. Complete remaining 11 smart city technology installation in Zone B 2. Complete cybersecurity penetration testing for Phase 1 3. Execute a contract with the Phase 2 vendor 4. Evaluate the deployed technologies for Phase 1 5. Complete lab testing of NLC nodes and report findings. 6. Issue LED streetlight conversion letter and invoice the City 7. Begin engineering design for Phase 2
Tasks/Timeline:	
Completed Project Tasks Since Last Quarterly Report:	1. Complete field installation of LED streetlight and NLC nodes in Zones A & B 2. Participated along with the City in Zone A technology platform trainings 3. Purchased additional smart city data platforms for the City 4. Cybersecurity penetration testing of Zone B smart city technology 5. Executed a contract with RPI for a lighting study 6. Led Phase 2 use case discovery meetings with local universities and the medical institution 7. Evaluated Phase 2 RFP bid proposals and identified presumptive awardee. 8. Continue to support City-owned smart city attachment to streetlights
Changes or Impacts to Schedule Since Last Quarterly Report:	1. Extend remaining Phase 1 activity into September 2020; 2. Extend lab test NLC nodes into September 2020; 3. Extend Procurement, Planning, and Design of Phase 2 technologies into March 2021; 4. Extend Phase 2 deployment into May 2021; 5. Continue to assist the City with City-owned attachments into September 2020; and 6. Delay Phase 3 steady-state evaluations to begin in July 2021
Lessons Learned:	Please refer to section 2.2 Challenges, Changes, and Lessons Learned above.
Work Stream Coordination:	Coordination occurring among the Company's electric business unit, gas business unit, procurement, communications, marketing, customer organization, energy efficiency, grid & network communications,

Quarterly Report Template	
	Metering and billing, and IT group for engineering design, review, and deployment.
Risks:	
Identified Risks:	Due to the ongoing COVID-19 situation, the remaining Phase 1 technology deployment will continue to be impacted. The joint decision to select new technology version with the Phase 2 presumptive awardee results in approximately 6-month project extension.
Risk Mitigation Plan:	The Company will work closely with Zone B vendors to secure materials after the manufacturing plant reopens. The Company targets to contract with the Phase 2 vendor in Q3 2020 and carefully plan deployment activities to minimize delays observed in Phase 1.
Finance:	
Total Spend to Date:	$3,578,500
Target Budget Spend:	$4,236,117
Actual Incremental Spend:	$0
Variance:	$657,617
In-Kind and Grant Support (Specifically for REV Demo):	Estimated $150,000 from Phase 1 vendors.
Additional Notes:	

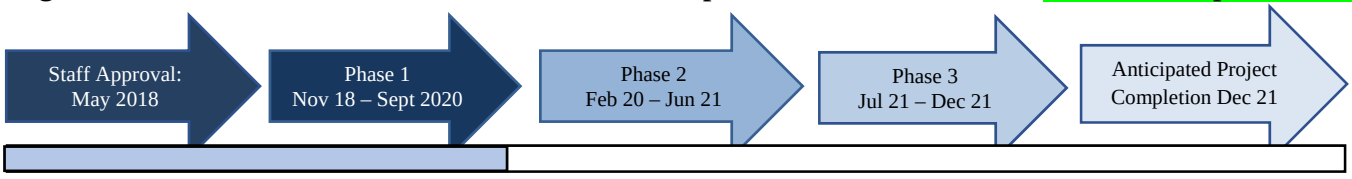
Appendix A – Updated Work Plan



Appendix B – Summary One Pager

nationalgrid **Smart City Schenectady REV Demo** **Q2 2020** **Overall Status (Active)**

Project Start Date: 05/24/2018 **Project End Date:** 12/30/2021
Budget: $7,585,000 **Current Quarter Spend:** $241,977 **Cumulative Spend**: $3,578,500



Project Summary: The Project is designed to test whether the Company's outdoor lighting infrastructure can serve as a platform for advanced services through the deployment of a multipurpose IoT network to enable smart-city technologies, and to develop viable business models to animate the advanced outdoor lighting and smart city markets.

Cumulative Lessons Learned		
The Customer	**Market Partners**	**Utility Operations**
• 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 continue to engage with stakeholders as the Project progress. • Conversion to smart LED street lights with NLC nodes provides greater control, convenience, and opportunity for additional GHG savings that help meet clean energy and CLCPA goals. • Protecting citizen privacy and practicing cybersecurity are core towards a successful smart city deployment.	• The definition of Smart City is different for each city. Technology solutions must be customized to meet the needs of the city. • Standardization and market advancements would improve network interoperability between smart-city devices. • Upfront costs are high. However, the cost of future deployment may be lower as the Project expands into other zones. • New and disruptive smart-city technologies are emerging in the market. The Project can benefit from new market entrants offering additional choices and new products. • The cost of smart lighting and IoT connectivity is decreasing.	• Building a smart city entails a complex deployment of diverse smart technologies. Utility involvement consolidates smart cities into a packaged solution. • Installation costs are high. However, deployment cost reductions can be achieved by combining smart city installation with LED upgrades. • Adequate time is needed to fully ensure the solution meets standard code compliance, data security, and data privacy requirements. Initial field surveys are also required to ensure code compliance. • NLC nodes offer a range of customer benefits and provide opportunities to enhance outdoor lighting services.

Application of lessons learned: Company is taking the learning gathered to inform its ongoing work and applying smart city attachment experience for other municipal applications.

Issues Identified: Due to the ongoing COVID-19 situation, remaining Phase 1 technology deployment will continue to be impacted. Secondly, the joint decision to select new technology version with the Phase 2 presumptive awardee extends the project schedule approximately six months.

Solutions Identified: The Company will work closely with Zone B vendors to secure materials after the manufacturing plant reopens. The Company targets to contract with the Phase 2 vendor in Q3 2020 and carefully plan deployment activities to minimize delays observed in Phase 1.

Recent Milestones/Targets Met: Remaining streetlight conversions with NLC nodes in both Zones A and B. The Company and the City evaluated bid proposals and selected the Phase 2 vendor.

Upcoming Milestones/Targets: Pursue make-ready services for the remaining 11 smart city sensor deployment in Zone B. Cybersecurity testing of remaining technologies. Evaluate the deployed technologies for Phase 1. Execute a contract with the Phase 2 vendor. Issue LED streetlight conversion letter. Complete lab testing of NLC nodes and report findings.