# Implementation Plan for the Smart City REV Demonstration Project City of Schenectady

**Case 14-M-0101**
**Reforming the Energy Vision**

**Niagara Mohawk Power Corporation d/b/a National Grid**

**October 24, 2018**

nationalgrid

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# Executive Summary

On March 26, 2018, Niagara Mohawk Power Corporation d/b/a National Grid ("National Grid or the "Company") filed a proposal for the Smart City REV Demonstration Project (the "Project") in the City of Schenectady, New York ("Schenectady" or the "City").[1] On May 24, 2018, Department of Public Service Staff ("Staff") notified the Company that the Project complied with the objectives in the REV Track One Order,[2] and directed the Company to develop and file an implementation plan. The Company proceeded to work with Staff to refine the Project approach – this filing is consistent with those discussions.[3]

The Project is designed to test whether the Company's outdoor lighting infrastructure can serve as a platform for advanced outdoor lighting services, the deployment of smart-city technologies, and the business models that will animate the advanced outdoor lighting and smart-city markets. The purpose of this implementation plan is to describe National Grid's detailed execution plan, as well as the items the Company hopes to learn from the Project, and to identify the core team supporting this work.

The Project aligns with both New York State's Clean Energy Standard ("CES"), incorporating the State Energy Plan, and the larger Reforming the Energy Vision ("REV") initiative. The CES, which adopted a goal "that 50% of New York's electricity is to be generated by renewable sources by 2030,"[4] complements the REV objectives of improving system efficiency, empowering customer choice, and encouraging "greater penetration of clean generation and efficiency technologies."[5] With this Project, National Grid will install approximately 4,275 efficient light-emitting diode ("LED") outdoor lighting fixtures, network lighting control ("NLC") nodes, and, along with the City, smart-city technologies. These 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.

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[1] Case 14-M-0101, *Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision* ("REV Proceeding"), Proposed Smart City REV Demonstration Project City of Schenectady (filed March 26, 2018).

[2] REV Proceeding, Letter from Colleen Gerwitz, Acting Director, Office of Markets & Innovation, New York Department of Public Service, to Arun Vedhathiri, Director, Program Management, New Energy Solutions, New York, National Grid (May 24, 2018) ("May 24 Letter").

[3] The May 24 Letter directed the Company to submit the Project implementation plan within 30 days of the date of the letter. However, subsequent conversations with Staff identified areas of the implementation plan that would benefit from further clarification. This filing reflects those refinements.

[4] Case 15-E-0302, *Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard*, Order Adopting a Clean Energy Standard (issued August 1, 2016) ("CES Order").

[5] *See* REV Proceeding, Order Instituting Proceeding (issued April 25, 2014) at page 5; *see also* CES Order, at page 6 ("The 50 by 30 goal is not only part of a larger greenhouse gas goal, it is part of the State's sweeping initiative to transform the way energy is produced, delivered, and consumed.").

# Project Design

## Project Component Details

The Project will include a phased approach to deploying the LED street lights, NLC nodes, and a primary Internet of Things ("IoT') network utilizing a Low-Power Wireless Personal Area Network ("6LoWPAN") communications protocol (or comparable IEEE 802.15.4 network) to enable remote lighting operations (*e.g.*, dimming). In addition, the Company and the City will work together to deploy and field test a network of smart-city sensor nodes and technologies, as well as three business models designed to animate the smart-city market.

In short, the Project is designed to test whether National Grid, by offering an advanced LED street lighting platform capable of hosting smart-city technology and services, can overcome the following perceived barriers to broad-scale smart-city deployment: 1) operational capabilities; 2) market uncertainty; and 3) regulatory constraints.

1. **Operational Capabilities:** A central component of the Project is the installation and operation of an advanced LED street light system throughout the City. Although the Company currently has an unmetered LED tariff option, some municipalities are looking for additional functionality (*e.g.*, different color temperatures, decorative lighting, and remote operating capabilities). The Company will work with the City to test residents' acceptance and preference for various lighting options. Likewise, the Company will use the deployment phase to better understand and refine its overall installation and commissioning processes for LED street lights, the NLC nodes, and the 6LoWPAN/IoT-enabled network. Once the advanced LED lighting system is installed, the Company will test operational capabilities; for example, whether increased system visibility results in asset management cost savings (*e.g.*, outage awareness), technology from different vendors is interoperable, and the chip meters embedded in the nodes are sufficiently accurate for purposes of moving forward with the meter approval process and ultimately for billing purposes. The chip meter evaluation will prove critically important to informing the Company's development of a LED tariff offering capable of capturing additional energy savings associated with remotely operating LED street lights. The Company will also evaluate the City's experience with the remote street lighting operations portal, and use the information learned to improve portal functionality. Finally, the Company will use the Project to conduct penetration tests to better understand cybersecurity issues that may arise from using this technology and to bolster protections. As the Project progresses, the Company will develop details on the methodology for penetration testing, which may be confidential.

2. **Market Uncertainty:** The Company will also use the Project to test three business models intended to animate the smart-city market by encouraging municipal adoption of technology through lower upfront costs and by enabling third-parties to develop innovative smart-city solutions. The first business model focuses on enhanced Company-owned infrastructure, where the Company owns the LED street lights, NLC nodes, and the 6LoWPAN/IoT-enabled communications network. The second business model is a hybrid Company/smart-city vendor shared infrastructure model, including Company-

owned smart-city sensor nodes, devices, and multipurpose mesh network (6LoWPAN/Wi-SUN), coupled with network access for third parties and a data-as-a-service offering. The third business model is intended to support City-owned smart-city infrastructure, where the Company would animate the smart-city market by providing attachment and energy services for smart-city devices owned by entities other than the Company that require a high-bandwidth network.

3. **Regulatory Constraints:** Although municipalities have indicated an interest in deploying advanced LED street lighting technology and smart-city devices, the Company's current P.S.C. No. 214 – Outdoor Lighting Tariff (the "Lighting Tariff") does not include mechanisms that would otherwise enable municipalities to cost-effectively adopt the technologies. With the Project, the Company will test the City's willingness to pay facility charges for the nodes that enable the advanced LED lighting platform and the related 6LoWPAN/IoT network. Likewise, the Company will test whether the chip-metering technology embedded in the nodes is accurate enough to move forward with the meter approval process for street lighting service, which would enable customers to realize additional energy savings. Taken together, addressing the regulatory constraints may reduce upfront costs and accelerate municipal adoption of smart-city technology.

# Infrastructure

The Project infrastructure will include approximately 4,275 Company-owned LED street lights, NLC nodes, and the Company-owned 6LoWPAN/IoT network. In addition, the Company will enable one Gateway/connected grid router ("CGR"), deploy a minimum of 100 Internet Protocol Version 6 ("IPv6") capable devices, install 30 advanced electric meters and 30 gas encoder receiver transmitters ("ERTs"). Once installed, the Company will test the connectivity, bandwidth, and security of the devices. In addition, the Company anticipates the City and/or third-party vendors will install and test smart-city sensor nodes, water meters, water-leak sensors, vacant-home sensors, and smart-home devices, among other smart-city solutions.

# Test Statements

The Company will test the validity of the aforementioned advanced LED street lighting and smart-city concepts by evaluating three key areas: 1) technology; 2) customer empowerment; and 3) market animation. As shown below, the Company proposes to test the functionality and customer acceptance of different lighting and smart node technologies. With these new technologies, the Company will also consider how the transformation of its outdoor lighting platform can empower the City (and other municipal customers) to more efficiently deliver services to their constituents. Finally, the Company will evaluate how the new platform can also animate the market for third-party vendors to create new and innovative solutions in the smart-city space. The results of the testing will be tracked, documented, and used to inform and modify any proposed tariff offerings or programs, as applicable.

**Table 1: Project Test Statements**

| Test Statement | If… | Then… |
|---|---|---|
| **Technology:** Municipal adoption of advanced LED street lighting service will lead to energy savings and increased customer satisfaction given greater customer choice. | (1) The Company expands its standard LED street light offerings to include a 3000K color temperature offering… | Municipal customers will use the 3000K light fixtures for residential applications in lieu of the current 4000K fixtures. |
| | (2) The Company installs and operates NLC nodes in a cost-effective manner... | Customers will be willing to pay for the NLC nodes and the advanced street lighting service they enable. |
| | (3) NLC nodes and the 6LoWPAN/IoT network are capable of remotely operating the advanced LED street light system ... | Municipalities will remotely operate their street lights (*e.g.*, dimming), and will realize a minimum of 15 percent in additional energy savings, as measured by the reduction in kWh consumed while dimming relative to the kWh calculated from the burn-hour schedule. |
| | (4) The Company includes chip-metering capability in its NLC nodes… | The Company will be able to use[6] the chip-meters to measure energy use accurately, within 0.5 percent of the Company's existing revenue grade meters. |

[6] The Company only proposes to test chip metering as part of this Project for non-billing purposes. If the Company deems the chip-meters worthy of further consideration, the Company would comply with the Commission's established meter review and approval process before seeking to incorporate chip meters into a tariff offering.

| Test Statement | If… | Then… |
|---|---|---|
| **Customer Empowerment:** Municipalities can expand the breadth of services offered and more efficiently meet the needs of their constituents through deployment of smart-city technology. | (5) The Company installs a 6LoWPAN/IoT network with NLC nodes and the end-to-end network availability is 97 percent… | The Company can offer smart-city solutions to municipal customers without deploying a Company-owned *high-bandwidth* smart-city solution. |
| | (6) The Company offers a suite of Company-owned smart-city technology with the costs recovered through a hardware-as-a-service charge… | Municipal customers will use a mixture of Company-owned, customer-owned, and third-party smart-city solutions. |
| | (7) The Company offers attachment and energy services for smart-city devices owned by municipalities or third-party vendors… | |
| **Market Animation:** Third-party vendors can meet municipal demand for smart-city solutions using an IoT network and data Platform | (8) The Company establishes a data-as-a-service offering that provides third-party access to the data collected from the devices that are used on the Company-owned 6LoWPAN/IoT network… | Third-party vendors will develop innovative smart-city solutions for municipal customers. |

# Test Population

The City, as the Company's primary customer-partner for the Project, broadly represents the test population. However, the City's many different constituencies (*e.g.*, residents, municipal service providers, etc.) are key stakeholders in understanding and evaluating the effectiveness of the Company's proposed smart-city approach. The ultimate objective of the City's interest in the Project is to more efficiently deliver services to its residents. As such, the City and the Company will use the Project to solicit feedback from residents and service providers that can be used to understand community acceptance and improve offerings. As shown in the appendix, the Company and the City divided the City into five zones (A through E) and identified five different test populations ("TP") within those zones, as shown in Table 2, to evaluate various Project components at the proof-of-concept level and as part of the citywide deployment.

**Table 2: Test Population**

| ID | Scale | Description of Test Population |
|---|---|---|
| TP1 | Proof of Concept | One street in each of zones A and B with 10 to 20 street light fixtures. |
| TP2 | One Network Gateway Zone | Geographic area served by a single network gateway, providing field area multipurpose IoT mesh network for enabling communications for an array of devices (covering approximately 5 to 10 percent of the City) |
| TP3 | Zones A and B | Approximately 2,300 street light fixtures, with two independent NLC node solutions for remotely operating the street lights (covering approximately half of the City) |
| TP4 | Zones C, D, and E | The remainder of the City with approximately 1,900 street light fixtures, deploying the best NLC node solution as identified in early stages of testing.[7] |
| TP5 | All Zones | All zones, supporting City-owned smart city infrastructure. |

[7] The NLC node solutions will be evaluated by an internal team with respect to connectivity, functionality, and durability. Connectivity will be assessed based on percentage uptime; functionality will be assessed based on usability by system operators; and durability will be assessed based on failure rates.

# Test Scenarios and Metrics

The Company anticipates beginning initial deployment of devices and supporting systems in the third quarter of 2018. The Company further expects to complete the deployment in the second quarter of 2020 with the installation of third-party smart-city devices. Throughout the deployment period, the Company proposes the following test scenarios and metrics.

**Table 3: Test Scenarios**

| **Technology: (1) Determine customer's preference for 4000K or 3000K LED Color Temperature** | |
|---|---|
| If… | (1) The Company expands its standard LED street light offerings to include a 3000K color temperature offering… |
| Then… | Customers will prefer the warmer (3000K) lights colder (4000K) ones. |
| **Test** | **Solicit customer feedback to determine whether there is a clear preference for 3000K LED or 4000Kstreet light fixtures in a residential setting.** |
| Schedule | Begin November 2018 |
| Method | Select a residential neighborhood to deploy 3000K LED street light fixtures at proof-of-concept scale (TP1), using wattages 15 percent or higher than the Company standard equivalent as depicted in Table 4.2 of the Company's P.S.C. No. 214 – Outdoor Lighting Tariff (Leaf 31). Higher wattages may be required to compensate for lower lumen levels from warmer LED light sources. Also install a sample of 4000K LED street light fixtures (*i.e.*, the Company's standard offering) on portions of the same street. The Company will also provide data to the City regarding costs for each fixture type, lighting performance, and energy differences between 3000K and 4000K LED fixtures, enabling City officials to analyze (quantitatively and qualitatively) each lighting option. |
| Measure | Using a questionnaire, the Company will solicit feedback on the color temperature differences, visual perception, and night-time ambiance from a minimum of 30 stakeholders, including impacted residents, City officials, and local businesses. |
| Metric | The questionnaire will measure color temperature favorability on a scale of 0 to 5. The Company will use the overall scores to determine if there is a clear preference for one color temperature over the other. |
| Alternate Strategy | If customers indicate a preference for the 3000K LED street lighting fixtures, as shown by a favorability score greater than 50 percent based on survey responses, the Company will procure additional 3000K units for this Project, with input from the City. The Company will conduct further analysis before proposing to incorporate 3000K LED fixtures into the Company's standard offering.[8] |

[8] This test is not meant to definitively determine what LED fixtures should be used across the Company's entire footprint; it is only meant to provide an initial data point.

| **Technology: (2) Facility Charge for NLC Nodes** | |
|---|---|
| If… | (2) The Company installs and operates NLC nodes in a cost-effective manner... |
| Then… | Customers will be willing to pay for the NLC nodes and the advanced street lighting service they enable. |
| Schedule | Begin November 2018 |
| Method | Deploy NLC nodes in demonstration area to assess the economics of the entire system. The Company will assess the fully loaded costs and work with the City to establish an acceptable facility charge that fully compensates the Company for expenses incurred. |
| Measure | Assess the viability of establishing a standardized facility charge that achieves cost recovery of NLC nodes. |
| Metric | NLC facility charge agreed to by the City and the Company realizes cost recovery over no longer than the useful life of the NLC nodes (*i.e.*, a 10-year period). |
| Alternate Strategy | If the City and the Company cannot agree on an acceptable facility charge that allows the Company to fully recover the costs of the NLC nodes, the Company will work with the City to establish an acceptable facility charge for the NLC nodes for purposes of this Project and will un-install the NLC nodes at the end of the Project term. |

| **Technology: (3) LED Street Light Remote Operation Acceptance and Optimization** | |
|---|---|
| If… | (3) NLC nodes and the 6LoWPAN/IoT network are capable of remotely operating the advanced LED street light system… |
| Then… | Municipalities will remotely operate their street lights, including dimming, and will realize a minimum of 15 percent in additional energy savings, as measured by the reduction in kWh consumed while dimming relative to the kWh calculated from the burn-hour schedule. |

| Technology: (3) LED Street Light Remote Operation Acceptance and Optimization | |
|---|---|
| **Test 3A** | **Test NLC node effectiveness in remotely operating LED street lights** |
| Schedule | Begin November 2018 |
| Method | Deploy two independent NLC node end-to-end solutions from the industry-leading vendors, each solution covering LED fixtures in an entire zone (*e.g.*, TP2 – Zones A and B approximately 1,100 to 1,200 fixtures per vendor). |
| Measure | Record performance of each solution for the following criteria:<br>1. Network integration and addressability of each fixture;<br>2. Fixture grouping and scheduling capabilities;<br>3. Enablement of continuous dimming;<br>4. Default photocell control; and<br>5. Compensation for available ambient light.<br>Compare performance between the two solutions and identify any major differences between the solutions including an analysis of reliability. Perform field measurements of light levels to confirm the effectiveness of dimming capabilities at 5 percent increments from 0 percent to 50 percent for any representative sample of fixtures. |
| Metric | For criteria 1 through 3: Determine whether 98 percent of the fixtures can be uniquely addressed and controlled in real time. Fixtures can be grouped in any combination within the software. Ensure dimming is consistent and proportional using field measured data that compares the level of dimming to reduction in field-measured lighting and energy.<br>For items 4 and 5: Ensure photocell control is enabled as a default master control for all fixtures, and report any fixtures that remain lit during day light hours. Verify whether dimming can be auto optimized based on photocell readings. |
| Alternate Strategy | Rank NLC node solutions based on field performance. If less than 95 percent of fixtures can be uniquely addressed and controlled, the Company will review network performance and identify opportunities to increase performance to 98 percent. |

| Technology: (3) LED Street Light Remote Operation Acceptance and Optimization | |
|---|---|
| **Test 3B** | **Test the network lighting system's overall features and use learnings to develop specifications and criteria for use in an at-scale request for proposal ("RFP") procurement.** |
| Method | Perform detailed field observation and hands-on review of various lighting system and software features from the two NLC node solutions. Work with the City to identify key lighting control areas, provide appropriate software access-control privileges to system operators, and solicit feedback from the City, impacted residents, and local businesses. Assist operators in programming the lighting system to implement zone-wide schedules and evaluate the effectiveness of the following lighting control software features:<br>1. Continuous dimming;<br>2. Scheduling and calendar integration;<br>3. Multi-scene capability;<br>4. Daylight /ambient light harvesting;<br>5. High and low limit settings;<br>6. Occupancy sensing;<br>7. Traffic sensing;<br>8. Demand response;<br>9. Emergency vehicle beacon / app control;<br>10. Software user interface features;<br>11. User access control;<br>12. Asset health tracking;<br>13. Features for third-party software integration using application program interfaces ("APIs");<br>14. Commissioning capabilities;<br>15. Geo-position reporting; and<br>16. Energy monitoring (covered under test scenario 3). |
| Measure | Using a questionnaire, the Company will qualitatively and quantitatively evaluate the effectiveness of each feature from stakeholders, including impacted residents, City officials, and local businesses. |
| Metric | The questionnaire will measure the effectiveness of each feature based on whether it is qualitatively a "must have," "optional," or "non-critical" feature, and quantitatively on a scale of 0 to 5 as to whether it was effective. The average scores will be used to assess preferences. |
| Alternate Strategy | Move forward with those features that are qualitatively and quantitatively effective for the City, impacted residents, and local businesses. |

| Technology: (3) LED Street Light Remote Operation Acceptance and Optimization | |
|---|---|
| **Test 3C** | **Determine whether dimming schedules and other energy savings features can be used to realize significant energy savings without compromising local lighting preferences.** |
| Method | Select representative streets for each zone and progressively increase dimming at 5 percent increments between 0 percent and 30 percent to evaluate performance. Establish an optimum dimming level and schedule for each application that is consistent with local lighting preferences and optical sensor requirements. Enable the City to use all available features with each lighting solution to capture the full potential of the advanced LED street lighting systems dimming capabilities. Key activities may include grouping fixtures into appropriate zones based on street types and activities, optimizing schedules based on feedback from residents, optical sensor requirements, field conditions (*e.g.*, tree cover, sunrise and sunset hours), time delays, holiday and special event schedules. |
| Measure | Using a questionnaire, the Company will solicit feedback from stakeholders in each representative area on dimming, including light-level readings, image quality captured by the City's optical sensors, local lighting preferences, and relevant field conditions. |
| Metric | Achieve an average annual energy savings of 15 percent as compared to a manually computed baseline that assumes the fixtures use their nameplate maximum energy for 4,200 hours per year. |
| Alternate Strategy | If the City does not realize 15 percent energy savings across all zones, identify zones were such savings are achievable and determine the reason why some zones failed to achieve the 15 percent energy savings threshold. Develop best practices and guidelines based on lessons learned and use the guidelines for future advanced LED street lighting deployments. Eliminate dimming features from zones where dimming capabilities are not compatible with local lighting preferences. |

| **Technology: (4) NLC Node and Smart-City Sensor Node Chip Meters** | |
|---|---|
| If… | (4) The Company includes chip-metering capability in its NLC nodes … |
| Then… | The Company will be able to use[9] the chip-meters to measure energy use accurately, within 0.5 percent of the Company's existing revenue grade meters. |
| Test | **Determine the accuracy of NLC node and smart-city sensor node metering and energy monitoring capabilities.** |
| Schedule | End March 30, 2020 |
| Method | Install a set of Company-standard revenue grade interval meters in a random sample (not to exceed 30 fixtures) for Zones A and B. Compare energy recordings from the NLC nodes as tracked in the lighting monitoring software against energy recordings from revenue grade interval meters, considering representative time steps (*e.g.*, day, month, and year). |
| Measure | Determine if the energy recordings from the chip meters are within 0.5 percent accuracy as established by the ANSI C-12 revenue grade meter specifications. Perform range and limit checks, time synchronization of readings, and continuity recordings. Identify any data gaps in the software history, and verify whether the data can be seamlessly transmitted over mesh networks. Further evaluate whether the Company can use the software historian to retrieve, visualize, and analyze the data. |
| Metric | All measurements at chip meters as recorded by the lighting software are within 0.5 percent of the Company's revenue-grade interval meters. |
| Alternate Strategy | Eliminate NLC nodes, smart-city sensor nodes, and software solutions that fail to meet the metering specification from future installations and utilize secondary interval meters to track energy use for fixtures installed as part of this Project. Develop a conservative estimate for overall energy savings using secondary interval meters. |

[9] The Company only proposes to test chip metering as part of this Project for non-billing purposes. If the Company deems the chip-meters worthy of further consideration, the Company would comply with the Commission's established meter review and approval process before seeking to incorporate chip meters into a tariff offering.

| **Customer Empowerment: (5) Company-Owned 6LoWPAN/IoT Network** | |
|---|---|
| If… | (5) The Company installs a 6LoWPAN/IoT network with NLC nodes and the end-to-end network availability is 97 percent… |
| Then… | The Company can offer smart-city solutions to municipal customers without deploying a Company-owned *high-bandwidth* smart-city solution. |
| Schedule | Begin December 30, 2018 |
| Method | Install at one network gateway zone (TP-2) an interoperable multipurpose industry-standards based network that follows IEEE 802.15.4 specifications and is capable of supporting low-bandwidth communication for a variety of field devices (both Company-owned and third-party owned). The mesh network will be configured to securely and consistently carry signals serving a bridge between field devices and the central gateway that has the internet backhaul. The mesh network's versatility will be tested with its performance to support multiple types of devices. |
| Measure | In collaboration with the City, select five different types of IoT devices that provide a unique "smart city" solution. For one year, the Company will test whether the devices are capable of fully functioning only on the Company-owned 6LoWPAN network without the need for an additional high-bandwidth communications network. |
| Metric | A single 6LoWPAN / Wi-Sun network supporting at least five different types of IoT devices with at least 90 percent of the deployed devices communicating per specification during the one-year test period. |
| Alternate Strategy | If the test shows that smart-city devices are not able to be used on the 6LoWPAN network, the smart-city devices associated with the Company-owned low-bandwidth network will be will be removed after the one-year test period. |

| **Customer Empowerment: (6) Hardware-as-a-Service** | |
|---|---|
| If… | The Company offers a suite of Company-owned smart-city technology with the costs recovered through a hardware-as-a-service charge… |
| Then… | Municipal customers will use a mixture of Company-owned, customer-owned, and third-party owned smart-city solutions |
| Schedule | Begin December 30, 2018 |
| Method | The Company will install make-ready hardware using the smart-city sensor nodes, which provide plug-and-play functionality, to support a variety of smart-city devices. The Company will install the make-ready hardware with the LED fixtures and will provide power supply options for wired and wireless internet backhaul services. The nodes will support a wide variety of ports to attach different smart-city sensors. The Company will further install a total of 200 smart-city sensor nodes at key locations based on an analysis of traffic and other conditions as determined in collaboration with the City. The Company will use the nameplate rating and assumed operations of 8760 hours per year to calculate energy use and associated costs for the nodes and sensor devices. In addition, the Company will evaluate the energy use numbers as compared to built-in chip meters, similar to NLC nodes. The Company will develop a charge acceptable to the City to fully recover the cost of the Company-owned smart-city devices. |
| Measure | Quantity of smart-city devices deployed by the City for use over a one-year test period. |
| Metric | Acceptance by the City of hardware-as-a-service facility charges that combine cost recovery for the hardware, as well as power and attachment service fees. This metric assumes the City or third-party providers will use 90 percent of smart-city sensor nodes. |
| Alternate Strategy | If cost-recovery or utilization thresholds are not met, the Company will not offer hardware as a service. Instead, the Company will offer standard attachment services and use secondary Company-installed meters to track and bill for energy use from the attachments. The City or third-party vendors will be responsible for procuring and installing hardware on Company-owned poles and will pay for the cost of the attachment space and the energy used by the attachments. |

| Customer Empowerment: (7) Attachment and Energy Services | |
|---|---|
| If… | The Company offers attachment and energy services for smart-city devices owned by municipalities or third-party vendors… |
| Then… | Municipal customers will use a mixture of Company-owned, customer-owned, and third-party smart-city solutions. |
| Schedule | Begin December 30, 2018 |
| Method | The Company will continue to support the City and third-party companies attaching various sensors and devices, subject to attachment license agreements, as part of smart-city rollout and provide power to these units in accordance with the Company's P.S.C. No. 220 – Electricity Tariff. The Company expects several new types of devices and higher quantities will be deployed over time and expects to review existing attachment fees and make necessary updates. |
| Measure | The City and third-party vendors will deploy a series of attachments and the Company will offer attachment and energy services for testing. |
| Metric | Acceptance by the City and / or third-party vendors of the attachment license agreement, as evidenced by the attachment of at least twenty non-Company-owned smart-city attachments during the Project term. |
| Alternate Strategy | Work with City to identify alternative attachment approaches. |

| Market Animation: (8) Data as a Service | |
|---|---|
| If… | The Company establishes a data-as-a-service offering that provides third-party access to the data collected from the devices that are used on the Company-owned 6LoWPAN/IoT network… |
| Then… | Third-party vendors will develop innovative smart-city solutions for municipal customers. |
| Schedule | Begin March 30, 2020 |
| Method | The Company will install sensors and meters, securely collect and curate data, and offer the data as a product via an API to third-party vendors who can use it to build new services and solutions. The Company-owned sensors will be integrated to communicate using the Company-owned 6LoWPAN/IoT network. In collaboration with the City and third-party vendors, the Company will identify new solutions that can be offered using the data collected from the Company-owned devices. The APIs and other data platform services will also be available to third-party vendors for a fee. |
| Measure | Quantity of third-party vendors who can provide new solutions using the data collected on the Company-owned hardware. |
| Metric | Enable data as a service for a minimum of two vendors. |
| Alternate Strategy | If the Company cannot obtain vendors who can provide new solutions using the API from the data, the Company will not develop a data-as-a-service offering for customers. |

# Cybersecurity

Consistent with its existing practices, the Company will review cybersecurity plans and field implementations for the solution providers, and perform risk assessments, remediation and monitoring across the advanced street lighting platform. Throughout deployment, the Company will leverage industry best practices, such as the National Institute of Standards and Technology ("NIST") Cybersecurity framework, to assess and identify risk. This will involve developing risk assessments that consider threat vulnerability, impact and likelihood. The Company will further analyze platform risks and evaluate overall compliance with the Company's internal standards, as well as the latest ANSI/UL Standard 2900-1 (Software Cybersecurity for Network-Connectable Products).

The Company leverages several mechanisms to identify and report risk, including risk and threat assessments, penetration testing, as well as application and build reviews. The output of the assessments determines a risk score that considers financial impact, reputational impact, and the likelihood of a cybersecurity incident. Should the testing reveal any platform vulnerabilities, the Company will determine an appropriate response plan considering the level of risk compared to business value. Acceptable risk responses include, accept, transfer, mitigate, and avoid. The risk and appropriate action plan will be entered into the risk register for ongoing monitoring until the risk is resolved. Using lessons learned from the cybersecurity risk and threat assessments, tests, and reviews, the Company will continue to refine its cybersecurity specifications, governance

criteria, as well as resource cost and maintenance estimates for when the advanced LED street lighting platform is deployed at scale.

## Milestones and Checkpoints

**Table 5: Three-Year Roadmap**

| Key Components | Phase 1 October 2018 to June 2019 | Phase 2 July 2019 to June 2020 | Phase 3 July 2020 to June 2021 |
|---|---|---|---|
| **LED and NLC Nodes** | Test phase: Install in Zones A and B (approx. 2,300 fixtures) | Install in Zones C, D and E (approx. 1,900 fixtures) | Steady state: evaluation, energy credit, lighting service |
| **Multipurpose Network and Devices** | Scope and Install 6LoWPAN/IoT network in one zone | Add devices: Company-owned and third-party owned | Steady state: evaluation, network and data-as-a-service |
| **Smart-City Sensor Nodes** | Plan and install in Zones A and B | Complete installation in all Zones (maximum 200) | Steady state: evaluation, hardware-as-a-service |
| **Third-Party Devices on the City-Owned broadband network** | Test and install meters, develop cost recovery model | Steady state (as developed by the City), energy and attachment services agreements | Steady state (as developed by the City), energy and attachment services agreements |

**Table 6: Milestone Schedule for LED and NLC Node Installation**

| Phase | Stages / Milestones | Key Activities | Start | End |
|---|---|---|---|---|
| **1** | **NG Install LED (proof-of-concept stage; max. 20 fixtures)** | LED color temperature acceptance; and Installation sequence procedures and training. | Oct 18 | Dec 18 |
| | **NG Install LED & NLC Nodes (Zones A and B; approx. 2,300 Fixtures TP-3)**<br><br>**Install and compare two vendor solutions** | **Plan, Design, Procure:**<br>Validate field surveys of inventory;<br>RFP for materials and labor (2 Vendors);<br>Construction fixture-by-fixture exclusions (decorative fixtures, deferred for pole maintenance);<br>Permits and approvals;<br>Purchase orders to vendors;<br>Weekly install targets, QA / QC goals;<br>City promise to pay net book value; | Oct 18 | Dec 18 |

| Phase | Stages / Milestones | Key Activities | Start | End |
|---|---|---|---|---|
| | | City signs off / notice to proceed issued; and<br>Safety and cybersecurity plan. | | |
| | | **Field Install LED and NLC:**<br>6LowPAN/IoT mesh network setup;<br>Backhaul setup;<br>Gateway NLC network integration;<br>Commissioning and punch list;<br>Lighting software setup;<br>Customer training for lighting software;<br>Secondary meter install (30 fixtures max.);<br>Meter data management system ("MDMS"); and<br>Integration of secondary meters. | Oct 18 | Mar 19 |
| | | **Evaluate:**<br>LED and NLC node performance;<br>Chip meter accuracy;<br>Dimming schedule optimization;<br>Energy savings calculation and credit;<br>Customer feedback;<br>Warranty and corrective actions;<br>Cybersecurity and penetration testing;<br>Asset health monitoring capability; and<br>Vendor/solution comparisons. | Apr 19 | Jun 19 |
| | | **Cost Recovery:**<br>Customer economics / promise to pay;<br>REV term charge; and<br>Tariff design guidance. | Apr 19 | Jun 19 |
| **2** | **NG install LED and NLC nodes (Zones C, D and E; approx. 2,000 fixtures TP-5)** | All plan, design, procure and field installation steps same as in phase 1 | Jul 19 | Dec 19 |
| | | Cost recovery for LED and NLC nodes for all zones. | Jul 19 | Jun 21 |
| **2 and 3** | **Steady State (LEDs and NLC nodes operational Citywide)** | Energy savings calculation and credit;<br>Penetration testing; and<br>Final evaluation report. | Jul 19 | Jun 21 |

**Table 7: Smart-City Sensor Node Installation**

| Phase | Milestones | Key Activities | Start | End |
|---|---|---|---|---|
| **1 and 2** | **NG Installs Smart City Sensor Nodes (Zones A and B; max. 100 nodes)** | **Plan, Design, Procure:**<br>Vendor solution architecture reviews;<br>Use case exploration;<br>Customer feedback;<br>Software review for data and analytics;<br>Zone A and B site identification;<br>Detailed technical requirements;<br>RFP for materials and labor;<br>Purchase orders to vendors (2 max.);<br>Solution architecture design;<br>Internet backhaul strategy; and<br>Safety and cybersecurity plan. | Oct 18 | Dec19 |
| | | **Pilot Test Install (max. 20 nodes)**<br>One to two vendor comparisons;<br>Installation sequence procedures;<br>Basic installation contractor training;<br>Power and internet backhaul setup;<br>Secondary meter setup and accuracy testing; and<br>Network / software setup, testing, and asset monitoring. | Jan 19 | Mar19 |
| | | **Zone A and B Field Install (max.100 nodes):**<br>Weekly install targets, QA / QC;<br>Field installations, internet and power setup;<br>Hardware / network commissioning; and<br>Cybersecurity and penetration testing. | Apr 19 | Sep 19 |
| **2** | **NG Install Smart-City Sensor Nodes (Zones C, D and E; max. 100 nodes)** | **Cost Recovery for Smart City Sensor Node:**<br>Customer economics / promise to pay;<br>REV term charge; and<br>Tariff design guidance | Jun 19 | Sep 19 |
| | | **Zone C, D and E field Install (max. 100 nodes):**<br>Same plan and field installs steps from zones A and B. | Oct 19 | Mar 20 |
| | **City Smart-City Device Attachments to Smart-City Sensor Nodes (All zones)** | **City Planning and Procurement:**<br>Hardware, use cases, quantities;<br>Data access, governance;<br>Software applications; and<br>Internet backhaul – fiber / cellular. | Oct 18 | Mar 19 |

| Phase | Milestones | Key Activities | Start | End |
|---|---|---|---|---|
| | | **NG Field Installation:**<br>Coordinate with node installation; and<br>Power and network connectivity. | Apr 19 | Mar 20 |
| | | **City Data, Software, Platform Integration:**<br>Cloud / on premise data warehousing;<br>Specialty software set up; and<br>Data-as-a-service with National Grid. | Apr 19 | Jun 20 |
| **3** | **Steady State** | **Review and Refine (as needed):**<br>Final evaluation report | Jul 20 | Jun 21 |

**Table 8: Multipurpose IoT Network and Smart Sensors & Devices Installation**

| Phase | Milestones | Key Activities | Start | End |
|---|---|---|---|---|
| **1** | **NG Implement Multipurpose IoT Mesh Network** | **Plan, Design, Procure:**<br>Vendor solution Architecture Reviews;<br>Functional specifications and standards;<br>Detailed technical requirements;<br>RFP for materials and labor;<br>Purchase orders to vendors;<br>Solution architecture design;<br>Internet backhaul strategy;<br>Safety and cybersecurity plan; and<br>Demonstration area selection. | Oct 18 | Mar 19 |
| | | **Network Field Install:**<br>Site installation;<br>Internet and power connectivity; and<br>Configure network / make-ready work. | Apr 18 | Jun 18 |
| **1 and 2** | **NG Install IoT Mesh Network, Sensors, and Meters (smart electric meters; gas ERTs; temperature sensors; environmental sensors; and others)** | **Plan, Design, Procure:**<br>Market research, product and use case identifications;<br>Vendor and specification reviews;<br>RFP for materials, labor, software;<br>Purchase orders to vendors; and<br>Data formats, API requirements. | Oct 18 | Mar 19 |
| | | **City Acquisition for Test Sites:**<br>Marketing, City commitments; and<br>Field installation plan and approvals. | Apr 19 | Jun 19 |
| | | **Field Installation:**<br>Weekly install targets, QA / QC;<br>Hardware and network commissioning;<br>Cybersecurity / penetration testing; and<br>Data and software integration. | Jul 19 | Dec 19 |

| Phase | Milestones | Key Activities | Start | End |
|---|---|---|---|---|
| **2** | **IoT Mesh Network – Third-Party Sensors and Meters (smart-home devices; EV chargers; water leak sensors; water shut off valves; water meters; vacant-home sensors; parking-management sensors)** | **Plan, Review and Coordination:** Vendor solution architecture reviews; Functional specifications/standards; and Network integration plan and governance. | Jan 19 | Dec 19 |
| | | **Field Installations:** Customer and vendor coordination; Network integration / management; and Cybersecurity penetration testing. | Jan 20 | Jun 20 |
| | | **Cost Recovery for Network and Data as Service:** Customer economics / promise to pay; and REV term charge, tariff design guidance. | Oct 19 | Dec 19 |
| **3** | **Steady State** | **Company-Owned Devices and Sensors:** Software and data applications and services evaluation, optimization; Network performance monitoring; and Cybersecurity. | Dec 19 | Jun 21 |
| | | **Third-Party Owned Devices and Sensors:** Network performance monitoring; and Cybersecurity. | Dec 19 | Jun 21 |
| | | **Cost Recovery:** REV term charge collection | Jul 20 | Jun 21 |

**Table 9: Energy and Attachment Service**
**For City or Third-Party Owned Devices Relying on the City's Broadband Network**

| Phase | Milestones | Key Activities | Start | End |
|---|---|---|---|---|
| **1** | | **Scoping:**<br>Review device lists and specifications;<br>Evaluate energy use profile;<br>Determine metering requirements; and<br>Determine installation support. | Oct 18 | Dec 18 |
| | | **Meter Accuracy Test:**<br>Install secondary meters for sample;<br>Evaluate metering accuracy; and<br>Identify opportunities to consolidate secondary meters reduce costs. | Jan 19 | Jun 19 |
| **2** | | **Cost Recovery:**<br>Develop scope and cost for chip meter data integration if meters meet revenue-grade requirements;<br>Develop proposed tariff modifications; and<br>Bill under standard tariff until Commission approves new tariff model. | Jul 19 | Dec 19 |

# Scalability

If successful, the Company believes the more than 200,000 street lights that span its service territory could serve as an advanced street lighting platform capable of helping cities save energy and more efficiently deliver municipal services. The Company will look to file a proposal with the Commission to adopt the successful components of this smart-city approach.

# Project Structure and Governance

## Executive Sponsorship

National Grid has assigned an executive sponsor for each of its REV demonstration projects, recognizing that active sponsorship is a critical factor for successful project management. Executive sponsor responsibilities include:

- Accountability for the ultimate success of the Project;
- Vision and leadership throughout the Project;
- Time commitment and active engagement throughout the Project, and
- Addresses conflicts and ensures senior stakeholders are engaged and supportive.

The executive sponsor for the Project is Carlos Nouel, Vice President ("VP") Customer Innovation and Development, Executive Sponsor.

## Core Project Team

**Table 10: Project Team**

| Name | Title | Contact Information |
|---|---|---|
| Carlos Nouel | VP, Customer Innovation and Development, Executive Sponsor | Tel.: (781) 907-1785<br>Email: carlos.nouel@nationalgrid.com |
| Fouad Dagher | Director, Customer Innovation | Tel.: (781) 907-1626<br>Email: fouad.dagher @nationalgrid.com |
| John Spring | Project Manager | Tel.: (781) 907-3694<br>Email: john.spring@nationalgrid.com |
| Chong Lin | Project Manager | Tel.: (929) 324-5297<br>Email: chong.lin@nationalgrid.com |
| Kris Kiefer | Legal, Regulatory | Tel.: (315) 428-3329<br>Email: kristoffer.kiefer@nationalgrid.com |
| Laurie Poltynski | Director, Community and Customer, East, NY Jurisdiction | Tel.: (518) 583-5252<br>Email: laura.poltynski@nationalgrid.com |
| Caeresa Richardson | Outdoor Lighting Manager, NY | Tel.: (315) 460-1136<br>Email: caeresa.richardson@nationalgrid.com |
| Mukund Ravipaty | Director, Digital Risk & Security | Tel: (781) 9072992<br>Email: Mukund.Ravipaty@nationalgrid.com |

Project governance will include the Core Project Team (as set forth above) and will consist of regular conference calls and in-person meetings (as needed) at milestones to report on project schedule, identified risks, project status, and the projected costs and benefits of services under development. The Company will identify and incorporate new Project team members as necessary during the Project term.

## Internal Stakeholders

There are various departments within National Grid that are critical to the delivery of the Project. They include:

- New York Jurisdiction
- Billing
- Customer Innovation and Development
- Legal
- Regulatory
- Digital Risk & Security

## External Stakeholders

The goal of the Project is to test the viability of deploying an advanced LED street lighting platform, smart-city technologies, and associated business models in tandem with the community at large. Key external stakeholders include:

- City of Schenectady (including all related city departments)
- National Grid customers
- Third-party smart-city vendors

## Roles and Responsibilities – Project Governance

Roles and Responsibilities below are for key Project responsibilities. Note that the roles and responsibilities in this document focus on this Project, and do not fully detail related activities.

**Table 11: Project Governance**

| **Role/Responsibility – National Grid** | **Description** |
|---|---|
| Support conceptual and detail design | Provide necessary data and expertise for the design work |
| Set up the Project Management Office ("PMO") | Create PMO to assist with coordination of the Project |
| Initial stakeholder outreach | Present Project objectives and receive feedback |
| Order materials | Provide materials to build the Project |
| Field construction | Safely install all LEDs and NLC nodes and other smart-city devices |
| Billing | Properly change/develop appropriate billing accounts for the Project |
| **Roles/Responsibility – City of Schenectady/Customer** | **Description** |
| Development in the Project zones | Participate in the Project |
| Participation in program evaluation, including data collection and analysis of surveys conducted among City residents | Gather data related to program performance to support the development of project analysis |
| **Department of Public Service Staff, Public Service Commission Role / Responsibility** | **Description** |
| Provide feedback on quarterly reports for this Project | Review progress against Project objectives and recommend any corrective actions. |

# Roles and Responsibility – Project Execution

**Table 12: Project Execution**

| Business Models | Enhanced Company-Owned Infrastructure | Hybrid Company and Third-Party Shared Infrastructure | Support City-Owned Smart-City Infrastructure |
|---|---|---|---|
| **Data Ownership** | National Grid | National Grid<br>Third-Party Vendors<br>City | City<br>Third-Party Vendors |
| **Field Network** | **National Grid Owned:**<br>6LoWPAN / Wi-SUN IoT mesh network | **National Grid Owned:**<br>6LoWPAN / Wi-SUN IoT mesh network<br>**City Owned:**<br>Wi-Fi / cellular | **City Owned:**<br>Wi-Fi / cellular |
| **Internet Backhaul** | Fiber | Fiber / cellular | Fiber / cellular |
| **Company-Owned Smart-City Sensor Nodes and Devices** | **National Grid Owned:**<br>LED street lights;<br>NLC nodes; and<br>Secondary electric meters. | **National Grid Owned:**<br>Secondary electric meters;<br>Smart electric meters;<br>Gas ERTs;<br>Temperature sensors;<br>Environmental sensors;<br>Smart-city nodes; and<br>Integrated hardware within smart-city sensor nodes.<br>**City Owned:**<br>Smart-home devices;<br>Electric vehicle ("EV") chargers;<br>Water leak sensors;<br>Water shutoff valves;<br>Water meters;<br>Vacant-home sensors; and<br>Parking sensors. | **National Grid Owned:**<br>Secondary electric meters<br>**City / Third-Party Owned:**<br>Traffic lighting;<br>Optical sensors;<br>Acoustical sensors;<br>Cameras;<br>Public Wi-Fi antennas;<br>Waste-management sensors;<br>Emergency vehicle beacons;<br>Parking sensors;<br>EV chargers;<br>Smart-mobility sensors; and<br>Any new devices and services. |
| **Platform / Software Applications** | **National Grid:**<br>Street light platform;<br>Salesforce for energy efficiency payments. | **National Grid:**<br>MDMS;<br>Environmental platform;<br>Water data management;<br>Enhanced GIS; and<br>Mesh network system. | **City:**<br>Optical and visual data;<br>Parking analytics;<br>Acoustic data analytics;<br>EV / smart-mobility;<br>Traffic lighting;<br>Data portal; and<br>City GIS. |

## Cadence

As noted above, the governance structure for the Project will include the Core Project Team and will consist of monthly conference calls and in-person meetings at milestone points to report on the Project's status, schedule, risks, lessons learned, as well as projected costs and benefits.

# Work Plan

The planned schedule is as set forth in Table 13 below.

**Table 13: Project Work Plan**

| Schedule Milestones | Target Start/Completion Date | Phase |
|---|---|---|
| Project Start/End | October 2018 – June 2021 | |
| Install LEDs and NLC Nodes (Zones A and B) | November 2018 to March 2019 | Phase 1 |
| NLC Node Facility Charge | June 2019 | Phase 1 |
| Smart Utility Network | January 2019 to June 2019 | Phase 1 |
| Install LEDs and NLC Nodes (Zones C, D, and E) | July 2019 to June 2019 | Phase 1 |
| Company-Owned Smart City Infrastructure (Set 1) | April 2019 to June 2019 | Phase 2 |
| Smart-City Infrastructure Charges | June 2019 | Phase 2 |
| Company-Owned Sensors and Meters | July 2019 to December 2019 | Phase 2 |
| Smart-City Sensor Node and Meter Charges | December 2019 | Phase 2 |
| Network as a Service Charge | December 2019 | Phase 2 |
| Company-Owned Smart City Infrastructure (Set 2) | January 2020 to June 2020 | Phase 3 |
| Third-Party Devices on Smart Utility Network | January 2020 to June 2020 | Phase 3 |
| Steady State | July 2020 to June 2021 | Phase 3 |

# Financial Elements/Revenue Model

## Project Budget

The Company estimates its initial upfront costs for design, engineering, the NLC nodes, and the network will be $7,585,000. When accounting for the forecasted revenue during the three-year period, the net cost is estimated at $6,177,538. The preliminary three-year budget with estimated costs for the Project broken down by year is summarized in Table 14 below.

**Table 14: Project Budget**

| Cost Elements | Gross Cost | Type | Annual Breakdown | | | Net Cost |
|---|---|---|---|---|---|---|
| | | | Year 1 | Year 2 | Year 3 | |
| Network Lighting Control Nodes | $2,350,000 | CapEx | $1,110,000 | $1,060,000 | - | $2,191,288 |
| | | OpEx | $70,000 | $70,000 | $40,000 | |
| | | Revenue | - | ($56,112) | ($102,600) | |
| Network | $1,105,000 | CapEx | $195,000 | $195,000 | - | $904,000 |
| | | OpEx | $240,000 | $255,000 | $220,000 | |
| | | Revenue | - | - | ($201,000) | |
| Sensors | $3,280,000 | CapEx | $1,550,000 | $1,550,000 | - | $2,232,250 |
| | | OpEx | $70,000 | $70,000 | $40,000 | |
| | | Revenue | - | - | ($1,047,750) | |
| Project Support (Contracted) | $100,000 | CapEx | $100,000 | - | - | $100,000 |
| | | OpEx | - | - | - | |
| | | Revenue | - | - | - | |
| Lighting System Evaluation (External) | $150,000 | CapEx | $150,000 | - | - | $150,000 |
| | | OpEx | - | - | - | |
| | | Revenue | - | - | - | |
| Smart City Data Analytics (External) | $100,000 | CapEx | $100,000 | - | - | $100,000 |
| | | OpEx | - | - | - | |
| | | Revenue | - | - | - | |
| Data Platform | $250,000 | CapEx | $125,000 | $125,000 | - | $250,000 |
| | | OpEx | - | - | - | |
| | | Revenue | - | - | - | |
| Network Management | $250,000 | CapEx | $125,000 | $125,000 | - | $250,000 |
| | | OpEx | - | - | - | |
| | | Revenue | - | - | - | |
| **TOTAL** | **$7,585,000** | | **$3,835,000** | **$3,393,888** | **($1,051,350)** | **$6,177,538** |

## Cost Recovery/Incentives

Assuming all listed programs are fully deployed, the Company estimates its revenues from the City through cost recovery of assets over the initial three years of the project to total $1,351,350:

**Table 15: Anticipated Cost Recovery**

| Revenue from City | 2018 | 2019 | 2020 |
|---|---|---|---|
| NLC Nodes | - | $56,112 | $102,600 |
| Network | - | - | $201,000 |
| Sensors | - | - | $1,047,750 |
| **Total** | - | $56,112 | $1,351,350 |

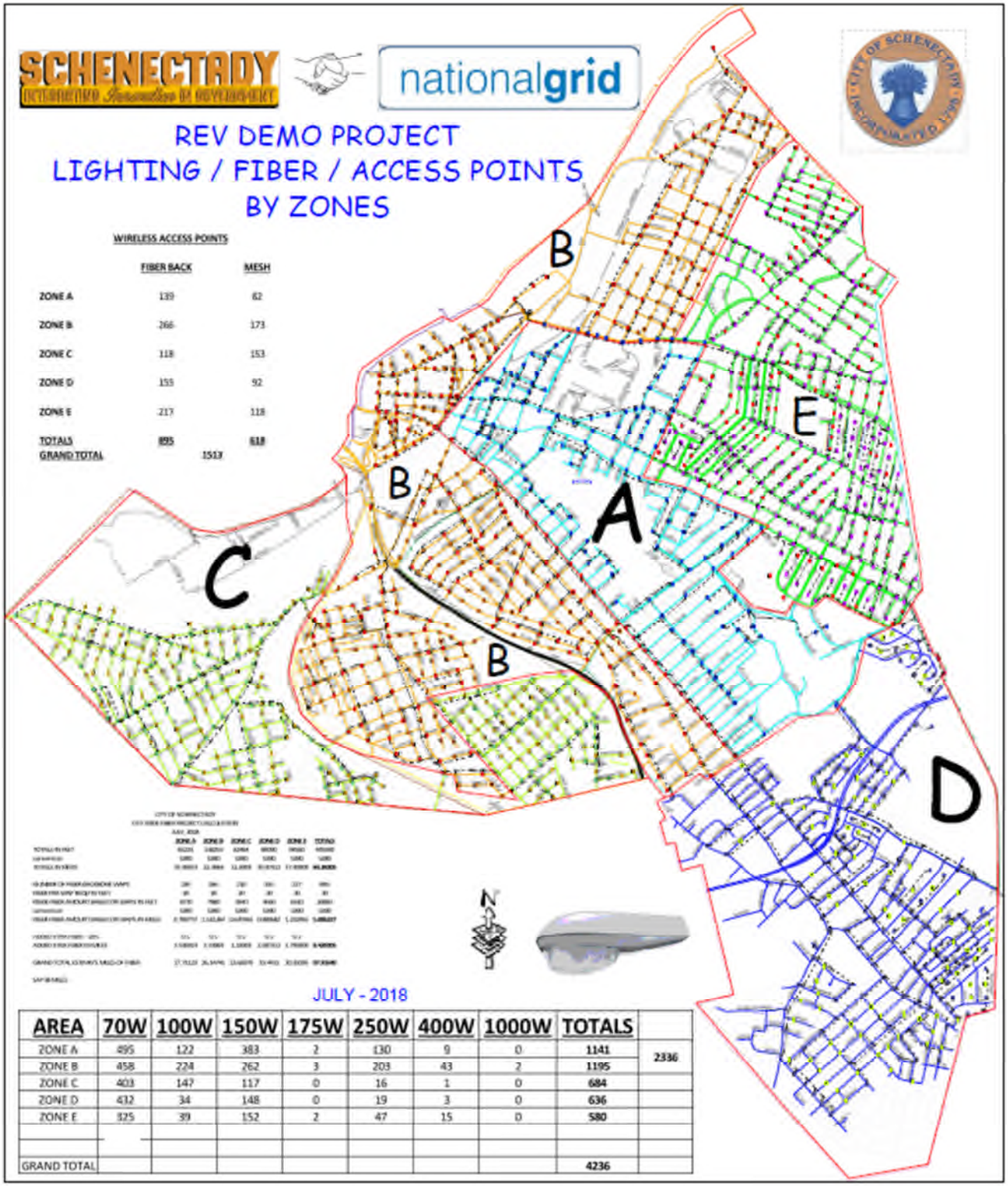
There will be no additional incentives to participate, as the objective of the Project is to determine if the City will seek to adopt smart-city technology and services in areas with where LEDs, NLC nodes and smart-city nodes are installed. However, since the City is converting the existing lights to LED under the Company's Lighting Tariff, including paying the net book value of the lights that will be removed, the City does qualify to receive the outdoor lighting LED energy efficiency incentive approved as part of the Joint Proposal adopted in the Company's rate case (Case 17-E-0238).

# Reporting Structure

National Grid will provide quarterly progress reports to Staff. The quarterly reports will include an overview of the Project's progress relative to the timeline set forth in this implementation plan, as well as Project results as they become available. The quarterly report template is provided below – the Company will use, update, and refine the template throughout the duration of the Project.

| Quarterly Report Template | |
|---|---|
| **Milestones:** | |
| Project Milestone Accomplished: | Describe milestones accomplished during the quarter and success stories. |
| Next Project Milestone: | Highlights milestones to be accomplished in the following quarter. |
| **Tasks/Timeline:** | |
| Completed Project Tasks Since Last Quarterly Report: | Describe Project tasks completed for the reporting quarter. |
| Changes or Impacts to Schedule Since Last Quarterly Report: | Identify tasks that may have a delayed start, at risk of on-time completion, and terminated or abandoned checkpoints. |
| Lessons Learned: | Highlight Project lessons learned, potential utility business models, potential rate designs, and scale up offerings. |
| Work Stream Coordination: | Highlight the progressive completion status performed by different groups and partners involved on the Project. |
| **Risks:** | |
| Identified Risks: | Identify risks involved executing the Project related to the network, partners, third-party vendors. |
| Risk Mitigation Plan: | Illustrate the process, actions, and options the Project team will take to enhance opportunities and minimize potential negative impacts to the Project objectives. |
| **Finance:** | |
| Total Incremental Spend to Date: | Total Project expenditure relative to the Project budget. |
| Target Incremental Spend: | Expected expenditures as described in Table 14 of the implementation plan. |
| Actual Incremental Spend: | Actual expenditures during the reporting quarter. |
| Incremental Spend Variance: | The difference between the actual and expected of expenditures incurred relative to the Project budget. |
| Non-Incremental Spend: | Spending that is not previously described in Table 14 of the implementation plan and may require additional spending requests. |
| In-Kind and Grant Support (Specifically for REV Demo): | Non-cash contributions and financial support committed to the goals of the Project. |
| **Additional Notes:** | |

# Appendix




| AREA | 70W | 100W | 150W | 175W | 250W | 400W | 1000W | TOTALS | |
|---|---|---|---|---|---|---|---|---|---|
| ZONE A | 495 | 122 | 383 | 2 | 130 | 9 | 0 | 1141 | 2336 |
| ZONE B | 458 | 224 | 262 | 3 | 203 | 43 | 2 | 1195 | |
| ZONE C | 403 | 147 | 117 | 0 | 16 | 1 | 0 | 684 | |
| ZONE D | 432 | 34 | 148 | 0 | 19 | 3 | 0 | 636 | |
| ZONE E | 325 | 39 | 152 | 2 | 47 | 15 | 0 | 580 | |
| | | | | | | | | | |
| | | | | | | | | | |
| GRAND TOTAL | | | | | | | | 4236 | |