Great Falls Eco-Energy Resiliency Project

Proposed by the City of Paterson, NJ

December 31, 2018

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1.0 Executive Summary

Paterson is the third largest city in New Jersey, and the second most densely populated city in the United States. It is the county seat for Passaic County, and provides a wide variety of crucial services for its 146,000 residents and the surrounding area. Despite that critical role, Paterson suffers from weak energy infrastructure that is relatively vulnerable to failure. Paterson suffered extensive energy disruptions during Super Storm Sandy, when power was out for over a week, and an even greater outage during Hurricane Irene the previous year. Both of these events caused widespread outages of public electricity service and interruptions in all critical functions that depend on electricity.
The Great Falls Eco-Energy Resiliency project proposes the creation of a core of critical municipal and county infrastructure in a Class Three Community Microgrid configuration. This "island of resiliency" will be able to operate virtually indefinitely during an extended outage of the public grid, providing critical services to both City and County residents and businesses.

This report documents the results of a Conceptual Feasibility Study for a Town Center Distributed Energy Resource (TC-DER) microgrid proposed for development in Paterson. The study identified project requirements, completed design analysis to identify optimal solution configurations, and assessed overall feasibility. The study considered feasibility based on the regulatory strategy, technical architecture, and commercial/financing framework developed as part of the project. Specifically, Paterson benefits from a unique combination of factors that make it an ideal Level Three community microgrid application. The town has exceptional characteristics that make the proposed microgrid **highly feasible**, and **highly impactful** on the community it serves:

- Paterson is a very compact municipality: it is the second most densely populated city in the United States and the **core municipal services are centrally located**, with several potential shelters and emergency staging areas located close to heavily populated residential areas.

- The heart of the microgrid will consist of essential municipal services (City Hall, municipal offices, and the police station) that are **clustered in the middle of the city** and will allow for **essential emergency management to operate in disaster conditions**. A majority of the city population will be able to **access shelter and critical supply depots** due the high schools and the community college being in close proximity to the various residential areas.

- Paterson has a functioning **hydroelectric plant** within half a mile of the municipal core of the city. The plant can be modified and used to **operate the entire proposed microgrid** under almost every peak loading scenario. A dedicated **circuit exists between the hydroelectric plant and the central Paterson substation** that feeds the municipal core.

- The proposed microgrid project has been under development and discussion for several years, so there is a **solid planning foundation in place, and strong community leadership support, for pursuing the project.** Paterson has demonstrated its commitment to advanced energy solutions in a variety of past projects and has a proven track record of taking innovative concepts through to completion.

- The project team has developed several novel concepts that will make this project feasible from a business model and regulatory perspective, including solutions that depend upon the public utility acting as an active partner in the solution development and realization. The Great

Falls Eco-Energy Resiliency Project microgrid will test and **demonstrate a fully functioning, Level Three, Community microgrid, with exceptional emergency management benefits to the surrounding community.** The elements of this advanced “proof of concept” will be **replicable and scalable for larger more complex projects anywhere in the state.**

Our submission contains all the items listed in the “Program Technical Requirements” section of the application document. However, please note that we have also added two additional sections (Project Overview and Feasibility Study: Work Program and Study Results), which provide critical information on the project and our intended approach to the study

2.0 Project Name and Introduction

This Feasibility Study Report is submitted by the City of Paterson, New Jersey (Paterson or the "City"), in fulfillment of an award made to the City by the Board of Public Utilities' (BPU) for a Town Center Distributed Energy Resource (TC-DER) Microgrid feasibility study. The project is named the **Great Falls Eco-Energy Resiliency Project (Great Falls EERP).**

3.0 Project Applicant

The municipal sponsor of the TC-DER feasibility study, and applicant to the NJ BPU TC-DER Feasibility Study solicitation, is the City of Paterson, New Jersey. The City was approved as an award recipient on July 10, 2017 and executed a Memorandum of Understanding (MOU) with the NJ BPU on July 11, 2017.

4.0 Project Partners

Paterson is the third largest city in New Jersey, and the second most densely populated city in the United States. It is the county seat for Passaic County, and provides a wide variety of crucial services for its 146,000 residents and the surrounding area. Despite that critical role, Paterson suffers from weak energy infrastructure that is relatively vulnerable to failure. Paterson suffered extensive energy disruptions during Super Storm Sandy, when power was out for over a week, and an even greater outage during Hurricane Irene the previous year. Both events featured widespread outages of public electricity service and interruptions in all critical functions that depend on electricity.

Paterson has a unique advantage that no other city in the state can claim: **a hydro-electric generation plant in the middle of the City**, only a few blocks from key facilities. The Great Falls Hydro-Electric Plant, now the heart of a new National Park, was the reason for the City's founding. With this project it can be the foundation for a stronger, more resilient future.

Based on negotiations with the City, the current owners of that Great Falls facility have agreed to explore integration of the Great Falls hydro plant with a resilient microgrid solution serving the urban core. This project is therefore unique: a chance to repurpose a resilient renewable generation asset to power one of the most densely populated county seats in the state. As a result, both the City and the County will be better able to serve their constituents, even during protracted outages of the public electric grid. Key load sites, including municipal buildings, high schools (that can double as emergency shelters), first responder locations, and important County buildings, have participated in the Feasibility Study, including:

1. **City Hall (155 Market):** The center for municipal functions, and a key command post and control facility during an emergency. This building provides a place for leadership and emergency support staff to meet and serves as a central point for disseminating information to the community.
2. **Health and Human Services, Community Development Office (125 Ellison):** Located near City Hall, the office provides essential support functions during an emergency.
3. **Municipal Recreation Offices (133 Ellison):** Meeting space located near City Hall that can host command and control and resident support functions during an emergency.
4. **Paterson Divison of Health (176 Broadway):** Critical organization and staging area for rescue operations and emergency management crews
5. **Passaic County Community College (1 College Boulevard):** A very large facility (>150 K sq-ft) that can provide key support functions to residents during an emergency, including: a) warming, b) cell phone charging, c) supply distribution point, and d) basic shelter in extreme events. This building is a designated emergency shelter for the community.
6. **Police Department (111 Broadway):** The primary law enforcement facility during an emergency period.
7. **International High School (200 Grand):** A very large facility (>121 K sq-ft) that can provide key support functions to residents during an emergency, including: a) warming, b) cell phone charging, c) supply distribution point, and d) basic shelter in extreme events. This building is a designated emergency shelter for the community.
8. **JFK High School (61-127 Preakness):** A very large facility (>300 K sq-ft) that can provide key support functions to residents during an emergency, including a) warming, b) cell phone

charging, c) supply distribution point, and d) basic shelter in extreme events. This building is a designated emergency shelter for the community.

9. **Fire Station Headquarters (300 McBride):** Critical first responder support during an emergency, the fire station serves as central headquarters for all first responder command and control during an emergency.

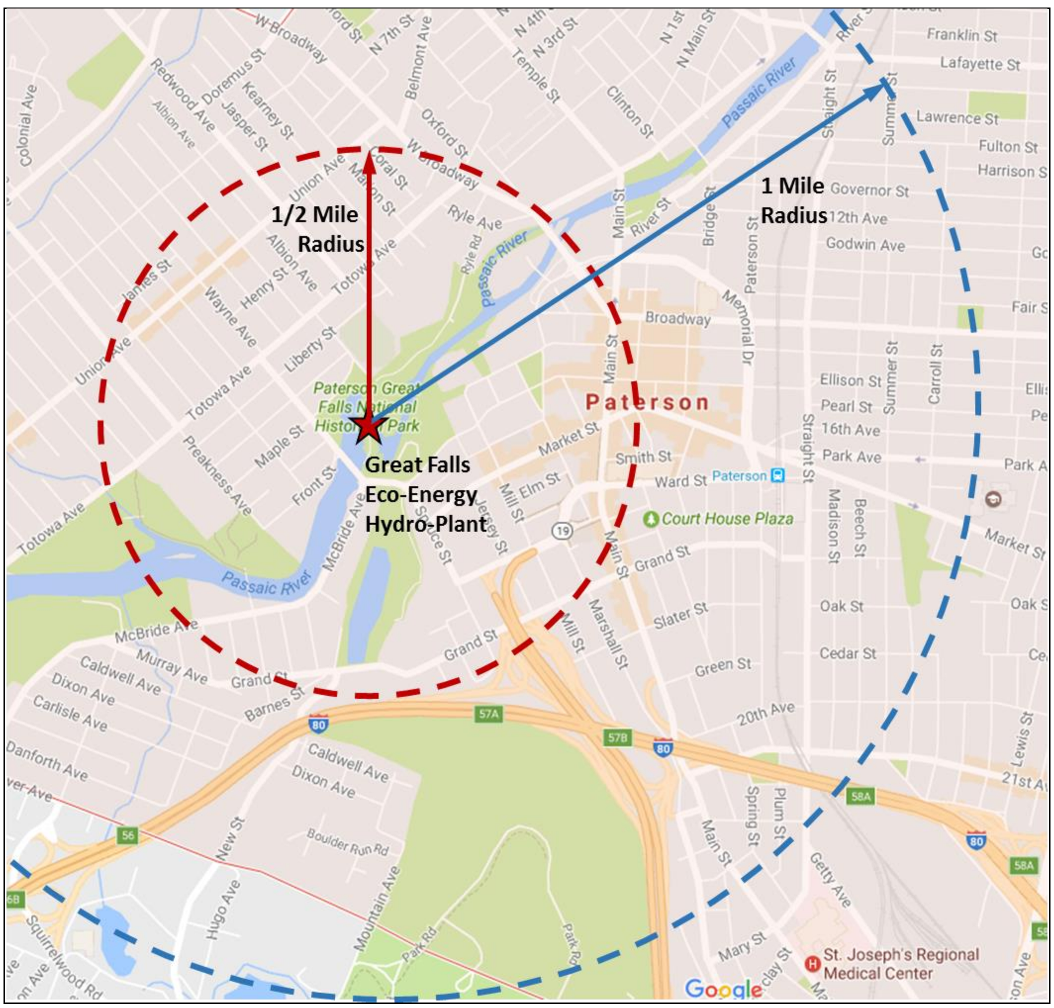
Project Consultants: The City engaged Burns Engineering, Inc., as the lead consulting engineer for the project. Headquartered in Philadelphia, Burns has extensive microgrid development and design experience, including serving as one of the two lead engineers for New Jersey's "TransitGrid". Burns partnered with Gabel Associates, a New Jersey-based energy consulting firm with significant relevant and specialized subject matter expertise. The fully adopted board resolution selecting Burns for this project is provided along with the other Letters of Support discussed above.

Please see **Appendix A** for copies of the Letters of Support noted above, and the authorizing resolution for consulting services being provided for the project by Burns Engineering.

5.0 Project Location

Paterson is a dense urban zone with core municipal and county facilities clustered within a relatively small area. The City Hall and key first responder services are all within half a mile of the Great Falls generation site. The Great EERP project proposes the creation of a core of critical municipal and county infrastructure in a Class Three Community Microgrid configuration. This “island of resiliency” will be able to operate virtually indefinitely during an extended outage of the public grid, providing critical services to both City and County residents and businesses. As one of the densest population centers in the state, the essential services enabled by this microgrid will serve an exceptionally large number of City residents. At the same time, its reach will be unusually broad through the support of key county services that benefit a large footprint. The beneficial impact of this project is therefore both deep and wide, and enabled by the unique availability of the nearby Great Falls generation facility and relatively tight clustering of key facilities.

The following diagram illustrates the reach of the Great Falls within half-mile and 1-mile perimeters:



The proposed microgrid will ensure a high level of functionality for City Hall, nearby municipal buildings that provide key support services, key first responder facilities (police and fire), two high schools (that can double as emergency shelters), and Passaic County Community College (which can also serve as a shelter). Most of these locations are within a half mile of the Great Falls generation point and provide a foundation for enhanced emergency support services during a grid outage. Some of these facilities already include back-up generation assets that, once connected to the microgrid, can provide support for multiple sites. Additional new renewable and dispatchable generation assets are also under consideration as part of the project, which will complement generation from Great Falls. Great Falls is already economically self-sustaining, and any new assets will generate value under “Blue Sky” conditions. This approach provides a framework for financing the investment required for the project. The Paterson project was not in one of the nine Sandy-impacted counties, and therefore was not identified in the New Jersey Institute of Technology (NJIT) study. However, the project has significant merit and serves one of the state’s largest cities, and the configuration being proposed has been confirmed to meet the screening criteria used in the NJIT study. **All eligibility requirements specified in the BPU application are satisfied by this project.**

The Great Falls EERP project benefits from a rare combination of factors that make it an ideal Class Three Community Microgrid application, providing essential emergency services in a tightly clustered urban core supporting both municipal and county facilities and a high-density residential zone. In short, the project leverages the **unique availability of the Great Falls** as a resiliency asset with proximate siting of key **nearby municipal and county facilities**:

- The proposed project is a rare opportunity for improving resiliency due to the availability of the **Great Falls hydro-generation plant that is in the center of one of the most densely populated urban cores in the country.** That plant provides an anchor, which when augmented with state of the art microgrid technologies (dispatchable generation, storage, controls), will enable a significant increase in resiliency in downtown Paterson.
- In addition to the high residential density, the City of **Paterson is home to critical municipal and county facilities.** The proposed microgrid is therefore unique in that it is serving a dense residential urban zone, city buildings that support those constituents directly, and county facilities with impact far beyond the borders of Paterson proper.
- The project has unparalleled **linkages to unique historical context and a forward-looking redevelopment opportunity.** The story of Paterson begins in 1791, when Alexander Hamilton recognized the economic growth that would result from leveraging the natural advantages of Great Falls. Developed initially to provide mechanical water power to nearby mills and converted eventually to a hydro-generation plant supplying electricity, Great Falls has been the foundation for planned development and economic growth for over 200 years. The proposed resiliency project continues that trajectory, leveraging this historical foundation to create a resilient energy solution that is essential for success in the 21st century. Meanwhile, the City is pursuing significant re-development plans for parts of the City, especially around the newly created Great Falls National Park, which will be enhanced by the availability of the resilient microgrid. This project is a unique opportunity to highlight the City’s proud past, while using enhanced resiliency to attract additional re-development investment to the City.
- The proposed microgrid project has been under development and discussion for over a year, so there is a **solid planning foundation in place for pursuing the project.** In March of 2016, Gabel Associates completed a preliminary study of microgrid potential for Paterson, specifically focusing on leveraging the Great Falls hydro-generation facility. The proposed Feasibility Study builds on that preliminary effort, and benefits from organized efforts over the last year.

- The project team has developed several novel concepts that will make this project feasible from a business and regulatory perspective, including solutions that depend upon the public utility as an active partner in the solution development. This project presents an opportunity to test and demonstrate a large scale, urban core community microgrid project in a demanding setting. This project will provide a very **high visibility proof of concept that can stimulate development of other similar projects** in New Jersey and beyond.
- Beyond the success factors inherent in the project itself, the project team is uniquely qualified to make this project successful. This project will benefit from engaged and committed City and County support, supportive community partners, and the expertise of two of the most knowledgeable consulting firms involved in energy project and microgrid development in New Jersey (Burns Engineering and Gabel Associates).

All the necessary success factors are in place to make this a uniquely powered, highly impactful Class Three Microgrid project, which will provide direct resiliency benefits to the residents of Paterson and the County of Passaic. This project therefore aligns strongly with the goals established for the BPU's TC-DER Microgrid Feasibility study project, addresses energy resiliency goals established by the state after Super Storm Sandy and supports objectives in the State's Energy Master Plan.

6.0 Project Description – Overview

The original study proposal identified various City and County facilities and other assets that could form the foundation for a community microgrid project. As part of the feasibility study, the study team worked with municipal leadership and staff to refine, expand, and prioritize the set of load sites to be included in the project, as well as other Distributed Energy Resources (DERs) that can be used to provide a reliable source of electricity during public grid outages. This section summarizes the study work plan, and the inventory of load sites and supporting DERs that will make up the Great Falls Eco-Energy and Resiliency Project.

6.1. Study Work Plan

The study team worked with project stakeholders to collect the necessary data, prioritize and refine project scope, develop alternative designs, and assess trade-offs. Based on that work, the study team completed design work on the recommended project configuration. Consistent with the work program outline in the study proposal, and the study requirements included in the award MOU, the team completed the following work functions:

1. Developed a detailed regulatory strategy for addressing challenges inherent in Level Three TC-DER applications. The regulatory framework informed subsequent technical and commercial strategy development.
2. Collected building and energy usage information from all load sites. Where data was missing, extrapolate or estimate the detail needed as needed to support analysis.
3. Collected information about existing Distributed Energy Resources (Great Falls Hydro-Electric Plant, backup generators, etc).
4. Worked with municipal and load-site staff to identify operating profiles for each site during an extended emergency event. Adjust building-use profiles to reflect these dark-sky operating conditions.
5. Met with the electric utility to review key design assumptions and project concepts. Based on the team's projection of impacted facilities, obtained detailed circuit maps.
6. Reviewed circuit maps in detail to identify potential backbone configurations, and opportunities for re-use of existing distribution infrastructure in the microgrid project.
7. Given detailed information about load sites, a collection of DERs, and existing utility circuit maps, identified a variety of backbone configuration/project-scope scenarios. These scenarios varied by microgrid project size and cost. Detailed topologies and related switchgear were developed to optimize use of existing utility distribution assets.
8. Developed use-case scenarios that combine seasonal energy use by supported facilities with generation profiles which are also seasonal (especially the Great Falls Hydro-Electric Plant).
9. Completed energy modeling for various cases that represent different energy use and hydro-electric plant contributions. Scenarios with and without the use of the hydro-electric plant were considered to ensure maximum reliability. Spreadsheet-based models were used to quantify system performance and asset sizing under a variety of conditions.
10. Developed a commercialization plan for the configuration, including details about ownership, financing, operational responsibility, and municipal procurement.
11. Worked with municipal leadership and staff throughout the project to provide updates, collect input from stakeholders, and prepare the final study report.

6.2. Load Sites

The City anticipates that it will be able to expand and strengthen its existing Emergency Management Plan based on the new capabilities enabled by the Great Falls EERP project. The sites were split up into two categories. 'Municipal Core' (MC) sites are fed from 'network circuits,' while 'Radial Extension' (RE) sites are powered by 'radial circuits.' A detailed description of each circuit type can be found in Section 7.4. The following facilities are planned for inclusion in the Nominal Case microgrid project configuration:

6.2.1. Municipal Core – Network Circuits in Downtown Paterson

The following comprise the facilities served by the microgrid within PSEG's network system:

- **City Hall (155 Market):** The center for municipal functions, and a key command post and control facility during an emergency. This building provides a place for leadership and emergency support staff to meet, and serves as a central point for disseminating information to the community.

- **Municipal Recreation Offices (133 Ellison):** Meeting space located near City Hall that can host command and control and resident support functions during an emergency.

- **Health and Human Services Office (125 Ellison):** Located near City Hall, the office provides essential support functions during an emergency.

- **Paterson Police Department (111 Broadway):** The primary law enforcement facility during an emergency period.

- **Paterson Division of Health (176 Broadway):** Critical organization and staging area for rescue operations and emergency management crews.

- **Passaic County Community College (1 College Boulevard):** A very large facility (>150 K sq-ft) that can provide key support functions to residents during an emergency, including: a) warming, b) cell phone charging, c) supply distribution point, and d) basic shelter in extreme events. This building is a designated emergency shelter for the community.

6.2.2. Radial Extension – Radial Circuits West of Downtown Paterson

The following comprise additional facilities served by the microgrid outside of PSEG's network system:

- **Paterson Fire Station Headquarters (300 McBride):** Critical first responder support during an emergency, the fire station serves as central headquarters for all first responder command and control during an emergency.

- **International High School (200 Grand):** A very large facility (>121 K sq-ft) that can provide key support functions to residents during an emergency, including: a) warming, b) cell phone charging, c) supply distribution point, and d) basic shelter in extreme events. This building is a designated emergency shelter for the community.

- **JFK High School (61-127 Preakness):** A very large facility (>300 K sq-ft) that can provide key support functions to residents during an emergency, including a) warming, b) cell phone charging, c) supply distribution point, and d) basic shelter in extreme events. This building is a designated emergency shelter for the community.

6.2.3. Electric Vehicle Chargers (EV)

Electric vehicle charging in included in the microgrid based on the growing trend of transportation electrification.

- **EV Charges:** Two new 150kW Direct-Current Fast Chargers (DCFCs) will be included as part of this microgrid to support the electric vehicles. These chargers will be publicly accessible and will allow electric vehicle owners to remain mobile during disaster conditions and can also serve to recharge any electric vehicles being operated by emergency management teams.

6.2.4. Load Site Summary

The following table contains a summary of all the information for each of the buildings considered for the Paterson Microgrid:

Table 1: Load Site Summary

Load Sites	Address	FEMA Class	Heated Sq. Ft	kWhr	Peak (kW)
City Hall	155 Market	IV	47,983	47,983	187
Health and Human Services Office	125 Ellison	III	24,300	189,393	227
Municipal Recreation Offices	133 Ellison	III	14,400	105,180	90
Paterson Police Department	111 Broadway	IV	71,064	2,549,357	513
Paterson Division of Health*	176 Broadway	III	25,000	575,922	160
Passaic County Community College*	1 College Boulevard	III	177,500	2,811,840	1096
Paterson Fire Station Headquarters	300 McBride	IV	40,000	300,511	82
International High School	200 Grand	III	121,275	1,371,293	504
JFK High School	61-127 Preakness	III	329,210	1,214,236	868

* Values are estimated based off EIA models. See Section 6.4 for further clarification

6.2.5. Load Site Energy Costs

The following tables provide energy costs for the sites included in the Paterson Microgrid.

Table 2: Load Site Energy Costs

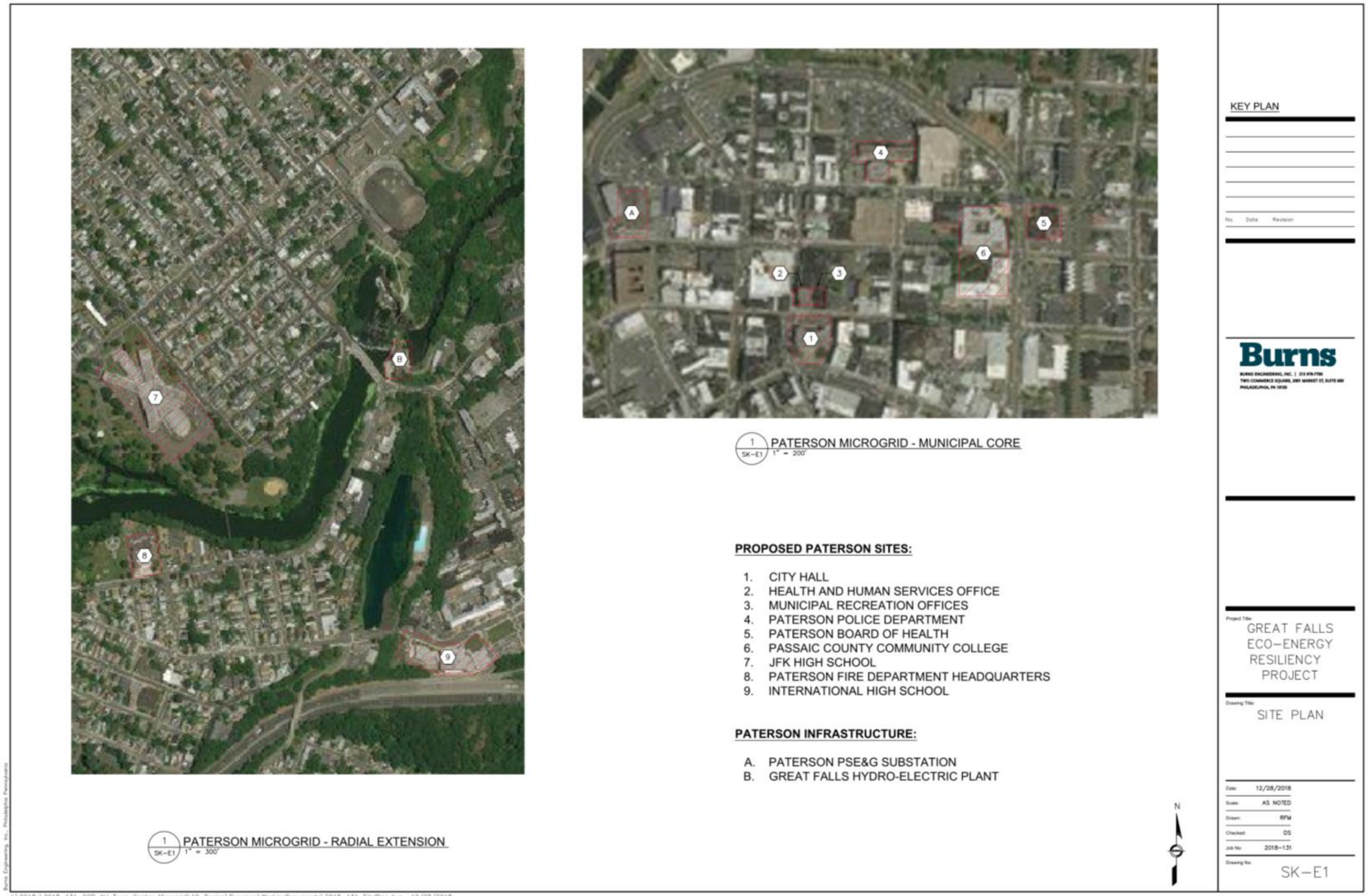
Month	City Hall	Municipal Recreation Offices	Health and Human Services Office	Paterson Police Department	Paterson Division of Health
January	$1,672.99	$806.98	$2,030.11	$4,583.48	$1,584.64
February	$1,474.19	$711.31	$1,788.78	$4,038.12	$1,499.75
March	$1,907.61	$919.90	$2,314.91	$5,227.12	$1,979.98
April	$1,865.21	$899.50	$2,263.45	$5,110.81	$1,869.88
May	$2,129.72	$1,026.80	$2,584.54	$5,836.45	$2,081.49
June	$2,181.73	$1,051.83	$2,647.67	$5,979.13	$2,096.38
July	$2,147.87	$1,035.54	$2,606.57	$5,886.24	$2,177.25
August	$2,321.20	$1,118.96	$2,816.97	$6,361.73	$2,188.69
September	$2,046.56	$986.78	$2,483.59	$5,608.31	$2,058.12
October	$1,993.05	$961.02	$2,418.62	$5,461.49	$2,070.74
November	$1,825.38	$880.33	$2,215.09	$5,001.53	$1,846.45
December	$1,641.75	$791.95	$1,992.19	$4,497.79	$1,681.08
TOTAL	**$23,207.28**	**$11,190.91**	**$28,162.48**	**$63,592.19**	**$23,134.47**

Table 3: Load Site Energy Costs (Continued)

Month	Passaic County Community College	Paterson Fire Department Headquarters	International High School	JFK High School
January	$5,847.13	$953.33	$7,652.68	$3,597.31
February	$5,072.45	$953.36	$8,258.94	$3,210.00
March	$6,940.71	$1,252.93	$5,054.23	$3,428.47
April	$6,595.08	$1,161.95	$3,228.64	$3,454.28
May	$9,642.79	$1,264.60	$3,184.95	$4,372.64
June	$12,515.39	$1,257.81	$6,450.56	$5,634.79
July	$11,492.54	$1,352.16	$7,752.10	$8,588.17
August	$11,174.11	$1,303.90	$6,320.59	$6,341.04
September	$10,288.85	$1,275.70	$7,612.95	$9,364.74
October	$7,622.45	$1,310.30	$3,575.79	$3,432.49
November	$6,378.01	$1,154.29	$3,879.22	$2,947.16
December	$5,454.67	$1,062.25	$4,317.95	$3,238.92
TOTAL	**$99,024.19**	**$14,302.58**	**$67,288.60**	**$57,610.01**

6.3. Project Map

Figure 1: Paterson Microgrid Map



6.4. Load Site Information

Energy data was gathered for sites within the microgrid. For a few sites, data gaps were addressed to estimate average and peak load for these buildings using sources from the Energy Information Administration (EIA) and the Commercial Buildings Energy Consumption Survey (CBECS). Most buildings within the project scope were only able to provide annual peak power loads, so the same sources were used to construct monthly load profiles. Only JFK High School and International High School provided monthly load profiles, making those two buildings the most accurate in regard to load forecasting.

The following load information was compiled to create the energy and power model for the Paterson microgrid project:

Table 4: Paterson Microgrid Peak Demand and Minimum Demand

Site	Peak Demand (kW)	Minimum Demand (kW)
Municipal Core		
City Hall	187	20.39
Recreation Offices	90	9.81
Health and Human Services Office	227	24.75
Paterson Police Station	513	55.94
Passaic County Community College	1096	73.20
Paterson Division of Health	160	17.41
Radial Extension		
International High School	504	53.21
JFK High School	965	58.50
Paterson Fire Department Headquarters	82	8.94

In addition to this, the microgrid will support two 150kW EV Chargers (EV)to provide energy to electric vehicles. For the purposes of this study, these chargers were modeled as a) always on and at maximum load under peak conditions, and b) offline and at zero load under minimum conditions.

To properly plan for the anticipated load, each of the building loads were projected over the course of a year using information from the EIA and the CBECSs building profiles. Interval data from these sources was used to create an hourly model that showed the microgrid performance over an 8760-hour period, or an entire calendar year. Individual models were created for each building in the microgrid. These models were then cross analyzed and combined with the other buildings in the microgrid to create both concurrent peak demands and concurrent minimum demands. The entire microgrid load profile appears as follows:

Table 5: Paterson Microgrid Concurrent Peak Demand and Concurrent Minimum Demand

Load	Peak Demand (kW)	Minimum Demand (kW)
Municipal Core	2062.15	202.52
Radial Extension	1428.20	127.07
EV Chargers	300.00	0.00
Total	3751.90	329.59

6.5. Distributed Energy Resources and Other Microgrid Equipment

One of the primary project goals was to leverage as much existing infrastructure as possible, including both distribution circuits and existing assets. It is important to note that, in a microgrid use case that requires indefinite operation, diesel generators cannot be factored into the generation asset calculations because on-site diesel fuel supplies are finite and, moreover, resupply cannot be counted on during emergency events. In addition to fuel supply limitations, diesel generators are rated for "continuous duty". The singular natural gas generation asset within Paterson (a 200kW generator at the Paterson Fire Department Headquarters) was reported as being in poor working order and not functioning reliably. Thus, it cannot be relied upon in any kind of emergency scenario.

In contrast to diesel units, natural gas-fueled engine generators are designed for continuous duty. Also, pipeline-supplied natural gas is a far more reliable source than truck-delivered diesel fuel.

As noted above, Paterson benefits from having the Great Falls Hydro-Electric Plant in close proximity to downtown Paterson. Based on the plant sizing and turbine configuration, it is possible that during optimal conditions and for finite periods of time, this asset could provide all of the power needed by the microgrid. Therefore, it is possible that the Paterson microgrid could be deployed and energized during emergency conditions and require little or no natural gas to operate.

Additionally, while downtown Paterson will need new designated microgrid circuits, the Radial Extension portion of the Nominal Case uses a substantial portion of existing utility circuits. This includes KUL 8021, which crosses the Passaic River, thus eliminating the need to construct additional infrastructure to bridge the eight buildings east of the river and JFK High School to the west of the river.

6.6. Permitting Requirements

As described above, and in more detail in Sections 7.0 and 8.0, many of the assets necessary to create the microgrid are either already in place, or already planned for construction independent of the microgrid project itself. The microgrid project represents a reconfiguration of these assets to deliver additional resiliency value. The primary new elements for the project include a) utility work to create the microgrid backbone (through isolation of existing feeders and new extensions) and related switchgear, b) construction of the new dispatchable generator used to complement the Great Falls Hydro-Electric Plant, and c) implementation of the microgrid control and communications system.

The utility work does not require permitting in the traditional sense and will be scheduled as per standard utility practice. The controller implementation is not a significant installation, and essentially represents the addition of a new computer and related communications equipment, probably at the police/fire facility. No permitting will likely be required for that installation, or if so, only local construction permits will be necessary.

The primary new permitting obligation for the project will be the installation of the new 1.0MW and 2.5MW natural gas generators serving the wholesale market. See Section 7.0 for further details. Permitting requirements for that asset are consistent with installation of any small-scale PJM-recognized grid-connected generation asset. Other than local construction permits that may be required, the primary approval requirements are a) interconnecting the 1.0MW generator and the 2.5MW generator as a qualified facility with PJM, and b) obtaining NJ-DEP permits for operation of the asset with the required scheduling profile. Small scale generators (<10MW) can be interconnected through an expedited PJM process that typically takes 6 – 9 months. Given the (relatively) small size for the generators, and the intention to include appropriate environmental controls, it is expected this asset can be installed under a "minor source" permitting protocol. DEP guidance in that case is approximately 90 days. Further detail on permitting intervals will depend on detailed design specifications that will be developed as part of the "phase two" detailed design process.

7.0 Project Description – Microgrid Design and Operation

Based on the facilities summarized in Section 6.2 and the existing assets already in place, the Team identified a variety of design configurations focused on developing a reliable microgrid at the lowest possible cost. This section summarizes the detailed design and planned operating profile, and the trade-off decisions and design analysis completed to develop the proposed solution.

7.1. Microgrid Design Challenges

A Level Three microgrid, also called a “community” microgrid or an “advanced” microgrid, is the most challenging to implement. There are significant legal and regulatory barriers that limit applications at this scale, which also have both technical and commercial implications. The Great Falls EERP project is a Level Three configuration, including load sites with their own independent utility meters and accounts, and load sites and generation assets separated by multiple rights of way. As noted in the BPU Microgrid Report (November 30, 2016), this type of application faces several challenges:

1. Utility Franchise: As a general matter, the utility franchise granted in existing statutes (and supporting regulations) prevent an on-site generator from providing electricity to end-consumers separated by a right of way (ROW). This restriction represents a limitation on Level Three microgrid configurations, which by definition, include sites separated by multiple ROWs. There are two known exceptions to this restriction which are frequently invoked to enable a Level Three microgrid:

    a. District Heating or CHP applications: there is an exception granted in cases where heat is delivered to end-consumers across ROWs, such that electricity may also be provided to any customer for which heat is provided. This exception can be used for district heating configurations, or for multi-site CHP applications.
    b. Contiguous Properties: A distributed energy resource may physically exist on one site but be connected so as to serve an adjacent property that shares a border. This approach is common for net metered solar systems that are hosted on one property but serve the load of a contiguous neighboring property.
    c. Paterson is not able to take advantage of either of these franchise exceptions. In fact, the exact circumstances required to take advantage of either of these exceptions, at “community scale” were multiple sites are being served, are relatively rare. Most municipalities in New Jersey, including Paterson, are not arranged to take advantage of these allowed distribution architectures. A more general solution for connecting more widely located sites and generation assets is required.

2. Utility Support: Utilities (EDCs) have generally been cautious about supporting advanced microgrid development in New Jersey, for a variety of reasons including the franchise concerns noted above. In many cases, microgrid proposals include development of new distribution infrastructure which could be outside utility control, introducing significant concerns about the efficiency, safety, and reliability of the distribution system. Level Three microgrids will be more feasible if the EDC is included as an essential partner in development of the microgrid solution.

3. Financing: The primary focus of the microgrid solution is resiliency, i.e. the ability to provide power to critical municipal facilities in the event of a widespread and prolonged failure of the

public grid. Although an ability to operate when the grid is down has strong public value, it is difficult to identify liquid revenue potential that can be used to secure project funding. Just as it is difficult to justify a backup generator using a traditional business case, it is challenging to fund microgrid development based exclusively on reliability and the ability to operate when the grid is down. Microgrid development therefore depends heavily on finding alternative financing strategies, including the capture of value during normal operations (i.e. during blue-sky conditions).

The study team recognized that the Great Falls EERP project was a Level Three microgrid topology, and solutions would need to be found to the three challenges noted above.

7.2. Design Approach

As noted in Section 7.1, there are strict statutory and regulatory limitations that constrain how a Level Three microgrid can be constructed. The typical approach is to focus on special case configurations based on heating districts or contiguous properties, but those configurations are rare, especially for Level Three microgrids, and not scalable to the more general market as exemplified by the Great Falls EERP project. The study team has developed an innovative strategy that addresses these concerns, which also establishes a framework that guides technical and commercial components of the design. The solution architecture is based on microgrid elements that operate in stand-alone mode under blue-sky conditions, but which reconfigure during a grid failure to create an islanded collection of facilities operating in a microgrid arrangement. Under this architecture, the microgrid essentially doesn't exist when the grid is operating, and only forms and operates when the public grid is down. The "as needed" formation of the solution is its essential characteristic, referred to as the Dynamically Organized Microgrid Architecture (DOMA).

The DOMA solution proposed for the Great Falls EERP project is structured as follows:

1. Blue-Sky Independence: All the load sites participating in the microgrid have independent utility meters and accounts, and buy electricity (and natural gas, where applicable) as per standard practice. All support elements – particularly including generation assets – are designed and operated to "stand alone" under blue-sky conditions. This structure avoids issues about delivering electricity across ROWs while the grid is active and provides a framework for structuring the financing needed to implement the project. As noted above, the microgrid essentially doesn't exist operationally when the public grid is operational. A number of microgrid components – particularly small parts of the backbone on existing radial circuits, the Municipal Core microgrid circuit, and the microgrid control system – are inactive under blue-sky conditions. Note there is no interaction between the public grid and the microgrid during normal operation (when the grid is operational).

2. Dynamic Configuration: When the public grid goes down, all key elements of the microgrid (both load sites and supporting assets such as backbone conductors and generators) reconfigure into the required microgrid configuration. This configuration process is accomplished by sequenced activation of switches and result in a localized distribution architecture that serves only the microgrid loads, and which is isolated (islanded) from the public grid. There is no interaction or exchange of power between the microgrid and the public

grid during an outage – other than the grid outage event that triggers microgrid formation, and the restoral event that converts the system back to routine (blue-sky) operating mode.

3. Un-Bundled Economics: The microgrid project is not organized or financed as a single project. Instead, there are a collection of coordinated projects that are financed independently depending on the nature of the asset and its blue-sky operation. These financing structures also determine operating roles for different parties depending on operating mode. This un-bundled strategy allows for more flexibility in financing and creates opportunities to match investment/operating entities with asset types and roles. In particular, the utility is contemplated to construct the backbone infrastructure, and any conductors and switchgear related to that backbone would be considered part of the utility distribution system.

The study team believes this approach creates an opportunity to address concerns about delivery of electricity across ROWs. We assert that when the grid is not operating, and that when a given collection of assets is operating in a form that is completely independent (islanded) from the public grid, special conditions can be said to apply. The rules that govern these matters when the grid is operating require additional flexibility during the relatively rare intervals when the public grid is down and providing backup power to critical infrastructure is a priority.

Given the state's priority for improving resiliency through the use of Level Three TC-DER microgrids, and the essential need to deliver power across ROWs inherent in the Level Three configuration for most municipal settings, it would be appropriate to grant temporary operating rights to an approved TC-DER to deliver electricity across multiple ROWs, but only during a public grid outage and only when the affected set of load sites are physically isolated from the public grid. The DOMA strategy creates an opportunity for authorizing this bounded resiliency operating mode, as justified by the exceptional conditions that exist during a widespread public grid outage and the importance of keeping crucial municipal infrastructure operational, due to its dynamic formation only when the grid goes down. This strategy also establishes a framework for the technical design (see the rest of Section 7.0), and the commercial framework that defines ownership, operating role, and financing (see Sections 8 through 11).

This approach also addresses traditional utility concerns regarding microgrid implementation. First, the DOMA strategy doesn't reduce utility operating revenues – when in normal operating mode, all load sites buy electricity from the utility as usual, and when the grid is down, the utility wouldn't be providing electricity to those customers anyway. So, there are no negative revenue impacts from DOMA-based microgrid solutions. Second, the DOMA strategy is based on the utility owning and constructing all the microgrid backbone elements, including related connecting switchgear. Consistent with N.J.S.A. 48:3-77.1, all electricity delivery through the microgrid is making use of infrastructure owned and operated by the franchised public utility.

7.3. Paterson Microgrid Load Profiles

As outlined in Section 186.4, building profiles were created using EIA information and the CBECS database. Each of the nine buildings a full year modeled in one-hour increments, thus producing 8760 data sets. These were analyzed individually and combined to create a complete microgrid load profile. This load profile is organized in the same manner as the load sites, with the Municipal Core, the Radial Extension, and the EV Chargers all considered separately and combined into one overall load profile.

As described above, the buildings had the maximum and minimum loads drawn from the individual load profiles, while the EV Chargers were considered at full capacity (300kW) for the peak and average load scenarios, and zero capacity (0kW) for the minimum load scenario:

Figure 2: Paterson Microgrid Monthly Peak Load

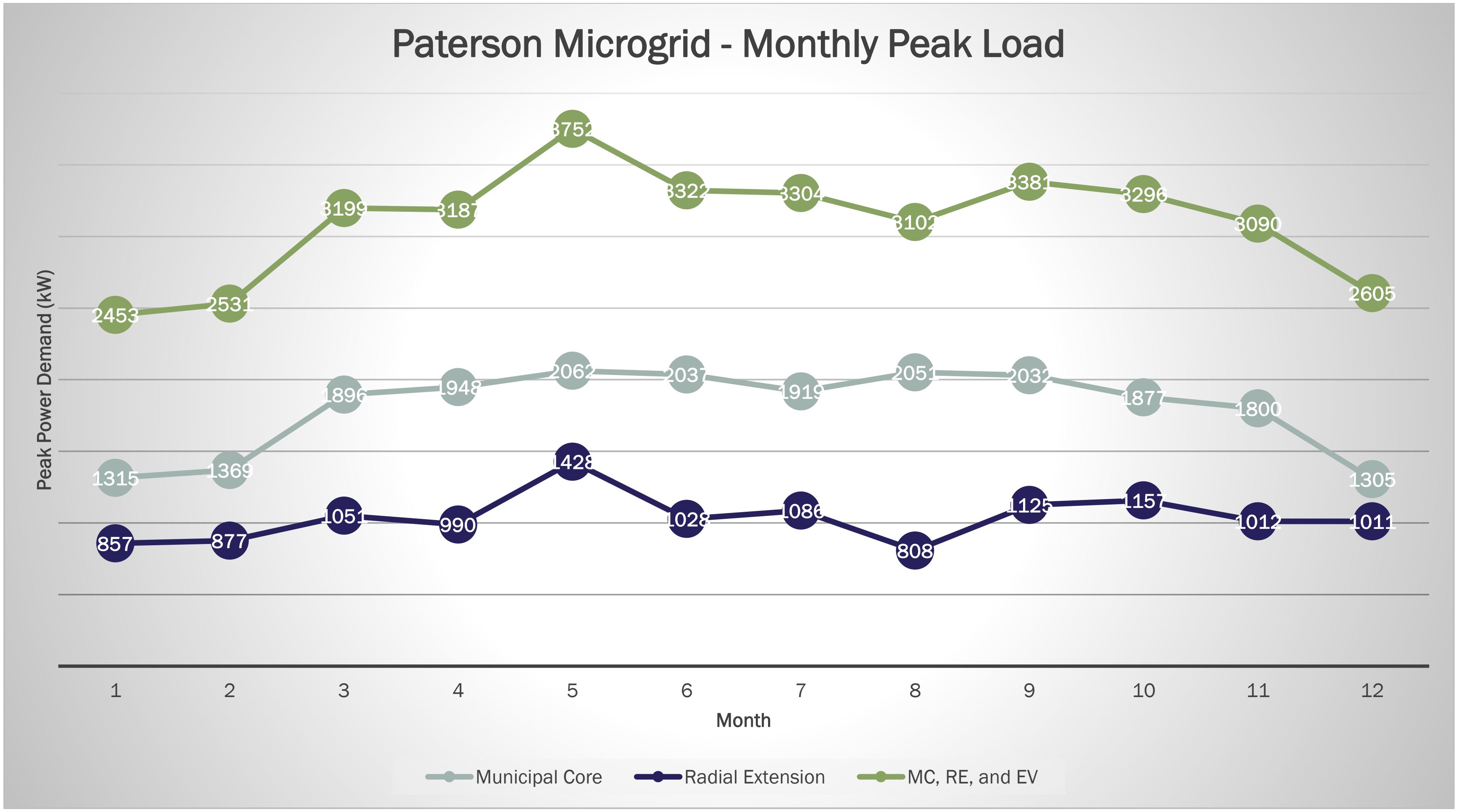


Figure 3: Paterson Microgrid Monthly Minimum Load

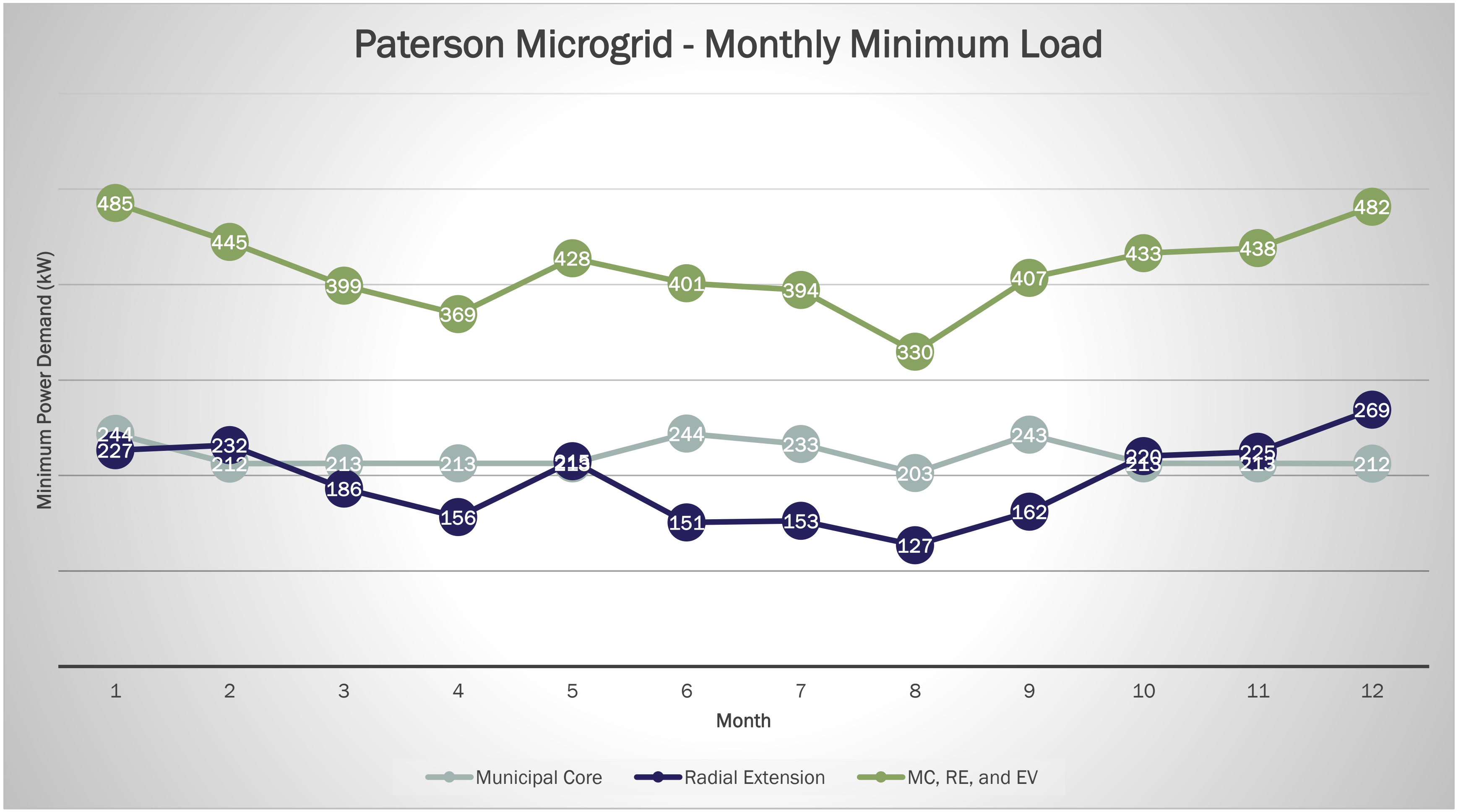
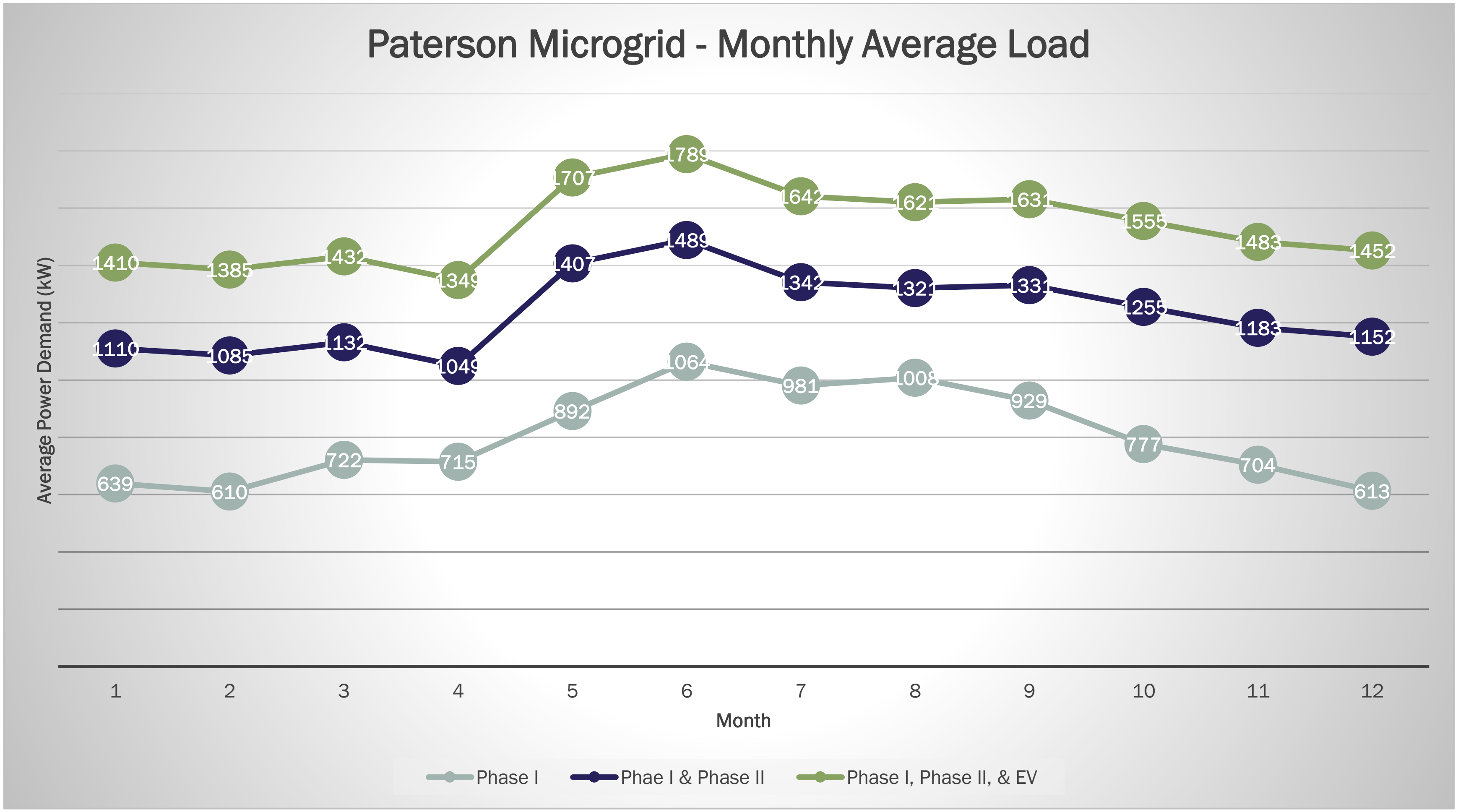


Figure 4: Paterson Microgrid - Monthly Average Load



7.4. Microgrid Backbone and Connections

Based on the load sites identified in Section 6.2 and a detailed engineering review of the circuit maps supplied by the utility, a strategy for providing the microgrid backbone (for use only during a grid outage events) has been identified. Due to the dense nature of downtown Paterson, several circuits utilize a ‘network’ topography as opposed to more traditional ‘radial’ structure. In the most basic terms, a building supplied by a network circuit will likely have two or more utility circuits feeding a shared transformer. This transformer will supply multiple buildings, and the redundant circuits act as backup if one circuit is de-energized (due to a fault, scheduled maintenance, etc.). This added reliability comes at a cost of simplicity and isolation, meaning any building fed from a network circuit within Paterson will require a new dedicated microgrid circuit. Fortunately, the buildings in downtown Paterson that form the core of the microgrid are relatively close together. All the buildings that are connected to the utility via a network configuration are identified as ‘Municipal Core’ buildings.

As mentioned above, the second circuit structure that is utilized within Paterson are ‘radial’ circuits. Radial circuits operate in a much more straightforward manner, with each circuit originating at a single substation and supplying several customers along the length of the circuit. For the purposes of this study, each building has a designated transformer and a single utility source. The buildings fed from radial circuits are identified as ‘Radial Extension’ buildings. Several of the radial circuits will be configured and upgraded to work as part of the microgrid. Unlike network circuits, the source-load arrangement of radial circuits makes isolating non-participating transformers (NPTs) possible. The isolation of NPTs, along with advanced switching schemes, allows for the savings of hundreds of thousands of dollars in new aerial conductors.

7.4.1. Existing Infrastructure

Existing Generation Assets: The focus on the microgrid design was to utilize the Great Falls Hydro-electric Generation Plant as the primary asset while providing enough redundant power resources to energize the microgrid in cases where the plant is unavailable. Thus, the following existing assets are critical for the microgrid design:

- Great Falls Hydro-Electric Generation Plant – 3650kW Kaplan Turbine
- Interconnection of Great Falls to the Paterson Substation via Circuit 0-587

These assets will be re-configured for use in the Base Case microgrid project.

The plant has an overall capacity of 10.95MW via three 3650kW Kaplan Turbines. However, the estimated peak load for the microgrid is only 3752kW. Therefore, a single turbine unit at maximum output can power the entire microgrid with minimal load management at a level approaching peak demand. Additionally, the functionality of a Kaplan Turbine allows for the power output to be modulated via control of the guide vanes that direct water into the turbine. There is a minimum operating threshold of approximately 1100kW, such that when microgrid load levels are below this lower limit, natural gas generation will be relied on to meet the microgrid power requirements. The average load for the entire base case along with a moderate amount of use at the EV Chargers is expected to be above 1100kW. Therefore, during periods of adequate river flow rates, the microgrid can be powered by the Great Falls Hydro-Electric Plant with minimal contribution from the generators.

Existing Distribution Infrastructure: Several circuits can be reconfigured and reused in the microgrid by adding multi-point transfer switches and reclosers in conjunction with the isolation of NPTs.

- KUL 8021: Over a mile of this circuit can be used as the main conductor for the Radial Extension portion of the microgrid, including the incredibly important section connection to JFK High School, which is across the Passaic River from the rest of the Base Case microgrid. Additionally, it provides electricity to International High School under normal conditions, so no modifications will be needed inside the school to tie into the microgrid.

- PAT 4016: This circuit can be utilized to energize the Paterson Fire Department Headquarters located about half a mile west of the Great Falls Hydro-Electric Plant down McBride Avenue.

- PAT 4017: Provide direct access into JFK High School such that no additional equipment will be needed inside the high school to tie into the microgrid. Close proximity to KUL 8021 means that the circuit will need relatively small improvements in order to connect to the microgrid.

7.4.2. New Infrastructure

New Assets: Several new assets will be required to fully power the proposed microgrid, especially if the Great Falls Hydro Plant is offline. Additionally, a new infrastructure is required to ensure that the microgrid can operate in a safe and efficacious manner:

- **Additional dispatchable generation:** Two additional generators are needed to fully backup the microgrid if the hydro plant goes offline. These generators will be located within the Paterson Substation:

    - One 2500kW Natural Gas Generator
    - One 1000kW Natural Gas Generator

- **Distribution assets:** A new dedicated microgrid circuit will need to be installed in the Municipal Core for the six buildings in downtown Paterson. Automatic transfer switches (ATSs) and transformers will be needed at each building to bring the power down from distribution voltage to building voltage. The routing of the proposed microgrid circuit can be seen below in Figure 5. Additionally, multi-point transfer switches (MPTPs) will be needed to incorporate the Radial Extension into the Municipal Core. This will be performed via 0-587, which is the dedicated circuit connecting the Great Falls Hydro-Electric Plant and the Paterson Substation.

- **Energy storage:** A small battery is proposed to be added to the microgrid for the purposes of stability and power quality. The battery will be located within the Paterson Substation. The battery will not serve as a long-term energy storage asset.

- **Switchgear:** New medium voltage switchgear will be needed to power and protect the microgrid. The gear will serve as the collection point for the assets and the battery. The switchgear will be located within the Paterson Substation.

- **Dispatchable Assets:** Under ideal circumstances, the microgrid will be able to operate exclusively on power from the Great Falls Hydro-Plant. However, due to the plant utilizing a 'run-of-the-river' type design, it is susceptible to going offline during times with low river flow. Thus, backup generators are required to power the entire microgrid to assure the highest degree of reliability and to fully support the anticipated load. Two generators will be needed as part of this project; one rated at 2.5MW and an additional unit rated 1.0MW generator. Both generators will be located at the Paterson Substation and will be supplied via piped natural gas.

- **Sensors, Communications, and Controls:** the microgrid will need a central microgrid controller along with sensing equipment to operate the generators and to utilize the hydro-plant. Communications will be provided to control systems at PSE&G as required.

7.4.3. Asset Summary

The Paterson Microgrid presents unique challenges regarding dispatching assets in and efficient and optimum manner. Utilizing the Great Falls Hydro Plant provides certain advantages related to limiting fuel consumption and related emissions. But because it cannot be relied on as a fully dispatchable asset, natural gas-fueled reciprocating engines are required to provide full microgrid resilience.

The focus of the asset deployment revolves around using the hydro plant in a safe yet efficient manner. In order to prevent overpowering any circuits, only one of the three 3650kw turbines will be utilized in the microgrid design. Due to the nature of Kaplan turbines, the minimum amount of power that can be drawn from the hydro plant is 1100kw, which is roughly 30% of the turbine output. Therefore, the hydro plant can be utilized to power the entire microgrid between usage ranges of 3650kw to 1100kw. Both limits are shown graphically in Figure 2 and Figure 3, respectively.

It is important to factor how the hydro plant connects and synchronizes with the grid, along with the yearly performance for the plant. As a 'run-of-the-river' style hydro plant, it has no reservoir of water; thus, it has no stored potential energy for conditions in which rainfall or snow melt has been scarce. Historical records show that the plant tends to operate at its highest capacity between the months of December and May and at its lowest capacity during the late summer. Additionally, documents show that the plant is frequently entirely offline for the months of September and October. Therefore, effective and safe use of the hydro plant will be entirely dependent on river conditions. To prepare for low or no production from the hydro plant, it is necessary to include reciprocating engines as part of the design.

Simulated load data shows that the maximum potential power usage for the microgrid is 3752kw. Therefore, the microgrid is designed to provide dispatchable generation close to that capacity. A combination of one 2500kw natural gas generator and one 1000kw natural gas generator are proposed to provide adequate backup power for the entire microgrid in the event that the microgrid load is below the lower operating limit of the hydro plant of 1100kW, or if the river flow rate renders the plant inoperable. The possibility of needing over 3500kW of power is unlikely, due to the fact that certain loads will almost never be operating all at once. For instance, the chance that the two EV chargers are each pulling 150kw of power while at the same time the two high schools and the community college all have their HVAC systems at full power is virtually impossible. Thus, two generators combining to 3500kw provides ample peak power to the microgrid. The microgrid controller can also be programmed to shed load in the unlikely instance that the demand of the microgrid exceeds the electrical production capacity of the Great Falls Hydro-Electric Plant and the two generators.

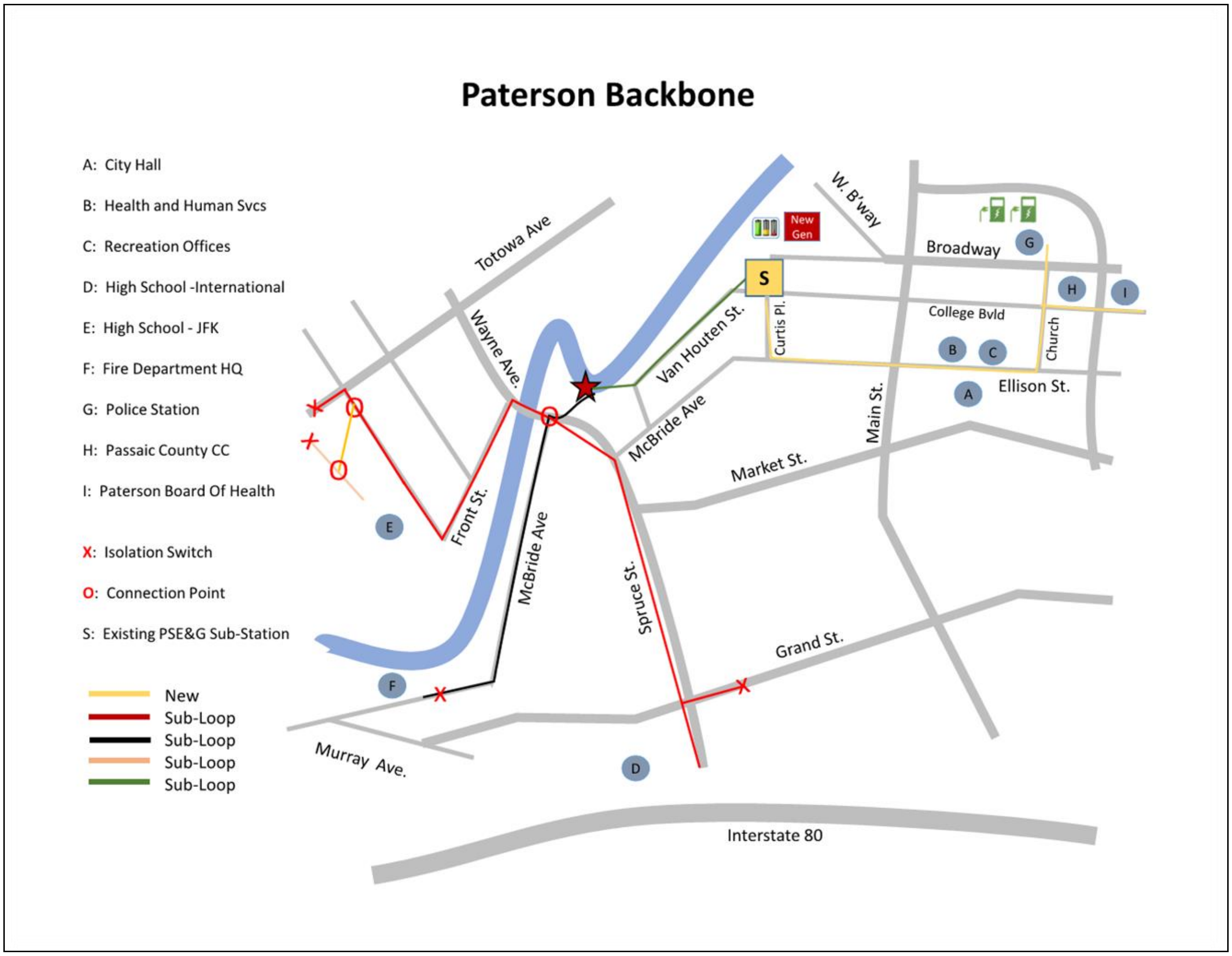
As with the hydro plant, reciprocating engines have a minimum power output as well. Each engine can "turn down" to as low as 30% output, so approximately 300kw can be expected as the minimum amount of power needed to operate the microgrid. As Table 4 shows, the minimum amount of power that will be required by the microgrid is projected to be 330kw. Therefore, the 1000kW generator will be able to produce the minimum amount of power to keep the microgrid operational while at the same time not exceeding the 30% turn-down rate of the generator.

Should the hydro plant be producing less than the demand of the microgrid, the reciprocating engines will serve to load follow and produce additional power as necessary to meet the demand. As explained above, the hydro plant can only produce full capacity when the river is running at a high level. Thus, during low water conditions, the reciprocating engines will likely be needed to fully power the microgrid. All the coordination and dispatching of these assets will be handled by a central microgrid controller.

7.4.4. Microgrid Maps

The following shows the specific connections of the microgrid and how the new and existing distribution and generation assets will be tied together:

Figure 5: Municipal Core Microgrid Circuit



7.5. Operating Profile

Consistent with the DOMA concept, all sites and generation assets connect to the grid through normal means, with independent utility accounts and meters. All microgrid components re-configure when the public grid goes down, resulting in an isolated (islanded) microgrid that runs independently during the outage. After the outage, the microgrid transitions back to normal operation. The following sections summarize these operating and transition modes.

7.5.1. Normal Operation

During normal operations, all load sites are connected to the public electricity grid (and, in most cases, piped natural gas) and will operate as usual. They each have separate utility accounts and meters. The Great Falls Hydro-Electric Plant will operate under normal conditions and at maximum available capacity. The Solar-For-All asset (solar PV and integrated storage) operates as a grid connected generation asset, providing electricity and power quality support to a local circuit as operated by PSE&G. Similarly, the 2.5MW natural gas generator and the 1.0MW natural gas generator operate as a small-scale grid-connected resource participating in the capacity market, predominantly as a peaking resource in the day-ahead market (and other ancillary services as determined to be feasible). During normal operation, the microgrid effectively doesn't exist. The designated microgrid circuit will also be completely unpowered, as it only is loaded when utility power is cut and the microgrid is engaged.

7.5.2. Transition to Microgrid Mode

During an outage of the public grid, all load sites and generation assets will disconnect from the public grid and connect to the microgrid backbone. Specifically:

- If the hydro plant is available, the Great Falls Hydro-Plant shuts down two turbines. The designated microgrid turbine is then transferred over to the microgrid circuit via the MPTS. O-587 is switched into the microgrid circuit and transferred over to the designated microgrid switchgear via a second MPTS in the Paterson Substation yard
    - Alternatively, under low flow/no flow scenarios, the same order of operations is keyed with the exception of the transfer of the Great Falls Hydro-Plant turbined being locked in to the MPTS at O-587
- Both generators turn on and get up to synchronous speed.
- All switching to the microgrid is carried out:
    - In the Municipal Core, each building has the ATS switch over to the microgrid circuit
    - In the Radial Extension, each recloser opens, islanding the circuit. NPTs are isolated out, and the three MPTSs switch over such that KUL 8021 supports both PAT 4016 and PAT 4017. KUL 8021 locks into O-587 via the interconnect
    - The Municipal Core and the Radial Extension are both turned over to the microgrid backup power via the MPTS in the Paterson Substation yard
- The microgrid controller will then close in to one or both generators, depending on the load needed on the circuit
- If hydro power is available and the load being drawn exceeds 1100kW, the microgrid controller will switch over to hydro power once the load stabilizes. One or both generators will be decoupled and powered down if the load is fully supported by the hydro power.

The transition to microgrid mode, and the operation of both isolation and transfer switches to accomplish that reconfiguration, are under utility control as triggered by a public grid outage. Utility responsibility (for microgrid functionality) ends after the microgrid is formed. As of the completion of this reconfiguration, the entire microgrid, and all facilities (load sites and generation assets) are completely isolated from the inoperable public grid. Full building loads are expected to be supported for all load sites, not just critical circuits.

Microgrid Mode: Once the microgrid is formed, the microgrid controller takes over and begins managing the overall system. Primary focus is on balancing supply (from the Great Falls Hydro-Electric Plant and the 2.5MW and 1.0MW natural gas generators) to meet the load of all connected sites. The generation assets have been sized to fully support these loads under a wide range of situations. Key elements of this operating profile include:

- Once the microgrid is formed, and the "backbone transition" is completed by the utility, operating responsibility passes to the microgrid controller.

- If the generation assets are not operating at the time of the microgrid transition, the microgrid controller will initiate black-start operations. The hydro plant will operate as normal, since the microgrid will function like the normal grid. The dispatchable generator will provide the "grid signal" necessary for hydro plant synching, and microgrid will transfer over to the hydro asset.

- Operating priority will be on using the hydro plant to the greatest extent possible to serve all microgrid loads. The dispatchable asset will be operated as necessary to ensure all loads are met. The existence of the solar array reduces the use of, and dependence on, fuel for the dispatchable generators.

- The existing backup generators (on the fire station and senior center) remain connected to the buildings they directly serve directly (i.e. there is no separate connection to the microgrid backbone). Under normal operation, they are not expected to be used since the microgrid will fully support operation of those buildings. IF NEEDED, the microgrid controller will engage those generators and disconnect those buildings from the microgrid (through existing transfer switches) to reduce load on the microgrid. Given the sizing of the generation assets on the microgrid, this situation is not expected to arise – but these generations provide a second level of back up support if needed.

- The dispatchable generator is sized to support all microgrid loads if necessary and will be served by firm (non-interruptible) piped natural gas supply. The microgrid can operate indefinitely if needed, as long as that natural gas supply is maintained.

Reconnection with the Public Grid: When the emergency event is over and public grid function is restored, all primary sites will reconnect to the public grid and resume normal operation. The timing of this restoration event will be controlled by the utility – the microgrid can continue to function as an isolated system as long as necessary. The restoral process is essentially the reverse of the microgrid-transition sequence outlined above, and proceeds as follows:

- Once triggered by the utility for the restoration cycle, the microgrid controller will put all generation assets into a mode appropriate for transition.

- The transfer switches on load sites, and on generation assets, are reversed to re-establish connection with the public grid.

- The transfer switches on all isolated site loads are reversed to re-establish connection to the public grid.

- The isolation switches for all NPTs are closed to re-establish connection of those facilities to the public grid.

- The isolation switches for the Radial Extension of the circuit that serves the municipal core are closed.
- The Municipal Core microgrid circuit is de-energized as power is restored to the standard network circuits.

As with the microgrid formation sequence, restoral is under the control of the utility. The utility will have some flexibility in how and when these loads are reconnected to the public grid, providing increased control in overall restoral operations.

7.6. Regulatory Implications

As noted in Section 7.1 and 7.2, an essential requirement for Level Three microgrids that can't take advantage of district heating or distributed generation contiguous property special cases is to be able to deliver electricity across multiple rights of way. The Dynamically Organized Microgrid Architecture (DOMA) approach enables a solution to this challenge by sharply distinguishing between "normal" operating modes (when the public grid is operational), and operation when the grid is down. Based on the intention to have the utility own and construct the microgrid backbone (and related switchgear) and make that part of the distribution system, all electricity delivery within the microgrid happens over distribution infrastructure owned by the franchised utility. In addition, the microgrid only functions when the public grid is down, and only when fully islanded from the public grid. By restricting microgrid operation to the rare cases when the grid is down and microgrid value (based on resiliency) is at its highest, justification can be made for issuing temporary operating rights to TC-DER microgrids exclusively under those conditions.

The Great Falls EERP project will require regulatory approval for this solution strategy. This flexibility, along with approval of the EDC building key backbone elements as part of the distribution system, could be addressed as part of an Advanced Microgrid DER Tariff (as contemplated in the BPU Microgrid Report), although pioneer project may be implemented under more limited filings short term. Note that this approach is highly replicable and would allow development of TC-DER microgrids for the many New Jersey communities that are not conducive to the heating or contiguous-property special cases.

There are regulatory requirements that must be met for installation of the dispatchable natural gas generator serving the wholesale market in PJM. Based on initial modeling as part of this conceptual feasibility study, current projections are that this generator would participate in the PJM Capacity Market under existing provisions. While no exceptions or specialized approvals are needed, the project may benefit from PJM clarification about rules that govern operation of an asset of this type in the capacity market when also serving as an emergency support asset.

8.0 Commercial Framework

The DOMA solution creates a framework for naturally identifying roles for both financing and operations, and the resulting procurement efforts that will be required for project implementation. In the case of the Great Falls EERP project, the commercial framework is further simplified by the fact that many of the assets required are either already in place or planned for implementation. Consistent with the DOMA strategy, most microgrid assets operate independently when the grid is up, which provides a basis for their financing and operation. In particular:

- **Existing Assets:** The Great Falls Hydro-Electric Plant is already in place and operational. It does not need to be built or financed as part of the microgrid project. Some interconnection and control modifications will need to be made to the plant, but that will be covered as part of the microgrid backbone noted below.

- **EV Chargers:** The town may contemplate installation of high powered DCFC EV chargers for public use, based on a) incentives under development for that purpose by PSE&G, and b) the use of a third-party owner-operator engaged by the City through an RFP. These chargers would operate as a public charging station and would recover investment on that basis (along with the utility incentives). They therefore do not need to be funded as part of the microgrid project directly.

- **Microgrid Backbone:** the utility is contemplated to build the backbone extensions required, and the switchgear needed to create the isolated sub-loop of the existing circuits (KUL 8021, PAT 4016, and PAT 4017) and all building/generator connections. These assets are proposed to become part of the distribution system itself, and those costs would be recovered by the utility as per usual practice based on a filing for the Paterson microgrid project. Given the utility basis for ownership and implementation, and assuming BPU approval of the associated utility filing, these assets do not need to be financed directly by the microgrid project.

- **Dispatchable Generator:** the natural gas generators (both the 1.0MW generator and the 2.5MW generator) must be financed by the microgrid project. The assets will be able to generate revenue during normal grid operation through participation in the PJM wholesale market, which will support asset financing. This will be accomplished through a public-private partnership in which a third-party investor designs, builds, owns, and operates the generators as engaged through a municipal RFP. The microgrid controller, and operational responsibility during microgrid operation, will also be made part of this work element.

This structure creates a natural alignment between asset ownership, financing, and operational responsibility. The utility owns and operates the microgrid backbone and related switchgear and is responsible for starting and stopping microgrid operation based on conditions of the public grid. The dispatchable generators, along with the microgrid control system, will be owned and operated by a third party who will have operational responsibility when the microgrid is functioning. Linking the dispatchable generator and overall microgrid function enables strong alignment of operating responsibility. The EV chargers would be installed and operated by a third party for normal operation (when the grid is up), but temporarily connect to the microgrid when the grid is down.

The primary implementation phases, building on this conceptual feasibility study, are therefore a) detailed design engineering and procurement planning, including coordination with the utility on the related filing, b) implementation of the backbone by the utility based on an approved filing for that purpose, c) a municipal RFP for an owner-operator of the EV chargers, ideally with support of the utility incentives currently being developed, and d) a municipal RFP to engage a third party in a public-private partnership for the generator and microgrid control system (including operational support when the microgrid is engaged during a grid outage).

9.0 Project Cost Estimates

As noted in Sections 7.1 and 7.2 and Section 8, the DOMA strategy enables significantly flexibility regarding how the microgrid project is structured commercially and financed. In general, most project elements are funded independently, separate from their microgrid function (when the microgrid is operating), based on value provided during normal (blue sky) conditions. In the case of Highland Park, the cost structure/financing challenges are also addressed since significant assets are either already in place, or already planned for construction – those costs are not estimated for the project since they are already financed separately. Consistent with the commercial framework in Section 8, the cost budgets are organized to account for several sub-projects for a) the EV chargers, b) the utility work related to the microgrid backbone, and c) a project for other microgrid components, including the dispatchable generator and the microgrid controller.

9.1. Electric Vehicle Chargers

The EV chargers could be a separate sub-project contemplated for implementation independent of the microgrid project financially. Those costs therefore do not need to be included as part of the microgrid budget. For completeness, however, an estimate of those costs are summarized below for each of the three configurations.

Table 6: Electric Vehicle Charger Costs

Description	Quantity	Unit	Unit Price		Total Price		Sub-Total	Total w/ COP
			Material	Labor	Material	Labor		
EV Chargers	2	EA	$125,000	$12,500	$250,000	$25,000	$275,000	$330,000

9.2. Utility Backbone Construction

An essential component of the microgrid is the backbone conductors and related isolation and transfer switchgear. The backbone conductors themselves are based on a combination of the reuse of sub-loops of the existing distribution system, new aerial extensions, and new underground ductbank in the Municipal Core. The DOMA strategy contemplates construction and ownership of these elements by the public utility, and inclusion of those assets as part of the distribution system itself. All electricity transfers during microgrid operation are therefore taking place over franchised utility assets. All of the following estimates include a 20% mark-up for Contingency, Overhead, and Profit (COP).

The cost estimate is organized by the main sections of the microgrid, with the Municipal Core total and the Radial Extension total both presented for comparison purposes. The following charts summarize projected costs for the Great Falls EERP project for these utility elements.

Description	Quantity	Unit	Unit Price Material	Unit Price Labor	Total Price Material	Total Price Labor	Sub-Total	Total w/ COP
Municipal Core - Conductors								
Core 1 - City Hall, Recreation Office, and HHS Building Connection (UG)	200	LF	$400	$800	$80,000	$160,000	$240,000	$288,000
Core 2 - PCCC, Division of Health, and Police Station Connection (UG)	1600	LF	$400	$800	$640,000	$1,280,000	$1,920,000	$2,304,000
Core 1 and Core 2 Connector (UG)	750	LF	$400	$800	$300,000	$600,000	$900,000	$1,080,000
Paterson Substation Connector (UG)	1600	LF	$400	$800	$640,000	$1,280,000	$1,920,000	$2,304,000
							Total	$5,976,000
Municipal Core – Utility Line Switching and Isolation								
ATS/Microgrid Connect - City Hall	1	EA	$20,000	$5,000	$20,000	$5,000	$25,000	$30,000
Transformer - City Hall	1	EA	$10,000	$2,500	$10,000	$2,500	$12,500	$15,000
ATS/Microgrid Connect - Recreation Office	1	EA	$15,000	$5,000	$15,000	$5,000	$20,000	$24,000
Transformer - Recreation Office	1	EA	$7,500	$1,125	$7,500	$1,125	$8,625	$10,350
ATS/Microgrid Connect - Health and Human Services	1	EA	$15,000	$5,000	$15,000	$5,000	$20,000	$24,000
Transformer - Health and Human Services	1	EA	$7,500	$1,125	$7,500	$1,125	$8,625	$10,350
ATS/Microgrid Connect - PCCC	1	EA	$50,000	$10,000	$50,000	$10,000	$60,000	$72,000
Transformer - PCCC	1	EA	$30,000	$7,500	$30,000	$7,500	$37,500	$45,000
ATS/Microgrid Connect - Paterson Division of Health	1	EA	$15,000	$5,000	$15,000	$5,000	$20,000	$24,000
Transformer - Division of Health	1	EA	$7,500	$1,125	$7,500	$1,125	$8,625	$10,350
ATS/Microgrid Connect - Paterson Police Station	1	EA	$50,000	$10,000	$50,000	$10,000	$60,000	$72,000

Description	Quantity	Unit	Unit Price		Total Price		Sub-Total	Total w/ COP
			Material	Labor	Material	Labor		
Municipal Core - Utility Line Switching and Isolation (Continued)								
Transformer - Paterson Police Station	1	EA	$20,000	$2,500	$20,000	$2,500	$22,500	$27,000
Communications (Misc.)	1	N/A	$0	$45,000	$0	$45,000	$45,000	$54,000
							Total	$418,050
Radial Extension – Isolation and Connection to Microgrid								
Isolation of eleven (11) XFMRs on KUL 8021	11	EA	$1,250	$5,000	$13,750	$55,000	$68,750	$82,500
Isolation of fourteen (14) XFMRs on PAT 4016	14	EA	$1,250	$5,000	$17,500	$70,000	$87,500	$105,000
KUL 8021 Reclosers/ Sectionalizers	2	EA	$25,000	$15,000	$50,000	$30,000	$80,000	$96,000
PAT 4016 Reclosers/ Sectionalizers	2	EA	$25,000	$15,000	$50,000	$30,000	$80,000	$96,000
PAT 4017 Recloser/ Sectionalizer	1	EA	$25,000	$15,000	$25,000	$15,000	$40,000	$48,000
KUL 8021 and PAT 4016 Interconnection	1	EA	$85,000	$15,000	$85,000	$15,000	$100,000	$120,000
KUL 8021 and PAT 4017 Interconnection	2	EA	$85,000	$15,000	$170,000	$30,000	$200,000	$240,000
Overhead Conductors between from KUL 8021 to PAT 4017	800	LF	$50	$140	$40,000	$112,000	$152,000	$182,400
Isolation of eleven (11) XFMRs on KUL 8021	11	EA	$1,250	$5,000	$13,750	$55,000	$68,750	$82,500
Isolation of fourteen (14) XFMRs on PAT 4016	14	EA	$1,250	$5,000	$17,500	$70,000	$87,500	$105,000
KUL 8021 Reclosers/ Sectionalizers	2	EA	$25,000	$15,000	$50,000	$30,000	$80,000	$96,000
PAT 4016 Reclosers/ Sectionalizers	2	EA	$25,000	$15,000	$50,000	$30,000	$80,000	$96,000
PAT 4017 Recloser/ Sectionalizer	1	EA	$25,000	$15,000	$25,000	$15,000	$40,000	$48,000

Description	Quantity	Unit	Unit Price		Total Price		Sub-Total	Total w/ COP
			Material	Labor	Material	Labor		
Radial Extension – Isolation and Connection to Microgrid (continued)								
KUL 8021 Reclosers/ Sectionalizers	2	EA	$25,000	$15,000	$50,000	$30,000	$80,000	$96,000
PAT 4016 Reclosers/ Sectionalizers	2	EA	$25,000	$15,000	$50,000	$30,000	$80,000	$96,000
PAT 4017 Recloser/ Sectionalizer	1	EA	$25,000	$15,000	$25,000	$15,000	$40,000	$48,000
KUL 8021 and PAT 4016 Interconnection	1	EA	$85,000	$15,000	$85,000	$15,000	$100,000	$120,000
KUL 8021 and PAT 4017 Interconnection	2	EA	$85,000	$15,000	$170,000	$30,000	$200,000	$240,000
Overhead Conductors between from KUL 8021 to PAT 4017	800	LF	$50	$140	$40,000	$112,000	$152,000	$182,400
							Total	$1,939,800

9.3. Substation Upgrades and Additional Assets

The final components needed for the microgrid are the dispatchable assets and the microgrid communications. These devices will be located within the Paterson Substation. A large portion of these components can be financed via a public-private partnership supported by a third -party investor. Further detail can be found in Section 10.0. All of the following estimates include a 20% mark-up for Contingency, Overhead, and Profit (COP).

Description	Quantity	Unit	Unit Price		Total Price		Sub-Total	Total w/ COP
			Material	Labor	Material	Labor		
Paterson Substation Upgrades								
MV Switchgear	1	EA	$150,000	$35,000	$150,000	$35,000	$185,000	$222,000
Microgrid Transformers	2	EA	$150,000	$18,750	$300,000	$37,500	$337,500	$405,000
							Total	$627,000
Microgrid Power Assets								
Battery	1	EA	$500,000	$10,000	$500,000	$10,000	$510,000	$612,000
1.0MW NG Generator	1000	KW	$400	$225	$400,000	$225,000	$625,000	$750,000
2.5MW NG Generator	2500	KW	$400	$225	$1,000,000	$562,500	$1,562,500	$1,875,000
Microgrid Control (Misc.)	1	N/A	$0	$80,000	$0	$80,000	$80,000	$96,000
Hydro Plant Upgrades	By Others							
							Total	$3,333,000

10.0 Cash Flow Projection

Consistent with the DOMA approach, different project elements are financed independently with each capturing unique economic value. The hydropower generation plant is owned and operated independently and does not need to be financed directly as part of the microgrid project. The backbone of the microgrid will be constructed by the electric utility and owned as part of the distribution system with cost recovery through rates. The primary direct new investment for the project includes the dispatchable natural gas fired generators, a battery storage asset, and the microgrid controller. This project element will be developed through a public-private partnership organized by the City through a competitive RFP process. A third-party investor will own and operate the generators, the storage asset, and the controller, and ensure operating support during a grid outage when the microgrid is functional. The cash flow projection for the project is focused on the economics of this third-party project.

To compliment the varying generation of the hydropower generation plant, two natural gas RICE (Reciprocating Internal Combustion Engine) generators, one sized at 1.0MW, and the other at 2.5MW, (for a total of 3.5MW) are planned. Under blue-sky conditions, these generators will be operated in the PJM capacity market, managed within operating boundaries typical for RICE generators.

The capacity market revenues are sufficient to finance the generator-storage-controller combination, achieving a 5.7% IRR over 15 years, and simple break even in year 11. A summary of the cash flow for this investment profile is summarized below.

Year	1	2	3	4	5
Investment	-$3,333,000	$0	$0	$0	$0
Revenues	$291,632	$298,923	$306,396	$314,056	$321,056
Operating Costs	-$80,001	-$81,201	-$82,419	-$83,655	-$84,910
Federal Tax Impacts	$66,660	$66,660	$66,660	$66,660	$66,660
Net Annual Cash Flow ($ in-year)	-$3,054,709	$282,382	$290,637	$297,061	$303,657
Cumulative Cashflow	-$3,054,709	-$2,770,326	-$2,479,689	-$2,182,628	-$1,878,971
Internal Rate of Return (%)	5.73%				

Year	6	7	8	9	10
Investment	$0	$0	$0	$0	$0
Revenues	$329,955	$338,204	$346,659	$355,325	364,209
Operating Costs	-$86,184	-$87,476	-$88,788	-$90,120	-$91,472
Federal Tax Impacts	$66,660	$66,660	$66,660	$66,660	$66,660
Net Annual Cash Flow ($ in-year)	$310,431	$317,388	$324,531	$324,531	$339,397
Cumulative Cashflow	-$1,568,539	-$1,251,152	-$926,621	-594,756	-$255,360
Internal Rate of Return (%)	5.73%				

Year	11	12	13	14	15
Investment	$0	$0	$0	$0	$0
Revenues	$373,314	$382,647	$392,213	$402,018	$412,069
Operating Costs	$-92,844	$-94,237	$-95,650	$-97,085	$-98,541
Federal Tax Impacts	$66,660	$66,660	$66,660	$66,660	$66,660
Net Annual Cash Flow ($ in-year)	$347,130	$355,070	$363,222	$371,593	$380,187
Cumulative Cashflow	$91,770	$446,840	$810,062	$1,181,655	$1,561,842
Internal Rate of Return (%)	5.73%				

While the project is profitable and within feasibility for a friendly investor, it is not a strong IRR for third party investment. Depending on further details to be refined as part of detailed design, a variety of improvements to this investment profile are anticipated:

1. This sub-project includes a small battery-based storage asset that could potentially be operated in PJM ancillary service markets. Those potential revenues were not captured as part of the initial investment model summarized above, but once included, could enhance the IRR significantly.

2. Similarly, the generators are only operated in the capacity market. Depending on the exact operating profile, those generators may be able to operate in other parallel PJM markets that could deliver additional revenue.

3. Consistent with the public-private partnership basis for the project, inexpensive debt-capital may be available for the project, which would provide leverage for improving the IRR.

4. The generators and storage asset are grid connected and participate in the PJM wholesale market. Depending on more detailed analysis and final installation location, the generators may be able to provide either electricity or heat to nearby load sites, thereby capturing additional “behind the meter” revenues.

5. The project delivers substantial resiliency value for the City which is not economized in any way directly through the model summarized above. Any grants or financing programs made available to help realize the state’s resiliency goals could be used to improve project economics. This includes possible federal funds, including block grants.

The direct investment required by the project is profitable based on a simple cash flow analysis that minimizes project financing assumptions. Depending on final design details, the profitability of the project may be improved in a variety of ways to strengthen the attractiveness of the project to a third-party investor as currently contemplated.

11.0 Project Financing

See sections 9, 10, and 11 for details about how different elements of the microgrid are financed.

This proposed project is consistent with the use of the Societal Benefit Charge (SBC) as set forth in N.J.S.A. 48:3-60(a)(3) since all identified load sites pay regulated utility power bills and therefore contribute to the SBC fund.

12.0 Project Benefits

The Great Falls EERP project provides significant benefits in two areas: a) benefits to the community during a grid outage, by delivering power to critical facilities and infrastructure, and b) benefits to the grid.

12.1. Benefits for The Community

Paterson currently has extremely limited energy resiliency for critical infrastructure. The City is committed to significantly expanding the level of support it provides to the community during grid outage events. This project is both highly feasible and highly impactful and represents an exceptional opportunity to dramatically improve the level of emergency support services provided to the community.

The proposed microgrid will be able to provide un-interrupted power to critical facilities for an indefinite period[1]. The use of renewable generation assets will reduce dependence on fuel supplies. Note that support will be provided for "full building" functionality at all critical facilities, not just "critical loads".

With the availability of expanded and more reliable power for critical facilities, the City will be able to significantly increase the level of support it provides to the community during an outage event, especially for events of longer duration. Key benefits <u>**DURING AN OUTAGE**</u> include:

Emergency Management: Assurance of back-up power for Police and Fire stations, which serve as the core for emergency management operations across the entire community.

Community Coordination: Assurance of back-up power for City Hall, which also plays a central role in coordinating numerous support functions during an extended outage. This facility serves as a meeting place for community leadership and response coordinators, and a primary source of information for residents during an extended event.

Proof of Concept and Project Learning: While this project is compact in physical size, it will be a fully functional Class Three community microgrid. This facility will serve as a proof of concept for a quintessential microgrid implementation, with working demonstration of key technical elements, regulatory concepts, and financial strategies. These advancements and learnings can then be scaled up and replicated for other more complex projects. Particular benefit will be realized through the combination of renewable and dispatchable generation assets in a microgrid configuration, which is a key strategic priority for New Jersey.

The residents of Paterson will therefore have significantly stronger municipal support during an extended power outage, including better command and control, better supply distribution arrangements, potentially shelter and food supply facilities (if needed), and support for senior and disabled housing that must shelter in place. There is high need for the resiliency benefits that will be enabled by the Great Falls Eco-Energy Resiliency Project, and by combining these critical facilities into

[1] The system can provide "uninterrupted" service once the microgrid is formed. There may be brief outage intervals during the transition to and from microgrid mode. The generators will be supported by a "firm" (non-curtailable) fuel supply contract.

a “resiliency island”, the microgrid meets a critical emergency management need in a highly cost-effective way compared with other alternatives.

13.0 Benefits to The Grid

Key microgrid assets will also deliver benefits and economic value during normal operation, when the microgrid itself isn't functioning. The generators will be participating in PJM capacity markets. Most importantly, the existence of the microgrid provides the utility with additional flexibility in handling restoration of service during an outage. Since the portfolio of facilities on the microgrid can be operated indefinitely – thereby allowing utility resources to be prioritized to other circuits. The utility can also control the sequence of restoring microgrid loads to normal operation, thereby allowing for a smoother restoration.

14.0 System Communications

Under some architectures considered for a TC-DER microgrid, there may be a need for significant communication and coordination between the public grid utility (EDC) and the microgrid itself. This tight coupling is necessary when the microgrid is interacting with the public grid (exchanging power in either direction) during blue-sky conditions.

That requirement doesn't exist under the DOMA strategy, because the overall microgrid entity does not exchange power with the grid under blue sky conditions. The microgrid only functions when fully isolated from the public grid, in which case control-level communications are not necessary. Both the natural gas generator and the Solar-For-All array will interact with PJM and the EDC for control of their "normal operation" modes under blue-sky. That communications and control infrastructure will be implemented as part of those stand-alone energy services projects, relatively independent of the microgrid project. Communication requirements for the microgrid project overall are therefore fairly minimal.

The once exception is during the transition modes, when the grid goes down (and is eventually restored), and the microgrids starts (and then terminates) operation. The best method for coordinating these start-up and shut-down transitions will depend on further details to be determined as part of detailed design and will depend heavily on utility preference/requirements.

15.0 Estimated Schedule

Following this conceptual feasibility study, the implementation of the project will include several phases (this schedule assumes that the Solar-For-All and EV charger projects are independently, since they will proceed regardless of the microgrid project):

Detailed Design: with the design created during the Conceptual Feasibility Study, developed a detailed design sufficient to drive actual implementation and related municipal procurement activities. Coordinate with the utility on all technical design matters. This effort is expected to be funded by BPU second stage funding.

Utility Project Implementation: construction of the microgrid backbone.

Municipal Procurement: an RFP-style process for a third-party owner/operator for construction of the natural gas generator and the microgrid controller.

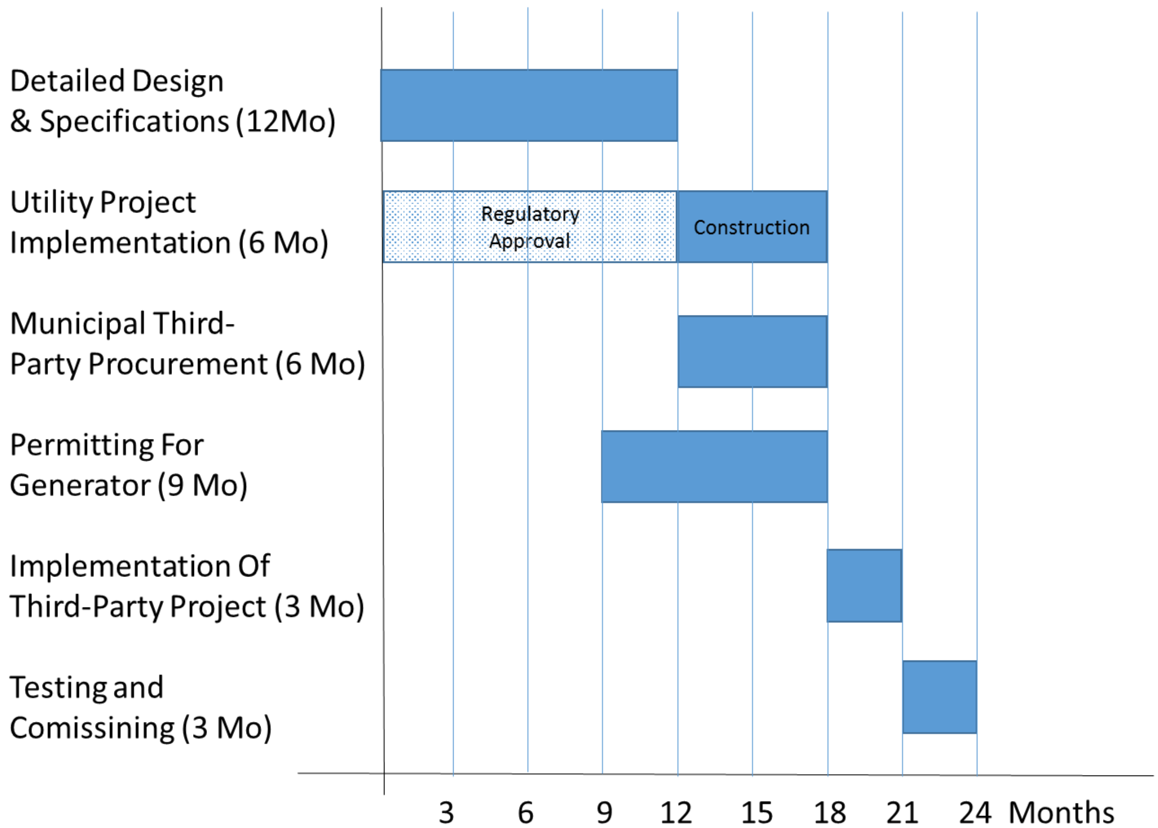
Permitting for Generators: including PJM interconnection and NJ-DEP emission permits, along with any local permits required.

Construction of the Generators: physical construction of the generator and microgrid controller, implemented in coordination with utility construction of the backbone.

Testing and Commissioning: After construction is completed, testing of microgrid operation and training of staff for operation.

This schedule does not account for regulatory approval of the DOMA strategy, and utility filing/approval of backbone construction activities, the timing of which is difficult to estimate at this stage. The following bar-chart summarizes high level estimates for each work phase:

Figure 6: High Level Schedule



16.0 Utility Involvement

As noted in Section 7, the DOMA strategy assumes significant involvement by the EDC in the construction of the microgrid, with a focus on designing, building, operating, and owning the backbone as an integrated part of the distribution system. Recovery of those investments would happen consistent with other distribution system investments and may (longer term) be supported by a TC-DER Advanced Microgrid Tariff. Shorter term, initial (pioneer) projects may depend on more specific filings to achieve the same purpose.

In the case of the Great Falls Eco-Energy Resiliency project, the backbone is built through a combination of a) isolated sub-loops of existing circuits, b) new aerial extensions to connect more remote load sites (the schools and DPW), and the provision of both isolation and transfer switching to enable interconnection with both load sites and generation assets included as part of the microgrid. Utility involvement will be critical for the detailed design phase, construction of the backbone, and operation of the microgrid transitions as described in Section 7. Note that under the DOMA strategy, a) the utility does not lose revenue, b) they have an active role in project development and construction, and can expand their rate-base with the new backbone assets (both conductors and switchgear), and they c) implement, and control the transitions to and from the microgrid operating modes.

17.0 Appendix A – Letters of Support and Authorization

Letters of support are provided from the following project partners:

- Paterson Public Schools
- Great Falls Hydroelectric Company Limited Partnership
- Passaic County Administrator
- PSE&G

17.1. Appendix A – 1: Letter of Support from Paterson Public Schools

PATERSON PUBLIC SCHOOLS

Office of the State District Superintendent
90 Delaware Avenue, Paterson, NJ 07503
Office: (973) 321-0980 Fax: (973) 321-0470

Donnie W. Evans, Ed.D.
State District Superintendent

March 24, 2017

Richard S. Mroz, Esq., President
New Jersey Board of Public Utilities
44 South Clinton Avenue
Trenton, New Jersey 08625

RE: Town Center Distributed Energy Resource Microgrid
Feasibility Study Incentive Program

Dear President Mroz:

I am writing in reference to the above-captioned application by the City of Paterson for funding from the New Jersey Board of Public Utilities to conduct a feasibility study on the possible creation of a microgrid in the City supported by hydroelectricity received from Paterson's Great Falls.

John F. Kennedy High School and International High School are designated as emergency shelters for the City. Participation in the feasibility study would assess the possibility of these venues maintaining continuous energy in the time of crisis. We are in full support of participating in the microgrid study, which can ultimately derive a method to provide extended power usage in the City, barring any financial support to the City.

I look forward to participating in the proposed study to explore the impact of the opportunity for all stakeholders.

Sincerely,

Donnie W. Evans

Donnie W. Evans, Ed.D.
State District Superintendent

c: Mayor Jose Torres
Mr. Steven Morlino, Executive Director of Facilities

Preparing All Children for College and Career

17.2. Appendix A – 2: Letter of Support from Great Falls Hydroelectric Limited Partnership

Great Falls Hydroelectric Company Limited Partnership
65 Madison Avenue, Suite 500
Morristown, NJ 07960

March 24, 2017

To: The New Jersey Board of Public Utilities

From: Great Falls Hydroelectric Company Limited Partnership

Re: Letter Of Support For Microgrid Study

Ladies and Gentlemen:

We understand that our community is preparing a proposal to the BPU for funding of a Town Center Microgrid feasibility study. Based on their preliminary conceptual studies for the project, we further understand that our facility is being considered for inclusion as part of the solution. We support the idea of a microgrid in our town to provide more resilient power in the case of extended outages, and offer our support for participation in the study effort being conducted by the community. We look forward to participating in the proposed study efforts of our community to explore that opportunity further.

Sincerely

Great falls Hydroelectric Limited Partnership

Bernard H. Cherry

President

17.3. Appendix A – 3: Letter of Support from Passaic County Administrator

County of Passaic
Administration Building Room 205
401 Grand Street • Paterson, New Jersey 07505-2023

Anthony J. DeNova
County Administrator
TEL: (973) 881-4405
FAX: (973) 881-2853
e-mail: adenova@passaiccountynj.org

March 23, 2017

Richard S. Mroz, Esq.
President
New Jersey Board of Public Utilities
44 South Clinton Avenue
Trenton, New Jersey 08625

RE: Town Center Distributed Energy Resource Microgrid Feasibility Study Incentive Program

Dear President Mroz:

I am the Administrator for the County of Passaic (hereafter "County") writing with respect to the above captioned application by the City of Paterson (hereafter "City") for funding from the New Jersey Board of Public Utilities to conduct a feasibility study on the potential creation of a microgrid in the City sustained by hydroelectricity derived from the Great Falls.

The County has several facilities within close proximity of the Great Falls that would benefit from a microgrid, including the Passaic County Jail and the Passaic County Court House and Administration Complex, both of which become vulnerable during power outages and cause operational issues.

The County is ready and willing to support this feasibility study if the City is awarded funding. I am available at the above listed number if there are any questions or concerns.

Sincerely,

Anthony J. DeNova, III
Passaic County Administrator

cc: Passaic County Board of Chosen Freeholders
Paterson Mayor Jose "Joey" Torres
Passaic County Engineer Steve Edmond
Matthew P. Jordan, Esq.

17.4. Appendix A – 4: Letter of Support from PSE&G

Public Service Electric and Gas Company
80 Park Plaza – T8, Newark, NJ 07102

PSEG

March 22, 2017

Mr. Ben-David Seligman
City of Paterson
City Hall
155 Market Street
Paterson NJ 07505

Dear Mr. Seligman:

This correspondence will serve to demonstrate PSE&G's support of your application to the Town Center Distributed Energy Resource Microgrid Feasibility Study Incentive program. PSE&G will work Paterson officials and its consultant to develop and submit your feasibility study, if selected for funding.

PSE&G will support your study in the following ways:

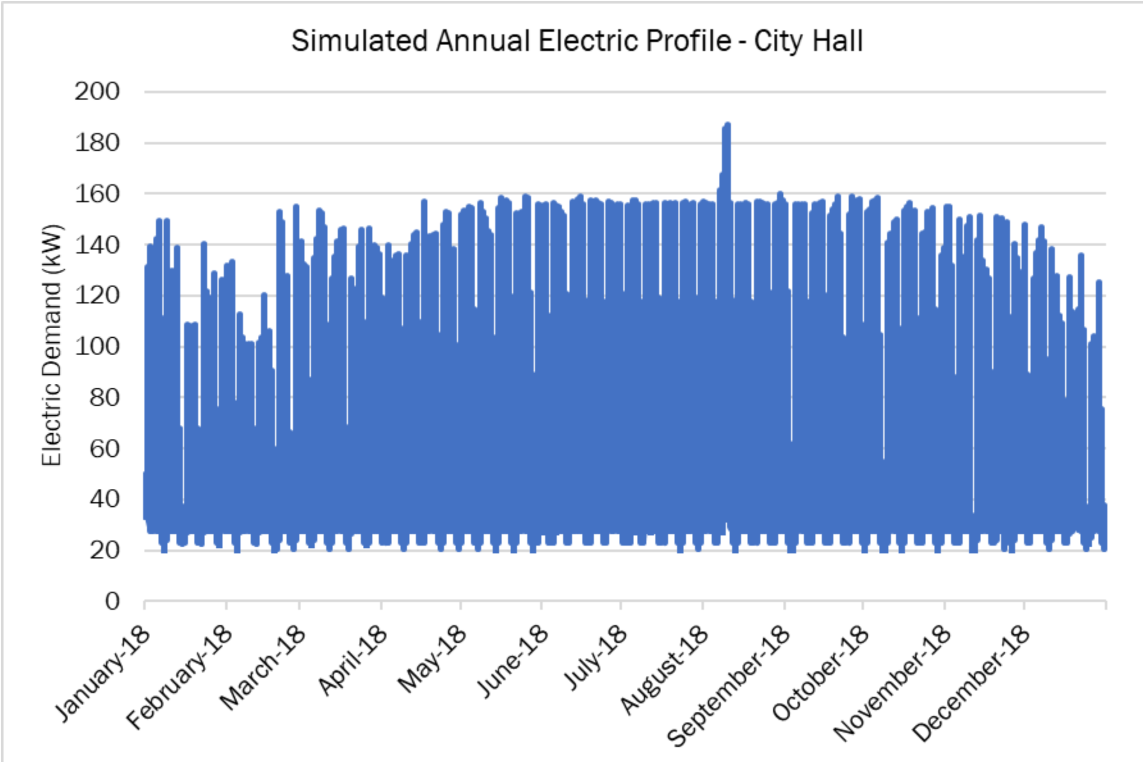
- PSE&G will provide building load data for all buildings included in your microgrid feasibility study, contingent on receiving approval from the owners of each of the buildings to release its electric and gas load data to the community or its consultant.
- PSE&G will provide technical support to Paterson's consultant in the development of your feasibility study. Release of any confidential or proprietary technical information will require the execution of a Non-Disclosure Agreement between all parties.

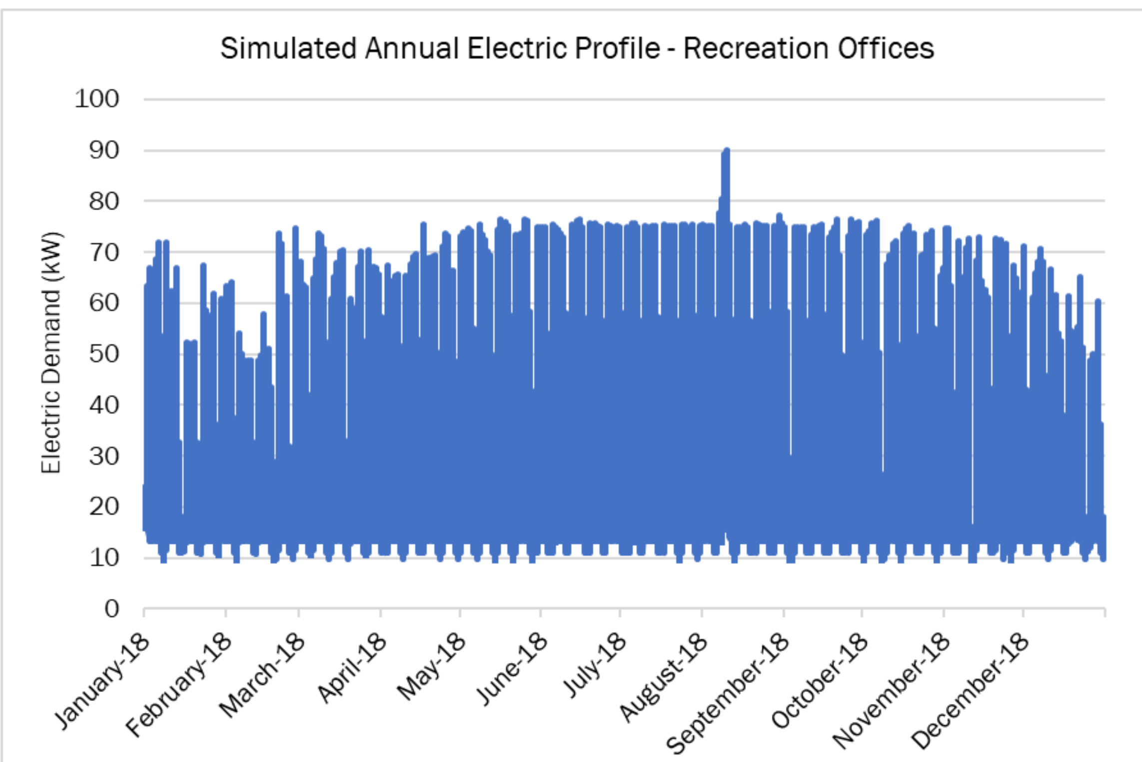
Mr. Everton Scott will be the primary point of contact for PSE&G to coordinate our efforts with your team. Please feel free to reach out to me at 856-778-6705 if you have any technical questions.

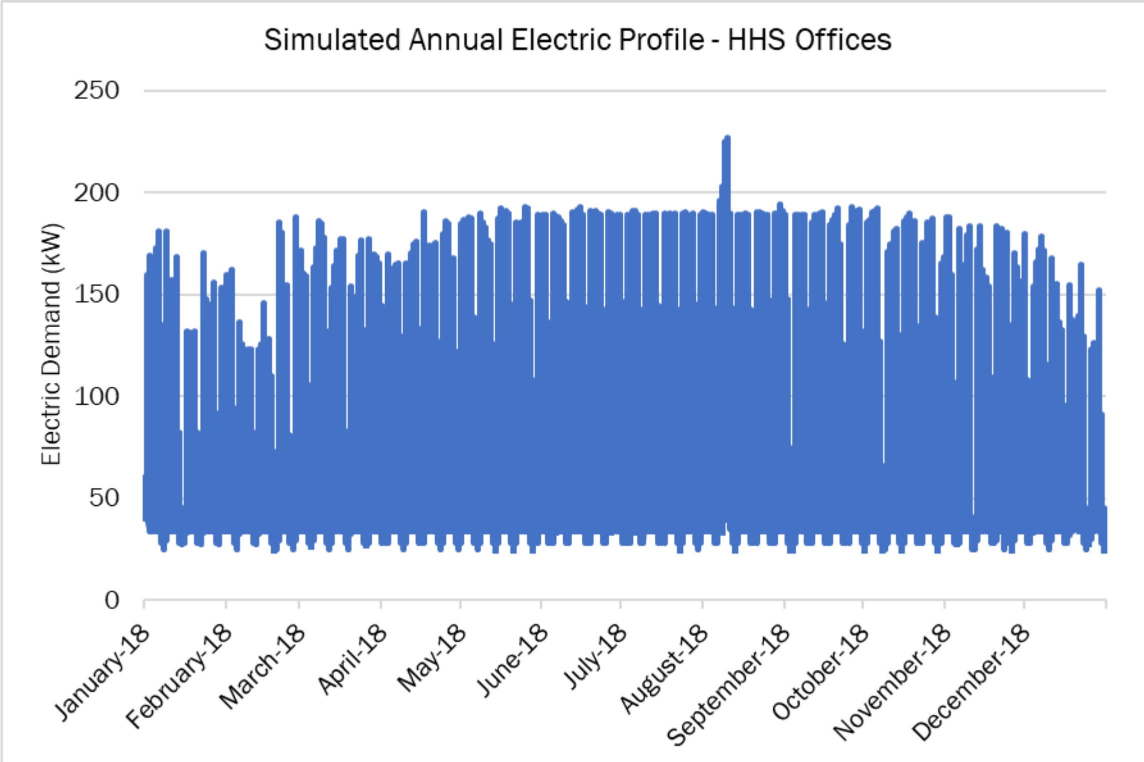
Sincerely,

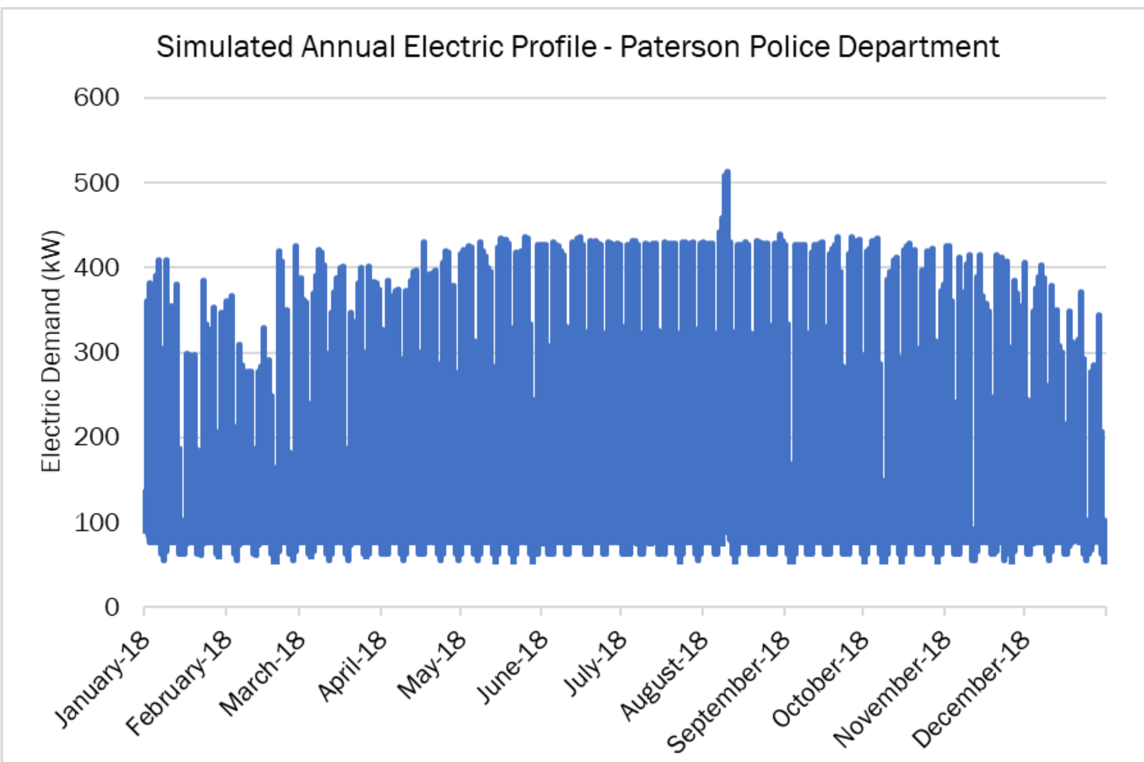
Michael Henry
Distribution Business Team Leader

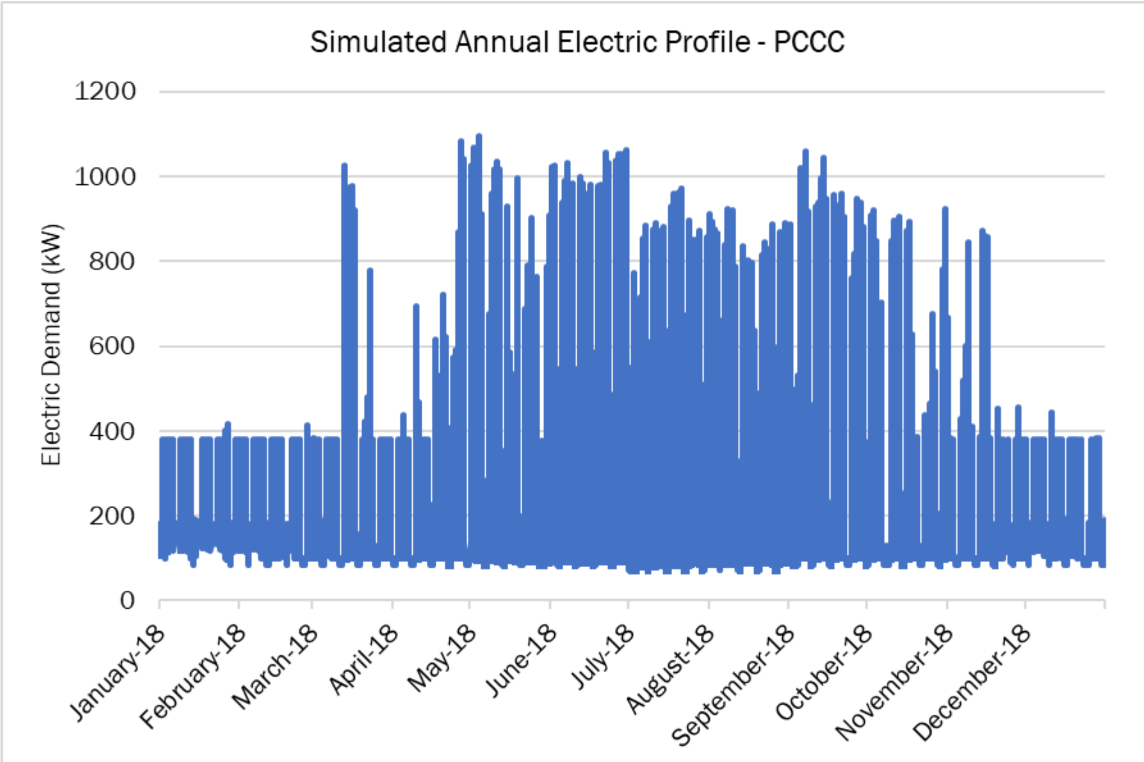
18.0 Appendix B – Load Sites Time-of-Day Profiles

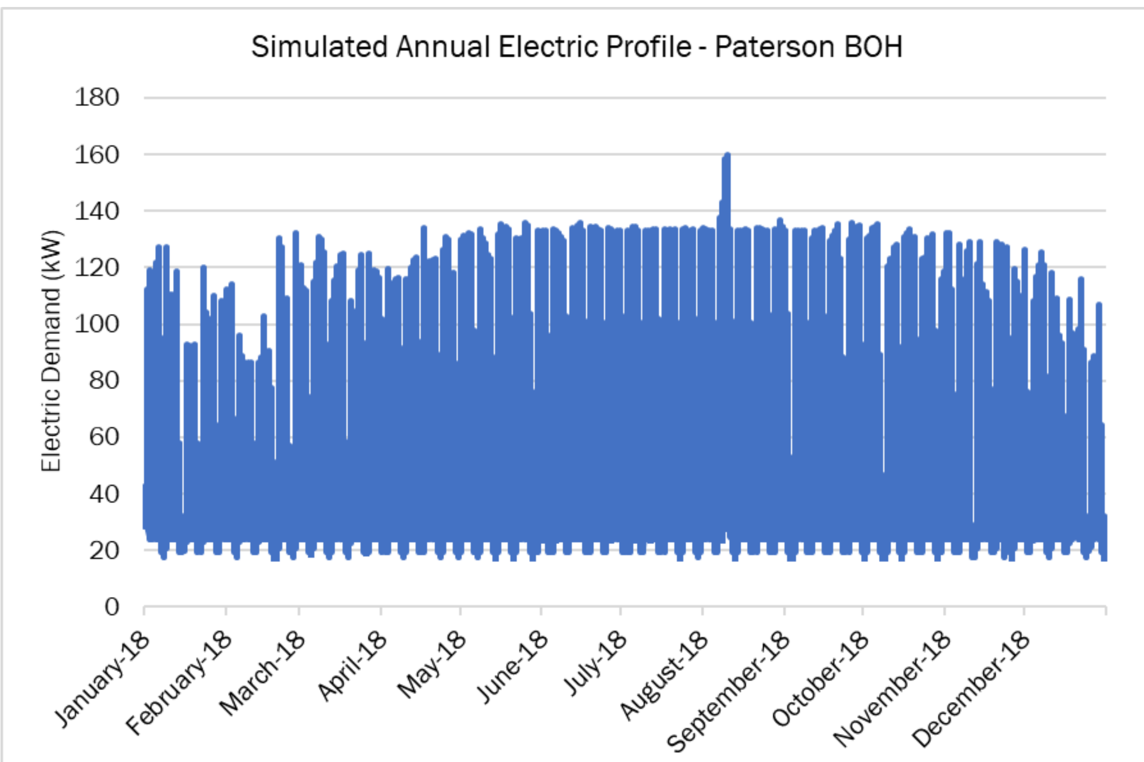


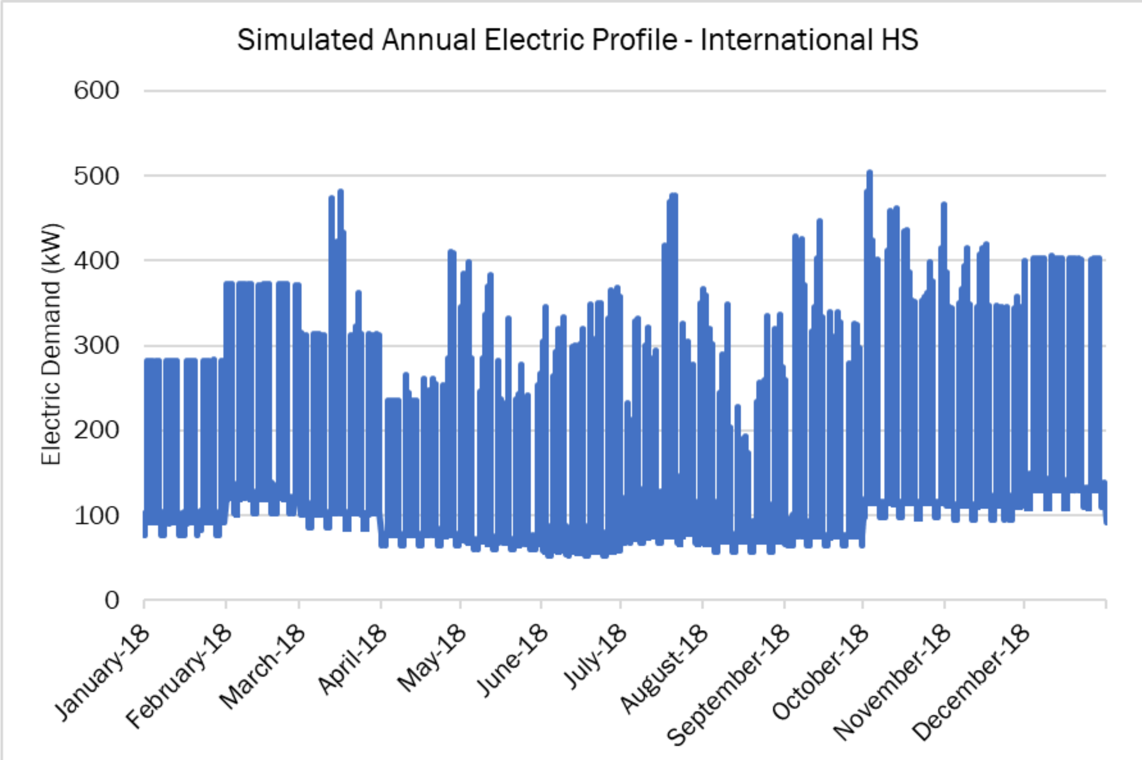


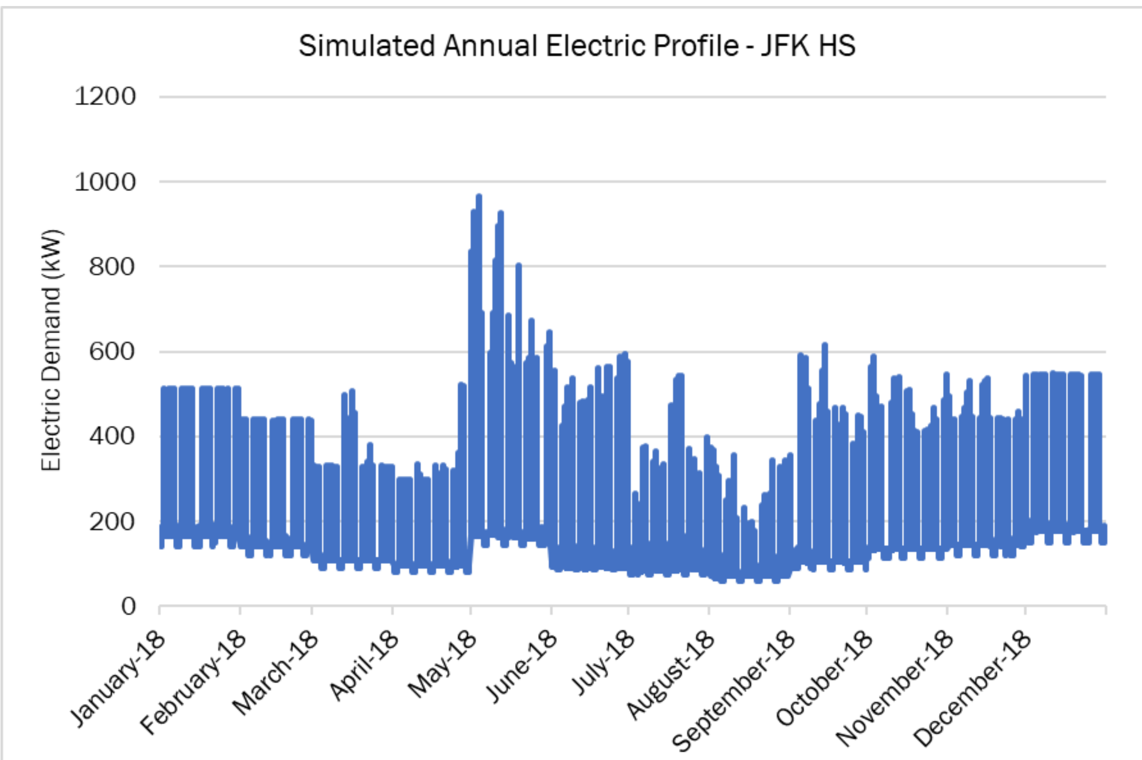

Simulated Annual Electric Profile - HHS Offices
Electric Demand (kW)
250
200
150
100
50
0
January-18
February-18
March-18
April-18
May-18
June-18
July-18
August-18
September-18
October-18
November-18
December-18

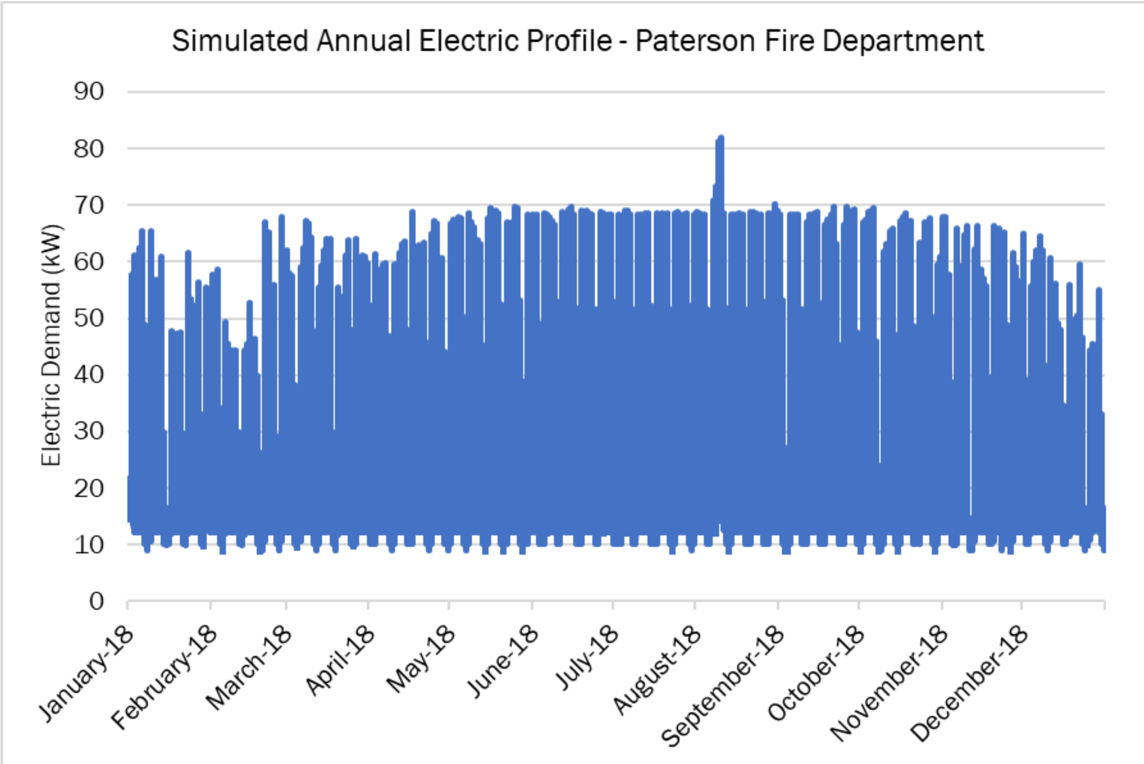

Simulated Annual Electric Profile - Paterson Police Department
Electric Demand (kW)
600
500
400
300
200
100
0
January-18
February-18
March-18
April-18
May-18
June-18
July-18
August-18
September-18
October-18
November-18
December-18


Simulated Annual Electric Profile - PCCC
Electric Demand (kW)
0
200
400
600
800
1000
1200
January-18
February-18
March-18
April-18
May-18
June-18
July-18
August-18
September-18
October-18
November-18
December-18

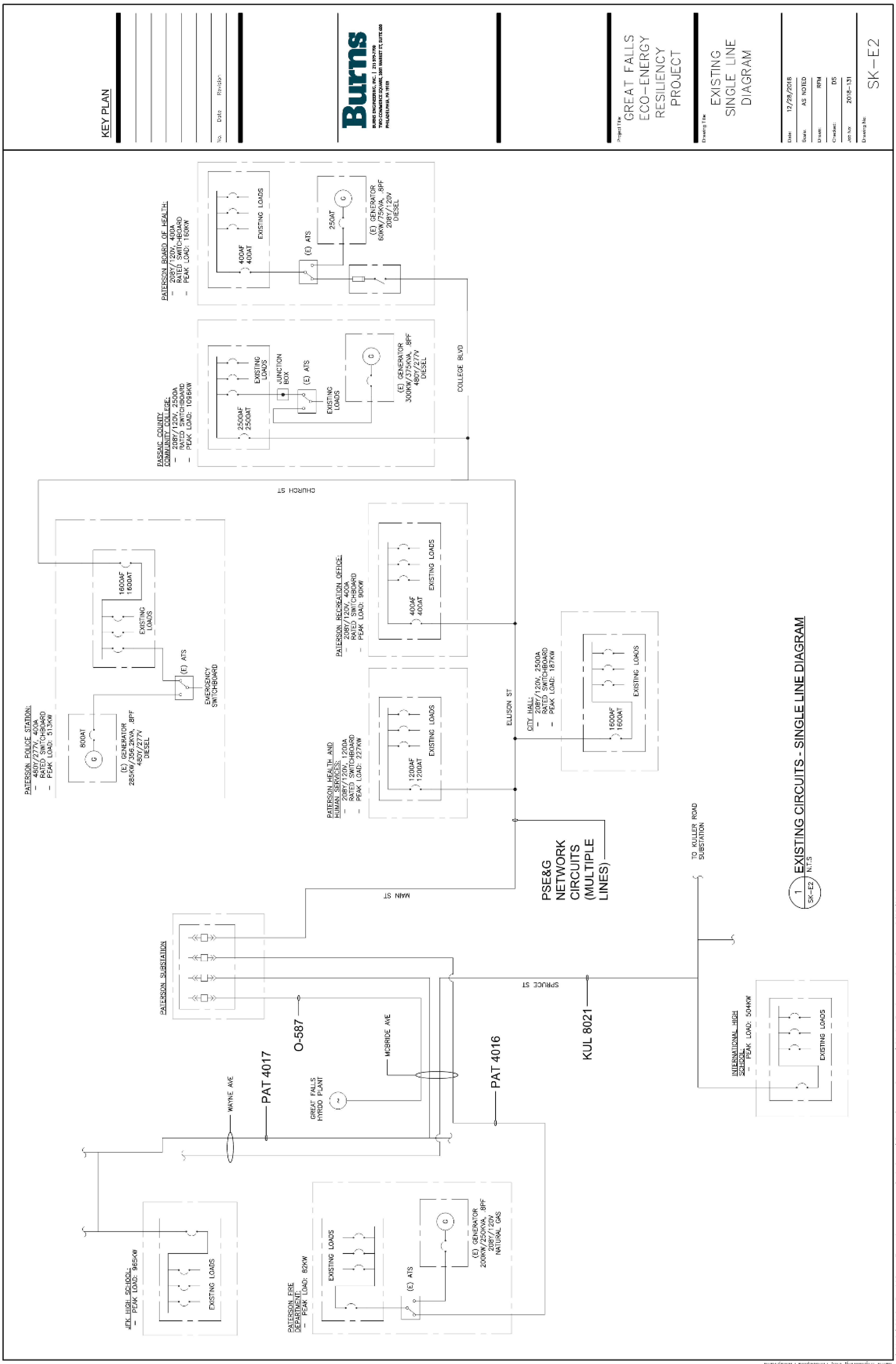

Simulated Annual Electric Profile - Paterson BOH
Electric Demand (kW)
0
20
40
60
80
100
120
140
160
180
January-18
February-18
March-18
April-18
May-18
June-18
July-18
August-18
September-18
October-18
November-18
December-18


Simulated Annual Electric Profile - International HS
Electric Demand (kW)
600
500
400
300
200
100
0
January-18
February-18
March-18
April-18
May-18
June-18
July-18
August-18
September-18
October-18
November-18
December-18


Simulated Annual Electric Profile - JFK HS
Electric Demand (kW)
1200
1000
800
600
400
200
0
January-18
February-18
March-18
April-18
May-18
June-18
July-18
August-18
September-18
October-18
November-18
December-18


Simulated Annual Electric Profile - Paterson Fire Department
Electric Demand (kW)
90
80
70
60
50
40
30
20
10
0
January-18
February-18
March-18
April-18
May-18
June-18
July-18
August-18
September-18
October-18
November-18
December-18

19.0 Appendix C – Existing Single Line Diagram



20.0 Appendix D – Proposed Single Line Diagram