CITY OF HOBOKEN

NEW JERSEY TOWN CENTER
DISTRIBUTED ENERGY RESOURCES MICROGRID
FEASIBILITY STUDY

94 WASHINGTON STREET
HOBOKEN, NJ 07030

ENGINEER

CONCORD ENGINEERING

520 SOUTH BURNT MILL ROAD
VOORHEES, NEW JERSEY 08043

BPU SUBMISSION
August 24, 2018
2C17556-RPT-001

REVISED SUBMISSION
January 24, 2019

TABLE OF CONTENTS

REVISION HISTORY*: the following major revisions have been made since the last submission to the BPU on 8/24/18:*

Section 2.3 *was added to address the total system loads of the microgrid. Specific graphs from Appendix C were added to this section to better illustrate the total system electric & thermal loads.*

Section 6.5 *was added to address the project financial pro-forma results. Specific values from Appendix E were added to new tables to identify the project financial analysis.*

Section 6.6 *was added to include results from additional financial pro-formas developed to identify the savings of constructing specific microgrid features in phases. The results of these pro-formas were also added to Appendix E.*

Section 6.7 *was added to identify the results of the Rutgers University DER-CAM modeling. An additional Appendix F was added to include the tables and graphs developed by Rutgers University.*

Section 9.0 *was revised to include additional detail on permitting.*

Abbreviations

AAA	Authentication, Authorization, Accountability
AC	Alternating current
ATS	Automatic transfer switch
BGS	Basic Generation service
BGS- CIEP	Basic Generation Service- Commercial and industrial energy pricing
BHP	Brake horse power
BPU	Board of Public Utility
CEP	Clean Energy Program
CHP	Combined heat and power
CIA	Confidentiality, integrity and availability
CIEP	Commercial and industry energy pricing
CSP	Curtailable service provider
DC	Direct current
DCA	Department of Community Affairs
DER-CAM	Distributed Energy Resources – Customer Adoption Model
DG	Distributed generation
DX	Direct Expansion
DoD	Depth of Discharge
ECM	Energy conservation methods
EDC	Electric distribution company
EDECA	Electrical discount and energy competition act
ESIP	Energy Savings Improvement Program
FEMA	Federal Emergency Management Agency
GDC	Gas Distribution company
GLP	General Light and Power
GOOSE	Generic object oriented system-wide events
HMI	Human Machine interface
HSR	High availability seamless redundancy
HUMC	Hoboken university medical center
HVAC	Heating ventilation and air conditioning
ICS	Industrial control systems
IEDS	Intelligent electric devices
IEEE	Institute of Electrical and Electronics Engineers
ISO	International standard organization
kW	Kilowatts
kV	Kilovolts
KVA	Kilovolt-amperes
LPL	Large power and light
PCC	Point of common coupling
PJM	Pennsylvania, Jersey, Maryland Power Pool
PRP	Parallel redundancy protocol
PSE&G	Public Service Electric & Gas
PTP	Precision time protocol
PV	Photovoltaic
RLM	Residential load management
RS	Residential Service
SCR	Selective catalytic reduction
SoC	State of Charge

SRECS	Solar renewable energy certificates
SUT	Sales and Use Tax
TOU	Time of use
TPS	Third party supplier
V	Volt
VFDs	Variable frequency drive
VLAN	Virtual local area network
WAN	Wide area network

1.0 EXECUTIVE SUMMARY AND BACKGROUND

The purpose of the Hoboken microgrid project is to power critical facilities when electricity from the larger grid is not available. Critical Facilities are defined by the essential nature of their service delivery – not necessarily just emergency services or ambulatory care – but facilities that absent their services the city would cease to function. The purpose of the feasibility study was to explore design alternatives within a financially viable business model to support installation of distributed energy resources, distribution infrastructure and control technologies.

In total, 29 locations owned by several different project partners were studied in this report. The study area falls into two corridors that are defined by the Washington Street Corridor, and the Housing Authority Corridor. Each corridor will serve critical facilities, with Washington St. having the distinction of being predominantly above the existing .1% design flood elevation. The main control and dispatch for the microgrid are proposed for City Hall, and will be able to control both corridors.

The Washington Street corridor is estimated to cost $30.5M at full build out and will be capable of dispatching approximately 7.4 MW of distributed energy resources that include natural gas & diesel reciprocating engines, combined heat and power, as well as solar + batteries. The Housing Authority corridor is estimated to cost $11.5M at full build out and will be capable of dispatching approximately 1 MW of distributed energy resources that include natural gas reciprocating engines. In addition to applying the best engineering practices, the project has been registered for PEER certification through the USGBC.

Background

The City of Hoboken is located in Hudson County New Jersey, along the Hudson River. The city is approximately one square mile with a population of over 55,000 residents. A significant portion of the city is positioned within the 1.0% floodplain and is susceptible to both coastal and stormwater flooding. During heavy rain events the city's combined sewer overflow system becomes overwhelmed resulting in shallow urban ponding and wet weather discharges of sewerage to the Hudson River. On October 29, 2012 Super Storm Sandy exposed many of these vulnerabilities. The storm produced less than an inch of rain in the city; however, the 13 foot storm surge from the Hudson River resulted in 8 feet of flooding. Damages were estimated in the Billions. The City responded to Sandy with numerous approaches to increase adaptive capacity and build resilience that include:

1. A $230 million grant from the United States Department of Housing and Urban Development allocated to the New Jersey Department of Environmental Protection on behalf of Hoboken as part of its Rebuild by Design initiative. Rebuild by Design is a comprehensive flood protection project that addresses coastal storm surge and rainfall flooding. The coastal storm surge risk reduction project is expected to be completed in 2022.
2. Comprehensive long term planning efforts:
    - The Building Resilience Design Guidelines focused on consolidating numerous technical resources that reduce flood risk in building design and construction.
    - Improvement to Codes Ordinances and Standards around stormwater management

  - A resilient Capital Improvements Plan, which is being updated in 2018
  - A hazard mitigation element with cost benefit analysis, an update to the emergency operations plan, and continuity of operations plan
  - An Open Space and Historic Preservation element that identified mitigation strategies for historic properties, and improved the City's understanding of recreation and open space opportunities to reduce flood risk.
- Adoption of the Green Building and Environmental Sustainability Element of the Masterplan in 2017, which articulates the City's resiliency and sustainability approaches, projects and goals.
- A collaboration with PSE&G to consolidate and elevate all 3 substations into two state of the art substations. PSE&G also replaced all low pressure natural gas lines, with high pressure gas mains. These projects combined represent approximately $500,000,000 of investment.
- A design investigation by Sandia National Laboratories supported by the Department of Energy to install a municipal microgrid.

The microgrid concept was developed because preceding, during, and following Superstorm Sandy the city's electrical distribution system was de-energized, and critical services lost the ability to function. To address municipal and citizen concerns related to prolonged electrical outages, and specifically the effect these outages have on the health and safety of urban residents, a memorandum of understanding was drafted between and among the Department of Energy Office of Electricity Delivery and Energy Reliability, the New Jersey Board of Public Utilities, Public Service Electric and Gas Company, and the City of Hoboken, New Jersey. The subject of the memorandum was to enhance electric power resiliency using advanced system design.

Sandia National Laboratories was engaged to prepare a design summary that would enable the city to maintain power to critical facilities under a design basis threat. In the case of Hoboken, this threat was established as a prolonged power outage of at least 7 days, including a flood event exceeding the 100 year flood elevation, as established by the Federal Emergency Management Agency. In September of 2014, Sandia National Laboratories published the City of Hoboken Energy Surety Analysis: Preliminary Design Summary, the contents of which informed the basis of this design.

To release the 2014 study, the City of Hoboken with the assistance of Greener by Design and the Stevens Institute of Technology, organized a symposium for technology providers, systems engineers, financial entities, local and state governments, regulatory agencies and service providers discussing the study findings. Concerns were voiced over the two following issues:

> First, franchise right restrictions in the State of New Jersey limit the ability of non-utility entities to produce and distribute energy to non-contiguous properties. To better understand the limits established by utility law the City of Hoboken engaged with the Environmental Defense Fund. The outcome of this research exercise highlighted uncertainties in municipal authority to operate a microgrid and therefore it was recommended that microgrid development be pursued with the collaboration of both Public Service Electric and Gas, as well as the Board of Public Utilities.

Second, it became clear that the microgrid must produce income during “blue sky” (usual grid functioning) conditions, and have clear operating parameters during “black sky” (compromised grid functioning) conditions. For this reason, a team was assembled in April of 2015 to engage with Rocky Mountain Institute at eLab Accelerator and build upon the work developed by Sandia National Laboratories towards a financially viable model. The team members that worked with Rocky Mountain Institute included representatives from Sandia National Laboratories, N.J.B.P.U., PSE&G, Concord Engineering, the City of Hoboken and Greener by Design.

The following feasibility study addresses a number of points discussed at the Rocky Mountain Institute Summit, although it does not contemplate certain elements of microgrid development. These recommended next steps include investigation of regulatory conflicts, technical support from PSE&G, financial modeling and community engagement.

The Microgrid encompasses 29 locations owned by several different project partners; including the city of Hoboken, North Hudson Sewerage Authority, Hoboken Housing Authority, Hoboken University Medical Center, along with various for profit and not for profit entities throughout the city. There are two main corridors that will be served by the microgrid. The first will be the Washington Street Corridor and will include one of the housing authority buildings, all of the city of Hoboken buildings, North Hudson Sewerage Authority facilities, Hoboken University Medical Center, and various for profit and not for profit buildings. The second corridor will be the Hoboken Housing Authority Corridor and will be located on the south west end of the city. This corridor will include Housing Authority complexes Harrison and Andrew Jackson Gardens. The proposed microgrid will consist of two separate power distribution systems based on the locations of the proposed facilities. The main control and dispatch for the microgrid will be housed at City Hall and able to control both corridors.

Washington Street:

The City of Hoboken has already installed a concrete encased duct bank and manhole system beneath Washington Street as part of a utility replacement project. The Duct bank contains spare conduits reserved for a future microgrid project. New conduit will be installed to extend the existing conduit to reach the buildings off of Washington Street. The corridor will be provided with a new 13.8 kW PSE&G electrical service from the 16th Street Substation. This will be the point of common coupling and a new utility meter will measure electrical usage for the entire corridor. Current and new generation resources will provide supplementary power to the microgrid during normal conditions. New generation resources, such as a new packaged reciprocating engine generator Combined Heat and Power (CHP) unit, a new simple cycle packaged engine distributed generator unit, Solar PV and battery storage, will support the Washington Street Corridor microgrid.

Housing Authority:

The City of Hoboken southwest section includes several multifamily, low income housing apartment buildings owned and maintained by the Hoboken Housing Authority. This corridor will include Harrison gardens and Andrew Jackson gardens, both of these complexes are too far from Washington Street to justify interconnecting the buildings to Washington Street. The buildings will have their own microgrid system. Each housing complex includes several; separate utility services that will require a redundant microgrid feed. Since the complexes are below the flood plain all electrical equipment will need to be moved from the basement to the first floor. This microgrid corridor will be served with a new 13.8 kV PSE&G feeder from the Madison Street Substation. This will be considered the point of common coupling and a new utility meter will measure electrical usage for the entire corridor. A new packaged, simple cycle engine generator will provide supplementary power to the microgrid during normal conditions, and during emergency conditions this generator along with current generators will supply the system.

In addition to providing Hoboken with improved electrical resiliency to withstand utility power outages, the microgrid will generate annual cost savings of approximately $1.9 million and 4,400 metric tons of carbon emissions reduction.

Detailed cost estimates have been developed to assign the value of the microgrid for both the Washington Street and Hoboken Housing Authority Corridors. The summary of the results of the cost estimates are below.

Washington Street Corridor:

Electrical Distribution System	$7,300,366
Distributed Generation Resources	$11,552,131
Microgrid Control System	$1,911,000
Professional Services	$4,686,717
Project Costs	$5,090,043
Total	**$30,540,257**

Hoboken Housing Authority Corridor:

Electrical Distribution System	$5,162,036
Distributed Generation Resources	$1,843,442
Microgrid Control System	$819,000
Professional Services	$1,774,868
Project Costs	$1,919,869
Total	**$11,519,216**

20 year life cycle economic models have been developed to illustrate the potential savings and expenses for the project. The results from the financial pro-forma are summarized in the below table for both the Washington Street and Housing Authority Corridors.

Microgrid Corridor	Washington Street	Housing Authority
Final Capital Cost w Incentives	$29,740,257	$11,519,216
Electricity Cost LPLS - Existing (/ kWh)	$0.130	$0.130
Electricity Cost LPLP - New (/ kWh)	$0.120	$0.120
Cost of Natural Gas (/ MMBtu)	$4.00	$4.00
Distributed Generation		
Capacity (kW)	2,000	1,000
Revenues	$834,208	$417,104
Expenses	$142,560	$71,280
Total Savings	**$691,648**	**$345,824**
Combined Heat and Power		
Capacity (kW)	800	
Revenues	$1,279,432	
Expenses	$313,127	
Total Savings	**$966,305**	
Solar PV & Battery Storage		
Capacity (kW)	772	
Revenues	$600,614	
Expenses	$60,438	
Total Savings	**$540,176**	
Microgrid System		
Utility Electric Reduction (kWh/hr)	9,568,840	1,200,000
Revenues	$83,951	$33,200
Expenses	$492,161	$6,640
Total Savings	**-$408,210**	**$26,560**
Total Savings	**$1,789,919**	**$372,384**
NPV @ 4%	-$3,809,780	-$6,153,075
Internal Rate of Return (IRR)	2.58%	-3.15%
Simple Payback	16.0	30.9
Annual Carbon Savings (Metric Ton)	4,405	NA

2.0 PROJECT DESCRIPTION

2.1 PROJECT APPLICANT

The City of Hoboken is located in Hudson County New Jersey, along the west bank of the Hudson River. The city is approximately one square mile with a population of over 50,000 residents. Over the last two decades Hoboken has transformed with the population increasing by over 45% since the 1990 census. Located in the New York metropolitan area directly west of Manhattan, the city is a major transportation hub for commuters and is the site of the Hoboken Terminal, which provides rail, ferry and bus services. The Hoboken community relies heavily on public transportation with 56% of working residents using public transport for everyday commuting purposes.

A significant portion of the city is positioned below the flood plain and is susceptible to both coastal and stormwater flooding. Hoboken was originally an island and as it was further developed during the 20th century, wetlands were filled in to facilitate construction projects. The lowest sections of the city are approximately 3 feet above sea level. The city's aging sewer and stormwater systems are combined and treated at the North Hudson Sewerage Authority facility. During heavy rain events the facility cannot process the combined systems and excess flow is discharged into the Hudson River. If heavy rain events coincide with the high tide, the water cannot discharge to the river and the city is vulnerable to flooding. Coastal flooding occurs less often; however, these events have a larger impact. High tides and surge water brought on from large storms overflow the city.

On October 29, 2012 heavy rain and high winds from Super Storm Sandy devastated the City of Hoboken. The storm left 1,700 homes flooded, many residents without power for over a week. The storm produced less than an inch of rain in the city; however, the 13 foot storm surge from the Hudson River resulted in 8 feet of flooding.

In June 2014, the United States department of housing allocated $230 million to Hoboken as part of its rebuild by design initiative. Through this initiative the city was tasked to build a microgrid to help Hoboken withstand emergency situations where power was unavailable. The city has already made efforts to invest in the microgrid by installing the infrastructure and conduit under Washington Street. The proposed Microgrid will allow the city to still access major emergency service locations, City Hall, hospitals, shelter in place areas, businesses that provide basic needs such as pharmacies and grocery stores.

2.2 PROJECT PARTNERS

The proposed Microgrid encompasses 29 locations throughout the City of Hoboken owned by several different project partners. The project partners described in this section are classified as the following entities:

i. The City of Hoboken
ii. Publicly Owned
iii. Not for Profit
iv. For Profit Businesses

Site plan layout drawings and electrical single line diagrams illustrating building locations and system interconnections are included in Appendix A. A table detailing information for each building considered is included in Appendix B. This includes information regarding location, square footage, electrical service, energy loads, energy costs, FEMA category, etc.

A. THE CITY OF HOBOKEN

The City of Hoboken is the local municipality providing public service to the community. The city operates several different sectors providing public safety, health & human services, community development, environmental services and general municipality services. The following city owned facilities are included in the proposed Microgrid based on their location and the essential services they provide to the city.

Numbers in brackets "[ ]" correspond to building numbers in the Appendix B table as well as the project drawings.

<u>City Hall [12]</u>

City Hall's main function is to provide services and information to the community of Hoboken. The building includes the municipal court as well as being the workplace of the City of Hoboken's administration and staff. City Hall is located on the southern end of Washington Street and is above the flood plain. The building was constructed in 1883 and is included in the National Register of Historic Places. It is 19,500 sqft and is open weekdays to the public from 9 am to 4 pm. The building is classified as a FEMA Category IV essential facility. City Hall is an important part of the microgrid because it is essential to keep the local government functioning. During an emergency city wide power outage, it will be used as a headquarters for utility crews, dispatch services, emergency aid services and any other administrative services necessary.

Electricity is provided to the facility from PSE&G's Washington Street network service and enters the building at 120/208V. The building consumes approximately 41.4 kW of power on average and peaks during the cooling season at approximately 239 kW. The utility meter and breakers are located in the building's lower level in a utility closet. The aging electric service is planned to be replaced and relocated as part of future renovation plans.. It is anticipated this will be completed before the proposed microgrid enters a future construction phase. The building includes a single 200 BHP fire tube boiler that produce low pressure steam to heat the building. The boilers operate from October to April based on the outdoor temperature. The building does not have a central cooling system. Individual spaces are cooled with dedicated direct expansion (DX) air handling units or packaged air conditioning window units.

An energy audit for the building was conducted in 2009 as part of the New Jersey Clean Energy Local Government Energy Audit Program. Energy Conservation Measures (ECM) were recommended for lighting retrofits, building envelope retrofits, upgrading the court room air conditioning system and replacing the domestic hot water system. The ECMs have not been implemented to date.

<u>Fire Department – Engine Company 3 [1]</u>

The main function of the Fire Department- Engine Company 3 is to provide fire protection and emergency medical services to Hoboken. The main building includes the main fire house dispatch. The building is located on the north side of Washington Street and was built in 1890. The building is above the flood plain. It is also included in the National Register of Historic Places. It is 10,626 sqft and is in operation 24 hours a day, 7 days a week. The building consists of offices, lounges, engine bays, storage rooms, boiler room, locker room, bunk room, etc. The building is a two story, brick masonry structure. The building is classified as a FEMA Category IV essential facility. The fire department is essential to be included in the microgrid because it will be required to dispatch fire safety and medical services during an emergency event.

Electric is provided to the facility from PSE&G's Washington Street network service and enters the building underground at 120/208V. The building consumes approximately 7.4 kW of power on average and peaks at approximately 36 kW. The utility meter and breakers are located in the building's basement. The engine bays are heated with two unit heaters and the rest of the building is heated with a natural gas fired hot water boiler. The building is cooled with three separate packaged window air conditioners. A natural gas fired, packaged engine generator is located outdoors behind the building to provide emergency power during a utility outage event.

An energy audit of the building was conducted in 2009 as part of the New Jersey Clean Energy Local Government Energy Audit Program. Energy Conservation Measures (ECM) were recommended for lighting retrofits, heater upgrades and boiler upgrades. The ECMs have not been implemented to date.

<u>Police Headquarters</u> [5]

The Police Headquarters' main function is to administer police activities to protect the community of Hoboken and provide emergency medical services when necessary. The main building includes the police department first response staff and the second floor includes the Hoboken police museum. The building is located on Hudson Street, above the flood plain. The building is 25,200 sqft and is occupied 24 hours per day and 7 days per week. The Police Headquarter includes offices, processing room, holding cells, inspectoral services, dispatch communications, locker rooms and a classroom. The building is classified as a FEMA Category IV essential facility. The police department is vital to the proposed microgrid because it will be required to be operational during an emergency utility outage event to administer police services.

Electricity is provided to the facility from PSE&G's network service and enters the building underground at 120/208V. The building consumes approximately 47.1 kW of power on average and peaks at approximately 206 kW. The utility meter and entrance breaker is located in the basement. The building includes a 150 kW packaged natural gas generator installed at the roof. It is heated by two natural gas fired hot water boilers located in the basement. Two split system rooftop units provide cooling to the building.

An energy audit of the building was conducted in 2009 as part of the New Jersey Clean Energy Local Government Energy Audit Program. Energy Conservation Measures (ECM) were recommended for lighting retrofits, high efficiency rooftop units, high efficiency split ac units, boiler upgrades and water heater upgrades. The ECMs have not been implemented to date.

Garage B [24]

Parking Garage B provides public parking for the City of Hoboken. The structure includes 5 floors of parking spaces. The building is located on the corner of Second Street and Hudson Street on the south end of the city, above the flood plain. The structure is 224,100 sqft and is operational 24 hours per day, 7 days per week. The building does not have a FEMA classification. Parking Garage B is important to be included in the microgrid because city parking facilities are vital for the community to function normally. The garage lighting, elevators, gates and office require power to keep the facility functional.

Electricity is provided to the facility through Washington Street's network feeder, MDS4004 service and enters the building at 120/208 V. The building consumes approximately 49.1 kW of power on average and peaks at approximately 106 kW. The utility meter and breakers are located in the building's lower level of the building near the north east side of the building in a utility closet. The building is an open air parking deck with no heating or cooling with an exception for the guard office.

An energy audit of the building was conducted in 2009 as part of the New Jersey Clean Energy Local Government Energy Audit Program. Energy Conservation Measures (ECM) were recommended for lighting retrofits throughout the garage and in the office. The ECMs have not been implemented to date.

Garage D [25]

Parking Garage D provides public parking for the City of Hoboken. The structure includes 5 levels of parking areas. The building is located on Hudson Street near the south end of the city. The building is partially in the flood plain. The building is 198,000 sq. ft. and operational 24 hours per day, 7 days per week. The building does not have a FEMA classification. Parking Garage D is important to be included in the microgrid because city parking facilities are vital for the community to function normally. The garage lighting, elevators, gates and office require power to keep the facility functional.

Electricity is provided to the facility through Washington Street's network feeder, MDS4007 service and enters the building at 120/208 V. The building consumes approximately 38 kW of power on average and peaks at approximately 94 kW. The utility meter and breakers are located on the lower level at the north east side of the building in a utility closet. The building is an open air parking deck with no heating or cooling with an exception for the guard office.

An energy audit of the building was conducted in 2009 as part of the New Jersey Clean Energy Local Government Energy Audit Program. Energy Conservation Measures (ECM) were recommended for lighting retrofits throughout the garage and in the office. The ECMs have not been implemented to date.

Garage G [26]

Parking Garage G provides public parking for the City of Hoboken. The structure includes 5 floors of parking areas. The building is located on the corner of Third Street and Hudson Street on the south end of the city, above the flood plain. The building is 178,500 sq. ft. and operational 24 hours per day, 7 days per week. The building does not have a FEMA classification. Parking Garage D is important to be included in the microgrid because city parking facilities are vital for the community to function normally. The garage lighting, elevators, gates and office require power to keep the facility functional.

Electricity is provided to the facility through Washington Street's network feeder, MDS4010 service and enters the building at 120/208 V. The building consumes approximately 29.1 kW of power on average and peaks at approximately 58 kW. The utility meter and breakers are located in the building's lower level at the north east side in a utility closet. The building is an open air parking deck with no heating or cooling with exception to the guard office.

An energy audit of the building was conducted in 2009 as part of the New Jersey Clean Energy Local Government Energy Audit Program. Energy Conservation Measures (ECM) were recommended for lighting retrofits throughout the garage and in the office. The ECMs have not been implemented to date.

B. PUBLICLY OWNED ENTITIES

There are several other publicly owned entities within the city that are not under the jurisdiction of the Hoboken municipality. A number of these facilities are proposed to be included in the microgrid based on the essential services they provide to the community.

North Hudson Sewerage Authority

North Hudson Sewerage Authority provides sewer services to the City of Hoboken. A treatment facility is located at the northern section of Hoboken and is at an elevation higher than sections of Hoboken's underground sewer system. Sewage at system low points is required to be pumped to the treatment facility. Additionally, the city's low elevation compared to the Hudson River's high tides creates challenges for North Hudson Sewerage Authority during severe rainfall events. The city becomes highly vulnerable to coastal flooding because storm water cannot discharge to the Hudson River when water levels rise above the outlet elevations. During high water conditions, storm water is required to be pumped to the treatment facility similar to the sewage that is discharged to low elevations. There are three pump stations along the Hudson River that provide pumping services for both the sewer and storm water systems.

5th Street Pump Station [8]

The three sewer pumps located at the 5th Street Pump Station are required to operate full time to pump sewage to the North Hudson Treatment Facility. The pump station is a 3 story building located on River Street in close proximity to the Hudson River above the flood plain. The building is approximately 1,400 sqft and is operational 24 hours per day, 7 days per week. The building is classified as a FEMA Category IV essential facility.

The building is fed from a PSE&G radial feed on the second level coming into the building, the electrical equipment is on the first floor. The building has a 335 kW diesel generator on a concrete slab outside of the building which is below the flood plain. The pumping system is underground in the street. The pumping station is located on River Street on the north eastern end of the city and is approximately 1,400 sqft. The building is operational 24 hours 7 days a week. The building is classified as a FEMA Category IV essential facility. The 5th street pumping station is an important part of the microgrid because due to its low elevation, severe rainfall and high tides, the city has problems with flooding. This combination prevents storm water from draining through the sewers and outfall pipes into the Hudson. With no way out storm water fills the sewer lines and backs on to the streets. Interconnecting the microgrid to this system will provide redundancy to the existing fuel oil generator and will allow the existing generator to shutdown during an emergency to conserve fuel oil.

Electricity is provided to the facility from PSE&G's service and enters the building at 277/480 V system. The pump station is fed from a 300 kVA transformer on HOE8032, a radial feeder. PSE&G feed comes in from the second floor to a step down transformer to breaker which is connected to a 335 kW diesel generator. The building consumes approximately 68.9 kW of power on average and peaks at approximately 164 kW. The utility meter and breakers are located in the building's lower level of the building. The pumps are located in the street and the generator is located next to the building.

<u>Pump station 11th Street (H5) [9]:</u>

The pump station's main function is to alleviate flooding in northwest Hoboken between 9th Street and 13th street. The pumping station has a pumping capacity of 80 million gallons per day. Three sanitary pumps operate at all times to pump sewer water to the treatment facility. Two wet weather pumps only operate during flood conditions. The building includes a 725 kW natural gas generator which is connected to pumps in the middle of 11th street, above the flood plain. The pumping system is underground in the street. The pumping station is located on 11th street on the northern end of the city. The building was constructed in 2016. It is 3600 sqft and operates 24 hours 7 days a week. The building is classified as a FEMA Category IV essential facility. The 11th street pumping station is an important part of the microgrid because due to its low elevation, severe rainfall and high tides, the city can flood causing the sewage to back up. The pumping stations pump the excess water out. The microgrid will provide redundant power to the system during an emergency to provide backup to the critical pumps.

Electricity is provided to the facility from PSE&G's service and enters the building at 120/208 V system. The pump station is fed from a 50 kVA transformer on HDS4004, a 4 kV network feeder. PSE&G feed comes in from the second floor to a step down transformer to breaker which is connected to the 725 kW natural gas generator. The building consumes approximately 6.7 kW of power on average and peaks at approximately 90kW The utility meter and breakers are located in the building's lower level of the building. The pumps are located in the street and the generator is located next to the building.

<u>Pump station H1 [10]:</u>

The pump station's main function is designed to alleviate flooding in the south end of Hoboken. The pumps only operate during flood conditions. The building includes a 750 kW diesel generator which is connected to pumps in the middle of the street. The pumping station has a pumping capacity of 84 million gallons per day. The pumping system is underground in the street. The pumping station is located on southern part of the city and was constructed in 2012. It is operational 24 hours 7 days a week. The building is approximately 2040 sqft and is classified as a FEMA Category IV essential facility. The pumping station is an important part of the microgrid because due to its low elevation, severe rainfall and high tides, the city can flood causing the sewage to back up. The pumping stations pump the excess water out. This pumping station also provides protection of the PSE&G substation that powers Hoboken neighborhoods as far east as the Hudson River.

Electricity is provided to the facility from PSE&G's service and enters the building at 277/480 V system. The pump station is fed from a 750 kVA transformer on HOE8047, a 13 kV radial feeder. PSE&G feed comes in from the second floor to a step down transformer to breaker which is connected to the 750 kW diesel generator that will switch on and turn the pumps in an emergency situation. The pumps are located in the street and are submerged underground. The building consumes approximately 44.9 kW of power on average and peaks at approximately 306kW. The utility meter and breakers are located in the building's lower level of the building. An energy audit of the building has not been conducted to recommend any Energy Conservation Measures (ECM).

Hoboken Housing Authority

The Hoboken Housing Authority provides housing assistance to low income residents through the federal Housing and Urban Development program, HUD. The Hoboken Housing Authority operates several different communities in Hoboken such as, Andrew Jackson Gardens, Harrison Gardens, Christopher Columbus, Fox Hill Gardens, and Adams and Monroe Gardens. The buildings were constructed in the 1960s. Several facilities include several clusters of buildings that have separate utility electrical feeds and low pressure steam heating systems. See Appendix B for a detailed description of each building. The following Hoboken Housing Authority owned facilities are included in the proposed Microgrid based on their location and the essential service they provide to the city. There are other Hoboken Housing Authority facilities; the following are the ones selected for the microgrid.

Andrew Jackson Gardens [31-35]:

Andrew Jackson Garden's main function is to provide low income housing to the city of Hoboken. Andrew Jackson Gardens is located in the south west part of the city, on the western part of the Hoboken Housing Authority's main campus along Harrison, Marshall and Jackson streets. The complex is located below the flood plain. Andrew Jackson Gardens consists of two primary building types, a three story garden apartments and seven story cross plan high rises. There are a total of 598 units consisting of 11 three story garden style apartments with 210 dwelling units and eight seven story high rises with 338 units. It is 512,750 square feet and is open 24 hours 7 days a week. The building is classified as a FEMA category III essential facility. Andrew Jackson Gardens is important to the microgrid because the majority of the residents do not have the economical means to evacuate in an emergency situation.

Electricity is provided to each building, 31 to 36, from PSE&G's 13 kV radial feeders. The buildings consume approximately 41 kW of power on average and peaks during the cooling season at approximately 88 kW. The utility meter and breakers are located in the building's basement, within the flood plain; these services will be moved to the first floor. Each cluster of buildings contains two redundant natural gas fired, low pressure firetube boilers to provide steam to heat the facilities. The buildings do not include central air conditioning; however, residents are allowed to install window units. Select buildings have emergency gas generators, which are sized for life safety purposes.

Harrison Gardens [36-39]:

Harrison Garden's main function is to provide low income housing to the city of Hoboken. Harrison Gardens is located on the south west part of Hoboken, in the southeastern part of the Hoboken Housing Authority's main campus, in the middle of Harrison, Marshall and Jackson streets. The housing complex is located below the flood plain. Harrison Gardens was constructed in 1959 and consists of two ten story H plan high rise buildings, subdivided into two additional buildings. There are a total of 208 units. It is 192,700 square feet and is open 24 hours 7 days a week. The building is classified as a FEMA category III essential facility. Harrison Gardens is important to the microgrid because the majority of the residents do not have the economical means to evacuate in an emergency situation.

Electric is provided to each building, 36 to39, the facility from PSE&G's 13 kV radial feeders. The buildings consume approximately 90 kW of power on average and peaks during the cooling season at approximately 187 kW. The utility meter and breakers are located in the building's basement, within the flood plain; these services will be moved to the first floor. The northern tower contains two redundant natural gas fired, low pressure firetube boilers to provide steam to heat the facilities. The buildings do not include central air conditioning; however, residents are allowed to install window units. Select buildings have emergency gas generators, which are sized for life safety purposes.

Fox Hill Gardens [40]:

Fox Hill Garden's main function is to provide low income housing to the city of Hoboken. Fox Hill Gardens is located on the north side of the city at 311 13th street. The building is located below the flood plain. The building is a ten story high. There are a total of 200 units. It is 243,00 square feet and is open 24 hours 7 days a week. The building is classified as a FEMA category III essential facility. Fox Hill Gardens is important to the microgrid because the majority of the residents do not have the economical means to evacuate in an emergency situation.

Electric is provided to the building, 40, from PSE&G's 13 kV radial feeders. The building consumes approximately 238 kW of power on average and peaks approximately 595 kW. The utility meter and breakers are located in the building's basement, within the flood plain; these services will be moved to the first floor. The basement contains two redundant natural gas fired, low pressure firetube boilers to provide steam to heat the facilities. The buildings do not include central air conditioning; however, residents are allowed to install window units. Select buildings have emergency gas generators, which are sized for life safety purposes.

C. NOT FOR PROFIT ENTITIES

YMCA [51]:

The YMCA'S main function is to provide housing space for men on the north side and will be undergoing renovations on the south building to make a community center. It is located on the northern end of Washington street above the flood plain.. The building includes housing, showers, living quarters and staff offices on the north side. The south building currently is empty and will be undergoing renovations to include a community center with a pool and recreational space. It is 75,000 sqft and is open 24 hours 7 days a week. The building is classified as a FEMA Category III essential facility. The YMCA is important to the microgrid because it provides low income housing to 91 men. The men who live in the YMCA do not have the finances to evacuate the city in an emergency situation. The community center which is being renovated on the south building will be able to be a shelter in place for citizens of Hoboken city.

Electric is provided to the facility from PSE&G's Washington Street network service and enters the building at 120/208V. The building consumes approximately 60 kW of power on average and peaks at approximately 120 kW, based on the transformer capacity. Interval data was not provided at the time of this report. PSE&G feed comes in from the street and the electrical room is about four feet below grade in the basement. The electrical room has room for the ATS and transformer for the microgrid.

Hoboken Homeless Shelter [15]:

The Hoboken homeless shelter provides shelter to 50 people nightly, 500 meals daily, host 1,000 showers weekly, and provide such support services. The building includes a kitchen area, offices for staff, restaurant grade kitchen, two showers, housing for men and women and a 25 kW gas generator in the bell tower. The homeless shelter is located on the southern side of the city on Bloomfield Street, below the flood plain. It is 8,250 sq. ft and is open 9am to 9pm, 7 days a week. The building is classified as a FEMA Category III essential facility. The homeless shelter is an important part of the microgrid because it provides shelter in place, meals and showers for the city in an emergency situation.

Electric is provided to the facility from PSE&G's radial HOE8047 service and enters the building at 120/208V. The building consumes approximately 18 kW of power on average and peaks approximately 36 kW, based on the transformer capacity. Interval data was not provided at the time of this report. The utility meter and breakers are located in the building's lower level right near the back entrance. The shelter has a 25 kW generator in the bell tower and PSE&G will be updating the gas service. It is anticipated this will be completed before the proposed Microgrid enters a future construction phase.

St. Peter and Paul Church [17]:

St. Peter and Paul Church provide a place to worship and a spiritual home for the community of Hoboken. The building includes an area for worship, offices for the church staff and a community center room for recreational purposes. The church is located on Hudson Street, above the flood plain. The building was constructed in 1889. It is 29,400 sqft and is open from 7:30 to 5 pm Monday and Friday, 7:30 am to 7 pm Tuesday to Thursday and Saturday, and 7:30 to 1pm Sunday. The building is classified as a FEMA Category III essential facility. The church is an important part of the microgrid because it provides shelter in place and, meals for the city in an emergency situation.

Electric is provided to the facility from PSE&G's Washington Street service and enters the building on the north east side of the building, but the building is upgrading the electrical service this summer. Currently they have a meter that is fed from the north east side of the building. This service is being upgraded to a different feeder sometime over the summer. It is anticipated this will be completed before the proposed Microgrid enters a future construction phase.

St. Matthews Church [16]:

St. Matthews Church is located at 57 8th street and is above the flood plain. The building was renovated in 2007 and is 20,200 sqft. The main purpose of the church is to provide a community center and a place of worship for the community. Currently the church does not want to be involved in the microgrid.

D. FOR PROFIT ENTITIES

Hoboken University Medical Center [6]:

Hoboken University medical center provides medical services to the community of Hoboken. It has both operating rooms and labor and delivery rooms. The hospital is located on Willow Ave on the south east side of the city, below the flood plain. The building was constructed in 1863 as St. Mary's hospital and operated under that name until 2007. It is 510,000 sqft and is open 24 hours a day 7 days a week. The hospital is an important part of the microgrid because its main function is to provide medical and emergency services and cannot shutdown for any reason. Capacity from Microgrid generation assets will provide power to supplement the existing hospital generators to meet electric needs above emergency loads. This will allow the hospital to remain open and operating during an outage, helping the community. Interconnecting the microgrid to the hospital will also provide redundancy to the existing fuel oil generators and will allow the existing generator to shutdown during an emergency to conserve fuel oil.

Electric is provided to the facility from PSE&G radial feeder and enters the building at 120/208V through 1500 kVA transformer. There are plans to upgrade the hospital service to 13 kV. The building consumes approximately 821 kW of power on average and peaks during the cooling season at approximately 1252 kW. The main electrical service comes in through the first floor and then splits to a south side metering service, at 480 V 600 kW, and a north side metering service. There are existing two emergency diesel generators rated at 600 kW and 350 kW. The hospital is heated with two dual fuel, 500 BHP fire tube boilers that produce 95 psig steam. Steam is distributed throughout the hospital. Two main mechanical rooms convert steam to heating hot water to heat hospital air handlers and domestic hot water. The operating rooms are cooled via a 400 ton natural gas reciprocating engine driven chiller. The remaining areas of the hospital is cooled using a 700 ton motor driven chiller.

Kings Grocery store (North) [20]:

Kings Grocery Store provides grocery services to the community of Hoboken. The building has a freezer section, grocery section, deli, and bakery. It is 9,000 sqft and open 7 am to 10 pm 7 days a week. The grocery store is located on the north side of the city and is below the flood plain. The building is classified as a FEMA Category NA essential facility. Kings grocery is an important part of the microgrid because it will be used to provide groceries and other essential needs. This will be essential for the Hoboken population to better function during a prolonged outage or flood.

Electric is provided to the facility from PSE&G's radial 13 kV, HOE8041, service and enters the building at 120/208V. The building is estimated to consume approximately 180 kW of power on average and peaks at approximately 360kW. Interval electric data was not provided at the time of the report and has been estimated. The utility meter and breakers are located next to the grocery store front in the buildings main electrical room. The utilities main transformer is located in the vault in the building at 1500 kVA.

Kings Grocery Store (South) [19]:

Kings Grocery Store provides grocery services to the community of Hoboken. The building has a freezer section, grocery section, deli, and bakery. It is 12,600 sqft and open 7 am to 10 pm 7 days a week. The building is located on the south side of the city and is below the flood plain. The building is classified as a FEMA Category NA essential facility. Kings grocery is an important part of the microgrid because it will be used to provide groceries and other essential needs. This will be essential for the Hoboken population to better function during a prolonged outage or flood.

Electric is provided to the facility from PSE&G's network, HOE8034, service and enters the building at 277/2480V. The building consumes approximately 180kW of power on average and peaks at approximately 360 kW. Interval electric data was not provided at the time of the report and has been estimated. There are two 1500 kVA transformers in vaults that feed the grocery store and the adjacent properties within the building. The grocery store has two voltage feeds coming in, a 480 V line feeding a 1200 amp breaker and a 208/120 volt line feeding an 800 amp breaker.

Columbian Towers [30]:

Columbian towers provide low income, affordable senior care options for elderly adults in Hoboken, NJ. The building has a main lobby area, staff offices, 135 apartments and a backup Diesel generator of 180 kW. It is 180,000 sqft and open 24 hours, 7 days a week. Columbian Towers is located on the south side of the city and is below the flood plain. The building is not classified as a FEMA essential facility. Columbian Towers is an important part of the microgrid because it provides low income housing for seniors who may not be able to leave the city in an emergency situation.

Electric is provided to the facility from PSE&G's 4kV network feeder, MAS400, service and enters the building at 120/208V. The building is fed from a 500 kVa transformer. The main electrical meter is located on the first floor towards the south side of the building. The building consumes approximately 60 kW of power on average and peaks at approximately 120 kW. Interval electric data was not provided at the time of the report and has been estimated.

CVS [54]:

CVS provides convenience products and pharmacy services to Hoboken. The building has a CVS and a NYC gym. The main electrical room is in the NYC gym. CVS has pharmacy items and services. The building is located on the south side of Washington Street and is above the flood plain. The building is 10,300 sqft and is open 24 hours a day. The building is classified as a FEMA category NA essential facility. The pharmacy is an important part of the microgrid because it can provide medications and first aid to the town of Hoboken during an extended emergency situation.

Electric is provided from PSE&G's Washington network feeder, MAS4004. The main electrical meter is located in the basement of the NYC gym. It has 120/ 208 V service and a 600 amp breaker. The building consumes approximately 60 kW of power on average and peaks at approximately 120 kW. Interval electric data was not provided at the time of the report and has been estimated.

<u>Walgreens [55] :</u>

Walgreens provides convenience products and pharmacy services to Hoboken. The main Walgreens has convinces items and pharmacy services. The building is 5,700 sqft and is open 24 hours a day. The building is located on the south side of the city above the flood plain. The building is classified as a FEMA category NA essential facility. The pharmacy is an important part of the microgrid because it can provide medications and first aid to the town of Hoboken during an extended emergency situation.

Electric is provided from PSE&G's Washington network feeder, MDA4007. The main electrical meter is located in the basement of the Walgreens. It has 120/ 208 V service and a 800 amp breaker. The building consumes approximately 60kW of power on average and peaks at approximately 120 kW. Interval electric data was not provided at the time of the report and has been estimated.

2.3 TOTAL SYSTEM UTILITY LOAD ANALYSIS

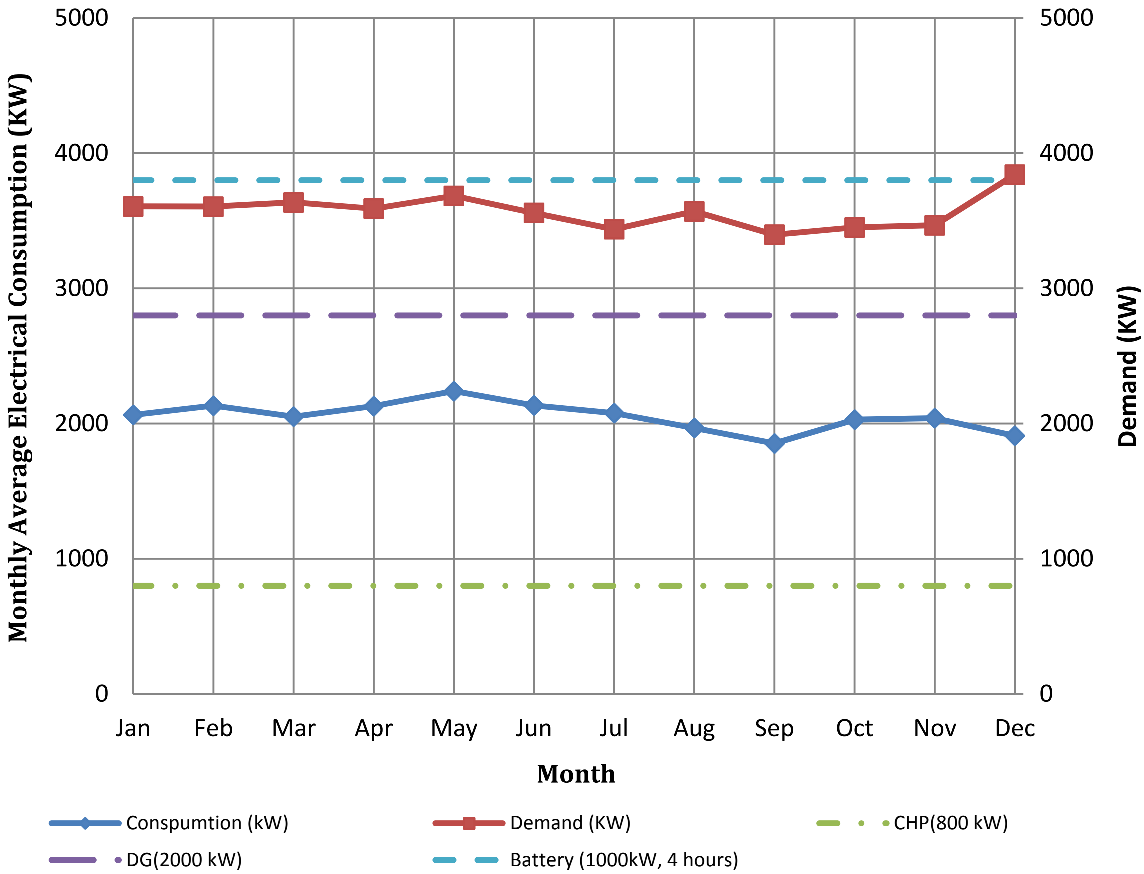
PSE&G currently provides power to each microgrid facility separately. It is the intent of this project to consolidate these services into two overall systems powering the Washington Street and Housing Authority Corridors from a single primary utility interconnection for each system. During normal operation, new microgrid distributed generation resources will offset power purchased from the utility to provide energy savings for project participants. To select the proposed capacities of the new generation resources, the total normal operating and peak loads for the two corridors have been estimated. The electric loads have been estimated based on utility interval data provided on an hourly and monthly basis. A few of the participating facilities did not provide billing data at the time of this report. The electric loads for these facilities were estimated based on 30% of the utility transformer capacity. These buildings are highlighted in the facility list located in Appendix B.

Information on billing data for individual facilities can be found in Appendix C. This includes natural gas and electric monthly utility usage and costs illustrated in both graph and table formats.

A. Washington Street Corridor Electrical Load

The results of the facility aggregate electric load are illustrated in the graph below for the Washington Street corridor. The aggregate capacities of the new microgrid generation resources are compared to the overall microgrid system monthly demand values.

**Graph 1: Hoboken Washington Street Corridor
Total Electrical Summary**



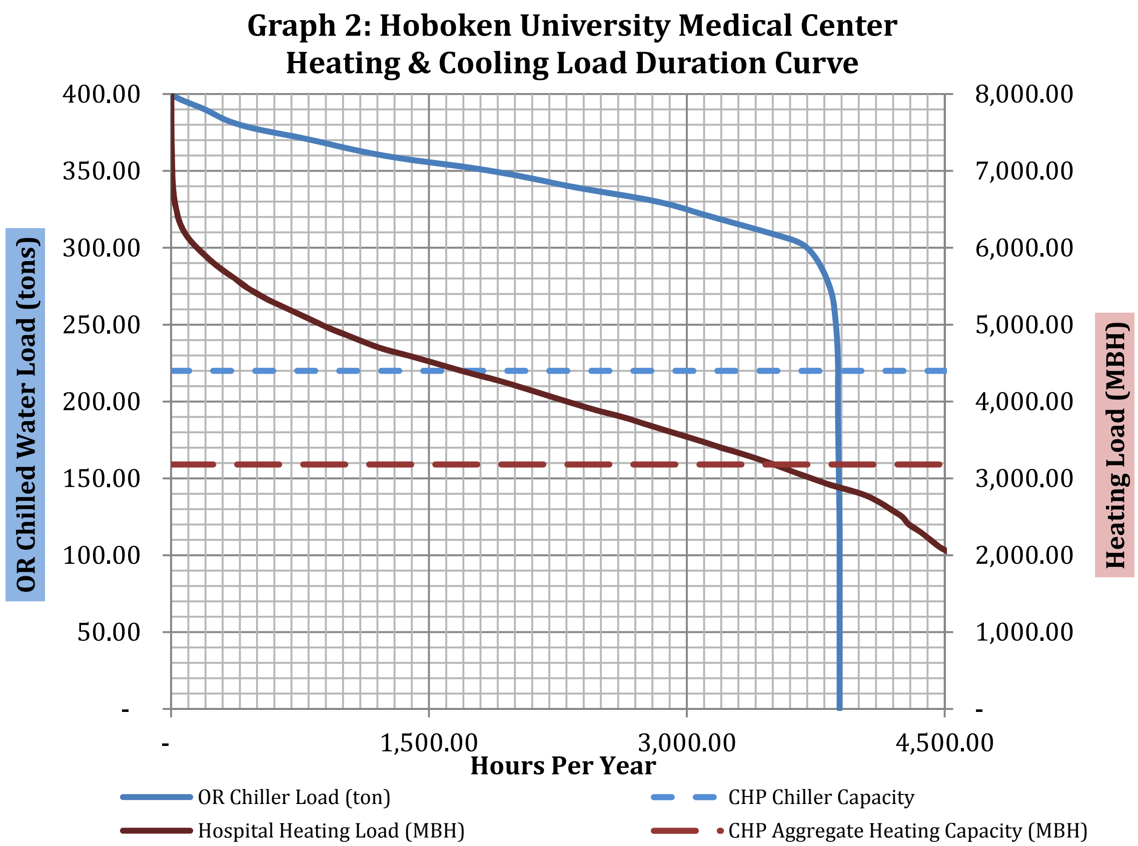
The Washington Street CHP generator size was selected based on the available thermal load of the hospital such that the system can operate for the entire year without having to reduce capacity, refer to Graph 2. The Washington Street simple cycle packaged engine generator capacity was selected with the goal of maximizing the utility savings from the demand management strategy by being capable of offsetting system peak demand when operating in parallel with the other generation resources. The Solar PV capacity is not shown as this resource is dependent on weather conditions. The battery capacity is based on discharging 4 hours of stored solar power. Demand management savings for the battery system has been reduced by 50% in the pro-forma due to the total system capacity being above the system demand. The total capacity of the generation resources is above the total system load and is expected to be capable of powering the entire system during a utility outage. In the event that a utility outage occurs during a period when the system load is at its peak and the Solar PV and battery system is not capable of operating, existing diesel and natural gas generators throughout the system will be dispatched as needed.

B. Washington Street Corridor Thermal Load

The CHP generator located at the Hoboken University Medical Center was selected based on the facility's available annual thermal load. The hospital is the only facility considered for

CHP because it is the only site with large enough thermal demand throughout the year to provide enough energy savings to offset the system capital cost. A district energy system was not considered to interconnect the project partners heating and cooling systems because of the high cost. The participating facilities are not in close proximity to one another and the installation of distribution piping within the dense urban area would be too costly to justify a larger CHP system. Additionally, a significant number of facilities use split systems for cooling and direct fired units for heating which would require a complete retrofit of the building HVAC systems, further increasing the project cost.

The Hoboken University Medical Center heating and cooling load duration curves below represent the number of total hours per year the campus' thermal demand is greater than a specific value, irrespective of the chronological time that the load occurs. The heating and cooling load curves represent the values provided by the utility for the year 2017. Overlaid on the chart is the waste heat recovery chiller and heating capacity of the proposed CHP system, represented by the dashed line. The area beneath the CHP chiller and heating capacity line represents the hours per year that the thermal load will be offset by the CHP prime mover. The area between the hospital load curves and the waste heat recovery capacity represents the hours per year that existing boiler capacity will be used to meet the thermal load.



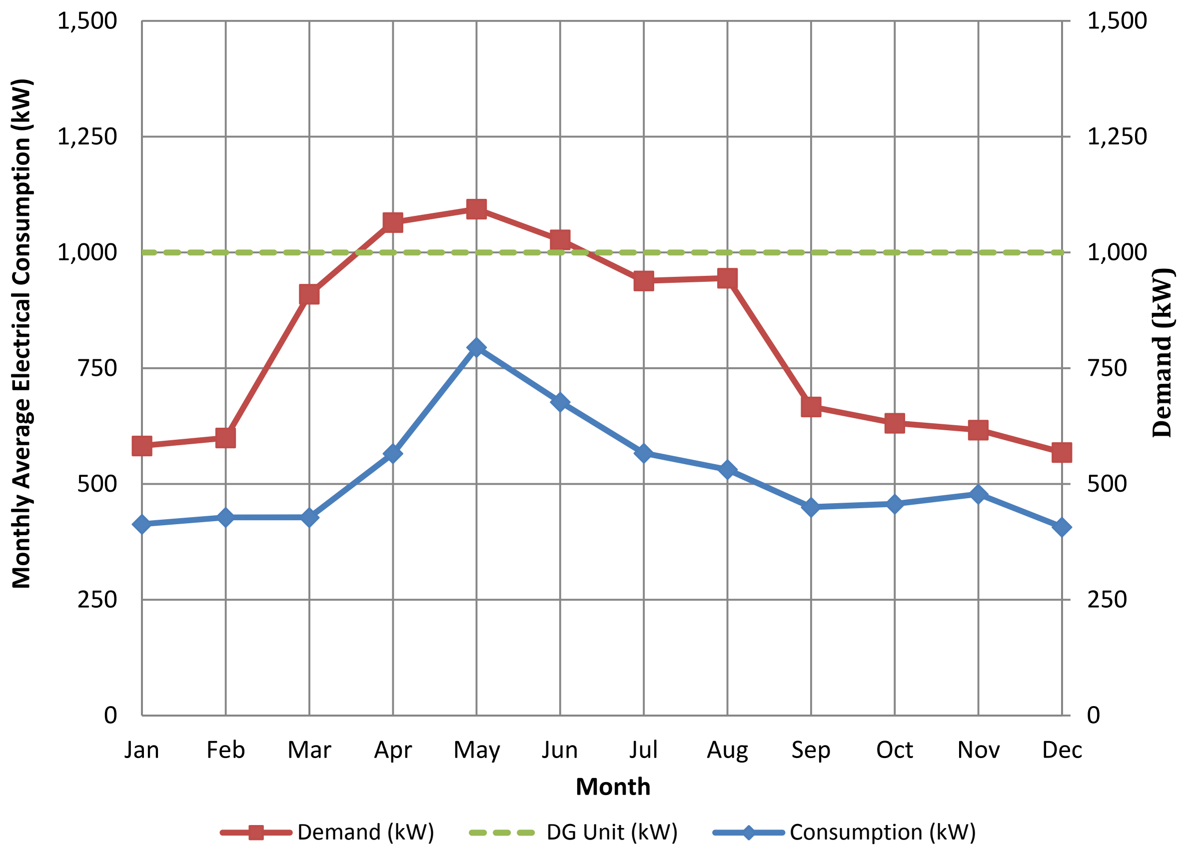
The load duration curve above illustrates the facility's thermal load is generally higher than the proposed CHP's waste heat capacity. The facility's thermal load will only fall below the limit that will require the prime mover to reject heat will only occur for approximately 11%

of the year. Maximizing the hours the system completely utilizes waste heat will maximize the CHP system energy efficiency.

C. Hoboken Housing Authority Corridor Electrical Load

The results of the facility aggregate electric load are illustrated in the graph below for the Washington Street corridor. The aggregate capacities of the new microgrid generation resources are compared to the overall microgrid system monthly demand values.

Graph 3: Housing Authority Corridor Total Electrical Summary



The Hoboken Housing Authority simple cycle packaged engine generator capacity was selected with the goal of maximizing the utility savings from the demand management strategy by being capable of offsetting system peak demand. The generator has the capacity to meet the aggregate electrical load with exception only during peak conditions. In the event that a utility outage occurs during a period when the system load is at its peak, the few installed natural gas generators at the facility will be dispatched to meet the load.

The packaged engine generator is the only new generation asset for this system as there is minimal space for Solar and the buildings do not have a central thermal system to utilize CHP. The energy savings from CHP would not offset the cost of installing a central steam distribution piping throughout the housing complex given the steam system only operates during the heating season. Absorption chilling is not an option because select Housing Authority apartments are cooled with window air conditioning units. The facility does not have a central cooling system.

2.4 PROJECT LOCATION

The city of Hoboken has a total area of approximately 2 square miles, including 1.25 square miles of land and 0.75 square miles of water. Hoboken is located on the west bank of the Hudson River between Union City and Weehawken to the north and Jersey City to the south and west. Hoboken has 48 streets laid out in a grid pattern.

There are two main corridors where the microgrid is proposed to be located. The first will be the Washington Street corridor which will include all of the buildings on and near Washington Street. The second corridor will be the Hoboken Housing Authority Corridor and will be located on the south west end of the city. This corridor will include Housing Authority complexes Harrison and Andrew Jackson Gardens. Table 1 provides the address and microgrid identification number for each building considered for the microgrid system. The Figure 1 site plan illustrates the locations of the buildings. Additional site plan drawings and single line diagrams are included in Appendix A.

Table 1: Critical facilities included in the Hoboken Microgrid

Building #	Building Type	Location
1	Fire Engine Co 3	1313 Washington Street
5	Police HQ	106 Hudson Street
6	Hoboken University Medical Center	308 Willow Avenue
8	Pump Station 5th Street	500 River Road
9	Pump Station 11th Street	83 11th Street
10	Pump Station H1	99 Observer Highway
12	Hoboken City Hall	94 Washington Street
15	Hoboken Homeless Shelter	300 Bloomfield
16	St. Matthew's Church	57 8th Street
17	St. Peter and Paul Church	404 Hudson Street
19	Grocery – Kings	325 River Street
20	Grocery – Kings	1212 Shipyard Lane
24	Garage B	28 2nd Street
25	Garage D	215 Hudson Street
26	Garage G	315 Hudson Street
30	Columbian Towers	76 Bloomfield Street
51	YMCA	1301 Washington Street
54	CVS	59 Washington Street
55	Walgreens	101 Washington Street
31-35	Andrew Jackson Gardens	655 6th Street
36-39	Harrison Gardens	321 Harrison Street
40	Fox Hill Gardens	311 13th Street

Figure 1: site plan

2.4 OWNERSHIP/BUSINESS MODEL

The ownership of the proposed microgrid would ideally involve or include the regulated public utility PSE&G. At a minimum, there will need to be close coordination between the microgrid and the electric distribution company. The core asset for the distribution of power within the microgrid is an underground feeder that will be located in an existing duct bank beneath Washington Street. Due to the network system design that PSE&G has developed in Hoboken there is no practical way to utilize existing utility distribution assets to serve a limited group of microgrid participants. In addition, simply utilizing the new Washington Street feeder and disconnecting facilities from PSE&G's network service would actually reduce the reliability of the electric supply by replacing networked feeders with multiple transformers and assets with a simple direct radial feeder.

The proposed CHP unit at Hoboken University Medical Center is expected to be a private owner either the hospital or a qualified third party. The behind the meter savings should be sufficient to justify this option. It is also anticipated that the hospital will qualify for a CEP Grant and if this is with a third party the third party would be eligible for a 10% Investment Tax Credit and accelerated depreciation.

The DG equipment including solar, packaged reciprocating engine and storage are expected to also be owned through a private developer. Several attractive ownership models based on cooperative ownership can be utilized. In particular private for profit entity is beneficial for the solar and storage assets which are eligible for a 30% Investment Tax Credit

Depending on the approved regulatory treatment there is also a possibility that the electric utility PSE&G could own and operate the generating assets and distribution assets. One of the potential development models considered was for a single DG natural gas generation asset be developed which would be designed to support the entire microgrid load in the event of a power failure. This was not pursued as a best case since there are currently several natural gas DG and or emergency generators already installed in some of the facilities. The least cost approach of incorporating these along with new DG and CHP assets minimizes the upfront costs.

The microgrid controller and monitoring software will be utilized to dispatch and collect data on the operation of DG assets as well as metering data at each facility within the microgrid. It will also be necessary to engage the services of a PJM certified Curtailable Service Provider (CSP) to be able to receive payments for ancillary services including frequency regulation and demand response generation. This entity will also be responsible for dispatching behind the meter DG to manage the PJM Capacity and transmission costs where DG is being utilized to reduce these costs. These are all being organized as behind the meter services so a shared savings approach is being considered as the best approach to distributing costs and savings. Each participant will have a contractual agreement with the microgrid owner or the collaborative which owns the microgrid defining responsibilities costs and benefits. Each participant will be billed based on electrical consumption sub-metered at each building.

At this time the privately owned for profit facilities that are being considered to be included in the microgrid for public needs are not showing interest in investing in this asset. As a initial measure we are proposing that a transfer switch be installed that a public agent could use to transfer power to these facilities in the event of a grid power outage so they can provide essential services. This aspect will need to be further vetted as to under what conditions this would be allowed and if used what the compensation would be for service.

The primary facility owner and participant in the microgrid is the City of Hoboken. As such we expect that the city will retain or contract out to a private entity specific management aspects under a long term energy services agreement. The city is subject to the requirements of Local Public Contracts Law. Some of the aspects of services from the microgrid are similar to the current Energy Savings Improvement Program (ESIP) public law and may be further advanced by recently proposed legislation regarding Public Private Partnerships. (P3)

3.0 PROPOSED MICROGRID SYSTEM DESCRIPTION

The proposed Microgrid is comprised of serval sub-systems required to operate in unison to meet the overall needs of the Microgrid. The Microgrid's needs will be subject to change based on varying internal and external conditions that will be monitored such that the all components within the system can be automatically adjusted to meet the microgrid's requirements. The three major sub-systems that are further described in this section are as follows:

i. Power Distribution System
ii. Distributed Generation Resources
iii. Distributed Automation Control System

During normal operations the system will be controlled to prioritize power from the generation resources and the electric utility to the various facilities based on a financial model that provides the greatest economic benefit given the current conditions. During a utility power failure, the system priorities will change to providing power first to the facilities identified as most critical. As generation resources are brought online and available to produce power to compensate for the outage, power will be distributed to all facilities within the system. Generation resources will be prioritized based on their ability to service critical loads and the quantity of available fuel.

3.1 POWER DISTRIBUTION SYSTEM

A completely new power distribution system will be constructed to service the new facilities included in the microgrid system. Due to the configuration of the existing electrical utility system with several services being fed from the same PSE&G network, it is not feasible to energize the existing system with new generation assets while only supplying power to the select microgrid participants. A new dedicated power distribution system is required to provide service only to the microgrid participants.

A. EXISTING PSE&G SYSTEM

The electric utility, PSE&G, currently supplies power to the Hoboken community from three existing 69 kV substations identified as Marshall Street, Madison Street and 16th Street. The three existing substation locations are identified in the Appendix A Site Plan Drawings. PSE&G is currently upgrading the existing substations as part of the utility's Energy Strong program to prevent future damage from flooding and increase the reliability of the system. The 16th Street Substation at the north end of the city is currently being upgraded and raised above the floodplain. The Madison Street substation is currently being completely replaced and installed at a higher elevation to protect against flooding. The services from the existing Marshall Street Substation will be relocated to the new Madison Street location and the Marshall Street Substation will be decommissioned once the project is completed.

The distribution voltage is reduced to 13.8 kV and 4.16kV at the existing PSE&G substations and is distributed throughout the City of Hoboken via pole mounted, overhead cables. Power is provided to individual building services by either a network or radial feed. The network feeds are served by a low voltage distribution system encompassing multiple transforms that step down the distribution power from either 13.8 kV or 4.16kV to 120/208 V. The utility owned transformers are located in underground vaults. The network system transformers are redundant and if one fails, it can be isolated with the remainder of the transformers servicing the network. Network feeds are primarily located beneath Washington Street and feed buildings underground. Radial feeds have dedicated transformers that step down distribution power from either 13.8 kV or 4.16 kV to 120/208 V. There are select large users that are served with higher voltage secondary power at 480V or 4.16 kV. This is specific to pump stations and the Hoboken University Medical Center. The radial feed transformers are pole mounted and the secondary service is routed down the pole and fed underground to the building. The primary and secondary supply voltage as well as the utility feeder type are listed for each proposed facility in the Microgrid Facility Summary Table located in Appendix B.

B. NEW MICROGRID POWER DISTRIBUTION SYSTEM

A new power distribution system will provide electricity to the proposed facilities to be included in the microgrid system. Power will be distributed throughout the microgrid system at 13.8 kV. Selection of 13.8kV voltage is due to smaller size of cable required for 13.8kV voltage, reliability of system. A majority of the microgrid electrical distribution is intended to be installed underground within concrete encased duct banks. Select areas will require overhead, pole mounted cables based on constructability issues. Power will be provided to the microgrid systems from a new utility service from the existing PSE&G substations. New microgrid distributed generation resources will provide supplementary power in parallel to the utility. The microgrid distribution system will be designed to prevent reverse powering of utility with the system's generators. When the utility feed is lost, the system will be designed for the distributed generation resources to power the system independently.

New dedicated transformers at each facility will step down power from 13.8 kV to the facility's existing utility service voltage. A new sub-meter will be installed on the secondary side of the transformer to collect individual facility usage data to be communicated to the microgrid controller for billing and dispatching purposes. The electrical tie-in from the new microgrid to the existing facility electrical system will occur downstream of the existing utility meter. The existing utility meter is currently being proposed to remain in service and act as a redundant feeder to each facility. An automatic transfer switch (ATS) will be located at the tie-in from the new microgrid to the existing facility electrical system. The ATS will be capable of automatically transferring facility supply power from the existing utility feeder to the microgrid system. If power from the microgrid system is lost because of an unforeseen outage, each facility will be capable of switching back to the existing feed. The ATS will be controlled by the microgrid control system. The dedicated facility transformer, sub-meter and ATS are proposed to be installed within each facility in the existing electrical rooms where the existing utility meters are located.

The proposed microgrid will consists of two separate power distribution systems based on the locations of the proposed facilities. The power distribution system along Washington Street will include the majority of the proposed facilities including all that are owned by the City of Hoboken, for profit entities and not for profit entities. An additional power distribution system is proposed at the Hoboken Housing Authority locations to serve Harrison Gardens and Andrew Jackson Gardens. This section of the housing authority's property includes a significant amount of multifamily apartment buildings that will benefit from having a microgrid resource; however, they are a significant distance from the Washington Street section. This section of the Hoboken Housing Authority has a large enough electric load to justify the installation of a separate electrical distribution system. Both systems will be included within the same control system.

Washington Street Corridor

The City of Hoboken has already spent approximately $2.5M installing a concrete encased duct bank and manhole system beneath Washington Street as part of a utility replacement project. The duct bank contains spare conduits reserved for a future microgrid project. The duct bank includes two 6" conduits for power cables and a single 4" conduit for communication cables. At every block along Washington Street, a manhole was installed that includes conduit take offs that end at the Washington Street curb on both the west and east side of the street. New conduit will be installed to extend the existing conduit beneath Washington Street to each facility included in the Washington Street Corridor. 13 kV wiring will be pulled through the installed conduit and terminated at the buildings according to the individual descriptions below. The routing of the existing and new conduit can be found in the Appendix A plan drawings.

The Washington Street Corridor will be provided with a new 13.8 kV PSE&G electrical service from the 16th Street Substation. The service will be pole mounted and will be routed overhead along 14th Street. The service will be extended down a pole and be routed underground at the 13th Street and Washington Street existing electrical manhole. This will be considered as the point of common coupling (PCC). A new utility meter will measure electrical usage for the entire Washington Street Corridor.

New generation resources will provide supplementary power to the microgrid during normal conditions. Facilities associated with publicly owned entities as well as non-profits are proposed to be regularly provided with power from the microgrid system. For profit facilities, with exception to the hospital, will remain purchasing power from their existing service. During a loss of utility power event, new and existing generation resources will be prioritized to meet the power demand requirements of the system. City emergency management officials will have the authority to switch the for profit facilities on to the microgrid system based on their determination that the continued operation of these facilities are necessary to meet the community's needs .

The Washington Street Corridor is proposed to be supported by a new packaged reciprocating engine generator CHP unit, a new simple cycle packaged engine distributed generator unit, Solar PV, battery storage as well as the existing generators located throughout the system. All new proposed generating assets will be equipped with emissions controls to enable discretionary operation.

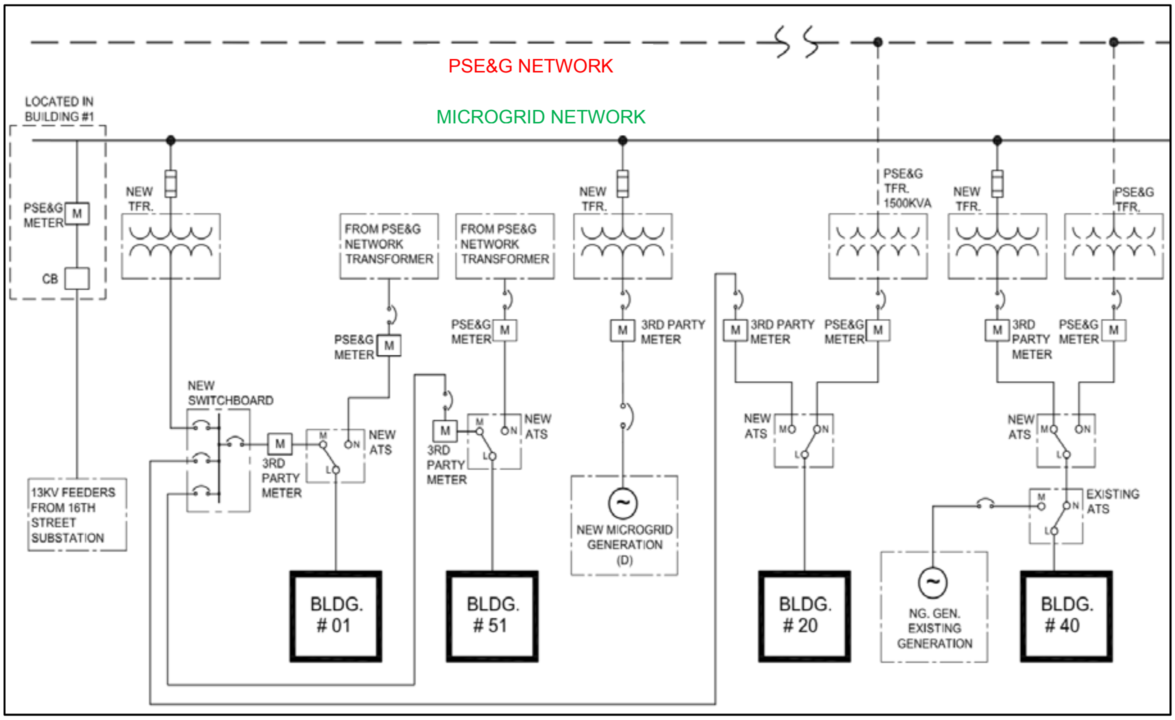


Fig. 2: Normal Operation of Microgrid along Washington Street

<u>Fire Company Engine 3, YMCA and King's Grocery:</u>

The Fire Company Engine 3 building is located adjacent to the YMCA and the King's Grocer is only a few hundred yards southwest of the buildings. The three buildings receive their existing electric service below grade from PSE&G network feeders. The Fire Company Engine 3 meter and main breaker are located in the basement of the building along Washington Street and the YMCA meter and main breaker are located in the building's south wing electrical room. To optimize the number of transformers and 13kV microgrid cable in the system, the Engine 3 building, YMCA and King's Grocery are proposed to be fed from a common switchboard. Dedicated ATS, data acquisition units and sub-meters will be located in each building. Both the Engine 3 Building and YMCA ATS's are proposed to normally receive power from the microgrid system with the existing PSE&G feeds to act as redundant power supply. The King's Grocery is proposed to normally be fed from the existing PSE&G feed. If there is a major power outage event, a city official will have the authority to switch the ATS to the microgrid system such that the grocery store can remain operational and accessible to the community.

The Engine 3 and YMCA locations are the closest to the 16th Street Substation and are recommended to house the main 13.8 kV utility breaker and meter. An electrical room will be required to contain these items as well as the switchboard. The ideal location will be in the Engine 3 building as it is city owned; however, space is limited. The equipment could fit in the building's basement, but this area could be susceptible to flooding. If the equipment cannot physically fit in the Engine 3 building, it is recommended to install within the YMCA south wing. The YMCA is currently beginning to plan renovations for the south wing and an electrical room space above the floodplain could be installed as part of the renovation.

Hoboken Housing Authority Fox Hill Gardens:

The Fox Hill Gardens multifamily apartment building is currently supplied from a PSE&G existing radial feed. To interconnect the building to the microgrid system, a new underground conduit will be installed along 12th Street from the existing Washington Street electrical manhole to the building entrance. A dedicated transformer, breaker, ATS panel and data acquisition panel will be required to be installed within the building. The ATS will be normally switched for the microgrid service to provide power. The existing PSE&G service will remain as a redundant backup feeder.

Fox Hills Garden's incoming electrical feed is currently below the FEMA 100 year floodplain. The new electrical equipment will be required to be installed a floor above the existing equipment to ensure it is not damaged during a flood event.

11st Street Pump Station:

The 11th Street Pump Station is currently supplied from a 120/208V PSE&G network feeder and has a natural gas backup generator in the event that the feed is lost during an outage event. 120/208V power feeds auxiliary equipment and a Sewerage Authority owned transformer steps up power to 480V to feed the pump VFDs. A new underground conduit will be installed from an existing electrical manhole at 11th and Washington Street to the Pump Station. A dedicated transformer will step the distribution voltage down to 120/208V to match the PSE&G network feed. A dedicated breaker, ATS panel and data acquisition panel will be installed outdoors adjacent to the existing electrical equipment. The ATS will be normally switched for the microgrid service to provide power. The existing PSE&G service will remain as a redundant backup feeder.

In the event of a city wide power outage, the microgrid controller will switch the existing emergency generator ATS to allow the unit to operate and power the local system. This will isolate the Pump Station and generator from the microgrid allowing the new microgrid generators to provide power to users without emergency generation capability. In the event that the existing Pump Station generator is not operational during an emergency, the ATS's will be positioned automatically by the microgrid controller such that the microgrid system will provide power to the pumps. This facility is crucial to be operational during emergency events as it has pumps serving both sewage and storm water systems.

St. Peter & Paul Church and Parking Garage G:

Parking Garage G and St. Peter & Paul Church are both located in close proximity to 4th Street. The parking garage existing electrical service is fed from a local low voltage PSE&G network. The service enters the building's northwest corner and the utility breaker and meter are located in an electrical closet. The St. Peter and Paul Church is fed from a PSE&G 13.8 kV radial fed with a dedicated, pole mounted transformer. Both buildings receive power at 120/208V.

It is proposed to route a new combined service down 4th Street from the Washington Street system. The 13.8 kV microgrid will enter the parking garage local to the existing service. A new common transformer and switchboard will be installed local to the existing electrical closet to feed both buildings. Each building will include dedicated sub-meters, data acquisition panels and ATS panels. Both buildings are proposed to receive power from the microgrid system regularly and the existing PSE&G services will remain as redundant power supplies.

King's Grocery and 5th Street Pump Station:

Both the King's Grocery and the 5th Street Pump Station are currently fed from separate 13 kV PSE&G services and are reduced down to 480V via utility owned, dedicated transformers. The King's Grocery service is a network feed and the Pump Station service is an overhead radial feed. A new underground conduit will be installed from an existing electrical manhole at 3rd and Washington Street to King's Grocery. A single transformer will be installed and will feed a switchboard located outdoors in a raised location adjacent to King's Grocery. The switchboard will distribute power from the microgrid system to both facilities. Dedicated ATS, data acquisition units and sub-meters will be located in each facility. The new electrical equipment and materials will be required to be installed at a raised location because both buildings are located below the flood plain

The King's Grocery is proposed to normally be fed from its existing PSE&G feed. If there is a major power outage event, a city official will have the authority to switch the ATS to the microgrid system such that the grocery store can remain operational and accessible to the community.

The Pump Station is proposed to normally receive power from the microgrid system with the existing PSE&G feed to act as redundant power supply. An existing outdoor diesel generator located below the FEMA 100 year floodplain provides emergency power to the pump system during a power outage. In the event of a city wide power outage, the microgrid controller will switch the existing emergency generator ATS to allow the unit to operate and power the local system. This will isolate the Pump Station and generator from the microgrid allowing the new microgrid generators to provide power to users without emergency generation capability. If the outage is expected to last more than a few hours and the microgrid system has adequate generation capacity, the controller will reposition the ATS's such that the pump station can be supplied by the microgrid system to conserve diesel fuel. In the event that the existing Pump Station generator is not operational during an emergency, the ATS's will be positioned automatically by the microgrid controller such that the microgrid system will provide power to the pumps. This facility is crucial to be operational during emergency events because the wet pumps are required to pump out storm water.

Hoboken Homeless Shelter:

The Hoboken Homeless Shelter is currently supplied from an existing PSE&G radial feed. A new underground conduit will be installed from an existing manhole located at 3rd and Washington Street to the building entrance to connect the shelter to the microgrid. A dedicated transformer, breaker, ATS panel and data acquisition panel will be required to be installed within the building. The existing entrance panel and new equipment will be required to be installed at a high elevation above the FEMA 100 year flood plain. The ATS will be normally switched for the microgrid service to provide power to the facility. The existing PSE&G service will remain as a redundant backup feeder.

Hoboken University Medical Center:

The Hoboken University Medical Center is powered by a single 4.16 kV utility radial feed. The feeder is located on an overhead pole and is routed underground on the south end of 3rd Street. The underground line runs below 3rd street and enters the hospital's entrance switchgear located on the first level. Power is distributed throughout the hospital and is backed up with two diesel generators. A new underground conduit will be installed from an existing electrical manhole at 3rd and Washington Street to the main hospital electrical room. A dedicated transformer, breaker, sub-meter, ATS panel and data acquisition panel will be installed within the existing electrical room. The ATS will be normally positioned for the microgrid service to provide power. The existing PSE&G service will remain as a redundant backup feeder. Multiple redundant utility feeders are typical for hospitals.

A new CHP packaged reciprocating engine generator is proposed to be installed at the hospital to offset the facility's thermal loads. Additionally, Solar PV and a battery system are proposed to be installed at the neighboring Midtown Parking Garage. Dedicated breakers between these assets and the main 13 kV system will be installed such that they will interconnect to the microgrid system separately from the hospital.

In the event of a city wide power outage, the microgrid controller will switch the existing emergency generator ATS to allow the units to operate and power the local hospital system as designed. This will isolate the hospital generators from the microgrid allowing the new microgrid generators to provide power to users without emergency generation capability. In the event that the existing hospital generator is not operational during an emergency, the ATS's will be positioned automatically by the microgrid controller such that the microgrid system will provide power to the pumps. In the event that a power outage is expected to last for a long enough duration that the diesel generators will run through their fuel supply, the microgrid system will be capable of reposition the ATS's such that the hospital's power demand can be supplied by the microgrid system. This will allow the hospital to conserve diesel fuel if it is not available because of flooding or other catastrophic events. The hospital is essential to be operational during emergency events.

The hospital is located below the FEMA 100 year floodplain. Essential assets shall be raised above the floodplain.

Parking Garage B and Parking Garage D:

Parking Garages B & D are located opposite one another from 2nd Street. Both garages are served from a local low voltage PSE&G network feed. The service enters both building's northwest corner and the utility breaker and meter are located in electrical closets. It is proposed to route a new combined service down 2nd Street from the Washington Street system. The 13.8 kV microgrid feed will enter the Parking Garage D local to the existing service. A new common transformer and switchboard will be installed local to the existing electrical closet to feed both garages. Each garage will include dedicated sub-meters, data acquisition panels and ATS panels. Both structures are proposed to receive power from the microgrid system regularly and the existing PSE&G services will remain as redundant power supplies. The Garage D existing electrical building entrance panel should be relocated to the floor above to keep it above the FEMA 100 year floodplain. Garage D will be adding a packaged distributed generator to the fourth or fifth floor.

Police Headquarters and Walgreens Pharmacy:

Both the Police Headquarters and Walgreens Pharmacy are fed from an underground local low voltage PSE&G network system. The two buildings are both in close proximity to the corner of 1st and Washington Street. It is proposed to install a new combined service from the 1st and Washington electrical manhole to the Police Headquarters. The 13.8 kV microgrid feed will enter the Police Headquarters building local to the existing utility entrance equipment. A new common transformer and switchboard will be installed to feed power back through the new duct bank to the Walgreens. Both the Police Headquarters and Walgreens will include dedicated sub-meters, data acquisition panels and ATS panels. The Police Headquarters is proposed to normally receive power from the microgrid system with the existing PSE&G feed to provide a redundant power supply.

An existing rooftop 150 kW natural gas fired packaged engine generator is located on the Police Headquarters roof. In the event of a city wide power outage, the microgrid controller will switch the existing emergency generator ATS to allow the unit to operate and power the local system. This will isolate the Police Headquarters and generator from the microgrid allowing the new microgrid generators to provide power to users without emergency generation capability. In the event that the existing generator is not operational during an emergency, the ATS's will be positioned automatically by the microgrid controller such that the microgrid system will provide power to the headquarters. It is important to public safety for this facility to be operational during emergency events.

The Walgreens is proposed to normally be fed from the existing PSE&G feed. If there is a major power outage event, a city official will have the authority to switch the ATS to the microgrid system such that the pharmacy can remain operational and accessible to the community.

CVS Pharmacy:

The CVS Pharmacy located on Washington Street is currently supplied from an existing PSE&G network system. It is proposed to install a new underground conduit from Newark Street to the building. A dedicated transformer, breaker, ATS panel and data acquisition panel will be required to be installed within the pharmacy. The pharmacy is proposed to be normally have power supplied by the existing PSE&G feed. During a power outage event, a city official will have the authority to switch the ATS to the microgrid system such that the pharmacy can remain operational and accessible to the community.

Hoboken City Hall and Columbian Towers:

Hoboken City Hall and Columbian Towers are both served from a local low voltage PSE&G network feed. It is proposed to route a new combined service from Washington Street into a new City Hall electrical room. A new common transformer and switchboard will be installed local to the new electrical equipment to replacement the existing utility entrance equipment. A new low voltage fed from the City Hall switchboard will be routed underground to Columbian Towers. Both buildings will include dedicated sub-meters, data acquisition panels and ATS panels. The City Hall ATS will be positioned to normally receive power from the microgrid system with the existing PSE&G feed to be a redundant power supply. The Columbian Towers are proposed to normally be fed from the existing PSE&G feed. If there is a major power outage event, a city official will have the authority to switch the ATS to the microgrid system such that the building can remain operational and remain a functional residence.

Pump Station H1:

The pump station is supplied from an overhead PSE&G radial feeder and a pole mounted transformer reduces the supply voltage from 13.8 kV to 480V. The facility's utility breaker and meter are located on the second floor along with the VFDs that feed the two wet weather pumps. An existing diesel generator is located at the 1st level on a raised pedestal to provide backup power to the pumping system.

It is proposed to extend the Washington Street duct bank across Observer Highway and route the new microgrid feed to the building's second level. A new microgrid dedicated transformer, ATS panel, sub-meter and data acquisition panel shall be located on the second level adjacent to the existing electrical equipment. The ATS is proposed to be normally positioned for the microgrid service to provide power. The existing PSE&G service will remain as a redundant backup feeder.

In the event of a city wide power outage, the microgrid controller will switch the existing emergency generator ATS to allow the unit to operate and power the local system. This will isolate the Pump Station and generator from the microgrid allowing the new microgrid generators to provide power to users without emergency generation capability. If the outage is expected to last more than a few hours and the microgrid system has adequate generation capacity, the controller will reposition the ATS's such that the pump station can be supplied by the microgrid system to conserve diesel fuel. In the event that the existing Pump Station generator is not operational during an emergency, the ATS's will be positioned automatically by the microgrid controller such that the microgrid system will provide power to the pumps. This facility is crucial to be operational during emergency events because the wet weather pumps are required to pump out storm water.

Hoboken Housing Authority Corridor

The City of Hoboken southwest section includes several multifamily, low income housing apartment buildings owned and maintained by the Hoboken Housing Authority. The buildings are too far from the Washington Street power distribution system to justify interconnecting the buildings; however, this section of buildings has a large enough electrical load to justify a separate microgrid power distribution system. The system will be controlled from a common Hoboken Microgrid distributed automation control system, but with completely independent electrical distribution systems. Existing duct banks have not been installed for this system yet, but the buildings are much closer in proximity and the distance of conduit runs is significantly less than what was required for Washington Street.

This section of the Hoboken Housing Authority consists of the housing complexes Andrew Jackson Gardens and Harrison Gardens. Each housing complex includes several, separate utility services that will require a redundant microgrid feed. The existing services enter the buildings underground and the utility entrance equipment is located in basements below the floodplain. The building entrance equipment will be required to be relocated to a higher level in the buildings such that it is not susceptible to damage during extreme flooding. The routing of the new conduit can be found in the Appendix A plan drawings.

The Hoboken Housing Authority Corridor will be served with a new 13.8 kV PSE&G electrical feed from the refurbished Madison Street Substation. The service will likely be pole mounted and is proposed to be routed overhead along Madison Street. The service will be routed underground and will feed into an Andrew Jackson Gardens building. This will be considered as the point of common coupling (PCC). A new utility meter will measure electrical usage for the entire Hoboken Housing Authority Corridor.

A new packaged, simple cycle engine generator will provide supplementary power to the microgrid during normal conditions. The Housing Authority buildings are proposed to be regularly provided with power from the microgrid system. During a loss of utility power event, new and existing generation resources will be prioritized to meet the power demand requirements of the system.

<u>Harrison Gardens</u>:

Harrison Gardens consist of two 10 story multifamily apartment towers. Each tower has an existing electrical services provided by a PSE&G radial feed. A utility owned, pole mounted transformer steps the supply voltage down from 4.16 kV to 120/208V. To interconnect the buildings to the microgrid system, a new underground conduit will enter each building from Harrison Street. A dedicated transformer, breaker, ATS panel and data acquisition panel will be required to be installed within each building. The ATS will be normally switched for the microgrid service to provide power. The existing PSE&G service will remain as a redundant backup feeder.

Each building includes an existing natural gas generator that provides power for life safety services during a utility outage. This includes emergency lighting, elevators, etc. In the event of a city wide power outage, the microgrid controller will switch the existing emergency generator ATS to allow the unit to operate and power the local system. Once the generator is operating and if there is adequate load, the existing generators will be shut down and the buildings will be fed by the microgrid system. This will allow the entire building to be powered.

<u>Andrew Jackson Gardens</u>:

Andrew Jackson Gardens consist of several multifamily apartment buildings and towers ranging from 3 to 7 stories tall. Each building cluster has an existing electrical services provided by a PSE&G radial feed. A utility owned, pole mounted transformer steps the supply voltage down from 4.16 kV to 120/208V. A new underground conduit will enter each building from Harrison Street to connect the buildings to the microgrid system. A dedicated transformer, breaker, ATS panel and data acquisition panel will be required to be installed within each building. The ATS will be normally switched for the microgrid service to provide power. The existing PSE&G service will remain as a redundant backup feeder.

Each 7 story building includes an existing natural gas generator that provides power for life safety services during a utility outage. This includes emergency lighting, elevators, etc. In the event of a city wide power outage, the microgrid controller will switch the existing emergency generator ATS to allow the unit to operate and power the local system. Once the microgrid system generators are operating and if there is adequate load, the existing generators will be shutdown and the buildings will be fed by the microgrid system. This will allow the entire building to be powered.

3.2 DISTRIBUTED GENERATION RESOURCES

During normal conditions, electricity will be supplied to the microgrid system from PSE&G's new services as well as from new and existing distributed generation resources. Existing resources include diesel and natural gas fired emergency generators currently installed at the critical facilities. New generation resources are proposed to be installed throughout the City of Hoboken to support the microgrid. This includes a packaged reciprocating engine generator CHP unit, simple cycle packaged engine distributed generator units, Solar PV and battery storage. The new units will operate in parallel with the utility and reverse power protections will be included in the system to prevent microgrid generation assets from exporting power to the utility grid.

During utility power outage, the existing generators will be brought online to power their respective critical facilities per their existing protocols. The new natural gas reciprocating engines will be started by the microgrid controller and will synchronize sequentially to the microgrid until they have paralleled. Individual building breakers will be closed based on a load shedding scheme to block load the generators. Critical buildings will be given priority. The Solar PV will provide power to the system as it is available based on weather conditions and the battery storage system will regulate the output such that sudden changes in cloud and sun conditions do not interfere with the microgrid system. Once the microgrid is fully operating and if there is enough generation capacity, select existing diesel generators will be shut off and their respective facilities will be supplied power from the microgrid system to conserve diesel fuel.

A. DISTRIBUTED GENERATION

The Distributed Generation (DG) concept is based on installing simple cycle packaged reciprocating engine generators to reduce the micro grid's utility peak demand charges. Cost savings is realized through a reduction in ISO capacity, transmission and ancillary charges. Engine operation is targeted at approximately 1,200 hours per year, primarily during daytime peak demand periods. The units will be fueled with utility natural gas.

In addition to providing energy cost savings, the DG engine generators will be designed and integrated into the existing electrical distribution system to significantly increase site resiliency. During an emergency event when power from the utility is lost, the new natural gas engines will be capable of generating electricity to power the microgrid system. Since the DG engines will be designed to operate on natural gas, the system will not be at risk of a disruption in diesel fuel supply in the event of a prolonged and significant loss of grid power.

<u>Packaged Units</u>

The new engines will be provided as factory assembled skid mounted packaged units equipped with accessories, including on-skid controls and auxiliary systems in an acoustic enclosure. The engine generator enclosure will be provided complete with combustion air filters, intake and exhaust ventilation and silencing muffler, internal lighting, gas detector, fire suppression system, intercooler, lube oil cooling, jacket water cooling and emissions reduction equipment as required. A roof mounted air cooled radiator will also be included with the engine enclosure design. The radiator will be designed to cool both high temperature and low temperature engine cooling water. The packages would be provided with a modular skid mounted SCR system and Urea tank with dosing system if determined to be required to meet emissions requirements.

Control and Dispatch

Control and dispatch of the unit will be accommodated through the microgrid control system and will allow operation in parallel with the utility or for islanding operation in event of grid failure.

For demand response the engines would be dispatched during periods of site electrical demand. Dispatch can be local through an operator observing market signals such as day-ahead demand pricing or nominal site electrical demand an alternative approach would be through external dispatch using sophisticated dispatch software that could further exploit market opportunities for dispatch.

Location:

The proposed packaged units are approximately 14' wide and 50' in length. The packages emit noise when operating and will discharge exhaust gas from the stack. These requirements offer challenges when locating packaged engine units in condensed urban environment with minimal available space for new power generation equipment. The conceptual design within the scope of this study considers multiple locations.

The primary location for the Washington Corridor is within the Hoboken Public Parking Garage D. This location is in close proximity to a majority of the microgrid facilities and there is a limited amount of conduit and cable required to be installed to connect to the microgrid. The location is in an already relatively noisy area within a parking garage and will likely have low impact on nearby residents. The installation will limit several parking spots and further investigation will be required to determine if additional structural reinforcement will be required to support the proposed unit. Engine stack breeching will be required to discharge exhaust gas in a safe location.

Additional available locations are proposed at the existing 16th Street Substation and the future pump station, H7 planned to be installed on the 13th and Jefferson block by North Hudson Sewerage Authority. Both locations are in the northern section of Hoboken and are a considerable distance from a majority of the microgrid buildings. These locations are in a more industrial section of the city; however, there are residences in close enough proximity that significant noise mitigation practices will still be required. The future pump station will require a generator for emergency use and the packaged natural gas engine could be used to serve both the microgrid DG application and pump power backup generator needs. This concept will require further evaluation as both the microgrid and pump projects advance. A commercial agreement will be required to be met between North Hudson and the City of Hoboken to determine who is responsible to operate and maintain the unit and who will gain the benefits from managing the micro grid's electrical demand cost.

The proposed location for the Hoboken Housing Authority Corridor is within the area currently used by the Marshall Street Substation. The Marshall Street Substation is planned to be decommissioned in time for the microgrid project. This space will be owned by the city and may be available for the microgrid project. The location is in close proximity to the housing authority.

This feasibility study is based on a single DG unit located in Parking Garage D for the Washington Street Corridor and a single DG unit located in the current Marshall Street Substation. For more information on the proposed engine locations, refer to the site plan drawings within Appendix A.

B. COMBINED HEAT AND POWER

A new 800 kW Combined Heat and Power (CHP) system is proposed to be installed at the Hoboken University Medical Center as part of the microgrid project. The proposed system will consist of a reciprocating engine generator to offset the micogrid's electric consumption. Thermal energy from the reciprocating engine exhaust and high temperature cooling water system will be will be used to produce hot water to offset the hospital's heating load. During the cooling season hot water will be used to produce chilled water for the operating rooms in a new absorption chiller.

The basis of design for the system is a reciprocating engine generator completely integrated on a packaged skid equipped with accessories, including on-skid controls and auxiliary systems in an acoustic enclosure, as manufactured by the engine vendor and shall be a heavy duty industrial type for continuous duty at full load. The engine generator enclosure will be provided complete with combustion air filters, intake and exhaust ventilation, internal lighting, gas detector, intercooler, lube oil cooling, jacket water cooling and emissions reduction equipment as required. A roof mounted air cooled radiator will also be included with the engine enclosure design. The radiator will be designed to cool both high temperature and low temperature engine cooling systems.

It is assumed that a Selective Catalytic Reduction (SCR) system will be required to reduce engine NOx emissions to levels acceptable by state regulatory agencies. This system will be packaged within the enclosure and include a urea injection manifold, urea dosing system, catalyst housing, air compressor and an outdoor urea storage tank.

The packaged unit is proposed to be located within the Midtown Parking Garage. Thermal distribution piping will be routed to the hospital beneath an existing access way that bridges between the garage and hospital.

Waste Heat Recovery System

A hot water waste heat recovery system will transfer waste heat energy from the CHP engine to the hospital's heating hot water, domestic hot water and chilled water system. High temperature engine cooling water used for jacket, first stage intercooler and lube oil cooling will be heat the new hot water system. The hot water system will be further heated by engine exhaust through a waste heat recovery unit. During the heating season, it will preheat building heating hot water and domestic hot water. This will offset natural gas usage within the existing steam boilers. During the cooling season, the hot water system will provide heat to a new absorption chiller located in the roof penthouse to service the operating rooms. A new piping system will be piped through the hospital to the 2nd level mechanical room and roof penthouse to supply the domestic hot water, heating hot water and absorption chiller loads. During periods of low demand, engine cooling water will be cooled through the remote radiator before passing through the engine cooling system.

Absorption Chiller

During the cooling season, the absorption chiller will utilize engine waste heat to provide the energy to produce chilled water. The absorption chiller generator will be heated with hot water produced from the engine heat recovery system. The new absorption chiller will replace an existing 400 ton natural gas fired reciprocating engine driven chiller that produces chilled water for the hospital's operating rooms. The chiller is passed its service life and does not have a redundant unit to supply the system if it fails. It is recommended to replace this chiller with a new absorption chiller. The existing cooling towers adjacent to the penthouse will also be required to be replaced.

C. ENERGY STORAGE AND SOLAR PV SYSTEM

A solar photo voltaic (PV) system and battery storage system is proposed to be located at the Hoboken Midtown Parking Garage of 650 kW and separate system proposed at roof of Hoboken University Medical center is 125 kW. This location is adjacent to the Hoboken University Medical Center and the two structures are connected with a walking bridge that crosses Clinton Street. This is the only parking garage owned by the City of Hoboken with available rooftop space for solar panel installation. The combined solar PV and battery storage systems primarily can be used during normal operation to reduce electrical bills by providing power during a time of use PSE&G rate schedule and by reducing the system's demand and reduce peak charges. The battery storage system will provide a full range of VAR control, store excess renewable energy for load shifting and respond quickly to load changes caused by the solar system's response to changing weather.

Solar Photovoltaic System

The available space at the top level of the parking garage and Hoboken University Medical Center was estimated during site visits and using scaled satellite images of the city. The estimated available square footage value is approximately 45,000 ft. The corresponding PV capacity was calculated based on the following assumptions:

i. Module Type-Standard, Crystalline Cell material, 15% nominal efficiency
ii. Array Type-Fixed
iii. DC to AC size ration is 1.1
iv. Inverter efficiency is 96%

Table 2: Output of Solar PV system

Month	Solar Radiation (kWh / m2 / day)	AC Energy (kWh)
January	8.7	60,472
February	11.76	72,287
March	13.71	90,913
April	16.23	98,660
May	16.23	99,991
June	17.88	103,859
July	18.51	108,891
August	17.64	104,272
September	15.48	91,142
October	12.18	75,912
November	9.18	58,241
December	7.23	48,995
Annual	164.73	1,013,635

The Solar PV system can produce almost 1,015,854 kWh per year and the maximum output is approximately 771 kWdc.

The panels will be installed above the rooftop parking area with overhead support steel such that vehicles can continue to park in this area. The installation of a Solar PV system on the roof of the Midtown Parking Garage will require a structural evaluation to determine if additional supports are required for the additional wind loading caused by the panels.

Energy Storage System

There are several different types of energy storage systems that can be incorporated into a microgrid system. This includes thermal storage, electrochemical battery storage, pumped hydro, compressed air, flywheels, etc. Each type of energy storage has advantages and disadvantages for different type of applications.

Electrochemical batteries are a common type of energy storage because of the flexibility they provide. As battery energy storage is constructed by combining smaller electrical units in series and parallel, it allows the system to be readily sized or modified to fit a wide range of applications. Further, the charging and discharging response time permits load flow and dynamic contribution for voltage control and frequency regulation, a critical element in coupling energy storage with renewable generation and maintaining grid stability. For battery storage applications, most manufacturers are supplying either lithium ion or lead acid types. A lithium ion system was selected for this system based on the compact physical dimensions, reliability, price per KW/KWh and industry acceptance.

Energy storage can be applicable for following applications

1) Time of use
2) Peak demand evaluation
3) Photovoltaic peak energy shifting
4) Uninterruptible Power supply (UPS)

Based on the conditions considered for this microgrid study, the battery storage system size is recommended to be within the range of 800-1000 kW and 4000 kWh. During a further engineering phase it is recommended to reevaluate this sizing based on any changes to the following items: microgrid configuration, utility charges, solar PV system size.

For this feasibility study application of energy storage is investigated was from the standpoint of increasing reliability and resiliency. However electrical savings were calculated for the times that energy storage system is operating in normal condition. There are currently energy storage goals and targeted programs being developed by the State which will need to be considered when sizing the energy storage system. In addition the energy storage system can participate in the PJM Frequency regulation market which can provide significant revenue. All of these considerations will be factored into the fibal sizing and economic analysis.

Solar PV Peak Energy Shifting

Solar PV power is generated only intermittently between sunrise and sunset, it is common that generation does not coincide with system's peak power demands. Even when the solar generation source coincides with peak power demands, the system must have generation assets to power the microgrid in case demand remains high while cloud coverage restricts PV generation. To address this issue energy storage coupled with a solar PV system is considered.

Peak-load shifting is the process of mitigating the effects of large energy load blocks during a period of time by advancing or delaying their effects until the power supply system can readily accept additional load. The concept of peak shifting can help remedy this situation with a slightly different approach: generation shifting. The energy storage system not only has the ability of supporting end users in reducing their costs, but through generation shifting also allows generators access to a higher value of dispatch able generation for specific periods of time.

The traditional intent behind this process is to minimize generation capacity requirements by regulating load flow. If the loads themselves cannot be regulated, this must be accomplished by implementing energy storage systems to shift the load profile as seen by the generators.

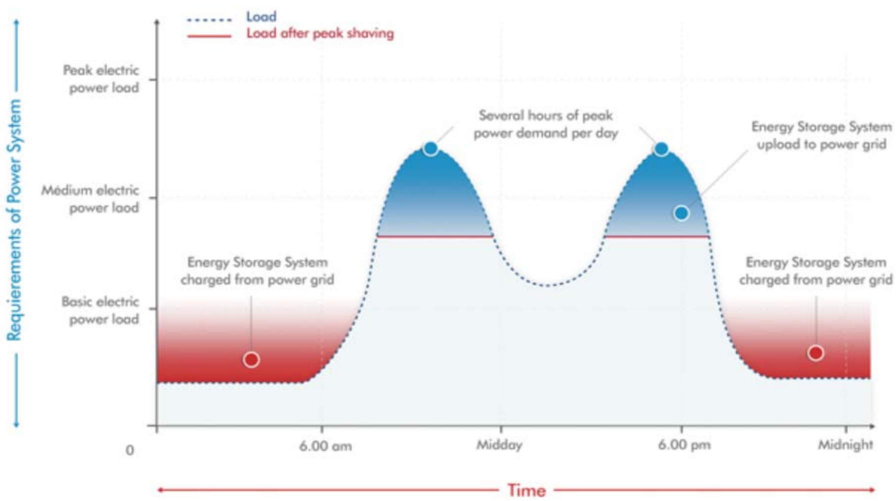


Figure 3: Peak Shaving of electrical loads by storing energy as low demand time

The energy storage system is charged while the electrical supply system is powering minimal load and the cost of electric usage is reduced, such as at night and also from the PV generation. It is then discharged to provide additional power during periods of increased loading, while costs for using electricity are increased. This technique can be employed to mitigate utility bills. It also effectively shifts the impact of the load on the system, minimizing the generation capacity required.

Solar photovoltaics (PV) provide irregular power due to meteorological and atmospheric conditions. As these power sources come to provide an increasingly significant contribution to the load flow in the electrical grid, their effects become more pronounced on the power quality of that grid. The erratic fluctuations in power generated by these renewables can be detrimental to maintaining transient and dynamic stability within the system. Power quality concerns generally associated with renewable energy sources include voltage transients, frequency deviation, and harmonics. However, by implementing an energy storage system, it is possible to turn the intermittent source into one with a relatively uniform and consistent output as anchor resource. As such, the large-scale deployment of renewable energy sources along with the energy shifting, energy storage can also charge during the off peak hours and discharge when the peak of the system occurs reducing the peak demand charge for the system load.

Time of Use (TOU)

PSE&G offers a "Time-of-Use" or "TOU" rate known as the residential load management or "RLM". Time of Use (TOU) pricing is where the utility varies the price of the electricity rate depending on the time-of-day based on supply and demand. The RLM rate varies the price of electricity between "peak" and "off-peak" hours of a day and by season. If it is chosen to switch to the RLM rate, the user will pay a lower rate for the entire weekend and during off-peak hours (9:00 PM – 7:00 AM, Monday through Friday). The user will pay a higher rate only during "peak" hours (7:00 AM – 9:00 PM, Monday through Friday). Table.3 shows the TOU rates PSEG put into place January 2015

Table3: PSEG time of use rates effective January 1, 2015

Summary Delivery and Supply Charges	RS	RLM
Monthly Service Charge	$2.43	$13.98
Charges per kWhr:		
0-600 Summer	0.181924	
Over 600 Summer	0.195146	
Summer On-Peak		0.273070
Summer Off-Peak		0.099443
0-600 Winter	0.180361	
Over 600 Winter	0.180361	
Winter On-Peak		0.216226
Winter Off-Peak		0.102579

Large Power and Light Primary Service (LPL-P)

PSE&G utilizes a LPL-P service tariff for 13 KV customers this rate would apply to the facilities taking both normal service and emergency (grid outage) services through the Microgrid Washington Street feeder. The LPL-P service reduces the cost of electric power and facilitates the ability of DG assets to manage capacity and transmission costs.

Peak Demand evaluation

The role of demand response and storage becomes increasingly important at very large Solar PV installations. By shifting supply and demand patterns, storage and demand response can not only significantly increase the output of PV generation, but also can provide other significant sources of value such as provision of firm capacity, which can eliminate the need for conventional peaking capacity. Furthermore, in addition to providing load shifting, both storage and demand response can also provide operational flexibility. For example, storage and demand response can provide operating reserves to the system.

Battery storage system will be implemented for peak shaving and simultaneously implement time of use in this scenario. By combining the peak demand response and TOU application, the greatest saving can be achieved.

3.3 DISTRIBUTED AUTOMATION CONTROL SYSTEM

A microgrid is typically operated by a microgrid operator with the main goal to optimize production and consumption of electricity from the microgrid components. That optimization will be in accordance to price related signals and grid signals (grid conditions form the distribution system operator) that microgrid controller has received. This will maximize the cost benefit of the system. The microgrid can also provide flexibility services to the grid using generators (e.g. voltage regulation) and loads (e.g. demand response) contained within the microgrid. To achieve an optimal solution for the microgrid, it is necessary to develop a microgrid controller as an information hub for the entire system. Each power generator, energy storage and facility load will also have its own local controller that will interpret signals received from the microgrid controller and respond accordingly. For example, during peak hours when the highest market price is reached, signals will automatically initiate generator assets to increase power output to the microgrid to minimize the utility's power supply.

The preliminary function of the microgrid control system will be to manage and optimize microgrid operations to ensure the safe, secure, reliable, sustainable, and efficient distribution of power during microgrid operations and transitions. Such a control strategy implies the need for supplementary communications between controlled assets and the addition of sensing, monitoring and processing equipment to provide accurate situational awareness of the microgrid state. Whether or not the architecture of these communication and controlled assets are based on a distributed or centralized control philosophy depends on the feasibility of available commercial solutions; however, either architecture will provide additional control and monitoring functionality to better optimize microgrid operations.

For design of Hoboken microgrid control system and support communications requires following recommendations and requirements:

- Existing protection settings
- Maximum rate of change of frequency of power supplied from microgrid.
- Existing details of service entrance such as system grounding, fault levels, impedances, voltage regulations, protection schemes and automation
- Acceptable voltage, frequency and harmonic quantity during normal and transient conditions
- Acceptable voltage imbalances tolerable
- Acceptable dynamic stability limits

A. Mode of Communication

Fiber optic cable will be the mode of communication between the facilities located in the Washington Street Corridor and the Hoboken Housing Authority Corridor. The two corridors will not be connected via fiber optic cable due to the physical distance separating them. The two corridors will communicate via a satellite communication signal. Fiber optic cables are recommended since they provide higher reliability, data rates and security. Wireless data radios, cellular communications, publicly switched telephone network communications, etc. are generally less reliable, more susceptible to electromagnetic interference, easier to subvert, and provide lower data rates.

The fiber optic cable will be routed through the Washington Street Corridor within the existing 4" conduit installed in the microgrid duck bank. New communication conduit will be installed adjacent to power conduit extending from the existing duct bank to the separate facilities. The Hoboken Housing Authority Corridor will include a completely new duct bank system that will include communication conduit for the fiber optic cable.

All microgrid control system network communications should be physically isolated from all other networks; however, provisions for remote access to communication network devices (i.e. Routers, switches, etc.) should be provided to allow for troubleshooting, remote maintenance, and software updates if physical access to the devices is not possible due to flooding emergency situation.

B. Microgrid Communication Architecture

The Hoboken microgrid communication architecture is the communication structure which is used for the transfer of microgrid metering data, status signals, generation details, maintenance details and remote access of microgrid equipment's from control room.

The Hoboken microgrid controller will monitor all low voltage main service panel statuses, all generator assets such as CHP, PV inverter, battery storage, DG engine generator, etc. All communications between the facilities must support interoperability between all communication equipment's functions, standard commands, and standard protocols and must be adequately extensible for future additions. Interoperability will also require network and communication device time synchronization between all communicating IED's within reasonable accuracy.

Network connectivity shall be provided in each facility along each corridor for data acquisition from the following equipment:

i. Controllable breakers and relays
ii. ATS
iii. Sub-meters
iv. PV generation, network-capable PV inverters
v. Battery storage units
vi. DG engine generator controllers
vii. CHP engine generator controllers

The network architecture shall include redundant communication paths, such as a ring or mesh architecture or Parallel Redundancy Protocol (PRP) or High-availability Seamless Redundancy (HSR) communication system as per IEEE 802, to remove single points of failure and mitigate the effects of accidental cable cuts, equipment failures. All microgrid signals shall have time synchronization as per precision time protocol (PTP) and time stamping as per IEEE 1588.

Provision shall be kept to communicate the status and metering data to PSE&G substation control room at 16th Street and Madison substations. The mode of communication will be fiber optic.

Refer to Appendix A for the system microgrid communication architecture diagram.

<u>**Natural Gas Engine Generator Control**</u>

New packaged CHP and DG engine generators are proposed to support both the Washington Street and Hoboken Housing Authority Corridors. The engine generation will provide voltage regulation, frequency regulation, and dynamic support. Generator controllers shall allow remote starting and stopping, permit exciter set-point control, include synchronization functionality, and provide detailed operational data for monitoring and situational awareness purposes (e.g., fuel consumption, temperature, alarms, etc.)

For the CHP engine generator proposed at the Hoboken University Medical Center, continuous monitoring and control shall be implemented by recording vital operational parameters (e.g., heat & power outputs, fuel consumption, water consumption, gas pressure & temperature, etc.) and reporting alarm conditions to a remote monitoring center, preferably for monitoring of real-time data by viewing a dynamic HMI.

Solar PV Generation Array Control

The Solar PV system proposed at the Midtown Parking Garage as part of the Washington Street Corridor need to be controlled and collected at a minimum for connection and disconnection of the PV output, PV output (active, reactive power, power factor, frequency) measurement and all PV output parameters. All data acquired will be transferred to the main control room. The solar PV connection shall be controlled using integrated controls. Voltage and current measurements of the array output during both islanded and grid connected operation shall also be gathered via a inverter. Real time and historical power generation data shall be logged and used to facilitate grid stability and provide metrics for decision making based on the predicted or expected PV power output forecasting the future weather conditions. Regulation capabilities to activate or modify volt/VAR support functions shall also be provided

Battery Storage

Battery storage is provided to supplement the PV generation. The microgrid controller shall dispatch the battery system for peak shaving and time of use (TOU) to reduce energy costs from PSE&G and to also reduce the fuel cost from the engine generators. The communication system shall allow for monitoring of the battery system connection and disconnection. Monitoring of the battery storage system shall include voltage, current, temperature, voltage drop and outside ambient conditions. Cell monitoring and performance assessment will be provided to acquire data for battery storage supplier controller. Integrating storage and DG allows Solar PV to operate during a grid power outage. Conventional solar assets require grid power to be able to produce electricity.

Microgrid Facility Loads

Microgrid communication within each building will collect data from the main breaker and ATS. The communication system will monitor voltage, current, real power and reactive power to properly execute load-shedding schemes. Inrush current mitigation strategies shall be implemented for all problematic loads, including large motor loads and transformers, to prevent frequency and voltage sags that may diminish grid stability.

Automation shall be added to medium and/or low voltage switchgear to regulate load connections, depending on the building location and cost. Real-time and historical load data for building loads during islanded and normal operation shall be collected and used to facilitate grid stability and provide metrics for decision making based on the predicted or expected load. Smart metering will be used to facilitate load data collection and augment grid telemetry in general. Inrush current mitigation for transformer inrush can be accomplished using numerous methods, including dead-bus closing or series inrush limiting reactors. Such measures will also alleviate cold-load pickup effects and abate the stress inflicted on generation assets. Filtering or demand response actions should be implemented for sensitive loads and large loads that may exacerbate harmonic distortion and poor power quality. Also, grounding schemes need to be maintained during microgrid operations, therefore, it may be necessary to switch in ground sources to maintain an adequate ground source at all times

C. Protection Systems

Hoboken microgrid shall be provided with protection schemes and devices required for reliable, fast and secure operation. Protection devices shall be microprocessor based relay and communicating on latest IEEE and IEC 61850, GOOSE communication. Protection systems will be designed in such a way that overall reliability will increase and reduction in outages. Each microgrid facility shall be provided with overcurrent relays, synchronizing relays and fuses to be provided in the facility to protection the facility loads and generation assets. The relay protection scheme shall isolate specific facilities in the event that of detected fault current.

All new generating assets that are part of the microgrid project will need synch check function for paralleling the generators with other generating asset. The fault recorder and diagnostic equipment shall be implemented for analysis of scenario post the fault.

The integration of distributed energy resources and power distribution devices embedded in the system challenges the characteristics of protection schemes in microgrids as compared with those of conventional distribution systems. Distributed energy resources located in microgrids can modify fault currents, change fault current flow paths, result in bidirectional power flows, and affect protective device operations. microgrid control systems integrate adaptive protection schemes into the system to ensure that personnel and equipment are always protected, regardless of the network configuration. Adaptive protection allows different settings in the same relay to be used to optimize protection.

A new PSE&G service is connected to the microgrid 13.8 kV system and the utility will normally be operating in parallel with the microgrid system. Power will not be exported from the microgrid to the PSE&G grid. This reverse power flow will be prevented by implementing a reverse power relay at the utility breaker to provide a transfer trip signal to open the breaker if power begins to export to the grid.

D. Microgrid Controller

The microgrid controller is the central communication hub of the entire Hoboken Microgrid system. The unit shall be provided with the following functions:

- Controller shall be able to respond to external data such as real time signals and fast changing systems dynamics
- Fast, deterministic controller can operate at sub cycle speeds, allowing it to reliably balance load with available generation.
- Control algorithms and demand response need to operate quickly to preserve the load and generation energy balance, maintain stability, and provide good quality power.

- Automatic generation control maintains balanced generation and nominal frequency under all scenarios.
- Dynamic capability curve calculations constantly monitors the maximum capability of distributed generation.
- Voltage control system balances reactive power and maintains system voltage under all scenarios

Control Philosophy

The main system control room is proposed to be located in Hoboken City Hall. A secondary location that is dedicated to the Hoboken Housing Authority Corridor will be located at the DG engine generator package at the Marshall Street Substation location. The control room consists of the microgrid controller server, the human machine interface (HMI) panels, printer and Ethernet switch board. Both control rooms can be connected through satellite communications. All parameters and measurements shall be archived using a data historian and shall be used heuristically. Using a historian, it is possible to optimize the microgrid generation resources dispatching based on weather forecasting and predicted renewable generation. The data historian shall be complete with data filters based on time stamping and rate of change of parameters, configurable sampling rate for voltage/current, temperature. The microgrid controller shall also maximize the use of renewable energy contributions within stability limits to reduce utility energy costs and to operate the generation assets in their most efficient ranges, with sufficient spinning reserves to accommodate load fluctuations.

The HMI shall include features like monitoring data points, changing parameters, sending control commands, visualizing historical data, viewing real-time and historical trends, viewing alarm states and history. Strong encryption/authentication methods shall be implemented to access the microgrid system.

E. CYBER SECURITY CONSIDERATIONS

The Hoboken Microgrid system requires a cyber security architecture that is more robust than that of tradition industrial control systems (ICS) because the microgrid will be used during emergency events and will be critical to the continuity of emergency operations. The microgrid shall be capable of functioning during active cyber-attacks by islanding the segmented section of the system.

In addition to referenced best practices, additional rigor should be applied to strengthen defense in-depth for the Hoboken Microgrid control system. Best practices for securing ICSs often leverage network segmentation, however, in most cases, network segregation is focused on separation of the control system network from other less-trusted networks, such as an enterprise network and the Internet. The concept of network segmentation within the control system itself should be leveraged to further reinforce defense-in-depth practices.

There are currently no cyber security standards available specifically for microgrid systems; however, existing security standards for typical ICSs, in which many are specific to power systems and the grid, can be leveraged. For example, the following set of relevant standards shall be considered. Accreditation may be leveraged to show compliance with energy security standards and assessments, including:

- DoD 8500-series for Cybersecurity and Risk Management
- NIST 800-series for federal government security policies, procedures and guidelines
- ICS-specific guidance, such as CNSSI 1253 and NIST 800-82
- Guidelines for Smart Grid Cybersecurity, such as NISTIR 7628
- Commercial guidelines, such as ANSI/ISA 62443 and NERC CIP v5
- DHS Cyber Security Evaluation Tool (CSET)

Defense-in-depth philosophy applies cybersecurity in a layered approach that maximizes reliability and minimizes the intrusiveness of controls on existing critical processes. Following recommended measures for Defense-in-depth philosophy

- Physical Security perimeter

Restricting physical access to the control system network and devices of microgrid network.

- Zone 0—Wide-Area Network (WAN) Transport

Supply strong data security functions using encryption to maximize the confidentiality, integrity, and availability (CIA) of critical data

- Zone 1—Access Control

Provide filtering of communications by using a firewall for Ethernet data or encryptions for dial-up or serial links. Also, integrate user authentication, authorization, and accountability (AAA) through in-line engineering access proxies.

- Zone 2—Data Aggregation

Integrate additional password controls, antimalware functions, and port-level security features on Ethernet devices and virtual local area networks (VLANs).

- Zone 3—IED or Process

Include security controls on the critical intelligent electronic devices (IEDs) themselves, especially additional password protection, alarm contracts, and the ability to disable unused serial or Ethernet ports and services.

These high-level defense-in-depth practices provide layers of security that help minimize the impact of a failure or subversion of any one mechanism. As such, these practices should be implemented at Hoboken and the relevant security standards should be referenced for more details regarding each mechanism. For Hoboken, the microgrid distributed architecture with segmented strategy shall be implemented to secure the microgrid from likelihood of disruption because of a cyber-attack.

4.0 MICROGRID COMMERCIAL STRUCTURE

The Electric Distribution Company (EDC) as well as the Gas Distribution Company (GDC) for all customers in Hoboken is PSE&G. There are currently no PJM qualified interconnections in Hoboken. The Hoboken Microgrid is being integrated into an existing fully developed urban environment. The existing electrical distribution level infrastructure was demonstrated to have serious vulnerabilities during and immediately following Superstorm Sandy. As with most of the electric customers served by PSE&G there was a large scale blackout due to flooding which damaged the electrical distribution system. PSE&G has made significant investments to address the vulnerabilities of their system.

From an infrastructure perspective the PSE&G transmission system and the natural gas distribution system were not incapacitated by Superstorm Sandy. Subsequently PSE&G has replaced all of the old cast iron low pressure gas distribution with new medium and low pressure plastic distribution lines. The remaining vulnerabilities are predominantly associated with the electrical distribution system. The one major concern that could impact the transmission system that energy planners are concerned remains is the potential for cyber-attacks which in theory could cause wide spread power outages. PSE&G as well as PJM has undertaken efforts to protect their systems and controls from cyber events; however, that is well beyond the scope of this investigation which is focused on distribution and customer level service. PSE&G has made significant investment in and around Hoboken that have made the electrical distribution system significantly less vulnerable to a repeat of the event that occurred during and following Superstorm Sandy.

As proposed in this report the Hoboken Microgrid is a dedicated distribution level electric power system. The microgrid serves 29 separate metered accounts these are separated into two service areas the first being the Washington Street Corridor comprising of both public and private entities the second being the group of building operated by the Hoboken Housing Authority. The microgrid is designed to provide economic benefits to participating public entities during normal grid connected operation and to provide resiliency benefits to both public and private entities during a black sky power failure type event.

A. Washington Street Corridor

The 19 building served by the Washington Street Corridor section of the microgrid include 6 facilities owned and operated by the city. The city facilities include three pumping stations three parking garages as well as Fire Engine Company 3, City Hall and the Police Headquarters. The proposed microgrid will utilize the new conduit installed under Washington Street during the reconstruction of Washington Street. Additional conduit will be extended from this main feeder to the individual facilities along with the necessary transformers and switches. A CHP unit is proposed for the hospital as well as utilization of existing and new distributed generators.

All of the Washington Street Corridor facilities are served as secondary service voltage customers except the hospital which is a primary service customer. The secondary services are a mix of network served underground utility feeders and radial underground and overhead feeders.

Due to the network service that exists there is no simple or practical way to isolate and serve the Washington Street Corridor by sectioning off and utilizing the existing PSE&G distribution system. This network service provides inherent redundancy which along with other efforts by PSE&G makes this a very reliable system. The proposed Washington Street Corridor microgrid feeder can be configured to operate in parallel with the existing PSE&G service or can be configured to be the primary source of power with PSE&G service being a secondary source of power. Isolation and transfer from primary source to back up can be accomplished by conventional switch gear typically utilized for emergency generators. The location of utility meters and the costs associated with backup power will be discussed further in this report.

Ownership and operation of the Washington Street Corridor Microgrid feeder could be by PSE&G as the EDC or with specific exemptions from current regulation and statute by a private party. Regardless of ownership the operation of a microgrid which would interact with a utility network distribution system in a high density urban core will require operational coordination and synchronization between the PSE&G as the public utility and the microgrid.

The inclusion of supermarkets, pharmacies, sewer pumps, nonprofit places of refuge was done to address vulnerabilities identified post Superstorm Sandy. During a grid scale power failure these facilities become public exigencies as sources of necessary resources for the public good. Although this represents good planning and public policy the fact that some of these are private for profit entities presents a challenge in configuring what the microgrid should be capable of and who pays the costs for this and avoiding public subsidy of private business. To further complicate this, the private entities were not able to provide their confidential energy use information or to make a commitment to financially participate in supporting a resiliency initiative for a very low frequency low probability scenario. To address these issues the microgrid has been configured to only be utilized during a full emergency grid power event. Under normal conditions these facilities would continue to be exclusively served by PSE&G.

From a regulatory perspective the existing definition of a utility and utility franchise issues would not allow a private entity to own and operate the parallel wire microgrid feeder serving all of the Washington Corridor facilities. A limited exception could be defined for the city owned assets based on the definition of an “On-site Generation Facility” found in the Electric Discount and Energy Competition Act (EDECA) N.J.S.A. 48:3-51. The premise is that both the city properties and city streets are all under one municipal owner and could therefore be consider contiguous properties as defined in EDECA. In order to also serve the non-city owned private parties which would be part of the Washington Street Corridor even as strictly back up resilient power would require granting of exceptions to current regulations unless the system were owned and or operated by PSE&G.

B. Hoboken University Medical Center (HUMC)

The hospital is a primary service facility but is included in the Washington Street Corridor. The hospital proposed solution would be to add CHP unit that would enable full operation during a grid power failure. To enhance this capability the microgrid will be connected with the hospital from the Washington Street microgrid feeder which will enable these resources to share in the redundancy and resiliency of the microgrid resources. The hospital CHP will be sized to support the thermal loads of the hospital and will be configured and controlled under normal operations as an On-site generation asset.

C. Hoboken Housing Authority

The Hoboken Housing Authority owns and operates 10 facilites located in a common area in the south west area of the city. These facilities can be addressed as contiguous properties however each is a separate electric service from PSE&G. The housing authority properties do not have a central utility plant for thermal or cooling systems with all HVAC being installed and operated at the building level. Given these circumstances the housing authority properties are not suitable candidates for CHP. The housing authority property is also too great a distance from the Washington Street corridor to make interconnection to the proposed microgrid in that location feasible. The best case for addressing resiliency at these facilities is to provide a distributed generation (DG) unit. These facilities are located within the FEMA 100 year flood plain and experience flooding at the ground floor during events like Superstorm Sandy. The proposed DG unit can be configured with emissions controls and be utilized for peak load management; however, further engineering is required to evaluate the existing service entrances from PSE&G as well as some previously acquired emergency only type generators. See following section regarding PSE&G system modifications to improve overall reliability and storm resiliency.

4.1 UTILITY COMMERCIAL ISSUES

The proposed microgrid will be required to operate and interact with the PSE&G electric distribution system. Due to the urban congestion and the network design of the PSE&G electric distribution system in Hoboken it is not technically feasible to build a fully separate distribution and supply microgrid such as is typified by a single campus or even a common radial feeder utility system. Under the BPU regulated PSE&G Tariff the type of service and voltage is defied in the following table.

Table 4: BPU regulated PSE&G Tariff the type of service and voltage

Type of Service		Volts
Secondary Distribution Service	Single-phase, two-wire	120
	Single-phase, three wire	120/240
	Single-phase, three-wire	120/208
	Three-phase, three-wire	240
	Three-phase, four wire	120/240
	Three-phase, four wire	120/208
	Three-phase, four-wire	277/480
Primary Distribution Service	Three-phase, four wire	2,400/4,160
	Three-phase, four-wire	13,200
Subtransmission Service:	Three-phase, three-wire	26,400
	Three-phase, three-wire	69,000
High Voltage Service:	Three-phase, three-wire	138,000
	Three-phase, three-wire	230,000

All of the originally identified participants in the Hoboken microgrid are served as Secondary Distribution Service customers. In the development of the study several high priority facilities were identified including the Hoboken University Medical Center (HUMC). The HUMC is the only facility being discussed which is served at Primary Voltage.

A. Secondary Distribution Service

This class of service covers all of the microgrid participants with the exception of HUMC. These customers are served by both underground networked services and in some specific cases with radial service. In particular the Hoboken Housing Authority buildings are served as radial customers.

As a secondary service customer each customer is required to furnish, install, and maintain the service entrance wiring and equipment on the customer's premises. PSE&G is responsible for providing transformers and network protectors for secondary service, and meters and metering equipment. All materials and equipment used are required to be of a type approved by Public Service and must be installed according to the requirements of governmental authorities, Public Service, and the current edition of the National Electrical Code.

B. Primary Distribution Service

This applies to HUMC only as a customer Primary Distribution is defined as customers metered at voltages exceeding 600 volts.

Where service is received at primary distribution, sub-transmission or high voltage entrance voltages, customer must furnish, install and maintain a service entrance interrupting device acceptable to Public Service. PSE&G provides the metering equipment and any required transformers to deliver the specified primary service to the customer. All subsequent transformers and equipment are the responsibility of the customer.

C. Tariff's

Customers served by the secondary distribution system are subject to the PSE&G General Light and Power (GLP) tariff where the customers' Monthly Peak Demand does not exceed 150 kilowatts in any month. Where customer's service exceeds 150 kilowatts in any month customers will be subject to the PSE&G Large Power and Light (LPL) tariff. Customers that are considered Primary Distribution service customers will also be served under the LPL tariff.

RATE SCHEDULE GLP
GENERAL LIGHTING AND POWER SERVICE

Delivery service for general purposes at secondary distribution voltages where the customer's measured peak demand does not exceed 150 kilowatts in any month. Under the GLP tariff customers may either purchase electric supply from a Third Party Supplier (TPS) or from Public Service's Basic Generation Service (BGS) default service. In addition the following charges will apply:

DELIVERY CHARGES: (EDC)

- Service Charge: $4.23 including New Jersey Sales and Use Tax (SUT)
- Distribution Kilowatt Charges:
    - Annual Demand Charge applicable in all months: Charge Including SUT $4.4626 per kilowatt of Monthly Peak Demand

   - Summer Demand Charge applicable in the months of June through September: Charge Including SUT $ 8.2821 per kilowatt of Monthly Peak Demand
- Distribution Kilowatthour Charges: In each of the months of the Months of October through May Including SUT Charge $ 0.003685 per kilowatt hour; in each of the months June through September Charge Including SUT $ 0.010481 per kilowatthour
- Societal Benefits Charge: This charge shall recover costs associated with activities that are required to be accomplished to achieve specific public policy determinations mandated by Government.
- Non-utility Generation Charge: This charge shall recover above market costs associated with non-utility generation costs and other generation related costs as may be approved by the Board. Refer to the Non-utility Generation Charge sheet of this Tariff for the current charge.
- Securitization Transition Charges: These charges include the Transition Bond Charge and the MTC-Tax charge and shall recover costs and associated taxes for transition bonds collected by PSE&G as servicer on behalf of PSE&G Transition Funding LLC.
- System Control Charge: This charge is designed to provide recovery of costs associated with the operation of certain programs as approved by the BPU.
- Commercial and Industrial Energy Pricing (CIEP) Standby Fee: Applicable to all kilowatthour usage for customers who have selected the option of hourly energy pricing service from either Basic Generation Service-Commercial and Industrial Energy Pricing (BGS-CIEP) This charge shall recover costs associated with the administration, maintenance and availability of BGS-CIEP default supply service.
- Solar Pilot Recovery Charge: This charge is designed to recover the revenue requirements associated with the Public Service Solar Pilot Program per the Board Order in Docket No. EO07040278 less the net proceeds from the sale of associated Solar Renewable Energy Certificates (SRECs) or cash received in lieu of SRECs.
- Green Programs Recovery Charge: This charge is designed to recover the revenue requirements associated with the PSE&G Green Programs.
- The Distribution Kilowatthour Charge, the Non-utility Generation Charge, the System Control Charge, the Solar Pilot Recovery Charge and the Green Programs Recovery Charge shall be combined for billing. The CIEP Standby Fee shall also be combined with these charges where applicable.
- Capital Adjustment Charge: These charges are designed to recover the revenue requirements associated with the acceleration of electric capital expenditures in the areas of distribution infrastructure related to improvement in reliability and operation of the system and capital expenditures related to energy efficiency infrastructure improvements.

ELECTRIC SUPPLY CHARGES:

- A customer may choose to receive electric supply from either:
   1. A TPS as described in Section 14 of this Tariff
   2. Public Service through its Basic Generation Service.

BILLING DETERMINANTS:

Monthly Peak Demand: (EDC)
The Monthly Peak Demand shall be determined either by the registration of a demand meter furnished by Public Service or by estimate. Where a demand meter is installed, the customer's Monthly Peak Demand in any month shall be the greatest average number of kilowatts delivered by Public Service during any thirty-minute interval. Where no demand meter is installed, the customer's Monthly Peak Demand shall be determined by estimate by dividing the kilowatthours by 100 for the applicable billing period.

Self-Generation Customer: For customers with operational self-generation units: 1) with a combined maximum net kilowatt output rating equal to or greater than 50% of their Annual Peak Demand; The Monthly Peak Demand used in the determination of the Summer Demand Charges shall be equal to the greatest average number of kilowatts delivered by Public Service during any thirty minute interval that occur during the single hour of monthly maximum peak demand of the Public Service distribution system for the applicable summer billing month. For self generation customers served under this standby provision, the Annual Demand Charge will be applied to the customer's Annual Peak Demand in lieu of the Monthly Peak Demand.

Annual Peak Demand: (EDC)
The customer's Annual Peak Demand in kilowatts shall be the highest Monthly Peak Demand occurring in any time period of the current month and the preceding 11 months.

Generation Obligation: (PJM)
The customer's Generation Obligation, in kilowatts, is determined by Public Service no less frequently than once a year. The Generation Obligation for existing customers or for new customers utilizing an existing building or premise is based upon the customer's share of the overall summer peak load assigned to Public Service by the Pennsylvania-New Jersey-Maryland Office of the Interconnection (PJM) as adjusted by PJM assigned capacity related factors and shall be in accordance with Section 9.1, Measurement of Electric Service, of the Standard Terms and Conditions. The Generation Obligation for customers taking service in a new building or premise, as determined by Public Service, is based upon the load requirements, as estimated by Public Service, of the customer's building or premise. The Generation Obligation represents the generator capacity that PJM requires an electric supplier to have available to provide electric supply to a customer.

Transmission Obligation: (PJM)
The customer's Transmission Obligation, in kilowatts, is determined in a similar manner to the Generation Obligation described above. The Transmission Obligation represents the level of transmission network service that must be procured by the customer's electric supplier from PJM to provide service to the customer. Generation and Transmission Obligations are used in the determination of the customer's charges for Basic Generation Service and may affect the price offered by a Third Party Supplier.

RATE SCHEDULE LPL
LARGE POWER AND LIGHTING SERVICE

Delivery service for general purposes at secondary distribution voltages where the customer's measured peak demand exceeds 150 kilowatts in any month and also at primary distribution voltages. Customers may either purchase electric supply from a Third Party Supplier (TPS) or from Public Service's Basic Generation Service default service as detailed in this rate schedule.

DELIVERY CHARGES for Secondary Distribution Voltages: (EDC)

- Service Charge: $371.68 in each month including New Jersey Sales and Use Tax (SUT)
- Distribution Kilowatt Charges:
    - Annual Demand Charge applicable in all months: Charge Including SUT $3.7200 per kilowatt per kilowatt of highest Monthly Peak Demand in any time period
    - Summer Demand Charge applicable in the months of June through September: Charge Including SUT $ 8.8500 per kilowatt of On-Peak Monthly Peak Demand
- Distribution Kilowatthour Charges: In each of the months of the Months of October through May Including SUT Charge $ 0.000 per kilowatt hour

DELIVERY CHARGES for Service at Primary Distribution Voltages: (EDC)

- Service Charge: $3.7168 in each month including New Jersey Sales and Use Tax (SUT)
- Distribution Kilowatt Charges:
    - Annual Demand Charge applicable in all months: Charge Including SUT $1.7568 per kilowatt per kilowatt of highest Monthly Peak Demand in any time period
    - Summer Demand Charge applicable in the months of June through September: Charge Including SUT $9.7527 per kilowatt of On-Peak Monthly Peak Demand
- Distribution Kilowatt-hour Charges: In each of the months of the Months of October through May Including SUT Charge $ 0.000 per kilowatt hour
- Societal Benefits Charge: This charge shall recover costs associated with activities that are required to be accomplished to achieve specific public policy determinations mandated by Government.
- Non-utility Generation Charge: This charge shall recover above market costs associated with non-utility generation costs and other generation related costs as may be approved by the Board. Refer to the Non-utility Generation Charge sheet of this Tariff for the current charge.
- Securitization Transition Charges: These charges include the Transition Bond Charge and the MTC-Tax charge and shall recover costs and associated taxes for transition bonds collected by PSE&G as servicer on behalf of PSE&G Transition Funding LLC.
- System Control Charge: This charge is designed to provide recovery of costs associated with the operation of certain programs as approved by the BPU.
- Commercial and Industrial Energy Pricing (CIEP) Standby Fee: Applicable to all kilowatt-hour usage for customers who have selected the option of hourly energy pricing service from either Basic Generation Service-Commercial and Industrial Energy Pricing (BGS-CIEP) This charge shall recover costs associated with the administration, maintenance and availability of BGS-CIEP default supply service.
- Solar Pilot Recovery Charge: This charge is designed to recover the revenue requirements associated with the Public Service Solar Pilot Program per the Board

Order in Docket No. EO07040278 less the net proceeds from the sale of associated Solar Renewable Energy Certificates (SRECs) or cash received in lieu of SRECs.
- Green Programs Recovery Charge: This charge is designed to recover the revenue requirements associated with the PSE&G Green Programs.
- The Distribution Kilowatt-hour Charge, the Non-utility Generation Charge, the System Control Charge, the Solar Pilot Recovery Charge and the Green Programs Recovery Charge shall be combined for billing. The CIEP Standby Fee shall also be combined with these charges where applicable.
- Capital Adjustment Charge: These charges are designed to recover the revenue requirements associated with the acceleration of electric capital expenditures in the areas of distribution infrastructure related to improvement in reliability and operation of the system and capital expenditures related to energy efficiency infrastructure improvements.

ELECTRIC SUPPLY CHARGES:
- A customer may choose to receive electric supply from either:
  3. A TPS as described in Section 14 of this Tariff
  4. Public Service through its Basic Generation Service.

BILLING DETERMINANTS:

Monthly Peak Demand: (EDC)
The Monthly Peak Demand shall be determined either by the registration of a demand meter furnished by Public Service or by estimate. Where a demand meter is installed, the customer's Monthly Peak Demand in any month shall be the greatest average number of kilowatts delivered by Public Service during any thirty-minute interval. Where no demand meter is installed, the customer's Monthly Peak Demand shall be determined by estimate by dividing the kilowatt-hours by 100 for the applicable billing period.

Self-Generation Customer: For customers with operational self-generation units: 1) with a combined maximum net kilowatt output rating equal to or greater than 50% of their Annual Peak Demand; The Monthly Peak Demand used in the determination of the Summer Demand Charges shall be equal to the greatest average number of kilowatts delivered by Public Service during any thirty minute interval that occur during the single hour of monthly maximum peak demand of the Public Service distribution system for the applicable summer billing month. For self-generation customers served under this standby provision, the Annual Demand Charge will be applied to the customer's Annual Peak Demand in lieu of the Monthly Peak Demand.

Annual Peak Demand: (EDC)
The customer's Annual Peak Demand in kilowatts shall be the highest Monthly Peak Demand occurring in any time period of the current month and the preceding 11 months.

Generation Obligation: (PJM)
The customer's Generation Obligation, in kilowatts, is determined by Public Service no less frequently than once a year. The Generation Obligation for existing customers or for new customers utilizing an existing building or premise is based upon the customer's share of the overall summer peak load assigned to Public Service by the Pennsylvania-New Jersey-Maryland Office of the Interconnection (PJM) as adjusted by PJM assigned capacity related factors and shall be in accordance with Section 9.1, Measurement of Electric Service, of the

Standard Terms and Conditions. The Generation Obligation for customers taking service in a new building or
premise, as determined by Public Service, is based upon the load requirements, as estimated by Public Service, of the customer's building or premise. The Generation Obligation represents the generator capacity that PJM requires an electric supplier to have available to provide electric supply to a customer.

Transmission Obligation: (PJM)
The customer's Transmission Obligation, in kilowatts, is determined in a similar manner to the Generation Obligation described above. The Transmission Obligation represents the level of transmission network service that must be procured by the customer's electric supplier from PJM to provide service to the customer. Generation and Transmission Obligations are used in the determination of the customer's charges for Basic Generation Service and may affect the price offered by a Third Party Supplier.

4.2 ENERGY SAVINGS POTENTIAL (ELECTRIC POWER)

The determination of who owns and operates the microgrid will have significant bearing of savings potential. There are two configurations that can enable microgrids to reduce utility costs. These are cost savings by displacing utility supplied power with onsite generation and selling of capacity or other resources under PJM grid power operation.

Displacing utility power is a behind the meter operation. Under this type of scenario all of the utility costs are displaced so the facility sees savings on all components of the normal supply of utility electric power. The most common application for onsite power is CHP, Solar or DG. Any or all of these can be combined with energy storage to optimize the economics and energy resiliency. Because these facilities need to be maintained they are still subject to annual EDC demand costs and may also incur PJM associated costs for generation and transmission. CHP is sized based on the combined electrical and thermal utilization and to achieve the desired efficiency typically does not meet the peak power demand of the host site. Supplemental power is purchased from the utility as is power required during annual maintenance. CHP is designed for maximum run time 94% but only meets 60-75% of peak power requirements. CHP is a minor overall resource in the Hoboken Microgrid due to the absence of centralized thermal distribution for either heating or cooling systems.

Solar is also proposed where there is available space. This is a limited resource but as proposed the microgrid will utilize both battery storage and microgrid controls to keep the Solar PV available as a resource during a grid scale power outage. These systems will need to utilize advanced microgrid control to enable this function.

The largest potential in Hoboken is for resilient Distributed Generation (DG) assets. These are emissions controlled packaged reciprocating engines designed and managed as both grid connected behind the meter systems and able to operate in the event of grid power failure as resilient microgrid assets. To generate energy savings these units under normal operating conditions are dispatched to reduce PSE&G demand costs and PJM Generation and transmission costs. They can also be dispatched based on spark spread that would indicate that onsite generation is less cost that grid power imports. The majority of the savings for these units is from reducing PJM related costs. These achieve their savings with low operating hours these are targeted operations which coincide with times that PJM assigns customers their share of costs. These times are almost exclusively during summer peak power time periods when the electric grid is utilizing the dirtiest and least efficient resources to meet peak power requirements. It is also when the transmission system is strained and operating at reduced efficiency.

4.3 COMPLICANCE WITH BPU CLEAN ENERGY FUNDS

The Electric Discount and Energy Competition Act (EDECA) P.L. 1999 Chapter 23 authorized the BPU in consultation with the DEP to establish within the Societal Benefits Charge funds for continuation and expansion of the then existing demand side management programs. This specifically charged the BPU to determine the funding levels for Energy Efficiency and Renewable Energy support.

The proposed Hoboken Microgrid incorporates both energy efficiency and renewable energy systems. The combined heat and power component delivers both electric power and thermal energy in a more efficient manner than separate production of electric power and thermal energy. This system will fully comply with the current BPU Clean Energy CHP incentive and will exceed the minimum efficiency required. In addition the establishment of a microgrid will enable the deployment of Solar PV with energy storage. Photovoltaic systems were specifically identified as eligible renewable energy under C.48:3-60 and the inclusion of energy storage will enable the microgrid to optimize the use of PV to address peak loads and to be a resilient resource. The microgrid does include distributed generation which is necessary to meet the island mode of operation in the event of a utility grid loss of power. In normal blue sky operations these units can be operated during periods of extremely high electrical demand. During these periods the operation of high efficiency natural gas engines avoid transmission losses and displace power which would have otherwise been generated by the least efficient grid peak power generation. In addition to being a more efficient source of power during these peak power periods the distributed generators which are equipped with SCR emissions controls are also lower emissions sources of electric power compared to older peaking combustion turbines which do not have SCR systems.

The proposed microgrid based on the deployment of renewable energy and energy efficient systems is consistent with the approved use of SBC funds as authorized by EDECA P.L. 1999 Chapter 23.

5.0 COST ESTIMATE

Budgetary construction cost estimates were developed for the proposed microgrid system to identify all costs associated with permitting, design, equipment procurement, construction, start-up testing and commissioning. The values represented in the cost estimates are based on several different factors investigated during the development of this phase of the project.

Equipment budgetary costs were provided by vendors for the electrical equipment including switchgear, transformers, transfer switches, breakers, meters, etc. Budgetary costs were also provided for the generation assets including the Solar PV system, battery storage cells, packaged distributed generation and combined heat and power units. The lengths of underground duct bank were estimated based on the developed layout drawings. Installation costs for this work were estimated and compared to the cost to install the existing duct bank recently installed beneath Washington Street. Site work, mechanical and electrical contracting costs for the generator installations were based on required materials and previous experience on similar design build projects in dense urban environments. The microgrid control system cost was developed by multiple vendors and the proposed costs and scopes were compared to determine an accurate cost for the project. The microgrid control system cost includes all required hardware and integration. Professional services costs including engineering, equipment procurement, construction management, commissioning, etc. were based on industry standard percentage of construction costs. Escalation was included as a project cost because this work will likely not begin for at least one year.

Washington Street Corridor:

Electrical Distribution System	$7,300,366
Distributed Generation Resources	$11,552,131
Microgrid Control System	$1,911,000
Professional Services	$4,686,717
Project Costs	$5,090,043
Total	**$30,540,257**

Hoboken Housing Authority Corridor:

Electrical Distribution System	$5,162,036
Distributed Generation Resources	$1,843,442
Microgrid Control System	$819,000
Professional Services	$1,774,868
Project Costs	$1,919,869
Total	**$11,519,216**

Line-item cost estimates are presented in Appendix D.

6.0 FINANCIAL PRO-FORMA

An unlevered financial pro-forma model was developed by Concord to project the individual cost savings of the CHP system, DG demand management strategy, solar PV and battery storage system. Inputs for the model were based on energy analysis, utility costs, estimated operating & maintenance costs, system performance and assumed equipment uptime. The financial pro-forma is based on a 20 year life cycle and is separated for the Washington Street and Housing Authority Corridors.

In addition to the Concord pro-forma models, Rutgers University developed a Distributed Energy Resources Customer Adoption Model (DER-CAM) for the two separate corridors.

6.1 COMBINED HEAT AND POWER

The model is based on 8,760 hourly electrical data and daily natural gas consumption provided by the hospital. The CHP system is projected to operate 95% of the year at full capacity. Generated power offsets purchased utility electricity supply the microgrid system. Waste heat from engine exhaust and jacket water is used to offset the hospital's thermal needs. The revenue accounted for in the model is based on the reduction in power required to be purchased to supply the microgrid and fuel offset from the reduction in steam production for the hospital for heating and cooling. The CHP Plant expenses included in the model are for engine fuel costs and plant operation and maintenance costs. The life cycle of the project is assumed to be 20 years; however, with proper maintenance and rebuilds, the equipment can operate beyond an excepted 20 year life cycle.

The financial model offset electricity cost is based on billing data provided for the 2017 year with a 2.5% annual escalation cost.

6.2 DISTRIBUTED GENERATION

Each engine was modeled to operate approximately 1,200 hours per year to reduce the site's electrical demand. The capacity to consistently shave the amount of electrical demand by the facilities collectively creates a mechanism to reduce transmission and demand charges imposed from the electrical utility and reduce the capacity charge from PJM. To fully monetize the DG capacity will require any new electricity wholesale commodity contract to be negotiated to include this attribute.

The DG financial model developed for this study fully monetizes reducing demand charges and includes cost savings from a reduction in ISO capacity charges, transmission charges, reduction in local utility peak demand charges. Additional revenue accounted for in the model is based on the offset of electricity purchased. The DG engines expenses included in the model are for fuel cost for electrical generation and engine operation and maintenance costs. The life cycle of the project is assumed to be 20 years; however, with proper maintenance and rebuilds, the equipment can operate beyond an excepted 20 year life cycle.

The financial model offset electricity cost is based on billing data provided for the 2017 year with a 2.5% annual escalation cost.

6.3 SOLAR PV

The microgrid PV system size is based on the available roof space on the midtown garage and a section of the hospital. The availability of solar generation is dependent on the estimated amount of sunny and clear hours in Hoboken. Solar generation will reduce the amount of electricity purchased from utility.

The Solar PV system financial model developed for the microgrid study considering standard module, fixed array type with 96% inverter efficiency. PV system operating costs include costs to maintain the solar equipment. The life time of PV system for this project is estimated to be 20 years; however, with proper replacement of inverter modules and maintenance, the equipment can operate beyond as expected 20 year life cycle. The financial model offset electricity cost is based on billing data provided for the 2017 year with a 2.5% annual escalation cost.

6.4 BATTERY STORAGE SYSTEM

As part of Hoboken microgrid project, the potential implementation of 1MW/4MWh battery storage is considered. It is fuel neutral, converting either purchased, solar generated or engine generated energy produced.

The battery storage system financial model developed considering lithium-ion technology with expected 5000-cycle life. Life time for battery storage depends on the Depth of discharge (DoD) of battery and state of charge (SoC) of battery.

Financial model offset the demand charges for 500kW peak demand available for the 2017 year, which is assumed for this study and further may be evaluated based on DoD and SoC.

6.5 PRO-FORMA RESULTS

The results from the financial pro-forma are summarized in the below table for both the Washington Street and Housing Authority Corridors. Additional information including the 20 year life cycle analysis' can be found in Appendix E.

Table 5: Financial Pro-Forma Results

Microgrid Corridor	Washington Street	Housing Authority
Final Capital Cost w Incentives	$29,740,257	$11,519,216
Electricity Cost LPLS - Existing (/ kWh)	$0.130	$0.130
Electricity Cost LPLP - New (/ kWh)	$0.120	$0.120
Cost of Natural Gas (/ MMBtu)	$4.00	$4.00
Distributed Generation		
Capacity (kW)	2,000	1,000
Revenues	$834,208	$417,104
Expenses	$142,560	$71,280
Total Savings	**$691,648**	**$345,824**
Combined Heat and Power		
Capacity (kW)	800	
Revenues	$1,279,432	
Expenses	$313,127	
Total Savings	**$966,305**	
Solar PV & Battery Storage		
Capacity (kW)	772	
Revenues	$600,614	
Expenses	$60,438	
Total Savings	**$540,176**	
Microgrid System		
Utility Electric Reduction (kWh/hr)	9,568,840	1,200,000
Revenues	$83,951	$33,200
Expenses	$492,161	$6,640
Total Savings	**-$408,210**	**$26,560**
Total Savings	**$1,789,919**	**$372,384**
NPV @ 4%	-$3,809,780	-$6,153,075
Internal Rate of Return (IRR)	2.58%	-3.15%
Simple Payback	16.0	30.9
Annual Carbon Savings (Metric Ton)	4,405	NA

6.6 PHASED APPROACH

An additional evaluation was conducted to determine the financial benefit of installing microgrid components in phases to identify the benefit of specific systems if only partial funding is available at the start of the project. In these proposed phases, only a portion of the microgrid is constructed at the start of the project.

The “City Owned Facilities Only” option evaluates the cost benefit of connecting city owned buildings to the Washington Street microgrid with a planned future phase to include all other buildings and assets in the future. This initial phase includes the interconnection scope to power the microgrid with a new utility feed. The existing Washington Street duct bank system would be utilized to route new power and controls cabling to the City Owned buildings. The buildings included in this option are City Hall, Police Headquarters, Fire Department Company 3 and the 3 parking garages. A new 500 kW packaged natural gas reciprocating generator will be used to power the system during peak hours as part of a demand management strategy. The new packaged engine generator and existing generators would be used to power the system during a power outage. Because the city owned buildings peak electric load is under 1 MW, a smaller engine generator is required for this option. This will require a second natural gas engine to be installed during the future phase, which will increase the overall project cost.

The “City and Sewer Authority” option is similar to the above; however, it also includes the 3 Sewer Authority pump stations. This option was evaluated because the system has a larger load above 1 MW allowing for a more beneficial demand management strategy. The originally proposed packaged reciprocating engine generator could be installed and operated at part load until additional buildings are added to the system or 2x 1 MW units can be installed in phases. The addition of the pump stations increases the financial benefit of the phased microgrid while supplying power to additional public facilities.

The “Medical Center CHP” option evaluates the benefit of installing an independent CHP system at Hoboken University Medical Center. During a future phase, the CHP Plant would be interconnected to the microgrid. The packaged engine generator would provide power to only the hospital until microgrid system phase is complete. Because the hospital base electrical load is slightly lower than the proposed 800 kW engine, the unit operates at part load for a portion of the year. The CHP Project has higher energy savings than the other microgrid power generating assets and provides a higher return on investment than the other proposed phases. This option includes the benefit of an annual carbon savings of over 3,400 metric tons.

The results for the three option are summarized in the below table. 20 year life cycle analyses are included in Appendix E.

Table 6: Phased Approach Financial Pro-Forma Results

Microgrid Corridor	City Owned Facilities Only	City & Sewer Authority	Medical Center CHP
Final Capital Cost w Incentives	$7,800,512	$9,535,922	$7,794,760
Electricity Cost LPLS - Existing (/ kWh)	$0.130	$0.130	$0.130
Electricity Cost LPLP - New (/ kWh)	$0.120	$0.120	$0.120
Cost of Natural Gas (/ MMBtu)	$4.00	$4.000	$4.000
Power Generation			
Capacity (kW)	500	1,000	800
Revenues	$208,552	$417,104	$1,159,406
Expenses	$35,640	$71,280	$313,127
Total Savings	**$172,912**	**$345,824**	**$846,279**
NPV @ 4%	-$4,718,972	-$3,372,842	$4,529,528
Internal Rate of Return (IRR)	-4.04%	-0.08%	9.49%
Simple Payback	28.5	20.1	9.4

6.7 DER-CAM MODEL

Rutgers University developed the Distributed Energy Resources – Customer Adoption Model (DER-CAM) for this project using inputs from this report's findings. The purpose of the DER-CAM model is to identify the effectiveness of the proposed microgrid and project how generation assets will operate to best benefit the system. The model uses an optimization algorithm to analyze several conditions including system energy consumption, load shifting, potential demand management revenues, energy costs, generation asset performance, weather conditions, etc. and uses these factors to estimate the impact of the microgrid assets on the community's energy infrastructure.

For this project, the DER-CAM model identifies the optimal time to deploy the DG, Solar, Battery and CHP technologies to maximize the financial benefit of the system. The model evaluates the impact of the microgrid system on the end users energy usage and compares existing and proposed energy values. This includes annual consumption, peak demand, power loss through distribution and heat recovery. The model generates graphs identifying how the generation assets are dispatched throughout the day and different times of year are compared for heating vs cooling seasons and weekdays vs weekends. The graphs also represent how electricity is purchased from the utility and they compare this with existing conditions and after the proposed microgrid is in service.

When comparing the DER-CAM model results with the pro-forma developed for this report the values are similar. The project power generation of the Washington Street Corridor generation assets is within 5% for both the pro-forma and the DER-CAM model. The generation values used for the financial pro-forma are less than the DER-CAM model, which identifies the projected revenue values used for this project are conservative. Results developed by the DER-CAM model are provided in the below tables. Additional graphs can be found in Appendix H.

Washington Street Annual Impact Analysis:

Annual Consumption (MWh)	Annual Energy Consumption Before MG (MWh)	17,964
	Annual Energy Consumption After MG (MWh)	7,834
	Energy Consumption Reduction (MWh)	10,130
	Energy Consumption Reduction (%)	% 56.2
Annual peak load (MW)	Peak Demand Before MG (MW)	4.3
	Peak Demand After MG (MW)	3.5
	Peak Demand Reduction (MW)	0.8
	Peak Demand Reduction (%)	% 18.6
Annual power Loss (MWh)	Real Power Loss Before MG (MWh)	160.45
	Real power Loss After MG (MWh)	70.85
	Distribution Power Loss Reduction (MWh)	89.6
	Power loss reduction (%)	% 55.8
Heat Recovery	Annual recovered heat at the hospital facility (US-Therm)	384.5

Housing Authority Annual Impact Analysis:

Annual Consumption (kWh)	Annual Energy Consumption Before MG (kWh)	4,554,903.66
	Annual Energy Consumption After MG (kWh)	674,914.14
	Energy Consumption Reduction (kWh)	3,879,989.52
	Energy Consumption Reduction (%)	85.18
Annual peak load (kW)	Peak Demand Before MG (kW)	1,455.97
	Peak Demand After MG (kW)	1,385.38
	Peak Demand Reduction (kW)	70.58
	Peak Demand Reduction (%)	4.85
Annual power Loss (kWh)	Real Power Loss Before MG (kWh)	33,435.10
	Real power Loss After MG (kWh)	14,054.63
	Distribution Power Loss Reduction (kWh)	19,380.47
	Power loss reduction (%)	57.96
Recip. Engine operation	Capacity (kW)	1,200
	Elec. Efficiency (%)	37
	Annual Elec. Production (kWh)	3,860,609.05
	Annual NG Consumption (U.S. Therm)	364,613.07

7.0 PROJECT FINANCING

The proposed microgrid serves municipal, public authority, Federal Housing Authority and privately owned facilities. The ownership structure will need to consider the public purchasing and public finance issues this raises. In addition where either distribution system assets or distributed generation is deployed there are both tax credit and taxable vs tax exempt issues.

The first issue will be to what extent PSE&G as a regulated public utility will be interested in owning and or operating distribution, control and distributed generation assets. Although PSE&G has chosen to place all of their originally owned generating assets into an unregulated subsidiary PSEG Power there is still a possibility that some or all of the microgrid could be owned and operated by PSE&G as a regulated public utility. This is particularly true of the proposed electrical distribution assets. PSE&G has not taken a position on this issue as they would need direction from the NJBPU as to whether this would be even feasible. This could also be implemented with private ownership of DG and PSE&G ownership of microgrid dedicated distribution. There is precedent for private entities constructing electrical distribution assets to utility standards and then deeding the assets over to the utility for operation. This was the case for the 69 KV substation improvements done for Rowan University.

In particular any renewable and storage should be structured as third party ownership to enable the project to take advantage of federal Investment Tax Credits and depreciation. This is also true of CHP to a lesser extent. In addition to grants such as the Clean Energy Program (CEP) CHP grant which could support the hospital CHP component there will be a funding gap that will need to address the value placed on resiliency. The proposed microgrid will be a capital intensive project and the resiliency benefit is an extremely low probability low frequency contingency. This will then make the successful implementation dependent on supplemental funding. To some extent depending on their participation PSE&G may be able to include components of the microgrid as rate based assets. This will need to consider that PSE&G has already made significant resiliency investments under the Energy Strong program and what additional value for resiliency that the microgrid can provide.

The microgrid could also receive exemptions from the BPU to allow a private owner to own and operate both the distribution and distributed generation assets which would a full third party ownership structure Legislation pending in the state S-865 may facilitate this type of public private partnership. There is also a precedent which was utilized for the redevelopment including district energy at the Army Walter Reid Hospital complex. For this project an owners association was formed to own the shared distribution assets structured along the lines of a cooperative association.

8.0 PROJECT BENEFITS

This project will provide additional resiliency to the Hoboken community that is vulnerable to emergency events based on past flooding events. Interconnecting critical facilities to a new microgrid will provide a means for emergency power during unplanned electric utility outages. Important municipality facilities that currently are shutdown during blackout events will be capable of operating and providing services to the community. The new generation assets fueled by natural gas and sunlight will be capable of operating for long durations during outages without the requirement of refueling with diesel fuel, which can be difficult to purchase and transport during utility outage events. Existing diesel generators within the hospital and pump stations will not be required to operate during long outage periods to conserve stored liquid fuel. This will provide flexibility to the hospital and sewerage authority such that their staffs' can focus on their priorities during an emergency and not have to focus on keeping emergency generators operating.

The addition of the new generator assets will provide approximately $1.9 million in annual utility cost savings. This savings is realized by reducing the peak electric loads with an extensive demand management strategy that dispatches the natural gas engines and Solar PV Battery system during peak demand periods. The addition of CHP reduces natural gas and electric loads by simultaneously producing power, hot water and chilled water with a single fuel. The Solar PV system reduces power purchased from the grid without the consumption of fossil fuel.

The addition of a CHP Plant and Solar PV will decrease the community's reliance on fossil fuels and will reduce the carbon footprint by approximately 4,400 metric tons per year. This equates to removing almost 1,000 cars from roadways.

8.1 PERFORMANCE EXCELLENCE IN ELECTRICITY RENEWAL (PEER)

Performance Excellence in Electricity Renewal (PEER) is a certification program for power systems that measures and provides inputs to improve system performance. It can be used for all types of electrical supply systems and provides guidance for cities, campuses, critical infrastructure and transit. PEER rates systems performance across the following categories:

- Reliability and resiliency
- Operations management and safety
- Energy efficiency and Environment
- Grid services
- Innovation & exemplary performance
- Regional priority

Certifications can be completed by meeting published requirements and meeting a specific score under the PEER rating system. The certification process includes four different levels to indicate how well a system is performing.

It is the intent of this project to submit the system for PEER evaluation during the design and construction phases as required. This will allow the City of Hoboken to understand the benefits of the microgrid system when compared to other city microgrids. During operation the PEER program will monitor the performance of the system and provide guidance on how it can be improved in the future.

8.2 PROJECT NEXT STEPS

There are several open items that need to be confirmed before the microgrid will enter the Phase II engineering phase. The BPU will need to provide guidance on the open regulatory issues defined in this report. This will allow the City of Hoboken to determine the best path forward in terms of ownership of the system. The City of Hoboken will need to define if the system will be owned and operated by PSE&G, the city itself, a third party co-op or third party for profit.

After the ownership is defined, the city will reach out to all project partners and present the project benefits as well as financial structure of the microgrid. At this point the project partners will enter an agreement to move forward with the project and be an active participant. During the phase II engineering effort, the engineer of record will begin by reevaluating the project partner facilities to ensure the energy profiles have not changed or incorporate any changes into the energy analysis.

The Phase II Engineering effort will include a 30-50% engineering effort and the development of a schematic design package. This will define the project scope of work, design basis, major equipment selections, mechanical/electrical diagrams to define piping and electrical system sizes and tie-ins, communication with the utility, microgrid control philosophy, equipment layout plans, etc. The schematic design package will be reviewed by the City of Hoboken, the BPU and PSE&G. Comments from the organizations will be incorporated and an investment grade level cost estimate will be developed to finalize the intent of the project. Project partners will be kept informed during this phase and will be allowed to provide input as necessary.

The documents will be distributed to potential bidders as part of an RFQ/RFP period. The City of Hoboken will solicit Engineer, Procure, Construct (EPC) contractors or Design Build Own Operate Maintain (DBOOM) contractors depending on the decided commercial agreement determined to be acceptable between the BPU and the City of Hoboken. The selected contractor will further develop the schematic design into construction level drawings, purchase major equipment and procure sub-contractors. The engineer whom provided services for the Phase II Engineering Effort will remain as Owner's Engineer to review progress and check construction is in accordance with the requirement set forth by the RFP.

After the project is started and operating, performance will be monitored to confirm it is in accordance with the design and project intent. The system will either be operated by the DBOOM contractor or handed over to PSE&G, the City of Hoboken or a 3rd party co-op to operate.

9.0 SCHEDULE & PERMITTING

A schedule was developed to detail the project's anticipated progress moving forward. The first step will be to receive direction from the BPU to address the regulatory issues relative to the microgrid. After the BPU provides a notice to proceed with Phase II engineering, the City of Hoboken will engage an engineering firm to develop a schematic design package to bid to EPC Bidders to complete the scope of work. The project partners will be reengaged during the Phase II engineering phase and the modifications to their facilities will be further defined as engineering progresses. The City of Hoboken, the BPU and PSE&G will be provided with draft engineering documents for review and comment before the RFP and RFP for EPC contractors is developed and put out to bid. The schedule includes expected durations for the EPC bid process; however, this could vary depending on organizations involved with this process. The schematic design and EPC bid period is expected to take approximately 11 months.

An EPC schedule was included which details the phases for developing construction documents, permitting, procuring equipment and constructing the project. This schedule assumes several phases of the projects are constructed concurrently. The construction schedule may be extended for specific sections of the project based on phasing and access to various sites within the project. The EPC phase is expected to take approximately 18 months.

The EPC contractor will be responsible for obtaining permits for the project. This includes construction permits, air permits and approval of the electrical interconnect application for the utility connections. The City of Hoboken's Construction Permit Department will require Road Opening Permits for all underground work beneath city streets and sidewalks. The Hoboken Construction Permit Department will not review the underground electrical design. The electrical distribution design will be per PSE&G standards and is anticipated to be reviewed by PSE&G for approval as part of the interconnection application. Separate interconnection applications will be required to be submitted for the Washington Street and Hoboken Housing Authority corridors. The State of New Jersey Department of Community Affairs (DCA) will view design drawings for facilities under their jurisdiction and will issue permits once approved. This will include the facilities for the Housing Authority, Hoboken University Medical Center, North Hudson Sewer Authority Hoboken Homeless Shelter, YMCA and Columbian Towers. The natural gas generators will require separate general air permit applications to be submitted to the State of New Jersey Department of Environmental Protection through the Bureau of Stationary Sources.

A detailed schedule is included in Appendix G.

10.0 CURRENT ELECTRIC & NATURAL GAS UTILITY UPGRADES

Starting in 2014, PSE&G has been implementing a major project to upgrade 60% of the natural gas distribution piping within the City of Hoboken as part of the utility's Energy Strong Program. The project is replacing 31,000 linear feet of low pressure old cast iron mains in or near flood areas with new polyethylene pipe. The new piping system will be rated for a higher pressure and the buried material will be capable of preventing water from penetrating the system during future flood events, increasing the reliability of natural gas service for the City of Hoboken.

As part of the Energy Strong program, PSE&G is combining Hoboken's three electrical substations into two and raising the substations to protect them from flooding. PSE&G has already invested $130 million to upgrading and elevating the 16th Street Substation. This project is nearing completion.

The Madison Street Substation project is underway and will upgrade the station to make it more reliable and resilient in the wake of severe weather. The new substation will be elevated to protect it from flooding, and make upgrades to improve the reliability of the distribution system. The new substation features state-of-the-art, 69,000-volt (69kV) gas insulated switchgear to serve the electric distribution system, benefiting Hoboken businesses and residents. This project is also relocating existing electric distribution infrastructure from the Marshall Street Substation on Second Street to the new Madison Street Substation, allowing for deconstruction of the Marshall Street Substation. Once the

Madison Street Substation is expanded and placed into service, the Marshall Street Station will be decommissioned and that property will be remediated and deeded to the city.

PSE&G will raise critical electric transmission facilities and distribution equipment above new Federal Emergency Management Agency (FEMA) flood guidelines, replace aging infrastructure, and install new technology that can monitor the station remotely and restore power more quickly if an outage occurs. These improvements will enhance the safety and reliability of the power delivery system and enhance resiliency during severe weather.

New 69kV circuits are also being added to connect the new station to existing stations in North Bergen, Kearny, and Jersey City to strengthen the local grid/circuits that support electric reliability in Hoboken. These lines will run on existing overhead pole lines, which will be replaced with taller, sturdier poles, and will run underground where needed.

11.0 APPENDIX

A Project Drawings
- Site Plan Layout Drawings
- Single Line Diagrams
- Control System Architecture
- CHP Heat and Mass Balance Diagram

B Microgrid Facility Summary Table

C Facility Electric and Thermal Load Graphs and Tables

D Project Cost Estimates

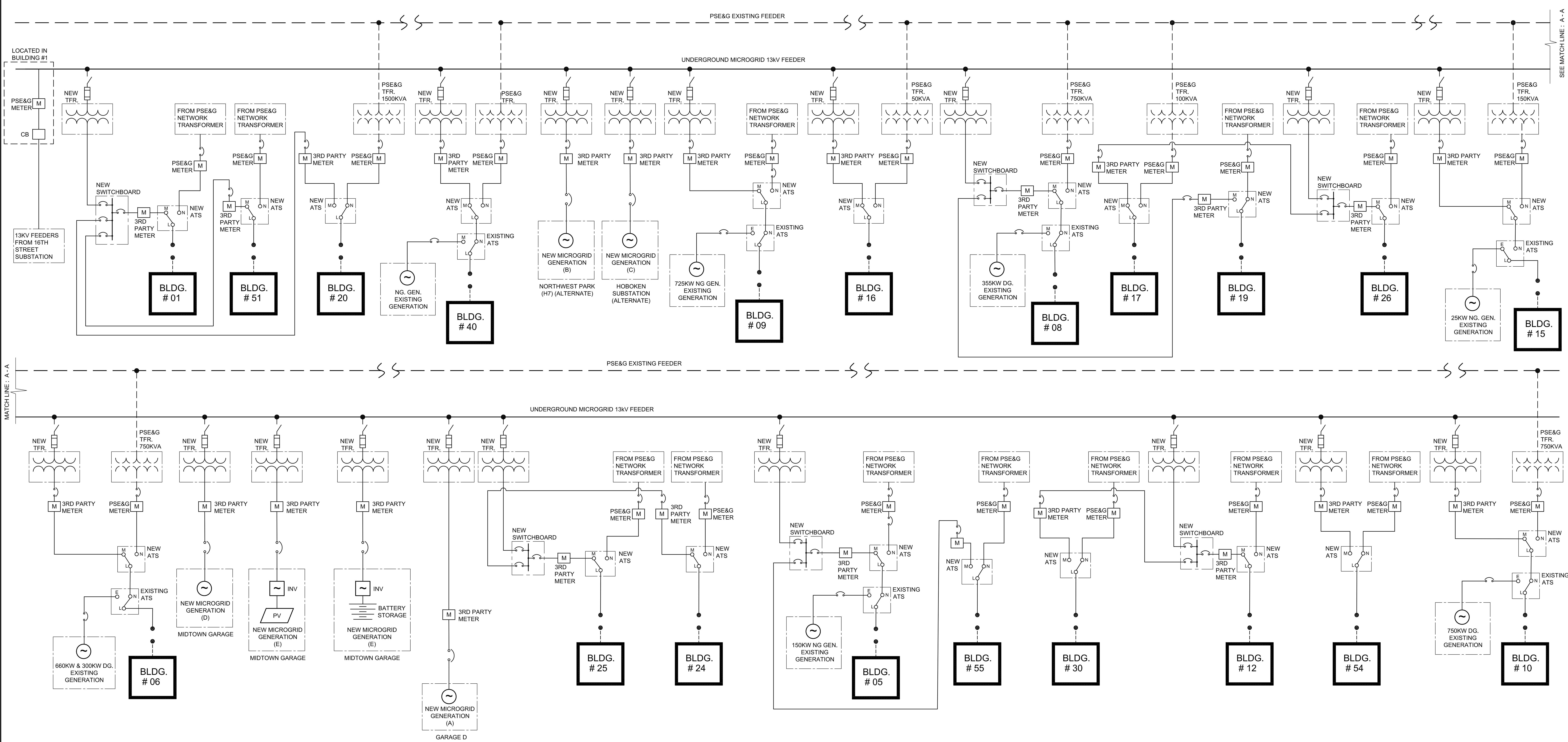
E Project Financial Pro-Forma Analysis

F DER-CAM Results

G Schedule

APPENDIX A

PROJECT DRAWINGS



MICROGRID GENERATION DETAILS							
DESIGN SUMMARY	LOCATION NAME	ADDRESS	PROPERTY OWNER	GENERATION TYPE	REVENUE SOURCE	USER	APPROXIMATE SIZE
A	GARAGE D	215 HUDSON STREET	CITY OF HOBOKEN	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	2 MW
B	NORTHWEST PARK (H7) (ALTERNATE)	13TH & JEFFERSON	NORTH HUDSON SEWARAGE	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	2 MW
C	HOBOKEN SUBSTATION (ALTERNATE)	16TH & CLINTON	CITY OF HOBOKEN OR PSE&G	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	2 MW
D	MIDTOWN GARAGE	330 CLINTON ST	CITY OF HOBOKEN	PACKAGED RECIPROCATING ENGINE GENERATOR	CHP	HOBOKEN UNIVERSITY MEDICAL CENTER	1 MW
E	MIDTOWN GARAGE	330 CLINTON ST	CITY OF HOBOKEN	SOLAR PV	SOLAR PV WITH STORAGE	COMPLETE MICROGRID	1 MW

WASHINGTON STREET FACILITY DETAILS		
BUILDING NO.	BUILDING TYPE	LOCATION
1	FIRE ENGINE CO 3	1313 WASHINGTON STREET
5	POLICE HQ	106 HUDSON STREET
6	HOBOKEN UNI MEDICAL CENTER	308 WILLOW AVENUE
8	PUMP STATION 5TH STREET	500 RIVER ROAD
9	PUMP STATION 11TH STREET	83 11TH STREET
10	PUMP STATION H1	99 OBSERVER HIGHWAY
12	HOBOKEN CITY HALL	94 WASHINGTON STREET
15	HOBOKEN HOMELESS SHELTER	300 BLOOMFIELD
16	ST. MATTHEW'S CHURCH	57 8TH STREET
17	ST. PETER AND PAUL CHURCH	404 HUDSON STREET
19	GROCERY KINGS	325 RIVER STREET
20	GROCERY KINGS	1212 SHIPYARD LANE
24	GARAGE B	28 2ND STREET
25	GARAGE D	215 HUDSON STREET
26	GARAGE G	315 HUDSON STREET
30	COLUMBIAN TOWERS	76 BLOOMFIELD STREET
40	HOUSING AUTHORITY 10	311 13TH STREET
51	YMCA	1301 WASHINGTON STREET
54	CVS	59 WASHINGTON STREET
55	WALGREENS	101 WASHINGTON STREET

OWN & OPERATE BY 3RD PARTY

CLIENT:

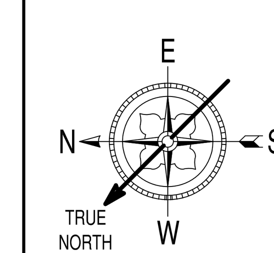
HOBOKEN

CONCORD ENGINEERING
P.A. 24GA27936700
520 South Burnt Mill Road
Voorhees, New Jersey 08043
(856) 427-0200
www.concord-engineering.com

A	06/15/2018	PRELIMINARY	DC	SK	DD
No.	Date	Description	BY	CHK	APP

REVISIONS:

KEY PLAN:



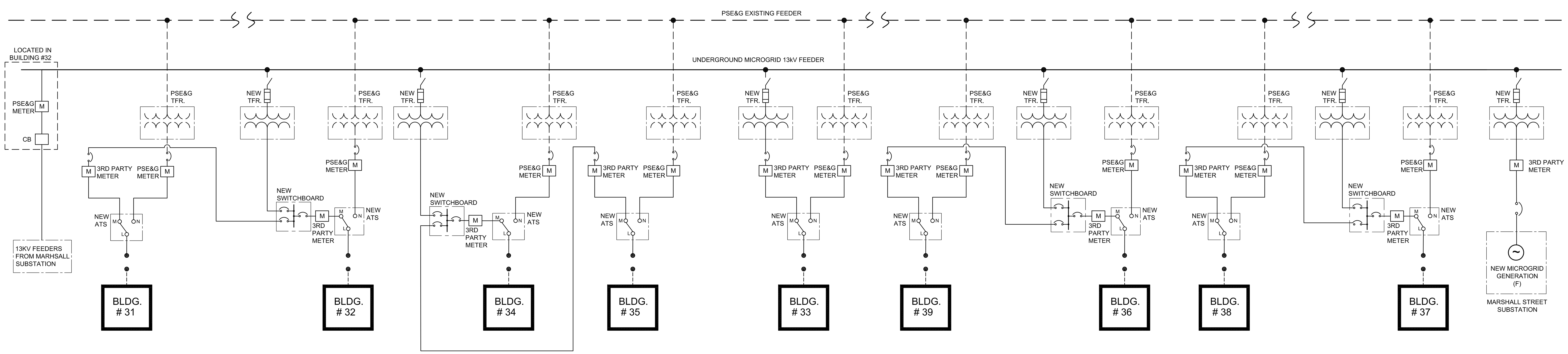
PROJECT:

HOBOKEN TOWNSHIP MICROGRID
CITY OF HOBOKEN
94 WASHINGTON STREET
HOBOKEN NJ 07030

DRAWING TITLE:

ELECTRICAL
KEY ONE LINE
WASHINGTON STREET

DRAWN BY: B.G	SCALE: AS NOTED	DWG SIZE: 24x36	
CHECKED BY: S.K	DRAWING NO.		REVISION
DATE: 03/22/2018	E-101		A
PROJECT NO.: 2C17556.00			



MICROGRID GENERATION DETAILS

DESIGN SUMMARY	LOCATION NAME	ADDRESS	PROPERTY OWNER	GENERATION TYPE	REVENUE SOURCE	USER	APPROXIMATE SIZE
F	MARSHALL STREET SUBSTATION	MARSHALL STREET AND 2ND STREET	CITY OF HOBOKEN OR PSE&G	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	1.2 MW

HOBOKEN HOUSING AUTHORITY FACILITY DETAILS

31	HOUSING AUTHORITY 1	655 6TH STREET
32	HOUSING AUTHORITY 2	501 MARSHALL DRIVE
33	HOUSING AUTHORITY 3	400 HARRISON STREET
34	HOUSING AUTHORITY 4	320 MARSHALL DRIVE
35	HOUSING AUTHORITY 5	300 MARSHALL DRIVE
36	HOUSING AUTHORITY 6	321 HARRISON STREET
37	HOUSING AUTHORITY 7	311 HARRISON STREET
38	HOUSING AUTHORITY 8	320 JACKSON STREET
39	HOUSING AUTHORITY 9	310 JACKSON STREET

OWN & OPERATE BY 3RD PARTY

CLIENT:

HOBOKEN

CONCORD ENGINEERING
P.A. 24GA27936700
520 South Burnt Mill Road
Voorhees, New Jersey 08043
(856) 427-0200
www.concord-engineering.com

No.	Date	Description	BY	CHK	APP
A	06/15/2018	PRELIMINARY	DC	SK	DD

REVISIONS:

KEY PLAN:

E
N
S
W
TRUE NORTH

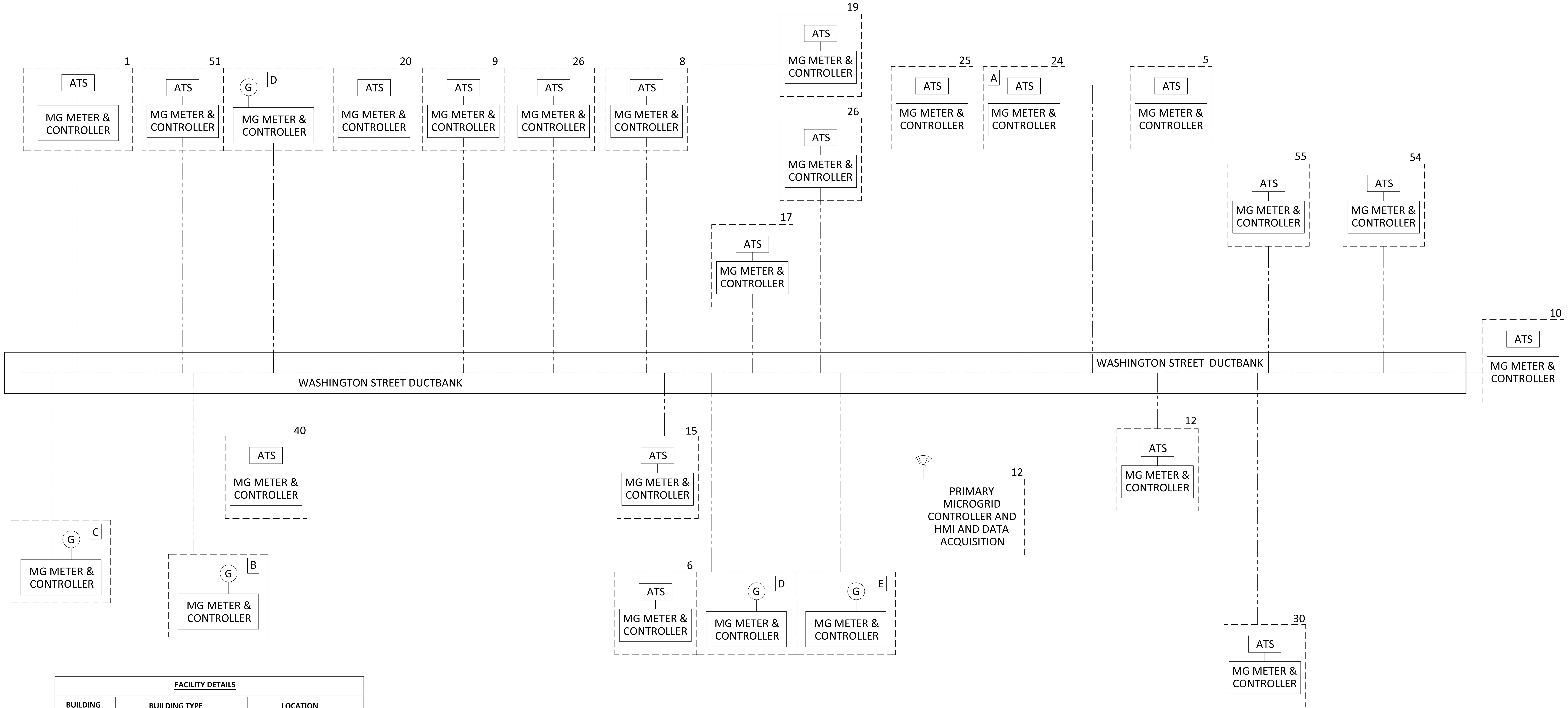
PROJECT:

HOBOKEN TOWNSHIP MICROGRID
CITY OF HOBOKEN
94 WASHINGTON STREET
HOBOKEN NJ 07030

DRAWING TITLE:

ELECTRICAL
KEY ONE LINE
HOBOKEN HOUSING AUTHORITY

DRAWN BY: B.G	SCALE: AS NOTED	DWG SIZE: 24x36
CHECKED BY: S.K	DRAWING NO. E-102	REVISION A
DATE: 03/22/2018		
PROJECT NO.: 2C17556.00		



FACILITY DETAILS		
BUILDING NO.	BUILDING TYPE	LOCATION
WASHINGTON STREET		
1	FIRE ENGINE CO 3	1313 WASHINGTON STREET
5	POLICE HQ	106 HUDSON STREET
6	HOBOKEN UNI MEDICAL CENTER	308 WILLOW AVENUE
8	PUMP STATION 5TH STREET	500 RIVER ROAD
9	PUMP STATION 11TH STREET	83 11TH STREET
10	PUMP STATION H1	99 OBSERVER HIGHWAY
12	HOBOKEN CITY HALL	94 WASHINGTON STREET
15	HOBOKEN HOMELESS SHELTER	300 BLOOMFIELD
16	ST. MATTHEW'S CHURCH	57 8TH STREET
17	ST. PETER AND PAUL CHURCH	404 HUDSON STREET
19	GROCERY KINGS	325 RIVER STREET
20	GROCERY KINGS	1212 SHIPYARD LANE
24	GARAGE B	28 2ND STREET
25	GARAGE D	215 HUDSON STREET
26	GARAGE G	315 HUDSON STREET
30	COLUMBIAN TOWERS	76 BLOOMFIELD STREET
51	YMCA	1301 WASHINGTON STREET
54	CVS	59 WASHINGTON STREET
55	WALGREENS	101 WASHINGTON STREET
40	HOUSING AUTHORITY 10	311 13TH STREET

MICROGRID GENERATION DETAILS							
DESIGN SUMMARY	LOCATION NAME	ADDRESS	PROPERTY OWNER	GENERATION TYPE	REVENUE SOURCE	USER	APPROXIMATE SIZE
A	GARAGE D	215 HUDSON STREET	CITY OF HOBOKEN	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	2 MW
B	NORTHWEST PARK (H7) (ALTERNATE)	13TH & JEFFERSON	NORTH HUDSON SEWARAGE	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	2 MW
C	HOBOKEN SUBSTATION (ALTERNATE)	16TH & CLINTON	CITY OF HOBOKEN OR PSE&G	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	2 MW
D	MIDTOWN GARAGE	330 CLINTON ST	CITY OF HOBOKEN	PACKAGED RECIPROCATING ENGINE GENERATOR	CHP	HOBOKEN UNIVERSITY MEDICAL CENTER	1 MW
E	MIDTOWN GARAGE	330 CLINTON ST	CITY OF HOBOKEN	SOLAR PV	SOLAR PV WITH STORAGE	COMPLETE MICROGRID	1 MW

LEGEND:

FIBER OPTIC CABLE

SATELLITE COMMUNICATION

GENERATION

CLIENT:

HOBOKEN

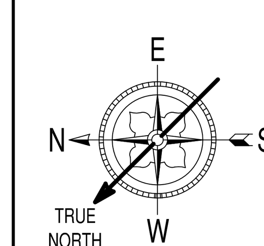
CONCORD ENGINEERING

P.A. 24GA27936700
520 South Burnt Mill Road
Voorhees, New Jersey 08043
(856) 427-0200
www.concord-engineering.com

No.	Date	Description	BY	CHK	APP
A	06/15/2018	PRELIMINARY	DC	SK	DD

REVISIONS:

KEY PLAN:



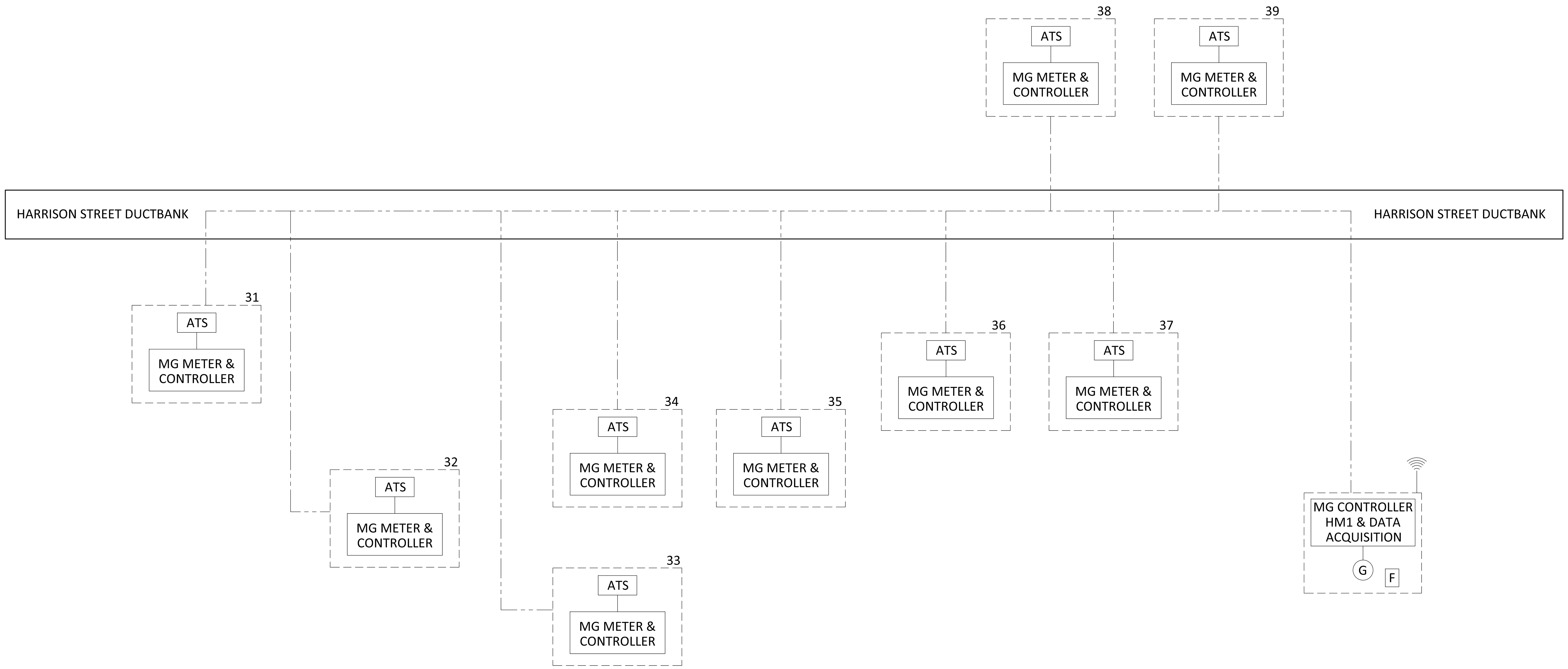
PROJECT:

HOBOKEN TOWNSHIP MICROGRID
CITY OF HOBOKEN
94 WASHINGTON STREET
HOBOKEN NJ 07030

DRAWING TITLE:

ELECTRICAL
MICROGRID COMMUNICATION ARCHITECTURE - WASHINGTON STREET CLUSTER

DRAWN BY: D.C.	SCALE: AS NOTED	DWG SIZE: 24x36
CHECKED BY: S.K	DRAWING NO. E-111	REVISION A
DATE: 03/22/2018		
PROJECT NO.: 2C17556.00		



FACILITY DETAILS		
BUILDING NO.	BUILDING TYPE	LOCATION
HOBOKEN HOUSING AUTHORITY		
31	HOUSING AUTHORITY 1	655 6TH STREET
32	HOUSING AUTHORITY 2	501 MARSHALL DRIVE
33	HOUSING AUTHORITY 3	400 HARRISON STREET
34	HOUSING AUTHORITY 4	320 MARSHALL DRIVE
35	HOUSING AUTHORITY 5	300 MARSHALL DRIVE
36	HOUSING AUTHORITY 6	321 HARRISON STREET
37	HOUSING AUTHORITY 7	311 HARRISON STREET
38	HOUSING AUTHORITY 8	320 JACKSON STREET
39	HOUSING AUTHORITY 9	310 JACKSON STREET

MICROGRID GENERATION DETAILS							
DESIGN SUMMARY	LOCATION NAME	ADDRESS	PROPERTY OWNER	GENERATION TYPE	REVENUE SOURCE	USER	APPROXIMATE SIZE
F	MARSHALL ST SUBSTATION	MARSHALL STREET AND 2ND STREET	CITY OF HOBOKEN OR PSE&G	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	1.2 MW

LEGEND:

FIBER OPTIC CABLE

SATELLITE COMMUNICATION

GENERATION

CLIENT:

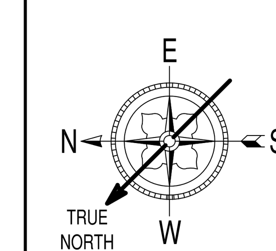
HOBOKEN

CONCORD ENGINEERING
P.A. 24GA27936700
520 South Burnt Mill Road
Voorhees, New Jersey 08043
(856) 427-0200
www.concord-engineering.com

No.	Date	Description	BY	CHK	APP
A	06/15/2018	PRELIMINARY	DC	SK	DD

REVISIONS:

KEY PLAN:



PROJECT:

HOBOKEN TOWNSHIP MICROGRID
CITY OF HOBOKEN
94 WASHINGTON STREET
HOBOKEN NJ 07030

DRAWING TITLE:

ELECTRICAL
MICROGRID COMMUNICATION ARCHITECTURE - HHA CLUSTER

DRAWN BY: D.C.
SCALE: AS NOTED
DWG SIZE: 24x36
CHECKED BY: S.K
DRAWING NO. E-112
REVISION A
DATE: 03/22/2018
PROJECT NO.: 2C17556.00

SCALE : NTS

FACILITY DETAILS		
BUILDING NO.	BUILDING TYPE	LOCATION
	WASHINGTON STREET	
1	FIRE ENGINE CO 3	1313 WASHINGTON STREET
5	POLICE HQ	106 HUDSON STREET
6	HOBOKEN UNI MEDICAL CENTER	308 WILLOW AVENUE
8	PUMP STATION 5TH STREET	500 RIVER ROAD
9	PUMP STATION 11TH STREET	83 11TH STREET
10	PUMP STATION H1	99 OBSERVER HIGHWAY
12	HOBOKEN CITY HALL	94 WASHINGTON STREET
15	HOBOKEN HOMELESS SHELTER	300 BLOOMFIELD
16	ST. MATTHEW'S CHURCH	57 8TH STREET
17	ST. PETER AND PAUL CHURCH	404 HUDSON STREET
19	GROCERY KINGS	325 RIVER STREET
20	GROCERY KINGS	1212 SHIPYARD LANE
24	GARAGE B	28 2ND STREET
25	GARAGE D	215 HUDSON STREET
26	GARAGE G	315 HUDSON STREET
30	COLUMBIAN TOWERS	76 BLOOMFIELD STREET
51	YMCA	1301 WASHINGTON STREET
54	CVS	59 WASHINGTON STREET
55	WALGREENS	101 WASHINGTON STREET
40	HOUSING AUTHORITY 10	311 13TH STREET
	HOBOKEN HOUSING AUTHORITY	
31	HOUSING AUTHORITY 1	655 6TH STREET
32	HOUSING AUTHORITY 2	501 MARSHALL DRIVE
33	HOUSING AUTHORITY 3	400 HARRISON STREET
34	HOUSING AUTHORITY 4	320 MARSHALL DRIVE
35	HOUSING AUTHORITY 5	300 MARSHALL DRIVE
36	HOUSING AUTHORITY 6	321 HARRISON STREET
37	HOUSING AUTHORITY 7	311 HARRISON STREET
38	HOUSING AUTHORITY 8	320 JACKSON STREET
39	HOUSING AUTHORITY 9	310 JACKSON STREET

NOTES:
1. FACILITY LOCATION OF CONDUIT ROUTING IS DIAGRAMMATIC ONLY.
2. POINT OF COMMON COUPLING (PCC) CONNECTION WILL BE ROUTED ON PSE&G UTILITY POLES FOR WASHINGTON STREET AND HOUSING AUTHORITY CORRIDOR.

LEGEND:

TRANSFORMER WITH SWITCHBOARD

TRANSFORMER

EXISTING CONDUIT ALONG WASHINGTON STREET

PSE&G SUBSTATIONS		
NO.	SUBSTATION DESCRIPTION	REMARKS
I	MARSHALL STREET SUBSTATION	SUBSTATION WILL BE DECOMMISSIONED AND FEEDERS WILL BE RELOCATED TO MADISON STREET SUBSTATION.
II	MADISON STREET SUBSTATION	SUBSTATION WILL BE ELEVATED AND MODERIZED TO 69KV AND ACCOMMODATE FEEDERS FROM MARSHALL STREET SUBSTATION.
III	16TH STREET SUBSTATION	SUBSTATION ALREADY ELEVATED AND UPGRADED.

MICROGRID GENERATION DETAILS							
DESIGN SUMMARY	LOCATION NAME	ADDRESS	PROPERTY OWNER	GENERATION TYPE	REVENUE SOURCE	USER	APPROXIMATE SIZE
A	GARAGE D	215 HUDSON STREET	CITY OF HOBOKEN	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	2 MW
B	NORTHWEST PARK (H7) (ALTERNATE)	13TH & JEFFERSON	NORTH HUDSON SEWERAGE	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	2 MW
C	HOBOKEN SUBSTATION (ALTERNATE)	16TH & CLINTON	CITY OF HOBOKEN OR PSE&G	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	2 MW
D	MIDTOWN GARAGE	330 CLINTON ST	CITY OF HOBOKEN	PACKAGED RECIPROCATING ENGINE GENERATOR	CHP	HOBOKEN UNIVERSITY MEDICAL CENTER	1 MW
E	MIDTOWN GARAGE	330 CLINTON ST	CITY OF HOBOKEN	SOLAR PV	SOLAR PV WITH STORAGE	COMPLETE MICROGRID	1 MW
F	MARSHALL STREET SUBSTATION	MARSHALL STREET AND 2ND STREET	CITY OF HOBOKEN OR PSE&G	PACKAGED RECIPROCATING ENGINE GENERATOR	DISTRIBUTED GENERATION	COMPLETE MICROGRID	1.2 MW

CLIENT:

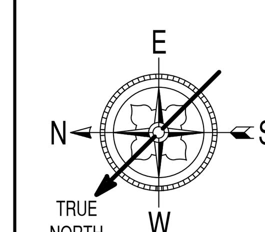
HOBOKEN

CONCORD ENGINEERING
P.A. 24GA27936700
520 South Burnt Mill Road
Voorhees, New Jersey 08043
(856) 427-0200
www.concord-engineering.com

No.	Date	Description	BY	CHK	APP
A	06/15/2018	PRELIMINARY	DC	SK	DD

REVISIONS:

KEY PLAN:



PROJECT:

HOBOKEN TOWNSHIP MICROGRID
CITY OF HOBOKEN
94 WASHINGTON STREET
HOBOKEN NJ 07030

DRAWING TITLE:

ELECTRICAL MICROGRID PLAN HOBOKEN CITY LEAD SHEET

DRAWN BY: B.G	SCALE: AS NOTED	DWG SIZE: 24x36
CHECKED BY: S.K	DRAWING NO. E-200	REVISION A
DATE: 03/22/2018		
PROJECT NO.: 2C17556.00		

MATCH LINE SEE DRAWING E-202

MATCH LINE SEE DRAWING E-204

CLIENT:

HOBOKEN

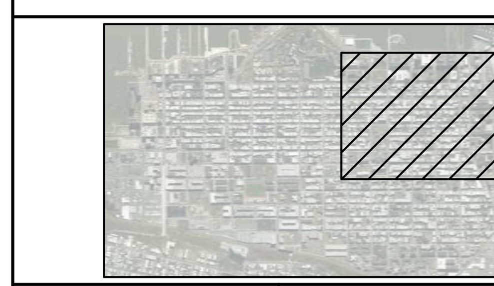
CONCORD ENGINEERING

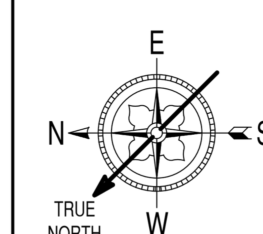
P.A. 24GA27936700
520 South Burnt Mill Road
Voorhees, New Jersey 08043
(856) 427-0200
www.concord-engineering.com

No.	Date	Description	BY	CHK	APP
A	06/15/2018	PRELIMINARY	DC	SK	DD

REVISIONS:

KEY PLAN:





PROJECT:

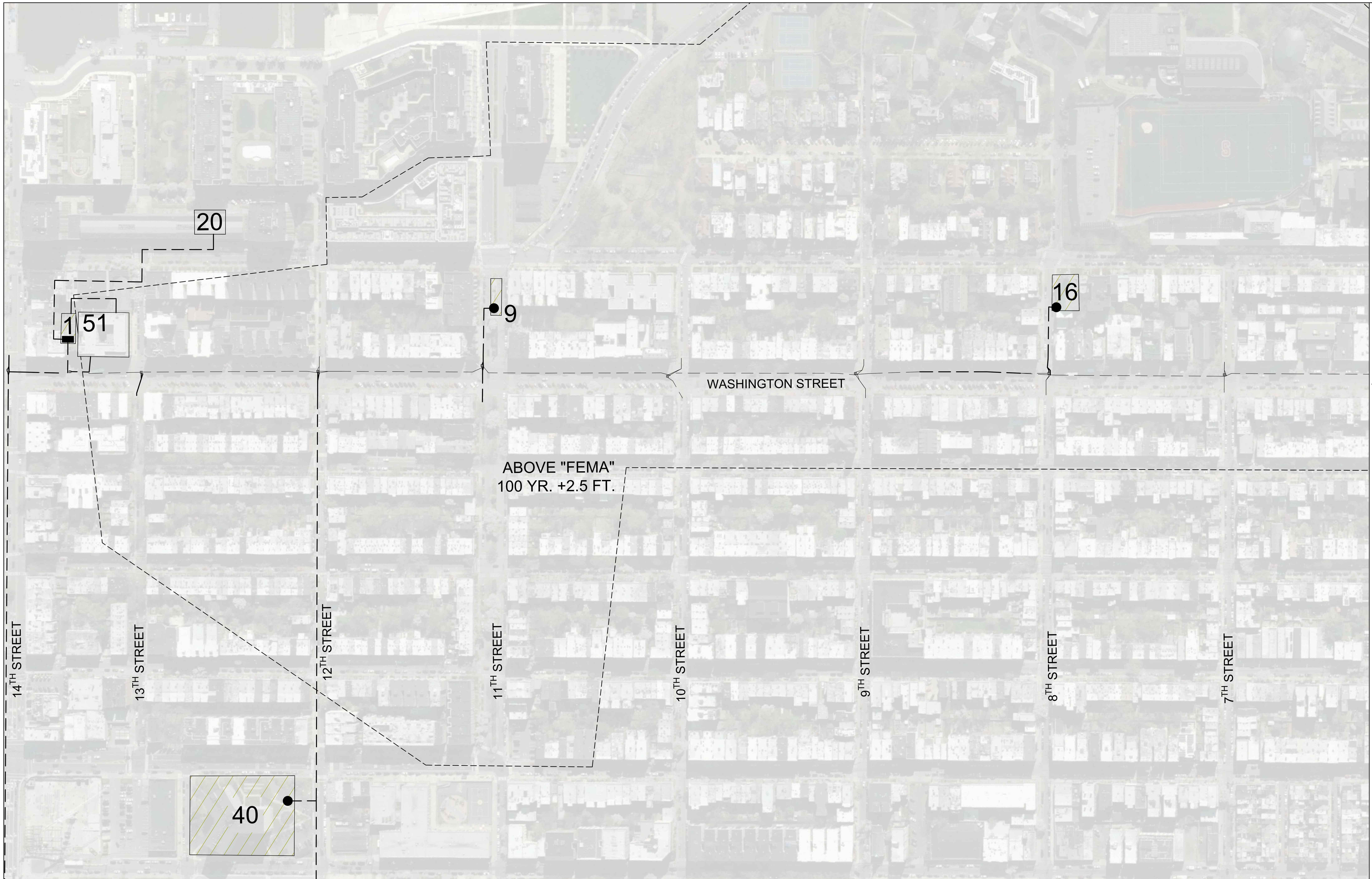
HOBOKEN TOWNSHIP MICROGRID
CITY OF HOBOKEN
94 WASHINGTON STREET
HOBOKEN NJ 07030

DRAWING TITLE:

ELECTRICAL MICROGRID PLAN WASHINGTON STREET

DRAWN BY: B.G	SCALE: AS NOTED	DWG SIZE: 24x36	
CHECKED BY: S.K	DRAWING NO.		REVISION
DATE: 03/22/2018	E-201		A
PROJECT NO.: 2C17556.00			

0' 2' 4' 8' 12' 20'
SCALE BAR: 3/32"=1'-0"



MATCH LINE SEE DRAWING E-201

MATCH LINE SEE DRAWING E-203

SCALE BAR: 3/32"=1'-0"

CLIENT:

HOBOKEN

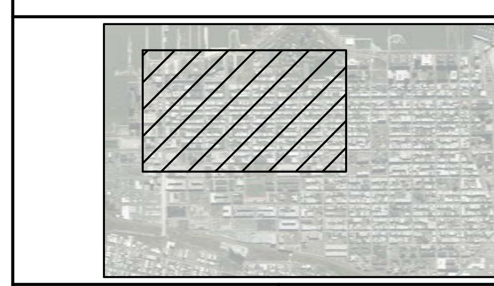
CONCORD ENGINEERING

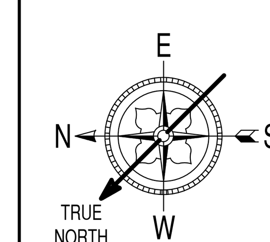
P.A. 24GA27936700
520 South Burnt Mill Road
Voorhees, New Jersey 08043
(856) 427-0200
www.concord-engineering.com

No.	Date	Description	BY	CHK	APP
A	06/15/2018	PRELIMINARY	DC	SK	DD

REVISIONS:

KEY PLAN:





PROJECT:

HOBOKEN TOWNSHIP MICROGRID
CITY OF HOBOKEN
94 WASHINGTON STREET
HOBOKEN NJ 07030

DRAWING TITLE:

ELECTRICAL
MICROGRID PLAN
WASHINGTON STREET &
HOUSING AUTHORITY

DRAWN BY: B.G	SCALE: AS NOTED	DWG SIZE: 24x36
CHECKED BY: S.K	DRAWING NO. E-202	REVISION A
DATE: 03/22/2018		
PROJECT NO.: 2C17556.00		

0' 2' 4' 8' 12' 20'
SCALE BAR: 3/32"=1'-0"

CLIENT:

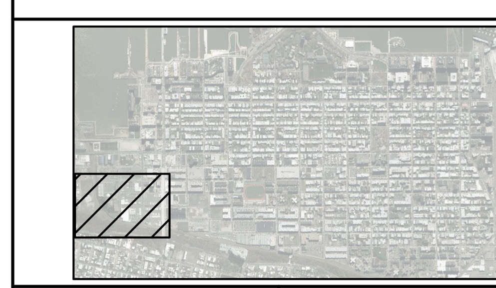
HOBOKEN

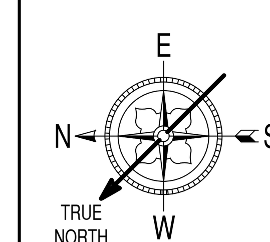
CONCORD ENGINEERING
P.A. 24GA27936700
520 South Burnt Mill Road
Voorhees, New Jersey 08043
(856) 427-0200
www.concord-engineering.com

No.	Date	Description	BY	CHK	APP
A	06/15/2018	PRELIMINARY	DC	SK	DD

REVISIONS:

KEY PLAN:





PROJECT:

HOBOKEN TOWNSHIP MICROGRID
CITY OF HOBOKEN
94 WASHINGTON STREET
HOBOKEN NJ 07030

DRAWING TITLE:

ELECTRICAL
MICROGRID PLAN
14TH STREET

DRAWN BY: B.G	SCALE: AS NOTED	DWG SIZE: 24x36	
CHECKED BY: S.K	DRAWING NO. E-203		REVISION A
DATE: 03/22/2018			
PROJECT NO.: 2C17556.00			

MATCH LINE SEE DRAWING E-201

MATCH LINE SEE DRAWING E-203

SCALE BAR: 3/32"=1'-0"

CLIENT:

HOBOKEN

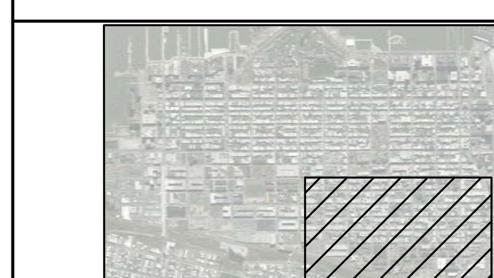
CONCORD ENGINEERING

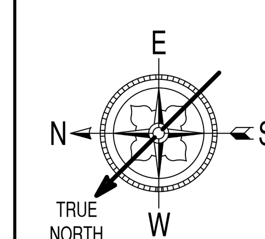
P.A. 24GA27936700
520 South Burnt Mill Road
Voorhees, New Jersey 08043
(856) 427-0200
www.concord-engineering.com

No.	Date	Description	BY	CHK	APP
A	06/15/2018	PRELIMINARY	DC	SK	DD

REVISIONS:

KEY PLAN:





PROJECT:

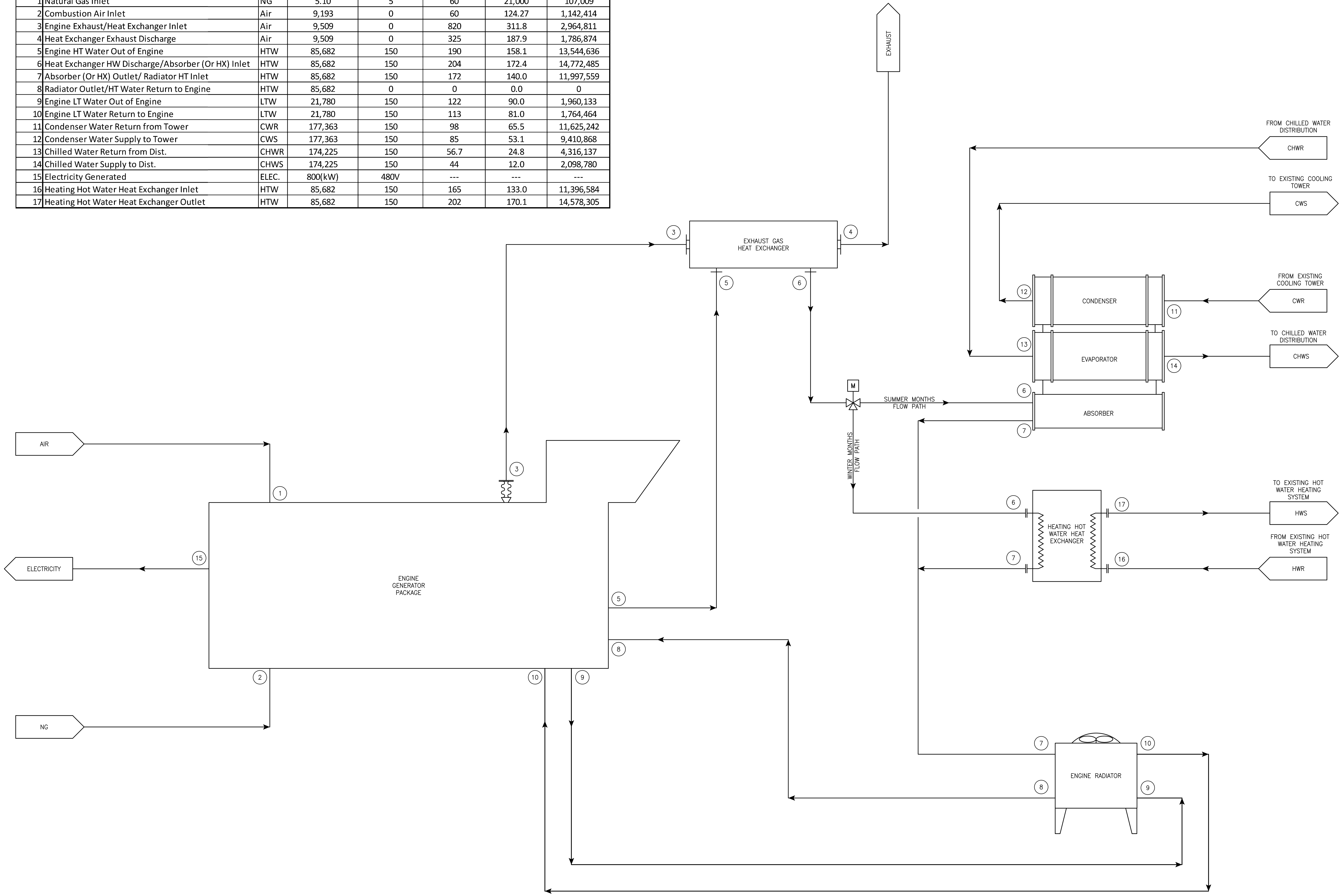
HOBOKEN TOWNSHIP MICROGRID
CITY OF HOBOKEN
94 WASHINGTON STREET
HOBOKEN NJ 07030

DRAWING TITLE:

ELECTRICAL
MICROGRID PLAN
HOUSING AUTHORITY

DRAWN BY: B.G	SCALE: AS NOTED	DWG SIZE: 24x36
CHECKED BY: S.K	DRAWING NO. E-204	REVISION A
DATE: 03/22/2018		
PROJECT NO.: 2C17556.00		

Line #	Description	Fluid	Flow (lb/hr)	Pressure (PSIG)	Temp (°F)	Enthalpy (BTU/lb)	BTU/hr
1	Natural Gas Inlet	NG	5.10	5	60	21,000	107,009
2	Combustion Air Inlet	Air	9,193	0	60	124.27	1,142,414
3	Engine Exhaust/Heat Exchanger Inlet	Air	9,509	0	820	311.8	2,964,811
4	Heat Exchanger Exhaust Discharge	Air	9,509	0	325	187.9	1,786,874
5	Engine HT Water Out of Engine	HTW	85,682	150	190	158.1	13,544,636
6	Heat Exchanger HW Discharge/Absorber (Or HX) Inlet	HTW	85,682	150	204	172.4	14,772,485
7	Absorber (Or HX) Outlet/ Radiator HT Inlet	HTW	85,682	150	172	140.0	11,997,559
8	Radiator Outlet/HT Water Return to Engine	HTW	85,682	0	0	0.0	0
9	Engine LT Water Out of Engine	LTW	21,780	150	122	90.0	1,960,133
10	Engine LT Water Return to Engine	LTW	21,780	150	113	81.0	1,764,464
11	Condenser Water Return from Tower	CWR	177,363	150	98	65.5	11,625,242
12	Condenser Water Supply to Tower	CWS	177,363	150	85	53.1	9,410,868
13	Chilled Water Return from Dist.	CHWR	174,225	150	56.7	24.8	4,316,137
14	Chilled Water Supply to Dist.	CHWS	174,225	150	44	12.0	2,098,780
15	Electricity Generated	ELEC.	800(kW)	480V	---	---	---
16	Heating Hot Water Heat Exchanger Inlet	HTW	85,682	150	165	133.0	11,396,584
17	Heating Hot Water Heat Exchanger Outlet	HTW	85,682	150	202	170.1	14,578,305



CLIENT:

HOBOKEN

CONCORD ENGINEERING
P.A. 24GA27936700
520 South Burnt Mill Road
Voorhees, New Jersey 08043
(856) 427-0200
www.concord-engineering.com

No.	Date	Description	BY	CHK	APP
A	06/22/2018	PRELIMINARY			

REVISIONS:

KEY PLAN:

PROJECT:

HOBOKEN TOWNSHIP MICROGRID
CITY OF HOBOKEN
94 WASHINGTON STREET
HOBOKEN NJ 07030

DRAWING TITLE:

MECHANICAL
HOSPITAL COMBINED HEAT AND POWER
MASS AND HEAT BALANCE

DRAWN BY: DCS
SCALE: AS NOTED
DWG SIZE: 24x36
CHECKED BY: MN
DATE: 03/22/2018
PROJECT NO.: 2C17556.00
DRAWING NO. M-101
REVISION A

APPENDIX B

Microgrid Facility Summary Table

Hoboken Township Microgrid: Load Estimate for Buildings

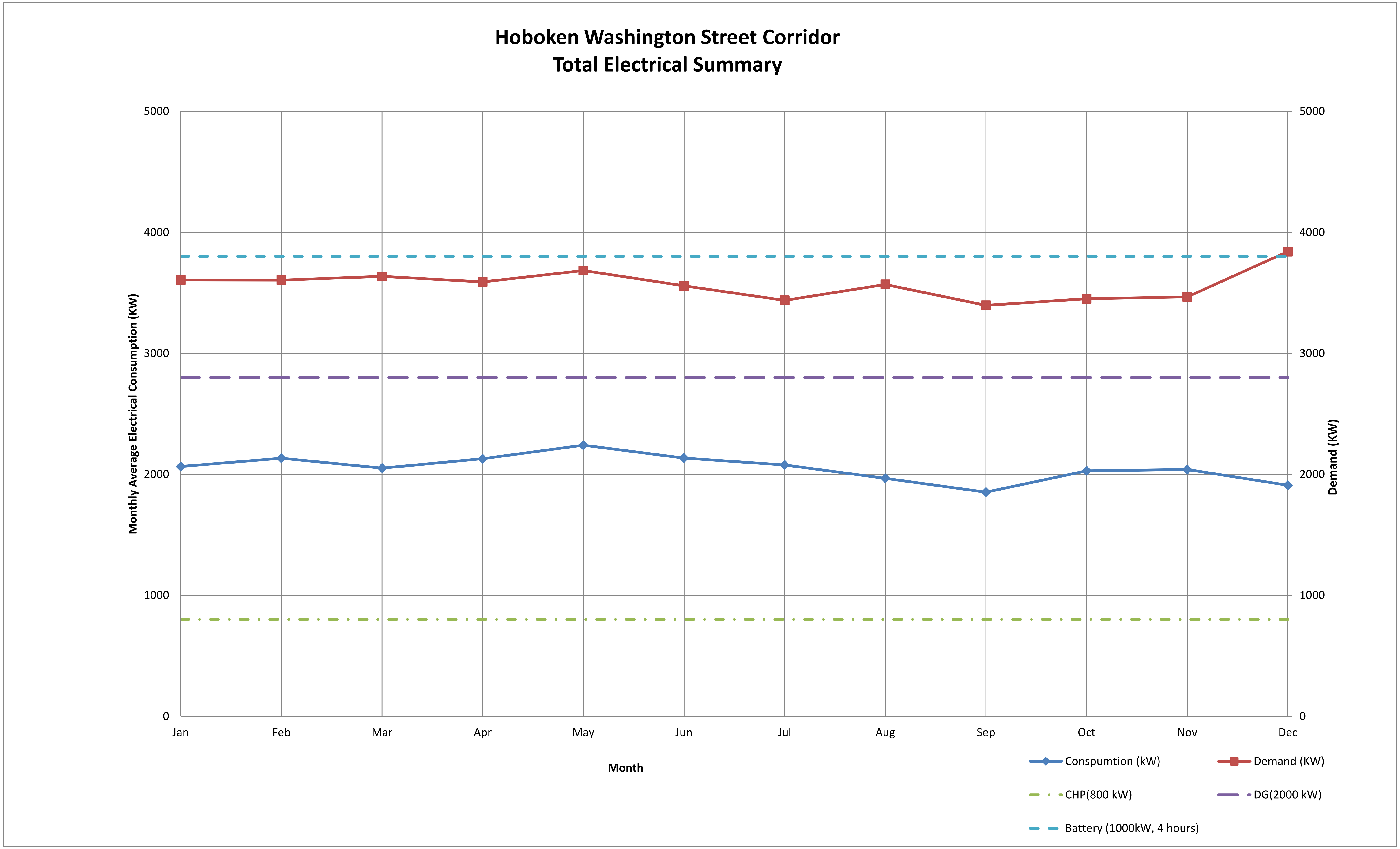
Area	Building #	Building Type	Location	Estimated SQFT	Distance from Connection Point (FT)	Transformer Size (KVA)	PSEG Circuit ID	Feeder Type (Network/Radial)	PSE&G TFR Primary Voltage (kV)	PSE&G TFR Secondary Volatge (V)	Estimated Load (kW)	One Year Average KW Consumption from Bill (kW)	Peak Bill (kW)	MG load (KVA)	% of Trans of loading	AVG load to Peak load ratio	Existing Generator Rating (kW)	Fuel Type	Building Size (Sqft)	FEMA Class
WASHINGTON STREET	1	Fire Engine Co 3	1313 Washington Street	4400	250	500	MDS4004	N	4kV	120/208	150	7.4	36	45	9	21	40	Natural Gas	10,626	IV
	5	Police HQ	106 Hudson Street	8400	300	500	MDS4010	N	4kV	120/208	150	47.1	206	258	52	23	150	Natural Gas	25,200	IV
	6	Hoboken Uni Medical Center	308 Willow Avenue	85000	1200	1500	MAS4001	R	4kV	4KVPrimary Svc	450	821	1252	1500	100	66	960	Diesel	510,000	
	8	Pump Station 5th Street	500 River Road	700	850	300	HOE8032	R	4kV	277/480	750	68.9	164	205	68	42	335	Diesel	1,400	IV
	9	Pump Station 11th Street	83 11th Street	1800	170	500	MDS4004	N	4kV	120/208	150	6.7	90	113	23	7	725	Natural Gas	3,600	IV
	10	Pump Station H1	99 Observer Highway	1020	100	750	HOE8047	R	13kV	277/480	225	44.9	306	383	51	15	750	Diesel	2,040	IV
	12	Hoboken City Hall	94 Washington Street	19500	150	750	MDS4004	N	4kV	120/208	225	41.4	239	299	40	17			19,500	IV
	15	Hoboken Homeless Shelter	300 Bloomfield	4125	350	150	HOE8047	R	13kV	120/208	45	18	36	45	30	50	25	Natural Gas	8,250	III
	16	St. Matthew's Church	57 8th Street	7800	300	50	HOE8047	R	13kV	120/208	15	6	12	15	30	50			20,200	III
	17	St. Peter and Paul Church	404 Hudson Street	9800	500	300	HOE8047	R	13kV	120/208	30	36	72	90	30	50			29,400	III
	19	Grocery – Kings	325 River Street	9000	800	1500	HOE8034	N	13kV	277/480	450	180	360	450	30	50	450	Diesel	9,000	N/A
	20	Grocery – Kings	1212 Shipyard Lane	12600	400	1500	HOE8041	R	13kV	120/208	450	180	360	450	30	50			12,600	N/A
	24	Garage B	28 2nd Street	44820	600	300	MDS4004	N	4kV	120/208	90	49.1	106	133	44	46			224,100	N/A
	25	Garage D	215 Hudson Street	37800	400	750	MDS4007	N	4kV	120/208	225	38	94	118	16	40			198,000	N/A
	26	Garage G	315 Hudson Street	35700	800	500	MDS4010	N	4kV	120/208	150	29.1	58	73	15	50			178,500	N/A
	30	Columbian Towers	76 Bloomfield Street	11250	700	500	MAS4004	N	4kV	120/208	150	60	120	150	30	50	180	Diesel	180,000	III
	51	YMCA	1301 Washington Street	15000	50	500	MDS4004	N	4kV	120/208	150	60	120	150	30	50			75,000	III
	54	CVS	59 Washington Street	10300	200	500	MDS4004	N	4kV	120/208	150	60	120	150	30	50			10,300	N/A
	55	Walgreens	101 Washington Street	5700	150	500	MDS4007	N	4kV	120/208	150	60	120	150	30	50			5,700	N/A
HOBOKEN HOUSING AUTHORITY	40	Housing Authority 10	311 13th Street	20200	1500	1500	MDS4003	R	4kV	120/208	600	237.7	595	744	50	40			243,000	III
TOTAL											**4755**	**2051.3**	**4466**							
HOBOKEN HOUSING AUTHORITY	31	Housing Authority 1	655 6th Street	7000	320	150	MAS4012	R	4kV	120/208	600	40.6	93	116	78	44			512,750	III
	32	Housing Authority 2	501 Marshall Drive	7000	1800	750	MAS4012	R	4kV	120/208		31.2	65	81	11	48				III
	33	Housing Authority 3	400 Harrison Drive	9500	120	75	MAS4003	R	4kV	277/480		2.5	33	41	55	8				III
	34	Housing Authority 4	320 Marshall Drive	9500	280	300	MAS4003	R	4kV	120/208		39.8	84	105	35	47				III
	35	Housing Authority 5	300 Marshall Drive	9500	450	150	MAS4003	R	4kV	120/208		40.7	88	110	73	46				III
	36	Housing Authority 6	321 Harrison Street	7200	100	150	MAS4012	R	4kV	120/208	600	88	187	234	156	47			192,700	III
	37	Housing Authority 7	311 Harrison Street	7200	100	25	MAS4003	R	4kV	120/240		88	187	234	935	47				III
	38	Housing Authority 8	320 Jackson Street	7200	100	100	MAS4012	R	4kV	120/240		92	184.8	231	231	50				III
	39	Housing Authority 9	310 Jackson Street	7200	100	300	MAS4003	R	4kV	120/208		92.9	185	231	77	50				III
TOTAL											**1200**	**515.7**	**1106.8**							

NOTE:

1) Power factor is assumed as 0.8
2) Secondary Voltage of Microgrid transformer is selected same as PSE&G transformer
3) Microgrid load for feeder is assumed as 30% of PSE&G transformer rating where billing data is not available.
4) PSE&G transformer rating furnished by PSE&G. Facility Number 36,37, 38 & 40 peak demand is more than transformer rating
5) Peak demand is assumed for facility number 36 & 38 same as 36. (all are 10 storey building)

APPENDIX C

FACILITY ELECTRICAL AND THERMAL LOAD GRAPHS AND TABLES



Hoboken Washington Street Corridor
Total Electrical Summary
5000
4000
3000
2000
1000
0
Monthly Average Electrical Consumption (KW)
Demand (KW)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
Conspumtion (kW)
Demand (KW)
CHP(800 kW)
DG(2000 kW)
Battery (1000kW, 4 hours)

ELECTRIC USAGE SUMMARY

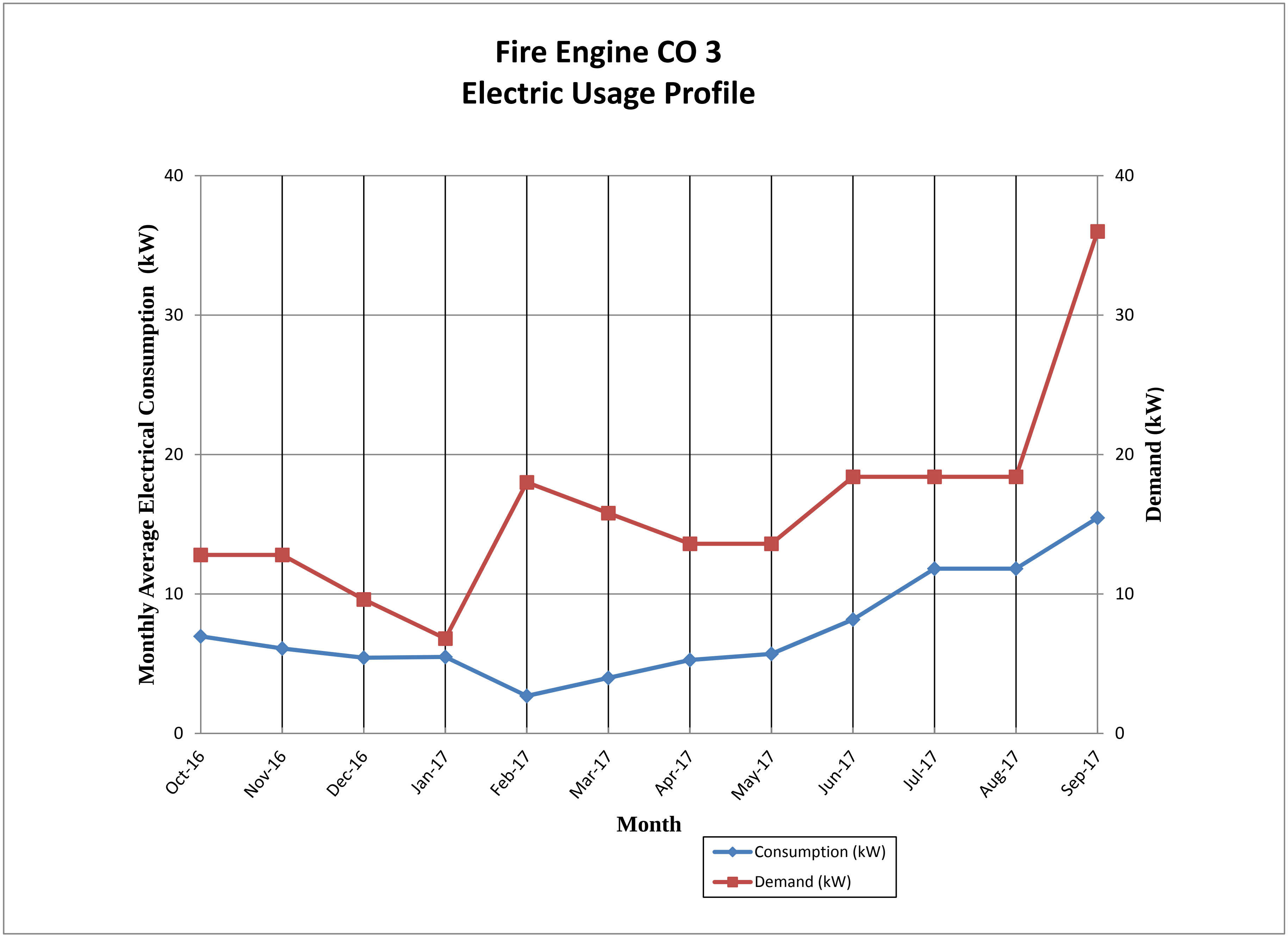
Facility : Washington Street Corridor
Utility Provider: PSE&G
Rate:
Meter No:
Customer ID No:
Third Party Utility
TPS Meter / Acct No:

MONTH OF USE	AVERAGE CONSUMPTION (KW)	DEMAND (KW)	TOTAL BILL
Jan	2063.9	3605.7	55211.7
Feb	2132.0	3604.7	52289.6
Mar	2051.0	3635.5	47955.9
Apr	2128.2	3589.9	45821.7
May	2239.8	3683.8	56994.6
Jun	2133.9	3557.6	54755.6
Jul	2076.9	3437.2	48391.1
Aug	1966.6	3568.9	45786.9
Sep	1852.4	3396.8	42619.0
Oct	2028.5	3450.6	62555.0
Nov	2039.3	3466.0	61368.2
Dec	1909.1	3841.0	72972.3
Totals	**24,622**	**3841.0 Max**	**$646,722**

AVERAGE DEMAND **2051.8 KW average**

AVERAGE RATE **$0.110** **$/kWh**

Some Facilities have no bills for that moth.



Fire Engine CO 3
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
40
30
20
10
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Consumption (kW)
Demand (kW)

ELECTRIC USAGE

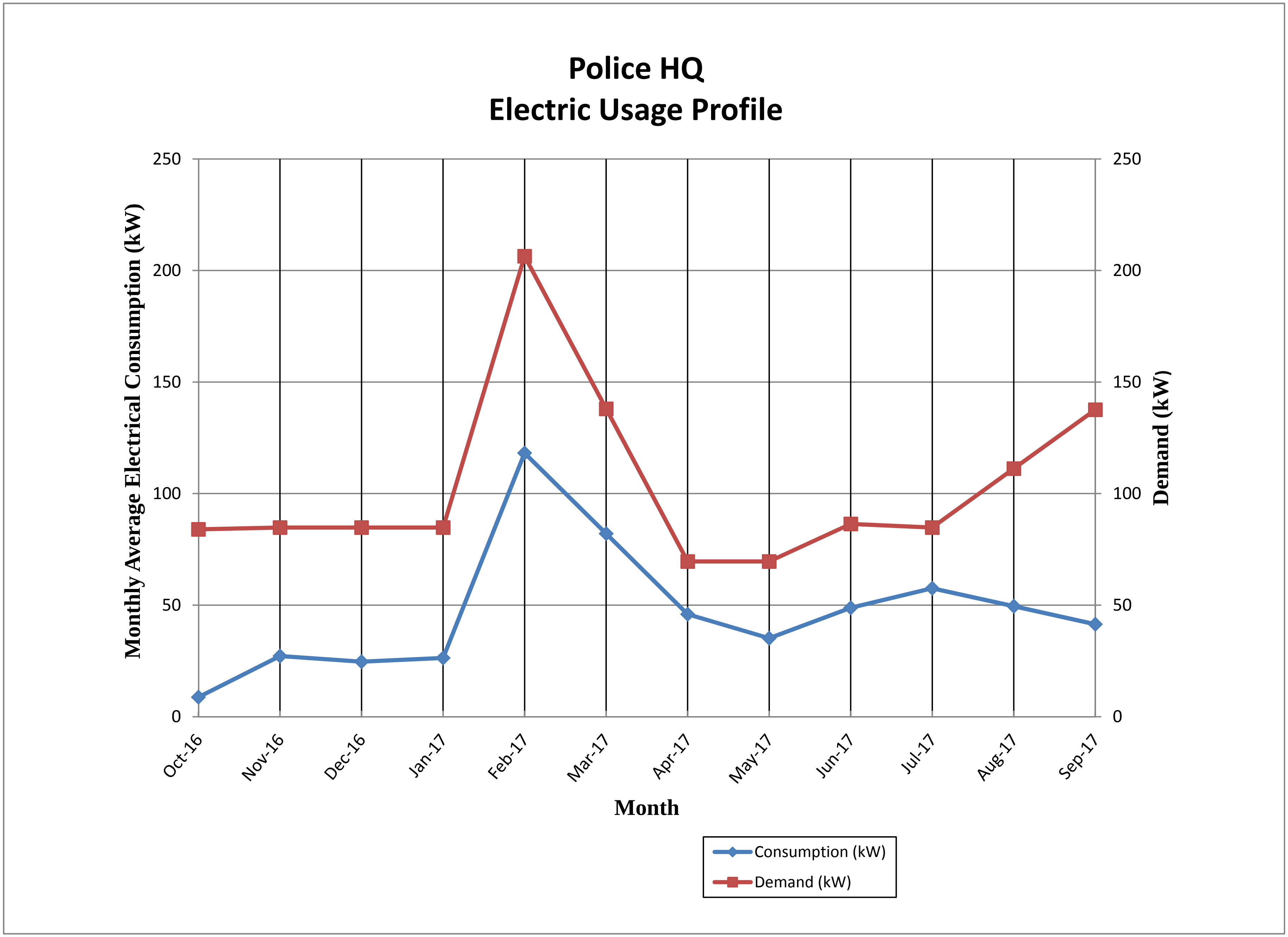
Facility : Fire Engine CO 3
Utility Provider: PSE&G
Rate: GLP
Meter No: 9197831
Customer ID No: PE000011373334925177
Acct No: 69 773 850 06

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Oct-16	5080	12.8	$647
Nov-16	4440	12.8	$600
Dec-16	3960	9.6	$557
Jan-17	4000	6.8	$568
Feb-17	1960	18.0	$469
Mar-17	2900	15.8	$540
Apr-17	3840	13.6	$611
May-17	4160	13.6	$660
Jun-17	5960	18.4	$954
Jul-17	8620	18.4	$1,350
Aug-17	8620	18.4	$1,350
Sep-17	11280	36.0	$1,746
Totals	**64,820**	**36.0 Max**	**$8,306**

AVERAGE CONSUMPTION **7.4 KW average**

AVERAGE RATE **$0.128** **$/kWh**

Note: Yellow Highlighted cell is average for previous and next month bill


Police HQ
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
250
200
150
100
50
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Consumption (kW)
Demand (kW)

ELECTRIC USAGE

Facility : Police HQ
Utility Provider: PSE&G
Rate: GLP
Meter No: 9198658
Customer ID No: PE000012157191325177
Acct No: 69 774 309 07

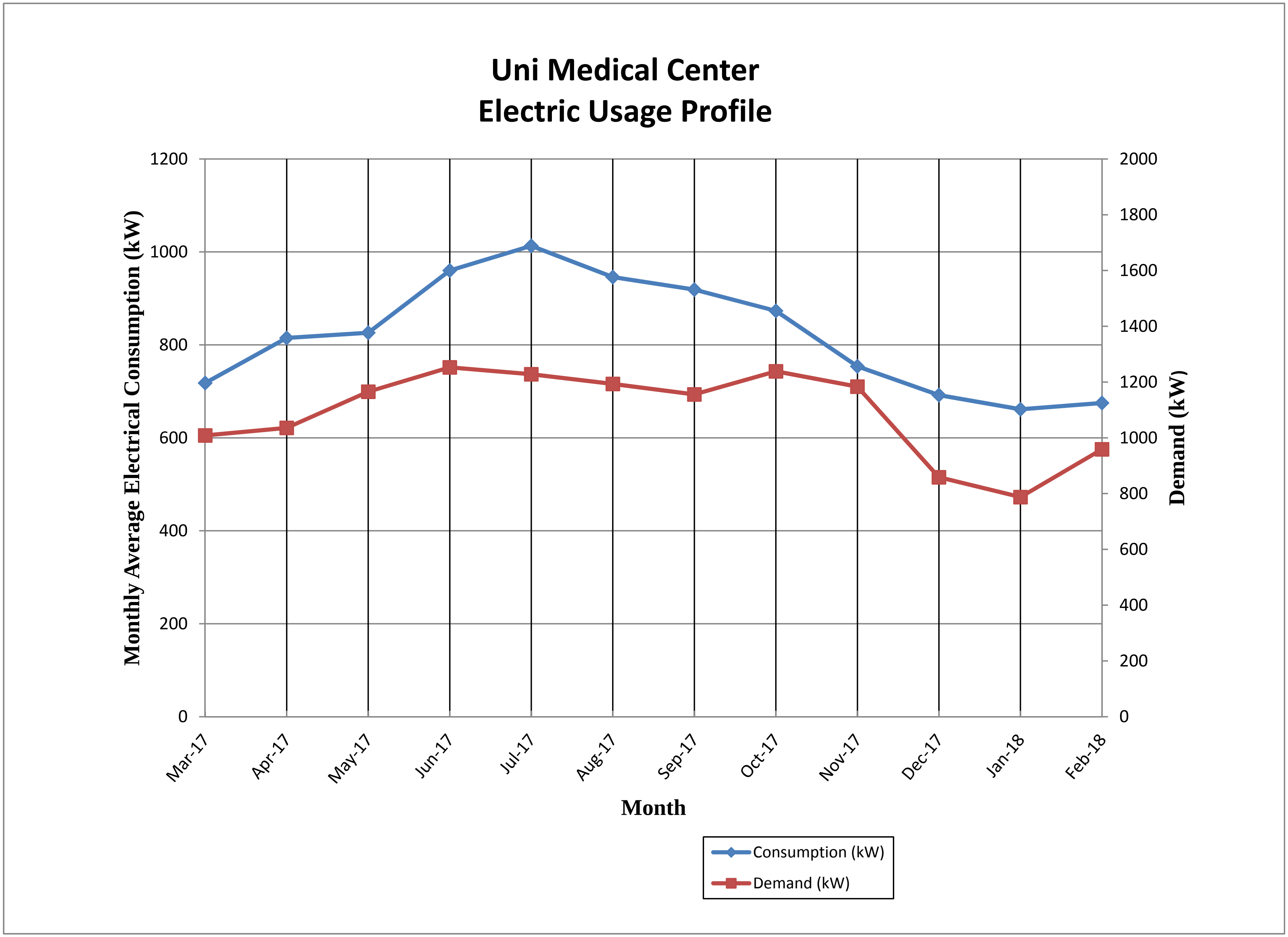
MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Oct-16	6400	84.0	$1,851
Nov-16	19840	84.8	$2,042
Dec-16	18000	84.8	$1,941
Jan-17	19200	84.8	$2,310
Feb-17	86240	206.4	$8,583
Mar-17	59880	138.0	$6,040
Apr-17	33520	69.6	$3,494
May-17	25680	69.6	$3,008
Jun-17	35600	86.4	$4,683
Jul-17	42000	84.8	$5,326
Aug-17	36120	111.2	$4,540
Sep-17	30240	137.6	$3,753
Totals	**412,720**	**206.4 Max**	**$43,818**

AVERAGE CONSUMPTION **47.1 KW average**

AVERAGE RATE **$0.106** **$/kWh**

Note: Yellow Highlighted cell is average for previous and next month bill

Billing Data for 120 Hudson st


Uni Medical Center
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
1200
1000
800
600
400
200
0
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
Month
Consumption (kW)
Demand (kW)

ELECTRIC USAGE

Facility : Uni Medical Center   Adress : 308 Willow Ave
Utility Provider: PSE&G
Rate:
Meter No:
Customer ID No:
Acct No:

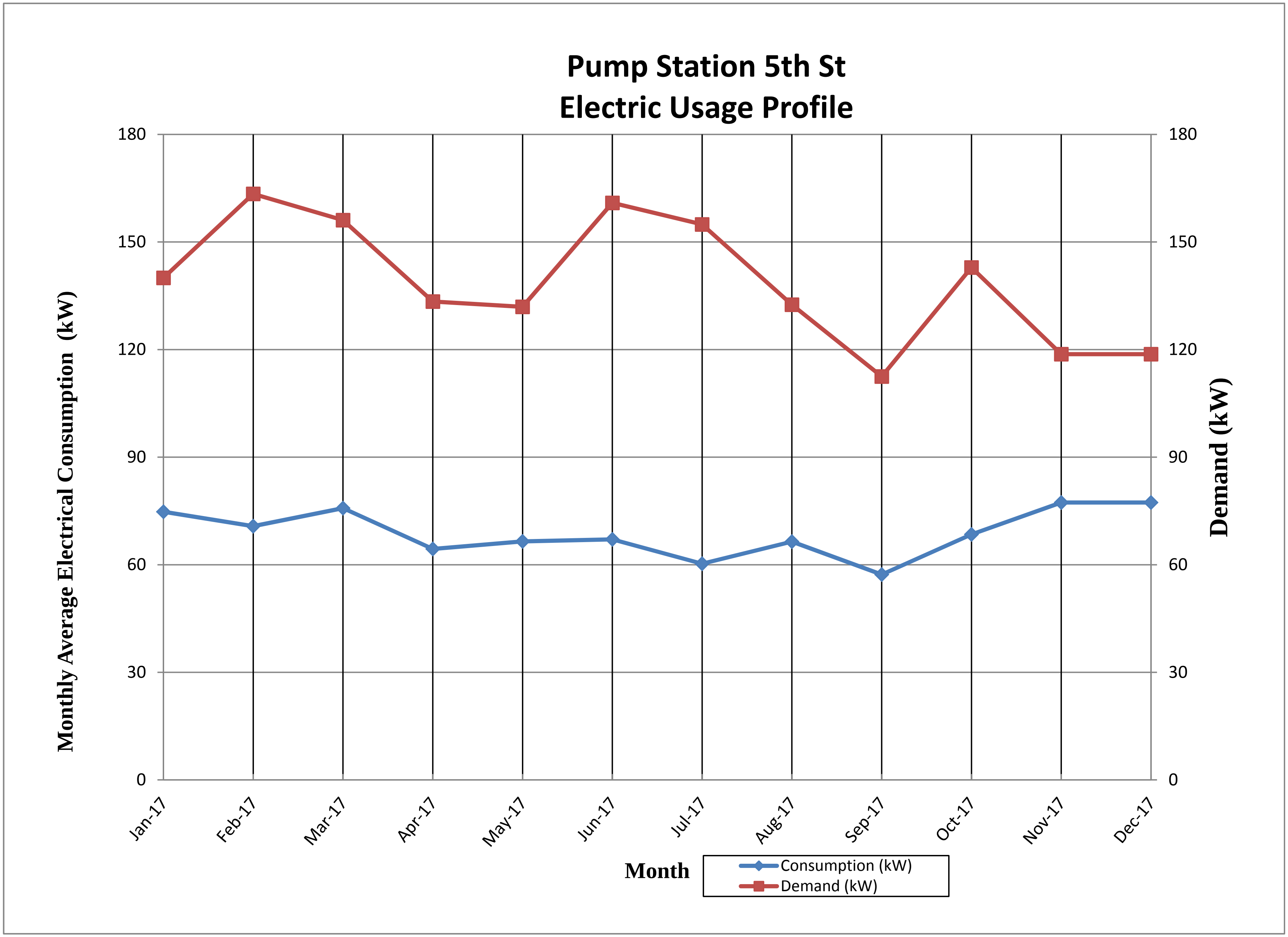
MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Mar-17	523852.8	1008.7	$4,600.98
Apr-17	594624	1035.7	$4,536.08
May-17	602649.6	1165.3	$4,026.01
Jun-17	700416	1252.8	$3,637.37
Jul-17	739084.8	1228.0	$3,875.85
Aug-17	690201.6	1193.4	$3,966.70
Sep-17	670502.4	1155.6	$3,673.51
Oct-17	637086.72	1238.8	$3,599.40
Nov-17	550032.3072	1183.7	$3,123.53
Dec-17	504781.056	858.6	$4,213.44
Jan-18	482630.4	787.3	$4,745.77
Feb-18	492480	959.0	$5,746.29
Totals	**7,188,342**	**1252.8 Max**	**$49,745**

AVERAGE DEMAND **821.0 KW average**

AVERAGE RATE **$0.110** **$/kWh**

Note: Yellow Highlighted cell is average for previous and next month bill

$ Billing data not available


Pump Station 5th St
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
180
150
120
90
60
30
0
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Month
Consumption (kW)
Demand (kW)

ELECTRIC USAGE

Facility : Pump Station 5th St
Address : 500 River Rd
Utility Provider: PSE&G
Rate: PETLPLS
Meter No: 4200259109
Customer ID No:
Acct No:

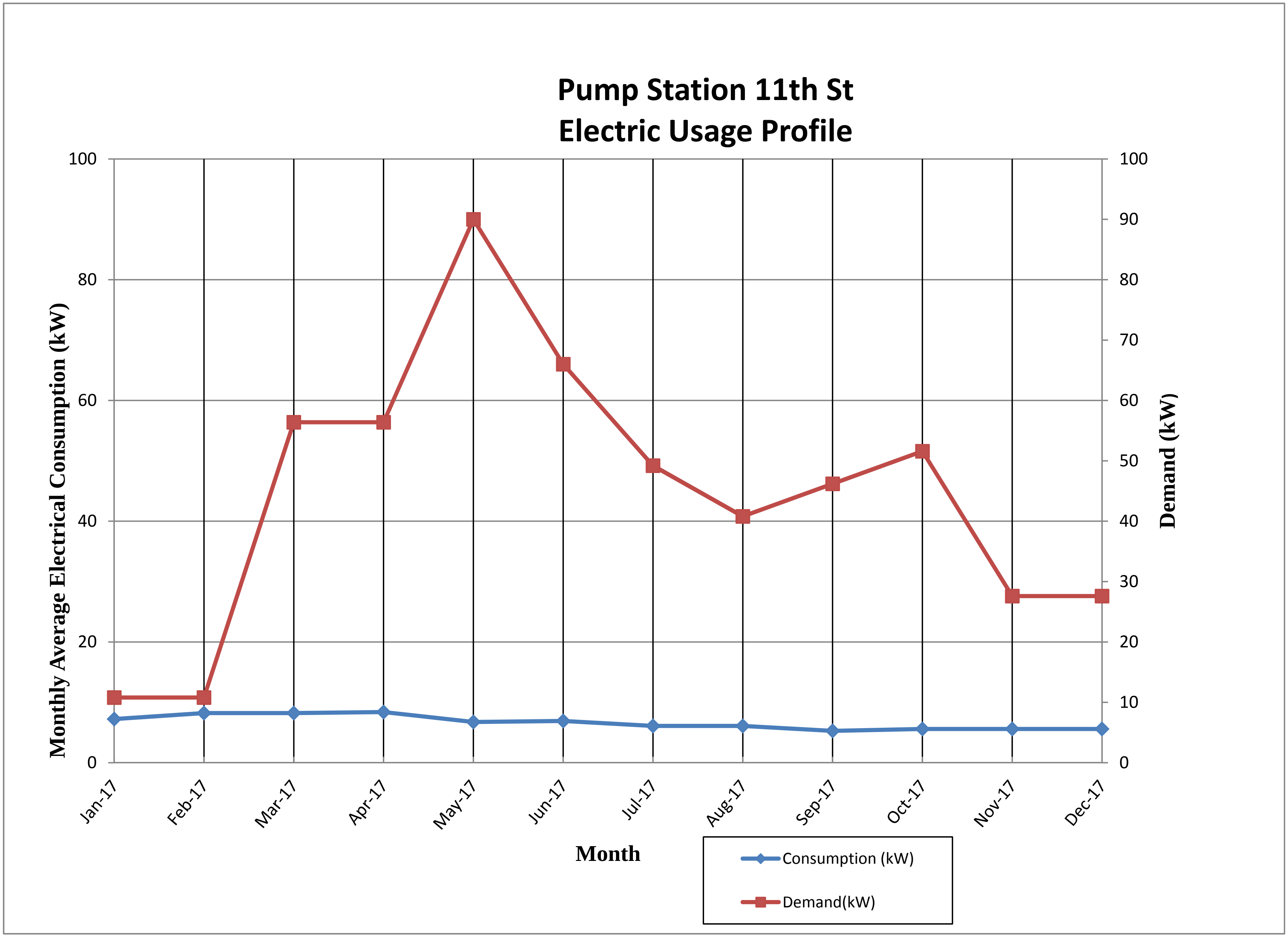
MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Jan-17	54545	140.0	$1,384
Feb-17	51622	163.4	$1,448
Mar-17	55290	156.1	$1,457
Apr-17	46987	133.4	$1,294
May-17	48527	131.9	$2,479
Jun-17	48937	160.9	$2,852
Jul-17	43993	154.9	$2,732
Aug-17	48474	132.5	$2,498
Sep-17	41774	112.5	$1,167
Oct-17	49941	142.9	$1,339
Nov-17	56432	118.7	$1,301
Dec-17	56432	118.7	$1,301
Totals	**602,954**	**163.4 Max**	**$19,950**

AVERAGE CONSUMPTION **68.9 KW average**

Supply cost not provided

AVERAGE RATE **$0.037** **$/kWh**

Note: Yellow Highlighted cell is average for previous and next month bill


Pump Station 11th St
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
100
80
60
40
20
0
100
90
80
70
60
50
40
30
20
10
0
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Month
Consumption (kW)
Demand(kW)

ELECTRIC USAGE

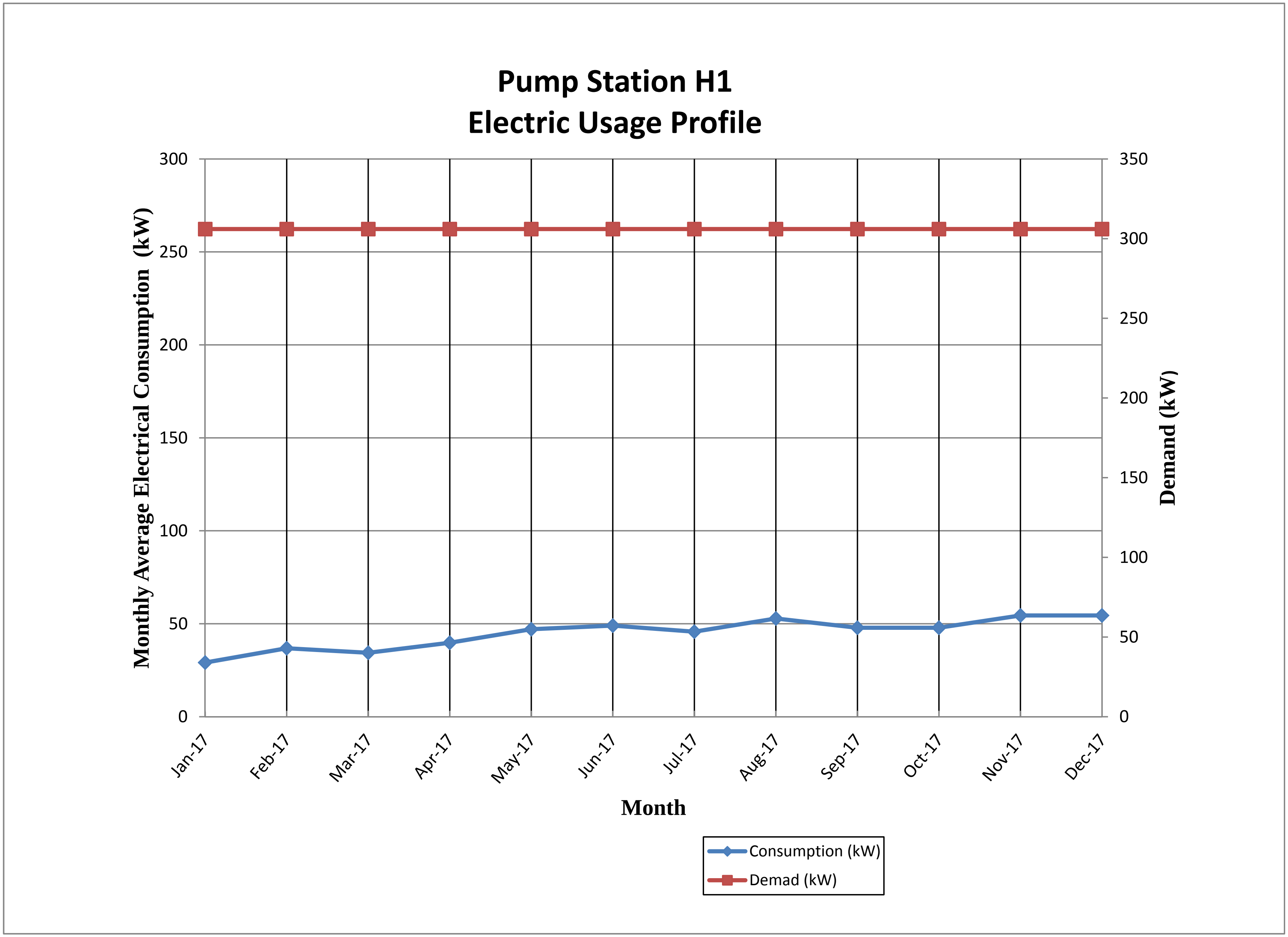
Facility : Pump Station 11th St   Adress : 83 11TH ST
Utility Provider: PSE&G
Rate: PEBGLPMD
Meter No: 7277838203
Customer ID No:
Acct No:

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Jan-17	5280	10.8	$586
Feb-17	6000	10.8	$645
Mar-17	6000	56.4	$866
Apr-17	6120	56.4	$899
May-17	4920	90.0	$1,650
Jun-17	5040	66.0	$1,392
Jul-17	4440	49.2	$1,115
Aug-17	4440	40.8	$986
Sep-17	3840	46.2	$400
Oct-17	4080	51.6	$615
Nov-17	4080	27.6	$556
Dec-17	4080	27.6	$556
Totals	**58,320**	**90.0 Max**	**$9,709**

AVERAGE CONSUMPTION **6.7 KW average**

AVERAGE RATE **$0.179** **$/kWh**

Note: Yellow Highlighted cell is average for previous and next month bill



Pump Station H1
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
300
250
200
150
100
50
0
350
300
250
200
150
100
50
0
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Month
Consumption (kW)
Demad (kW)

ELECTRIC USAGE

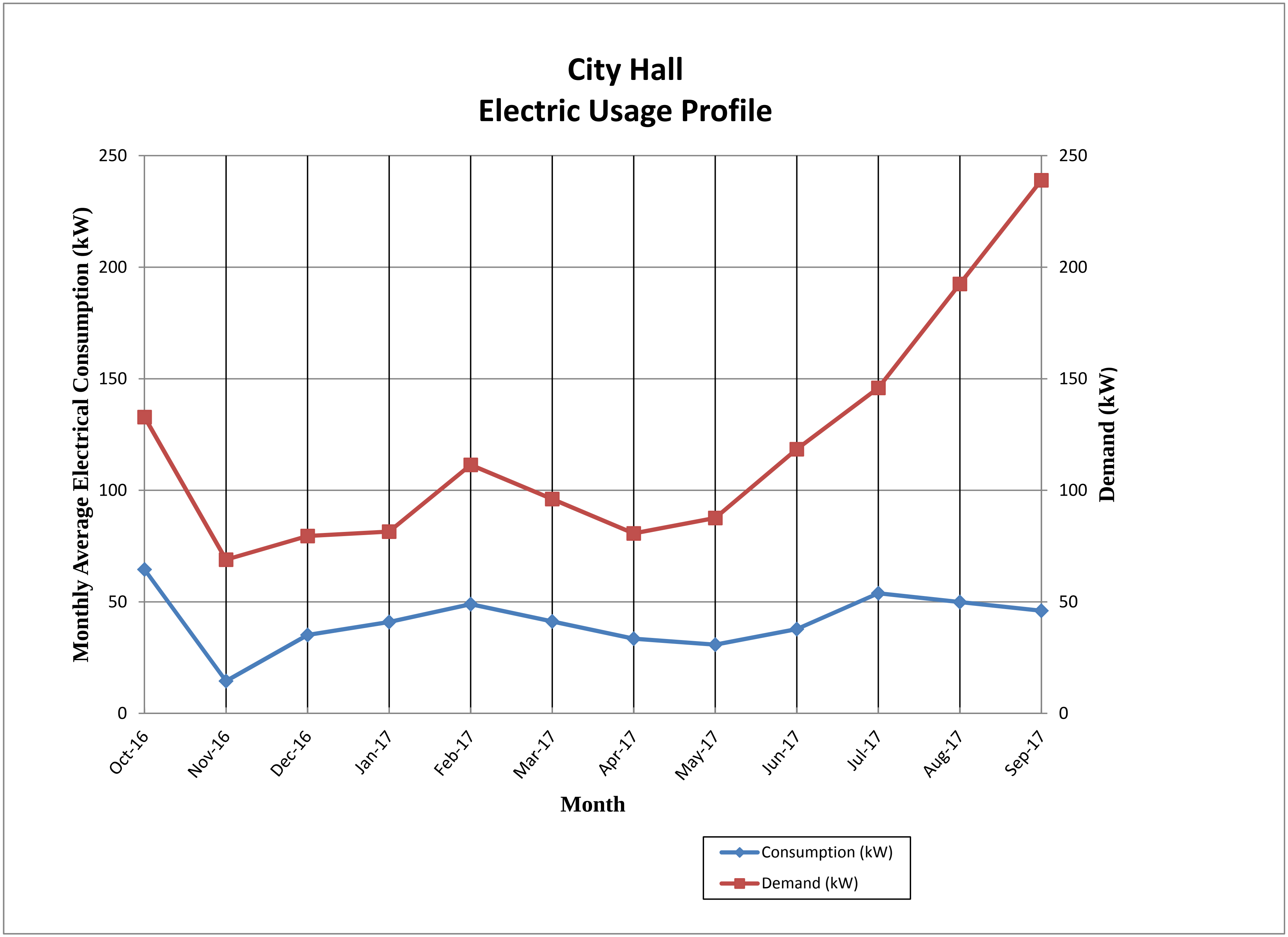
Facility : Pump Station H1   Adress : 99 Observer Highway
Utility Provider: PSE&G
Rate: PEBGLPMD
Meter No: 7090689018
Customer ID No:
Acct No:

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Jan-17	21240	306.0	$3,000
Feb-17	26880	306.0	$3,429
Mar-17	25080	306.0	$3,363
Apr-17	29040	306.0	$3,784
May-17	34320	306.0	$6,616
Jun-17	35760	306.0	$6,876
Jul-17	33360	306.0	$6,597
Aug-17	38520	306.0	$6,814
Sep-17	34920	306.0	$3,573
Oct-17	34920	306.0	$3,537
Nov-17	39720	306.0	$4,324
Dec-17	39720	306.0	$4,324
Totals	**393,480**	**306.0 Max**	**$51,913**

AVERAGE CONSUMPTION **44.9 KW average**

AVERAGE RATE **$0.147** **$/kWh**

Note: Yellow Highlighted cell is average for previous and next month bill


City Hall
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
250
200
150
100
50
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Consumption (kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

Facility :	City Hall
Utility Provider:	PSE&G
Rate:	GLP
Meter No:	236010400 & 9200485
Customer ID No:	PE000008937538025177 &
Third Party Utility	
TPS Meter / Acct No:	69 776 652 03

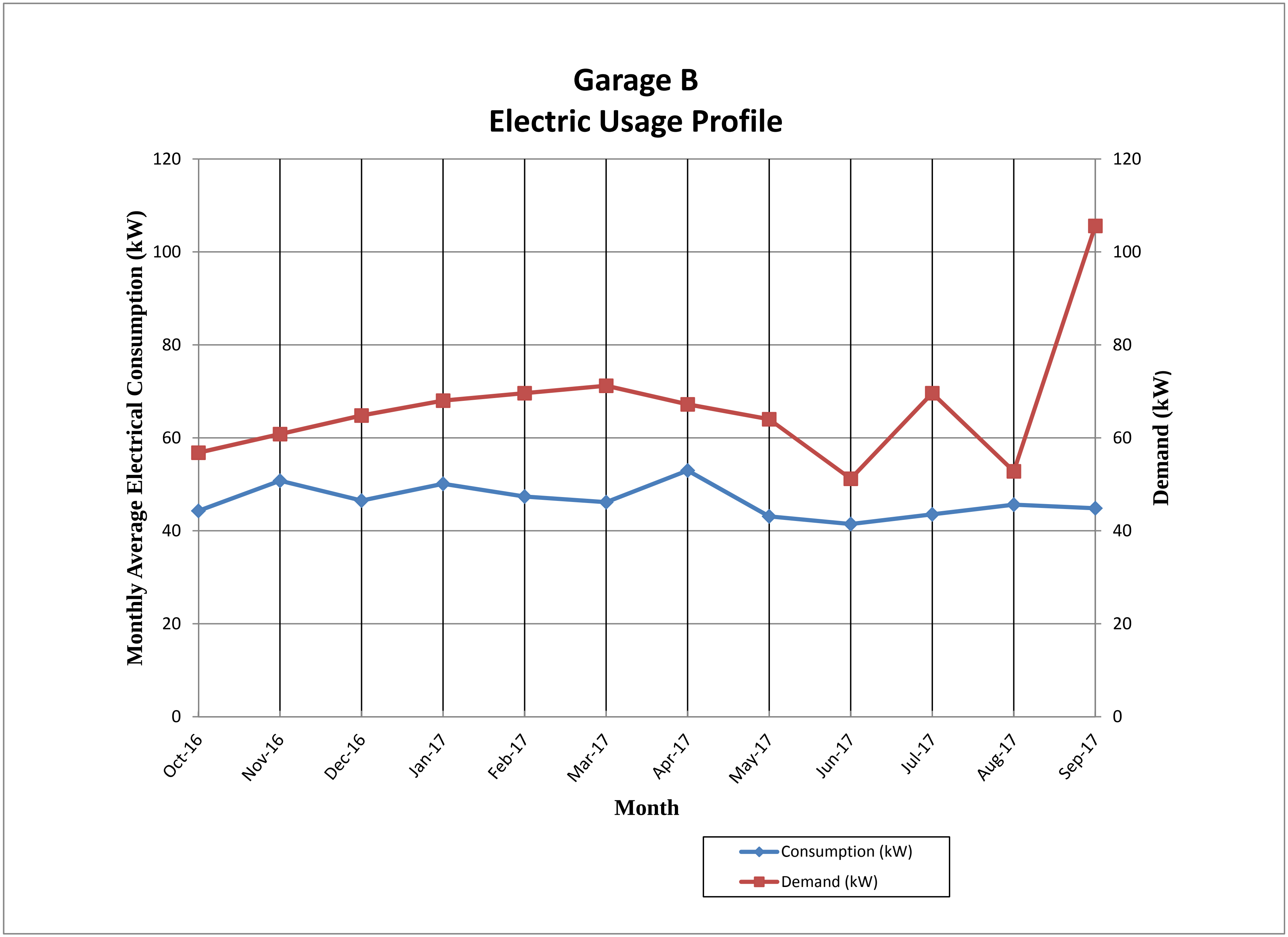
MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Oct-16	47082	132.8	$5,658
Nov-16	10584	68.9	$1,738
Dec-16	25634	79.5	$3,874
Jan-17	29878	81.5	$4,270
Feb-17	35720	111.4	$5,427
Mar-17	30083	96	$4,742
Apr-17	24446	80.7	$4,057
May-17	22486	87.6	$4,013
Jun-17	27582	118.4	$5,685
Jul-17	39272	145.9	$6,944
Aug-17	36419	193	$6,313
Sep-17	33566	239.0	$5,683
Totals	**362,752**	**239.0 Max**	**$52,719**

AVERAGE CONSUMPTION **41.4 KW average**

AVERAGE RATE **$0.145** **$/kWh**

Note: Total bill is based on supply price if the building purchased electric supply from PSE&G

Note: Yellow Highlighted cell is average for previous and next month bill



Garage B
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
120
100
80
60
40
20
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Consumption (kW)
Demand (kW)

ELECTRIC USAGE

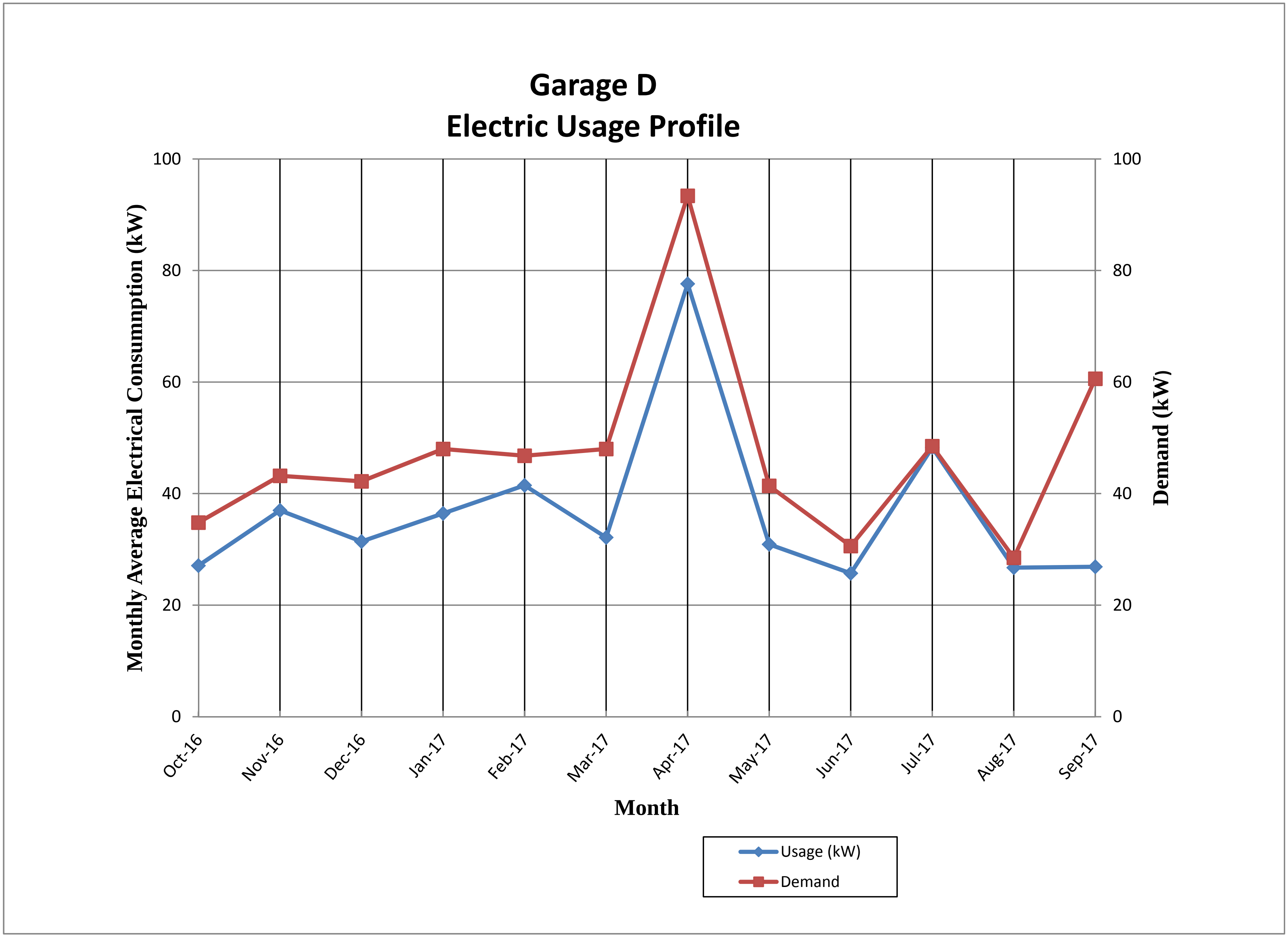
Facility : Garage B
Utility Provider: PSE&G
Rate: GLP
Meter No: 9193578
Customer ID No: PE000008657387039643
Acct No: 66 573 407 02

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Oct-16	32320	56.8	$3,356
Nov-16	37040	60.8	$3,698
Dec-16	33920	64.8	$3,549
Jan-17	36560	68.0	$3,670
Feb-17	34560	69.6	$3,736
Mar-17	33680	71.2	$3,954
Apr-17	38640	67.2	$4,226
May-17	31440	64.0	$3,800
Jun-17	30240	51.2	$4,951
Jul-17	55280	69.6	$6,316
Aug-17	33280	52.8	$3,937
Sep-17	32720	105.6	$3,822
Totals	**429,680**	**105.6 Max**	**$49,014**

AVERAGE CONSUMPTION **49.1 KW average**

Supply cost not provided **AVERAGE RATE** **$0.114** **$/kWh**

Note: Yellow Highlighted cell is average for previous and next month bill


Garage D
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
0
20
40
60
80
100
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Usage (kW)
Demand

ELECTRIC USAGE

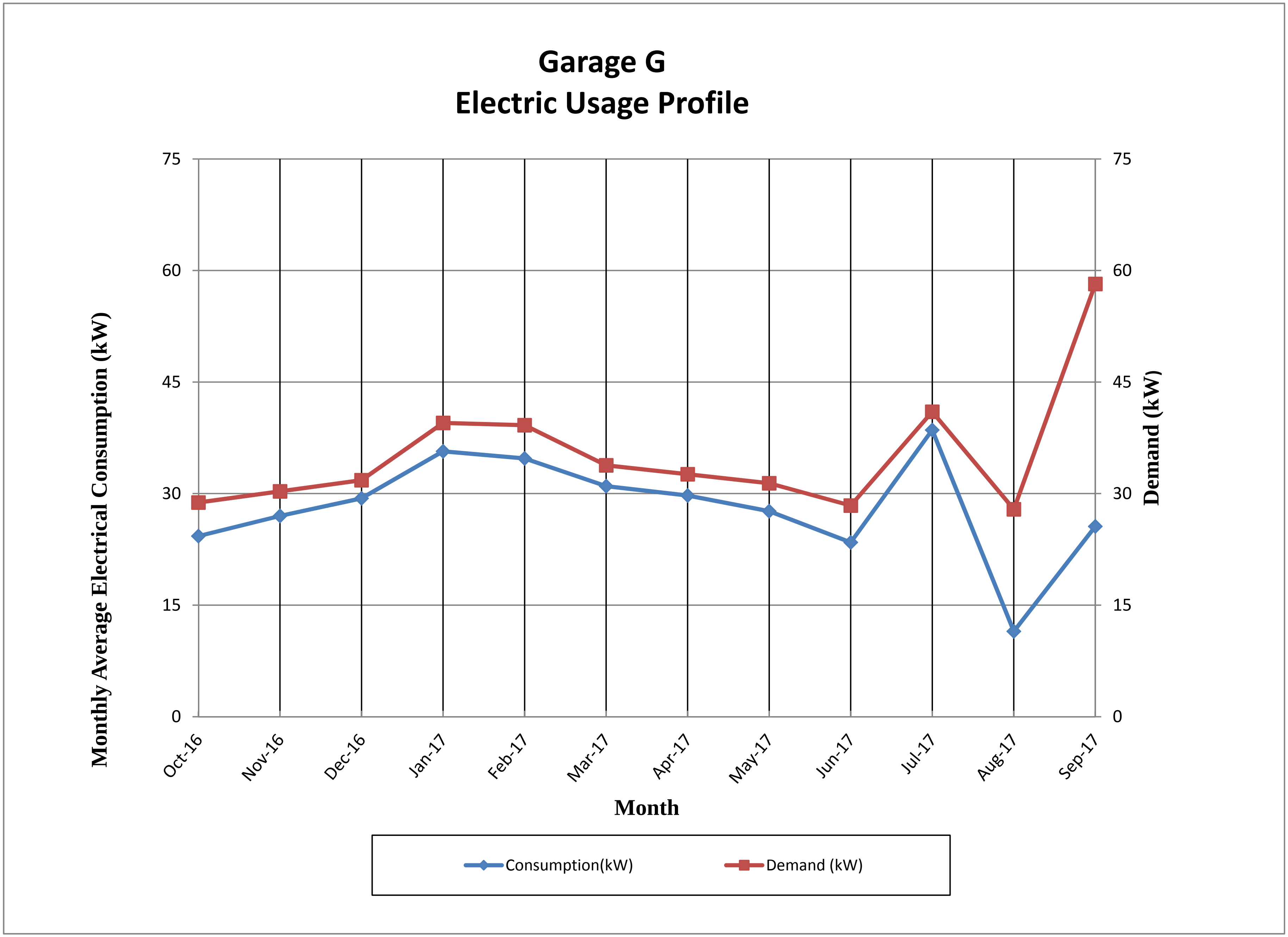
Facility : Garage D (215 Hudson St)
Utility Provider: PSE&G
Rate: GLP
Meter No: 678000974
Customer ID No: PE000009144893639656
Acct No: 65 309 079 04

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Oct-16	19755	34.8	$2,007
Nov-16	26985	43.2	$2,550
Dec-16	22920	42.2	$2,292
Jan-17	40965	48.0	$3,837
Feb-17	30255	46.8	$2,950
Mar-17	23445	48.0	$2,522
Apr-17	56625	93.4	$3,214
May-17	22545	41.4	$2,598
Jun-17	18765	30.6	$2,384
Jul-17	35220	48.5	$4,050
Aug-17	19500	28.5	$2,286
Sep-17	19620	60.6	$2,274
Totals	**336,600**	**93.4 Max**	**$28,405**

AVERAGE CONSUMPTION **38.4 KW average**

Supply cost not provided **AVERAGE RATE** **$0.084** **$/kWh**

Note: Yellow Highlighted cell is average for previous and next month bill


Garage G
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
Month
75
60
45
30
15
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Consumption(kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

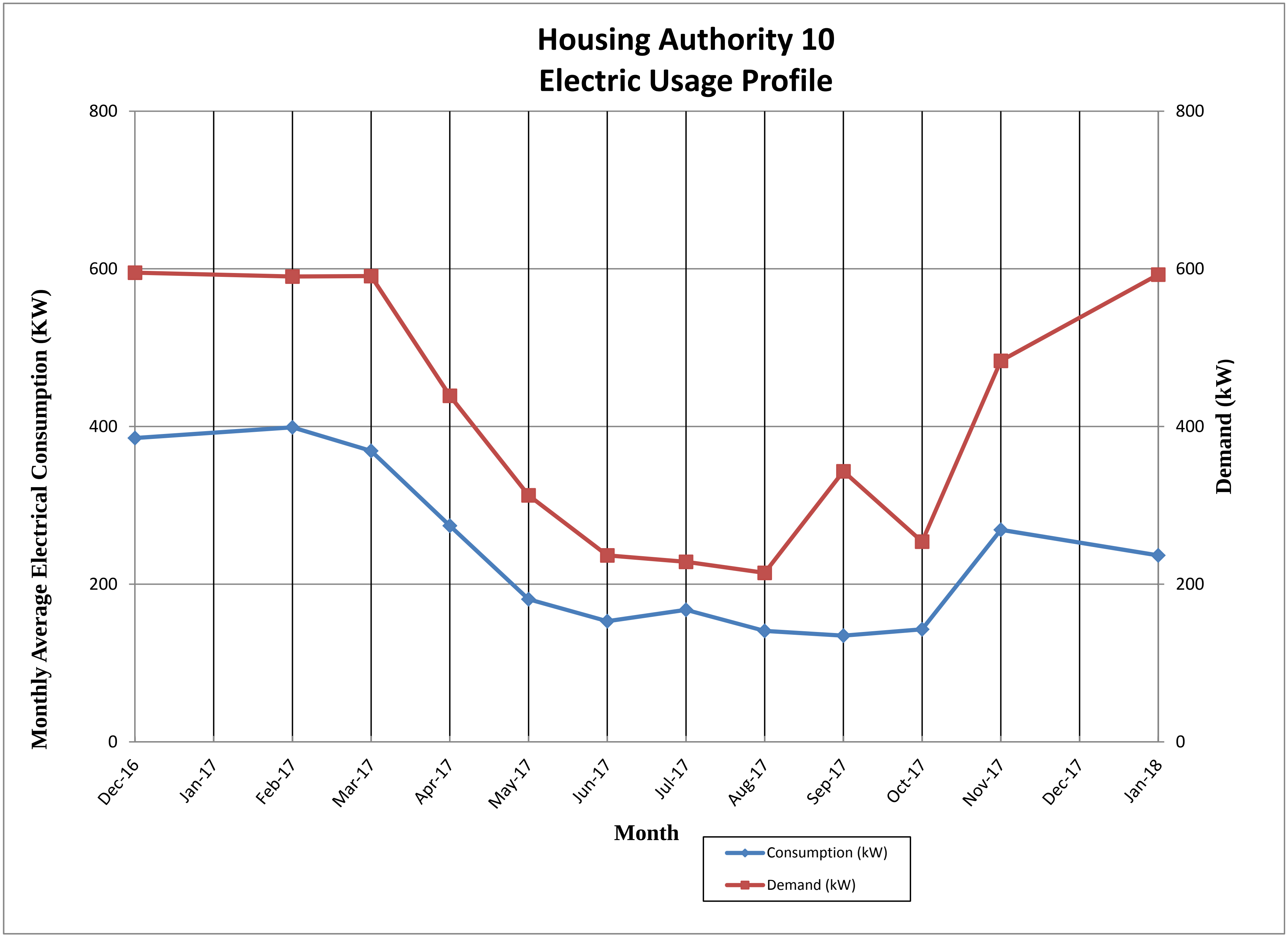
Facility : Garage G (315 Hudson St)
Utility Provider: PSE&G
Rate: GLP
Meter No: 278002370
Customer ID No: PE000007930940739629
Acct No: 65 042 202 04

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Oct-16	17715	28.8	$1,779
Nov-16	26670	30.3	$2,403
Dec-16	21420	31.8	$2,374
Jan-17	26040	39.5	$2,592
Feb-17	25335	39.2	$2,456
Mar-17	23235	33.8	$2,380
Apr-17	21697.5	32.6	$2,128
May-17	20160	31.4	$2,298
Jun-17	17100	28.4	$2,179
Jul-17	28125	41.0	$3,320
Aug-17	8370	27.9	$1,403
Sep-17	18675	58.2	$2,149
Totals	**254,543**	**58.2 Max**	**$23,908**

AVERAGE CONSUMPTION **29.1 KW average**

Supply cost not provided **AVERAGE RATE** **$0.094** **$/kWh**

Note: Yellow Highlighted cell is average for previous and next month bill


Housing Authority 10
Electric Usage Profile
Monthly Average Electrical Consumption (KW)
Demand (kW)
800
600
400
200
0
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Month
Consumption (kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

Facility :	Housing Authority 10
Utility Provider:	PSE&G
Rate:	GLP
Meter No:	9204371
Customer ID No:	PG000011457290223140
Third Party Utility	
TPS Meter / Acct No:	42 457 521 06

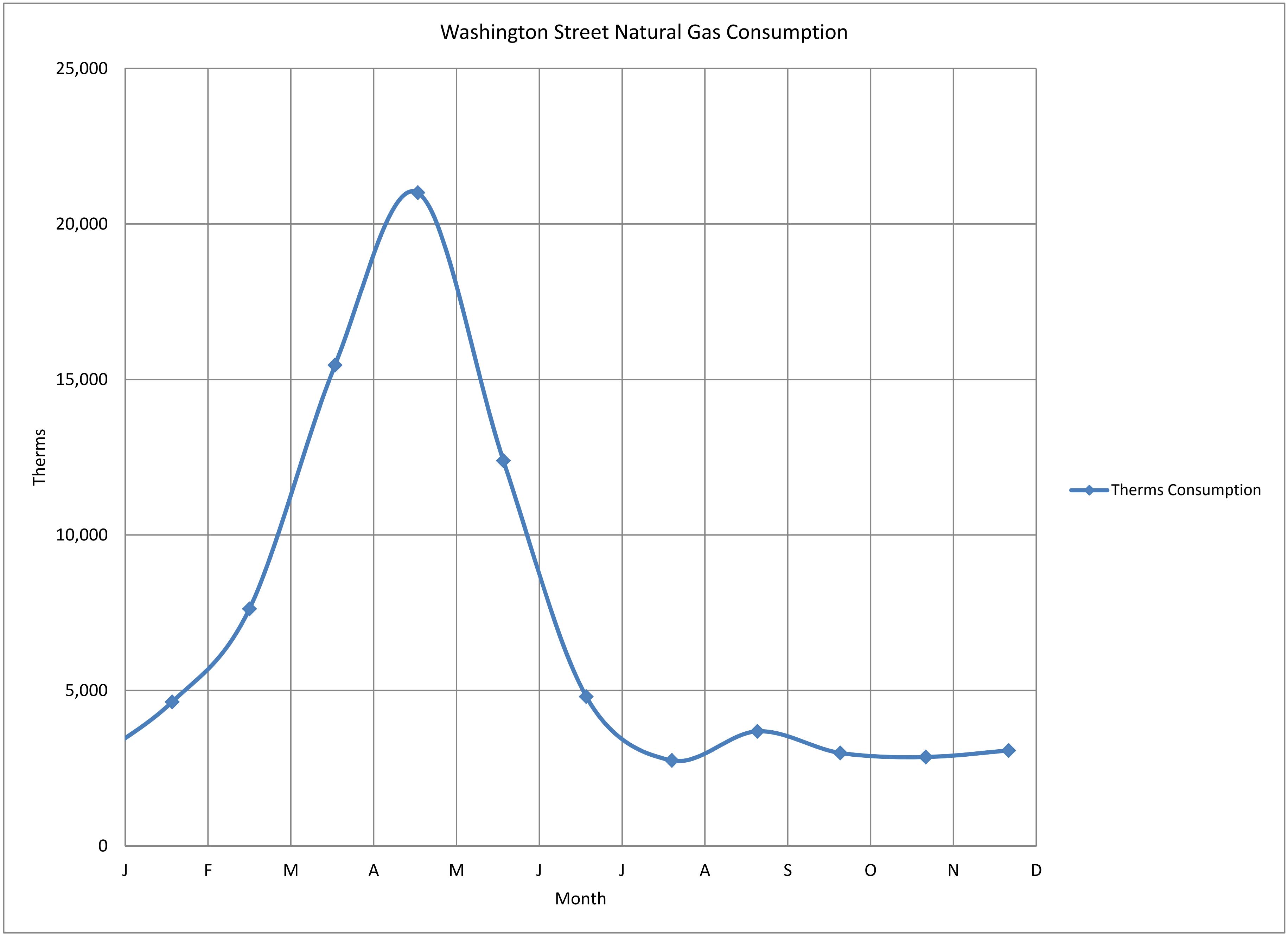
MONTH OF USE	CONSUMPTION KW	DEMAND	TOTAL BILL
Feb-17	291048	590.2	$25,744
Mar-17	269304	590.8	$24,665
Apr-17	200032	439.0	$19,631
May-17	131968	312.7	$15,323
Jun-17	111699	236.5	$14,876
Jul-17	122230	228.4	$15,525
Aug-17	102702	214.4	$12,872
Sep-17	98315	343.2	$11,913
Oct-17	104151	254.0	$10,396
Nov-17	196219	483.3	$21,331
Dec-16	281131	595.1	$25,867
Jan-18	172543	592.7	$35,873
Totals	**2,081,342**	**595.1 Max**	**$234,015**

AVERAGE CONSUMPTION **237.7 KW average**

AVERAGE RATE **$0.112 $/kWh**

Note: Yellow Highlighted cell is average for previous and next month bill

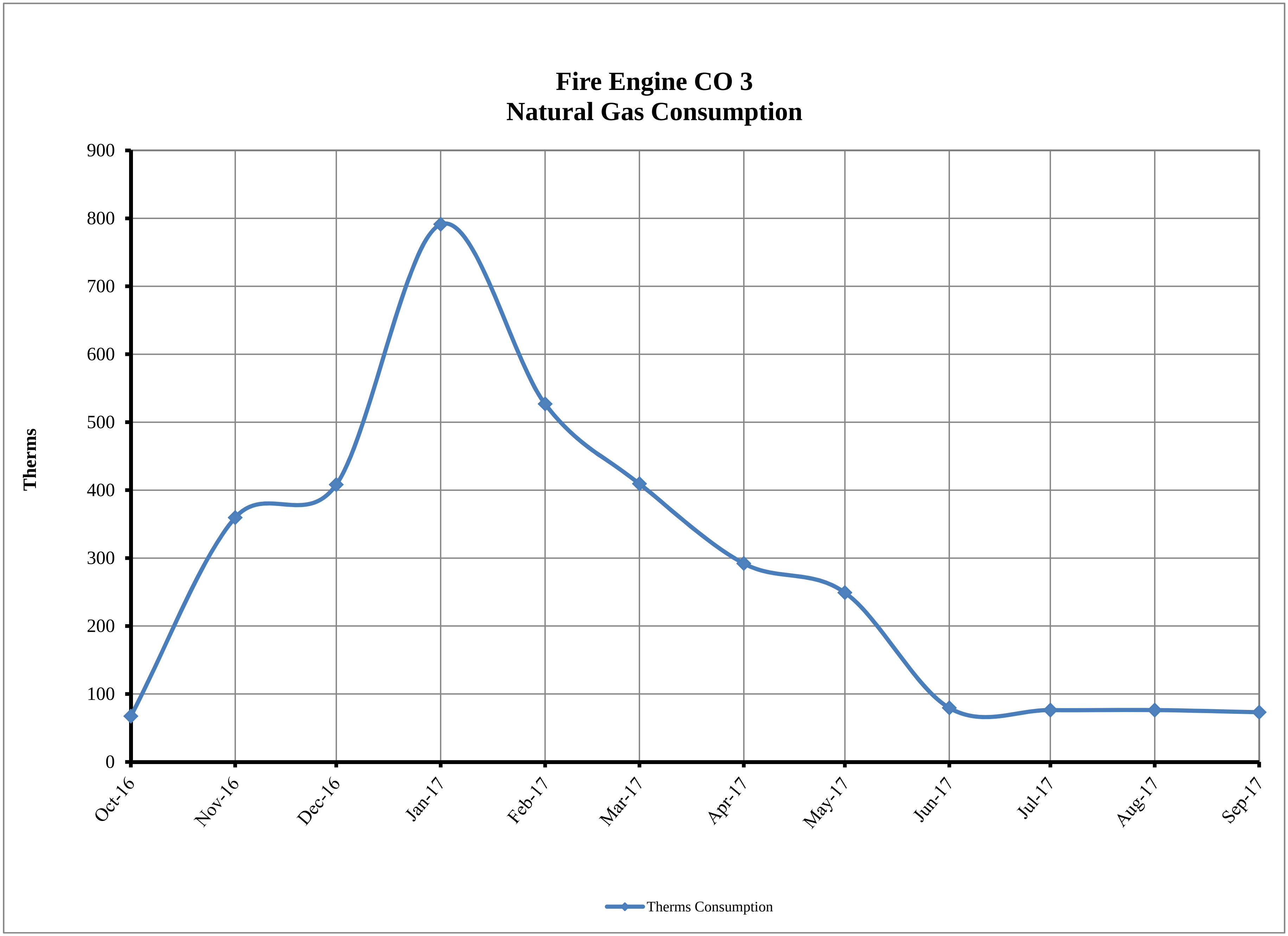
Note: for load calculation 595 kW is considered


Washington Street Natural Gas Consumption
25,000
20,000
15,000
10,000
5,000
0
Therms
J
F
M
A
M
J
J
A
S
O
N
D
Month
Therms Consumption

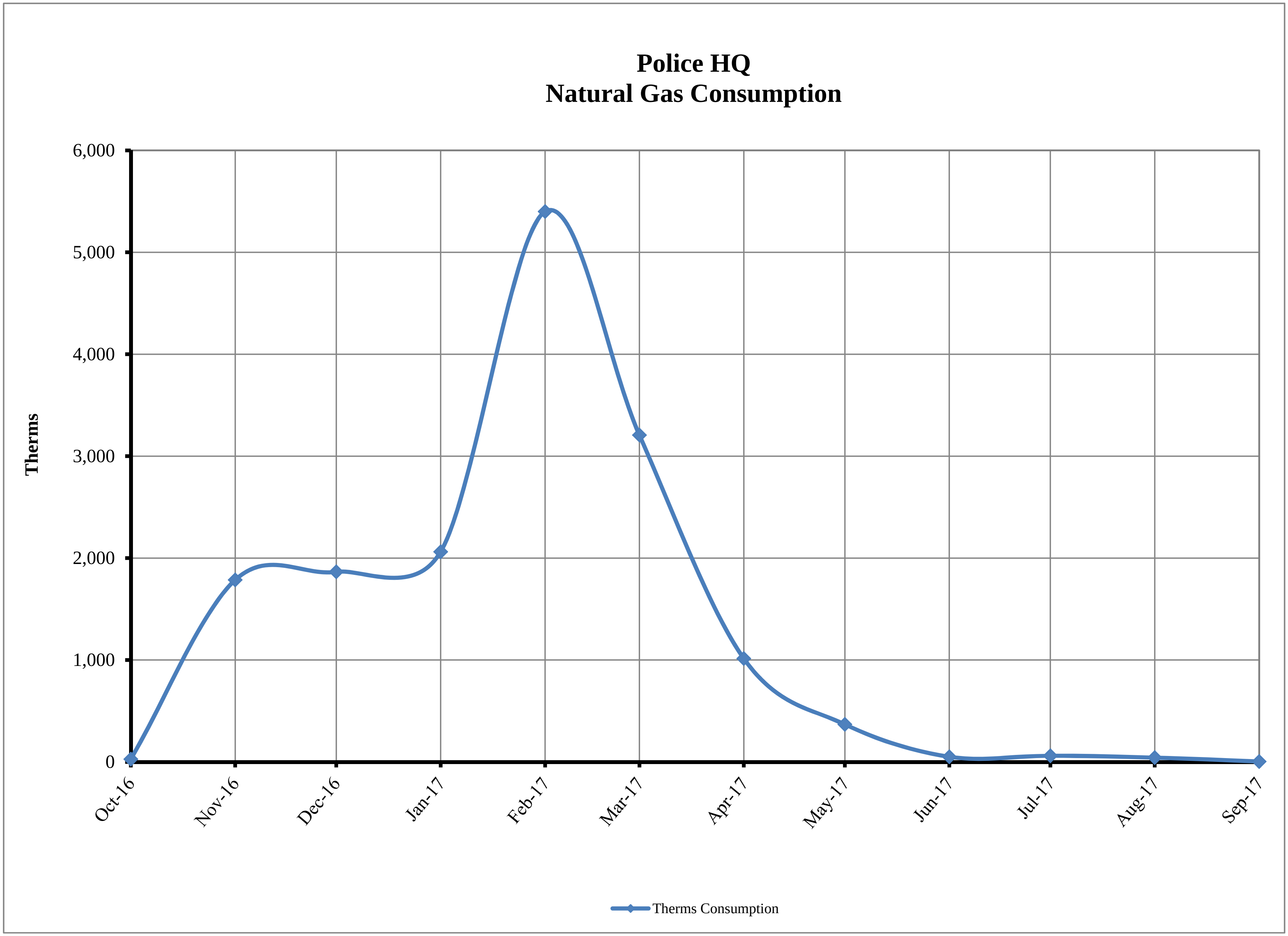
NATURAL GAS USAGE SUMMARY		
Facility :		
Utility Provider:	PSE&G	
Rate:	GSG	
Meter No:		
Point of Delivery ID:		
Third Party Utility Provider:		
TPS Meter No:		

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Jan-17	2,626.71	2,743.74
Feb-17	4,632.94	4,336.72
Mar-17	7,625.40	6,901.58
Apr-17	15,462.19	10,325.21
May-17	21,008.39	11,808.98
Jun-17	12,390.87	5,317.97
Jul-17	4,803.44	2,503.83
Aug-17	2,754.13	2,507.62
Sep-16	3,688.47	3,398.04
Oct-16	2,991.12	3,184.21
Nov-16	2,862.78	2,611.63
Dec-16	3,069.88	2,969.48
TOTALS	**83,916.31**	**$58,609.01**

AVERAGE RATE: **$0.70** **$/THERM**


Fire Engine CO 3
Natural Gas Consumption
Therms
900
800
700
600
500
400
300
200
100
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Therms Consumption

NATURAL GAS USAGE SUMMARY		
Facility :	Fire Engine CO 3	
Utility Provider:	PSE&G	
Rate:	GSG	
Meter No:	2412806	
Point of Delivery ID:	PG000007967137625177	
Acct No:		
MONTH OF USE	**CONSUMPTION (THERMS)**	**TOTAL BILL**
Oct-16	67.36	$88.92
Nov-16	359.61	$159.59
Dec-16	408.10	$335.76
Jan-17	791.28	$436.54
Feb-17	526.79	$742.29
Mar-17	409.41	$164.89
Apr-17	292.03	$283.69
May-17	249.20	$257.78
Jun-17	79.53	$38.71
Jul-17	76.32	$239.21
Aug-17	76.32	$37.41
Sep-17	73.11	$184.80
TOTALS	**3,409.04**	**$2,969.59**
AVERAGE RATE:	**$0.87**	**$/THERM**



Police HQ
Natural Gas Consumption
Therms
6,000
5,000
4,000
3,000
2,000
1,000
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Therms Consumption

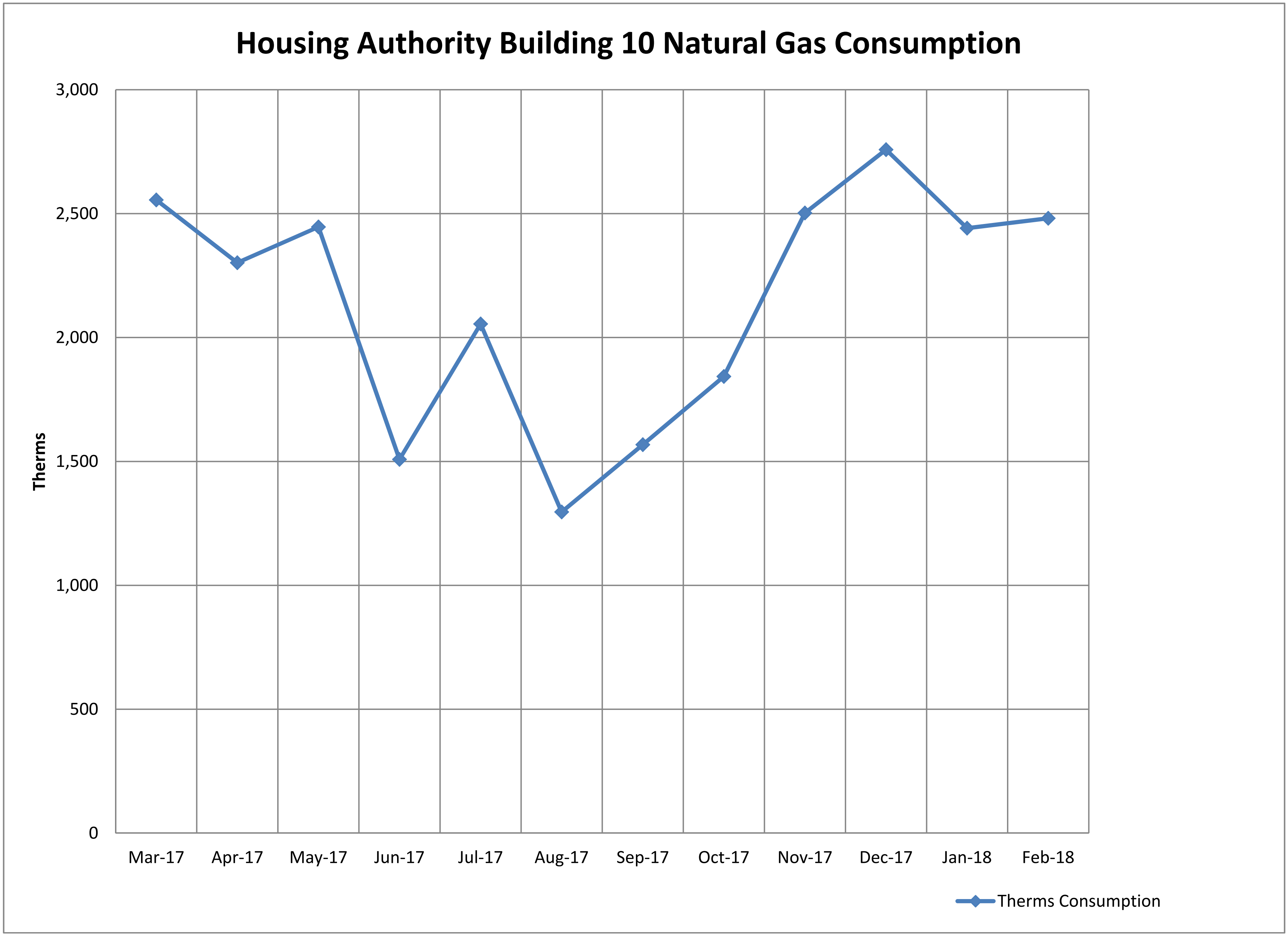
NATURAL GAS USAGE SUMMARY		
Facility :	Police HQ	
Utility Provider:	PSE&G	
Rate:	GSG	
Meter No:	4018605 & 3163918	
Point of Delivery ID:	PG000012173294525177	
Acct No:	69 774 309 07	

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Oct-16	27.40	$38.13
Nov-16	1,786.00	$1,161.55
Dec-16	1,864.99	$1,722.04
Jan-17	2,062.39	$1,796.12
Feb-17	5,399.65	$3,402.87
Mar-17	3,206.81	$1,415.94
Apr-17	1,013.98	$638.27
May-17	368.25	$224.66
Jun-17	50.52	$55.31
Jul-17	60.81	$59.73
Aug-17	42.53	$39.12
Sep-17	4.41	$59.51
TOTALS	**15,887.73**	**$10,613.25**

AVERAGE RATE: **$0.67** **$/THERM**

Note: Yellow Highlighted cell is average for previous and next month bill

Billing Data for 120 Hudson st



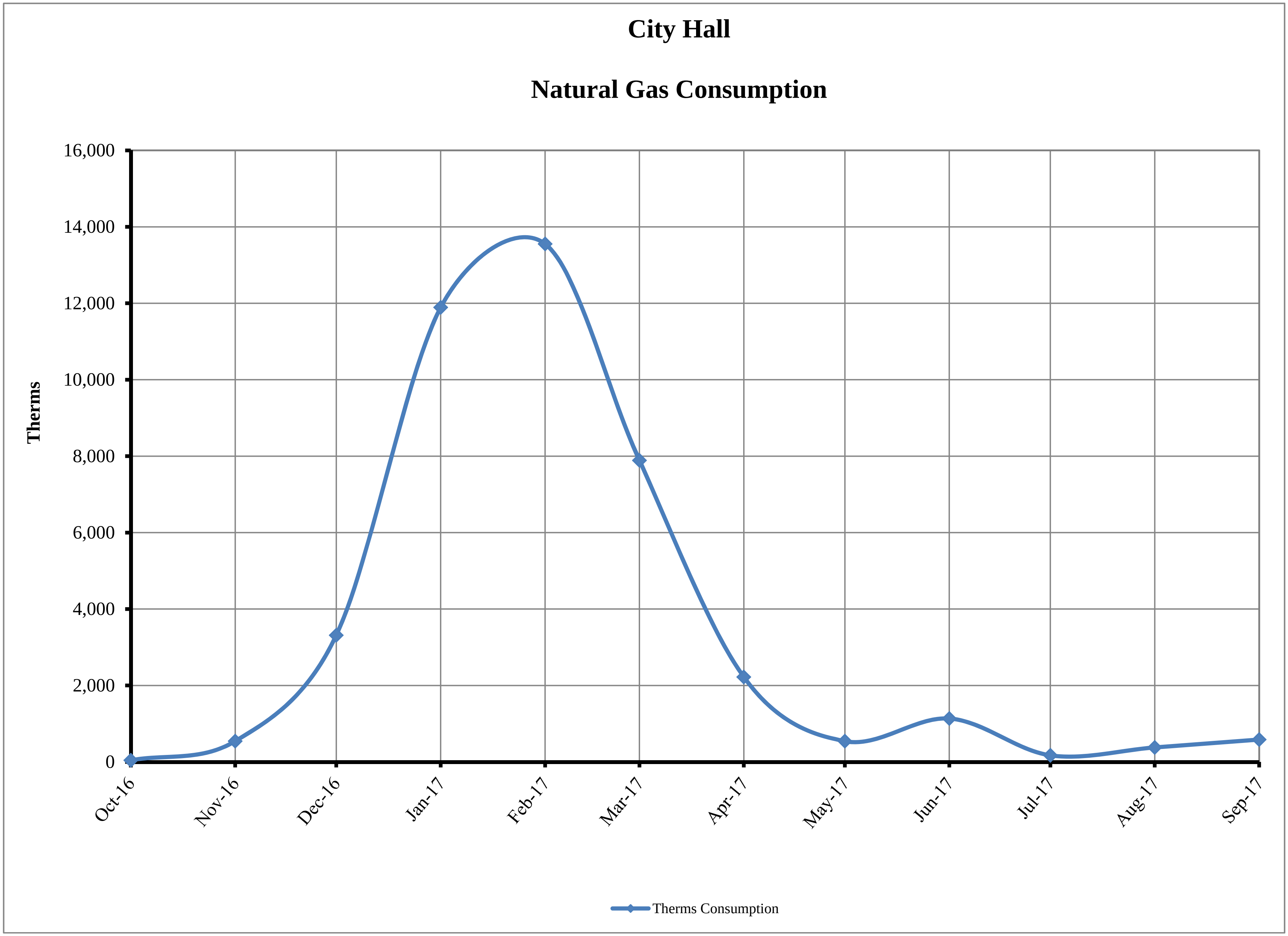
Housing Authority Building 10 Natural Gas Consumption
Therms
3,000
2,500
2,000
1,500
1,000
500
0
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
Therms Consumption

NATURAL GAS USAGE SUMMARY

Facility : Housing Authority 10
Utility Provider: PSE&G
Rate: GSG
Meter No: 2808422
Point of Delivery ID: PG000011457289423140
Third Party Utility Provider:
TPS Meter No/ Acct No: 42 457 521 06

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Mar-17	2,555.26	$2,193.08
Apr-17	2,302.06	$2,001.44
May-17	2,446.44	$2,141.91
Jun-17	1,508.04	$1,314.37
Jul-17	2,055.01	$1,765.00
Aug-17	1,296.39	$1,113.63
Sep-17	1,567.85	$1,342.20
Oct-17	1,842.69	$1,573.40
Nov-17	2,502.65	$2,210.91
Dec-17	2,758.14	$2,680.15
Jan-18	2,441.50	$2,363.69
Feb-18	2,481.21	$2,191.01
TOTALS	**25,757.24**	**$22,890.79**

AVERAGE RATE: **$0.89** **$/THERM**



City Hall
Natural Gas Consumption
Therms
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Therms Consumption

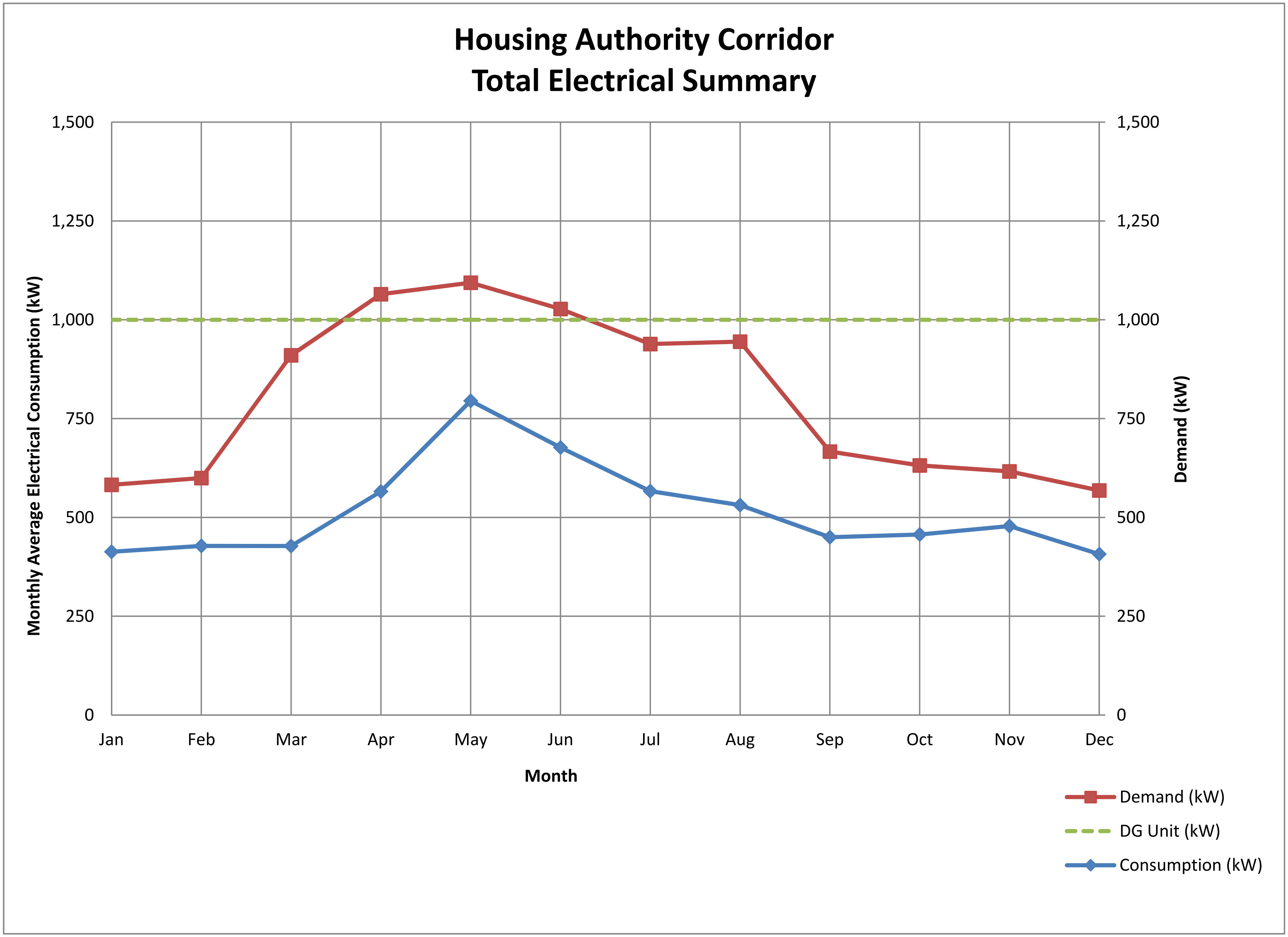
NATURAL GAS USAGE SUMMARY

Facility : City Hall
Utility Provider: PSE&G
Rate: LVG
Meter No: 3164294
Point of Delivery ID: PG000008937537225177
Acct No: 69 776 652 03

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Oct-16	44.05	$512.53
Nov-16	544.88	$1,173.73
Dec-16	3,313.97	$3,037.63
Jan-17	11,891.75	$7,214.72
Feb-17	13,553.73	$6,641.11
Mar-17	7,887.67	$2,788.40
Apr-17	2,221.61	$523.36
May-17	543.19	$709.56
Jun-17	1,135.30	$1,131.82
Jul-17	172.18	$444.33
Aug-17	378.74	$208.82
Sep-17	584.26	$718.96
TOTALS	**42,271.34**	$25,104.97

AVERAGE RATE: **$0.59** **$/THERM**

Note: Yellow Highlighted cell is average for previous and next month bill


Housing Authority Corridor
Total Electrical Summary
1,500
1,250
1,000
750
500
250
0
Monthly Average Electrical Consumption (kW)
Demand (kW)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
Demand (kW)
DG Unit (kW)
Consumption (kW)

ELECTRIC USAGE SUMMARY

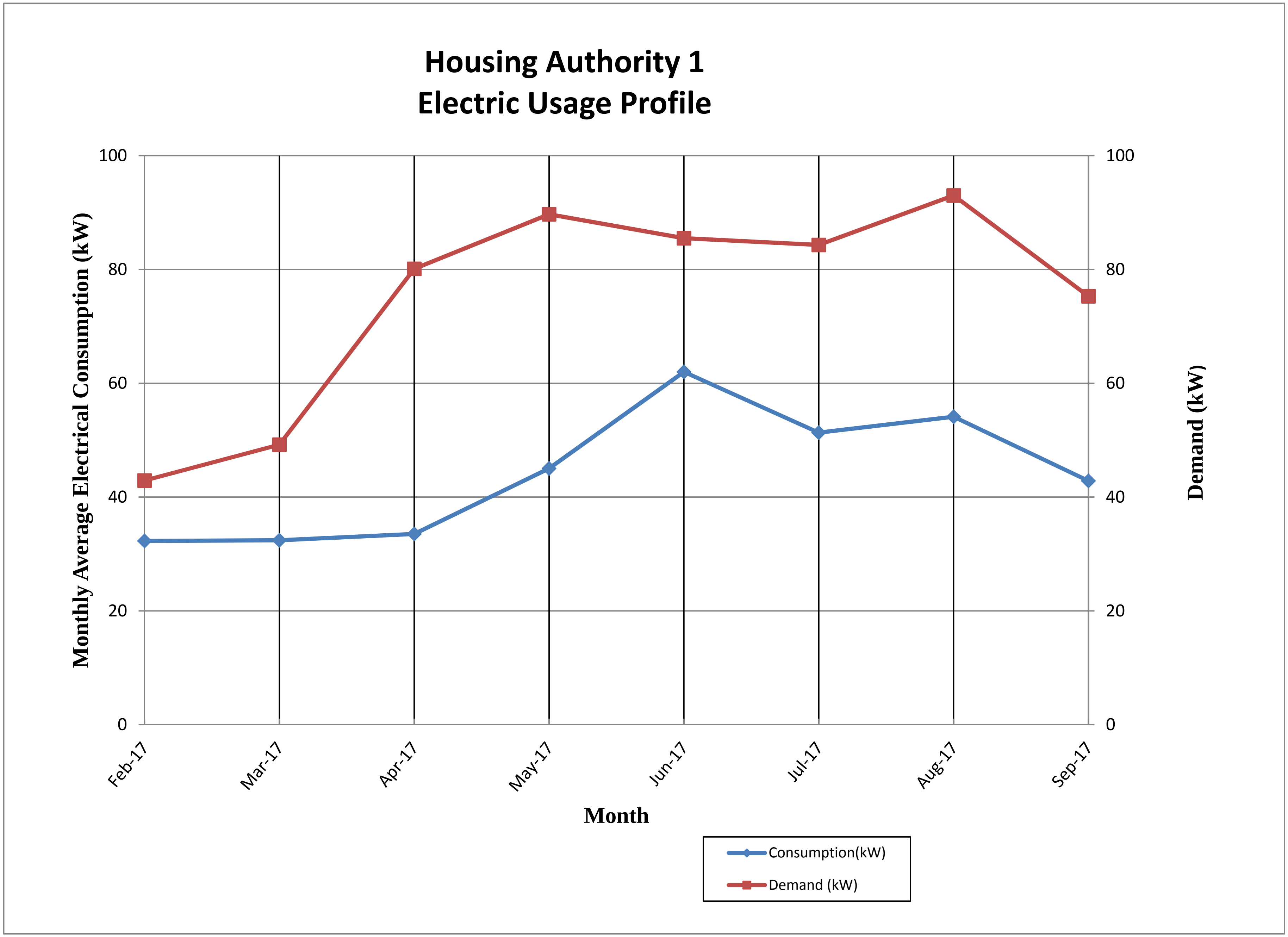
Facility : Hoboken Housing Authority Total Electrical Usage Summary
Utility Provider: PSE&G
Rate:
Meter No:
Customer ID No:
Third Party Utility
TPS Meter / Acct No:

MONTH OF USE	CONSUMPTION KW	DEMAND KW	TOTAL BILL
Jan	413.1	582.4	$44,086
Feb	427.8	599.5	$44,919
Mar	427.7	910.0	$47,819
Apr	565.7	1064.8	$63,509
May	794.9	1093.7	$74,378
Jun	677.0	1027.3	$63,914
Jul	566.4	938.7	$56,732
Aug	531.1	944.5	$43,541
Sep	449.8	666.6	$40,898
Oct	456.6	631.4	$45,602
Nov	478.1	616.5	$46,174
Dec	407.0	568.2	$42,902
Totals	**6,195**	**1093.7**	**$614,475**

AVERAGE DEMAND **825.0**

AVERAGE RATE **$0.136**

Some Facilities do not have bills for that moth.

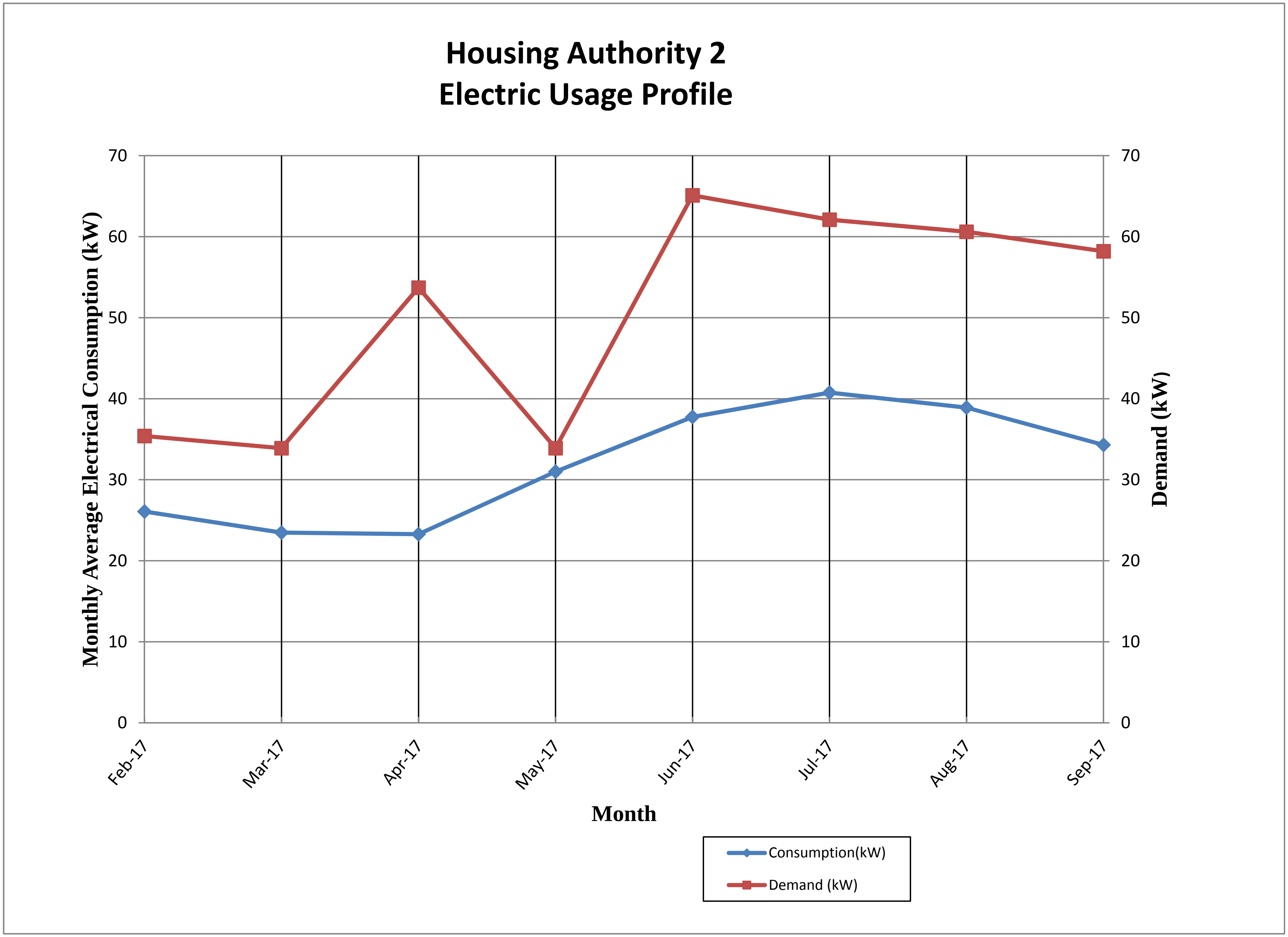

Housing Authority 1
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
Month
0
20
40
60
80
100
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Consumption(kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

Facility : Housing Authority 1
Utility Provider: PSE&G
Rate: GLP
Meter No: 678003354
Customer ID No: PE000011213527223140
Third Party Utility
TPS Meter / Acct No: 73 396 623 08

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Feb-17	23550	42.9	$3,245
Mar-17	23640	49.2	$3,332
Apr-17	24450	80.1	$3,651
May-17	32850	89.7	$5,164
Jun-17	45240	85.5	$5,968
Jul-17	37440	84.3	$5,075
Aug-17	39480	93.0	$5,260
Sep-17	31260	75.3	$3,381
Oct-17	23760	47.1	$2,898
Nov-17	27060	49.2	$3,423
Dec-16	26250	46.8	$3,372
Jan-18	20430	42.0	$2,948
Totals	**355,410**	**93.0 Max**	**$47,717**

AVERAGE CONSUMPTION **40.6 KW average**
AVERAGE RATE **$0.134** **$/kWh**



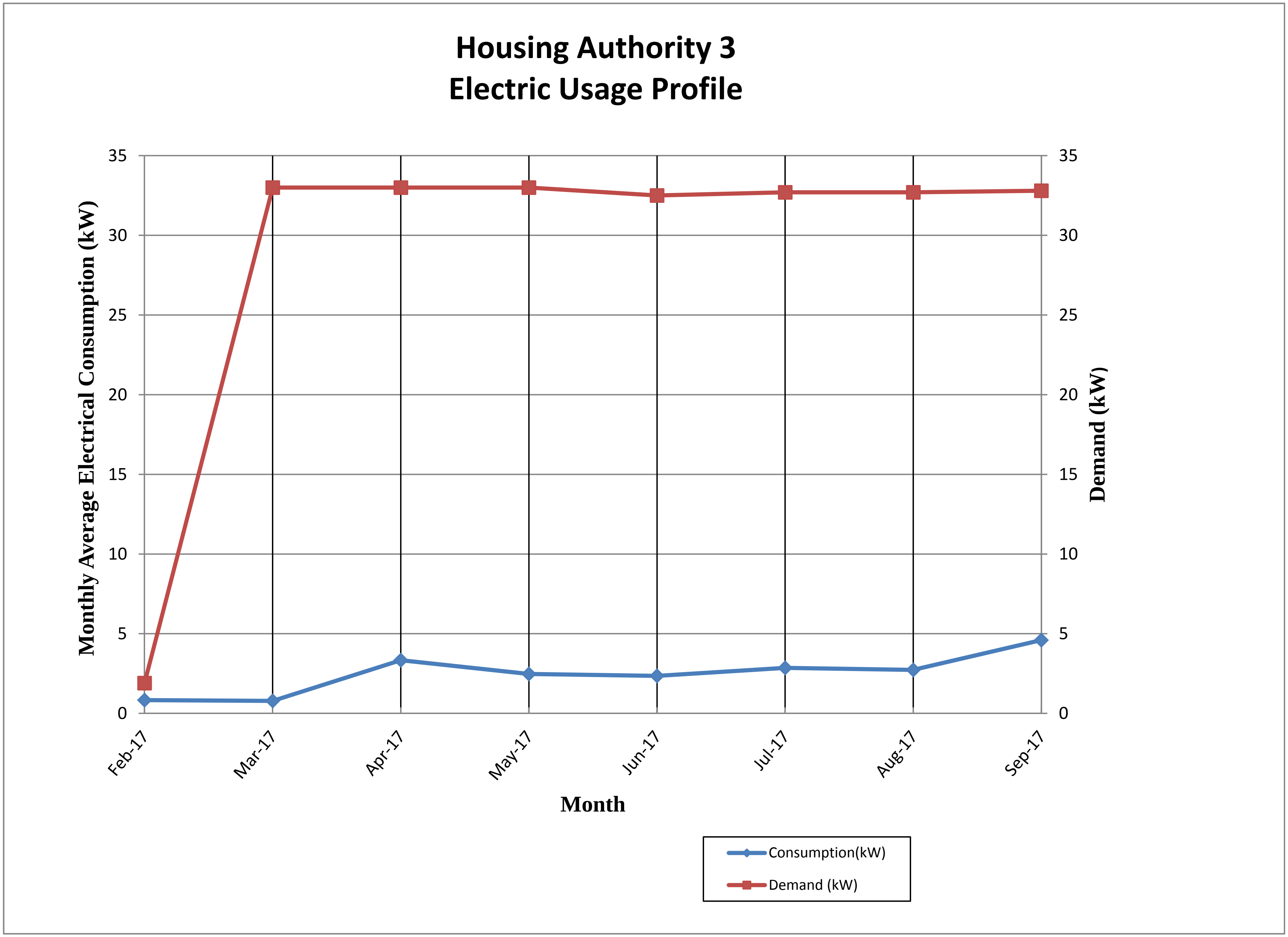
Housing Authority 2
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
70
60
50
40
30
20
10
0
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Consumption(kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

Facility : Housing Authority 2
Utility Provider: PSE&G
Rate: GLP
Meter No: 6780000260
Customer ID No: PE000009507713723140
Third Party Utility Provider:
TPS Meter / Acct No: 73 396 620 06

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Feb-17	19020	35.4	$3,738
Mar-17	17130	33.9	$3,496
Apr-17	16980	53.7	$3,497
May-17	29610	33.9	$4,726
Jun-17	27540	65.1	$4,596
Jul-17	29730	62.1	$4,488
Aug-17	28380	60.6	$4,364
Sep-17	25020	58.2	$3,192
Oct-17	19680	42.0	$2,994
Nov-17	21780	39.3	$3,660
Dec-16	21120	36.3	$3,919
Jan-18	17310	35.4	$3,495
Totals	**273,300**	**65.1 Max**	**$46,165**

AVERAGE CONSUMPTION **31.2 KW average**
AVERAGE RATE **$0.169** **$/kWh**

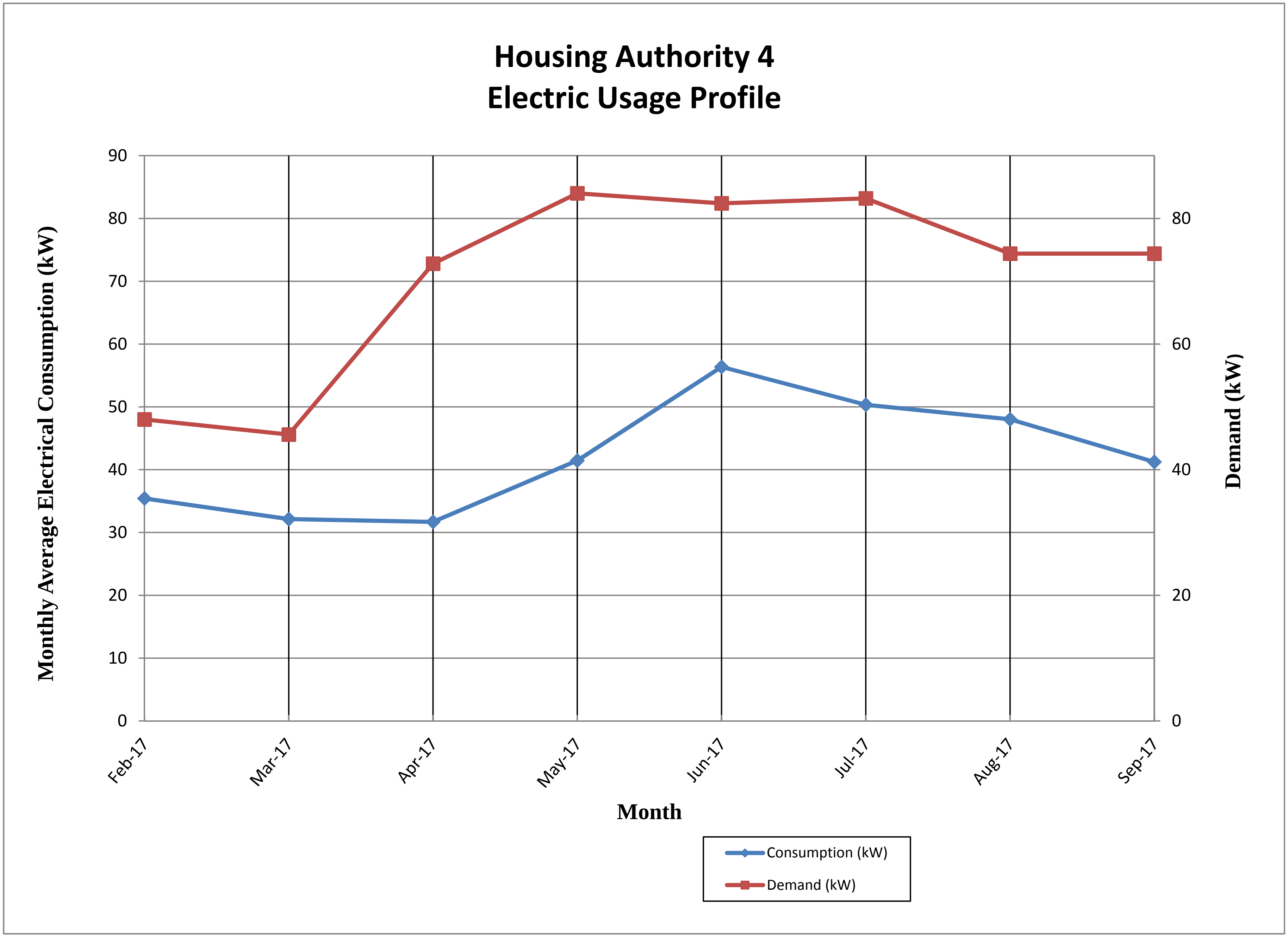

Housing Authority 3
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
0
5
10
15
20
25
30
35
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Consumption(kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

Facility : Housing Authority 3
Utility Provider: PSE&G
Rate: GLP
Meter No: 16425154
Customer ID No: PE000009021482635932
Third Party Utility Provider:
TPS Meter / Acct No: 73 396 618 08

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Feb-17	610	1.9	$521
Mar-17	572	33.0	$660
Apr-17	2437	33.0	$821
May-17	1805	33.0	$1,032
Jun-17	1716	32.5	$1,002
Jul-17	2086	32.7	$997
Aug-17	1991	32.7	$1,014
Sep-17	3353	32.8	$794
Oct-17	3900	32.9	$843
Nov-17	998	32.9	$668
Dec-16	998	33.0	$438
Jan-18	998	33.0	$456
Totals	**21,464**	**33.0 Max**	**$9,246**

AVERAGE CONSUMPTION **2.5 KW average**
AVERAGE RATE **$0.431** **$/kWh**

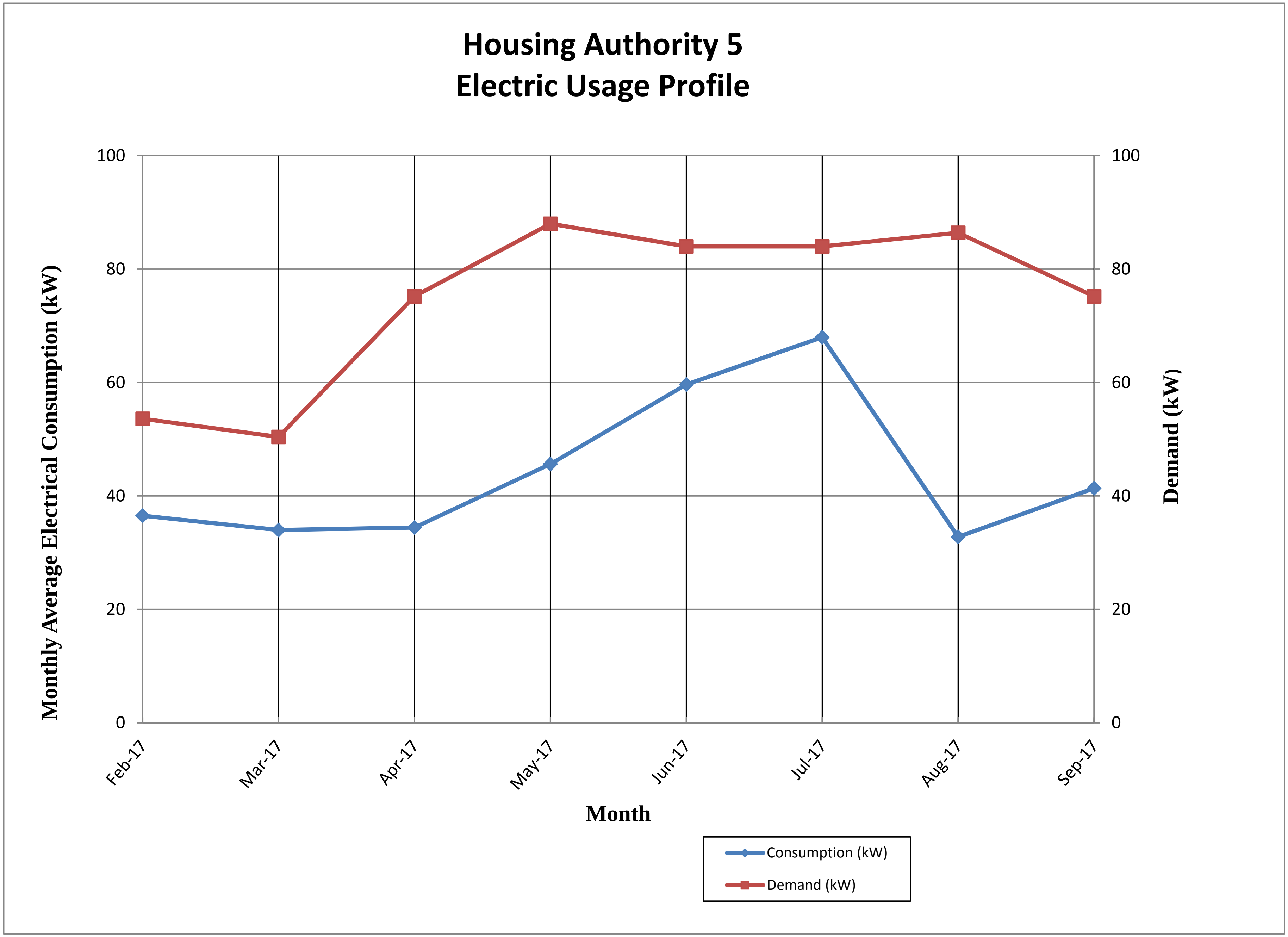

Housing Authority 4
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
Month
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
0
10
20
30
40
50
60
70
80
90
Consumption (kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

Facility :	Housing Authority 4
Utility Provider:	PSE&G
Rate:	GLP
Meter No:	9203284
Customer ID No:	PE000008292165123140
Third Party Utility Provider:	
TPS Meter / Acct No:	73 396 634 01

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Feb-17	25840	48.0	$4,698
Mar-17	23440	45.6	$4,323
Apr-17	23120	72.8	$4,496
May-17	30240	84.0	$5,835
Jun-17	41120	82.4	$6,271
Jul-17	36720	83.2	$5,777
Aug-17	35040	74.4	$5,534
Sep-17	30080	74.4	$4,075
Oct-17	24800	52.0	$3,839
Nov-17	27680	54.4	$4,637
Dec-16	27680	50.4	$5,003
Jan-18	22880	49.6	$4,487
Totals	**348,640**	**84.0 Max**	**$58,976**

AVERAGE CONSUMPTION **39.8** **KW average**
AVERAGE RATE **$0.169** **$/kWh**


Housing Authority 5
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
100
80
60
40
20
0
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Consumption (kW)
Demand (kW)

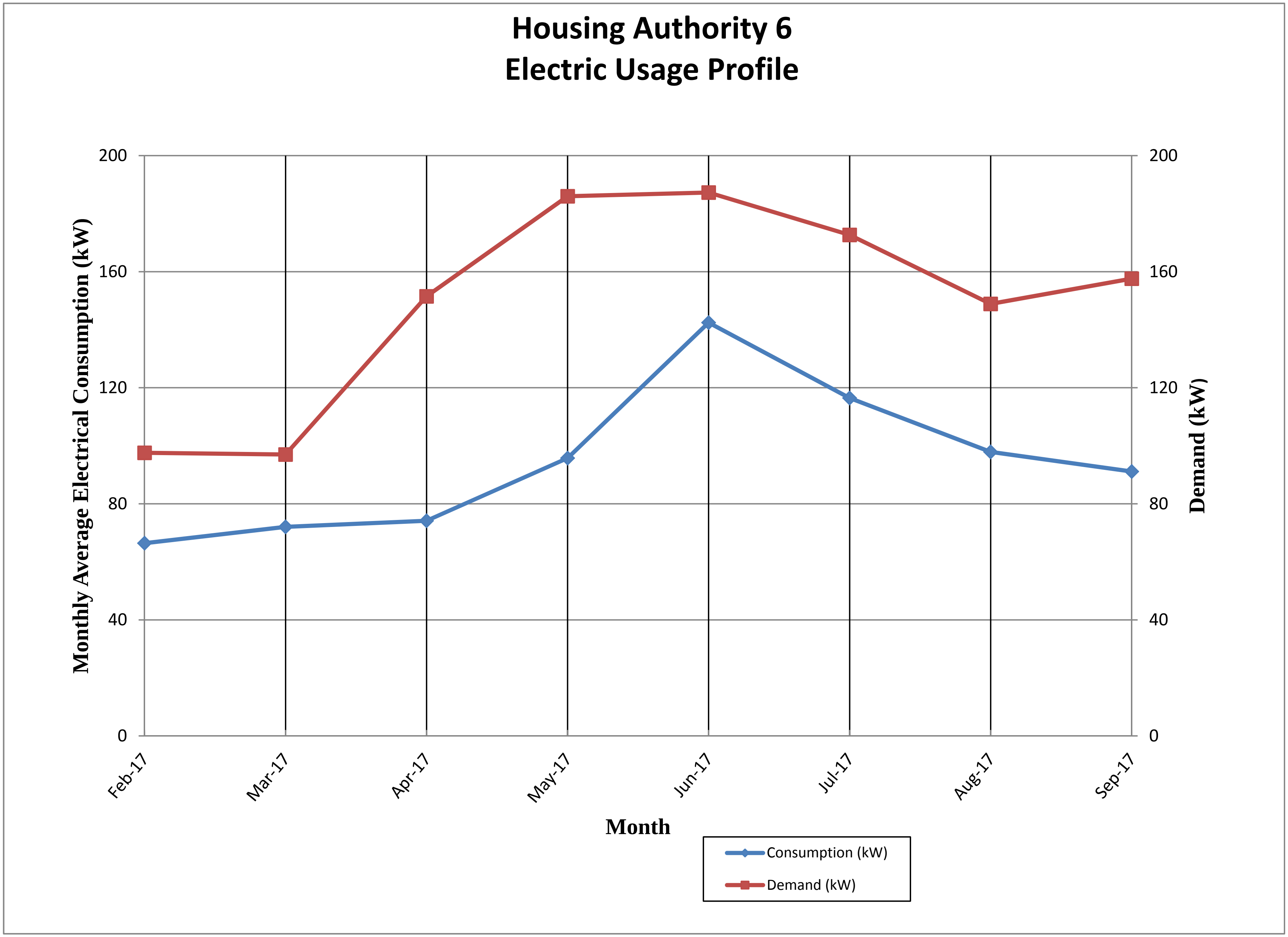
ELECTRIC USAGE SUMMARY

Facility :	Housing Authority 5
Utility Provider:	PSE&G
Rate:	GLP
Meter No:	9203285
Customer ID No:	PE000011213525623140
Third Party Utility Provider:	
TPS Meter / Acct No:	73 396 622 00

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Feb-17	26640	53.6	$3,537
Mar-17	24800	50.4	$3,436
Apr-17	25120	75.2	$3,692
May-17	33280	88.0	$5,187
Jun-17	43520	84.0	$5,670
Jul-17	49600	84.0	$6,025
Aug-17	23920	86.4	$4,043
Sep-17	30160	75.2	$3,323
Oct-17	22320	49.6	$2,826
Nov-17	25200	47.2	$3,283
Dec-16	27920	56.0	$3,546
Jan-18	23520	53.6	$3,241
Totals	356000	**88.0 Max**	**$47,809**

AVERAGE CONSUMPTION **40.7 KW average**

AVERAGE RATE **$0.134** **$/kWh**

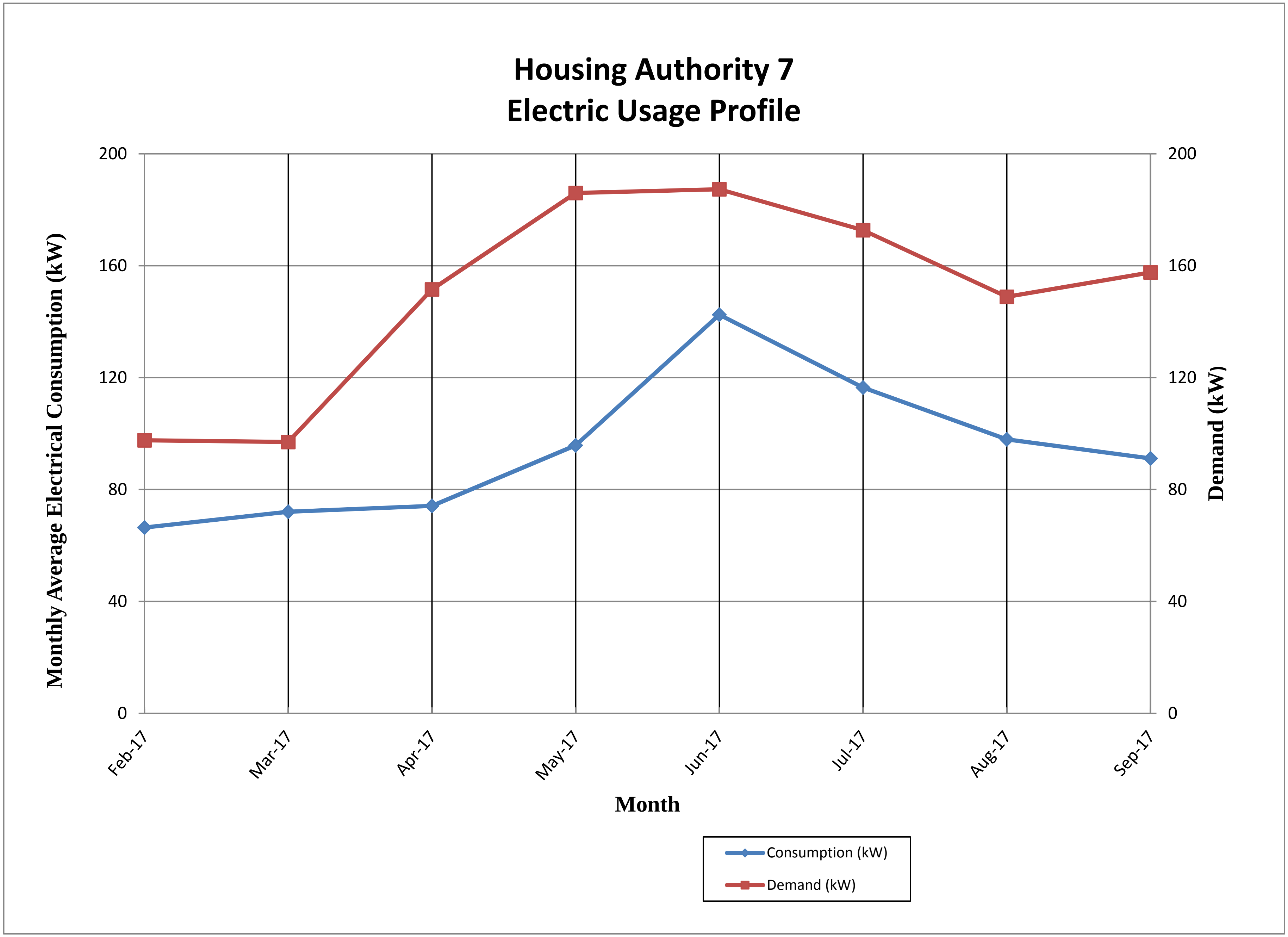

Housing Authority 6
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
200
160
120
80
40
0
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Consumption (kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

Facility : Housing Authority 6
Utility Provider: PSE&G
Rate: GLP
Meter No:
Customer ID No:
Third Party Utility Provider:
TPS Meter / Acct No: 42 258 500 05

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Feb-17	48475	97.6	$6,886
Mar-17	52574	97.0	$7,218
Apr-17	54114	151.5	$7,873
May-17	69878	186.0	$10,312
Jun-17	103945	187.3	$12,073
Jul-17	84961	172.7	$10,503
Aug-17	71432	148.9	$9,109
Sep-17	66489	157.6	$7,159
Oct-17	56651	115.7	$6,773
Nov-17	54978	97.2	$7,267
Dec-16	57658	107.8	$7,243
Jan-18	49487	92.1	$6,809
Totals	**770,642**	**187.3 Max**	**$99,226**

AVERAGE CONSUMPTION **88.0 KW average**
AVERAGE RATE **$0.129** **$/kWh**



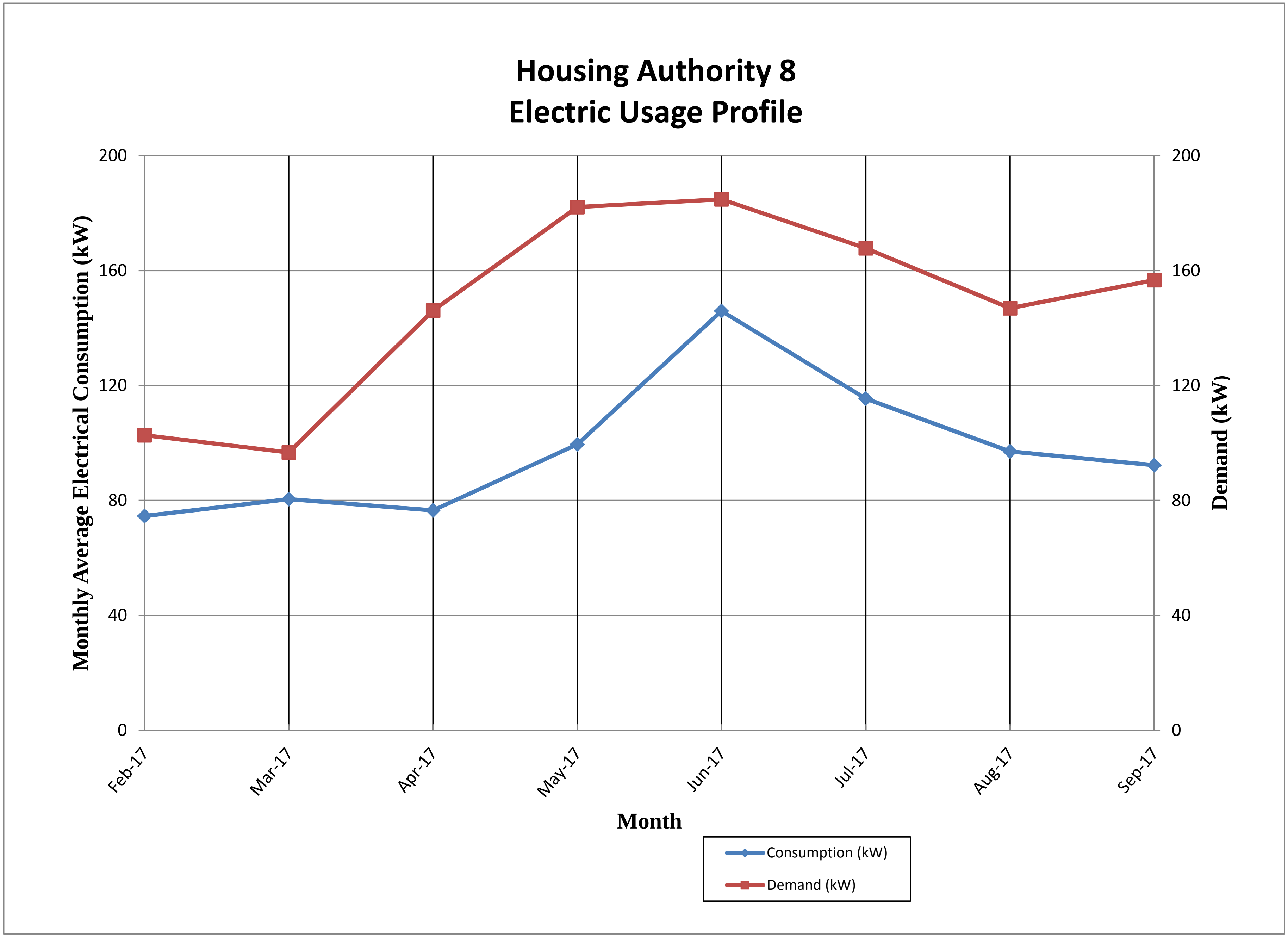
Housing Authority 7
Electric Usage Profile
200
160
120
80
40
0
Monthly Average Electrical Consumption (kW)
Demand (kW)
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Consumption (kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

Facility : Housing Authority 7
Utility Provider: PSE&G
Rate: GLP
Meter No: 9206087
Customer ID No: PE000012314687223140
Third Party Utility Provider:
TPS Meter / Acct No: 42 258 500 05

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Feb-17	48475	97.6	$6,886
Mar-17	52574	97.0	$7,218
Apr-17	54114	151.5	$7,873
May-17	69878	186.0	$10,312
Jun-17	103945	187.3	$12,073
Jul-17	84961	172.7	$10,503
Aug-17	71432	148.9	$9,109
Sep-17	66489	157.6	$7,159
Oct-17	56651	115.7	$6,773
Nov-17	54978	97.2	$7,267
Dec-16	57658	107.8	$7,243
Jan-18	49487	92.1	$6,809
Totals	**770,642**	**187.3 Max**	**$99,226**

AVERAGE CONSUMPTION **88.0** **KW average**
AVERAGE RATE **$0.129** **$/kWh**

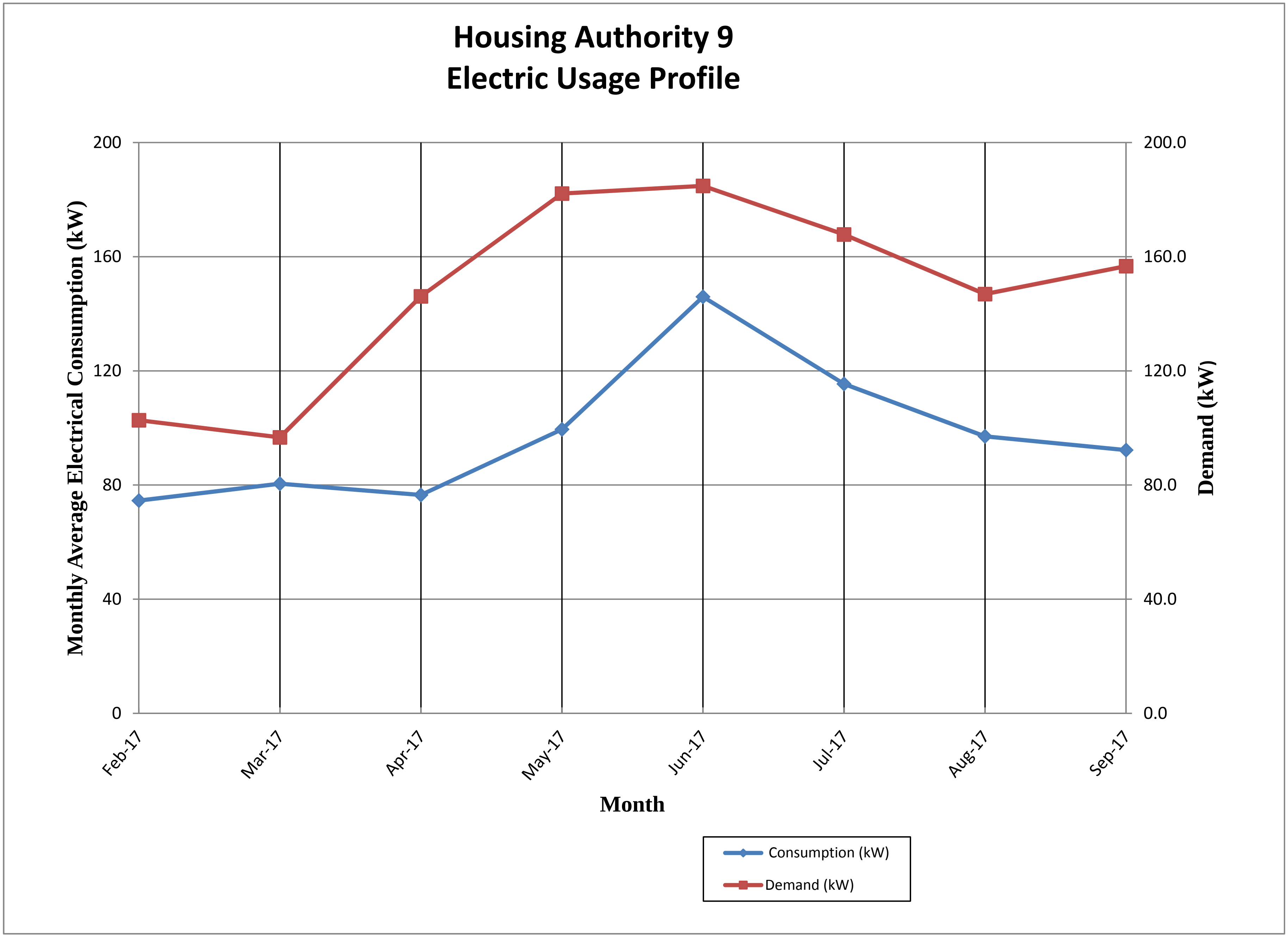

Housing Authority 8
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
Month
200
160
120
80
40
0
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Consumption (kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

Facility :	Housing Authority 8
Utility Provider:	PSE&G
Rate:	GLP
Meter No:	
Customer ID No:	
Third Party Utility Provider:	
TPS Meter / Acct No:	42 457 522 03

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Feb-17	54395	102.7	$7,287
Mar-17	58702	96.7	$7,618
Apr-17	55845	146.1	$7,958
May-17	72606	182.1	$10,470
Jun-17	106472	184.8	$12,424
Jul-17	84222	167.8	$10,273
Aug-17	70803	146.9	$9,150
Sep-17	67309	156.7	$7,230
Oct-17	60192	105.8	$6,976
Nov-17	60244	107.0	$7,698
Dec-16	65247	105.7	$7,704
Jan-18	56920	101.7	$7,328
Totals	**812,957**	**184.8 Max**	**$102,116**

AVERAGE DEMAND	**92.9**	**KW average**
AVERAGE RATE	**$0.126**	**$/kWh**



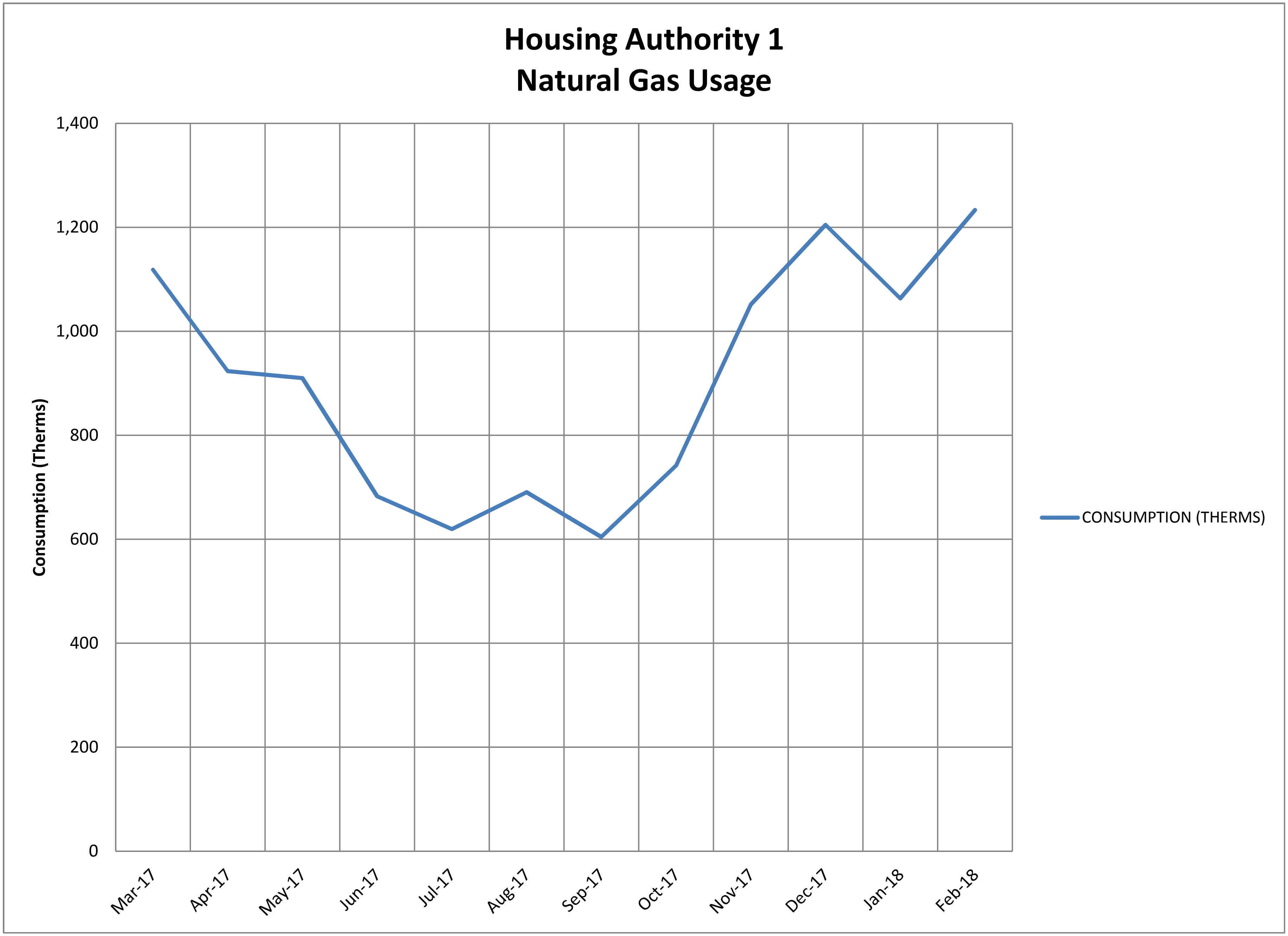
Housing Authority 9
Electric Usage Profile
Monthly Average Electrical Consumption (kW)
Demand (kW)
200
160
120
80
40
0
200.0
160.0
120.0
80.0
40.0
0.0
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Month
Consumption (kW)
Demand (kW)

ELECTRIC USAGE SUMMARY

Facility : Housing Authority 9
Utility Provider: PSE&G
Rate: GLP
Meter No: 9205933
Customer ID No: PE000120271390231410
Third Party Utility Provider:
TPS Meter / Acct No: 42 457 522 03

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Feb-17	54395	102.7	$7,287
Mar-17	58702	96.7	$7,618
Apr-17	55845	146.1	$7,958
May-17	72606	182.1	$10,470
Jun-17	106472	184.8	$12,424
Jul-17	84222	167.8	$10,273
Aug-17	70803	146.9	$9,150
Sep-17	67309	156.7	$7,230
Oct-17	60192	105.8	$6,976
Nov-17	60244	107.0	$7,698
Dec-16	65247	105.7	$7,704
Jan-18	56920	101.7	$7,328
Totals	**812,957**	**184.8 Max**	**$102,116**

AVERAGE DEMAND **92.9** **KW average**
AVERAGE RATE **$0.126** **$/kWh**

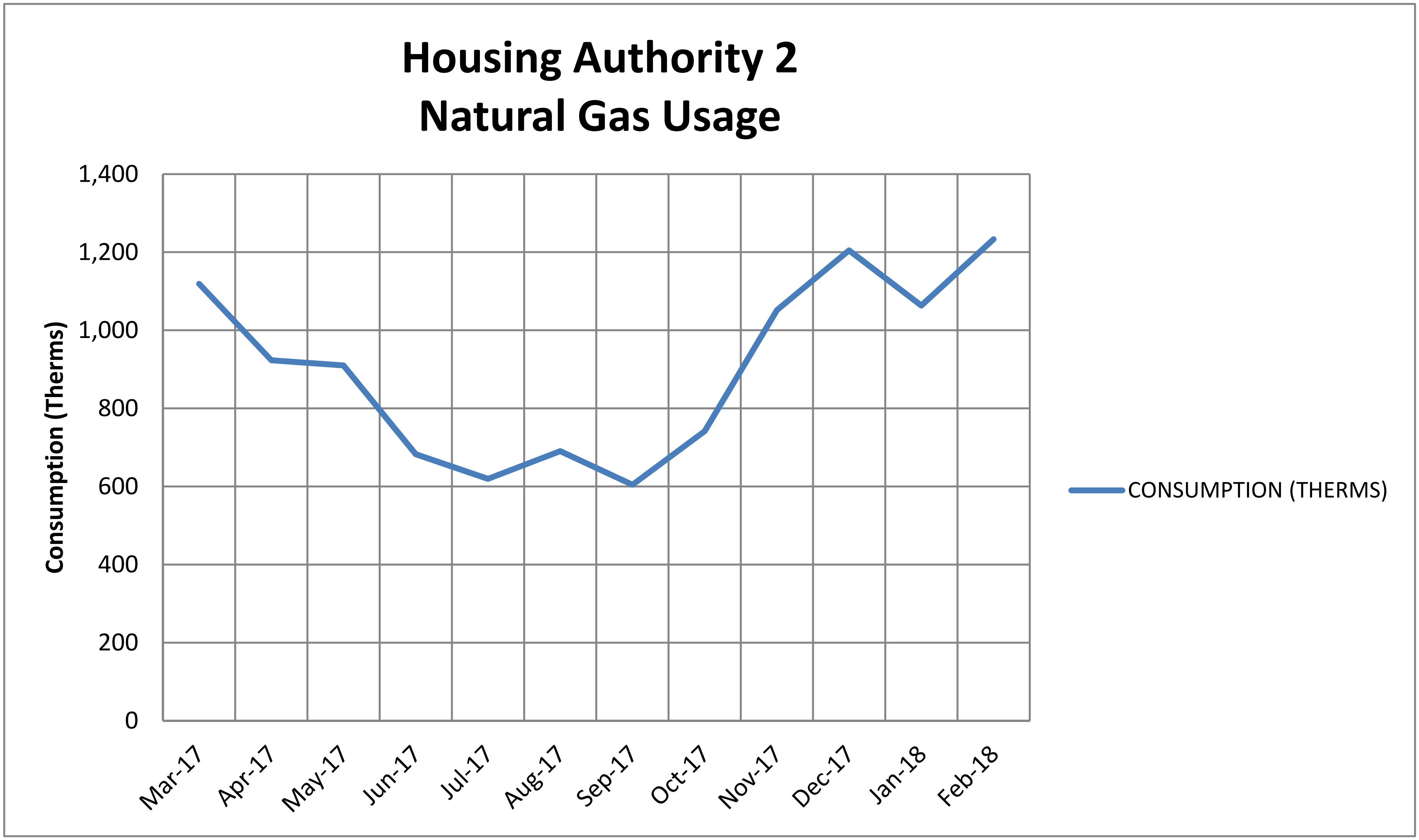

Housing Authority 1
Natural Gas Usage
Consumption (Therms)
1,400
1,200
1,000
800
600
400
200
0
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
CONSUMPTION (THERMS)

NATURAL GAS USAGE SUMMARY

Facility : Housing Authority1
Utility Provider: PSE&G
Rate: GSG
Meter No:
Point of Delivery ID:
Third Party Utility Provider:
TPS Meter No/ Acct No:

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Mar-17	1,118.74	$3,495.68
Apr-17	923.19	$3,497.09
May-17	910.04	$4,725.80
Jun-17	682.64	$4,596.20
Jul-17	619.32	$4,488.43
Aug-17	690.34	$4,363.79
Sep-17	604.24	$3,191.80
Oct-17	741.57	$2,993.73
Nov-17	1,051.64	$3,660.39
Dec-17	1,204.65	$3,919.32
Jan-18	1,063.06	$3,494.98
Feb-18	1,233.24	$3,737.85
TOTALS	**10,842.66**	**$46,165.06**

AVERAGE RATE: **$4.26** **$/THERM**

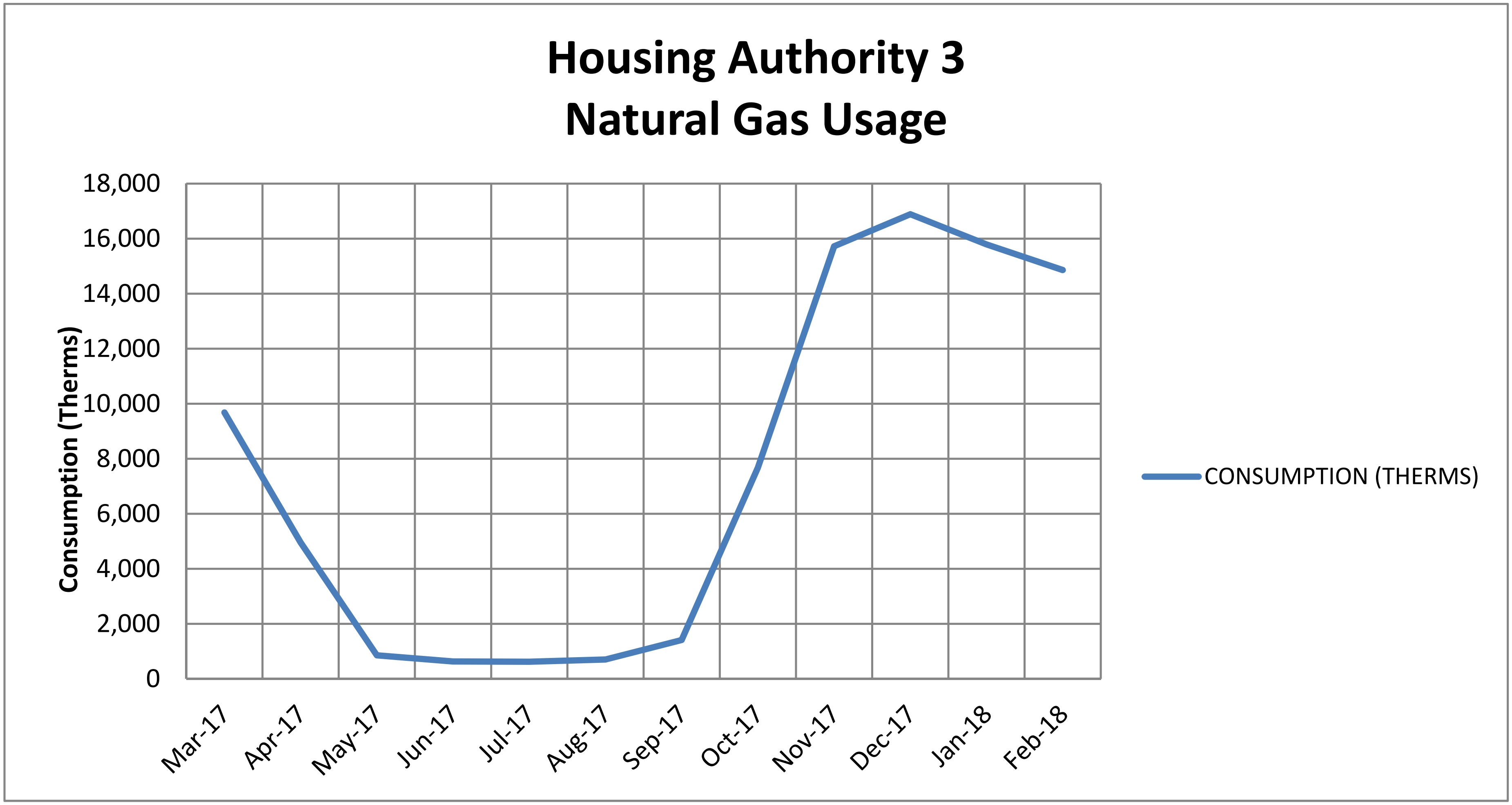

Housing Authority 2
Natural Gas Usage
Consumption (Therms)
1,400
1,200
1,000
800
600
400
200
0
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
CONSUMPTION (THERMS)

NATURAL GAS USAGE SUMMARY

Facility : Housing Authority 2
Utility Provider: PSE&G
Rate: GSG
Meter No: 3766450
Point of Delivery ID: PG000012103156123140
Third Party Utility Provider:
TPS Meter No/ Acct No: 73 396 625 02 / 73 396 638 00

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Mar-17	1,118.74	$3,495.68
Apr-17	923.19	$3,497.09
May-17	910.04	$4,725.80
Jun-17	682.64	$4,596.20
Jul-17	619.32	$4,488.43
Aug-17	690.34	$4,363.79
Sep-17	604.24	$3,191.80
Oct-17	741.57	$2,993.73
Nov-17	1,051.64	$3,660.39
Dec-17	1,204.65	$3,919.32
Jan-18	1,063.06	$3,494.98
Feb-18	1,233.24	$3,737.85
TOTALS	**10,842.66**	**$46,165.06**

AVERAGE RATE: **$4.26** **$/THERM**

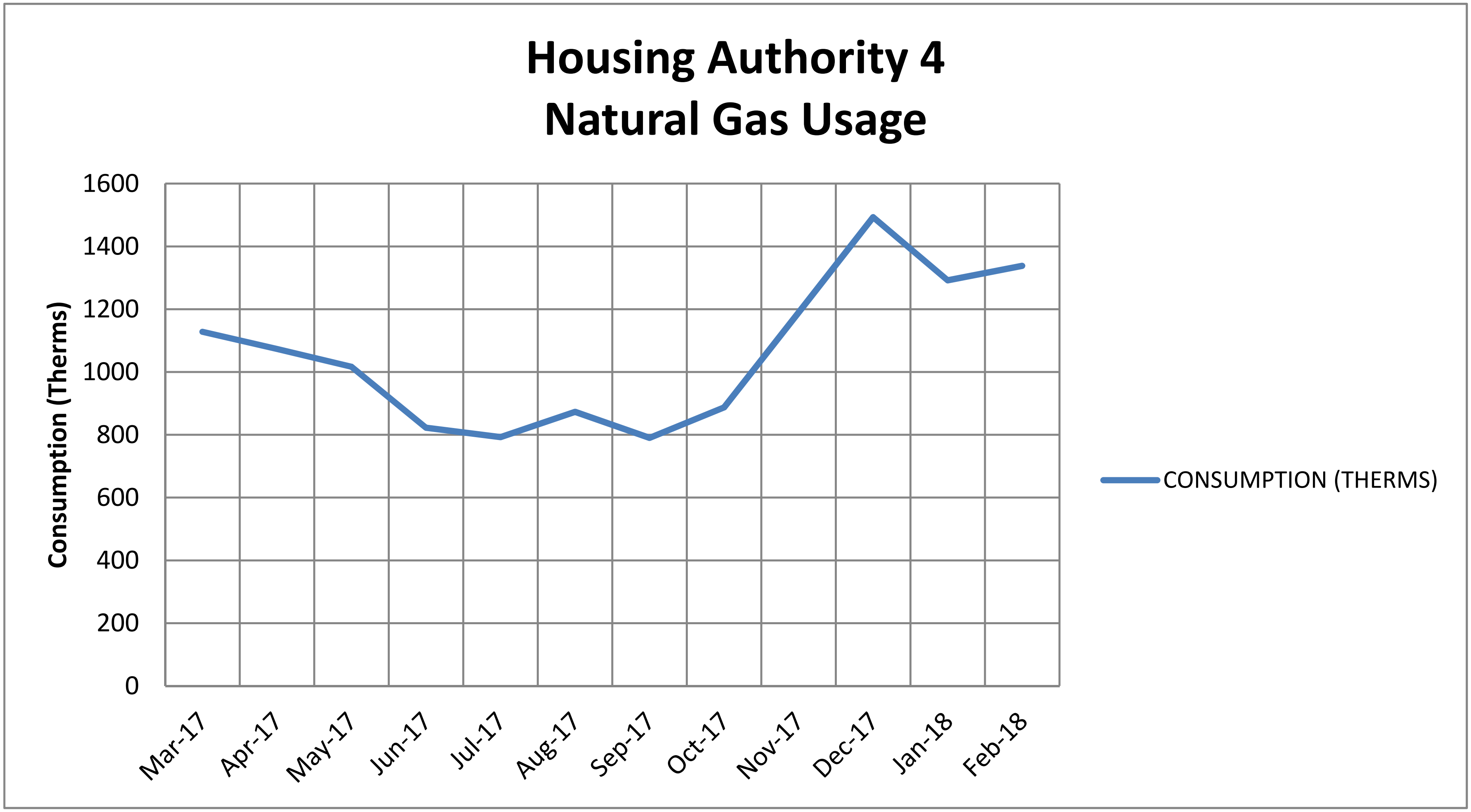

Housing Authority 3
Natural Gas Usage
Consumption (Therms)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
CONSUMPTION (THERMS)

NATURAL GAS USAGE SUMMARY

Facility :	Housing Authority 3
Utility Provider:	PSE&G
Rate:	GSG
Meter No:	2283043-2415360
Point of Delivery ID:	PG000008050796523140
Third Party Utility Provider:	
TPS Meter No/ Acct No:	73 396 625 02 / 73 396 638 00

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Mar-17	9,683.10	$6,292.62
Apr-17	4,956.62	$3,382.69
May-17	857.62	$769.89
Jun-17	632.46	$620.50
Jul-17	623.50	$600.28
Aug-17	706.00	$656.72
Sep-17	1,410.24	$1,096.18
Oct-17	7,673.40	$6,801.28
Nov-17	15,722.28	$13,747.64
Dec-17	16,889.19	$16,218.42
Jan-18	15,792.56	$15,143.37
Feb-18	14,859.75	$13,250.12
TOTALS	**89,806.72**	**$78,579.71**

AVERAGE RATE: **$0.87** **$/THERM**

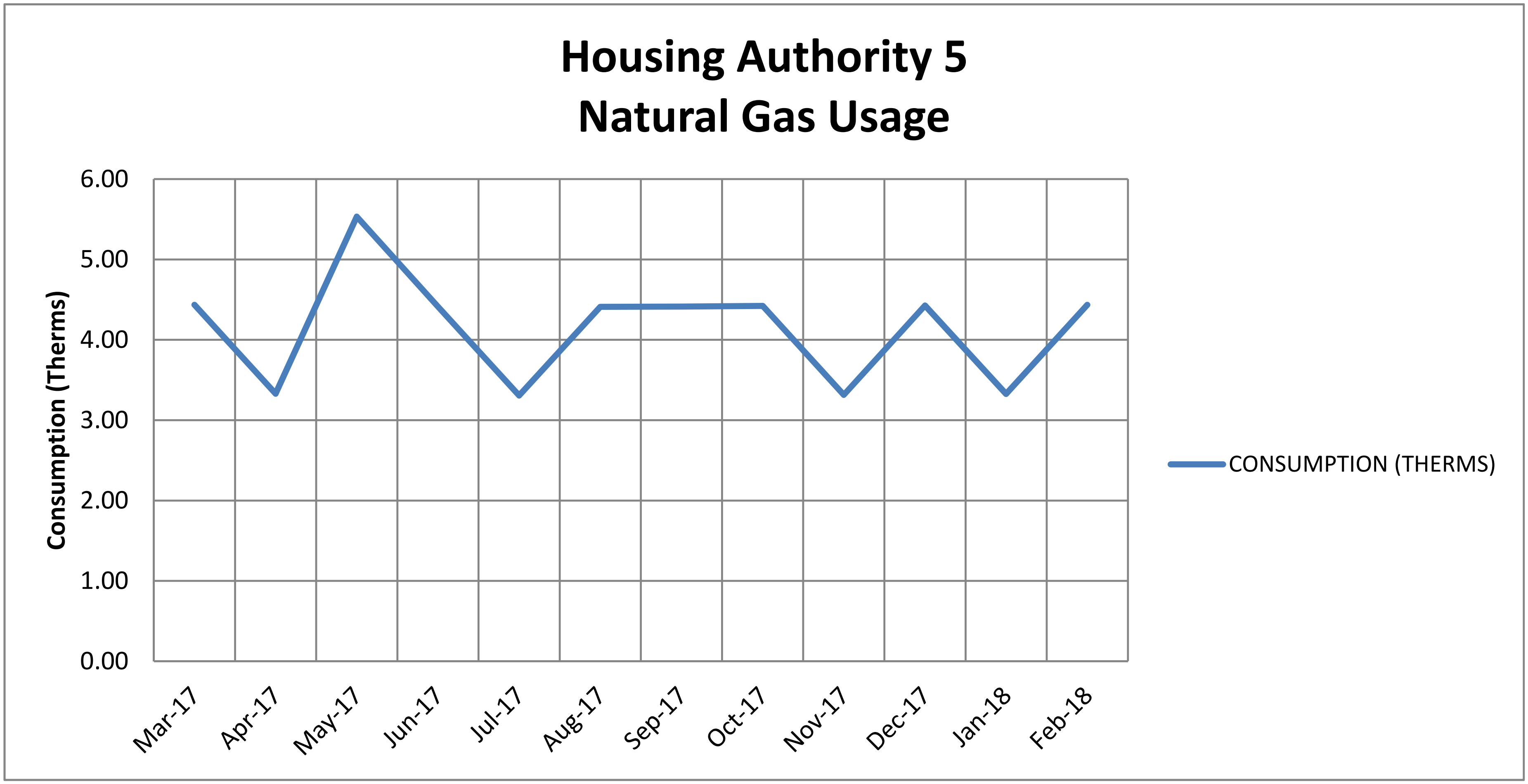

Housing Authority 4
Natural Gas Usage
Consumption (Therms)
1600
1400
1200
1000
800
600
400
200
0
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
CONSUMPTION (THERMS)

NATURAL GAS USAGE SUMMARY

Facility : Housing Authority 4
Utility Provider: PSE&G
Rate: GSG
Meter No: 3766139
Point of Delivery ID: PG000008292163623140
Third Party Utility Provider:
TPS Meter No/ Acct No: 73 396 634 01

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Mar-17	1128.189	$4,323.24
Apr-17	1073.549	$4,496.05
May-17	1016.979	$5,835.40
Jun-17	822.726	$6,400.92
Jul-17	792.687	$5,777.33
Aug-17	873.105	$5,533.71
Sep-17	790.319	$4,074.72
Oct-17	887.165	$3,838.85
Nov-17	1189.766	$4,637.40
Dec-17	1492.968	$5,003.11
Jan-18	1292.061	$4,486.58
Feb-18	1338.281	$4,698.45
TOTALS	**12,697.80**	**$59,105.76**

AVERAGE RATE: **$4.65** **$/THERM**

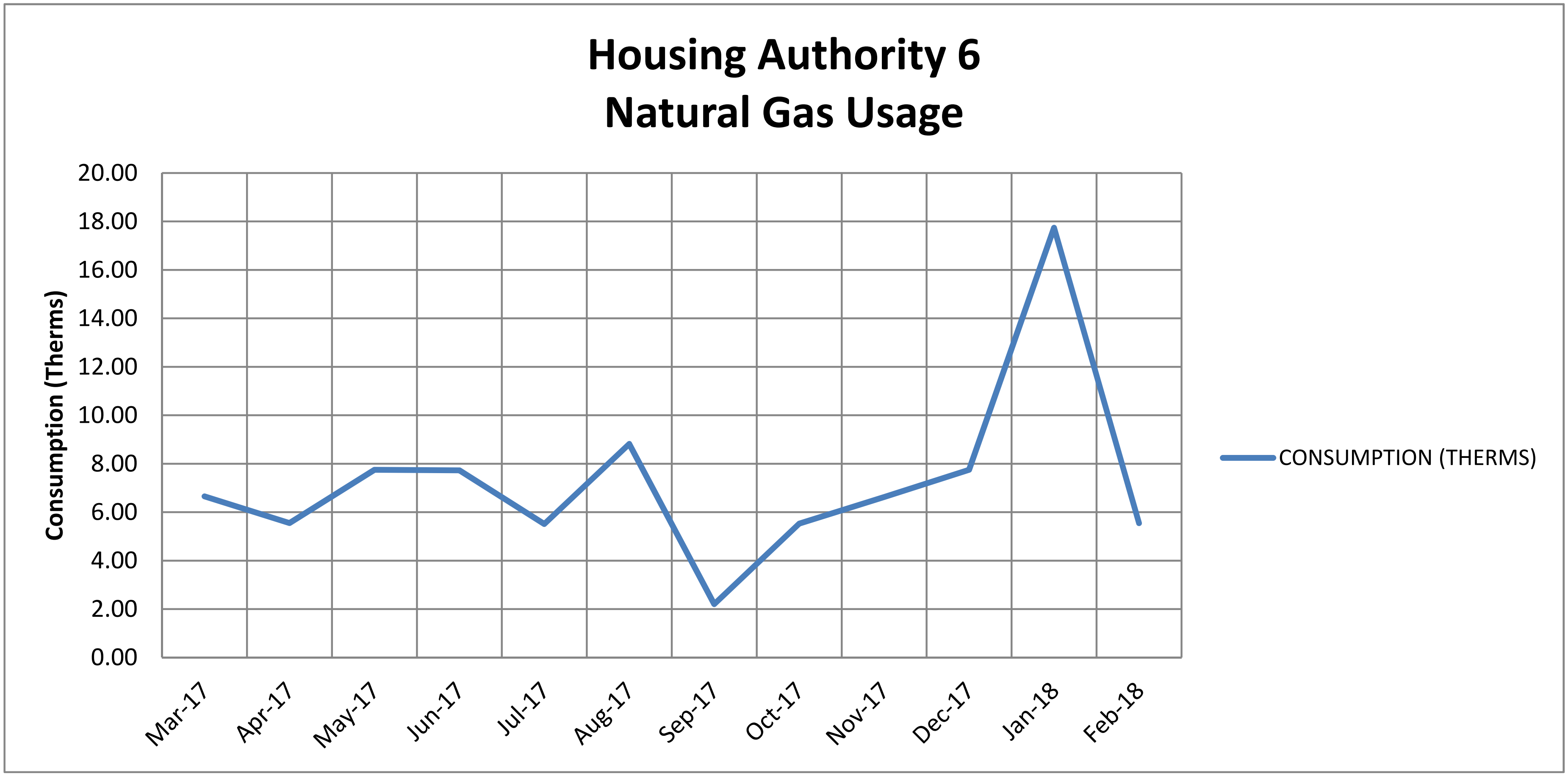

Housing Authority 5
Natural Gas Usage
Consumption (Therms)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
CONSUMPTION (THERMS)

NATURAL GAS USAGE SUMMARY

Facility : Housing Authority 5
Utility Provider: PSE&G
Rate: GSG
Meter No: 3882565
Point of Delivery ID: PG000012088085123140
Third Party Utility Provider:
TPS Meter No/ Acct No: 73 396 644 08

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Mar-17	4.44	$16.19
Apr-17	3.33	$15.27
May-17	5.53	$17.22
Jun-17	4.41	$16.20
Jul-17	3.31	$14.80
Aug-17	4.41	$16.17
Sep-17	4.41	$16.19
Oct-17	4.42	$16.16
Nov-17	3.31	$15.28
Dec-17	4.43	$16.94
Jan-18	3.33	$15.82
Feb-18	4.44	$16.60
TOTALS	**49.77**	**$192.84**

AVERAGE RATE: **$3.87** **$/THERM**

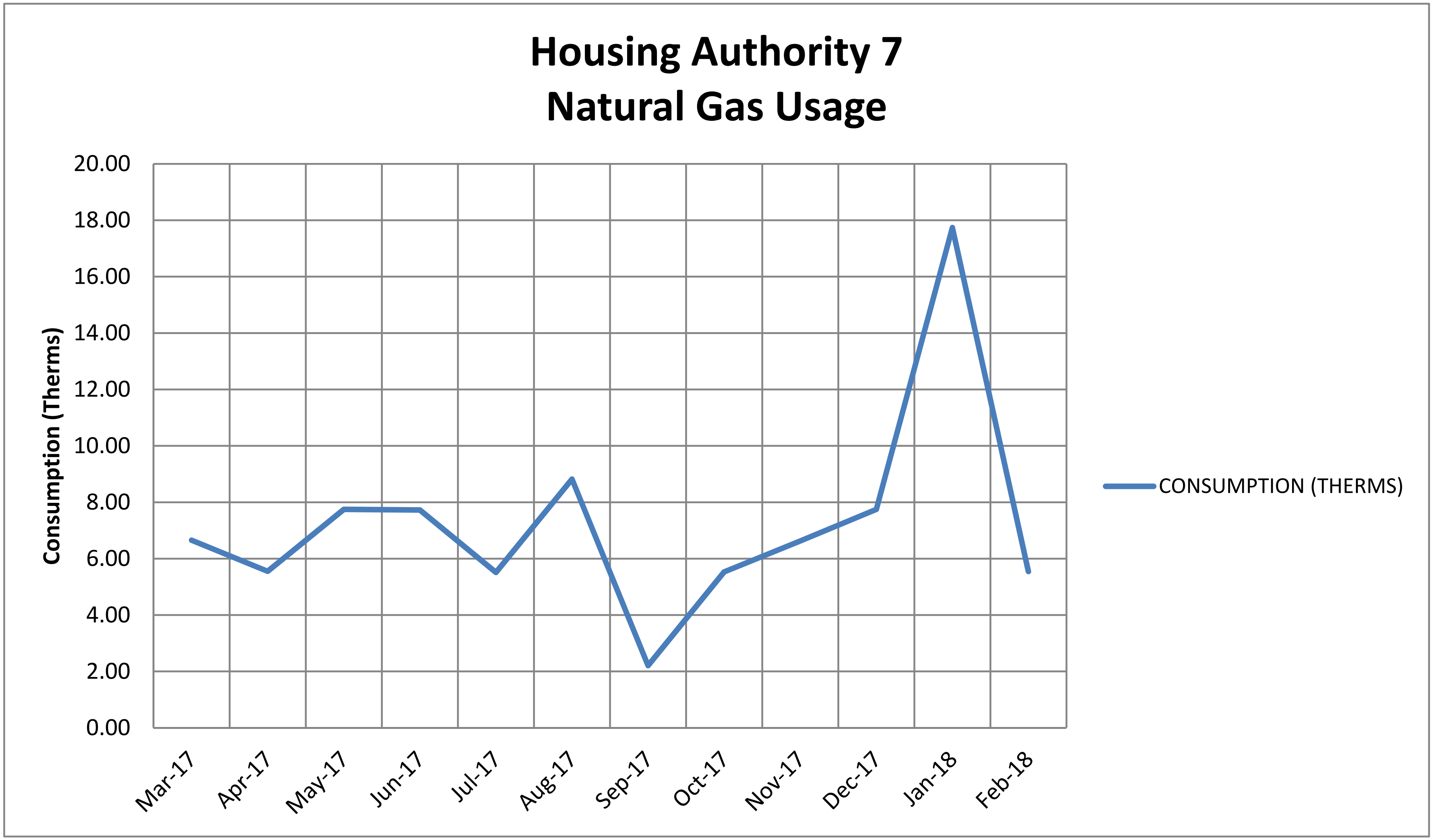

Housing Authority 6
Natural Gas Usage
Consumption (Therms)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
CONSUMPTION (THERMS)

NATURAL GAS USAGE SUMMARY

Facility :	Housing Authority 6
Utility Provider:	PSE&G
Rate:	GSG
Meter No:	3929166
Point of Delivery ID:	PG000012114685623140
Third Party Utility Provider:	
TPS Meter No/ Acct No:	73 396 645 05

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Mar-17	6.65	$18.07
Apr-17	5.55	$17.17
May-17	7.75	$19.15
Jun-17	7.72	$19.07
Jul-17	5.51	$16.67
Aug-17	8.82	$19.91
Sep-17	2.21	$14.32
Oct-17	5.53	$17.07
Nov-17	6.63	$18.12
Dec-17	7.75	$20.28
Jan-18	17.74	$30.61
Feb-18	5.54	$17.50
TOTALS	**87.40**	**$227.94**

AVERAGE RATE: **$2.61** **$/THERM**

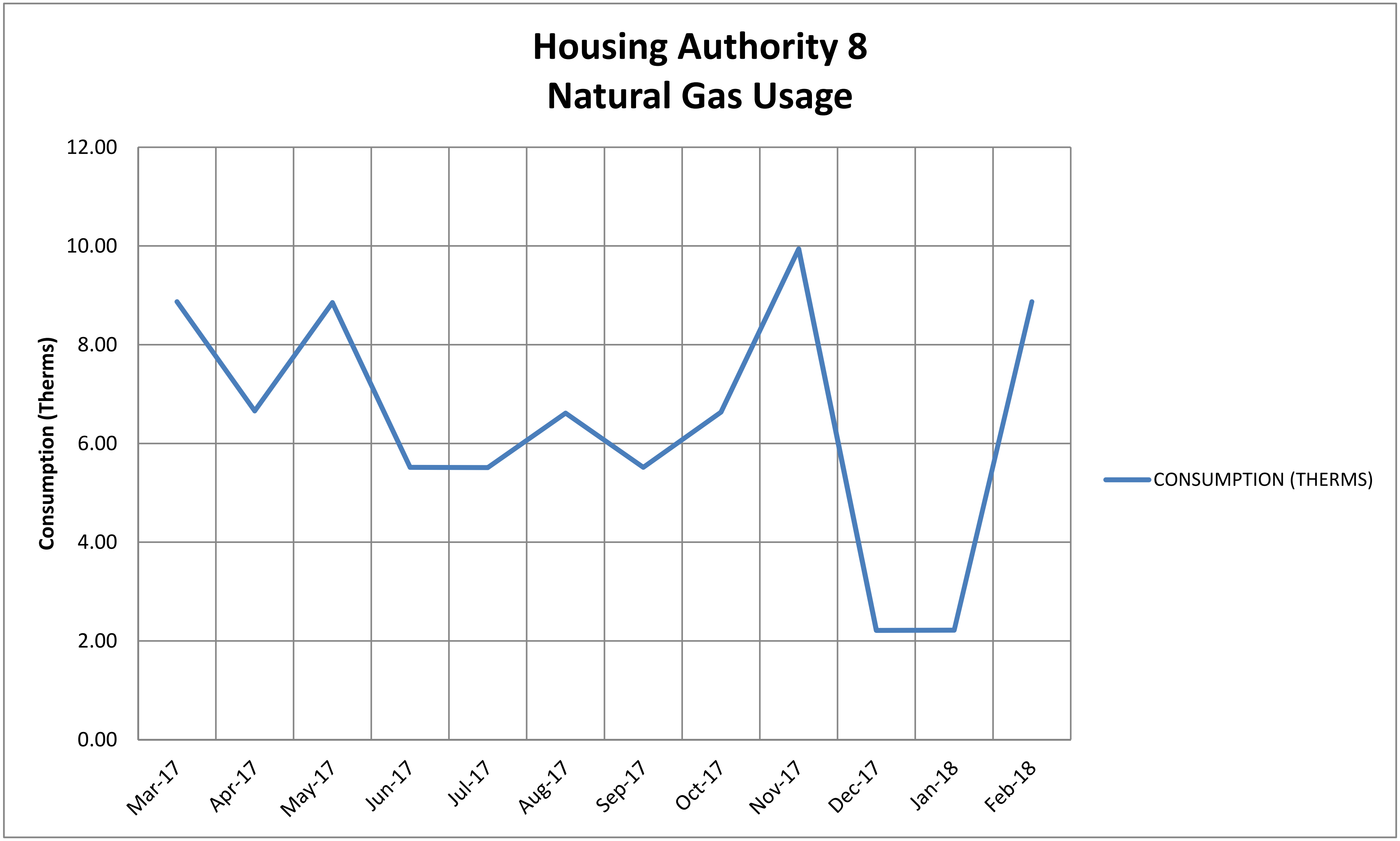

Housing Authority 7
Natural Gas Usage
Consumption (Therms)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
CONSUMPTION (THERMS)

NATURAL GAS USAGE SUMMARY

Facility : Housing Authority 7
Utility Provider: PSE&G
Rate: GSG
Meter No: 3929166
Point of Delivery ID: PG000012114685623140
Third Party Utility Provider:
TPS Meter No/ Acct No: 73 396 645 05

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Mar-17	6.65	$18.07
Apr-17	5.55	$17.17
May-17	7.75	$19.15
Jun-17	7.72	$19.07
Jul-17	5.51	$16.67
Aug-17	8.82	$19.91
Sep-17	2.21	$14.32
Oct-17	5.53	$17.07
Nov-17	6.63	$18.12
Dec-17	7.75	$20.28
Jan-18	17.74	$30.61
Feb-18	5.54	$17.50
TOTALS	**87.40**	**$227.94**

AVERAGE RATE: **$2.61** **$/THERM**

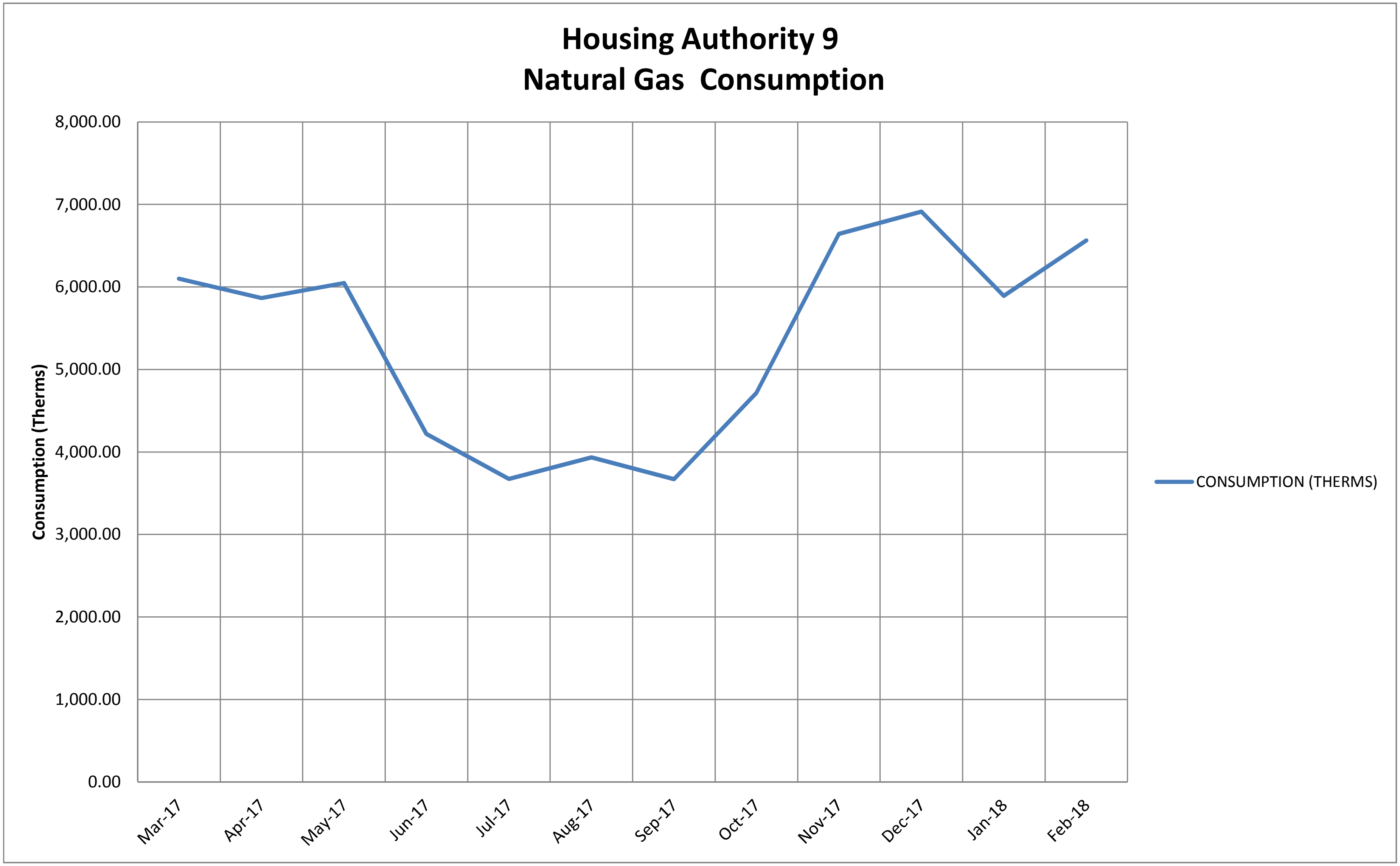

Housing Authority 8
Natural Gas Usage
Consumption (Therms)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
CONSUMPTION (THERMS)

NATURAL GAS USAGE SUMMARY

Facility : Housing Authority 8
Utility Provider: PSE&G
Rate: GSG
Meter No: 3929167
Point of Delivery ID: PG000012114687223140
Third Party Utility Provider:
TPS Meter No/ Acct No: 73 396 647 18

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Mar-17	8.87	$20.00
Apr-17	6.66	$18.14
May-17	8.85	$20.09
Jun-17	5.52	$17.14
Jul-17	5.51	$16.67
Aug-17	6.61	$18.02
Sep-17	5.52	$17.11
Oct-17	6.63	$18.05
Nov-17	9.94	$21.28
Dec-17	2.21	$14.63
Jan-18	2.22	$14.60
Feb-18	8.87	$20.78
TOTALS	**77.42**	**$216.51**

AVERAGE RATE: **$2.80** **$/THERM**

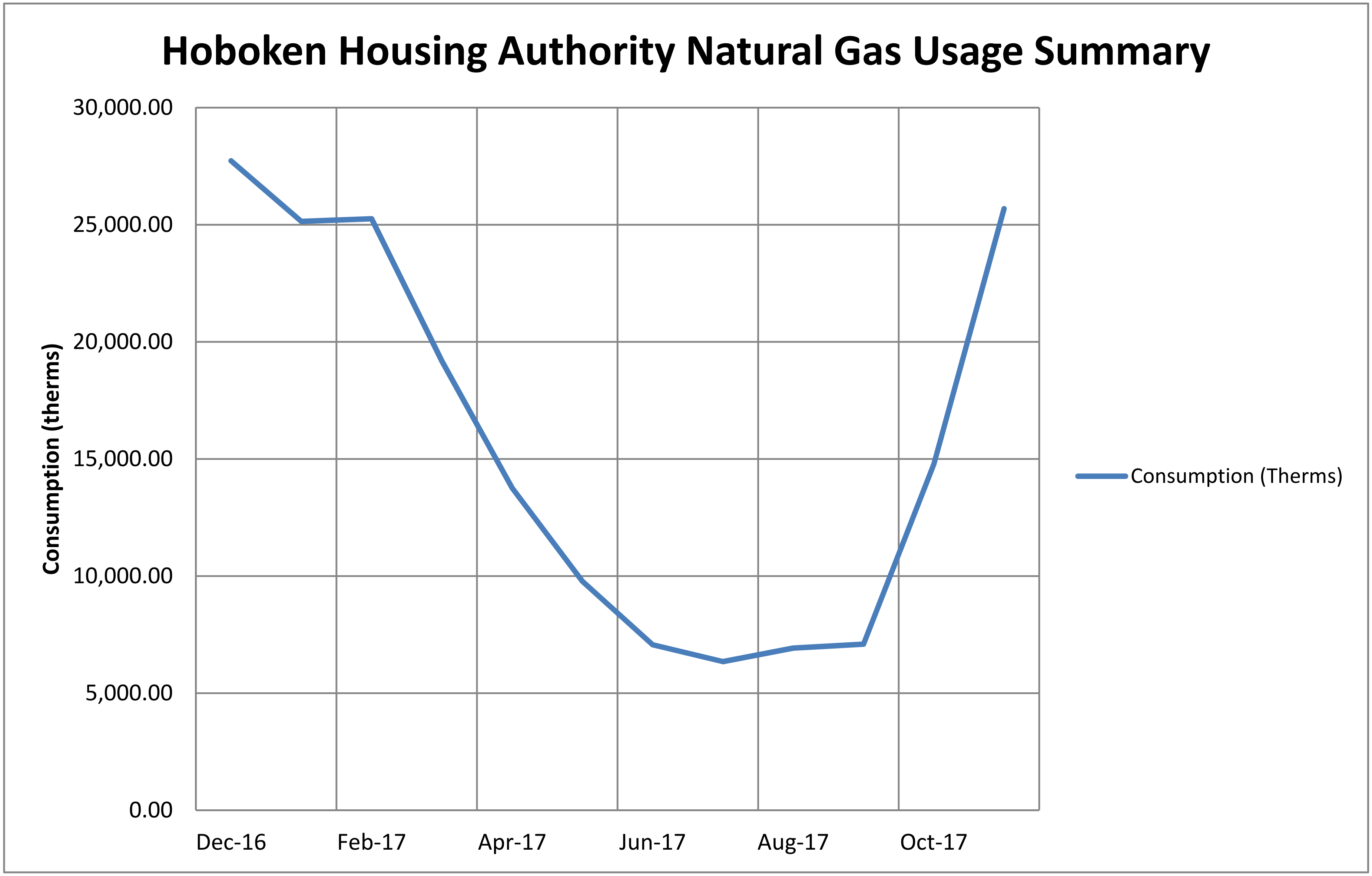

Housing Authority 9
Natural Gas Consumption
Consumption (Therms)
8,000.00
7,000.00
6,000.00
5,000.00
4,000.00
3,000.00
2,000.00
1,000.00
0.00
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
CONSUMPTION (THERMS)

NATURAL GAS USAGE SUMMARY

Facility : Housing Authority 9
Utility Provider: PSE&G
Rate: GSG
Meter No: 3744997- 2678517 - 3744994- 2744707
Point of Delivery ID: PG000010724341223140
Third Party Utility Provider:
TPS Meter No/ Acct No: 73 396 645 05

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Mar-17	6,098.83	$4,041.38
Apr-17	5,865.79	$3,957.58
May-17	6,047.35	$4,109.98
Jun-17	4,218.71	$2,910.71
Jul-17	3,671.84	$2,511.28
Aug-17	3,935.08	$2,668.12
Sep-17	3,670.82	$2,498.19
Oct-17	4,714.22	$3,831.01
Nov-17	6,642.07	$5,417.85
Dec-17	6,914.39	$6,213.46
Jan-18	5,890.49	$5,418.99
Feb-18	6,563.07	$5,394.16
TOTALS	**64,232.63**	**$48,972.71**

AVERAGE RATE: **$0.76** **$/THERM**



Hoboken Housing Authority Natural Gas Usage Summary
Consumption (therms)
30,000.00
25,000.00
20,000.00
15,000.00
10,000.00
5,000.00
0.00
Dec-16
Feb-17
Apr-17
Jun-17
Aug-17
Oct-17
Consumption (Therms)

NATURAL GAS USAGE SUMMARY		
Facility :	Hoboken Housing Authority Natural Gas Usage Summary	
Utility Provider:	PSE&G	
Rate:	GSG	
Meter No:		
Point of Delivery ID:		
Third Party Utility Provider:		
TPS Meter No:		

MONTH OF USE	CONSUMPTION (THERMS)	TOTAL BILL
Jan-17	25,143.36	32,144.03
Feb-17	25,251.96	30,903.20
Mar-17	19,174.20	21,733.32
Apr-17	13,763.42	18,910.64
May-17	9,773.01	20,255.84
Jun-17	7,065.67	19,209.35
Jul-17	6,347.61	17,943.48
Aug-17	6,923.53	17,672.56
Sep-17	7,094.20	14,127.07
Oct-17	14,780.04	20,539.39
Nov-17	25,685.01	31,209.89
Dec-16	27,727.99	35,358.06
TOTALS	25,143.36	280,006.83

AVERAGE RATE: **$11.14** **$/THERM**

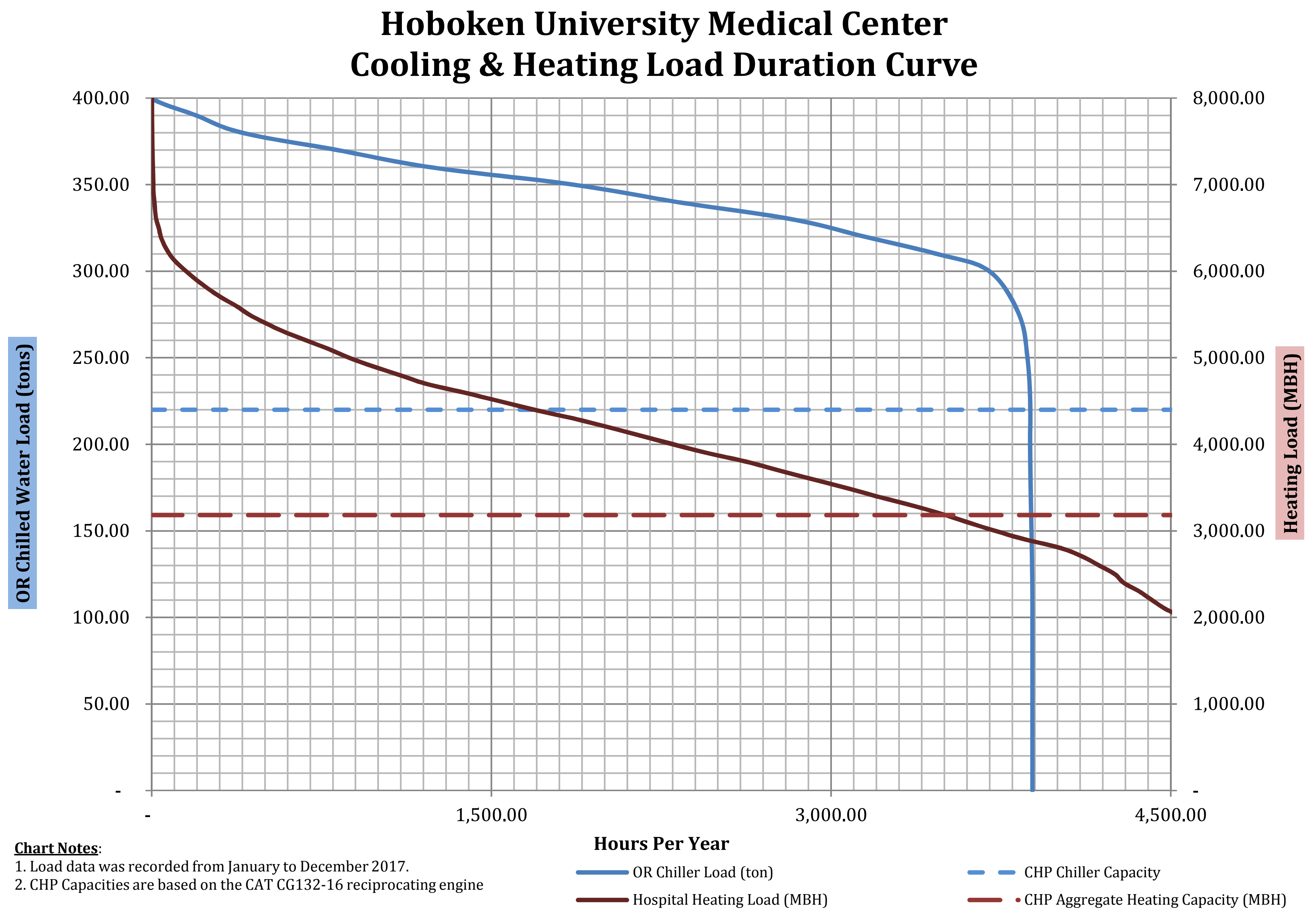


Chart Notes:
1. Load data was recorded from January to December 2017.
2. CHP Capacities are based on the CAT CG132-16 reciprocating engine

APPENDIX D

COST ESTIMATES

CITY OF HOBOKEN
NEW JERSEY TOWN CENTER
DISTRIBUTED ENERGY RESOURCES
MICROGRID COST ESTIMATE

WASHINGTON STREET CORRIDOR

ITEM #	DESCRIPTION		TOTAL
	Electrical Distribution System		**$7,300,366**
	Individual Building Modifications	$5,586,893	
	Underground Duct and Cabling System	$1,713,473	
	Distributed Generation Resources		**$12,217,131**
	Major Equipment	$7,765,000	
	Site Work, Foundations, Steel, Architectural	$1,083,540	
	Mechanical	$2,074,060	
	Electrical	$1,294,531	
	Microgrid Control		**$1,911,000**
	Sub-Total		**$21,428,497**
	Professional Services		**$4,889,542**
	Engineering - Development / Schematic Design	$642,855	
	Engineering - Construction Documents / Detailed Design	$749,997	
	Additional professional services (geotech, sound, emissions, etc.)	$125,000	
	Major equipment procurement	$371,700	
	Construction administration	$428,570	
	Construction management & general conditions	$2,142,850	
	Commissioning, startup & testing	$428,570	
	Sub-Total Including Professional Services		**$26,318,039**
	Project Costs		**$5,263,608**
	Project Soft Costs	$526,361	
	Taxes	$0	
	Bonding & Insurance	$1,315,902	
	Escalation	$789,541	
	Contingency	$2,631,804	
TOTAL PROJECT COST			
	Total Project Cost		**$31,581,647**

Notes:

1. Equipment prices are budgetary
2. Labor rates based on prevailing wage

CITY OF HOBOKEN

NEW JERSEY TOWN CENTER
DISTRIBUTED ENERGY RESOURCES
MICROGRID COST ESTIMATE

HOUSING AUTHORITY CORRIDOR

ITEM #	DESCRIPTION		TOTAL
	Electrical Distribution System		**$5,162,036**
	Individual Building Modifications	$3,730,078	
	Underground Duct and Cabling System	$1,431,958	
	Distributed Generation Resources		**$1,843,442**
	Major Equipment	$958,500	
	Site Work, Foundations & Steel	$284,200	
	Mechanical	$211,280	
	Electrical	$389,462	
	Microgrid Control		**$819,000**
	Sub-Total		**$7,824,479**
	Professional Services		**$1,774,868**
	Engineering - Development / Schematic Design	$234,734	
	Engineering - Construction Documents / Detailed Design	$273,857	
	Additional professional services (geotech, sound, emissions, etc.)	$75,000	
	Major equipment procurement	$95,850	
	Construction administration	$156,490	
	Construction management & general conditions	$782,448	
	Commissioning, startup & testing	$156,490	
	Sub-Total Including Professional Services		**$9,599,347**
	Project Costs		**$1,919,869**
	Project Soft Costs	$191,987	
	Taxes	$0	
	Bonding & Insurance	$479,967	
	Escalation	$287,980	
	Contingency	$959,935	
TOTAL PROJECT COST			
	Total Project Cost		**$11,519,216**

Notes:

1. Equipment prices are budgetary
2. Labor rates based on prevailing wage

APPENDIX E

PROJECT FINANICAL PRO-FORMA ANALYSIS

City of Hoboken New Jersey Town Center Distributed Energy Resources Microgrid
Complete Project Financial Proforma Summary
Revision A

Microgrid Corridor	Washington Street	Housing Authority
Final Capital Cost w Incentives	$29,740,257	$11,519,216
Electricity Cost LPLS - Existing (/ kWh)	$0.130	$0.130
Electricity Cost LPLP - New (/ kWh)	$0.120	$0.120
Cost of Natural Gas (/ MMBtu)	$4.00	$4.00
Distributed Generation		
Capacity (kW)	2,000	1,000
Revenues	$834,208	$417,104
Expenses	$142,560	$71,280
Total Savings	**$691,648**	**$345,824**
Combined Heat and Power		
Capacity (kW)	800	
Revenues	$1,279,432	
Expenses	$313,127	
Total Savings	**$966,305**	
Solar PV & Battery Storage		
Capacity (kW)	772	
Revenues	$600,614	
Expenses	$60,438	
Total Savings	**$540,176**	
Microgrid System		
Utility Electric Reduction (kWh/hr)	9,568,840	1,200,000
Revenues	$83,951	$33,200
Expenses	$492,161	$6,640
Total Savings	**-$408,210**	**$26,560**
Total Savings	**$1,789,919**	**$372,384**
NPV @ 4%	-$3,809,780	-$6,153,075
Internal Rate of Return (IRR)	2.58%	-3.15%
Simple Payback	16.0	30.9
Annual Carbon Savings (Metric Ton)	4,405	NA

City of Hoboken New Jersey Town Center Distributed Energy Resources Microgrid
Washington Street Corridor Financial Proforma
Revision A

Cost Assumptions	
Initial Capital Cost	$30,540,257
CHP NJ Clean Energy Incentive	$800,000
Final Capital Cost	$29,740,257
Escalation	3.00%
Cost of Purchased Electricity LPLS - Existing (/ kWh)	$0.130
Cost of Purchased Electricity LPLP - New (/ kWh)	$0.120
Cost of Natural Gas (/ MMBtu)	$4.00
Annual Microgrid Maintenance Cost ($/kWh)	$0.008

Annual Demand Management Avoided Costs	
EMAAC Zone ICAP RPM Auction ($/MW)	$71,569
PSE&G Zone PJM Transmission ($/MW)	$130,535
PJM Ancillary ($/MW)	$30,000
PSE&G Summer Peak Demand ($/MW)	$16,000
PSE&G Annual Demand ($/MW)	$13,000

DG Equipment Assumptions	
Engine Output (kW@59F)	2,000
Engine Quantity	1
Engine Heat Rate (Btu/kWh@59F)	9,850
Operating Hours	1,200
DG Maintenance Cost ($/kWh)	0.02

CHP Equipment Assumptions	
Engine Output (kW@59F)	800
Engine Quantity	1
Engine Heat Rate (Btu/kWh@59F)	8,026
Operating Hours	8,322
CHP Maintenance Cost ($/kWh)	$0.150
CHP Investment Tax Credit (ITC)	10%

Solar PV and Battery Equipment Assumptions	
Solar DC system size (kW)	771.9
Solar (kWH)	1,013,639
Battery Energy Storage(kWH)	4,000
Battery Power Generation (kW)	1,000
Battery Frequency Regulation ($/kW)	$225
Solar Maintenance Cost ($/kW)	$20
Battery Maintenance Cost ($/kW)	$45
Solar Investiment Tax Credit (ITC)	30%

		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 - Utility Prices																					
Cost of Purchased Electricity LPLS - Existing (/ kWh)		$0.1300	$0.1339	$0.1379	$0.1421	$0.1463	$0.1507	$0.1552	$0.1599	$0.1647	$0.1696	$0.1747	$0.1800	$0.1853	$0.1909	$0.1966	$0.2025	$0.2086	$0.2149	$0.2213	$0.2280
Cost of Purchased Electricity LPLP - New (/ kWh)		$0.1200	$0.1236	$0.1273	$0.1311	$0.1351	$0.1391	$0.1433	$0.1476	$0.1520	$0.1566	$0.1613	$0.1661	$0.1711	$0.1762	$0.1815	$0.1870	$0.1926	$0.1983	$0.2043	$0.2104
Cost of NG Fuel (/ MMBtu)		$4.00	$4.12	$4.24	$4.37	$4.50	$4.64	$4.78	$4.92	$5.07	$5.22	$5.38	$5.54	$5.70	$5.87	$6.05	$6.23	$6.42	$6.61	$6.81	$7.01
Demand Management Offset Costs																					
EMAAC Zone ICAP RPM Auction		$71,569	$73,716	$75,928	$78,205	$80,552	$82,968	$85,457	$88,021	$90,661	$93,381	$96,183	$99,068	$102,040	$105,101	$108,255	$111,502	$114,847	$118,293	$121,841	$125,497
PSE&G Zone PJM Transmission		$130,535	$134,451	$138,485	$142,639	$146,918	$151,326	$155,866	$160,542	$165,358	$170,319	$175,428	$180,691	$186,112	$191,695	$197,446	$203,369	$209,470	$215,754	$222,227	$228,894
PJM Ancillary		$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$36,896	$38,003	$39,143	$40,317	$41,527	$42,773	$44,056	$45,378	$46,739	$48,141	$49,585	$51,073	$52,605
PSE&G Summer Peak Demand		$16,000	$16,480	$16,974	$17,484	$18,008	$18,548	$19,105	$19,678	$20,268	$20,876	$21,503	$22,148	$22,812	$23,497	$24,201	$24,927	$25,675	$26,446	$27,239	$28,056
PSE&G Annual Demand		$13,000	$13,390	$13,792	$14,205	$14,632	$15,071	$15,523	$15,988	$16,468	$16,962	$17,471	$17,995	$18,535	$19,091	$19,664	$20,254	$20,861	$21,487	$22,132	$22,796
Total Demand Management Offset Costs ($/ MW)		**$261,104**	**$268,937**	**$277,005**	**$285,315**	**$293,875**	**$302,691**	**$311,772**	**$321,125**	**$330,759**	**$340,681**	**$350,902**	**$361,429**	**$372,272**	**$383,440**	**$394,943**	**$406,792**	**$418,995**	**$431,565**	**$444,512**	**$457,847**
2 - Distribute Generation System																					
Electricity Generated (KWh/yr)		2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000
Fuel Consumed by Engines (MMBtu/yr HHV)		23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640	23,640
DG Revenue																					
Avoided Purchased Electric Cost		$312,000	$321,360	$331,001	$340,931	$351,159	$361,694	$372,544	$383,721	$395,232	$407,089	$419,302	$431,881	$444,837	$458,183	$471,928	$486,086	$500,668	$515,688	$531,159	$547,094
Demand Management Savings		$522,208	$537,874	$554,010	$570,631	$587,750	$605,382	$623,544	$642,250	$661,517	$681,363	$701,804	$722,858	$744,544	$766,880	$789,886	$813,583	$837,991	$863,130	$889,024	$915,695
Total DG Revenue		**$834,208**	**$859,234**	**$885,011**	**$911,562**	**$938,908**	**$967,076**	**$996,088**	**$1,025,971**	**$1,056,750**	**$1,088,452**	**$1,121,106**	**$1,154,739**	**$1,189,381**	**$1,225,063**	**$1,261,814**	**$1,299,669**	**$1,338,659**	**$1,378,819**	**$1,420,183**	**$1,462,789**
DG Expenses																					
Cost of Engine Fuel		$94,560	$97,397	$100,319	$103,328	$106,428	$109,621	$112,910	$116,297	$119,786	$123,379	$127,081	$130,893	$134,820	$138,865	$143,030	$147,321	$151,741	$156,293	$160,982	$165,812
Maintenance Costs		$48,000	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440	$49,440
Total DG Expenses		**$142,560**	**$146,837**	**$149,759**	**$152,768**	**$155,868**	**$159,061**	**$162,350**	**$165,737**	**$169,226**	**$172,819**	**$176,521**	**$180,333**	**$184,260**	**$188,305**	**$192,470**	**$196,761**	**$201,181**	**$205,733**	**$210,422**	**$215,252**
DG Energy Cost Savings		**$691,648**	**$712,397**	**$735,253**	**$758,793**	**$783,040**	**$808,015**	**$833,738**	**$860,234**	**$887,524**	**$915,633**	**$944,585**	**$974,406**	**$1,005,121**	**$1,036,758**	**$1,069,344**	**$1,102,907**	**$1,137,478**	**$1,173,085**	**$1,209,761**	**$1,247,537**
3 -Combined Heat and Power System																					
Electricity Supplied to the Microgrid (kWh/yr)		6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201	6,155,201
Reduction in Hospital Boiler Fuel Use (MMBtu/yr HHV)		13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054	13,054
Reduction in Hospital Chiller Fuel Use (MMBtu/yr HHV)		9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205
Fuel Consumed by Engine (MMBtu/yr HHV)		53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316
CHP Revenue																					
Avoided Purchased Electric Cost		$800,176	$824,181	$848,907	$874,374	$900,605	$927,623	$955,452	$984,116	$1,013,639	$1,044,048	$1,075,370	$1,107,631	$1,140,860	$1,175,086	$1,210,338	$1,246,648	$1,284,048	$1,322,569	$1,362,246	$1,403,114
Demand Management Savings		$208,883	$215,150	$221,604	$228,252	$235,100	$242,153	$249,417	$256,900	$264,607	$272,545	$280,722	$289,143	$297,817	$306,752	$315,955	$325,433	$335,196	$345,252	$355,610	$366,278
Avoided Fuel Cost (Natural Gas for Boiler and Chiller)		$89,034	$90,595	$93,313	$96,112	$98,996	$101,966	$105,025	$108,175	$111,421	$114,763	$118,206	$121,752	$125,405	$129,167	$133,042	$137,033	$141,144	$145,378	$149,740	$154,232
CHP Investment Tax Credit (ITC)		$181,339	$181,339	$181,339	$181,339																
Total CHP Revenue		**$1,279,432**	**$1,311,265**	**$1,345,163**	**$1,380,078**	**$1,234,701**	**$1,271,742**	**$1,309,894**	**$1,349,191**	**$1,389,667**	**$1,431,357**	**$1,474,297**	**$1,518,526**	**$1,564,082**	**$1,611,004**	**$1,659,335**	**$1,709,115**	**$1,760,388**	**$1,813,200**	**$1,867,596**	**$1,923,624**
CHP Expenses																					
Cost of Engine Fuel		$213,263	$219,661	$226,251	$233,039	$240,030	$247,231	$254,648	$262,287	$270,156	$278,260	$286,608	$295,206	$304,063	$313,184	$322,580	$332,257	$342,225	$352,492	$363,067	$373,959
Maintenance Costs		$99,864	$102,860	$105,946	$109,124	$112,398	$115,770	$119,243	$122,820	$126,505	$130,300	$134,209	$138,235	$142,382	$146,654	$151,053	$155,585	$160,252	$165,060	$170,012	$175,112
Total CHP Expenses		**$313,127**	**$322,521**	**$332,197**	**$342,163**	**$352,428**	**$363,000**	**$373,890**	**$385,107**	**$396,660**	**$408,560**	**$420,817**	**$433,442**	**$446,445**	**$459,838**	**$473,633**	**$487,842**	**$502,478**	**$517,552**	**$533,078**	**$549,071**
CHP Energy Cost Savings		**$966,305**	**$988,744**	**$1,012,966**	**$1,037,915**	**$882,273**	**$908,741**	**$936,004**	**$964,084**	**$993,006**	**$1,022,796**	**$1,053,480**	**$1,085,085**	**$1,117,637**	**$1,151,166**	**$1,185,701**	**$1,221,272**	**$1,257,911**	**$1,295,648**	**$1,334,517**	**$1,374,553**
4- Solar PV and Battery Storage																					
Solar Electricity Generated (KWh/yr)		1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639	1,013,639
Solar PV & Battery Revenue																					
Avoided Purchased Electric Cost		$131,773	$135,726	$139,798	$143,992	$148,312	$152,761	$157,344	$162,064	$166,926	$171,934	$177,092	$182,405	$187,877	$193,513	$199,319	$205,298	$211,457	$217,801	$224,335	$231,065
Demand Management - Battery Discharge (50%)		$130,552	$134,469	$138,503	$142,658	$146,937	$151,346	$155,886	$160,562	$165,379	$170,341	$175,451	$180,715	$186,136	$191,720	$197,472	$203,396	$209,498	$215,783	$222,256	$228,924
Frequency Regulation		$112,500	$115,875	$119,351	$122,932	$126,620	$130,418	$134,331	$138,361	$142,512	$146,787	$151,191	$155,726	$160,398	$165,210	$170,166	$175,271	$180,529	$185,945	$191,524	$197,269
Solar Investment Tax Credit (ITC)		$225,789	$225,789	$225,789	$225,789																
Total Solar PV & Battery Revenue		**$600,614**	**$611,859**	**$623,441**	**$635,370**	**$421,869**	**$434,525**	**$447,561**	**$460,988**	**$474,817**	**$489,062**	**$503,734**	**$518,846**	**$534,411**	**$550,443**	**$566,957**	**$583,965**	**$601,484**	**$619,529**	**$638,115**	**$657,258**
Solar PV & Battery Expenses																					
Maintenance Costs		$60,438	$62,251	$64,119	$66,042	$68,024	$70,064	$72,166	$74,331	$76,561	$78,858	$81,224	$83,660	$86,170	$88,755	$91,418	$94,160	$96,985	$99,895	$102,892	$105,978
Total Expenses		**$60,438**	**$62,251**	**$64,119**	**$66,042**	**$68,024**	**$70,064**	**$72,166**	**$74,331**	**$76,561**	**$78,858**	**$81,224**	**$83,660**	**$86,170**	**$88,755**	**$91,418**	**$94,160**	**$96,985**	**$99,895**	**$102,892**	**$105,978**
Solar PV & Battery Cost Savings		**$540,176**	**$549,608**	**$559,322**	**$569,328**	**$353,845**	**$364,461**	**$375,395**	**$386,656**	**$398,256**	**$410,204**	**$422,510**	**$435,185**	**$448,241**	**$461,688**	**$475,539**	**$489,805**	**$504,499**	**$519,634**	**$535,223**	**$551,280**
5- Microgrid System																					
Existing Utility Electrical Consumption (kWh/hr)		17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984	17,963,984
New Microgrid Utility Electrical Consumption (kWh/hr)		8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144	8,395,144
Microgrid Revenue																					
LPLP Utility Rate Savings		$83,951	$86,470	$89,064	$91,736	$94,488	$97,323	$100,242	$103,250	$106,347	$109,538	$112,824	$116,208	$119,695	$123,286	$126,984	$130,794	$134,717	$138,759	$142,922	$147,209
Microgrid Expenses																					
Maintenance Costs		$67,161	$69,176	$71,251	$73,389	$75,590	$77,858	$80,194	$82,600	$85,078	$87,630	$90,259	$92,967	$95,756	$98,628	$101,587	$104,635	$107,774	$111,007	$114,337	$117,767
Operation and Management Costs		$425,000	$437,750	$450,883	$464,409	$478,341	$492,691	$507,472	$522,696	$538,377	$554,529	$571,164	$588,299	$605,948	$624,127	$642,851	$662,136	$682,000	$702,460	$723,534	$745,240
Total Expenses		$492,161	$506,926	$522,134	$537,798	$553,932	$570,550	$587,666	$605,296	$623,455	$642,159	$661,423	$681,266	$701,704	$722,755	$744,438	$766,771	$789,774	$813,467	$837,871	$863,008
Total Microgrid Savings		**-$408,210**	**-$420,456**	**-$433,070**	**-$446,062**	**-$459,444**	**-$473,227**	**-$487,424**	**-$502,046**	**-$517,108**	**-$532,621**	**-$548,600**	**-$565,058**	**-$582,009**	**-$599,470**	**-$617,454**	**-$635,977**	**-$655,057**	**-$674,708**	**-$694,950**	**-$715,798**
TOTAL MICROGRID ENERGY SAVINGS																					
	-$29,740,257	**$1,789,919**	**$1,830,293**	**$1,874,471**	**$1,919,975**	**$1,559,715**	**$1,607,990**	**$1,657,713**	**$1,708,927**	**$1,761,678**	**$1,816,012**	**$1,871,976**	**$1,929,618**	**$1,988,990**	**$2,050,143**	**$2,113,130**	**$2,178,007**	**$2,244,831**	**$2,313,659**	**$2,384,552**	**$2,457,572**

Turbine GeneratorMicrogrid Life Cycle Savings		
Net Present Value	**4.00%**	**-$3,809,780**
Internal Rate of Return (IRR)		**2.6%**
Simple Payback		**16.04**
CHP Plant Efficiency (LHV)		**82.9%**
Annual Carbon Savings (Metric Ton)		**4,405**
Annual Carbon Savings (Cars)		**941**

City of Hoboken New Jersey Town Center Distributed Energy Resources Microgrid
Housing Authority Corridor Finicial Proforma
Revision A

Cost Assumptions	
Initial Capital Cost	$11,519,216
Escalation	2.50%
Cost of Purchased Electricity LPLS - Existing (/ kWh)	$0.120
Cost of Purchased Electricity LPLP - New (/ kWh)	$0.110
Cost of NG (/ MMBtu)	$4.00
Annual Microgrid Maintenance Cost ($/kWh)	$0.0020

Annual Demand Management Avoided Costs	
EMAAC Zone ICAP RPM Auction ($/MW)	$71,569
PSE&G Zone PJM Transmission ($/MW)	$130,535
PJM Ancillary ($/MW)	$30,000
PSE&G Summer Peak Demand ($/MW)	$16,000
PSE&G Annual Demand ($/MW)	$13,000

DG Equipment Assumptions	
Engine Output (kW@59F)	1,000
Engine Quantity	1
Engine Heat Rate (Btu/kWh@59F)	9,850
Operating Hours	1,200
DG Maintenance Cost ($/kWh)	0.02

Year		2022 1	2023 2	2024 3	2025 4	2026 5	2027 6	2028 7	2029 8	2030 9	2031 10
1 - Utility Prices											
Cost of Purchased Electricity LPLS - Existing (/ kWh)		$0.1200	$0.1230	$0.1261	$0.1292	$0.1325	$0.1358	$0.1392	$0.1426	$0.1462	$0.1499
Cost of Purchased Electricity LPLP - New (/ kWh)		$0.1100	$0.1128	$0.1156	$0.1185	$0.1214	$0.1245	$0.1276	$0.1308	$0.1340	$0.1374
Cost of NG Fuel (/ MMBtu)		$4.00	$4.10	$4.20	$4.31	$4.42	$4.53	$4.64	$4.75	$4.87	$5.00
Demand Management Offset Costs											
EMAAC Zone ICAP RPM Auction		$71,569	$71,569	$71,569	$71,569	$71,569	$71,569	$71,569	$71,569	$71,569	$71,569
PSE&G Zone PJM Transmission		$130,535	$130,535	$130,535	$130,535	$130,535	$130,535	$130,535	$130,535	$130,535	$130,535
PJM Ancillary		$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000
PSE&G Summer Peak Demand		$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000
PSE&G Annual Demand		$13,000	$13,000	$13,000	$13,000	$13,000	$13,000	$13,000	$13,000	$13,000	$13,000
Total Offset Costs ($/ MW)		**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**
2 - Distribute Generation System											
System Energy Balance											
Electricity Generated (KWh/yr)		1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
Fuel Consumed by Engines (MMBtu/yr HHV)		11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820
Revenue											
Avoided Purchased Electric Cost		$144,000	$147,600	$151,290	$155,072	$158,949	$162,923	$166,996	$171,171	$175,450	$179,836
Demand Management Savings		$261,104	$250,200	$250,200	$250,200	$250,200	$250,200	$250,200	$250,200	$250,200	$250,200
Total DG Revenue		**$405,104**	**$397,800**	**$401,490**	**$405,272**	**$409,149**	**$413,123**	**$417,196**	**$421,371**	**$425,650**	**$430,036**
DG Expenses											
Cost of Engine Fuel		$47,280	$48,462	$49,674	$50,915	$52,188	$53,493	$54,830	$56,201	$57,606	$59,046
Maintenance Costs		$24,000	$24,600	$25,215	$25,845	$26,492	$27,154	$27,833	$28,528	$29,242	$29,973
Total DG Expenses		**$71,280**	**$73,062**	**$74,889**	**$76,761**	**$78,680**	**$80,647**	**$82,663**	**$84,730**	**$86,848**	**$89,019**
DG Energy Savings											
Annual Savings	-$11,519,216	$333,824	$324,738	$326,601	$328,511	$330,469	$332,476	$334,533	$336,641	$338,802	$341,017
3 - Microgrid System											
Existing Utility Electrical Consumption (kWh/hr)		4,520,041	4,520,042	4,520,043	4,520,044	4,520,045	4,520,046	4,520,047	4,520,048	4,520,049	4,520,050
New Microgrid Utility Electrical Consumption (kWh/hr)		3,320,041	3,320,042	3,320,043	3,320,044	3,320,045	3,320,046	3,320,047	3,320,048	3,320,049	3,320,050
Microgrid Revenue											
LPLP Utility Rate Savings		$33,200	$34,030	$34,881	$35,753	$36,647	$37,563	$38,502	$39,465	$40,452	$41,463
Microgrid Expenses											
Maintenance Costs		$6,640	$6,806	$6,976	$7,151	$7,329	$7,513	$7,700	$7,893	$8,090	$8,293
Total Microgrid Savings		**$26,560**	**$27,224**	**$27,905**	**$28,603**	**$29,318**	**$30,051**	**$30,802**	**$31,572**	**$32,361**	**$33,170**
TOTAL MICROGRID ENERGY SAVINGS											
	-$11,519,216	**$360,384**	**$351,962**	**$354,506**	**$357,114**	**$359,787**	**$362,527**	**$365,335**	**$368,213**	**$371,164**	**$374,188**

Year	2032 11	2033 12	2034 13	2035 14	2036 15	2037 16	2038 17	2039 18	2040 19	2041 20
1 - Utility Prices										
Cost of Purchased Electricity LPLS - Existing (/ kWh)	$0.1536	$0.1575	$0.1614	$0.1654	$0.1696	$0.1738	$0.1781	$0.1826	$0.1872	$0.1918
Cost of Purchased Electricity LPLP - New (/ kWh)	$0.1408	$0.1443	$0.1479	$0.1516	$0.1554	$0.1593	$0.1633	$0.1674	$0.1716	$0.1759
Cost of NG Fuel (/ MMBtu)	$5.12	$5.25	$5.38	$5.51	$5.65	$5.79	$5.94	$6.09	$6.24	$6.39
Demand Management Offset Costs										
EMAAC Zone ICAP RPM Auction	$71,569	$71,569	$71,569	$71,569	$71,569	$71,569	$71,569	$71,569	$71,569	$71,569
PSE&G Zone PJM Transmission	$130,535	$130,535	$130,535	$130,535	$130,535	$130,535	$130,535	$130,535	$130,535	$130,535
PJM Ancillary	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000
PSE&G Summer Peak Demand	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000
PSE&G Annual Demand	$13,000	$13,000	$13,000	$13,000	$13,000	$13,000	$13,000	$13,000	$13,000	$13,000
Total Offset Costs ($/ MW)	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**	**$261,104**
2 - Distribute Generation System										
System Energy Balance										
Electricity Generated (KWh/yr)	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
Fuel Consumed by Engines (MMBtu/yr HHV)	11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820
Revenue										
Avoided Purchased Electric Cost	$184,332	$188,940	$193,664	$198,506	$203,468	$208,555	$213,769	$219,113	$224,591	$230,206
Demand Management Savings	$250,200	$250,200	$250,200	$250,200	$250,200	$250,200	$250,200	$250,200	$250,200	$250,200
Total DG Revenue	**$434,532**	**$439,140**	**$443,864**	**$448,706**	**$453,668**	**$458,755**	**$463,969**	**$469,313**	**$474,791**	**$480,406**
DG Expenses										
Cost of Engine Fuel	$60,522	$62,035	$63,586	$65,176	$66,805	$68,476	$70,187	$71,942	$73,741	$75,584
Maintenance Costs	$30,722	$31,490	$32,277	$33,084	$33,911	$34,759	$35,628	$36,519	$37,432	$38,368
Total DG Expenses	**$91,244**	**$93,526**	**$95,864**	**$98,260**	**$100,717**	**$103,235**	**$105,816**	**$108,461**	**$111,172**	**$113,952**
DG Energy Savings										
Annual Savings	$343,288	$345,615	$348,000	$350,445	$352,951	$355,520	$358,153	$360,852	$363,618	$366,454
3 - Microgrid System										
Existing Utility Electrical Consumption (kWh/hr)	4,520,051	4,520,052	4,520,053	4,520,054	4,520,055	4,520,056	4,520,057	4,520,058	4,520,059	4,520,060
New Microgrid Utility Electrical Consumption (kWh/hr)	3,320,051	3,320,052	3,320,053	3,320,054	3,320,055	3,320,056	3,320,057	3,320,058	3,320,059	3,320,060
Microgrid Revenue										
LPLP Utility Rate Savings	$42,499	$43,562	$44,651	$45,767	$46,912	$48,084	$49,286	$50,519	$51,782	$53,076
Microgrid Expenses										
Maintenance Costs	$8,500	$8,712	$8,930	$9,153	$9,382	$9,617	$9,857	$10,104	$10,356	$10,615
Total Microgrid Savings	**$34,000**	**$34,850**	**$35,721**	**$36,614**	**$37,529**	**$38,467**	**$39,429**	**$40,415**	**$41,425**	**$42,461**
TOTAL MICROGRID ENERGY SAVINGS										
	$377,287	**$380,465**	**$383,721**	**$387,059**	**$390,481**	**$393,988**	**$397,582**	**$401,267**	**$405,044**	**$408,915**

Turbine Generator CHP Life Cycle Savings		
Net Present Value	**(4.00%**	**-$6,439,483**
Internal Rate of Return (IRR)		**-3.6%**
Simple Payback		**31.96**

CONCORD ENGINEERING

City of Hoboken New Jersey Town Center Distributed Energy Resources Microgrid
Phased Approach Financial Proforma Summary
Revision A

Microgrid Corridor	**City Owned Facilities Only**	**City & Sewer Authority**	**Medical Center CHP**
Final Capital Cost w Incentives	$7,800,512	$9,535,922	$7,794,760
Electricity Cost LPLS - Existing (/ kWh)	$0.130	$0.130	$0.130
Electricity Cost LPLP - New (/ kWh)	$0.120	$0.120	$0.120
Cost of Natural Gas (/ MMBtu)	$4.00	$4.000	$4.000
Power Generation			
Capacity (kW)	500	1,000	800
Revenues	$208,552	$417,104	$1,159,406
Expenses	$35,640	$71,280	$313,127
Total Savings	**$172,912**	**$345,824**	**$846,279**
NPV @ 4%	-$4,718,972	-$3,372,842	$4,529,528
Internal Rate of Return (IRR)	-4.04%	-0.08%	9.49%
Simple Payback	28.5	20.1	9.4
Annual Carbon Savings (Metric Ton)	NA	NA	3,430

CONCORD ENGINEERING

City of Hoboken New Jersey Town Center Distributed Energy Resources Microgrid
PHASED APPROACH - City Owned Facilities Distributed Generation
Revision A

Cost Assumptions	
Initial Capital Cost	$7,800,512
CHP NJ Clean Energy Incentive	$0
Final Capital Cost	$7,800,512
Escalation	3.00%
Cost of Purchased Electricity LPLS - Existing (/ kWh)	$0.130
Cost of Purchased Electricity LPLP - New (/ kWh)	$0.120
Cost of Natural Gas (/ MMBtu)	$4.00
Annual Microgrid Maintenance Cost ($/kWh)	$0.004

Annual Demand Management Avoided Costs	
EMAAC Zone ICAP RPM Auction ($/MW)	$71,569
PSE&G Zone PJM Transmission ($/MW)	$130,535
PJM Ancillary ($/MW)	$30,000
PSE&G Summer Peak Demand ($/MW)	$16,000
PSE&G Annual Demand ($/MW)	$13,000

DG Equipment Assumptions	
Engine Output (kW@59F)	500
Engine Quantity	1
Engine Heat Rate (Btu/kWh@59F)	9,850
Operating Hours	1,200
DG Maintenance Cost ($/kWh)	0.02

		2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1 - Utility Prices											
Cost of Purchased Electricity LPLS - Existing (/ kWh)		$0.1300	$0.1339	$0.1379	$0.1421	$0.1463	$0.1507	$0.1552	$0.1599	$0.1647	$0.1696
Cost of Purchased Electricity LPLP - New (/ kWh)		$0.1200	$0.1236	$0.1273	$0.1311	$0.1351	$0.1391	$0.1433	$0.1476	$0.1520	$0.1566
Cost of NG Fuel (/ MMBtu)		$4.00	$4.12	$4.24	$4.37	$4.50	$4.64	$4.78	$4.92	$5.07	$5.22
Demand Management Offset Costs											
EMAAC Zone ICAP RPM Auction		$71,569	$73,716	$75,928	$78,205	$80,552	$82,968	$85,457	$88,021	$90,661	$93,381
PSE&G Zone PJM Transmission		$130,535	$134,451	$138,485	$142,639	$146,918	$151,326	$155,866	$160,542	$165,358	$170,319
PJM Ancillary		$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$36,896	$38,003	$39,143
PSE&G Summer Peak Demand		$16,000	$16,480	$16,974	$17,484	$18,008	$18,548	$19,105	$19,678	$20,268	$20,876
PSE&G Annual Demand		$13,000	$13,390	$13,792	$14,205	$14,632	$15,071	$15,523	$15,988	$16,468	$16,962
Total Demand Management Offset Costs ($/ MW)		**$261,104**	**$268,937**	**$277,005**	**$285,315**	**$293,875**	**$302,691**	**$311,772**	**$321,125**	**$330,759**	**$340,681**
2 - Distribute Generation System											
Electricity Generated (KWh/yr)		600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000
Fuel Consumed by Engines (MMBtu/yr HHV)		5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910
DG Revenue											
Avoided Purchased Electric Cost		$78,000	$80,340	$82,750	$85,233	$87,790	$90,423	$93,136	$95,930	$98,808	$101,772
Demand Management Savings		$130,552	$134,469	$138,503	$142,658	$146,937	$151,346	$155,886	$160,562	$165,379	$170,341
Total DG Revenue		**$208,552**	**$214,809**	**$221,253**	**$227,890**	**$234,727**	**$241,769**	**$249,022**	**$256,493**	**$264,187**	**$272,113**
DG Expenses											
Cost of Engine Fuel		$23,640	$24,349	$25,080	$25,832	$26,607	$27,405	$28,227	$29,074	$29,946	$30,845
Maintenance Costs		$12,000	$12,360	$12,360	$12,360	$12,360	$12,360	$12,360	$12,360	$12,360	$12,360
Total DG Expenses		**$35,640**	**$36,709**	**$37,440**	**$38,192**	**$38,967**	**$39,765**	**$40,587**	**$41,434**	**$42,306**	**$43,205**
DG Energy Cost Savings		**$172,912**	**$178,099**	**$183,813**	**$189,698**	**$195,760**	**$202,004**	**$208,435**	**$215,058**	**$221,881**	**$228,908**
TOTAL MICROGRID ENERGY SAVINGS											
	-$7,800,512	**$172,912**	**$178,099**	**$183,813**	**$189,698**	**$195,760**	**$202,004**	**$208,435**	**$215,058**	**$221,881**	**$228,908**

	2032	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**
Year	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1 - Utility Prices										
Cost of Purchased Electricity LPLS - Existing (/ kWh)	$0.1747	$0.1800	$0.1853	$0.1909	$0.1966	$0.2025	$0.2086	$0.2149	$0.2213	$0.2280
Cost of Purchased Electricity LPLP - New (/ kWh)	$0.1613	$0.1661	$0.1711	$0.1762	$0.1815	$0.1870	$0.1926	$0.1983	$0.2043	$0.2104
Cost of NG Fuel (/ MMBtu)	$5.38	$5.54	$5.70	$5.87	$6.05	$6.23	$6.42	$6.61	$6.81	$7.01
Demand Management Offset Costs										
EMAAC Zone ICAP RPM Auction	$96,183	$99,068	$102,040	$105,101	$108,255	$111,502	$114,847	$118,293	$121,841	$125,497
PSE&G Zone PJM Transmission	$175,428	$180,691	$186,112	$191,695	$197,446	$203,369	$209,470	$215,754	$222,227	$228,894
PJM Ancillary	$40,317	$41,527	$42,773	$44,056	$45,378	$46,739	$48,141	$49,585	$51,073	$52,605
PSE&G Summer Peak Demand	$21,503	$22,148	$22,812	$23,497	$24,201	$24,927	$25,675	$26,446	$27,239	$28,056
PSE&G Annual Demand	$17,471	$17,995	$18,535	$19,091	$19,664	$20,254	$20,861	$21,487	$22,132	$22,796
Total Demand Management Offset Costs ($/ MW)	**$350,902**	**$361,429**	**$372,272**	**$383,440**	**$394,943**	**$406,792**	**$418,995**	**$431,565**	**$444,512**	**$457,847**
2 - Distribute Generation System										
Electricity Generated (KWh/yr)	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000
Fuel Consumed by Engines (MMBtu/yr HHV)	5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910	5,910
DG Revenue										
Avoided Purchased Electric Cost	$104,825	$107,970	$111,209	$114,546	$117,982	$121,521	$125,167	$128,922	$132,790	$136,773
Demand Management Savings	$175,451	$180,715	$186,136	$191,720	$197,472	$203,396	$209,498	$215,783	$222,256	$228,924
Total DG Revenue	**$280,276**	**$288,685**	**$297,345**	**$306,266**	**$315,454**	**$324,917**	**$334,665**	**$344,705**	**$355,046**	**$365,697**
DG Expenses										
Cost of Engine Fuel	$31,770	$32,723	$33,705	$34,716	$35,758	$36,830	$37,935	$39,073	$40,246	$41,453
Maintenance Costs	$12,360	$12,360	$12,360	$12,360	$12,360	$12,360	$12,360	$12,360	$12,360	$12,360
Total DG Expenses	**$44,130**	**$45,083**	**$46,065**	**$47,076**	**$48,118**	**$49,190**	**$50,295**	**$51,433**	**$52,606**	**$53,813**
DG Energy Cost Savings	**$236,146**	**$243,601**	**$251,280**	**$259,190**	**$267,336**	**$275,727**	**$284,369**	**$293,271**	**$302,440**	**$311,884**
TOTAL MICROGRID ENERGY SAVINGS										
	$236,146	**$243,601**	**$251,280**	**$259,190**	**$267,336**	**$275,727**	**$284,369**	**$293,271**	**$302,440**	**$311,884**

Turbine GeneratorMicrogrid Life Cycle Savings		
Net Present Value	**(4.00%**	**-$4,718,972**
Internal Rate of Return (IRR)		**-4.0%**
Simple Payback		**28.51**

CONCORD ENGINEERING

City of Hoboken New Jersey Town Center Distributed Energy Resources Microgrid
PHASED APPROACH - City and Sewer Authority Distributed Generation
Revision A

Cost Assumptions	
Initial Capital Cost	$9,535,922
CHP NJ Clean Energy Incentive	$0
Final Capital Cost	$9,535,922
Escalation	3.00%
Cost of Purchased Electricity LPLS - Existing (/ kWh)	$0.130
Cost of Purchased Electricity LPLP - New (/ kWh)	$0.120
Cost of Natural Gas (/ MMBtu)	$4.00
Annual Microgrid Maintenance Cost ($/kWh)	$0.004

Annual Demand Management Avoided Costs	
EMAAC Zone ICAP RPM Auction ($/MW)	$71,569
PSE&G Zone PJM Transmission ($/MW)	$130,535
PJM Ancillary ($/MW)	$30,000
PSE&G Summer Peak Demand ($/MW)	$16,000
PSE&G Annual Demand ($/MW)	$13,000

DG Equipment Assumptions	
Engine Output (kW@59F)	1,000
Engine Quantity	1
Engine Heat Rate (Btu/kWh@59F)	9,850
Operating Hours	1,200
DG Maintenance Cost ($/kWh)	0.02

		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Utility Prices											
Cost of Purchased Electricity LPLS - Existing (/ kWh)		$0.1300	$0.1339	$0.1379	$0.1421	$0.1463	$0.1507	$0.1552	$0.1599	$0.1647	$0.1696
Cost of Purchased Electricity LPLP - New (/ kWh)		$0.1200	$0.1236	$0.1273	$0.1311	$0.1351	$0.1391	$0.1433	$0.1476	$0.1520	$0.1566
Cost of NG Fuel (/ MMBtu)		$4.00	$4.12	$4.24	$4.37	$4.50	$4.64	$4.78	$4.92	$5.07	$5.22
Demand Management Offset Costs											
EMAAC Zone ICAP RPM Auction		$71,569	$73,716	$75,928	$78,205	$80,552	$82,968	$85,457	$88,021	$90,661	$93,381
PSE&G Zone PJM Transmission		$130,535	$134,451	$138,485	$142,639	$146,918	$151,326	$155,866	$160,542	$165,358	$170,319
PJM Ancillary		$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$36,896	$38,003	$39,143
PSE&G Summer Peak Demand		$16,000	$16,480	$16,974	$17,484	$18,008	$18,548	$19,105	$19,678	$20,268	$20,876
PSE&G Annual Demand		$13,000	$13,390	$13,792	$14,205	$14,632	$15,071	$15,523	$15,988	$16,468	$16,962
Total Demand Management Offset Costs ($/ MW)		**$261,104**	**$268,937**	**$277,005**	**$285,315**	**$293,875**	**$302,691**	**$311,772**	**$321,125**	**$330,759**	**$340,681**
Distribute Generation System											
Electricity Generated (KWh/yr)		1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
Fuel Consumed by Engines (MMBtu/yr HHV)		11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820
DG Revenue											
Avoided Purchased Electric Cost		$156,000	$160,680	$165,500	$170,465	$175,579	$180,847	$186,272	$191,860	$197,616	$203,545
Demand Management Savings		$261,104	$268,937	$277,005	$285,315	$293,875	$302,691	$311,772	$321,125	$330,759	$340,681
Total DG Revenue		**$417,104**	**$429,617**	**$442,506**	**$455,781**	**$469,454**	**$483,538**	**$498,044**	**$512,985**	**$528,375**	**$544,226**
DG Expenses											
Cost of Engine Fuel		$47,280	$48,698	$50,159	$51,664	$53,214	$54,810	$56,455	$58,148	$59,893	$61,690
Maintenance Costs		$24,000	$24,720	$24,720	$24,720	$24,720	$24,720	$24,720	$24,720	$24,720	$24,720
Total DG Expenses		**$71,280**	**$73,418**	**$74,879**	**$76,384**	**$77,934**	**$79,530**	**$81,175**	**$82,868**	**$84,613**	**$86,410**
DG Energy Cost Savings		**$345,824**	**$356,199**	**$367,626**	**$379,397**	**$391,520**	**$404,007**	**$416,869**	**$430,117**	**$443,762**	**$457,816**
TOTAL MICROGRID ENERGY SAVINGS											
	-$9,535,922	**$345,824**	**$356,199**	**$367,626**	**$379,397**	**$391,520**	**$404,007**	**$416,869**	**$430,117**	**$443,762**	**$457,816**

	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
Year	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Utility Prices										
Cost of Purchased Electricity LPLS - Existing (/ kWh)	$0.1747	$0.1800	$0.1853	$0.1909	$0.1966	$0.2025	$0.2086	$0.2149	$0.2213	$0.2280
Cost of Purchased Electricity LPLP - New (/ kWh)	$0.1613	$0.1661	$0.1711	$0.1762	$0.1815	$0.1870	$0.1926	$0.1983	$0.2043	$0.2104
Cost of NG Fuel (/ MMBtu)	$5.38	$5.54	$5.70	$5.87	$6.05	$6.23	$6.42	$6.61	$6.81	$7.01
Demand Management Offset Costs										
EMAAC Zone ICAP RPM Auction	$96,183	$99,068	$102,040	$105,101	$108,255	$111,502	$114,847	$118,293	$121,841	$125,497
PSE&G Zone PJM Transmission	$175,428	$180,691	$186,112	$191,695	$197,446	$203,369	$209,470	$215,754	$222,227	$228,894
PJM Ancillary	$40,317	$41,527	$42,773	$44,056	$45,378	$46,739	$48,141	$49,585	$51,073	$52,605
PSE&G Summer Peak Demand	$21,503	$22,148	$22,812	$23,497	$24,201	$24,927	$25,675	$26,446	$27,239	$28,056
PSE&G Annual Demand	$17,471	$17,995	$18,535	$19,091	$19,664	$20,254	$20,861	$21,487	$22,132	$22,796
Total Demand Management Offset Costs ($/ MW)	**$350,902**	**$361,429**	**$372,272**	**$383,440**	**$394,943**	**$406,792**	**$418,995**	**$431,565**	**$444,512**	**$457,847**
Distribute Generation System										
Electricity Generated (KWh/yr)	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
Fuel Consumed by Engines (MMBtu/yr HHV)	11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820	11,820
DG Revenue										
Avoided Purchased Electric Cost	$209,651	$215,940	$222,419	$229,091	$235,964	$243,043	$250,334	$257,844	$265,580	$273,547
Demand Management Savings	$350,902	$361,429	$372,272	$383,440	$394,943	$406,792	$418,995	$431,565	$444,512	$457,847
Total DG Revenue	**$560,553**	**$577,369**	**$594,691**	**$612,531**	**$630,907**	**$649,834**	**$669,329**	**$689,409**	**$710,092**	**$731,394**
DG Expenses										
Cost of Engine Fuel	$63,540	$65,447	$67,410	$69,432	$71,515	$73,661	$75,871	$78,147	$80,491	$82,906
Maintenance Costs	$24,720	$24,720	$24,720	$24,720	$24,720	$24,720	$24,720	$24,720	$24,720	$24,720
Total DG Expenses	**$88,260**	**$90,167**	**$92,130**	**$94,152**	**$96,235**	**$98,381**	**$100,591**	**$102,867**	**$105,211**	**$107,626**
DG Energy Cost Savings	**$472,293**	**$487,203**	**$502,561**	**$518,379**	**$534,672**	**$551,454**	**$568,739**	**$586,543**	**$604,881**	**$623,769**
TOTAL MICROGRID ENERGY SAVINGS										
	$472,293	**$487,203**	**$502,561**	**$518,379**	**$534,672**	**$551,454**	**$568,739**	**$586,543**	**$604,881**	**$623,769**

Turbine GeneratorMicrogrid Life Cycle Savings		
Net Present Value	**(4.00%**	**-$3,372,842**
Internal Rate of Return (IRR)		**-0.1%**
Simple Payback		**20.14**

City of Hoboken New Jersey Town Center Distributed Energy Resources Microgrid
PHASED APPROACH - Hoboken Medical Center CHP Financial Proforma
Revision A

Cost Assumptions	
Initial Capital Cost	$8,594,760
CHP NJ Clean Energy Incentive	$800,000
Final Capital Cost	$7,794,760
Escalation	3.00%
Cost of Purchased Electricity LPLS - Existing (/ kWh)	$0.130
Cost of Purchased Electricity LPLP - New (/ kWh)	$0.120
Cost of Natural Gas (/ MMBtu)	$4.00
Annual Microgrid Maintenance Cost ($/kWh)	$0.008

Annual Demand Management Avoided Costs	
EMAAC Zone ICAP RPM Auction ($/MW)	$71,569
PSE&G Zone PJM Transmission ($/MW)	$130,535
PJM Ancillary ($/MW)	$30,000
PSE&G Summer Peak Demand ($/MW)	$16,000
PSE&G Annual Demand ($/MW)	$13,000

CHP Equipment Assumptions	
Engine Output (kW@59F)	800
Engine Quantity	1
Engine Heat Rate (Btu/kWh@59F)	8,026
Operating Hours	8,322
CHP Maintenance Cost ($/kWh)	$0.150
CHP Investiment Tax Credit (ITC)	10%

Year		**2022** **1**	**2023** **2**	**2024** **3**	**2025** **4**	**2026** **5**	**2027** **6**	**2028** **7**	**2029** **8**	**2030** **9**	**2031** **10**
1 - Utility Prices											
Cost of Purchased Electricity LPLS - Existing (/ kWh)		$0.1300	$0.1339	$0.1379	$0.1421	$0.1463	$0.1507	$0.1552	$0.1599	$0.1647	$0.1696
Cost of Purchased Electricity LPLP - New (/ kWh)		$0.1200	$0.1236	$0.1273	$0.1311	$0.1351	$0.1391	$0.1433	$0.1476	$0.1520	$0.1566
Cost of NG Fuel (/ MMBtu)		$4.00	$4.12	$4.24	$4.37	$4.50	$4.64	$4.78	$4.92	$5.07	$5.22
Demand Management Offset Costs											
EMAAC Zone ICAP RPM Auction		$71,569	$73,716	$75,928	$78,205	$80,552	$82,968	$85,457	$88,021	$90,661	$93,381
PSE&G Zone PJM Transmission		$130,535	$134,451	$138,485	$142,639	$146,918	$151,326	$155,866	$160,542	$165,358	$170,319
PJM Ancillary		$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$36,896	$38,003	$39,143
PSE&G Summer Peak Demand		$16,000	$16,480	$16,974	$17,484	$18,008	$18,548	$19,105	$19,678	$20,268	$20,876
PSE&G Annual Demand		$13,000	$13,390	$13,792	$14,205	$14,632	$15,071	$15,523	$15,988	$16,468	$16,962
Total Demand Management Offset Costs ($/ MW)		**$261,104**	**$268,937**	**$277,005**	**$285,315**	**$293,875**	**$302,691**	**$311,772**	**$321,125**	**$330,759**	**$340,681**
2 - Combined Heat and Power System											
Electricity Supplied to the Microgrid (kWh/yr)		5,231,921	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921
Reduction in Hospital Boiler Fuel Use (MMBtu/yr HHV)		11,096	11,096	11,096	11,096	11,096	11,096	11,096	11,096	11,096	11,096
Reduction in Hospital Chiller Fuel Use (MMBtu/yr HHV)		9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205
Fuel Consumed by Engine (MMBtu/yr HHV)		53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316
CHP Revenue											
Avoided Purchased Electric Cost		$680,150	$700,554	$721,571	$743,218	$765,514	$788,480	$812,134	$836,498	$861,593	$887,441
Demand Management Savings		$208,883	$215,150	$221,604	$228,252	$235,100	$242,153	$249,417	$256,900	$264,607	$272,545
Avoided Fuel Cost (Natural Gas for Boiler and Chiller)		$89,034	$90,595	$93,313	$96,112	$98,996	$101,966	$105,025	$108,175	$111,421	$114,763
CHP Investiment Tax Credit (ITC)		$181,339	$181,339	$181,339	$181,339						
Total CHP Revenue		**$1,159,406**	**$1,187,638**	**$1,217,827**	**$1,248,922**	**$1,099,610**	**$1,132,598**	**$1,166,576**	**$1,201,574**	**$1,237,621**	**$1,274,749**
CHP Expenses											
Cost of Engine Fuel		$213,263	$219,661	$226,251	$233,039	$240,030	$247,231	$254,648	$262,287	$270,156	$278,260
Maintenance Costs		$99,864	$102,860	$105,946	$109,124	$112,398	$115,770	$119,243	$122,820	$126,505	$130,300
Total CHP Expenses		**$313,127**	**$322,521**	**$332,197**	**$342,163**	**$352,428**	**$363,000**	**$373,890**	**$385,107**	**$396,660**	**$408,560**
CHP Energy Cost Savings		**$846,279**	**$865,117**	**$885,630**	**$906,759**	**$747,182**	**$769,598**	**$792,686**	**$816,466**	**$840,960**	**$866,189**
TOTAL MICROGRID ENERGY SAVINGS											
	-$7,794,760	**$846,279**	**$865,117**	**$885,630**	**$906,759**	**$747,182**	**$769,598**	**$792,686**	**$816,466**	**$840,960**	**$866,189**

Year	**2032** **11**	**2033** **12**	**2034** **13**	**2035** **14**	**2036** **15**	**2037** **16**	**2038** **17**	**2039** **18**	**2040** **19**	**2041** **20**
1 - Utility Prices										
Cost of Purchased Electricity LPLS - Existing (/ kWh)	$0.1747	$0.1800	$0.1853	$0.1909	$0.1966	$0.2025	$0.2086	$0.2149	$0.2213	$0.2280
Cost of Purchased Electricity LPLP - New (/ kWh)	$0.1613	$0.1661	$0.1711	$0.1762	$0.1815	$0.1870	$0.1926	$0.1983	$0.2043	$0.2104
Cost of NG Fuel (/ MMBtu)	$5.38	$5.54	$5.70	$5.87	$6.05	$6.23	$6.42	$6.61	$6.81	$7.01
Demand Management Offset Costs										
EMAAC Zone ICAP RPM Auction	$96,183	$99,068	$102,040	$105,101	$108,255	$111,502	$114,847	$118,293	$121,841	$125,497
PSE&G Zone PJM Transmission	$175,428	$180,691	$186,112	$191,695	$197,446	$203,369	$209,470	$215,754	$222,227	$228,894
PJM Ancillary	$40,317	$41,527	$42,773	$44,056	$45,378	$46,739	$48,141	$49,585	$51,073	$52,605
PSE&G Summer Peak Demand	$21,503	$22,148	$22,812	$23,497	$24,201	$24,927	$25,675	$26,446	$27,239	$28,056
PSE&G Annual Demand	$17,471	$17,995	$18,535	$19,091	$19,664	$20,254	$20,861	$21,487	$22,132	$22,796
Total Demand Management Offset Costs ($/ MW)	**$350,902**	**$361,429**	**$372,272**	**$383,440**	**$394,943**	**$406,792**	**$418,995**	**$431,565**	**$444,512**	**$457,847**
2 - Combined Heat and Power System										
Electricity Supplied to the Microgrid (kWh/yr)	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921	5,231,921
Reduction in Hospital Boiler Fuel Use (MMBtu/yr HHV)	11,096	11,096	11,096	11,096	11,096	11,096	11,096	11,096	11,096	11,096
Reduction in Hospital Chiller Fuel Use (MMBtu/yr HHV)	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205	9,205
Fuel Consumed by Engine (MMBtu/yr HHV)	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316	53,316
CHP Revenue										
Avoided Purchased Electric Cost	$914,064	$941,486	$969,731	$998,823	$1,028,787	$1,059,651	$1,091,441	$1,124,184	$1,157,909	$1,192,647
Demand Management Savings	$280,722	$289,143	$297,817	$306,752	$315,955	$325,433	$335,196	$345,252	$355,610	$366,278
Avoided Fuel Cost (Natural Gas for Boiler and Chiller)	$118,206	$121,752	$125,405	$129,167	$133,042	$137,033	$141,144	$145,378	$149,740	$154,232
CHP Investiment Tax Credit (ITC)										
Total CHP Revenue	**$1,312,992**	**$1,352,382**	**$1,392,953**	**$1,434,742**	**$1,477,784**	**$1,522,117**	**$1,567,781**	**$1,614,814**	**$1,663,259**	**$1,713,157**
CHP Expenses										
Cost of Engine Fuel	$286,608	$295,206	$304,063	$313,184	$322,580	$332,257	$342,225	$352,492	$363,067	$373,959
Maintenance Costs	$134,209	$138,235	$142,382	$146,654	$151,053	$155,585	$160,252	$165,060	$170,012	$175,112
Total CHP Expenses	**$420,817**	**$433,442**	**$446,445**	**$459,838**	**$473,633**	**$487,842**	**$502,478**	**$517,552**	**$533,078**	**$549,071**
CHP Energy Cost Savings	**$892,175**	**$918,940**	**$946,508**	**$974,904**	**$1,004,151**	**$1,034,275**	**$1,065,303**	**$1,097,263**	**$1,130,180**	**$1,164,086**
TOTAL MICROGRID ENERGY SAVINGS										
	$892,175	**$918,940**	**$946,508**	**$974,904**	**$1,004,151**	**$1,034,275**	**$1,065,303**	**$1,097,263**	**$1,130,180**	**$1,164,086**

Turbine GeneratorMicrogrid Life Cycle Savings		
Net Present Value	**4.00%**	**$4,529,528**
Internal Rate of Return (IRR)		**9.5%**
Simple Payback		**9.37**
CHP Plant Efficiency (LHV)		**82.9%**
Annual Carbon Savings (Metric Ton)		**3,430**
Annual Carbon Savings (Cars)		**733**

APPENDIX F

DER-CAM RESULTS

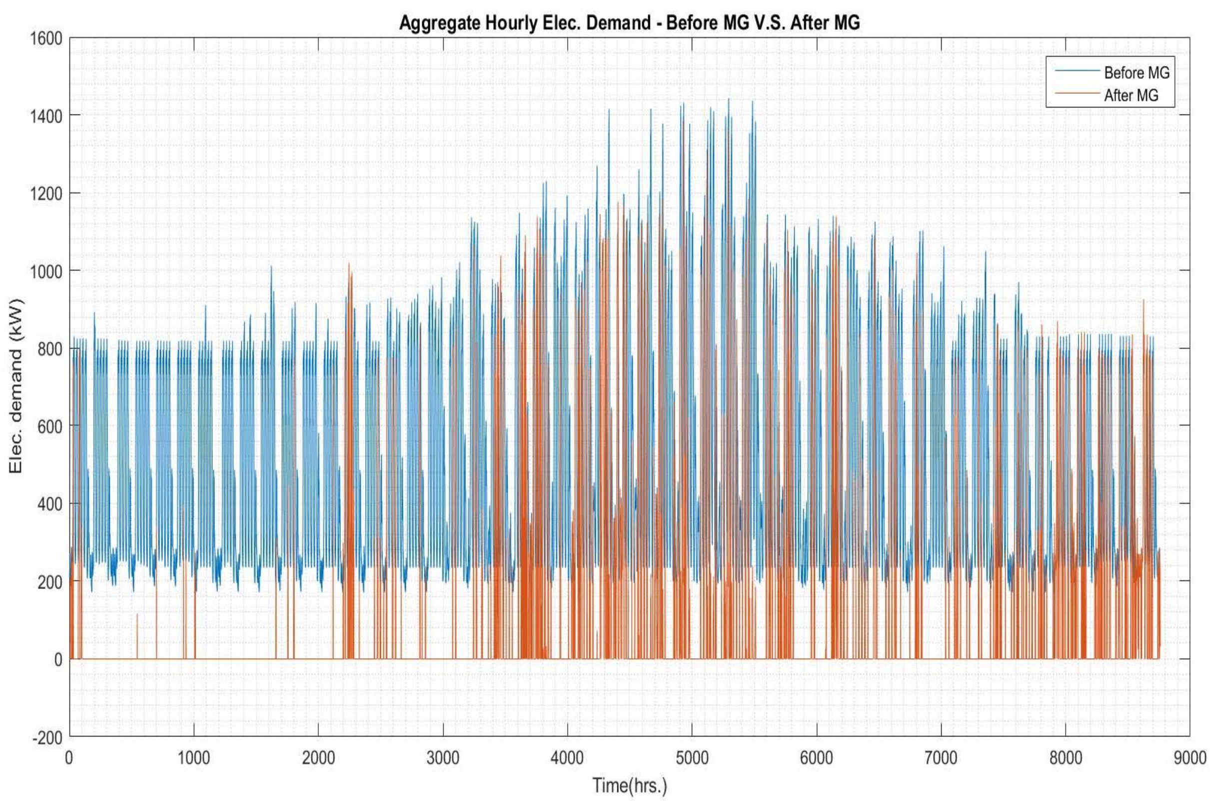
520 South Burnt Mill Road, Voorhees, NJ 08043 **P:** (856) 427-0200 **F:** (856) 427-6529

www.concord-engineering.com

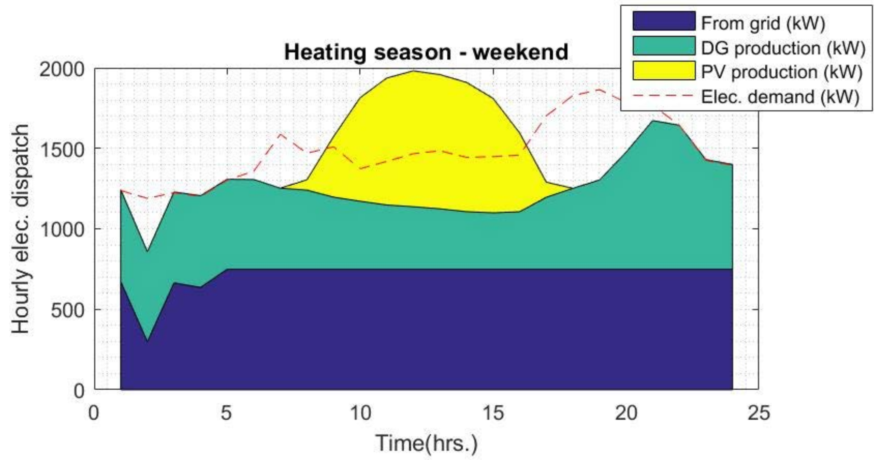
Annual Impact Analysis – Hoboken Washington Street TCMG

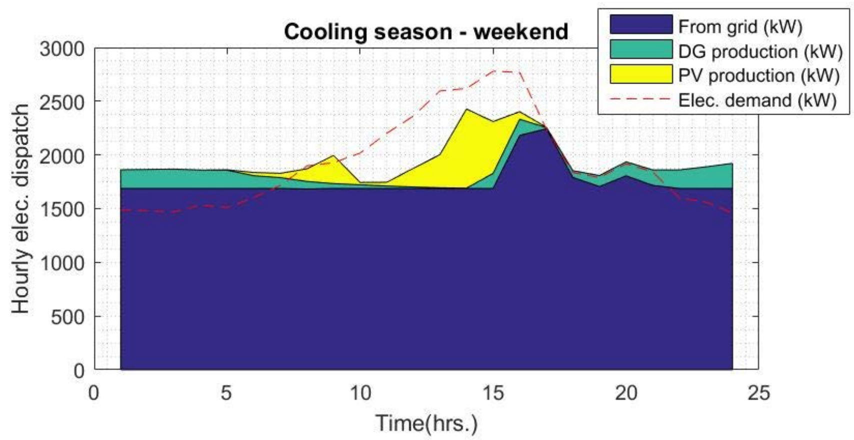
Annual Consumption (MWh)	Annual Energy Consumption Before MG (MWh)	17,964
	Annual Energy Consumption After MG (MWh)	7,834
	Energy Consumption Reduction (MWh)	10,130
	Energy Consumption Reduction (%)	% 56.2
Annual peak load (MW)	Peak Demand Before MG (MW)	4.3
	Peak Demand After MG (MW)	3.5
	Peak Demand Reduction (MW)	0.8
	Peak Demand Reduction (%)	% 18.6
Annual power Loss (MWh)	Real Power Loss Before MG (MWh)	160.45
	Real power Loss After MG (MWh)	70.85
	Distribution Power Loss Reduction (MWh)	89.6
	Power loss reduction (%)	% 55.8
Heat Recovery	Annual recovered heat at the hospital facility (US-Therm)	384.5

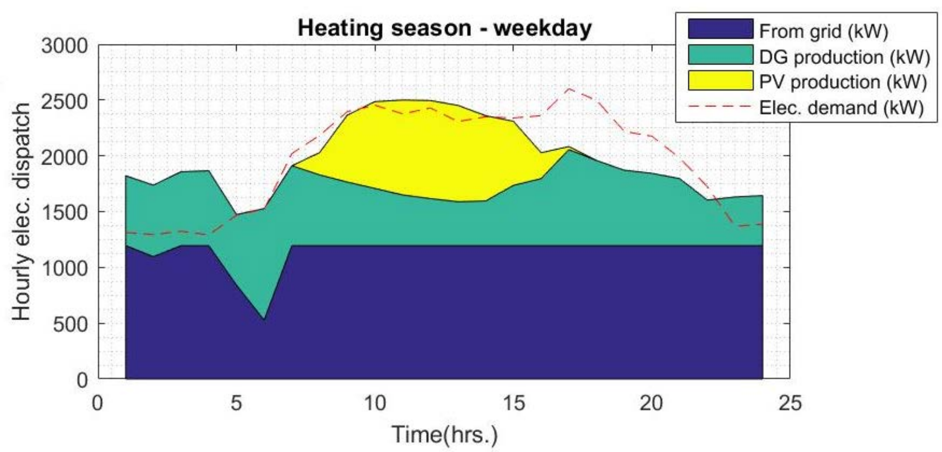
Aggregate Hourly Electrical Demand – Annual, Washington Street

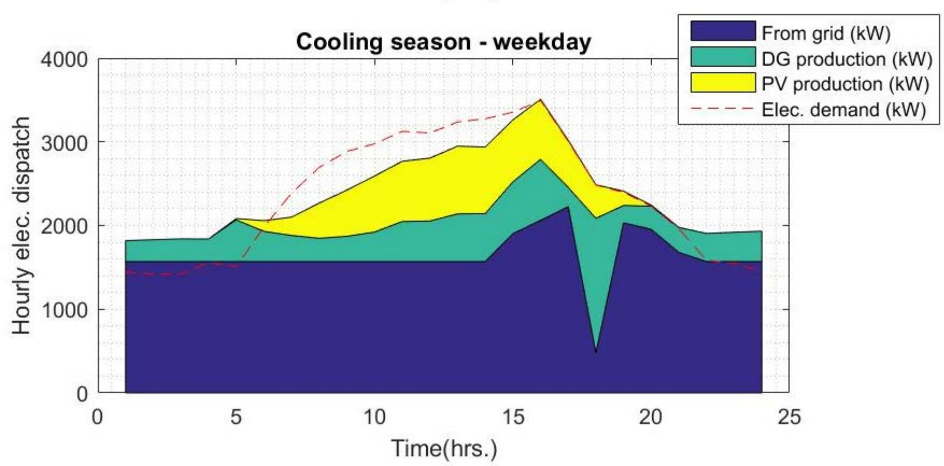


Aggregate MG Hourly Dispatch – 4 Representative Days, Washington Street

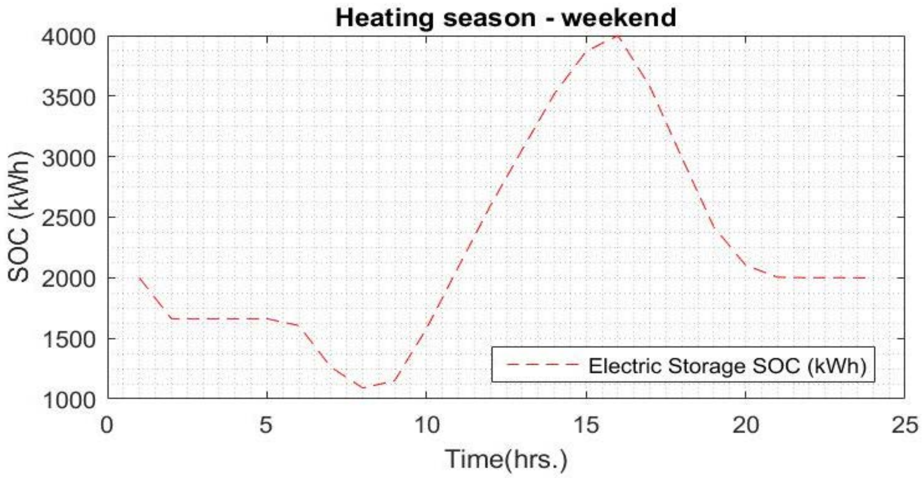


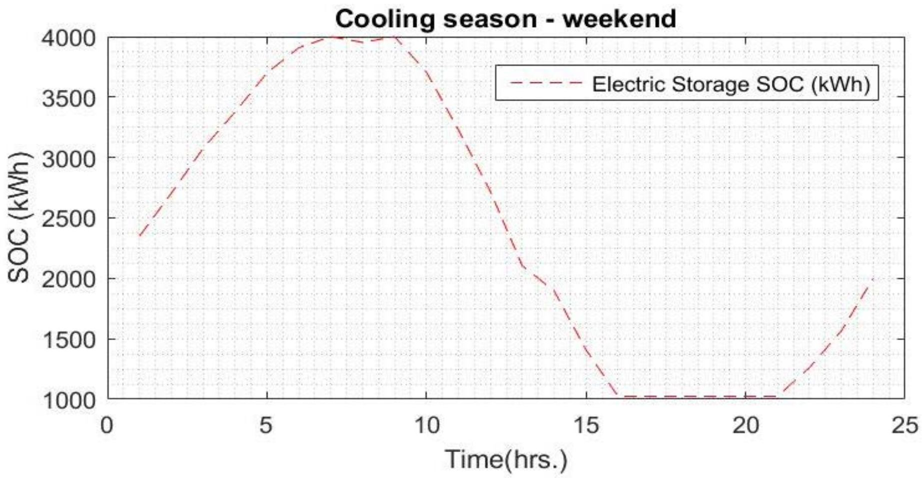


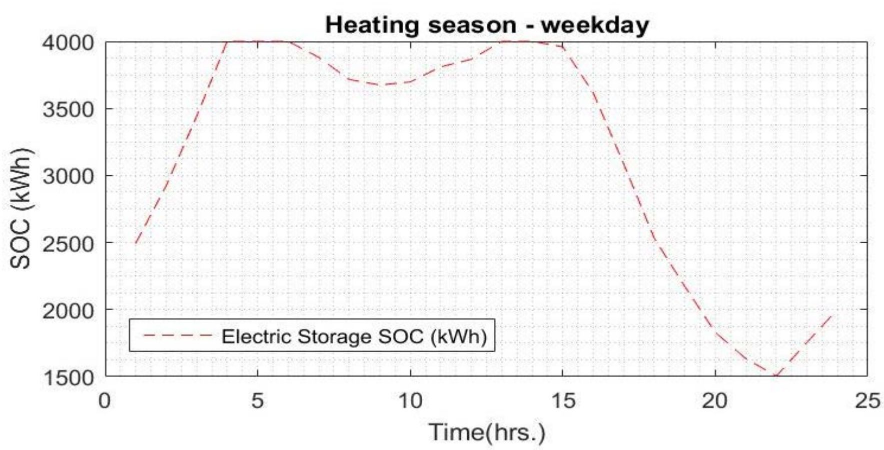


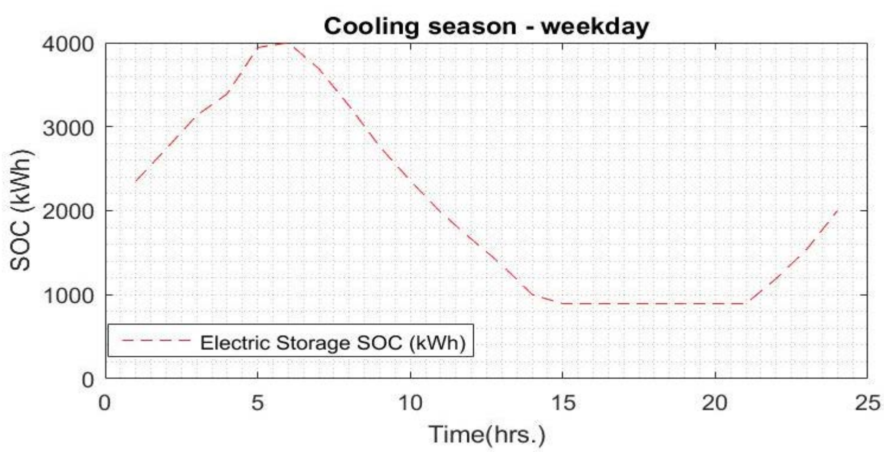


Aggregate Grid Imported Power – 4 representative days, Washington Street





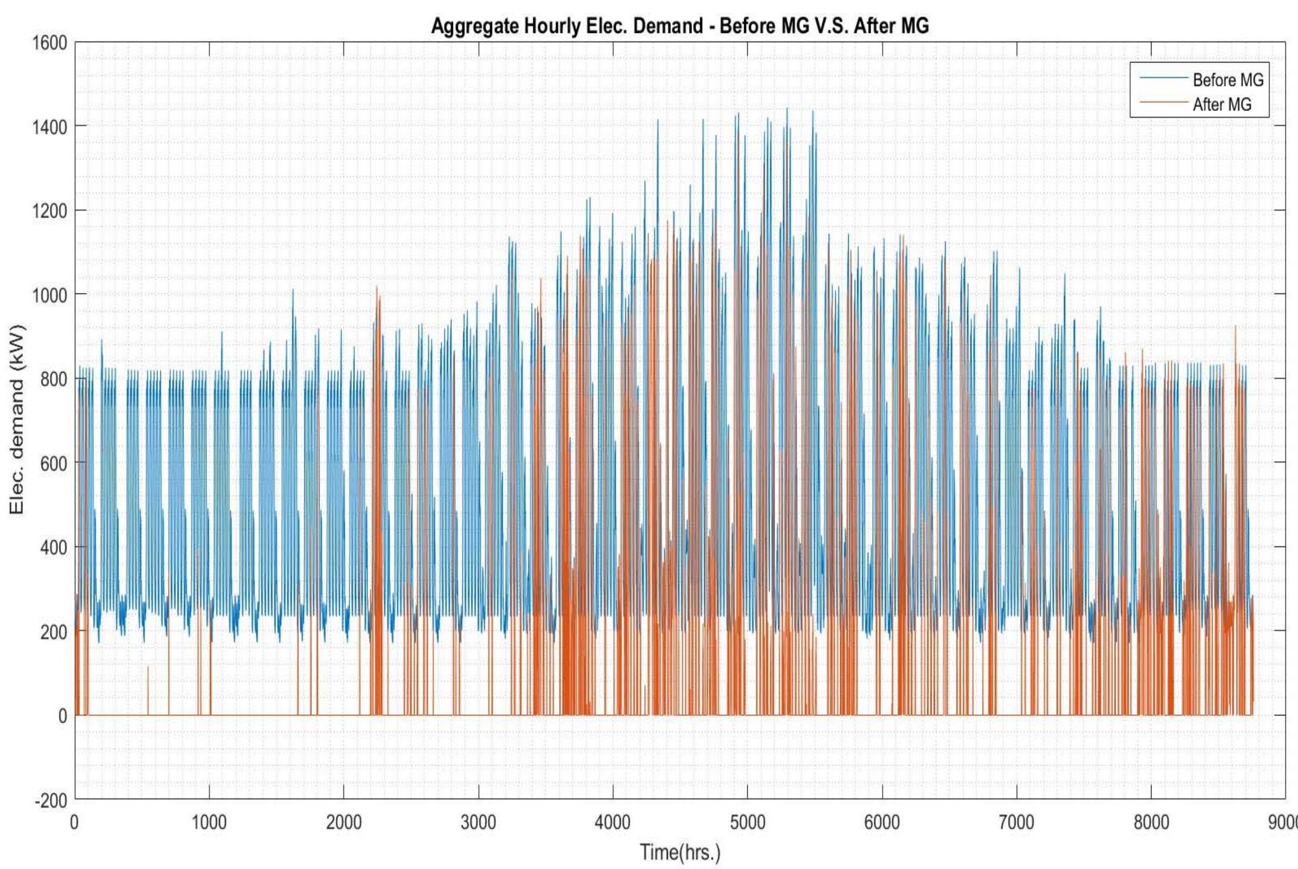




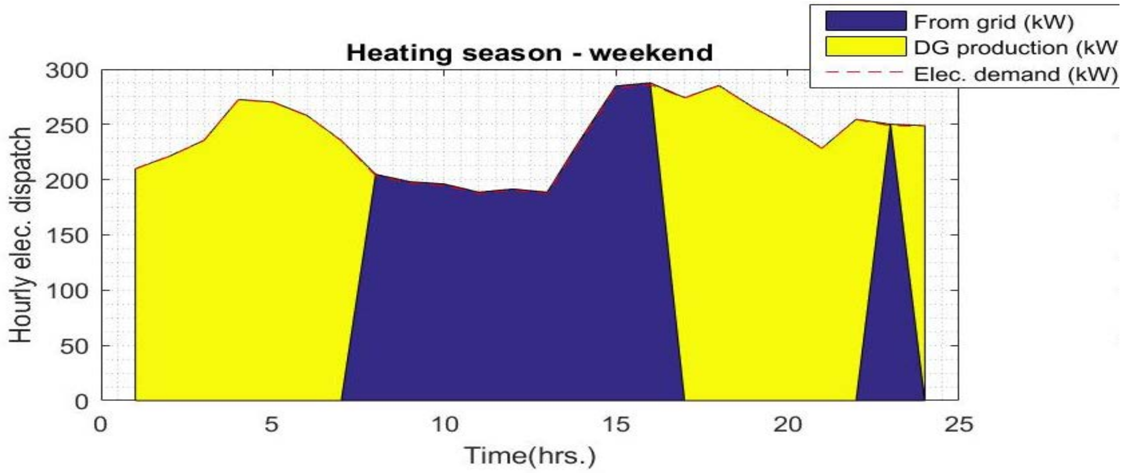
Annual Impact Analysis – Hoboken Housing Authority (HA) TCMG

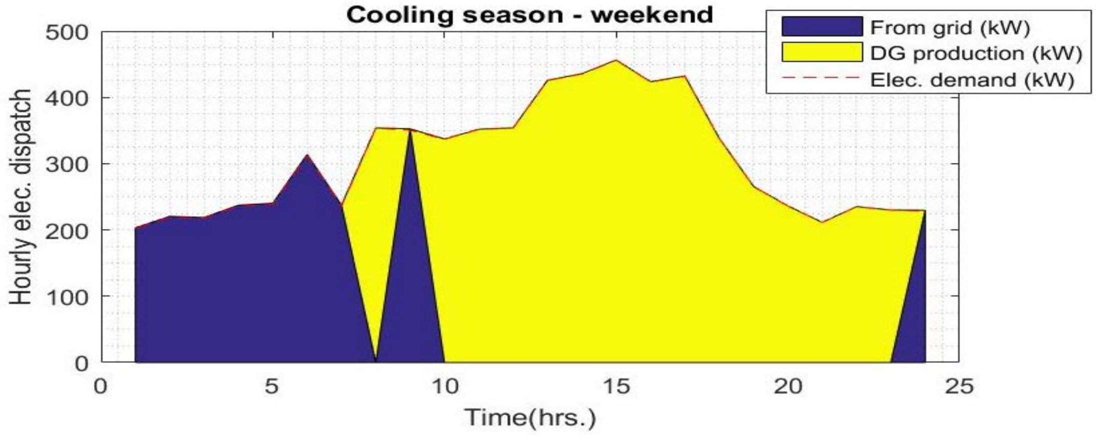
Annual Consumption (kWh)	Annual Energy Consumption Before MG (kWh)	4,554,903.66
	Annual Energy Consumption After MG (kWh)	674,914.14
	Energy Consumption Reduction (kWh)	3,879,989.52
	Energy Consumption Reduction (%)	85.18
Annual peak load (kW)	Peak Demand Before MG (kW)	1,455.97
	Peak Demand After MG (kW)	1,385.38
	Peak Demand Reduction (kW)	70.58
	Peak Demand Reduction (%)	4.85
Annual power Loss (kWh)	Real Power Loss Before MG (kWh)	33,435.10
	Real power Loss After MG (kWh)	14,054.63
	Distribution Power Loss Reduction (kWh)	19,380.47
	Power loss reduction (%)	57.96
Recip. Engine operation	Capacity (kW)	1,200
	Elec. Efficiency (%)	37
	Annual Elec. Production (kWh)	3,860,609.05
	Annual NG Consumption (U.S. Therm)	364,613.07

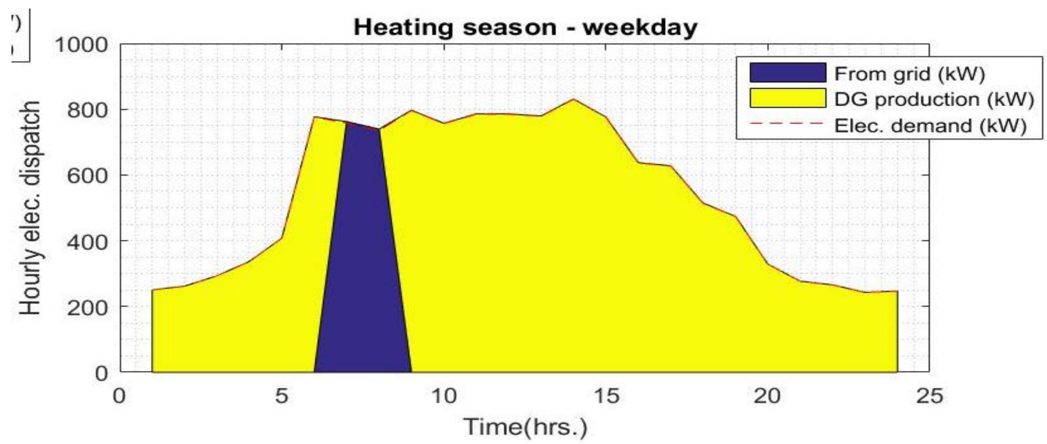
Aggregate Hourly Elec. demand – Annual, Housing Authority

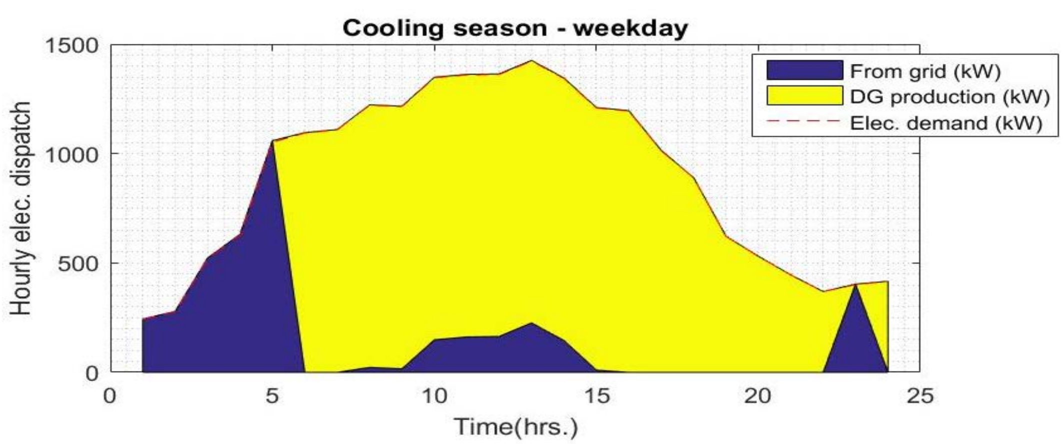


Aggregate MG Hourly Dispatch – 4 Representative Days, Housing Authority

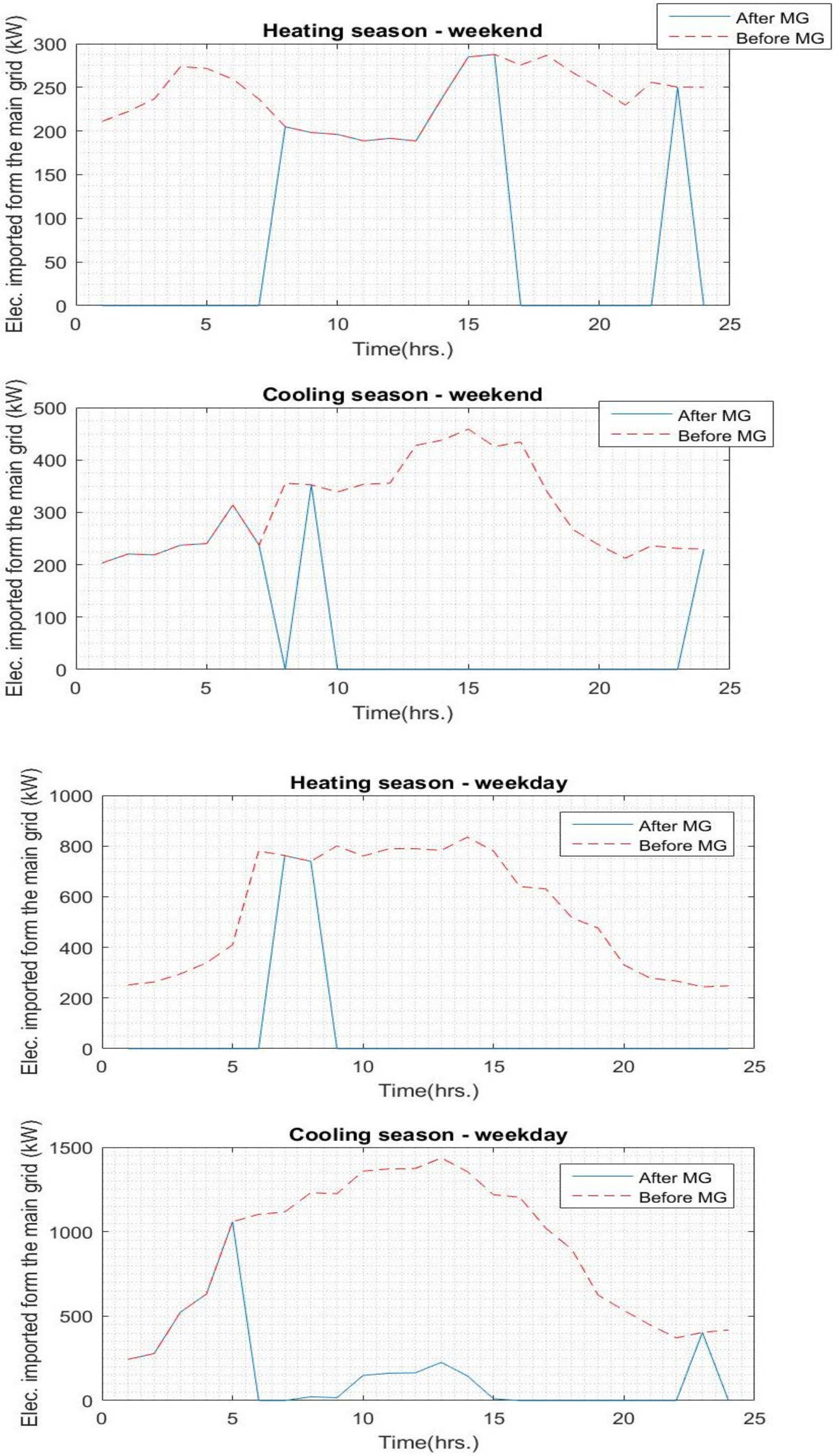








Aggregate Grid Imported Power – 4 representative days, Housing Authority

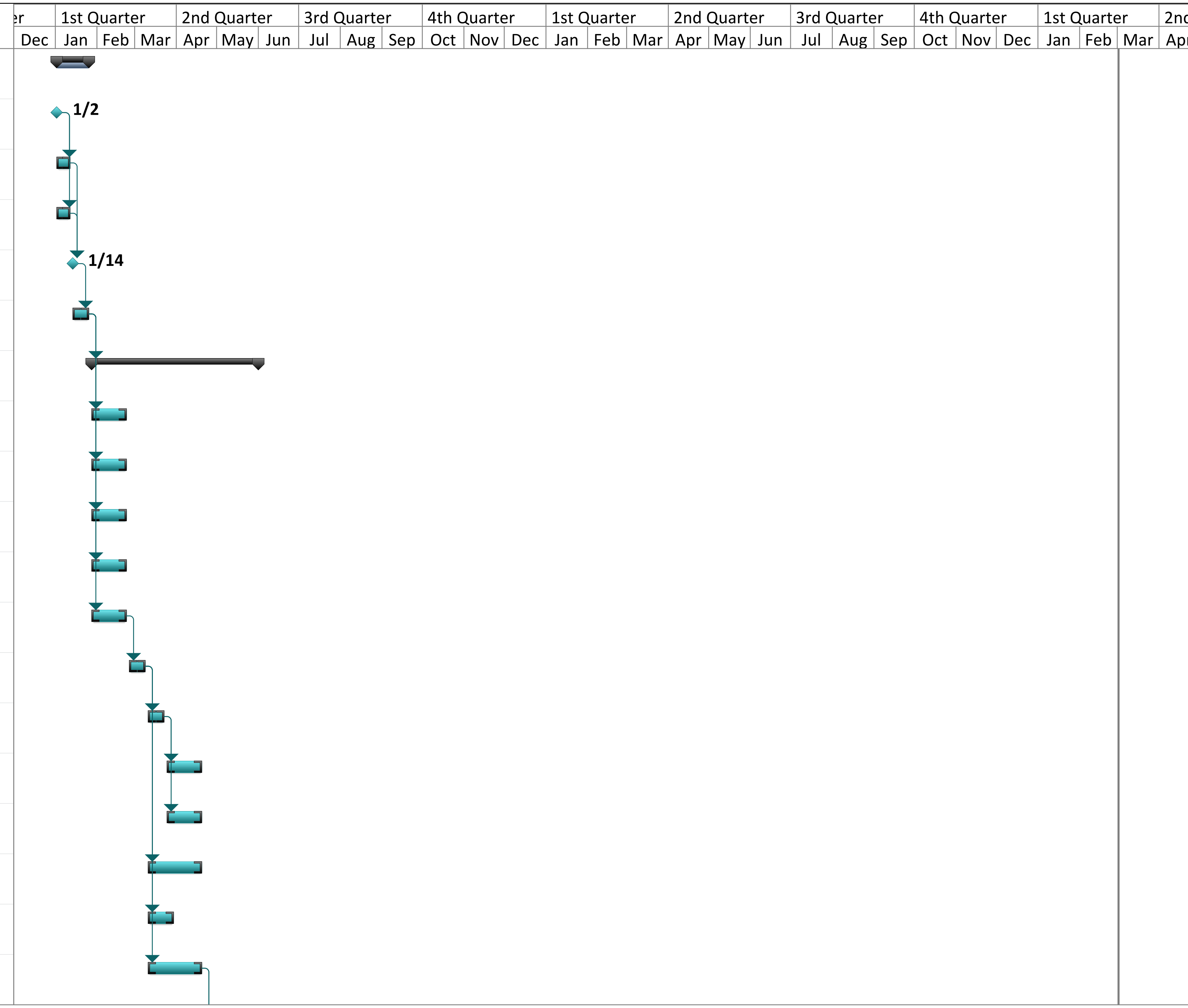


APPENDIX G

SCHEDULE

City of Hoboken
NJ Town Center Distributed Energy Resources Microgrid Feasibility Study
Phase 2 & EPC Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Phase 2 Kickoff**	**18 days**	**Wed 1/2/19**	**Fri 1/25/19**	
2	Receive Approval from BPU to Proceed with Phase 2	0 days	Wed 1/2/19	Wed 1/2/19	
3	Procure Engineering	8 days	Wed 1/2/19	Fri 1/11/19	2
4	Re-engage Project Partners	8 days	Wed 1/2/19	Fri 1/11/19	2
5	Kickoff Meeting with Engineer and Project Partners	0 days	Mon 1/14/19	Mon 1/14/19	3,4
6	Confirm Partner List & Revise Energy Analysis as Needed	10 days	Mon 1/14/19	Fri 1/25/19	5
7	**Phase 2 Engineering (Schematic Design)**	**90 days**	**Mon 1/28/19**	**Fri 5/31/19**	**6**
8	Issue Major Equipment Specifications	20 days	Mon 1/28/19	Fri 2/22/19	6
9	Issue Microgrid Controller and Integration Specification	20 days	Mon 1/28/19	Fri 2/22/19	6
10	Develop One Line & Piping, Instrument Diagrams	20 days	Mon 1/28/19	Fri 2/22/19	6
11	Define Electrical, Mechanical Tie-Ins	20 days	Mon 1/28/19	Fri 2/22/19	6
12	Develop Physical Electrical, Mechanical Arrangements	20 days	Mon 1/28/19	Fri 2/22/19	6
13	Hoboken & Project Partners Review Preliminary Engineering Documents	10 days	Mon 2/25/19	Fri 3/8/19	12
14	Perform Underground Utility Analysis	10 days	Mon 3/11/19	Fri 3/22/19	13
15	Develop Underground Ductbank Drawings	20 days	Mon 3/25/19	Fri 4/19/19	14
16	Develop Civil Stormwater and Sediment Control Documents	20 days	Mon 3/25/19	Fri 4/19/19	14
17	Develop Structural Drawings and Details	30 days	Mon 3/11/19	Fri 4/19/19	13
18	Define Parameters & Perform Acoustic Evaluation	15 days	Mon 3/11/19	Fri 3/29/19	13
19	Draft Design Criteria and Project Scope of Work	30 days	Mon 3/11/19	Fri 4/19/19	13

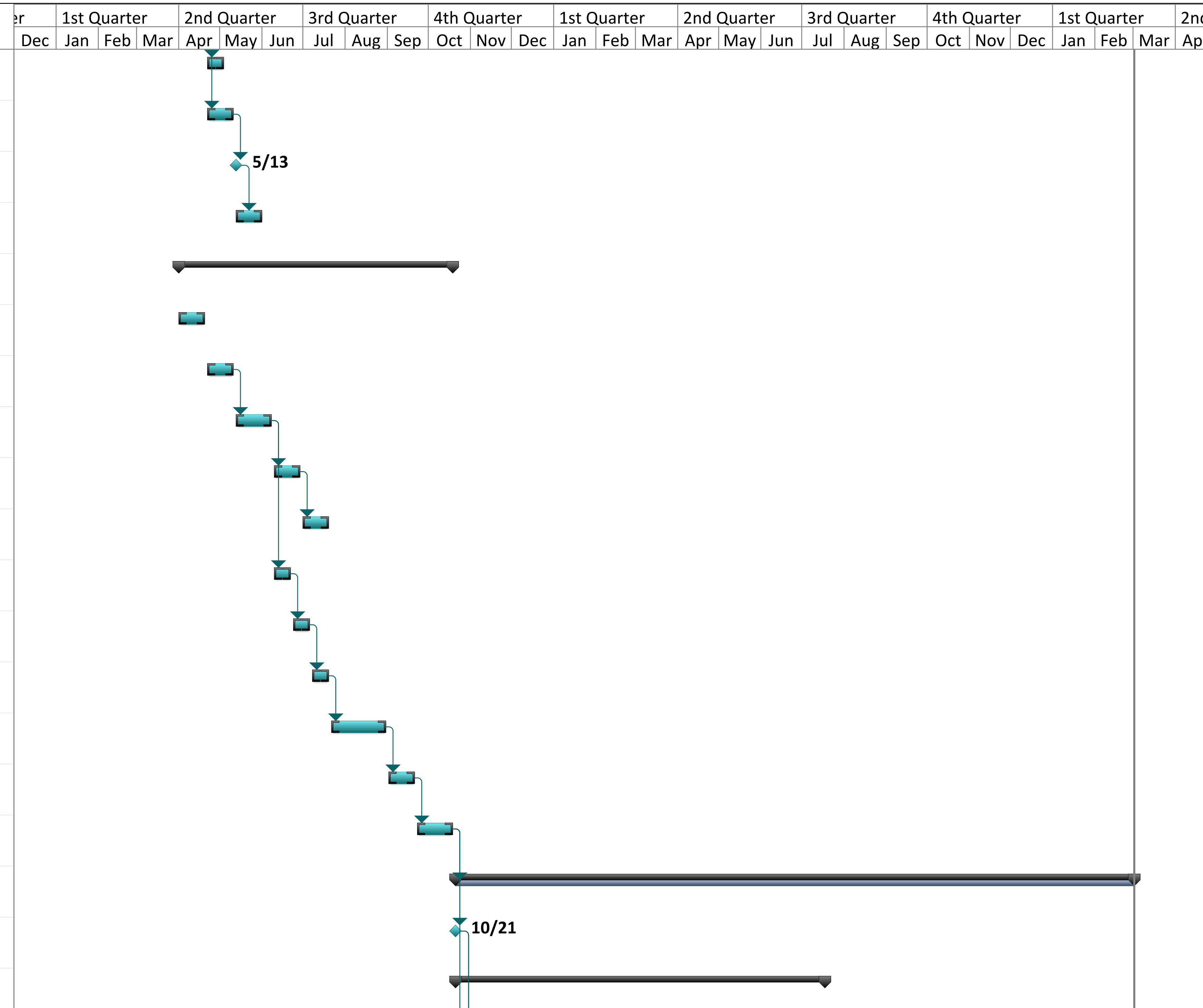


Project: Hoboken Schedule
Date: Wed 6/20/18

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

City of Hoboken
NJ Town Center Distributed Energy Resources Microgrid Feasibility Study
Phase 2 & EPC Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
20	Perform Investment Grade Cost Estimate	10 days	Mon 4/22/19	Fri 5/3/19	19
21	Issue Documents to Hoboken, Project Partners, PSE&G and BPU for Review	15 days	Mon 4/22/19	Fri 5/10/19	19
22	Phase 2 Engineering Review Meeting with Project Partners, PSE&G, and BPU	0 days	Mon 5/13/19	Mon 5/13/19	21
23	Revise Phase 2 Engineering Documents	15 days	Mon 5/13/19	Fri 5/31/19	22
24	**EPC Bid Period**	**145 days**	**Mon 4/1/19**	**Fri 10/18/19**	
25	Draft Request for Qualifications (RFQ)	15 days	Mon 4/1/19	Fri 4/19/19	
26	BPU Review RFQ	15 days	Mon 4/22/19	Fri 5/10/19	
27	Revise & Issue RFQ to Potential Bidders	20 days	Mon 5/13/19	Fri 6/7/19	26
28	Potential Bidders Submit Qualifications	15 days	Mon 6/10/19	Fri 6/28/19	27
29	Review RFQ Responses & Recommend Bid List	15 days	Mon 7/1/19	Fri 7/19/19	28
30	Draft Request for Proposals	10 days	Mon 6/10/19	Fri 6/21/19	27
31	BPU Review RFP	10 days	Mon 6/24/19	Fri 7/5/19	30
32	Revise & Issue RFP to Bidders	10 days	Mon 7/8/19	Fri 7/19/19	31
33	Bidders Submit Responses	30 days	Mon 7/22/19	Fri 8/30/19	32
34	Review RFP Responses & Recommend Winner	15 days	Mon 9/2/19	Fri 9/20/19	33
35	Issue Contract to Successful EPC Bidder	20 days	Mon 9/23/19	Fri 10/18/19	34
36	**Detailed Engineering, Procurement and Construction**	**356 days**	**Mon 10/21/19**	**Mon 3/1/21**	**35**
37	Kickoff Meeting	0 days	Mon 10/21/19	Mon 10/21/19	35
38	**Equipment Procurement**	**195 days**	**Mon 10/21/19**	**Fri 7/17/20**	

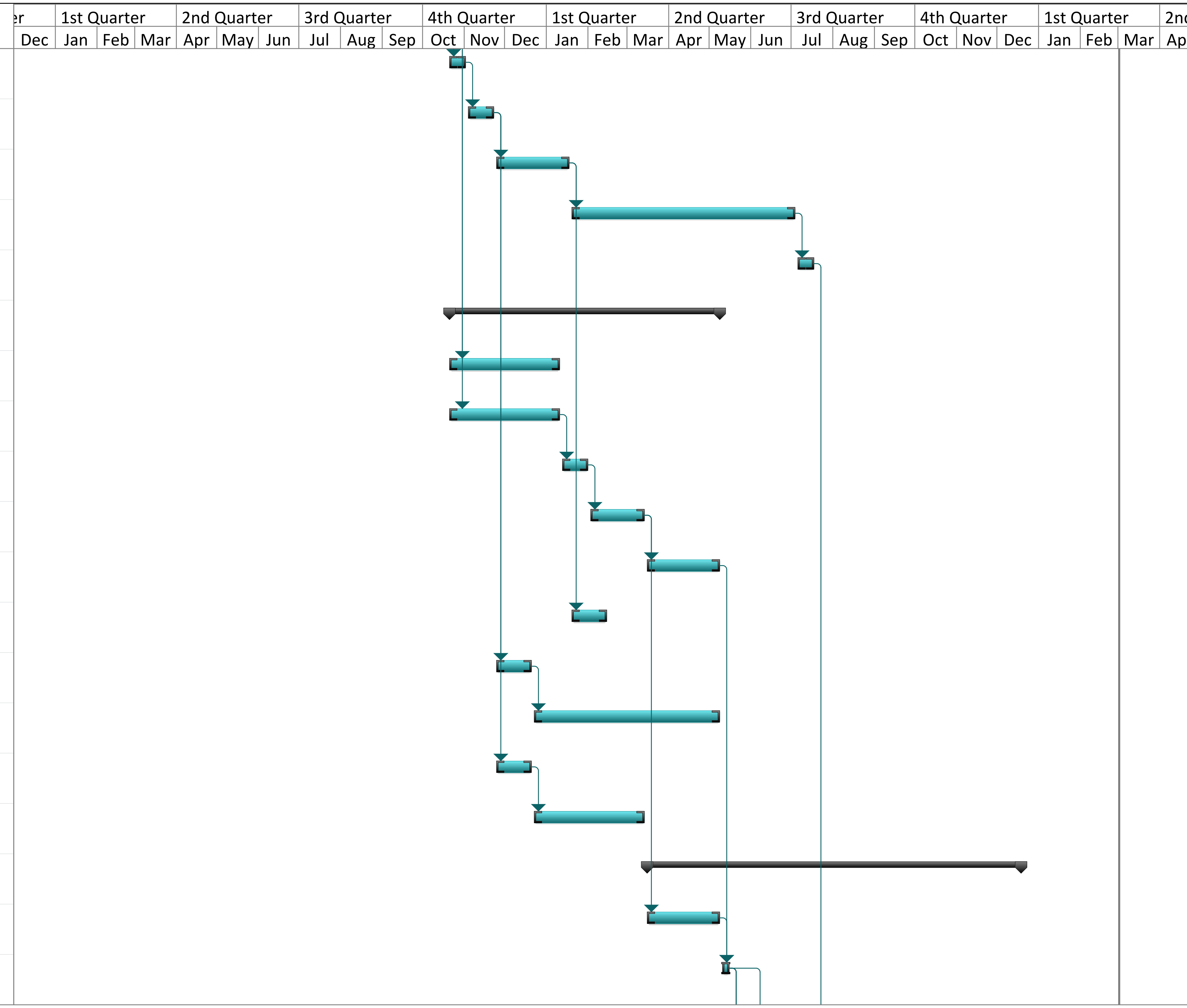


Project: Hoboken Schedule
Date: Wed 6/20/18

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

City of Hoboken
NJ Town Center Distributed Energy Resources Microgrid Feasibility Study
Phase 2 & EPC Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
39	Issue Major Equipment Specifications & RFP to Vendors	10 days	Mon 10/21/19	Fri 11/1/19	35
40	Major Equipment Vendor Bid Period and Negotiations	15 days	Mon 11/4/19	Fri 11/22/19	39
41	Shop Drawing Development and Engineering Review Period	40 days	Mon 11/25/19	Fri 1/17/20	40
42	Major Equipment Fabrication	120 days	Mon 1/20/20	Fri 7/3/20	41
43	Major Equipment Delivery to Site	10 days	Mon 7/6/20	Fri 7/17/20	42
44	**Detailed Engineering**	**145 days**	**Mon 10/21/19**	**Fri 5/8/20**	
45	Develop Drawings	60 days	Mon 10/21/19	Fri 1/10/20	37
46	Develop Material Specifications	60 days	Mon 10/21/19	Fri 1/10/20	37
47	Hoboken and Project Partners Review	15 days	Mon 1/13/20	Fri 1/31/20	46
48	Revise Design Documents and Submit to DCA for Permits	30 days	Mon 2/3/20	Fri 3/13/20	47
49	Receive Construction Permit	40 days	Mon 3/16/20	Fri 5/8/20	48
50	Revise Acoustic Analysis	20 days	Mon 1/20/20	Fri 2/14/20	41
51	Submit Air Permit	20 days	Mon 11/25/19	Fri 12/20/19	40
52	Receive Air Permit	100 days	Mon 12/23/19	Fri 5/8/20	51
53	Submit Electrical Interconnection Application	20 days	Mon 11/25/19	Fri 12/20/19	40
54	Receive Electrical Interconnection Approval	60 days	Mon 12/23/19	Fri 3/13/20	53
55	**Construction**	**200 days**	**Mon 3/16/20**	**Fri 12/18/20**	
56	Procure Sub-Contractors	40 days	Mon 3/16/20	Fri 5/8/20	48
57	Site Mobilization	5 days	Mon 5/11/20	Fri 5/15/20	49,56

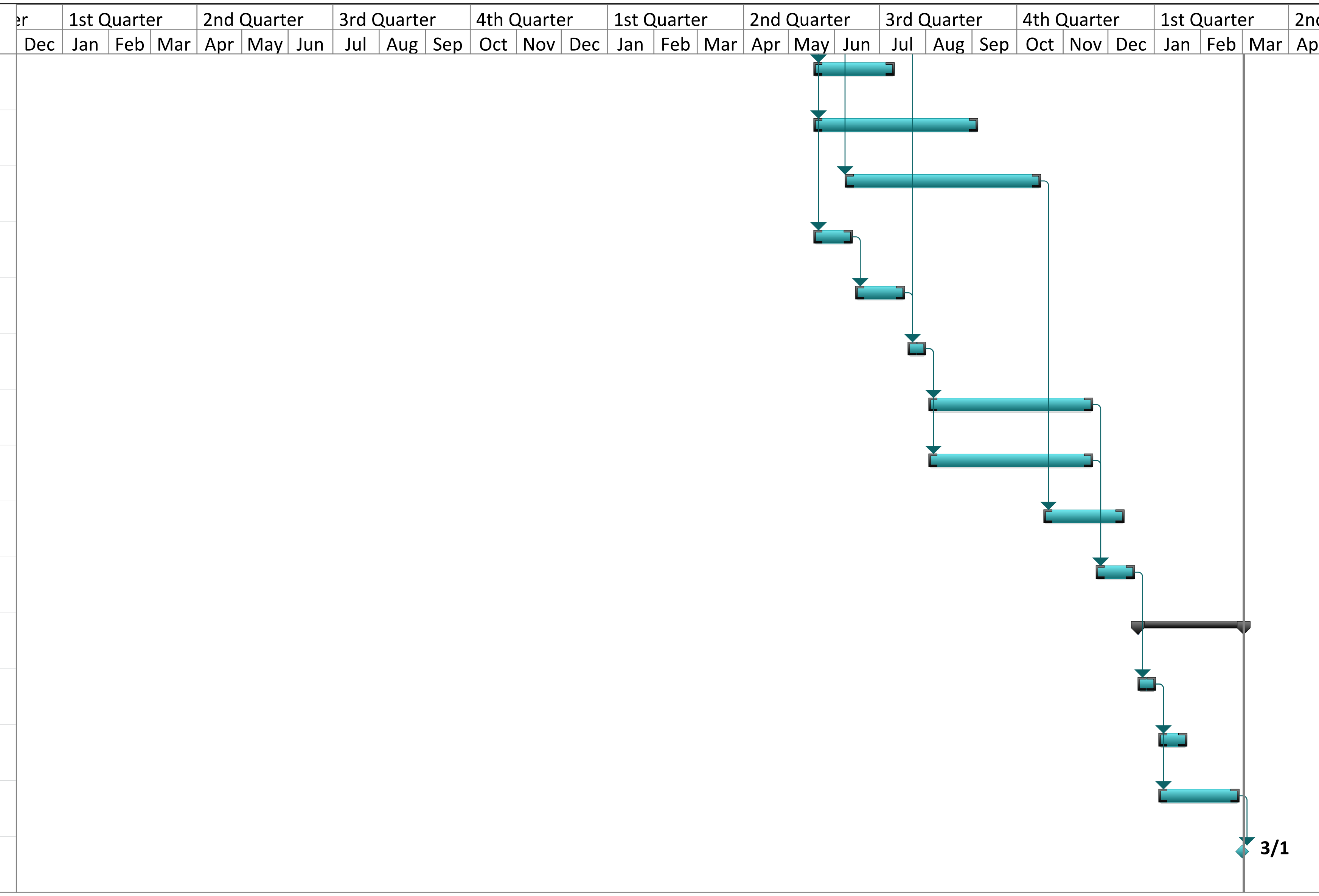


Project: Hoboken Schedule
Date: Wed 6/20/18

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

City of Hoboken
NJ Town Center Distributed Energy Resources Microgrid Feasibility Study
Phase 2 & EPC Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
58	Site Work	40 days	Mon 5/18/20	Fri 7/10/20	57
59	Underground Conduit Installation	80 days	Mon 5/18/20	Fri 9/4/20	57
60	Install New Feeds at Buildings	95 days	Mon 6/8/20	Fri 10/16/20	57
61	Demolition Work for Generator Installation	20 days	Mon 5/18/20	Fri 6/12/20	57
62	DG/CHP/Solar Foundations and Steel Erecting	25 days	Mon 6/15/20	Fri 7/17/20	61
63	Set Major Equipment	10 days	Mon 7/20/20	Fri 7/31/20	43,62
64	DG/CHP Mechanical Rough In	80 days	Mon 8/3/20	Fri 11/20/20	63
65	DG/CHP/Solar Electrical Rough In	80 days	Mon 8/3/20	Fri 11/20/20	63
66	Microgrid Installation and Integration	40 days	Mon 10/19/20	Fri 12/11/20	60
67	Pre-Commissioning, Testing and Checkout	20 days	Mon 11/23/20	Fri 12/18/20	64,65
68	**Start-Up and Commissioning**	**51 days**	**Mon 12/21/20**	**Mon 3/1/21**	
70	Energize Electrical Equipment	10 days	Mon 12/21/20	Fri 1/1/21	67
71	Start-up DG/CHP/Solar PV Generation Assets	15 days	Mon 1/4/21	Fri 1/22/21	70
72	Performance Testing and Commissioning	40 days	Mon 1/4/21	Fri 2/26/21	70
73	Substantial Completion	0 days	Mon 3/1/21	Mon 3/1/21	72



Project: Hoboken Schedule
Date: Wed 6/20/18

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	