The Neptune Township Advanced Microgrid (NTAM)

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Project Name

TB Technologies, LLC is pleased to submit this summary report or our analyses, findings and recommendations for the successful implementation of the Neptune Township Advanced Microgrid (NTAM) in Neptune, New Jersey. This comprehensive feasibility study is a product of the New Jersey Board of Public Utilities (NJBPU) program to provide incentives for local and State government agencies to analyze the viability of Town Center Microgrids in accordance with the New Jersey Energy Master Plan Update goal to improve energy infrastructure resiliency and emergency preparedness following recent extreme weather events causing extended interruptions to vital utility and basic human services.

Project Applicant

The initial BPU grant funding assistance application for the Neptune Township Advanced Microgrid was submitted by Neptune Township in March 2017. The Project partners included Neptune Township, Neptune Township School Board, Neptune Township Housing Authority, Monmouth County, and several private sector entities. The critical facilities as part of the original Project included Jersey Shore University Medical Center, now called Hackensack-Meridian University Medical Center (HMUMC), Monmouth County Academy of Allied Health & Science, Meridian Dentistry for Children, Pediatric Associates, Neptune Municipal Facility (including the Police Department and Library), Neptune Department of Public Works, Gables Elementary School, Neptune Middle School, Neptune Board of Education, which houses Brookdale Community College, Monmouth County Vocational School – Neptune Annex, Neptune High School, Neptune Aquatic Center, County Sheriff Backup Communications Center and Emergency Medical Squad Training Center, Neptune Senior Citizens Center, Neptune Township Housing Authority, NJ Employment Services, US Post Office, DaVita Neptune Dialysis Center, Excelsior Medical Corporation, Walgreens, Neptune Getty Station, ALDI Supermarket, Neptune Township Sewage Department and Wastewater Treatment Facility, New Jersey American Water Company, Monmouth County Emergency Communications Tower, Shark River Hills Fire Company, Shark River Hills First Aid Squad, and the Neptune City Housing Authority.

Based on the list of partners and proposed critical facilities, we identified two (2) FEMA Category IV designated facilities and seven (7) FEMA Category III facilities in Area A. The estimated total annual fuel usage of all twelve (12) facilities in the proposed Area A Project is 131,225 MMBtus. The FEMA Category III and IV facilities in the proposed Area with an average energy consumption of approximately 93,988 Btu's per square foot.

The NTAM Project will include utilizing the existing 3.6 MW combined heat and power facility at the HMUMC. The Project will evaluate approximately 15 MW of new power generating capacity which may include solar and dispatchable generation such as CHP and other new electric infrastructure to allow the proposed Project to operate during normal and emergency conditions. Jersey Central Power and Light (JCP&L) is the electric utility and New Jersey Natural Gas (NJNG) is the natural gas utility for Neptune Township, and both JCP&L and NJNG provided a letter of support (LOS) to participate in the feasibility study.

Project Partners

Team Lead:

TB Technologies, LLC, is an energy firm with a documented track record of success assisting Municipalities, Counties, Authorities and Commissions throughout the State with the development of energy procurement cooperatives, efficiency planning and redevelopment Project implementation. Our Partners, Greener by Design, GI Energy, CHA and Microgrid Architect bring unparalleled experience with Microgrid development in New Jersey.

Sub-Contractors:

Greener by Design

Greener by Design, an Energy Investment and Environmental Asset Management™ firm, and its multidisciplinary staff of energy, engineering and environmental financial, Project management and grant writing professionals, is pleased to present this Town Center Distributed Energy Resource Microgrid Feasibility Study proposal to the Township of Neptune. Greener by Design's regular service offerings and experience are extremely well suited to the requirements of this RFP. In fact, accomplishing assignments such as this is a major focus of our firm. Greener by Design brings a comprehensive understanding of the economic and policy underpinnings of a rapidly changing energy and environmental landscape as well as a fresh perspective on how technology, innovation and legislation will influence the market in years to come.

Greener by Design presently provides or has provided Energy Investment and Environmental Asset Management planning and grants services to several private and public clients. Of these, NJ municipalities include Hoboken, Seaside Heights, Mantoloking, Woodbridge, Paterson, Linden, Rahway, Dover, Jersey City, Newark, Greenwich, Harding Township, Parsippany-Troy Hills, Warren and Monmouth Counties, CCMUA (Camden County Municipal Utilities Authority and grant writing and management/compliance services for Hudson County Improvement Authority (2011 through 2017). Additionally, under contract to the non-profit New Jersey Clean Cities Coalition, Greener by Design managed a $15 million DOE grant to offset the cost of the conversion of 305 garbage trucks and shuttle buses to Compressed Natural Gas (CNG), and the installation of six CNG fueling stations. The major public/private participants in the NJCCC Project include the City of Newark, Atlantic County Utilities Authority (ACUA), Waste Management, Central Jersey Waste, Atlantic City Jitney Association, and Clean Energy.

Greener by Design specializes in facilitating several programs offered by the New Jersey Clean Energy Program. Our detailed Project management and familiarity with the programs has allowed our team to successfully secure incentive monies from Direct Install, Pay for Performance, Local Government Energy Audit, Combined Heat and Power and Fuel Cells, Prescriptive and Custom Upgrades for Indoor Lighting, and procured SRECs for several solar Projects.

Greener by Design's staff has recently worked on a variety of post-Sandy planning Projects for energy master planning. Under a sub-contract with NJIT, Greener by Design is working with Neptune, Galloway, and Newark to create a toolkit and academic program for resiliency planning and the preliminary feasibility of back-up power or Microgrids. GbD also obtained a Gardinier Environmental Fund Grant through Sustainable Jersey Small Grants program in December 2015 to examine the potential development of a Microgrid in the Township of Woodbridge. The study identified public and private stakeholders that would need the ability to operate critical functions and provide necessary support for the town and the surrounding area.

CHA Consulting, Inc.

CHA is a full-service engineering consulting firm, is ranked among Engineering News-Record's Top 100 firms in the nation. A staff of 700 highly qualified and skilled professionals provides a wide range of engineering and support services. We are extremely active in the energy audit market as well as energy conservation and renewable energy design. Our energy audits have saved our clients over $50 million dollars in energy costs. CHA has many years of experience and has successfully completed over 10,000 Projects in the engineering of building systems (structural, mechanical, electrical and plumbing) and the design and installation of roof mounted telecommunications equipment. CHA is currently working on renewable Projects throughout the U.S. Most notably, we are completing a wind/solar roof mounted system at the Rochester International Airport and are in the preliminary planning of a 20MW solar farm in southern New Jersey.

CHA has served the energy industry nationwide from offices throughout the United States. Our Project management expertise, efficient production methods, and fast-track Project scheduling enables us to quickly and effectively plan, design, permit, and construct energy systems of all sizes and scopes. Expertise gained from our long successful history of designing building systems can be applied to a wide variety of renewable energy solutions include structural analysis and design, utility coordination and design, zoning, permitting, preparation of construction documents, permitting, grounding design and photo simulations. With regard to roof mounted equipment, whether it is solar arrays, HVAC equipment or communication antennas, the issues are very similar and our ability to effectively execute these types of Projects is solid.

GI Energy

GI Energy is an innovative integrator of distributed energy and sustainability resources for large commercial facilities, campuses, municipalities and large real estate developers. As a technology agnostic provider, our team focuses on delivering bespoke solutions for our clients, leveraging the latest in commercial technologies including geo-exchange HVAC, energy storage, renewable electricity generation, fuel cells and combined heat and power. We seek opportunities where multiple technological solutions can be brought to bear on a complex set of economic and environmental problems.

GI Energy specializes in providing consulting, development, underwriting, engineering, management, construction and advisory services to facility owners and property developers with a specific focus on distributed energy resources (DERs). GI Energy operates with offices in California, Illinois and New York and includes seasoned energy and financial analysts, engineers, Project development professionals and operations and maintenance technicians.

GI Energy's development group possesses unique commercial and technical expertise in developing sustainable and efficient distributed energy resources.

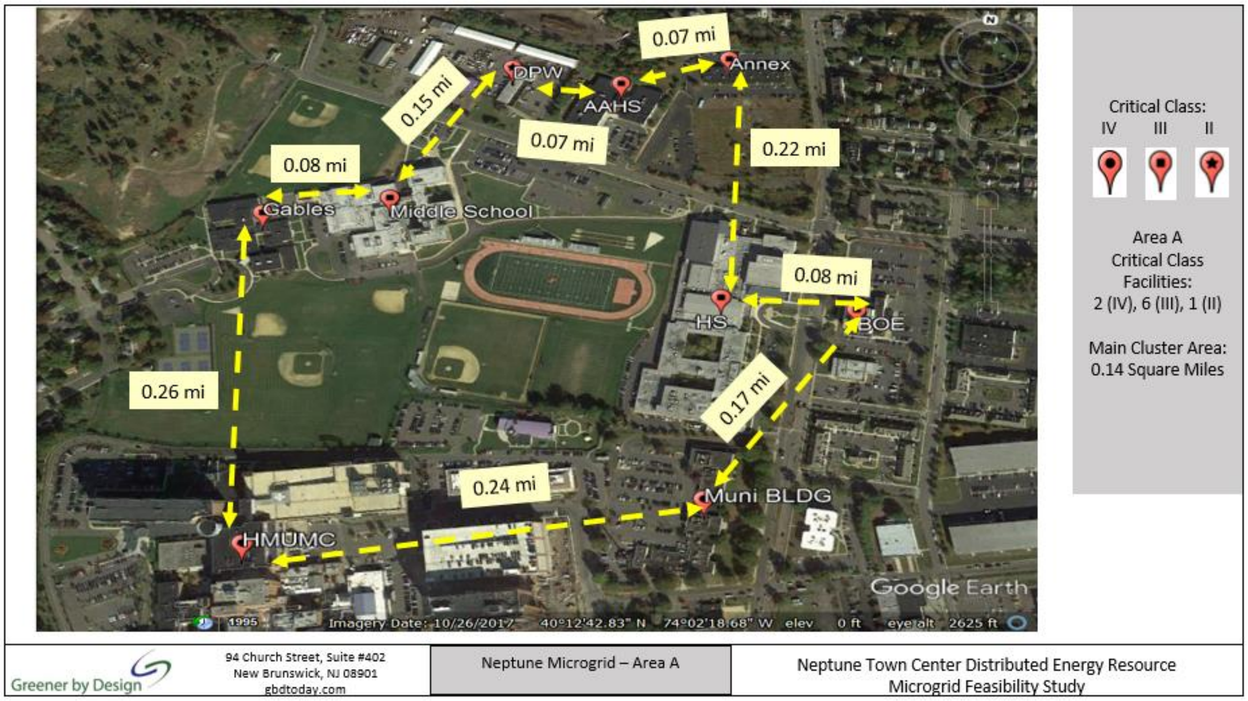
Microgrid Architect

Shalom Flank, PhD., became the nation's first "Microgrid architect" a decade ago, as Pareto Energy‘s Chief Technology Officer. Dr. Flank has managed all technical and engineering aspects of Pareto‘s Microgrid Projects, from initial assessments and conceptual design, through full engineering and implementation. He has also overseen the development of Pareto‘s proprietary Microgrid systems, such as the GridLink non-synchronous interconnection technology. Dr. Flank was trained at MIT, where he studied energy engineering, economics, and policy.

Dr. Flank has been a frequent advisor to commercial companies and public agencies on energy technologies, from helping the National Science Foundation assess the commercial viability of new photovoltaic and fuel cell technologies to working with cutting-edge companies commercializing clean energy and energy efficiency technologies. He served for several years as a program manager at the Defense Advanced Projects Agency (DARPA) and as a staff member at Lawrence Livermore National Laboratory and the U.S. House of Representatives and has held appointments at Harvard and MIT.

Project Location

The finalized Area A map detailing the boundaries of the Neptune TC DER Microgrid approach within Neptune Municipality is shown below.



Project Description

Executive Summary

The NTAM feasibility study contemplated two (2) main areas of development, Area A and Area B   The following sections outline the facilities critical to the primary functions of the NTAM, including the Municipal Complex, the Hackensack-Meridian University Medical Center (HMUMC), and the Department of Public Works (DPW). The Microgrid will support the electric baseload of these critical facilities, allowing them to operate during Black-sky conditions. These facilities are considered critical because of their location in proximity to the nerve-center of town, their electric and thermal loads, primary use and potential uses, occupancy, size, and FEMA classifications. Overall, electric demand tends to peak in the summer for these facilities, due to high occupancy from seasonal tourism and weather-based cooling requirements. To prepare for NTAM implementation, each facility has undergone technical inspections to determine energy demand requirements and management opportunities, energy conservation measures, and equipment requirements for a dynamic network of distributed generation.

Our recommended approach includes a new pair of reciprocating engines with approximately 6.2 MW output to be installed at the HMUMC, to be operated and managed in baseload mode and to compliment the existing pair of reciprocating engines at the Medical Center. In addition, we are recommending Photovoltaics (PV) be added to all Township and County-owned facilities in Area A, with the except of the Neptune Board of Education (BOE), pending further technical information.

The needs of the potential sheltering candidates and evacuees can be complimented and NTAM Black Sky services can be supplemented with the inclusion additional facilities and infrastructure. To maintain focus on the intent of the study, we completed the evaluation and analyses for Area A and performed additional work investigated a secondary cluster of facilities identified as Area B, which can be included in the NTAM as an optional extension of Area A.

Area A Project Description

Area A	
Area (Sq. Ft.)	1,497,296
Annual Electric Consumption (kWh)	62,854,860
Annual Gas Consumption (Therms)	2,051,123

Area A's energy consumption characteristics are typical for facilities located in New Jersey and depend primarily on occupancy and the outside air temperature. While occupancy and dynamic heat loads are scheduled, repetitive and predictable, the weather is variable. Accordingly, Area A uses more electric in the warmer summer months to accommodate space cooling. It is expected that during these periods, the demand costs will be higher. Conversely as electric consumption reduces, natural gas consumption increases to provide heating during the colder months.

Area A - Energy Consumption and Cost			
Facility Name	**Annual Electric Consumption**	**Annual Thermal Consumption**	**Annual Energy Costs**
Neptune Municipal Building (inc. PD & Library)	1,229,064	46,177	$192,354
Neptune Department of Public Works	248,880	12,041	$44,153
Hackensack-Meridian University Medical Center	51,640,666	1,808,400	$7,578,883
Neptune High School and Aquatic Center	5,515,089	31,351	$700,761
Monmouth County Vocational School: Academy of Allied Health and Science	725,520	35,751	$106,635
Neptune Middle School	2,059,561	91,576	$343,604
Gables Elementary School	734,560	0	$85,919
Neptune Board of Education / Brookdale Community College	502,640	18,164	$80,400
Monmouth County Vocational School: Neptune Annex	198,880	7,663	$33,561
Total:	**62,854,860**	**2,051,123**	**$9,166,271**

During Black-sky events, shelter, life safety and human services will be provided in the Emergency Sheltering Facilities (ESFs). The extent of services, staffing and capacity will be prescribed in advance to maintain adequate resources and manage critical supply logistics throughout the Microgrid Area. The Township OEM leadership, Microgrid operator and relevant Stakeholder Representatives will continuously monitor the status of each ESF and provide reporting of operating status and availability of services in real time using a standard communication protocol. The reporting will be readily dispatchable to media outlets and emergency broadcast systems.

The available Black-sky shelter area has been estimated based on the practical and supportable resources and, contingency sheltering space for special needs (EMS, Police, Fire, Homeland Security, etc.) in the below table.

Emergency Sheltering Facilities					
Facility Description	**Address**	**Risk Category**	**Total Area (Sq. Ft.)**	**Shelter Area (Sq. Ft)**	**Potential Emergency Shelter Hours**
Neptune Municipal Building (incl. PD & Library)	25 Neptune Blvd, Neptune City, NJ 07753	IV	83,000		
Neptune Department of Public Works	2201 Heck Ave, Neptune City, NJ 07753	II	11,000	2,750	9 AM to 5 PM
Hackensack-Meridian University Medical Center	1945 NJ-33, Neptune City, NJ 07753	IV	815,955		
Neptune High School	55 Neptune Blvd, Neptune City, NJ 07753	III	303,371	151,686	24/7
Monmouth County Academy of Allied Health & Science	2325 Heck Ave, Neptune City, NJ 07753	III	44,299	22,150	24/7
Neptune Middle School	2300 Heck Ave, Neptune City, NJ 07753	III	167,190	83,595	24/7
Gables Elementary School	1 Gables Court, Neptune City, NJ 07753	III	53,332	26,666	24/7
Neptune BOE / Brookdale Community College	60 Neptune Blvd, Neptune City, NJ 07753	III	44,149	22,075	24/7
Monmouth County Vocational School - Annex	105 Neptune Blvd, Neptune City, NJ 07753	III	20,038	10,019	24/7

Critical Facility Project Description

Neptune Municipal Building (incl. PD & Library)	
Address	25 Neptune Boulevard, Neptune City, NJ 07753
Risk Category	IV
Area (Sq. Ft.)	83,000
Annual Electric Consumption (kWh)	1,229,064
Annual Gas Consumption (Therms)	46,177

Neptune Township was formed in 1879 and is named after the Roman God of the Sea. The Township has a land area of eight (8) square miles and is situated in the central easternmost part of Monmouth County. Neptune is a community with several diverse neighborhoods including Ocean Grove, Shark River Hills, Mid-Town, Bradley Park, the Gables, Seaview Island and West Neptune. This facility serves as a Municipal Complex to the Township and includes the Police Department and Library. The facility is critical for serving public safety, coordinating any disaster response, and maintaining public services.

The Municipal Building contains two (2) electric and two (2) gas meters which serve the whole complex.

The Municipal Building Complex was visited in our site tour on December 19th. Highlights included in our design and modeling assumptions include metering information and current facilities description. The team developed potential Energy Conservation Measures (ECMs) to be implemented on-site to reduce electric and gas consumption, these ECMs include:

- LED installation
- Install occupancy sensors for light switches in light/occasional traffic areas
- Increase participation in DR programs and equipment that could help utilize these programs
- Reduce losses of conditioned air at points of ingress and egress – fan blower or revolving door
- Envelope improvements – weather sealing, windows

Neptune Municipal Building (inc. PD & Library)			
Month	Electric Consumption (kWh)	Thermal Consumption (Therms)	Energy Costs
January	78,922	4,894	$12,323
February	85,122	4,476	$13,910
March	90,922	4,530	$14,084
April	78,122	3,207	$12,203
May	94,922	2,914	$14,226
June	118,522	2,340	$18,241
July	128,322	2,280	$18,917
August	138,322	2,858	$21,427
September	119,722	2,340	$16,708
October	127,322	3,217	$17,447
November	86,122	5,069	$15,226
December	82,722	8,052	$17,642
Total:	**1,229,064**	**46,177**	**$192,354**

Neptune Department of Public Works	
Address	2201 Heck Ave, Neptune City, NJ 07753
Risk Category	II
Area (Sq. Ft.)	11,000
Annual Electric Consumption (kWh)	248,880
Annual Gas Consumption (Therms)	12,041

Neptune Department of Public Works (DPW) serves the community in several critical ways, including waste management, infrastructure repair, and other public services. A functioning DPW is critical to supporting infrastructure and logistics and can mitigate the impacts of disasters and directly serve citizens in during Black Sky events.

The DPW's energy consumption characteristics are typical for a public facility of similar size and shape and depend primarily on occupancy and the outside air temperature. While occupancy and dynamic heat loads are scheduled, repetitive and predictable, the weather is variable. Accordingly, the DPW uses more electric in the warmer summer months to accommodate space cooling. Conversely as electric consumption reduces, natural gas consumption increases to provide heating during the colder months. The DPW has one (1) electric and one (1) gas meter which serves the whole facility.

The Neptune Department of Public Works was visited in our site tour on December 19th. Highlights included in our design and modeling assumptions include metering information and current facilities description. The team developed potential ECMs to be implemented on-site to reduce electric and gas consumption, these ECMs include:

- LED installation

- Replace Weil McLain Series 2 LGB-11 mid efficiency boiler with condensing boiler which higher efficiency, probably past expected life
- Envelope improvements – weather sealing, windows
- Repair/replace insulation on heating supply pipes to AHU's
- Decommission/remove natural circulation heating unit.
- Spray foam insulation/fire retardant on exposed roof decking and open frame truss network.
- Replace older window mounted A/C units

Neptune Department of Public Works			
Month	**Electric Consumption (kWh)**	**Thermal Consumption (Therms)**	**Energy Costs**
January	32,560	1,792	$5,842
February	29,200	1,907	$5,706
March	24,480	1,290	$4,557
April	23,760	1,008	$4,257
May	15,000	746	$2,856
June	16,840	540	$2,879
July	17,800	5	$2,450
August	17,720	5	$2,562
September	14,600	5	$1,918
October	13,640	552	$2,207
November	17,520	1,699	$3,657
December	25,760	2,491	$5,262
Total:	**248,880**	**12,041**	**$44,153**

Hackensack-Meridian University Medical Center	
Address	1945 NJ-33, Neptune City, NJ 07753
Risk Category	IV
Area (Sq. Ft.)	815,955
Annual Electric Consumption (kWh)	51,640,666
Annual Gas Consumption (Therms)	1,808,400

Hackensack-Meridian University Medical Center (HMUMC) is a key Stakeholder with unmatched crisis assistance resources within miles of the evacuation routes which pass through Neptune Township. Founded in 1904, HMUMC has grown from a fifty (50) bed Home for Women and Children to an approximately 1.5 million square foot multi-building facility, providing a long list of services, including cancer care, diagnostic imaging, interventional radiology, neuroscience institute, and rehabilitation services. HMUMC is broken up into seven (7) pavilions, which include the Brennan Pavilion, the Booker Pavilion, the Mehandru Pavilion, the Ackerman Pavilion, the Rosa Pavilion, the Rosa Diagnostic and Treatment Pavilion, and the Northwest Pavilion. In addition, the trauma center provides expertise and specialty capabilities unavailable at any other Medical Center in Monmouth or Ocean County. Designated by the State as a Level II Trauma Center in 1990, HMUMC treats more than 1,600 trauma patients per year.

A Level II Trauma Center means patients are cared for by a team of experts who specialize in traumatic injury. HMUMC is staffed 24-hours-a-day, seven days a week, 365 days a year. HMUMC provides vital elements not available at other medical centers, including: full time board-certified trauma surgeons, 24-hour CT scans, operating rooms staffed around-the-clock, a dedicated Surgical Intensive Care unit and a Pediatric Intensive Care Unit. The trauma admitting area is staffed by specialized nurses and technicians whose sole responsibility is to care for trauma patients. All elements ensure that trauma patients will receive the specialized care they need to increase the chance of survival from serious injury. NTAM will center on providing adequate support to the necessary services and infrastructure required to protect and maintain the essential needs of the facility, staff and suppliers of this medical center.

HMUMC was visited in our site tour on December 19th and July 24th. The following information was realized on-site, from both field observations and from HMUMC staff.

HMUMC has a Central Utilities Plant, which contains equipment for electricity distribution to the various Medical Center spaces, generators, and the major mechanical equipment. It is served by JCP&L's J-88 sub-transmission 34kV feeder, entering at Corlies Avenue and Davis Avenue, where it is transformed to 12kV for distribution to most facilities, with the exception of the Booker Child Care Center and the Medical Office Facility at 81 Davis Avenue, which is distributed at 480V. In addition to this feeder, the Central Utilities Plant has two (2) black-start capable 2000 kV oil emergency generators, as well as two (2) 1500 kV natural gas generators. The natural gas reciprocating engines have an approximately 3.6 MW output, with heat-recovery equipment to utilize the heat generated from running the engines, functioning as Combined Heat and Power (CHP) units. There are four other emergency diesel generators, located at the Brennan Pavilion, Ackerman Pavilion, Amdur Ambulatory Care Center, and Mehandru Pavilion.

Regarding thermal consumption, HMUMC utilizes their CHP units, as well as three (3) boilers, rated 20,000 pounds/hour. Steam is used for sterilization, humidification in the Hope Towers, and space heating in the winter, as some facilities have steam converters. The only direct steam load is for their ten (10) sterilizers, which include three (3) vacuum sterilizers, five (5) cart sterilizers, and two (2) standup sterilizers located throughout the campus. Approximately 120,000 square feet of the Medical Center utilizes steam converters, including the Rose Pavilion, Booker Pavilion, Ackerman Pavilion, and Amdur Ambulatory Care Center. Hot water is used for space heating during the winter in most facilities, as well as domestic hot water and the VAV reheat system year-round.

Regarding chilling, HMUMC has four vapor compression chillers and one absorption chiller, with a combined capacity of 5,900 tons. The Medical Center supplies chilled water year-round, to provide cooling to certain types of medical equipment (such as MRI machines) and to their interval server room, with a much larger load on hot summer days. The chilling baseload is approximately 1,200 tons, while the peak is around 5,000 tons of chilling, with one of the chillers functioning in reserve.

The Medical Center's energy consumption characteristics are typical for an acute-care Medical Center and trauma center of similar size and shape and depends primarily on the outside air temperature. Occupancy is high, repetitive and predictable, the weather is variable. Accordingly, the Medical Center uses more electric in the warmer summer months to accommodate space cooling. Conversely as electric consumption reduces, natural gas consumption increases to provide heating during the colder months. The consumption is balanced using the on-site CHP system. HMUMC includes one electric meter and several gas meters that serve the entirety of the Medical Center.

TB Tech developed potential ECMs to be implemented on-site to reduce electric and gas consumption, these ECMs include:

- Envelope improvements – weather sealing, windows
- Reduce losses of conditioned air at points of ingress and egress – fan blower or revolving door
- CHP improvements to increase heat usage; fix bottleneck so can run engines all the time; catalyst vulnerability to high temperature; add source of high temp hot water so absorber can be run even if one engine is down
- Increase cooling air supply to Caterpillar alternators and exhaust waste heat from SWGR area
- Insulate face-plate of shell and tube heat exchanger serving the Caterpillar engine-generators
- Install occupancy sensors for light switches in light/occasional traffic areas
- Retro Commissioning (Cx) thermal distribution for Medical Center, other than Hope Tower
- Increase participation in DR programs and equipment that could help utilize these programs

Hackensack-Meridian University Medical Center			
Month	Electric Consumption (kWh)	Thermal Consumption (Therms)	Energy Costs
January	4,218,576	207,576	$690,709
February	3,898,640	168,000	$609,818
March	4,163,540	199,392	$675,148
April	3,502,589	143,280	$538,714
May	4,125,004	96,720	$548,299
June	4,393,725	101,520	$582,223
July	5,278,803	131,688	$711,130
August	4,911,090	125,736	$665,447
September	4,606,495	131,760	$640,708
October	4,482,503	142,104	$640,076
November	3,914,333	162,720	$605,149
December	4,145,368	197,904	$671,462
Total:	**51,640,666**	**1,808,400**	**$7,578,883**

Neptune High School & Aquatic Center	
Address	55 Neptune Boulevard, Neptune City, NJ 07753
Risk Category	III
Area (Sq. Ft.)	303,371
Annual Electric Consumption (kWh)	5,515,089
Annual Gas Consumption (Therms)	31,351

The Neptune Township Schools are a comprehensive community public school district that serves students in pre-kindergarten through twelfth grade from Neptune Township, Monmouth County, New Jersey. The Neptune High School (NHS) encompasses the Neptune Aquatic Center, which holds a 32,000 square-foot, 335,000 gallon pool that is used for instructional, educational, recreational, and therapeutic activities. The community relies on the center, which itself relies on consistent energy for temperature control and comfort.

NHS's energy consumption characteristics are typical for a public facility of similar size and shape and depend primarily on occupancy and the outside air temperature. While occupancy and dynamic heat loads are scheduled, repetitive and predictable, the weather is variable. Accordingly, NHS uses more electric in the warmer summer months to accommodate space cooling. Conversely as electric consumption reduces, natural gas consumption increases to provide heating during the colder months. NHS contains two (2) electric and two (2) gas meters which serve the whole facility.

NHS and Aquatic Center was visited in our site tour on December 19th. Highlights included in our design and modeling assumptions include metering information and current facilities description. The team developed potential ECMs to be implemented on-site to reduce electric and gas consumption, these ECMs include:

- LEDs/ Install occupancy sensors for light switches in light/occasional traffic areas
- Improve thermal envelope for roof when installing PV panels; use a reflective cool roof
- Envelope improvements – weather sealing, windows
- Reduce losses of conditioned air at points of ingress and egress – fan blower or revolving door
- Increase participation in DR programs and equipment that could help utilize these programs

Neptune High School and Aquatic Center			
Month	**Electric Consumption (kWh)**	**Thermal Consumption (Therms)**	**Energy Costs**
January	434,353	4,895	$57,059
February	438,706	5,293	$56,093
March	465,637	3,240	$62,014
April	371,325	2,092	$49,007
May	447,208	1,205	$56,545
June	453,797	593	$53,089
July	527,732	272	$58,027
August	485,052	675	$51,422
September	504,292	870	$57,109
October	422,362	1,367	$47,838
November	463,941	4,272	$55,071
December	500,684	6,576	$97,486
Total:	**5,515,089**	**31,351**	**$700,761**

Monmouth County Academy of Allied Health and Science	
Address	2325 Heck Ave, Neptune City, NJ 07753
Risk Category	III
Area (Sq. Ft.)	44,299
Annual Electric Consumption (kWh)	725,520
Annual Gas Consumption (Therms)	35,751

The Academy of Allied Health and Science (AAHS) was established in 1996, as a small magnet public high school located in Neptune Township, in Monmouth County, New Jersey. The school is one of five career academies offered by the Monmouth County Vocational School District. This high school is based upon the expansion of medical knowledge for teenagers who want to pursue medical careers. It serves grades nine through twelve and maintains about 300 students.

The AAHS's energy consumption characteristics are typical for facilities of similar size and shape and depend primarily on occupancy and the outside air temperature. While occupancy and dynamic heat loads are scheduled, repetitive and predictable, the weather is variable. Accordingly, the AAHS use more electric in the warmer summer months to accommodate space cooling. Conversely as electric consumption reduces, natural gas consumption increases to provide heating during the colder months. The AAHS contains one (1) electric and one (1) gas meter which serve the whole facility.

The facility was not included in our site visit schedule due to its smaller size and the team's larger focus on the anchor site nearby of the HMUMC.

Monmouth County Vocational School: Academy of Allied Health and Science			
Month	Electric Consumption (kWh)	Thermal Consumption (Therms)	Energy Costs
January	40,160	5,055	$7,252
February	47,520	3,957	$9,587
March	45,600	3,081	$7,161
April	47,040	2,754	$8,131
May	60,000	2,374	$9,509
June	83,360	3,229	$11,717
July	117,840	105	$12,660
August	82,000	1,068	$9,746
September	37,920	2,260	$5,808
October	85,200	2,454	$10,599
November	35,760	3,546	$6,551
December	43,120	5,867	$7,913
Total:	**725,520**	**35,751**	**$106,635**

Neptune Middle School	
Address	2300 Heck Ave, Neptune City, NJ 07753
Risk Category	III
Area (Sq. Ft.)	167,190
Annual Electric Consumption (kWh)	2,059,561
Annual Gas Consumption (Therms)	91,576

Neptune Middle School (NMS) is located adjacent to Neptune High School and Gables Elementary School. NMS provides utility services to Gables Elementary School, so its thermal consumption is inclusive of both facilities.

NMS's energy consumption characteristics are typical for a public facility of similar size and shape and depend primarily on occupancy and the outside air temperature. While occupancy and dynamic heat loads are scheduled, repetitive and predictable, the weather is variable. Accordingly, NMS uses more electric in the warmer summer months to accommodate space cooling. Conversely as electric consumption reduces, natural gas consumption increases to provide heating during the colder months. The NMS/Gables Elementary contain one (1) electric and one (1) gas meter which serve both facilities.

NMS was visited in our site tour on December 19th. Highlights included in our design and modeling assumptions include metering information and current facilities description. The team developed potential ECMs to be implemented on-site to reduce electric and gas consumption, these ECMs include:

- Improve thermal envelope for roof when installing PV panels; use a reflective cool roof
- Decommission Hot Water Heater No.2.
- Consider Variable Frequency Drives (VFD's) for Hydronic Pump # 1 & 2
- Install occupancy sensors for light switches in light/occasional traffic areas
- Envelope improvements – weather sealing, windows
- Reduce losses of conditioned air at points of ingress and egress – fan blower or revolving door

- Increase participation in DR programs and equipment that could help utilize these programs

Neptune Middle School			
Month	**Electric Consumption (kWh)**	**Thermal Consumption (Therms)**	**Energy Costs**
January	142,152	15,271	$33,902
February	146,448	15,851	$33,454
March	152,668	8,858	$28,811
April	140,981	5,900	$24,597
May	188,107	3,280	$27,485
June	211,169	795	$26,153
July	213,580	471	$24,816
August	220,534	696	$24,700
September	217,272	1,630	$26,723
October	154,370	5,762	$22,629
November	145,446	12,411	$27,745
December	126,834	20,651	$42,590
Total:	**2,059,561**	**91,576**	**$343,604**

Gables Elementary School	
Address	1 Gables Court, Neptune City, NJ 07753
Risk Category	III
Area (Sq. Ft.)	53,332
Annual Electric Consumption (kWh)	734,560
Annual Gas Consumption (Therms)	0

Gables Elementary School (GES) teaches approximately 300 students from pre-kindergarten through fifth grade and is adjacent to and shares utility services with NMS.

GES's energy consumption characteristics are typical for a public facility of similar size and shape and depend primarily on occupancy and the outside air temperature. While occupancy and dynamic heat loads are scheduled, repetitive and predictable, the weather is variable. Accordingly, the GES uses more electric in the warmer summer months to accommodate space cooling. The NMS/Gables Elementary contain one (1) electric and one (1) gas meter which serve both facilities.

GES was not included in our site visit schedule due to the facilities smaller size, main mechanical equipment located at NMS, and the team's larger focus on NHS.

Gables Elementary School			
Month	Electric Consumption (kWh)	Thermal Consumption (Therms)	Energy Costs
January	44,800	0	$5,295
February	47,280	0	$5,418
March	42,880	0	$5,369
April	45,120	0	$5,631
May	67,840	0	$8,304
June	68,000	0	$7,779
July	82,160	0	$8,898
August	83,600	0	$8,653
September	69,360	0	$7,671
October	101,680	0	$11,114
November	42,880	0	$4,700
December	38,960	0	$7,087
Total:	**734,560**	**0**	**$85,919**

Neptune Board of Education / Brookdale Community College	
Address	60 Neptune Boulevard, Neptune City, NJ 07753
Risk Category	III
Area (Sq. Ft.)	44,149
Annual Electric Consumption (kWh)	502,640
Annual Gas Consumption (Therms)	18,164

The Neptune Board of Education (BoE) is responsible for the administrative, security, and financial well-being of the Township's school district. It also houses Brookdale Community College, which serves over 12,000 students across Monmouth County. In addition to protecting their security, a Microgrid would enable Brookdale Community College (BCC) to leverage its facilities for shelter and triage should that become necessary.

The Community College Facility's energy consumption characteristics are typical for a public facility of similar size and shape and depend primarily on occupancy and the outside air temperature. While occupancy and dynamic heat loads are scheduled, repetitive and predictable, the weather is variable. Accordingly, the Community College Facility uses more electric in the warmer summer months to accommodate space cooling. Conversely as electric consumption reduces, natural gas consumption increases to provide heating during the colder months. The Neptune BoE/BCC contain one (1) electric and one (1) gas meter, which serve both facilities.

Neptune BoE/BCC was visited in our site tour on December 19th. Highlights included in our design and modeling assumptions include metering information and current facilities description. The team developed potential ECMs to be implemented on-site to reduce electric and gas consumption, these ECMs include:

- Improve thermal envelope for roof when installing PV panels; use a reflective cool roof
- Envelope improvements – weather sealing, windows
- Install occupancy sensors for light switches in mechanical room
- Reduce losses of conditioned air at points of ingress and egress – fan blower or revolving door
- Increase participation in DR programs and equipment that could help utilize these programs

Neptune Board of Education / Brookdale Community College			
Month	**Electric Consumption (kWh)**	**Thermal Consumption (Therms)**	**Energy Costs**
January	35,200	3,041	$7,622
February	38,560	3,088	$7,776
March	34,880	1,739	$6,360
April	40,160	1,061	$6,381
May	47,840	483	$6,664
June	48,080	9	$5,847
July	49,280	11	$5,685
August	47,520	198	$5,428
September	48,960	212	$5,907
October	41,600	1,009	$5,634
November	37,440	2,554	$6,569
December	33,120	4,760	$10,526
Total:	**502,640**	**18,164**	**$80,400**

Monmouth County Vocational School: Neptune Annex	
Address	105 Neptune Boulevard, Neptune City, NJ 07753
Risk Category	III
Area (Sq. Ft.)	20,038
Annual Electric Consumption (kWh)	198,880
Annual Gas Consumption (Therms)	7,663

The Neptune Annex of Monmouth County Vocational School supports the Monmouth County Allied Health and Science Facility.

The Annex energy consumption characteristics are typical for facilities of similar size and shape and depend primarily on occupancy and the outside air temperature. While occupancy and dynamic heat loads are scheduled, repetitive and predictable, the weather is variable. Accordingly, the Vocational School and Annex use more electric in the warmer summer months to accommodate space cooling. Conversely as electric consumption reduces, natural gas consumption increases to provide heating during the colder months. The Annex includes nine (9) electric meters and one (1) natural gas meter that support the complex.

The site was not included in our site visit rotation due to the team's larger focus on the anchor site nearby of the HMUMC.

Monmouth County Vocational School: Neptune Annex			
Month	**Electric Consumption (kWh)**	**Thermal Consumption (Therms)**	**Energy Costs**
January	14,369	1,302	$2,685
February	15,914	1,437	$3,822
March	14,715	838	$2,613
April	15,589	143	$2,612
May	16,290	98	$2,872
June	19,536	3	$2,922
July	17,890	20	$2,571
August	18,251	3	$2,423
September	13,509	20	$2,062
October	20,334	392	$2,830
November	17,131	1,064	$2,876
December	15,352	2,341	$3,274
Total:	**198,880**	**7,663**	**$33,561**

Energy Procurement and Planning

The Hosting Contracting Unit (HCU) and/or Microgrid operator will employ a long-term collaborative procurement strategy to assist with the most economical methods for utilizing distributed and renewable energy to offset market cost premiums and risk exposure. The approach is based on managing the component costs of power and transmission associated with the stakeholder accounts and seeks to utilize a portfolio management approach to effectively aggregate the retail accounts and mange market supply resources.

The supply strategy will include a block/index approach, supplemented by physical DER and energy purchases and capacity management. The strategy will entail purchasing wholesale fixed-price blocks of power to control price risk, and marginal purchases on the hourly market with most load scheduled on the Day-Ahead market, receiving physical energy from internal sources within PJM (e.g., PV, and receiving RECs/SRECs from contracted sources, some of which may be resold).

Total energy price risk will include all component costs and will be managed by the Microgrid Operator and/or HCU and the Sustainable Energy Management consultant.

The energy supply strategy will provide the NTAM with a secure first-line reliable revenue stream and provide leverage of creditworthiness and contract flexibility to compress wholesale margins to the lowest possible level.

Area A - Energy Consumption and Cost			
Facility Name	**Annual Electric Consumption**	**Annual Thermal Consumption**	**Annual Energy Costs**
Neptune Municipal Building (inc. PD & Library)	1,229,064	46,177	$192,354
Neptune Department of Public Works	248,880	12,041	$44,153
Hackensack-Meridian University Medical Center	51,640,666	1,808,400	$7,578,883
Neptune High School and Aquatic Center	5,515,089	31,351	$700,761
Monmouth County Vocational School: Academy of Allied Health and Science	725,520	35,751	$106,635
Neptune Middle School	2,059,561	91,576	$343,604
Gables Elementary School	734,560	0	$85,919
Neptune Board of Education / Brookdale Community College	502,640	18,164	$80,400
Monmouth County Vocational School: Neptune Annex	198,880	7,663	$33,561
Total:	**62,854,860**	**2,051,123**	**$9,166,271**

The NTAM stakeholder group represents 19 electric and over 10 natural gas accounts. The total annual consumption for all stakeholder facilities is 62 GWh and 2,051,123 Therms. The total projected distributed generation within the NTAM is 53 GWh and over 1,550,000 Therms (equivalent). To maximize the potential energy revenue, the study contemplates the application of an Energy Revenue Optimization Model (EROM) that will include the following:

- All accounts for all stakeholders (wherever possible) will be enrolled into a single procurement portfolio

- Accounts will be aggregated by rate class and competitively supplied at the wholesale electric market trading level
- Load profile and consumption patterns will be meshed, where possible for source-to-sync transmission
- NTAM Registers for PJM Membership
- All interconnected facilities will include 15-minute interval meters
- First Energy (JCP&L) / NTAM consolidated billing for electric
- New Jersey Natural Gas / NTAM consolidated billing for natural gas
- 12-month Electric supply service begins June 2019
- 12-month Natural Gas supply service begins April 2019
- Generator Maintenance and Fueling contracts integrated into NTAM utility service
- Stakeholder energy supply procurement agreements

Evaluate purchasing RECs

The NTAM economic findings indicate a financial interdependence with Solar Renewable Energy Certificates (SRECs). The financial viability of the PV portion of the proposed distributed energy resource allocation depends on the revenue forecasted from the SREC sale proceeds. Because the NTAM is expected to operate with renewable generation and consumption on-site, purchasing Renewable Energy Certificates (RECs) is not recommended or and anticipated future obligation.

Right of Way Crossings Maps

To serve the thermal loads at each facility prescribed in Area A, it is envisioned that an underground supply/return network of pre-insulated, direct buried piping would connect the JSMC CUP (heating supply) to an energy transfer station (ETS) residing within each facility's respective mechanical room. The governing concept is that thermal energy (available as a bi-product of generating electricity in a gas-engine generator) would be pumped though this underground network wherein each facility's respective heating demand would be independently satisfied by drawing the proportionate amount of energy from the thermal loop's heating media ("hot water" aka - 50% propylene glycol-water based solution). The energy contained in the "hot water" would be transferred to the respective facility's heating system through a bank of dedicated heat exchangers (ETS) essentially displacing the quantity of energy that would otherwise be produced by the facility's on-site boiler system(s) firing natural gas.

Installation and operation of this underground thermal network would require that the systems owner engage the respective land owners, public utilities and any other authorities having jurisdiction within this domain to obtain express consent and/or easement of the subject properties.

A Thermal Distribution Network Diagram serving the prescribed facilities in area A is presented in Appendix A, which shows that under the current design, the only non-Area A parcel that needs to be crossed is essentially just Heck Avenue. An alternative Thermal Distribution Network Diagram can be seen in Appendix B.

To serve the electrical loads at each facility prescribed in Area A, a new underground duct bank will need to be installed to connect JCP&L's 57498 underground 12.47kV feeder, entering at Neptune Boulevard between Corlies and Washington, to HMUMC, as can be seen in Appendix A. This connection and subsequent segregation of JCP&L's circuit would require coordination and express consent from JCP&L in addition to the Public Works Department (for the effected roadways – Davis Ave and Washington Ave) and any other authorities having jurisdiction.

Listing of Potential Permits

Permitting consideration for various generation types and sources must be done early in the process. Many areas in New Jersey are "Non-Attainment" areas as classified by US EPA. This means that in those areas, New Jersey's Department of Environmental Protection (NJ DEP) maintains a tight threshold for air emissions and thus any generation type must be compliant with those thresholds. Today, there are many technologies and systems that are compliant with NJ DEP and NJ EPA rules for run time and emissions, but they must be specked as part of the process of identifying generation sources.

In addition, the utility and PJM play a special role in the connection of various generation sources to the overall grid. Having a contact person in the utility to work with is critical and should also happen early in the process. Each County has its own Utility point person and that individual can help you understand the steps necessary to make sure that all the various generation sources are connected and operational in a timely manner.

Lastly, each generation source comes with its own warranties and operational guidelines. It is important that the specifications that you want to see in those warranties are closely pointed out in any bid documents that get created.

Permit Outline by Generation

<u>Type: Cogeneration full time:</u>

NJ DEP Air Compliance Permit

Air Preconstruction permit	N.J.A.C. 7.27-8.2©1
Air Operating permits	N.J.A.C. 7:27--22.1
Air Permits Upgrade	7:27-18

Time Line: 120 Days Depending on Answers above

Note: This assumes permitting for full operation and run time of 8760

Cost $1,500

Requirement: Air Model

Water: If the systems will require an additional flow rate of 2000 gallons a day, the following definitions should be used to assist in identifying discharge activities: Industrial wastewater is any wastewater or discharge which is not sanitary or domestic in nature, including non-contact or contact cooling water, process wastewater, discharges from floor drains, air conditioner condensate, etc.

IP for general water withdraw	100 Days under 2k
	240 Days over 2k
Permit Cost	$1,500

<u>Permit Outline for Solar Generation:</u>

NJ BPU GATTS Register

Local Planning Board Approval and Fire Safety

PJM Interconnection and Utility Metering Approvals

Time Line: 90 to 120 Days

Cost: $1500

CAFRA Note: If area is in CAFRA zone for ground-based systems, then impervious cover calculations will be necessary

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Permit Outline for Storage

NJ BPU Approval

Utility: Interconnection

Local Inspection and Fire Safety

Cost: $3,500 Note: Assuming some interconnection studies to determine battery discharge impact

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Note: Although wind and fuel cells were not considered for the study, changes in public policy or incentives may make them economically feasible in the future. The permitting for them is as follows:

Permits Necessary for Wind:

NJ DEP Land Use, Habitat and T/E impact study

NJ BPU Registration and go forward potential WREC registration via GATTS

Interconnection for Utility and PJM

Local Approvals including planning, zoning and council.

One Year local anemometer readings

Time Line: 18 to 24 Months

Cost: $35,000

Permits for Fuel Cell

NJ BPU Registration

Local Approval and Fire Safety

Utility Interconnection

Time Line: 8 Months

Cost: $2,500

Description of the Ownership/Business Model

A detailed description of the ownership/business model for the overall Project **including all procurement issues between the various local government and State government partners.** This should include a detailed description of the statutory and regulatory provisions of proposed ownership models, EDC/GDC utility roles, as well as any billing systems for electricity and thermal energy.

Overview

State energy policy, incentive programs, current regulatory landscape, and local utility delivery tariff structures affect, in part, how and where behind-the-meter (BTM) distributed energy resources (DERs) are deployed across New Jersey. As DERs are the cornerstone assets of a Microgrid, the Microgrid business model is informed, in part, by factors that shape BTM DER business models. However, the fact that Microgrids touch multiple facilities, link unaffiliated customers, and likely cross public Rights of Way introduces many new challenges around procurement, satisfying regulatory requirements, and the role of the utility (EDC or GDC). These challenges and proposed solutions are discussed here in the context of the NTAM.

The growing demand for resilient community Microgrids has emerged in recent years, especially in the Mid-Atlantic and Northeast where communities have experienced significant destruction and disruption in the wake of natural disasters. The challenge for Microgrids is to present a technical solution that delivers resiliency in a cost-effective way that does not overburden the Microgrid customers while engaging the local distribution utilities in a cooperative and equitable way. These requirements, together with critical load profiles and the existing infrastructure topography, ultimately need to be configured to deliver an economically and financially viable Microgrid that will serve the resiliency needs of the community long term.

The objective of establishing the Town Center Microgrid is to ensure resiliency and uninterrupted service to Critical Loads during grid-outage or *black-sky* events, which may arise due to several reasons, ranging from failure of grid components to cyberattacks to natural disasters. However, the frequency and probability of major grid failure, while historically low, is expected become more frequent. Even infrequent grid failures have proven to be highly destructive and costly to impacted communities. In addition to providing resiliency during black-sky events, the Microgrid should also be able to operate cost effectively during Blue-sky conditions. Under normal operations or *Blue-sky* conditions, there will need to be revenue streams to ensure an appropriate rate of return on investment for the Microgrid owner or owners.

Traditionally, several business models have evolved under the current paradigm of interconnection standards, tariff structures, incentives and other supporting regulations. Three generic business structures assume specific roles for each major stakeholder - the local utility company, the Microgrid owner, and the customers. There are also a handful of existing or developing Microgrids throughout the world, which provide nuance to these roles, and overall Microgrid business model approaches. Broadly, the general business models that exist today are described in the table below:

Business Model	Description
Entirely Private	The Entirely Private model involves financing, owning and operating the Microgrid by a non-utility, third-party or municipal entity. The role of the utility is minimal. Existing and/or new generation and distribution assets are owned and operated by the non-utility entity. DERs in this model may be sited at various locations among the Microgrid with the owner determining the economic dispatch. Revenues are generated through energy services, demand reduction and/or Microgrid resilience premiums. Customers would purchase most or all their energy from the Microgrid.
Entirely Utility	The Entirely Utility model places control of all infrastructure and generation assets with the utility's ownership and control. The utility finances and owns the Microgrid and controls the dispatch of assets. The utility and customers enter into an agreement regarding fees for resiliency services. The customers continue their interaction with the utility as they would without the Microgrid, i.e. paying regular utility bills. However, they may pay a premium for Microgrid services over and above their existing rates. In general, complete utility-owned Microgrids are not feasible in deregulated States where there are restrictions on utilities owning generation assets.
Hybrid (Private & Utility)	The Hybrid model sits somewhere between the Entirely Private and Entirely Utility models. Generally, a non-utility entity would own the generating assets and control their dispatch during normal Blue-sky conditions. Typically, DERs would be sited BTM at one or more customer sites. Power would then be wheeled during Blue-sky and/or black-sky conditions to other Microgrid customers through Microgrid-owned distribution assets. Close coordination is required between the utility and Microgrid owner to sequence the islanding and paralleling modes of the Microgrid. Revenues to the Microgrid owner would come from energy sales to customers, services sold into wholesale energy markets, and services rendered to the local distribution utility, such as demand reduction. The Microgrid customers might pay for services through the utility billing mechanism or may receive bills from both the utility and the Microgrid owner. This model allows the utility to play a role in Microgrid distribution asset ownership and operations, even within deregulated States where utility ownership of generation may be prohibited.

Proposed Business Model for the NTAM

The proposed Town Center Microgrid for Neptune includes the following Area A sites.

Neptune Microgrid Development Plan	
Facility Description	**Address**
Hackensack-Meridian University Medical Center	1945 NJ-33, Neptune City, NJ 07753
Monmouth County Academy of Allied Health & Science	2325 Heck Ave, Neptune City, NJ 07753
Neptune Municipal Building (incl. PD & Library)	25 Neptune Blvd, Neptune City, NJ 07753
Neptune Department of Public Works	2201 Heck Ave, Neptune City, NJ 07753
Gables Elementary School	1 Gables Court, Neptune City, NJ 07753
Neptune Middle School	2300 Heck Ave, Neptune City, NJ 07753
Neptune BOE / Brookdale Community College	60 Neptune Blvd, Neptune City, NJ 07753
Monmouth County Vocational School - Annex	105 Neptune Blvd, Neptune City, NJ 07753
Neptune High School	55 Neptune Blvd, Neptune City, NJ 07753

Most of these properties are contiguous and have a total annual electric consumption of 62,854,860 kWh. The current all-in electric rate paid by these sites range from $0.10/kWh to $0.14/kWh.[1] Some sites have multiple meters that see varying all-in rates, primarily due to the loads being served. (In general, smaller loads tend to have higher all-in rates, in the range of $0.17/kWh to $0.20/kWh).

The proposed Microgrid includes installing additional generation assets.

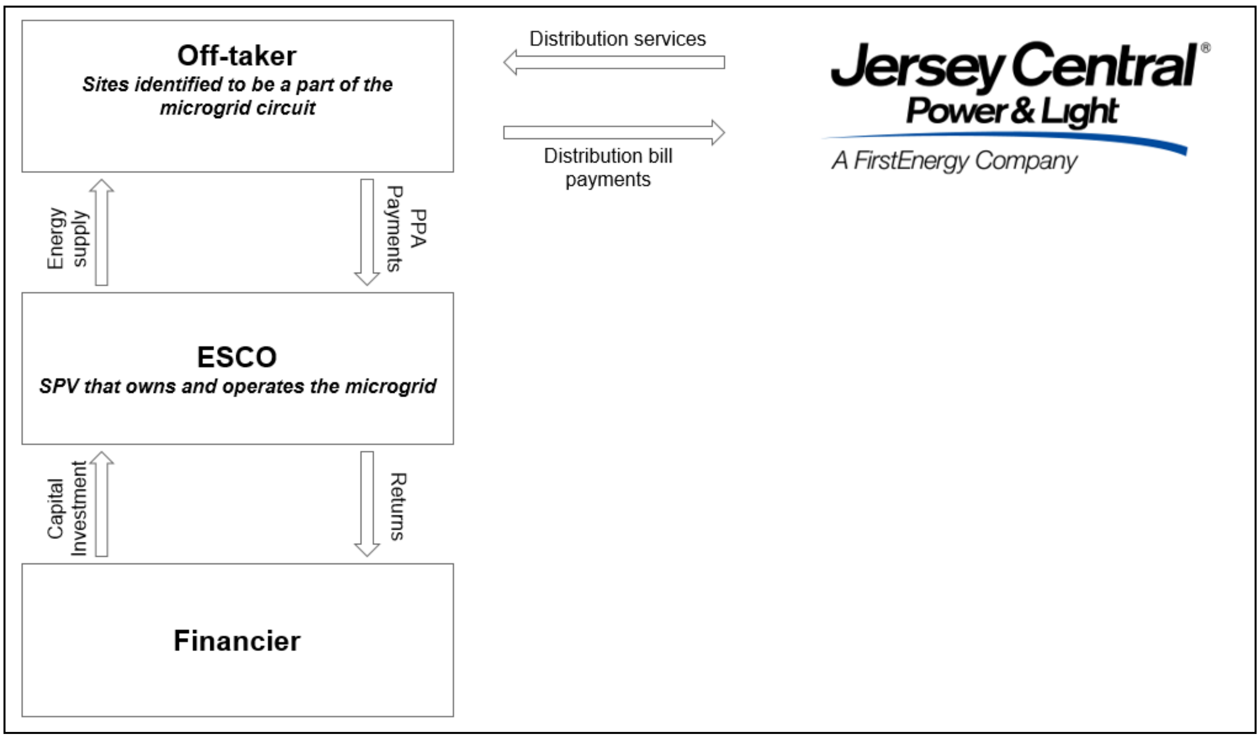
- 6.2 MW of additional CHP sited at the HMUMC
- 920 kW to 1.5 MW of Roof-mounted PV system

Under ideal conditions, the Microgrid must be able to provide Blue-sky operations at an all-in cost that is on par with current cost. Furthermore, the identified sites must be insulated from taking up any infrastructure costs and on-going maintenance expenses. Since New Jersey is a de-regulated market, utility ownership of dispatchable generation assets is not possible. Therefore, we believe that the most cost-effective business model will be a Hybrid model. Under this structure, we envision a non-utility third-party developer-owner would be responsible for designing, building, owning, operating, and maintaining (DBOOM) the Microgrid generation assets. It is unclear whether the DBOOM entity would also own additional distribution assets that would be required, or whether those assets would ultimately be owned by JCP&L. All electricity (and thermal energy in the case of the CHP system) would be sold to Microgrid customers at the owner's Levelized Cost of Electricity (LCOE[2]).

[1] Average all-in electric prices taken from recent 12-months of delivery and supply bills.
[2] The $/kWh rate that allows the Microgrid owner to earn their required rate of return

The utility would continue to own the distribution assets connecting the Microgrid and would continue to bill customers for distribution services. It may be that Microgrid customer will be billed under a new Microgrid tariff to ensure the equitable balance of costs and services.

To keep the LCOE (and thus, the all-in electric rates charged to customers) as low as possible, it is imperative to suppress soft costs, maximize incentives, and ensure that all revenues streams are being monetized. This can be achieved by structuring the Microgrid owner and Offtaker relationship depicted in the diagram below:



The DBOOM entity would enter into Energy Service Agreement (ESA) contracts with each of the identified sites. These contracts would be structured in the following way:

- The host site would first take energy from the coincident production of the Microgrid.
- Any excess that is fed back into the grid will be sold to other Microgrid customers sites, proportionate to their overall energy consumption.

Since the Microgrid assets will utilize existing utility distribution infrastructure, the host site will continue to pay JCP&L via a delivery bill. They would amend their existing bi-lateral supply agreements to account for the fact that a portion of their supply would now come from the Microgrid. Each Microgrid generating asset will be paired with a dedicated meter that will measure the output.

An alternative arrangement could see the Microgrid and distribution infrastructure being completely privatized. This is possible primarily due to the identified being contiguous and not passing through multiple utility ROW (Right of Ways). The Microgrid owner could purchase the existing distribution infrastructure within the proposed boundaries at the full depreciated book value and proceed to operate as a municipality. However, purchasing the distribution infrastructure will add costs that are only likely to inflate the LCOE. This will necessitate higher grant funding or incentive payments to ensure that the price is within acceptable limits for all Offtakers.

Description of the Technology, Business and Operational Protocol

A detailed description of the technology, business and operational protocol to be developed and/or utilized and the location within the TC DER Microgrid. This should include the following:

Description of Technology and Sizing

The NTAM is designed to provide power and thermal energy to a tight cluster of critical facilities in Neptune Township, which include the Neptune Township Municipal Facility (including the Police Station) and the Neptune Township DPW, HMUMC, Monmouth County Vocational Schools, and four Board of Education facilities. There were three major criteria used to aid in designing and sizing the NTAM generation resources, in no order of importance. One was meeting the black-sky non-HMUMC loads, which included the Neptune Township Municipal Facility (including the Police Department), the Neptune Township DPW, the Monmouth County Vocational School Allied Academy of Health and Science and Neptune Annex, and the four BOE facilities. The Critical Loads for the non-HMUMC loads were estimated to be 2.5 MW, while the summer peak loads were estimated to be 3.5 MW. The second criterion was to meet the black-sky HMUMC loads. The HMUMC's "Essential Load," which is somewhere between its full peak load and its required emergency load, is approximately 7.5 MW, including the New Hope Tower, while its summer peak load is 9.4 MW. Finally, the last criterion was for the technology to serve Blue-sky loads with positive economic returns to provide a reasonable rate of return on investment for the Project.

To meet the three above criteria, a CHP installation centered on a new pair of reciprocating engines with approximately 6.2 MW output is recommended, along with photovoltaics, a hot-water distribution loop, and appropriate Microgrid sectionalization and controls. This CHP system would be designed to run in baseload mode and equipment selection should emphasize reliability, maintainability, and availability. The existing CHP generation at the medical center should be retained and be run in peaking mode. The existing emergency generators at HMUMC and for the non-HMUMC facilities should be retained and can be used to help increase the total generation capacity of the Microgrid and/or provide a tertiary level of back-up, particular for generators that can be supplied from the natural gas pipeline, and therefore do not require extensive fuel storage or re-supply during an emergency. In addition to the new CHP engines, new PV systems should be added to every suitable roof of the Township- and County-owned facilities, with the potential to add Roof-mounted PV systems and parking lot canopies to HMUMC. At least 920 kW to 1.5 MW of PV system could be added to Area A, as can be seen in the below table. Proposed PV system layouts can be seen in Appendix C. Note: Although the Proposed PV system layouts are included, they are potential layouts, and none were proposed to or approved by the property owners at this time.

Neptune Township: Area A - PV System Sizing			
Location	Address	Estimated kW	Likely Installation
Hackensack-Meridian University Medical Center	1945 NJ-33, Neptune City, NJ 07753	493	0
Monmouth County Academy of Allied Health & Science	2325 Heck Ave, Neptune City, NJ 07753	186	149
Neptune Municipal Building (incl. PD & Library)	25 Neptune Blvd, Neptune City, NJ 07753	63	50
Neptune Department of Public Works	2201 Heck Ave, Neptune City, NJ 07753	45	36
Gables Elementary School	1 Gables Court, Neptune City, NJ 07753	167	134
Neptune Middle School	2300 Heck Ave, Neptune City, NJ 07753	324	259
Brookdale Community College	60 Neptune Blvd, Neptune City, NJ 07753	17	0
Monmouth County Vocational School	105 Neptune Blvd, Neptune City, NJ 07753	87	70
Neptune High School	55 Neptune Blvd, Neptune City, NJ 07753	485	388
Neptune Aquatic Center	55 Neptune Blvd, Neptune City, NJ 07753	121	96
	Total PV Estimated Capacity (kWDC):	**1,986**	**1,181**
	Total PV Output (kW AC):	**1,629**	**969**

Baseload Microgrid generation resources, which include both dispatchable and continuous assets, should be able to meet non-HMUMC Critical Loads and HMUMC's Essential Loads during an extended outage. Total Microgrid generation resources, which include the baseload generation, as well as the PV system, batteries, existing Area A natural gas back-up generators, and HMUMC diesel generators, should be able to meet even the peak summer loads for the non-HMUMC facilities and peak HMUMC loads. In addition, the sizing, selection, and configuration of the new equipment is intended to optimize the Blue-sky economics to minimize the capital expenditure needed to achieve the required Black-sky capacity. This first-cut design exercise was based on guidelines reflecting the NTAM design team's extensive experience, described in the sections below.

Proposed Connections of Critical Facilities and the DER Technologies

The dispatchable and continuous generation assets at the HMUMC will be electrically connected from the HMUMC's 12kV mini-substation to the underground portion of feeder 57498, which feeds the non-HMUMC facilities, as can be seen in Appendix A. Thermally, a hot water loop will be created from HMUMC to supply the non-HMUMC facilities, which could potentially be done by shallow trenching across the athletic fields, as seen in Appendix A, or by installing pipes through the High School, as seen in Appendix B. The below information summarizes the proposed connections and modifications to be made to each facility in Area A.

Municipal Facility (Township Administration Facility and Library)

Proposed Connection

Electric Distribution	Up-stream connection from CHP/Central Utilities Plant. EV charging stations. Roof-mounted PV System.
Heating Plant	Heating plant hot water supply piping and appurtenances, from CHP/Central Utilities Plant.
Emergency Power System	

Neptune Township DPW

Proposed Connection	
Electric Distribution	Up-stream connection from CHP/Central Utilities Plant. EV charging stations. Roof-mounted PV Systems.

Hackensack-Meridian University Medical Center

Proposed Connections:	
Medical Center Central Utilities Plant - Heating Plant	CHP heat recovery and utilization piping and equipment
Medical Center Central Utilities Plant - Cooling Plant	CHP absorption chiller and cooling water optimization and cooling thermal storage
Electrical Distribution	PV Systems w/Electric Storage
Electric Distribution	EV Charging Stations

High School and Aquatic Center

Proposed Connections:	
Electric Distribution	Up-stream connection from CHP/Central Utilities Plant EV charging stations.
Emergency Power System	
Heating Plant	Heating plant hot water supply piping and appurtenances, from CHP/Central Utilities Plant.

MCVS AAHS

Proposed Connection	
Electric Distribution	Up-stream connection from CHP/Central Utilities Plant. EV charging stations. Roof-mounted PV System.
Heating Plant	Heating plant hot water supply piping and appurtenances, from CHP/Central Utilities Plant.

Middle School

Proposed Connections:	
Electric Distribution	Up-stream connection from CHP/Central Utilities Plant. Roof-mounted PV System.

Emergency Power System	Retain and retrofit 200 kW existing natural-gas fueled generator. The switchgear will be enhanced with synchronizing gear to deliver generation to the Microgrid.
Heating Plant	Heating plant hot water supply piping and appurtenances, from CHP/Central Utilities Plant.

Gables Elementary School

Proposed Connections:	
Electric Distribution	Up-stream connection from CHP/Central Utilities Plant. Roof-mounted PV System.
	Emergency Power System
	Retain and retrofit 100 kW existing natural-gas fueled generator. The switchgear for the engine may be enhanced with synchronizing gear to deliver generation to the Microgrid.
Heating Plant	Heating plant hot water supply piping and appurtenances. from CHP/Central Utilities Plant.

Board of Education Offices

Proposed Connection:	
Electric Distribution	Up-stream connection from CHP/Central Utilities Plant.
	Emergency Power System
	Retain and retrofit 150 kW existing natural-gas fueled generator. The switchgear for the engine may be enhanced with synchronizing gear to deliver generation to the Microgrid.
Heating Plant	Heating plant hot water supply piping and appurtenances. from CHP/Central Utilities Plant.

MCVS Annex

Proposed Connection	
Electric Distribution	Up-steam connection from CHP/Central Utilities Plant. EV charging stations. Roof-mounted PV System.
Heating Plant	Heating plant hot water supply piping and appurtenances. from CHP/Central Utilities Plant.

One-Line Diagram of Area A

Please see Appendix D.

Detailed Description of JCP&L's Existing Distribution System

Hackensack-Meridian University Medical Center
Existing:
Served by JCP&L's J-88 networked sub-transmission 34kV feeder, entering at Corlies and Davis. Existing generators at HMUMC output their power at 1500V and 2000V, transformed to 480V for house loads and transformed to 12kV for distribution to the rest of the Medical Center.

Non-HMUMC Facilities
Existing:
Served by JCP&L's 57498 radial underground 12.47kV feeder, entering at Neptune Boulevard between Corlies and Washington, originating at the Neptune Substation, fed by JCP&L's D130 sub-transmission 34kV feeder.

Feeder 57498 extends north on Neptune Boulevard, serving the Walgreen's, Town Hall, the police headquarters, library, high school, aquatic center, post office, Brookdale community college and board of education headquarters, with a normally-open switch connecting to JCP&L's 57448-C aboveground 12.47kV feeder at the northeast corner of Heck and Neptune Boulevard.

Feeder 57498 continues west on Heck, serving the Middle Schools, Gables elementary school, the DPW, and the lighting for the athletic fields, along with the MCVS AAHS and Neptune Annex.

Medical offices on the south side of Corlies, some affiliated with the Medical Center, are served by an above-ground portion of the same Feeder 57498, via a branch going west on 6th Ave on its way north on Neptune Boulevard from the Neptune Substation, connecting to those loads from the south side of each property.

Proposed Modifications
Serve Township loads from the Medical Center's existing 12kV mini-substation.
Medical Center's existing 12kV mini-substation is already fed by the J-88 feeder and the existing synched generators at the Central Utilities Plant, both CHP and diesel.
Continue to receive the same service from JCP&L at the Medical Center, now synching the output of new CHP generation as well, including the addition of the new switchgear shown in the 1-line drawings.

Install new feeder connecting the Medical Center's mini-substation to the underground portion of feeder 57498.

Upgrade the existing switch immediately on the south side of Corlies (JC146NPT), with normally-open operation to sectionalize the underground portion of the feeder serving the non-HMUMC loads.

Place isolation transformer as required to eliminate about voltage, recirculation current, and fault current.

Isolation switches will be installed between the Medical Center mini-substation, the new feeder, and the existing JCP&L feeder – which will serve as certain demarcation points for ownership.

Preserve the option to subsequently add private remote medical office loads to Area A, while adding redundant automation and load shedding switches for the Alberta Ave and Lakeview Ave extensions of Feeder 57498, north of 6th Ave.

Mutually agreeable ownership and operating agreements will be developed and executed with JCP&L, the Medical Center, the Township, and potentially a third-party Microgrid operator (see below).

As a back-up for the existing J-88 feed to the Medical Center, the connection to Feeder 57498 will be designed to provide power from Neptune Substation to the Medical Center, in the event of a J-88 failure.

Relays, protection settings etc should be configured to permit two-way power flows.
Cabling should be selected to tolerate the necessary power flows.

The combination of existing and new on-site generation at the Medical Center (plus any new PV system at the schools) would serve all of the Medical Center, town, and school loads under Blue-sky conditions, supplemented by peak power from J-88.

Detailed Description of Area A MG Operations

Black-sky:
JCP&L grid is entirely down. The generation assets at the Medical Center switch into island mode. Automated and manual load-shedding procedures bring sources and loads into balance, if needed. If the initial transition into island mode fails, and the generators trip off, then the Medical Center uses its existing emergency black-start procedures, which are regularly exercised in accordance with the requirements for Joint Commission certification.

As during Blue-sky operations, the underground 12kV feeder 57498 is served only by the new feeder connecting it to the Medical Center mini-substation, but now the non-HMUMC loads must be met entirely by on-site generation (including PV system) until the JCP&L grid is safely restored. The Microgrid control system will manage load stepping and shedding with redundant automation to ensure continuous power for Critical Loads.

Blue-sky contingency A:
On-site generation is down. The underground 12kV feeder 57498 is served only by power from J-88, through the Medical Center substation. The J-88 supply should have enough ampacity (e.g. 3 MW new load at 34kV adds ~80 amps, presumably less than 25% of the wires' capacity). JCP&L shall have enough transmission supply to meet all loads, since there are no *net* new loads, since all non-HMUMC loads are currently supplied by the Neptune Substation, which in turn is powered by Feeder D-130. Reconfiguration between the J-88 and D-130 feeders may conceivably be required.

Blue-sky contingency B:
J-88 is down. This situation is of great concern to the Medical Center today, since the facility would be entirely dependent on its existing emergency power systems. With the Microgrid, the normally-open

switch at Corlies and Neptune Boulevard can be closed to re-connect the 12kV feeder to the Neptune Substation, providing alternative supply for the Medical Center.

Load-stepping, load-shedding and sectionalizing gear on Feeder 57498 will prioritize Medical Center loads.

For an always-on power-sharing configuration:
As a potential enhancement, a transmission-style interconnection could tie J-88 to 57498 while keeping both independent in terms of voltage, frequency and phase, with redundant automation and a modular and expandable battery-plus-inverter system in between to manage power flows.

If large PV system deployments are confirmed possible on the flat industrial roofs of many of the facilities in Area B, then additional battery storage capacity would be added accordingly.

Configure the battery storage systems with two outputs, one dedicated to the circuit supplied by J-88, one dedicated to the circuit supplied by 57498, with the switch connecting the underground portion of 57498 to the Neptune Substation now able to be normally closed.

The battery will enable back-feed from Feeder 57498 to the Medical Center in the event of a loss of J-88. Load-shedding on that feeder (and potentially at the Neptune Substation) would probably take longer than the 10-second start-up for the Medical Center's emergency power system generators, so this approach may only constitute a tertiary back-up.

During Blue-sky operations, the storage will be optimized and managed by forward-looking wholesale market input and automation.

Elements of the Tariff Structure

Introduction

The purpose of this section of the NTAM Feasibility Study Report is to provide a detailed description of the governing tariff requirements and issues, tariff controls on distributed generation interconnection requirements, and the potential impacts on tariffs by planned scenarios for smart grid distribution automation improvements. This section also includes discussion of proposed changes to the various tariffs that would address factors that have inhibited the implementation of advanced Microgrids and potentially improve Project financial performance. These changes generally include removing barriers to interconnection and establishing standard terms for the value of services exchanged between the Microgrid operator and the utility.

The development of an advanced (multi-user) Microgrid challenges the existing tariff structure in multiple ways that were not anticipated in the historic development of the centralized transmission grid, nor in the subsequent decades of deregulation of the energy industry. To address these varied and overlapping issues and identify current applicable tariff requirements in a systematic way, a techno/economic model of the NTAM is provided in Appendix E to identify the six (6) principal metered energy flows that comprise the proposed system. Each of these six energy flows are then described in detail. These six energy flows include: 1) the local utility (JCP&L) distribution grid, including feeders and distribution equipment installed onto the feeders; 2) the localized Microgrid generation meshed network modelled as an AC bus; 3) a captured portion of the JCP&L distribution grid repurposed for use of Microgrid power distribution between host facilities and with the larger grid; 4) natural gas distribution; 5) the Microgrid thermal energy loop; and 6) a virtual Microgrid residing outside of the Microgrid boundaries, but connected to Microgrid generation resources.

Regulatory Framework

In the United States, jurisdiction over energy industry operating standards and commodity prices are generally divided between the federal government and the States. The Federal Energy Regulatory Commission (FERC) of the U.S. Department of Energy (DOE) regulates the interstate transmission of electricity, natural gas, and oil, while the States govern intra-State retail markets. In the 13-State area that includes all of New Jersey, FERC delegates administrative authority over the power transmission grid on a regional basis to the PJM Interconnection (PJM) Regional Transmission Organization subject to the Open Access Transmission Tariff (OATT). FERC sets natural gas and oil wholesale transportation rates directly through approved tariffs for interstate pipeline services.

In New Jersey, the Board of Public Utilities (BPU) authorizes Electric Distribution Companies (EDC) and Gas Distribution Companies (GDC) to act as public utilities offering basic delivery and retail services. Neptune Township and NTAM are within the service regions of Jersey Central Power & Light (JCP&L) and New Jersey Natural Gas (NJNG). Due to New Jersey's energy industry deregulation, supply and distribution charges provided for in the governing tariffs are separate to open competition for supply from Third Party Suppliers (TPS) who are licensed and regulated by BPU. The EDC and GDC continue to deliver energy as a monopoly through their wires and pipes and maintain ownership and responsibility for the maintenance and repair of the delivery infrastructure.

It should be noted that several of the energy flows in the Microgrid are non-tariff, in that they are flows between generating resources and co-located loads on the same premises or inside the Microgrid boundary, which for purposes of this discussion are assumed to operate free of the EDC franchise on the distribution of electric power. These energy flows within the NTAM, where properties are contiguous or otherwise separated by an easement, public thoroughfare, transportation or utility-owned Right of Way are considered non-tariff due to provisions of N.J.S.A. 48:3-51 et seq., ("Electric Discount and Energy Competition Act") that allows on-site generation facilities to make sales of electricity without being considered a public utility.

Tariff Structure

Tariffs are complex. They do double duty of setting industry prices and terms & conditions for service and are necessarily detailed and multi-layered. Retail electricity tariffs generally offer single or "flat" rates (non-time-dependent), time-of-use rates (dependent on time of day to capture peak demand), and rates for controlled loads. Tariffs typically identify various service categories dependent on the customer type (i.e., residential, commercial, industrial, institutional, etc.) and selected rate type. Tariffs also provide for rate riders for additional (sometimes temporary) charges or refunds separate from the basic monthly rates. These can include rate riders for generation services such as energy, transmission and capacity charges which are a pass-through from the wholesale provider of electric power; societal benefits charges; and (of course) sales and use taxes. The final monthly bill will therefore be an aggregate of the many applicable charges, fees and possible refunds broken down into the basic separable categories of: generation, transmission, distribution, and retail services. The single bill is delivered by the local utility, who serves as an agent for others, such as PJM and third-party suppliers, who receive portions of the customer payment for their particular contribution to the metered energy flow.

Natural gas tariffs typically only provide a single non-time varying rate type but will offer price discrimination based on the quantity of gas delivered within a certain time block (i.e. daily, monthly or quarterly delivery). Natural gas prices also vary with the season with increases expected in winter months due to increased demand for space heating. Basic natural gas rates, like electricity rates, include separable charges for customer use (per meter), demand, and delivery charges. Service categories include use for commercial natural gas customers using distributed generation technologies such as microturbines and fuel cells, and also for large consumers of natural gas (greater than 10,000 therms daily) for the sole purpose of generating electricity.

Distributed Generation Interconnection Requirements

One tariff jurisdictional issue of particular importance to Microgrid Projects is the threshold question for a small generator Project of whether the Project falls under the PJM or the JCP&L interconnection process. JCP&L (governed by BPU) manages retail applications. PJM Interconnection (governed by FERC) is responsible for managing all wholesale interconnections to member EDC systems.[3]

Three basic factors determine the jurisdiction of the small generator Project: 1) the type of facility to which the Project proposes to interconnect; 2) whether the output of the generator would only serve local load, and 3) whether all or some of the output of the generator may be available for wholesale sales under the OATT (the FERC-approved tariff). As the NTAM Project anticipates connection only to the JCP&L retail distribution network (a non-FERC network) and the NTAM generation will not be selling into the wholesale market under a FERC tariff (but will only be consuming the power locally), no PJM interaction is anticipated. However, as potential export markets, including to the PJM wholesale markets for energy, capacity and ancillary services are attractive sources of future income for the Project, this potential pathway is included in the detailed tariff structure analysis.

Retail interconnection to the JCP&L system is defined in the operating tariff and requires a detailed application process to avoid violations of the tariff's *Single Source of Energy Supply* requirements. Interconnection fees and costs for distributed generation, standby service and demand charges are also applicable. The interconnection process consists of 3 levels based on the type and capacity of the generator. Levels 1 & 2 applies to inverter-based facilities limited to 2 MW and apply principally in the case of the NTAM to solar photovoltaic systems installed at the host facilities. Level 3 applies to facilities which do not qualify for either the Level 1 or Level 2 and applies to the larger fuel-fired existing and planned generation at the NTAM facilities. Distributed generation systems that want to sell or provide their excess energy and capacity to the PJM wholesale market must be interconnected per PJM requirements through a separate application process. The PJM interconnection requirements are

[3] Interconnections are restricted to "Qualifying Facilities" as defined in the Public Utility Regulatory Policies Act of 1978 (PURPA). These include renewable generation facilities and small (i.e. less than 80 MW) cogeneration (such as Combined Heat & Power) but does not include battery storage.

provided in Manual 14A (Generation and Interconnection Process) and follow the small generator interconnection procedures included in the OATT.

Customers that wish to sell power to JCP&L are restricted by the terms and conditions of Rider QFS of the JCP&L tariff for Cogeneration and Small Power Production Service. For generators larger than 1 MW, specific contract arrangements must be negotiated as part of the interconnection process to determine the price of delivered energy and capacity, which are controlled by the utility's ability to receive compensation for resale of the energy and capacity at PJM wholesale market prices. All such contracts are subject to BPU approval and JCP&L may require significant restrictions on delivery of energy based on local circuit conditions and may refuse to allow such an interconnection should it not be technically feasible for feed-in to the meshed network. For example, energy capacity is typically limited to 15% of the connecting circuit's peak load to prevent overloading at the distributed resource on the connected feeder. The NTAM Area A generators connected to the 12-kV underground JCP&L feeder would therefore be limited to 3 MW of production.

The interconnection of more than one type of distributed generation technology at the same site would also be complicated by net metering requirements. Net metering is a type of feed-in tariff that can generate offsets against JCP&L charges for owners of Class 1 renewable behind-the-meter generation assets in the Microgrid. In the case of the NTAM, net metering will apply to Level 1 & 2 interconnections (inverter-based facilities limited to 2 MW), which, as indicated, will be principally solar photovoltaic systems installed at the host facilities. Therefore, if CHP (not a Class 1 renewable) and the PV system are combined, a conflict may arise as net metered electricity from the Class 1 assets must be recorded and reported separately from other components of the Microgrid system.

Another potential complication for the interconnection of assets is the feed-in to a meshed network, rather than a radial system. The Town Center DER Microgrids are typically located in downtown areas served by a secondary network system of the distribution grid. There are many of these types of systems across New Jersey. These systems typically employ network protectors to prevent reverse flow onto the primary feeders. Behind-the-meter distributed generation on the secondary network may be prevented from exporting power to the grid, particularly if they are on a dedicated spot network or on a smaller secondary network. The potential for provision of generation and load reduction services that the Microgrid can provide to support a substation during contingencies, given an improved and more robust interconnection system, are discussed further in Part 3.

Smart Grid Distribution Automation

In response to demand to improve reliability and efficiency of the power system, smart grid communication and control enhancements, paired with increased automation is being implemented on distribution systems. Microgrids through their use of interconnected distributed energy resources, and automated interfaces with end-users can provide opportunities for the development of new automation scenarios that build off primary distribution smart grid and automation functions implemented by the EDC at the substation and feeder distribution equipment. These functions currently include monitoring and control of distributed equipment to perform system protection actions when necessary, such as in the case of undetected faults or unplanned islanding of the Microgrid. Improved automation and smart grid enhancements by the local utility could provide enhanced demand response and load management to the

Microgrid, and assist in contingency planning and analysis, monitoring of non-operational data (e.g. reference and historical data for making short and mid-term load predictions) and market operations of the distributed equipment, and assisting with predicative maintenance.

Smart grid distribution automation functions can provide both benefits and costs. The potential benefits include: 1) financial benefits such as lower costs (to customers), avoided costs (to utilities), and price stability; 2) power reliability and quality improvements; 3) increased visibility for utilities and field personnel into unsafe situations providing increased safety performance; 4) energy efficiency improvements, reduced energy usage and reduced peak demand; and 5) environmental and conservation benefits. Benefits that directly reduce costs for utilities, should result in lower tariffs or avoiding increased tariffs, although the connection may not be direct. Societal benefits are often harder to quantify but can be equally critical in assessing the overall benefits of a particular function.

As discussed in Part 3, developing improved market-based valuation schemes to capture and quantify these benefits may lead to a viable rate-basing scenario for utility investments in improvements to distribution infrastructure, including new smart-grid automation, that will be needed for the Microgrid to achieve full functionality.

The NTAM Tariff Structure

Appendix E identifies six (6) principal metered energy flows that comprise the proposed system. Each is described in detail within this section.

Distribution Grid (JCP&L/PJM)

This system includes local feeders servicing the Microgrid and distribution equipment installed onto the feeders. These feeders are not dedicated solely to the Microgrid and are energized through one or more local substations. Metered flows include the following:

1) Retail Distribution: Retail sale of electricity by JCP&L to the Microgrid through an aggregated Point of Common Connection (PCC). One or more meters is anticipated with aggregated monthly billing paid by either by the Special Purpose Entity (SPE) that will own and operate the Microgrid assets, or by the host Microgrid facilities directly responsible for their own consumption of grid-supplied power.
2) Retail Interconnection: Levels 1, 2 or 3 Interconnection to the JCP&L distribution grid for resale by the utility at rates pegged to PJM wholesale rates. Also includes any net metering from Class 1 renewables at the Microgrid (principally PV system). As indicated, many technical factors currently inhibit the full functioning of this interconnection to reach its maximum economic value.
3) Wholesale Interconnection: Small generator interconnection[4] allowing access to the PJM wholesale market. In this interconnection, JCP&L wheels the energy through its system to PJM. The owner of the Microgrid assets deals with PJM directly for sales of services on the wholesale markets.

[4] As per FERC/PJM standards, small generator includes less than 80 MW capacity.

Microgrid Generation Bus (Non-Tariff)

This energy flow resides on a localized Microgrid generation meshed network modelled as an AC bus. Metered flows for use inside the Microgrid, which are not subject to any tariff (see Part 1), include solar photovoltaics, battery storage, conventional (fuel-fired) generation, and service to co-located loads. As per the Ownership & Business Model of the Feasibility Study Report, a host site would first take energy from the coincident production of the Microgrid. In other words, each facility will use resources on its property to provide baseload, and then consume imported power to make up its residual load. Inherent in the structure of the Microgrid, is the ability to use non-tariff metering between various local distributed energy resources and across Microgrid connected facilities.

This cost offset, from facility-to-facility and from customer-to-customer, is a major contributor to the overall value proposition of the Microgrid. Any excess energy from the distributed generation that is fed back into the grid through the captured JCP&L infrastructure (see below) will be sold to other Microgrid customers sites, proportionate to their overall energy consumption. Each Microgrid generating asset will be paired with a dedicated meter (as shown on the diagram) that will measure the output for internal accounting

Captured JCP&L Distribution Grid (Non-Tariff)

Portions of the feeders and attached distribution equipment of the JCP&L distribution grid will be repurposed for use of Microgrid power distribution between host facilities and with the larger grid. Excess power exported from the host facilities will be distributed and sold to other Microgrid customers sites, proportionate to their overall energy consumption. Individual host facilities importing energy from this internal network will have a meter to capture in-flows for internal accounting.

The repurposing of existing JCP&L infrastructure and possible expansions of service with new wires and equipment may take many forms and result in various economic and financial terms for payment of use of the infrastructure for delivery of energy. In some cases, such as the Area A 34 kV connection at the Medical Center to the JCP&L sub-transmission line, host sites can continue to pay JCP&L via the delivery charge on the monthly bill while amending their existing bi-lateral supply agreements to account for the fact that a portion of their supply would now come from the Microgrid. In other cases, where the value of the distribution in the energy flows becomes an increasingly smaller percentage of the value of the energy delivery, payments to JCP&L should be decreased accordingly to preserve the feasibility of the Microgrid Project.

Full privatization of the captured infrastructure would not appear to be a feasible option. If the captured portion of the feeder was purchased by the Microgrid to absorb any distribution charges into the price of on-site energy delivery this benefit would almost certainly be entirely offset by the cost to purchase the assets and the on-going cost to maintain and operate them.

Natural Gas Distribution (NJNG)

Natural gas will be provided by the local GDC (New Jersey Natural Gas) and used directly at the host facilities to power conventional generation such as microturbine combined heat and power units, and for elements of the thermal loop including adoption chillers and boilers. Each type of service (i.e. electrical generation and thermal production) is shown with a separate meter.

Microgrid Thermal Energy Loop (Non-Tariff)

The thermal energy loop includes the use of co-located thermal energy resources at the host facilities, and the circulation of thermal energy from adsorption chillers, boilers, etc. Exhaust from the CHP units will also be used in the thermal loop and is therefore metered to compensate the owner of the CHP asset. Like the flow energy on the Microgrid Generation Bus and the Captured JCP&L Distribution Grid, the energy flows in the thermal loop to Microgrid facilities is not subject to tariff.

Virtual Microgrid (JCP&L)

The virtual Microgrid refers to loads residing outside of the Microgrid boundaries but connected by feeders to Microgrid generation resources. Using the JCP&L Level 3 interconnection these Microgrid DER should, in theory, be able to energize the feeder and brings these loads back on line in the case of contingencies lasting anywhere from a few minutes to several days or weeks (depending on the flow of natural gas and State of the JCP&L infrastructure). As indicated, there are multiple technical challenges involved with making this potential revenue stream a reality, including access to the meshed network in a way that is safe and reliable. Primary Critical Loads are those that provide critical services and are the priority targets for service restoration in contingencies. Secondary loads are those loads on the feeder between the Critical Loads and the Microgrid that will be energized incidentally as primary Critical Loads are brought back on line. These loads will continue to pay for their service under normal tariffs to the distribution company (JCP&L) however, a tariff rider that compensates the Microgrid distributed resource asset owners for the reliability and resiliency services should be developed to service and avoided costs to the utility.

Conclusions & Recommendations

Microgrid Tariff

The interconnection standards in the JCP&L/BPU tariff is based, in part, on the IEEE 1547 series that addresses the interconnection of distributed generation to the distribution grid. As the use of distributed generation clusters, embedded networks and Microgrids (especially advanced Microgrids) have grown, there has been additional work done on advanced topics, such as IEEE 1547.4, which addresses the standard related to islanding of Microgrids. As such, special Microgrid tariffs have been proposed in certain jurisdictions to address the unique nature of the emerging business models. These tariffs would address factors that have inhibited the implementation of advanced Microgrids and potentially improve Project financial performance. These changes generally include 1) establishing standard terms for the value of services exchanged between the Microgrid operator and the utility; and 2) removing technical barriers to interconnection. Each are described in more detail below.

The Value of Microgrids to the Distribution Systems

Several studies have been completed that review the current State of distributed generation deployment and how a proper economic framework for determining their value to the wider electrical system may be determined. In one study completed by the Analysis Group on deployments of distributed generation in the Con Ed system (New York City), different tracks of value chains were established for distributed generation resources to various parts of the electric system (including the power generation system, the high-voltage transmission system, and the distribution system) and separately, the external value to society. One finding of particular note is that current incentives for use of distributed generation are based on renewable portfolio goals and more recently resiliency goals, which can act as a rather "blunt and imprecise pricing instrument" that may not accurately reflect the value of distributed generation resources – particularly to the distribution system.[5]

Recommendations provided by the Analysis Group to achieve a more precise valuation framework include: 1) proceeding with more location-based analyses that focus on both expected and actual performance of distributed generation assets as cost-effective substitutes for traditional distribution-system reinforcements; 2) encouraging market-based competitive prices for procurement distributed generation services, rather than at avoided cost for maintenance and capacity expansion, and 3) development of forward contracting by utilities for distributed generation resource capacity. Improved valuation schemes may lead to a viable rate-basing scenario for utility investments in distributed generation resources and other improvements to distribution infrastructure that will be needed for the Microgrid to achieve full functionality, such as automated sectionalizing gear.

Other important improvements that could be established with Microgrid tariffs that recognize the value imparted by the Microgrid to the distribution grid for increased reliability and resilience should include special Microgrid rates for imported power and by eliminating (or mitigating) standby and demand charges. The implementation of demand charges for installed distributed generation in the current tariff should be reexamined in light of the high reliability of these units and how much reserve is actually required to serve a large and growing distributed generation capacity. Rather than pricing standby service for installed distributed generation based on a highly improbable emergency outage of the CHP system (for example) the tariff should instead recognize the benefits that highly efficient distributed generation systems provide, including increased system reliability and power quality, and reduced distribution losses. In other words, standby service is a value to distribution systems that may not need compensation from the distributed resources.

Improved Interconnection Procedures

With improved interconnection procedures that address the technical challenges of adding fully functional distributed generation to the grid, Microgrids could provide a host of generation services to support a substation during contingencies that would provide an alternative to distribution-system capacity improvements. These generation services, when combined with load reduction could provide utilities a very valuable resource to minimize customer loss of service and power quality problems during contingencies. Studies produced by the Pacific Northwest National Laboratory have evaluated the potential for use of Microgrids as a resiliency resource to local grids in the event of a severe weather

[5] Tierney, S., *The Value of "DER" to "D": The Role of Distributed Energy Resources in Supporting Local Electric Distribution System Reliability*. Boston, MA: The Analysis Group, 2016.

events and has found that, given the right conditions, Microgrids can supply Critical Loads outside of the Microgrid during contingencies where the utility power is unavailable for days or even weeks.[6]

In return for these services Microgrids could receive payments for deliberate islanding to manage load, payments for exporting power, and payments for maintaining Critical Loads during a larger system outage. A contract between the Microgrid and the local utility for resiliency and reliability resources could call for immediate response in local contingencies, not just to reduce peak system demand. Short-term markets for local service would include local voltage and VAR support, short-term substation relief, and emergency services. Microgrids could make on-call energy exports to the grid or assume pre-determined load shapes or provide circuit-by-circuit grid restoration services to ensure local reliability. These potential markets should be studied by BPU and included into future tariffs. However, to achieve this variety of services to the grid, the interconnection process must become more robust allowing full integration of distributed generation resources into the larger grid.

Overall cost

A 20-year financial model was developed to estimate the overall performance of the proposed NTAM. The financial model incorporates capital costs, operating assumption, fuel costs, other ongoing costs, and applicable incentives. Revenues and expenses are incorporated into a cash flow model which calculates the return on investment to the Microgrid owner. While the ultimate ownership of the Microgrid remains flexible, we assume a hybrid model whereby there is a private (non-utility) Microgrid owner, Area A customers, and a role to play for JCP&L to own a critical electric distribution system upgrade.

Microgrid Asset	Owner	Est. Capital Cost	Revenue Model
PV System	Non-Utility Microgrid Owner	$2,300,000	20-year PPA
CHP & Thermal HW Loop	Non-Utility Microgrid Owner	$26,542,000	ESA with Unit Prices based on Current HMUMC Energy Costs
New conductor between Medical Center and existing 57498 Feeder	JCP&L	$1,000,000	Traditional Utility Rate Recovery Mechanisms

Key input assumptions related to the financial model are listed below.

Financing

- Includes 30% debt financing at 5% over a 15-year loan tenure
- Assumes CHP gas costs are $9.50/MMBtu escalated at 2% per year

[6] K. P. Schneider, F. K. Tuffner, M. A. Elizondo, C. Liu, Y. Xu and D. Ton, "Evaluating the Feasibility to Use Microgrids as a Resiliency Resource," in IEEE Transactions on Smart Grid, vol. 8, no. 2, pp. 687-696, March 2017.

- Incentives:
    - NJ Clean Energy Program: $350/KW of CHP capacity, 30% of Project cost or $3 million cap
    - 30% Investment Tax Credit (ITC) applied for PV system at 30% effective tax rate
    - MACRS and bonus depreciation included in model

Revenues

- Assume energy sold by the Microgrid at current customer costs
- Assumes 3% annual escalator for electricity prices and 2% annual escalator for natural gas and thermal energy prices over 20 years
- SRECs generated by PV systems are sold at $210/SREC[7] for a 10-year term
    - The sale could be on an open trading platform or by entering into a long-term contract with an interested counter party in the PJM territory
- All electric and thermal energy is sold at the prevailing average all-in rates of current customers
- Assumes CHP electric and thermal energy sold to the HMUMC during Blue-sky conditions, with all electricity required, plus excess thermal energy, sold to the Neptune Municipal Facility, MCVS AAHS, Neptune High School, Neptune Middle School, Gables Elementary School, MCVS Neptune Annex. Electric-only service would be provided to the Neptune Board of Education and Brookdale Community College and to the Neptune Department of Public Works.
- To qualify for prevailing incentives, it is necessary to use the thermal energy productively so that the minimum efficiency required (60%) to qualify for federal and State incentives. Preliminary analysis indicates that at least 70% efficiency will be achieved for this combination of loads and generation assets.

The overall energy costs for each critical facility, and the overall project as a whole, can be seen in under the previous section "Area A Project Description." The proposed ECM and DR measures outlined earlier in the report were from a Preliminary Energy Walk-through of each facility. Most of the critical facilities included in Area A were in good condition and many have recently completed, currently are competing, or plan on completing energy-related improvements in the near future, including the Municipal Complex, Neptune High School, and other Board of Education facilities. The measures being completed or planned to be completed should be verified, and then any additional low-hanging fruit should be identified through an Energy Audit, to accurately estimate the effects of these ECMs on the overall energy consumption and overall energy costs to each critical facility individually and to the project as a whole.

Cash Flow Evaluation

Objective and financial model approach

- [7] Latest 2019 vintage SREC trading price

The eventual success of the Project will be determined by the difference between the computed LCOE of the Microgrid and the energy rates paid by host sites under the status quo. The LCOE in turn, is governed by the following factors:

- The feasibility of assumptions around operating parameters of each Microgrid asset, which include:
    - Average percentage capacity at which the CHP can operate across the year taking into consideration available loads and regulations that govern back-feeding of excess CHP production onto the grid
    - Off-take of thermal energy generated by operating the CHP system
    - Available loads to off-take PV system production and regulations that govern back-feeding of excess PV system production onto the grid
- Availability of incentives and rules governing the layering of different incentive schemes in a mixed-technology Project such as the proposed NTAM
- The total capital expenditure required to install all the proposed assets for the Microgrid

It follows that a simple and robust business model that avoids complexity and inflated soft costs is critical. GI Energy computed the LCOE taking into consideration the following factors:

Revenues

- All energy (kWh) produced by the Microgrid assets (CHP and PV Systems) are sold at a fixed price, either to the identified sites in the form of a supply contract or via tariff rates approved by the BPU.
- All thermal energy is sold at the prevailing average gas rate
    - Thermal energy is a useful byproduct of CHP generation and is an added bonus revenue stream
    - In order to qualify for prevailing incentives, it is necessary to use the thermal energy productively so that the efficiency required to qualify for the incentive is met

An important note here is that the batteries are assumed to behave as a sink of any excess production. There may be opportunities to capture additional revenues if the batteries are deployed for services such as Demand Charge Reduction and Energy Arbitrage.

Costs

- Annual natural gas expenditure to run the CHP plant
- Annual O&M expenditure for the PV system, CHP and potentially batteries (see Area B below)

Financing

- Expected rate of return of 12% for Microgrid owner
- 30% debt financing at 5% over a 10-year loan tenure
- $11/MMBtu average gas price to operate the CHP
- $11/MMBtu price for thermal energy generated by the CHP (adjusted for efficiency)
- 2% appreciation in LCOE price, thermal energy price and operating costs per year
- NJCEP CHP incentive, Solar ITC, MACRS and bonus depreciation available for Project

Concurrently, the supply strategy will service and maintain the NTAMs position regarding liquidating SRECs and RECs, curtailment incentive-based revenue, storage-based peak load servicing by integrating the day-ahead market intelligence with the redundant automation and telemetry managing the NTAM’s optimization, which should only improve the economic projections.

Financing of Location/Critical Facility

This section will include a detailed description of the potential financing of each location/critical facility and/or the overall Project.

System Constraints and Considerations

The Microgrid is expected to operate in Blue-sky conditions nearly all the time. During Blue-sky conditions, the Microgrid can earn regular revenues through energy sales to pay the Microgrid owner for the initial capital investment. Minimum annual earnings are required to show a viable Project and attract investment in the Microgrid. In addition, the Microgrid customers are likely unwilling to pay significantly more for energy than they pay today. There is generally a case to be made that a premium should be charged for the resiliency benefits that a Microgrid delivers. Yet, it should not be assumed that customers are willing to bear additional costs beyond what they pay under a business as usual scenario. Therefore, to be conservative, energy sold from the Microgrid to customers should be fixed as close as possible to what they pay today.

Besides adding additional generation within the proposed NTAM, the Project proposes the addition of an electrical connection between HMUMC and JCP&L's feeder 57498. This additional feeder would allow the new CHP system at the Medical Center to provide power to the other Area A customers during a Black-sky condition. Under Blue-sky conditions, the new feeder being proposed would simultaneously serve as a redundant feeder to the Medical Center and provide an alternate source of utility power to the Medical Center in the event that the J-88 feeder to the Medical Center fails. If configured as a redundant utility feeder to the Medical Center, along with the resiliency benefits to the non-HMUMC loads during Black-sky events, then it would make sense for JCP&L to own the new feeder and ultimately pay for that upgrade through traditional rate recovery mechanisms, at vastly lower cost than a new independent 34kV supply to the Medical Center. This ownership model for the new feeder would reduce capital costs for the Microgrid Project and the cost burden on the Microgrid customers, while benefiting a broad group of ratepayers that rely on emergency services from the Medical Center and the Township. While installing the new feeder that would connect the Microgird CHP system at HMUMC with the 57498 feeder to serve the rest of Area A, it would also make sense to connect the Area A Microgrid with the Area B Microgrid via a connection to the 57497 feeder. Feeder 57497 is located across the street from where we propose to connect the CHP system to the existing 57498 feeder (near Washington Ave and Neptune Boulevard). This connection could also provide access to Area B's battery storage capacity for use by Area A, reducing peak-demand and ramp-rate issues for the broader JCP&L grid under Blue-sky conditions.

PV Business Model

Using recent utility bill data, we determined that the non-HMUMC facilities consume approximately 11.6 GWh of electricity per year. Non-HMUMC customers in Area A pay, on average, $0.120/kWh. The Medical

Center, since it enjoys sub-transmission service, pays a lower $0.105/kWh for electricity. This is illustrated in the table below:

Critical Facility	All-in electric rate
Hackensack-Meridian University Medical Center	$0.105/kWh
Neptune Municipal Facility (incl. PD & Library)	$ 0.125/kWh
Neptune Department of Public Works	$ 0.123/kWh
Gables Elementary School	$ 0.117/kWh
Neptune Middle School	$ 0.118/kWh
Neptune Board of Ed & Brookdale Community College	$ 0.119/kWh
Neptune High School & Aquatic Center	$ 0.120/kWh
Monmouth County Academy of Allied Health & Science	$ 0.115/kWh
Monmouth County Vocational School	$ 0.136/kWh

Energy generated by the Microgrid during Blue-sky conditions can be grouped into two categories. First, most facilities besides the Medical Center will adopt PV system panels installed on their rooftops. This analysis assumes reasonable estimates for PV system that would be deployed for each roof. By estimating the solar irradiation for the area (1,281 kWh/kW), the annual PV system electric production can be estimated for each facility. The Table below illustrates the historic electricity use and PV system potential for each facility in Area A. This conservative analysis, which assumed slightly less PV system capacity than the PV layouts provided, indicates that the PV system production would easily be consumed within the host facility during Blue-sky conditions throughout the year.

Critical Facility	Annual Electricity Use (kWh)	PV System Capacity (kW AC)	Est. Annual PV System Production (kWh)
Neptune Municipal Facility (incl. PD & Library)	1,322,760	48	61,488
Neptune Department of Public Works	245,280	32	40,992
Gables Elementary School	753,360	120	153,720
Neptune Middle School	2,137,440	240	307,440
Neptune Board of Ed & Brookdale Community College	516,840	0	0
Neptune High School & Aquatic Center	5,702,760	476	609,756
Monmouth County Academy of Allied Health & Science	753,360	140	179,340
Monmouth County Vocational School	210,240	64	81,984
Total	**11,642,040**	**918**	**1,434,720**

The business model that best fits this configuration would be a Power Purchase Agreement (PPA) because each of the PV systems would offset roughly 12% of the host facility's electricity use and be consumed on-site. PPAs are a well understood business model with standard contract templates. There would be no up-front costs to the host facilities. The Microgrid owner would issue a bill for electricity produced and consumed. The PPA price would be fixed at the current electricity rate (roughly $0.12/kWh for non-HMUMC Area A accounts). Typical PPA terms are set for 20 to 25 years. During Black-Sky events, the PV systems would still generate electricity and would be connected to support the Microgrid. Yet, the Black-sky operations would have little to no effect on the Blue-Sky business model for deploying the 920 kW of PV system proposed for Area A.

CHP System Business Model

The proposed 6.2 MW CHP system will become the essential generation asset and the cornerstone of the NTAM. The CHP system will be sited at the Medical Center and will produce both electric and thermal energy. Most of this energy will be used on-site within the Medical Center, especially during the heating and cooling seasons.

This analysis assumes that the CHP system will operate nearly continuously (excluding scheduled maintenance downtimes). Electricity produced by the CHP system will offset electricity normally procured from the grid. The constant and relatively coincident electric and thermal loads make CHP extremely efficient in a Medical Center application. This type of on-site energy system is familiar to the Medical Center and their operations staff as they have been operating a CHP system within their Central Utilities Plant for many years.

The proposed CHP configuration would offer the flexibility to generate thermal energy in the form of steam, hot water, and/or chilled water, all of which are currently used by the Medical Center. Thermal energy from the engines' exhaust would be converted to steam and used within the existing Medical Center's steam distribution system. Hot water from the engines' other heat recovery circuits, such as the engine jacket water, can be used as either hot water in the HMUMC, or as the energy to drive an absorption chiller to make chilled water. The chilled water would also be used to offset chilled water normally generated by the electric chillers or existing absorption chiller.

Most of the electricity and thermal energy generated by the CHP plant would be sold to the HMUMC during Blue-sky conditions at a rate comparable to what they pay today for electricity, steam, hot water, or chilled water, with the remainder distributed to the non-HMUMC loads within Area A at prices similarly comparable to today's rates. The Table below estimates costs for each of the energy types used by HMUMC today using utility bill data and assumptions related to existing equipment efficiency. Ultimately, all energy within the Medical Center relies on electricity or natural gas. Recent unit prices for electricity and natural gas at the Medical Center are also included.

Energy Type	**Conventional Source**	**Fuel**	**Fuel Unit Price**	**Energy Unit Price**	**Notes**
Electricity (kWh)	Grid	Electricity	$0.105/kWh	$0.105/kWh	
Steam (MMBtu)	Steam Boiler	Natural Gas	$11.96/MMBtu	$14.071/MMBtu	Assumes 85% efficient steam boiler
Hot Water (MMBtu)	Steam Boiler and/or Hot Water Boilers	Natural Gas	$11.96/MMBtu	$13.289/MMBtu	Assumes 90% efficient hot water boiler

Chilled Water (ton-hr)	Electric Chiller	Electricity	$0.105/kWh	$0.105/ton-hr	Assumes electric chiller at 1 kW/RT efficiency

The financial model uses the Energy Unit Prices above as unit costs for energy sold to HMUMC by the Microgrid owner.

Summary of Operating Assumptions and Energy Production

While the PV system assets and CHP system will play an integrated role supporting the Microgrid during Black-sky conditions, their Blue-sky business models will likely be treated as separate Energy Service Agreements or a Multi-Party ESA, even if there is a single Microgrid owner. As such, we present the operations and production summaries separately in the Tables below, with a detailed summary of operating conditions included in Appendix F.

Critical Facility	Annual Electricity Use (kWh)	Est. Annual PV System Production (kWh)	Annual PV System PPA Payment to Microgrid Owner
Neptune Municipal Facility (incl. PD & Library)	1,322,760	61,488	$7,379
Neptune Department of Public Works	245,280	40,992	$4,919
Gables Elementary School	753,360	153,720	$18,446
Neptune Middle School	2,137,440	307,440	$36,893
Neptune Board of Ed & Brookdale Community College	516,840	0	$0
Neptune High School & Aquatic Center	5,702,760	609,756	$73,171
Monmouth County Academy of Allied Health & Science	753,360	179,340	$21,521
Monmouth County Vocational School	210,240	81,984	$9,838
Total	**11,642,040**	**1,434,720**	**$172,166**

Note: Assumes $0.12/kWh PPA rate. Remaining electricity use at these facilities would be charged at a rate comparable to what they pay today, with an escalation clause as described above.

CHP System Parameter	Annual Value	Notes
CHP System Size (kW)	6.2 MW (Jenbacher J620 x 2)	Each J620 rated at 3.1 MW
CHP System Uptime	95%	5% downtime for scheduled maintenance
CHP Electricity Production (kWh)	51,463,248 kWh	Assumes 41% electric fuel conversion efficiency (HHV)
CHP Steam Production	86,335 MMBtu	Assumes 20% of fuel energy converted to steam via HRSG

CHP Hot Water Production	69,499 MMBtu	Assumes 43% overall thermal efficiency (steam & HW) – 23% fuel energy converted to HW
CHP Chilled Water Production	1,737,487 ton-hr	Assumes 30% of HW converted to CHW via absorption chiller

Based on existing Energy Unit Prices from the table above, the Table below summarizes energy sales to HMUMC and/or Microgrid customers.

CHP System Parameter	Annual Value	Energy Unit Price	Annual Energy Sales
CHP Electricity Production	51,463,248 kWh	$0.105/kWh for HMUMC, slightly higher for other Microgrid customers	At least $5,403,641
CHP Steam Production	86,335 MMBtu	$14.071/MMBtu	$1,214,781
CHP Hot Water Production	69,499 MMBtu	$13.289/MMBtu	Maximum of $923,571
CHP Chilled Water Production	1,737,487 ton-hr	$0.105/ton-hr	Maximum of $182,436

Note: While not included in the base model, there is likely a financial case to be made to include chilled water storage at the Medical Center. This would improve the operations of the absorption chiller and existing chilled water plant and drive down the costs associated with generating chilled water during on-peak electric times.

The Table below summarizes operating costs for the CHP system.

CHP System Parameter	Annual Value	Notes
Annual CHP Fuel Input	431,674 MMBtu	Heat rate of 8,388 Btu/kWh HHV
Annual CHP Fuel Cost	$4,100,900	5% downtime for scheduled maintenance
Annual CHP O&M Cost	$771,949	Assumes $0.015/kWh

Analysis of key financial metrics

The objective of the financial analysis is to evaluate the feasibility of the Microgrid Project from the point of view of both the Microgrid owner and Microgrid customers. Each entity has specific requirements; the end users would like to continue paying the same rates as the status quo (if not cheaper), while the Microgrid owner and finance partners aims to ensure stable cash flows and low risk to the Project to meeting their own hurdle rate.

Satisfying the Current Energy Rates Paid by Customers

If the electricity produced is to be sold at the prevailing average rates described above, the impact on rate of return to the Project is as follows:

Scenario	Energy Sale Price	IRR
CHP operates at 100% capacity, 90% uptime, and energy sold to HMUMC and Microgrid customers	$0.120/kWh Solar PPA $0.105/kWh for HMUMC, slightly higher for other Microgrid customers $14.071/MMBtu Steam $13.289/MMBtu Hot Water $0.105/ton-hr Chilled Water	13.2%

The analysis suggests that the Microgrid is potentially financeable while keeping energy costs at today's rates and assuming no additional financial support from the State or Township. However, private investors and Microgrid owners may seek higher rates of return for Projects of this type with long time horizons and potential risk for changes to future loads. There are a few options that could be explored that would boost the IRR to a private investor. These include:

- Increasing energy sale rates by charging for "resiliency"
- Coordinating with the Township to de-risk the offtake Projections
- Seeking financial grants from the State and/or Township

Each of these options is explored are summarized below.

Alt. Scenario	Description	Energy Sale Price	IRR
Resiliency Premium	Increase electric sale prices by $0.010/kWh to pay for resilience	$0.130/kWh Solar PPA $0.115/kWh CHP Elec $14.071/MMBtu Steam $13.289/MMBtu Hot Water $0.115/ton-hr Chilled Water	15.9%
De-Risk Offtake	Township would guarantee a minimum revenue to the Microgrid owner covering if revenue does not materialize due to customer load changes in the future.	Sale prices would remain the same as the base case. Guarantees would not increase IRR, but would de-risk the Project and attract investors with different risk profiles.	13.2%
State / Township Grant	Initial grant funding to increase IRR and attract additional investors.	Prices remain the same as base case. Any grant contribution would increase IRR and attract more investors.	17.7% with $2,000,000 grant

Conclusion and Recommendations

Based on the analysis above, the Microgrid is technically feasible. The PV system assets present an attractive value proposition to the host facilities and could be pursued independent of the Microgrid. The CHP system fits well within HMUMC's operations and indicates opportunity for highly efficient operations. The thermal loop ensures that all thermal energy produced will be sold to Off-takers, even during shoulder seasons. This combination of assets is a solid foundation for the Microgrid, both from a technical and business model perspective.

The Microgrid may attract wide interest from investors and developers if some level of enhancement was made to the base Project financials. As noted above, this could come in the form of one or more of the following:

- Increasing energy sale rates by charging for "resiliency"
- Coordinating with the Township to de-risk the offtake Projections
- Seeking financial grants from the State and/or Township

The analysis reveals several opportunities for policy and/or regulations solutions that may improve the business model of the NTAM from the perspective of the Microgrid owner, customers, and utility. We recommend that the New Jersey Board of Public Utilities explore the following options:

- Consider amendments to regulations that prohibit back-feeding of CHP output, as allowing the CHP system to operate at full capacity, which will result in the highest efficiency and lowest cost solution.
- Create a new Microgrid tariff that would allow the Microgrid to wheel electricity to other Microgrid customers at a discounted delivery rate since transmission charges and most distribution charges should not apply to power generated / consumed within the Microgrid.
- Create provisions that exempt host sites from moving to stand-by charges if the generating asset is a part of a Microgrid. The argument here is that the CHP asset is installed for the benefit of the larger community and not only for the host site exclusively – HMUMC in this case.
- Provide grant funding and access to cheaper forms of capital (e.g. Green Bonds created specifically to finance the proposed NTAM) which will enhance the overall financial opportunity and more easily attract investors
    - Creating a dedicated bond to finance part of this Microgrid is likely to have a halo effect; it will inspire more confidence in the Project and attract equity partners with lower hurdle rates, as well as allow the community to invest in the asset and feel a sense of pride in contributing to the well-being of the Township. Furthermore, the earnings will be channeled back to the bond holders.

There is increasing evidence from other parts of the country that suggests that New Jersey can benefit from expanding the sources of funding and possibly establish a standalone Green Bank as well as expand the scope of the NJ Environmental Infrastructure Trust, which is currently set up to support water infrastructure Projects. New Jersey does have an established *Energy Resilience Bank*, which was set up after Hurricane Sandy to drive greater investment into resilient energy supply systems at critical facilities like hospitals, water and wastewater treatment facilities. This was originally meant to operate similar to a Green Bank; however, it has stopped receiving applications for funding.

The Energy Resilience Bank sits under the larger umbrella of the New Jersey Economic Development Authority (NJEDA). The New Jersey Economic Development Authority is an independent State agency that finances small and mid-sized businesses, administers tax incentives to retain and grow jobs, revitalizes communities through redevelopment initiatives, and supports entrepreneurial development by providing access to training and mentoring programs. In particular, NJEDA provides bond financing options for Large Business and Development. Under this scheme, $500,000 to $10 million in tax-exempt bonds are available for for-profit companies, up to 20 years for real estate and 10 years for equipment. Eligible Projects include facilities that furnish electric power. This suggests that the Microgrid owner may be able to collaborate with the NJEDA to create unique financing opportunities using cheaper capital.

Project Benefits

A detailed description of the benefits of the proposed Town Center DER Microgrid as well as the need for the proposed Project. This should include an estimate of the value for reliability, resiliency, flexibility, sustainability including avoided environmental impacts such as air emissions, water usage, wastewater discharges, land use and waste generation, affordability, and security.

Neptune Township is a popular summer destination at the crux of major evacuation routes from the Jersey shore. After the devastating effects of Hurricane Sandy, which left many residents without power and critical services for over a week, Neptune Township and other shore communities contemplated improvements to energy resiliency and reliability. The Township was especially keen on ensuring reliability, since it hosts the HMUMC and associated trauma center. As climate change continues to increase the intensity of storms along the coast, putting human health, safety, and productivity severely at risk, Neptune Township has planned to implement an Advanced Town Center Distributed Energy Resources (DER) Microgrid.

The central benefit of the DER NTAM is keeping essential services up and running regardless of the impact of storms, black-outs, heat-waves, cyber-threats, or other potential grid disruptions. Hospitals, fire and police, emergency communications, heliport, evacuation shelters etc., must all have resilient and reliable power in order to serve the Township. These services are also essential for the surrounding region, for example, by serving as a State-designated Comprehensive Stroke Center and as the only Level II trauma center with pediatric commitment in Monmouth and Ocean counties. Providing gas stations, grocery stores, dialysis centers, public internet, and so on with energy can make even extended outages and disaster recovery periods manageable for the residents and businesses of the Township. The NTAM approach includes 27 critical facilities with major-fuel consumption totaling approximately 163,000 MMBtu annually. The Primary area contemplated for dedicated “Blue-sky” electric and thermal distribution (Area A) totals approximately 0.34 Square Miles. NTAM Area A includes three Class II, seven Class III and two Class IV critical facilities with a maximum distance between facilities of 0.15 Miles. The NTAM is particularly suitable for the Township because of the high summer peak-load within the electric utilities distribution circuits serving the Township and shoreline communities.

The Microgrid also provides a long list of additional benefits. The new generation and improved operational efficiencies both create concrete value, with associated revenue streams, meaning that most elements of the Microgrid pay for themselves, thus minimizing the capital cost associated with achieving the desired resiliency and emergency response capabilities. These Blue-sky benefits and value streams include:

- The kWh output from the solar panels, monetized as avoided electricity bills, net-metering, and power exports.
- The zero emissions from solar power, monetized as SRECs and other incentives.
- The kWh output from the existing and future expansion of the CHP facilities at the medical complex, monetized as avoided electricity bills and power exports.
- The recycled waste heat from the CHP facilities, monetized as avoided heating and cooling bills and the avoided costs of operating, maintaining and then replacing aging boilers and chillers.
- The lower emissions from the use of recycled waste heat for heating and cooling, currently poorly monetized.
- The avoided or deferred investment in transmission and/or distribution system equipment to serve Neptune Township and surrounding communities, since a significant fraction of the load (including peak loads) will be met by local resources, currently monetized through BPU-authorized incentives for CHP and Microgrids and potentially through future capacity-like markets for DER.
- The avoided costs of providing ancillary services and peak reduction through the Microgrid's combination of resources, load control, and storage, instead of relying on other more expensive or less efficient means. This is somewhat monetized through existing PJM and JCP&L programs and markets, hopefully receiving more robust compensation as those mechanisms continue to develop.
- The avoided costs of equipment malfunctions and failures due to poor power quality, especially for sensitive medical equipment but also for computers, electronics, and electric motors (such as elevators), poorly monetized except when avoiding the expense of standalone UPS systems.
- The real-options value of the physical components of the Microgrid, enabling future investment flexibility in the face of the evolution of energy markets and energy-system performance.
- The real-options value of the operational capabilities of the Microgrid, enabling minute-to-minute flexibility in the production and procurement of electricity and thermal energy.

These every day and every minute benefits, especially those with full monetary compensation for value delivered, are the backbone for the vast majority of the required Microgrid investment. The resiliency and emergency response benefits described above will outweigh any remaining capital cost contribution needed to achieve full “island-ability” for the complete set of Critical Loads and functions within the boundaries of the Microgrid. All the Partner facilities identified in the application maintain electric and natural gas utility accounts in good standing with standard contributions to the Societal Benefits.

Project Communication System

Communication between the TC DER MG (embedded generators) and the utility will occur through remote terminal units utilizing intertie network protection for the generation assets for all Blue-sky modes of operation. When power from the utility is lost all embedded generators will be tripped off. If power from the utility is not restored within a prescribed period of time (~10s) the direct transfer trip looking out on the utility will command breaker no. 52-M1 to open isolating the underground circuit Neptune/Heck Ave Bus 1 where denoted in the Single-Line Drawings in Appendix D. Thereafter, all embedded (micro grid) generators will need to be black-started and reloaded in a priority sequence such as not to over/underload the any given DER (to be defined at the detail design stages of this Project).

Timeframe for the Completion

The estimated timeframe for the completion of the construction and commencement of operations of the individual critical facilities and the overall Project is shown as Appendix G.

On-going work with the EDC and GDC

The NTAM development team will require direct collaboration with the EDC and GDC. The NTAM implementation priority is to identify and plan for the complete interoperability of the DER resources and facilities within the proposed NTAM while providing maximum benefit to the local grid circuits. The information developed to that end will be included within the overall NTAM investment-grade implementation plan. Once documented, the EDC ad GDC requirements will be quantified and integrated in the tariff development and project financing models.

Area B – Potential Extension of the NTAM

Executive Summary

Area B is a potential extended cluster that would supplement and potentially expand Area A. Area B is east of Area A and includes facilities that provide essential services to the local community, including emergency response assets, food service, and sheltering capabilities. In almost all situations, power will be available from the generation assets in Area A that can be shared for critical needs in Area B. After analyzing Area B, 10 facilities were found to have PV potential, estimated at about 1.6 MW DC. Additionally, a 1 MW/ 1.6 MWh central battery plant should be included to help store and dispatch energy when Area A power and Area B PV is unavailable.

Project Location

Area B Project Description

Area B was developed to be a potential extended cluster to fortify and potentially expand on the main Area A described above in this report. The original methodology in determining Area B's cluster of facilities was to include several businesses, institutions, and key services directly to the east of Area A that have supplemental value to that of Area A regarding resiliency in the event of a Black-sky event.

The team performed limited outreach regarding utility bill collection for Area B since this report's main structure is to develop Area A, with Area B as an option or expansion. However, electric consumption was estimated for each of the below critical facilities, using assumptions based on facilities of similar size and usage. In addition, research and PV system expertise of the NTAM team were utilized to evaluate the PV system potential of each facility and were incorporated to provide an accurate analysis should the Township of Neptune choose to include the additional cluster.

Area B - Initial Critical Facility List				
Location	Address	Building Type	Area (Square Footage)	Estimated Electric Consumption (kWh)
10 Neptune Blvd Office Building	10 Neptune Blvd Neptune City, NJ 07753	Office	20,640	328,176
1928 Heck Ave	1928 Heck Ave Neptune City, NJ 07753	Enclosed and Strip Malls	15,000	316,500
1930 Heck Ave	1930 Heck Ave Neptune City, NJ 07753	Office	94,500	1,502,550
Shore Area Communications Center	1825 NJ-33, Neptune City, NJ 07753	Public Order and Safety	17,100	254,790
Aldi Foods	15 NJ Hwy 35, Neptune City, NJ 07753	Food Sales	17,000	827,900
Battle Homes	56 N Taylor Ave, Neptune City, NJ 07753	Outpatient	30,000	561,000
Delta Fuel Station	1800 Corlies Avenue, Neptune City, NJ 07753	Retail (Other than Mall)	2,150	32,680
Electro Impulse	1805 NJ-33, Neptune City, NJ 07753	Other	60,750	1,719,225
Excelsior Medical	1933 Heck Ave, Neptune City, NJ 07753	Retail (Other than Mall)	54,300	825,360
First Aid Squad	5 Neptune Boulevard, Neptune City, NJ 07753	Public Order and Safety	5,460	81,354
Hoop Group	1930 Heck Ave Neptune City, NJ 07753	Service	82,444	684,285
Lager Glass	1913 Heck Ave, Neptune City, NJ 07753	Other	11,620	328,846
Living World Church	81 NJ-35, Neptune City, NJ 07753	Religious Worship	20,769	107,999
Physicians' Offices	1820 NJ-33, Neptune City, NJ 07753	Enclosed and Strip Malls	16,419	346,441
Post Office	50 Neptune Blvd, Neptune City, NJ 07753	Service	9,000	74,700
Senior Center	1607 NJ-33, Neptune City, NJ 07753	Outpatient	12,566	241,960
Shore Industrial Supply	1916 Heck Ave, Neptune City, NJ 07753	Warehouse and Storage	7,800	51,480
Simply Self Storage	1515 Washington Ave, Neptune City, NJ 07753	Warehouse and Storage	45,000	297,000
Trimed Pharmacy	1520 Washington Ave, Neptune City, NJ 07753	Retail (Other than Mall)	8,075	122,740
Unemployment Office	60 Taylor Ave N, Neptune City, NJ 07753	Office	19,800	314,820
Walgreens	1905 NJ-33, Neptune City, NJ 07753	Food Sales	19,631	956,030
Wawa	1344 Corlies Ave, Neptune City, NJ 07753	Food Service	6,500	291,850

Our Team's analysis over the past year has categorized three outcomes to our Initial Critical Facility List of Area B, which include:

1. Realistic photovoltaic installations,
2. critical facilities, and
3. removed sites that were not suitable for the Microgrid.

The critical facilities that met the criteria described in the previous section included facilities with a variety of functions, as can be seen in the below final table of PV System Sizing for Area B. This list is flexible and malleable moving forward, as some facilities may be added or subtracted from the list as more information is gathered, the Project details are pinned down, and the below list of facilities is contacted regarding the Project.

Neptune Township: Area B - PV System Sizing		
Location	Address	Estimated Potential (kW)
Walgreens	1905 NJ-33, Neptune City, NJ 07753	40
Electro Impulse	1805 NJ-33, Neptune City, NJ 07753	275
1930 Heck Ave	1930 Heck Ave Neptune City, NJ 07753	225
Excelsior Medical	1933 Heck Ave, Neptune City, NJ 07753	400
Simply Self Storage	1515 Washington Ave, Neptune City, NJ 07753	300
Unemployment Office	60 Taylor Ave N, Neptune City, NJ 07753	125
Senior Center	1607 NJ-33, Neptune City, NJ 07753	70
Physicians' offices	1820 NJ-33, Neptune City, NJ 07753	40
Aldi Foods	15 NJ Hwy 35, Neptune City, NJ 07753	100
Wawa	1344 Corlies Ave, Neptune City, NJ 07753	35
	Total PV Estimated Capacity (kW DC):	**1610**
	Total PV Estimated Capacity (kW AC):	**1320.2**

In addition to these facilities being able to host PV systems to provide electricity to Area B, some of the facilities provide essential services to the local community:

- Walgreens is a chain pharmacy and convenience store. Pharmacy services include prescription dispensing, vaccinations, medical disposal, and a drive-thru. The Walgreens in Neptune also includes an ATM, FedEx pickup and drop-off, Western Union, and beauty consultation. This 19,631 square foot commercial facility relies on consistent electric and gas supply to control climate for food and medicine, dispense cash, and secure sensitive materials. It operates for 24 hours a day for seven days a week.
- The Neptune Township Department of Senior Services and Senior Center, located at 1607 NJ-33, Neptune, NJ serves residents of Neptune Township who are 60 years of age or older and their families. The center offers recreational, nutritional, health and wellness, physical fitness, and educational programs to seniors on weekdays from 8 AM to 4 PM. It also offers transportation services to and from the center as well as trips for medical appointments, food shopping, and person requests. This facility aids a vulnerable population and can potentially provide additional shelter and act as a cooling center during Black-sky events.
- Aldi Foods is a chain supermarket that sells a variety of products, including fresh produce and frozen foods. In the case of an emergency, the supermarket could provide residents of Neptune with food and water.
- Wawa is a chain convenience store and gas station. The commercial facility at 1344 Corlies Avenue is identified by store number 8329. The Wawa is a critical facility during a grid outage because it sells a large variety of food and because it dispenses cash through the ATM. The attached gas station is also crucial for an emergency, in which residents would need gas to fuel generators and vehicles.

In addition to the facilities hosting the PV system, Area B includes the Shore Area Communications Center, the Neptune First Aid Squad (First Aid Squad), the Almerth M. Battle Homes, Neptune's Post Office, and the Delta Gas Station. Shore Area Communications Center is part of the Monmouth County Sheriff's Office Shore Area Communications Center. The Neptune office serves as a backup/disaster recovery center that supplements the 9-11 center in Freehold, NJ. This 17,100 square foot facility operates seven days a week, 24 hours a day. This critical function compliments the First Aid Squad across the street well, which responds to about 1,700 emergency calls per year. The Almerth M. Battle Homes are 30,000 square feet of senior apartments. The apartment complex is comprised of 50 senior housing units built on diagonal pieces of land. Keeping the power flowing to this particularly vulnerable population is essential. Finally, the Post Office and Delta Gas Station provide critical functions to the local population.

After some background research was completed, it was determined by the Microgrid team that 10 Neptune Boulevard Office Building, the Hoop Group, 1928 Heck Avenue, Shore Industrial Supply, Living World Church, and Lager Glass should be removed from the Area B critical facility list. These facilities were removed for a variety of reasons, but in general, did not have a high FEMA tier. Even without receiving power during a black-sky event, some of these additional sites that share an existing JCP&L feeder with the rest of Area B may still have the ability to host a PV system, pending further investigation of shading, roof type, and building type.

Proposed Connections of Critical Facilities and the DER Technologies

Area B is served by JCP&L's 57497 aboveground 12.47kV feeder, originating at the Neptune Substation, heading north on Hawthorne Ave to serve loads along Taylor Ave and branching east to serve loads along Corlies Ave, Washington Ave, and Heck Ave.

JCP&L's typical hosting-capacity restrictions for PV system installations would set a maximum of roughly 5 MW for a single 12kV feeder, such as the one serving Area B. The study team has not seen any indications of conditions that would reduce that hosting capacity below the typical maximum. Therefore, deployment of 1.3MW of new Roof-mounted solar seems likely to gain interconnection approval from the utility.

Existing Feeder 57497 serves all the potential connected loads within Area B (with a few exceptions, as described below). During an outage, the Microgrid would take over service for the selected loads by “sectionalizing” the existing feeder. Switches (hopefully remotely-operated automated switches with SCADA connections) would open to cut off the feeder from the Neptune Substation.

Additional sectionalizing gear would shed loads from portions of Feeder 57497 that do not serve designated Essential Loads. For example, loads further east on Corlies Ave could be sectionalized via the existing switch near the Wawa market. SCADA-enabled remotely-operated switches are ideal and would also provide grid-healing and faster service-restoration capabilities for JCP&L in other scenarios, but at over $20,000 apiece, they should be deployed sparingly. To shed load at individual facilities (for example, the Hoop Group facility), manual zero-load switches may be a suitable low-cost solution. Procedures would need to be instituted to confirm that such loads are indeed disconnected, preferably without requiring building access, so that power can be provided to Area B immediately upon successful sectionalization, without exceeding battery capacity or drawing down the available storage too quickly.

Control and additional power when available would come from the Area A Microgrid, connected to Area B where Feeder 57497 and 57498 are in close physical proximity. Successful sectionalization and load-shedding would need to be confirmed manually, before the tie breaker between Area A and Area B could be closed. In order to reduce costs, some load-shedding switches within Area B may also be manually operated, either on utility poles for feeder sections or at end-user premises for larger individual loads. While utility personnel would be preferred to operate such gear, it may be desirable to certify selected Township personnel and/or Medical Center and Microgrid facilities staff to carry out these functions in the event that JCP&L staff cannot travel to Neptune quickly enough.

A few loads, namely the Walgreen's and the First Aid Squad, are served by Feeder 57498 which also serves Area A, but just before that feeder transitions to being underground. These facilities could be included in Area A by upgrading the existing switch or could be included with the Area B loads that are added to the Microgrid only under Black-sky conditions.

The only two gas stations within Area B are the Wawa and the Delta station at the SW corner of Taylor and Corlies. The latter site receives its JCP&L service from the utility pole at that same corner, which is connected to Feeder 57497, but which may need additional isolation switches to avoid taking on more load beyond the service station itself.

The only supermarket within Area B, the Aldi on Route 35, is currently served by JCP&L's 53226 above-ground 4.16kV feeder, even though it is immediately adjoining other loads, such as corner McDonalds, served by Feeder 57497. In order to ensure access to food supplies during an extended outage, it may be necessary to convert Aldi's existing service to 12.47kV from Feeder 57497. Given the risk of food spoilage during an outage, the business owner may be willing to contribute to some of the costs of switching service in return for the reliable back-up power from the Township's Microgrid. Current electrical service comes underground from a pole across the service drive at the NE corner, with the meter around the mid-point of the north wall. The feeder branch serving the McDonalds terminates at a utility pole near the take-out ordering stations, south of the Aldi parking lot. The recommended route is probably a new pole in the Aldi lot, then across the roof to the existing electrical service (either via the roof or a new north-wall penetration). The site will require a new JCP&L transformer (12kV instead of 4160V).

Potential additions to Area B include high-priority loads such as King Manor Care and Sebastian Villa to the north of Heck Ave and west of Neptune Boulevard, and the DaVita Neptune Dialysis Center on the NE corner of Heck and Neptune, currently served by JCP&L's 57448-C aboveground 12.47kV feeder, originating at the Green Grove substation. An existing, normally-open switch at the northeast corner of Heck and Neptune Boulevard connects feeders 57448-C and 57498. These loads could be incorporated into Area B with a similar sectionalizing strategy for Feeder 57448-C, cutting off the feeder from the Green Grove substation and shedding loads served by other portions of that feeder. This strategy could also be postponed for later implementation, after the initial investment is successfully operating with the first set of Area B loads.

Energy Storage

A centralized battery installation is likely to be the simplest and lowest-cost option, consolidating balance-of-plant and installation expenses and simplifying land-use issues. The recommended sizing of 1MW / 1.6 MWh is documented in the Area B Generation Configuration, Section E.

To simplify grid integration issues for the connection between Areas A and B during Black-sky scenarios, the batteries should be located near the connection between the Microgrid supply from the Medical Center and the existing Feeder 57498 serving the rest of the Area A loads.

Leading candidates include the open area immediately south of the rescue squad facility at 5 Neptune Boulevard, and open area just north of the existing emergency diesel genset for the Shore Area Communication Center at 1825 Corlies Ave. Fenced outdoor enclosures similar to that diesel genset are the most likely deployment mode.

Detailed Description of Area B MG Operations

In almost all situations, power will be available from the generation assets in Area A that can be shared for critical needs in Area B. Over 2 MW of the critical Area A load is due to cooling needs that present only during the summer. A black-sky event during the winter or shoulder-season months would therefore leave plenty of available capacity to serve critical 24-hour loads in Area B, regardless of PV output or battery capacity. Even during the summer, generation that was sized for peak demand in Area A will have modest amounts of excess capacity to share, especially overnight or simply when operational needs within Area A fall below the absolute peak.

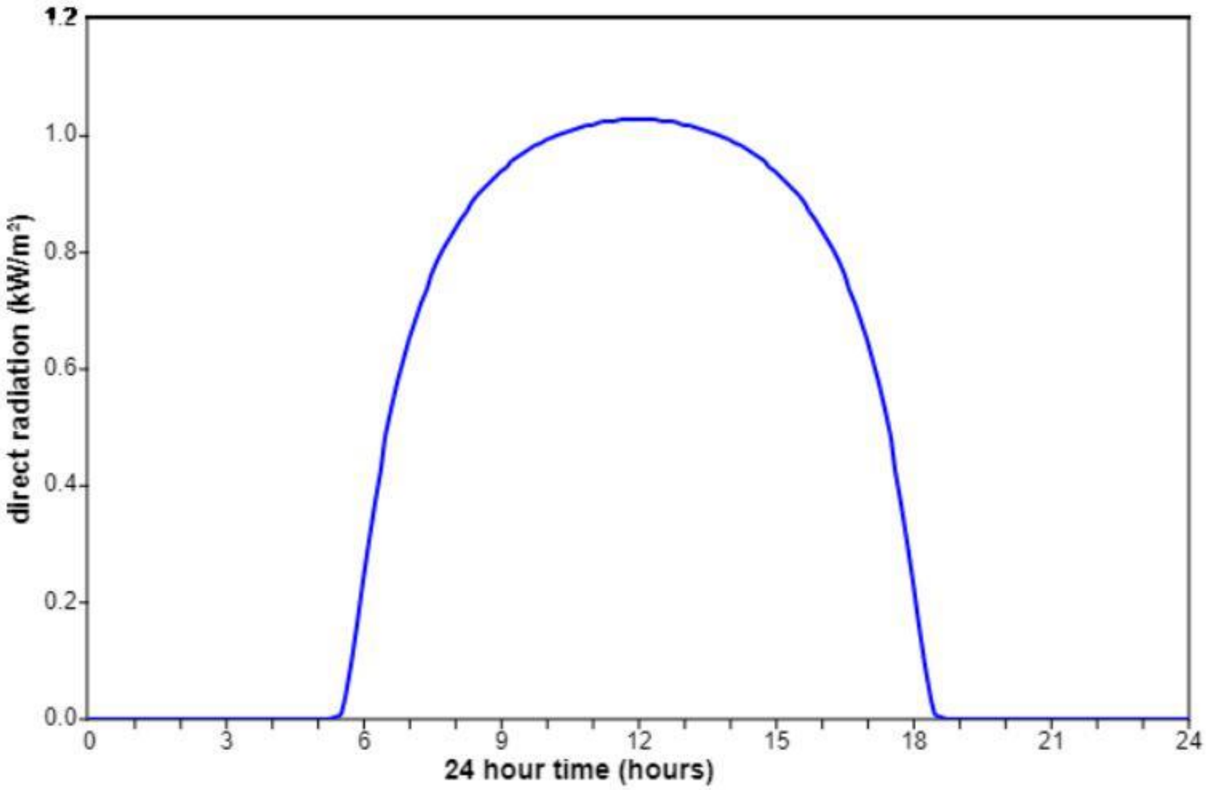
Note: There are worst-case scenarios where overnight power may not be available – for example, an outage that coincides with a mass casualty event requiring full operational tempo at the Hospital overnight, and simultaneous sheltering of mass evacuees at the Township's school properties requiring high power consumption overnight, all occurring in hot weather that requires at least some cooling. In such a thankfully unlikely event, Area B would need to rely exclusively on its own internal assets for overnight power.

Even without relying extensively on power shared from Area A, suitable flat roofs exist in Area B to support well over 1 MW in new generation, as described above. Any amount of installed solar is likely to be cost-effective based on Blue-sky revenues and would therefore only be limited by available space.

Area B requires a modest amount of energy storage is needed to bridge any gaps between these two primary assets. When Area A assets do not have spare capacity, and when the sun is not shining, batteries would provide power to the highest priority, critical loads within Area B until conditions change and other sources of power are once again available, in order of priority, for the roughly 200kW in "critical" loads, for the additional 500kW in "essential" daytime-only loads, and to re-charge the batteries so they are again available for the next hours when their bridging function will be called upon.

Note: As a last resort, a few critical sites within Area B already have back-up diesel generators, including the Shore Area Communications Center and the Township's Senior Center. If the energy levels in the batteries are too low to bridge the hours until either Area A assets or PV output become available, then those sites can refrain from drawing down the batteries further by utilizing their stored diesel fuel, freeing up reserves for other critical sites without emergency generators.

The most challenging scenario for Area B will be when cooling loads are high, limiting the export from Area A into Area B, and solar output is low, leaving batteries as the last line of defense for critical 24-loads. Therefore, an appropriate design day would be a sultry, late-August day (the 233rd day of the year, when hot ambient temperatures coincide with days that are the farthest from the summer solstice). The figure below provides the solar irradiance curve for that specific day for solar panels located in Neptune. The scenario assumes "average sun," given that below-average irradiance would mean greater cloud cover, which would tend to reduce outdoor temperatures, thus freeing up Area A capacity. The 24-hour critical demand exceeds the expected PV production on that design day at approximately 6pm. By midnight, Area A loads can be counted on to drop, due to overnight cooling and to lower operational tempos that drop the overall power demand. Those lower Area A loads would continue to allow export into Area B until the morning shift begins after 7am and the temperature begins to rise, coinciding with higher PV production that could once again pick up the 24-hour critical loads in Area B.



Given the potential for severe coastal storms in Neptune, PV panels will presumably be deployed flush to roof as flat arrays, to avoid wind-loading, reducing output by 17% compared to optimally tilted panels. To achieve 200kW output from a 1310kWAC array and meet the needs of the Area B critical loads, we therefore need at least 20% of peak solar irradiance, which continues on an average August day until 6pm (or actually 7pm given daylight savings time). Due to potential shading issues as the shadows lengthen late in the day, assume that the batteries need to start picking up a portion of the load as early as 5pm, tapering to 7pm, with the equivalent full-load drain from the batteries being from 6pm on.

Therefore, the bridging role of the battery storage system focused on those six evening hours between 6pm and midnight. This design-day scenario requires 6 hrs at 200+kW or roughly 1.3MWh of usable storage. With typical 83% round-trip efficiency for lithium-ion batteries, that storage capacity is just over one-hour of the maximum PV output – a power-to-energy ratio that also corresponds well with many grid-support applications, such as frequency regulation, ramp-rate leveling, and so on.

Including 20% minimum discharge, the Area B energy storage capacity is therefore recommended at 1.6 MWh, yielding a battery capital cost under $2 million. This cost is included in the financial analysis below.

Each utility customer within Area B should be offered the option to pay for additional capacity that would enable them to remain at a given level of operations during an extended outage. For businesses, the cost of ceasing operations or production during an outage may be high enough to make the battery cost attractive. For residents, the cost of a stand-alone emergency generator for their house or multi-family building may similarly be high enough to make the incremental cost of expanding the battery capacity the more attractive option.

Note that these estimates are based on an annual average of four hours of full-sun equivalent per day to maintain the charging level of the battery storage. If sunnier conditions prevail, then additional loads or longer operating hours would be made available, especially if the extended outage occurs during a time of the year with longer daylight hours. In the case of cloudier conditions and/or a winter outage, then agreements about prioritization within these daytime services will be needed, always providing a clear reserve for the critical 24-hour services described above. Fortunately, allocation decisions can be made on the time-scale of an hour or more (unlike the load-shedding operations of only seconds that are needed when energy storage is absent). By the nature of this design, flexibility in response to changing conditions will help maximize the provision of key services to the broader community.

The Role of Load Management

Most loads within Area B are important but not necessarily critical. Unlike Area A, the generation resources within Area B are intermittent, even with the potential inclusion of significant battery storage. Therefore, operational strategies must be implemented to accommodate situations where the microgrid does not have enough power to maintain all loads all the time.

The use of the finite generation and storage resources within Area B should be optimized through a community-focused collaborative process for prioritizing and accommodating a variety of needs. Life-safety will clearly take the lead position, such as the Shore Area Communications Center, along with services to particularly vulnerable demographics such as senior citizens. Core community services such as groceries will presumably rank high as well. Shelter-in-place and other emergency services are planned to be met within the municipal facilities that are part of Area A. This collaborative allocation approach could be implemented using a new Business Improvement District for Area B, which could contribute an important part of any proposed governance process, along with a potential mechanism for project financing. A similar strategy has been pioneered in Connecticut, using Energy Improvement Districts enabled by statewide legislation in 2007 (see https://www.cga.ct.gov/current/pub/chap_585.htm#sec_32-80a).

Connected loads within Area B will include redundant automation and controls to facilitate load management and load shedding capabilities, along with communications to a central controller with appropriate dispatch algorithms. A community process could secure consensus on the relative priority of different Area B loads during a full emergency, during an extended blackout, during a power failure that is expected to be brief, and so on.

To increase the power from the generation resources within Area A to serve loads within Area B, load shedding capabilities there for lower-priority loads should match the similar procedures within Area B.

Next, prioritizing critical loads *within* a specific building means turning off everything else at those sites. Employees will need a documented procedure to follow, and training to go with it. Even more so, at Battle Homes, residents who have medical equipment that simply must stay up and running will need to rely on neighbors and staff to avoid using the TV or the microwave all night long, to avoid overtaxing the combination of generators and batteries.

Note: Technical solutions are available, for example a "red socket" approach that echoes the emergency-power outlets at a hospital. But they are intrusive and would be prohibitively expensive to retrofit for Area B. If the microgrid is implemented as planned, then new construction within Area B could consider including separate circuits for critical power needs. The technical analysis of potential sources and loads provided here represents technically sound and documented concepts and assumptions. The next step in the implementation process will include detailed design and investment-grade analysis and cost estimating process to adequately plan energy demand and generation prioritization.

If the batteries are an integral part of the same Community Solar installation as the PV deployments within Area B, the batteries would presumably utilize a front-of-the-meter connection consistent with community solar pilot's regulatory requirements.

Grid-making capability

During blue-sky conditions, the battery output inverters would operate in current-source mode synched to the JCP&L grid, with charge and discharge cycles that could be tuned to ramp-rate modulation for PV output or that could maximize revenues via frequency regulation services or peak-demand reduction.

During islanded operations of the Microgrid, if the tie between Area A and Area B is closed, then the reciprocating engines located at the Hospital would provide the grid-making capability, and the battery output inverters would remain in current-source mode, synched to the rest of the Microgrid. Charge and discharge cycles would be focused on preserving power for the critical loads within Area B, as described above.

Whenever Area B is sectionalized from the rest of the JCP&L grid and does not have a connection to the rest of the Microgrid (Area A), then the batteries would provide the grid-making capability for Area B, with the output inverters operating in voltage-source mode, with the PV output within Area B synching to frequency, voltage and phase angle established by the batteries. Charge and discharge cycles would again be focused on preserving power for the critical loads within Area B.

Community Solar Implementation Approach

As a town-center microgrid, the various rooftop deployments within Area B would likely be implemented under a single procurement initiated by the Township. The individual site owners may have modest financial incentives to participate, but the instigation for installation would be for the sake of the resiliency and other collective benefits of the microgrid. This background lends itself to the new community solar approach being piloted in New Jersey. In particular, sizing of the solar capacity installed on each rooftop would be maximized in order to increase the resiliency benefit for the Township as a whole and could well be disassociated from the actual load at each particular building. However, the initial community solar pilot has thus far been focused on a single large installation (perhaps ground-mounted), sharing power with multiple subscribers. In Neptune, multiple sites would instead be integrated into a single communal microgrid.

As community solar moves from this year's pilot program to a more comprehensive implementation, the BPU may be asked to consider multiple project sites similar to the one encountered in this microgrid.

Requiring each individual building, with its associated utility billing meter, to limit solar deployments to the precise amount of its own individual annual load may be unnecessary when multiple buildings, rooftops, and loads are prepared to act collectively, precisely as envisioned by the community solar concept. End-users who wish to should be able to aggregate the output of designated solar installations, associated with a particular set of meter numbers. Appropriate regulations could restrict the installations to those sharing a single feeder or alternatively served by a single substation. That pool of solar production should then be available for aggregated net-metering by each participating end users (as defined either by those same meter numbers or by a service address), presumably along with the same up-to-10 additional community subscribers as with any other community solar facility.

This approach also supports a more robust deployment of shared energy storage assets. Requiring each individual owner to find room for batteries, to manage the additional cost, complexity, and operational burden, and to size the battery for their individual set of panels poses unnecessary set of barriers. The collective solar output of multiple nearby buildings can be managed more effectively with a single, larger battery, most likely connected directly to the relevant distribution feeder. It could be sized for the full PV capacity on that feeder and operated to ensure the overall stability of that section of the distribution system. Finally, this approach would raise the hosting capacity of the existing grid, provide invaluable flexibility and responsiveness for distribution system management, and increase resiliency and black-start capabilities during an outage or other grid emergency.

Proposed Business Model for the NTAM

The NTAM includes a cluster of potential sites within Area B that could be included in the overall Microgrid solution. The Area B facilities would not be electrically or thermally connected to the Area A sites. However, extending resiliency to the sites in Area B would enhance the overall value of the Microgrid to the Township and increase the use of renewable energy on the Area B sites. The proposed NTAM includes the following Area B sites.

Neptune Township: Final Area B Facilities	
Location	**Address**
Walgreens	1905 NJ-33, Neptune City, NJ 07753
Electro Impulse	1805 NJ-33, Neptune City, NJ 07753
1930 Heck Ave	1930 Heck Ave Neptune City, NJ 07753
Excelsior Medical	1933 Heck Ave, Neptune City, NJ 07753
Simply Self Storage	1515 Washington Ave, Neptune City, NJ 07753
Unemployment Office	60 Taylor Ave N, Neptune City, NJ 07753
Senior Center	1607 NJ-33, Neptune City, NJ 07753
Physicians' offices	1820 NJ-33, Neptune City, NJ 07753
Aldi Foods	15 NJ Hwy 35, Neptune City, NJ 07753
Wawa	1344 Corlies Ave, Neptune City, NJ 07753
Delta Fuel Station	1800 Corlies Avenue, Neptune City, NJ 07753
Shore Area Communications Center	1825 NJ-33, Neptune City, NJ 07753
Post Office	50 Neptune Blvd, Neptune City, NJ 07753
Battle Homes	56 N Taylor Ave, Neptune City, NJ 07753
First Aid Squad	5 Neptune Boulevard, Neptune City, NJ 07753

The Area B Microgrid would include Roof-mounted PV systems combined with one or more batteries. During Blue-sky operations, the PV systems will produce renewable electricity for use at the host site. The batteries can enhance the PV systems by extending the use of PV system energy during times when the solar resource is not available. In this way, all the PV system energy is used on-site. During Black-sky conditions, the PV system and battery assets would work tougher to provide electricity to the Area B customers. While energy during Black-sky conditions would not be unlimited (as in the case with Area A customers), the expectation is that electricity would be provided to Critical Loads within Area B, enhancing the overall resiliency value to the Township.

Most of the Area B properties are contiguous and have a total estimated annual electric consumption of 9,070,396 kWh. We have assumed that the current all-in electric rate paid by these sites is $0.12/KWH on average.[8]

The proposed Microgrid includes installing these additional generation assets:

[8] Since utility bills were not available for Area B, we have assumed a similar rate to that paid by Area A sites

Neptune Township: Area B - PV System Sizing		
Location	Address	Estimated Potential (kW)
Walgreens	1905 NJ-33, Neptune City, NJ 07753	40
Electro Impulse	1805 NJ-33, Neptune City, NJ 07753	275
1930 Heck Ave	1930 Heck Ave Neptune City, NJ 07753	225
Excelsior Medical	1933 Heck Ave, Neptune City, NJ 07753	400
Simply Self Storage	1515 Washington Ave, Neptune City, NJ 07753	300
Unemployment Office	60 Taylor Ave N, Neptune City, NJ 07753	125
Senior Center	1607 NJ-33, Neptune City, NJ 07753	70
Physicians' offices	1820 NJ-33, Neptune City, NJ 07753	40
Aldi Foods	15 NJ Hwy 35, Neptune City, NJ 07753	100
Wawa	1344 Corlies Ave, Neptune City, NJ 07753	35
	Total PV Estimated Capacity (kW DC):	**1610**
	Total PV Estimated Capacity (kW AC):	**1320.2**

The total technical potential for solar PV throughout Area B is estimated at 2.1 MW (AC). It is reasonable to expect the listed installed capacity, roughly 1.3 MW, after accounting for site specific constraints. In addition to deploying rooftop solar PV systems, the Area B microgrid contemplates installing up to a 1MW battery with approximately 1.6 MWh storage that can be paired with the PV to provide resilience during black sky events.

PV system installations totaling 1.3 MW will produce an estimated 1,665,300 kWh of electricity annually, which represents 18% of Area B's total consumption. Under Blue-sky conditions, each site would enter into a PPA with the Microgrid owner for supply of energy produced by the solar panels. The battery would be used to store excess solar and discharge during non-generating hours, thereby ensuring that all the solar energy is consumed on-site. In the event of a grid outage, the PV system and battery systems would together provide backup power to critical sites.

Financial Summary

A summary of financial parameters for the Area B Microgrid is listed in the Table below. Based on the costs, revenues, and IRR, the Area B Microgrid is financially and technically viable. Including this as part of the overall Microgrid would greatly enhance the resiliency capacity of the Microgrid for the Township and add value to the Area B sites during both Blue-sky and Black-sky conditions.

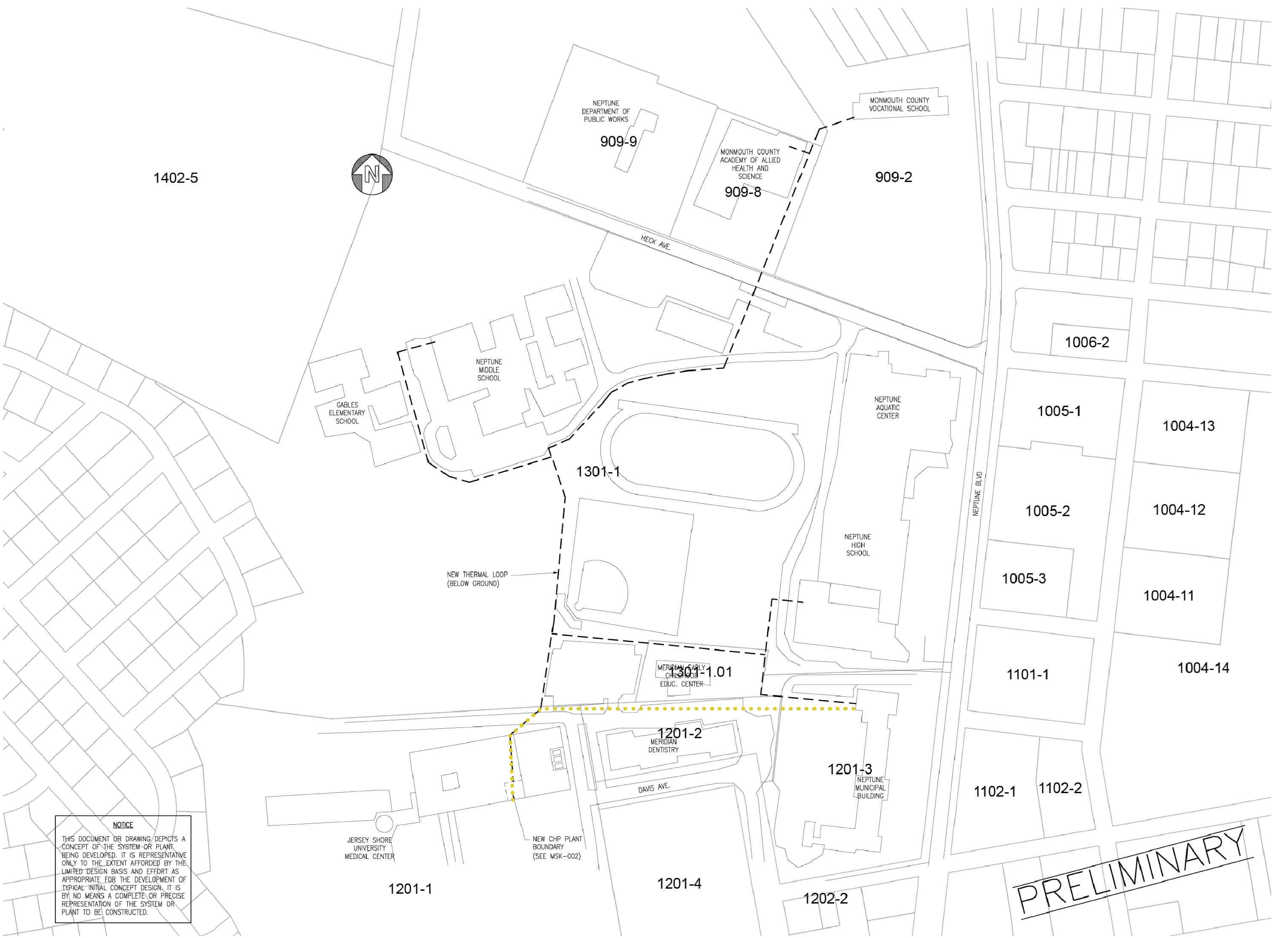
Total PV System capex	$3,250,000
Total Battery capex	$1,820,000
Total Project capex	**$5,070,000**
Annual Solar O&M	$15,600
Annual Battery O&M	$20,000
Total annual O&M expense	**$35,600**
Annual Electricity Bill to Area B	**$199,836** (Escalate at 2% per year)
Project IRR for Equity Partner	**11.3 %**

There would be additional costs required for sectionalizing gear to isolate the target buildings within Area B during Black Sky events. However, as in the case of adding the new feeder for Area A, it would be an appropriate role of the utility to install and recover those costs as part of its overall rate base. These new distribution automation functions would ensure that Area B continues to be served even under Black Sky conditions, an important capability for the utility, in conjunction with the Microgrid, to achieve. The same equipment will also provide greater maintainability for the utility's existing assets under Blue Sky conditions and will reduce service restoration times for utility repair crews in the event of smaller outages and equipment failures that fall well short of a full Black Sky scenario.

This financial analysis omits the multiple blue-sky revenue streams that the batteries could potentially generate, from PJM frequency regulation to helping manage monthly demand charges for the Area A loads and the Hospital. It also omits any economies of scale if other businesses or residents choose to pay for incremental additions to battery capacity, in order to avoid having to shed some or all of their own loads during an outage. Finally, as was the case with Area A, some capital costs could potentially be covered by public funding from appropriate agencies that are responsible for emergency response and community safety, in order to provide precisely the town-center microgrid functions that this design is intended to fulfill.

Appendices

Appendix A – Electric and Thermal Distribution Network Diagram – Path 1



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NEPTUNE TOWNSHIP ADVANCED MICROGRID

No.	Submittal / Revision	App'd.	By	Date
PA	ISSUED FOR REVIEW	CC	DM	17/08/18
PB	ISSUED FOR REVIEW	CC	BG	22/08/18

AREA A THERMAL LOOP PATH 1

Designed By:	Drawn By:	Checked By:
CC	DM	CC
Issue Date:	Project No:	Scale:
20180817	33808	NONE

Drawing No.:

MSK-001A

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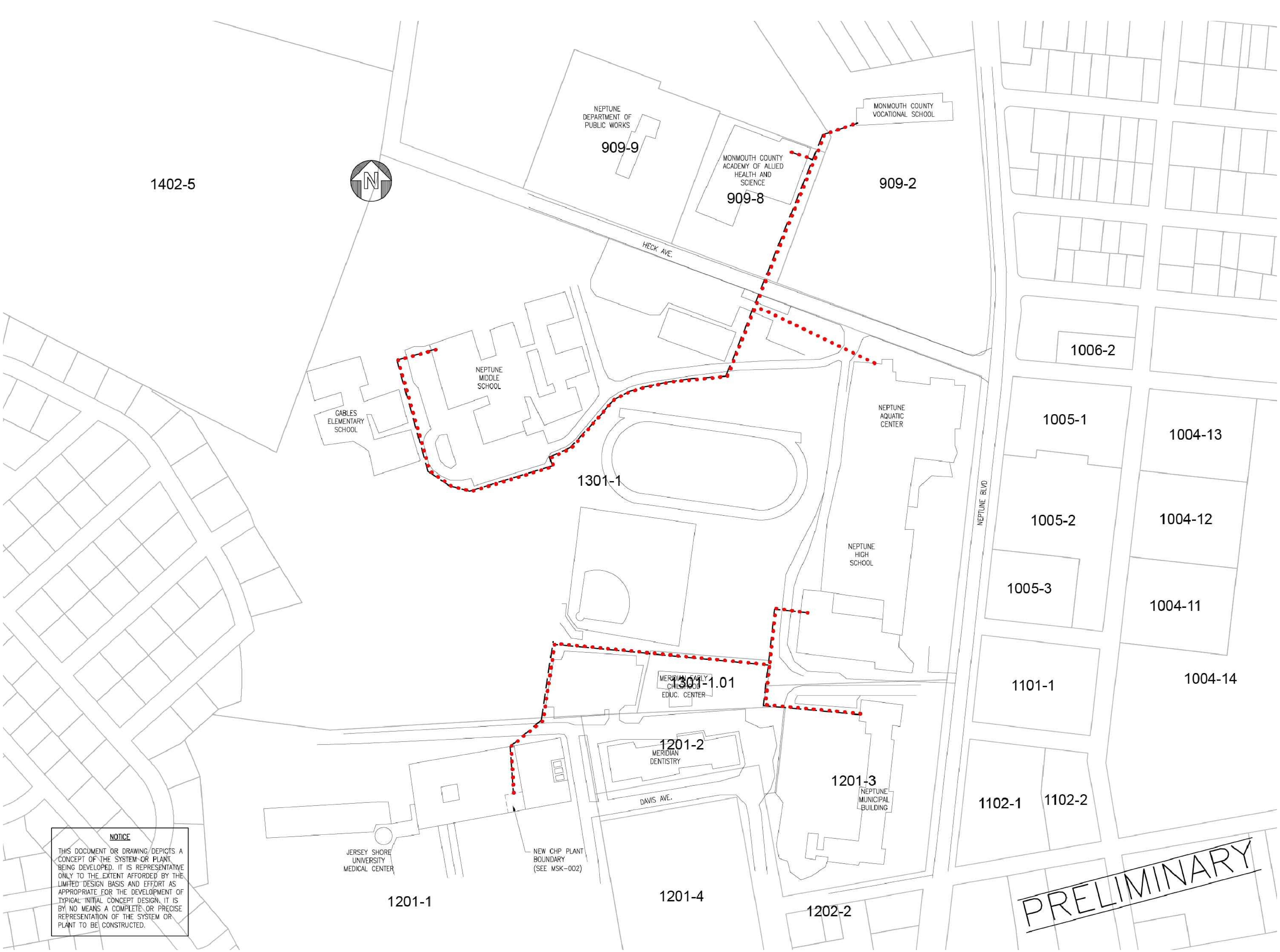
Appendix B – Thermal Distribution Network Diagram – Path 2



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NEPTUNE TOWNSHIP
ADVANCED MICROGRID

No.	Submittal / Revision	App'd.	By	Date
PA	ISSUED FOR REVIEW	CC	DM	17/08/18
PB	ISSUED FOR REVIEW	CC	BG	22/08/18

AREA A
THERMAL LOOP
PATH 2

Designed By:	Drawn By:	Checked By:
CC	DM	CC
Issue Date:	Project No:	Scale:
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Drawing No.:
MSK-001B

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Appendix C – Area A Proposed PV System Layouts - Helioscope

Neptune Municipal Building Neptune Microgrid Area A, 2201 Heck Ave, Neptune City, NJ 07753

Design

Design	Neptune Municipal Building
DC Nameplate	62.7 kW
AC Nameplate	52.7 kW (1.19 DC/AC)
Last Modified	Tom Brys (05/10/2018)

Project Location

Components

Component	Name	Count
Inverters	SB4000TL-US-22 (208V) (SMA)	13 (52.7 kW)
Strings	10 AWG (Copper)	26 (1,114.3 ft)
Module	Trina Solar, TSM-315 PD14 2014_05 (315W)	199 (62.7 kW)

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Lower Roof	Fixed Tilt	Landscape (Horizontal)	5°	186.137°	0.7 ft	1x1	45	45	14.2 kW
lower roof 2	Fixed Tilt	Landscape (Horizontal)	5°	186.137°	0.7 ft	1x1	77	77	24.3 kW
Upper Roof 1	Fixed Tilt	Landscape (Horizontal)	5°	186.137°	0.7 ft	1x1			0
Upper Roof 2	Fixed Tilt	Landscape (Horizontal)	5°	186.137°	0.7 ft	1x1	77	77	24.3 kW

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	5-12	Along Racking

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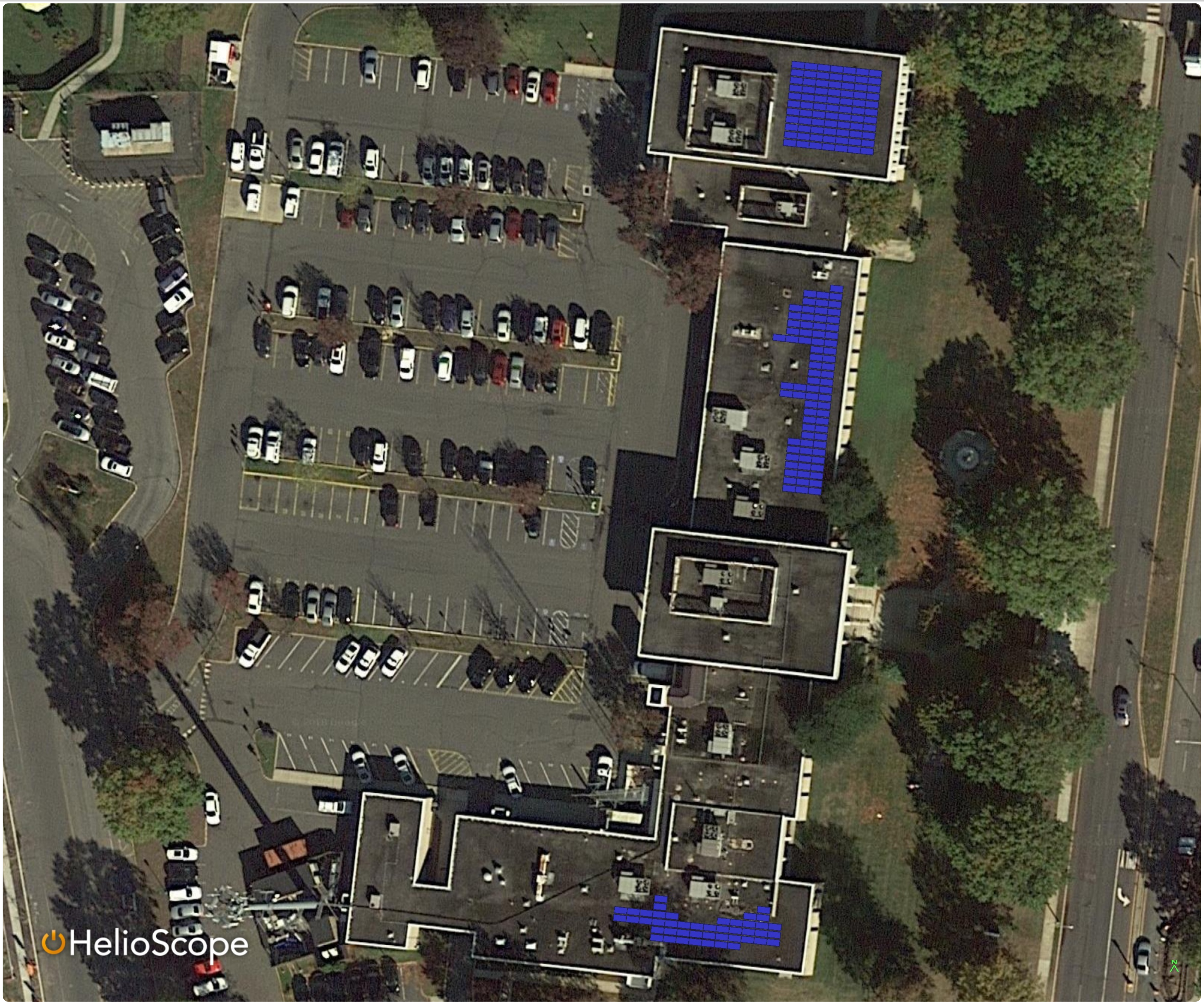
Detailed Layout



Dept of Public Works Neptune Microgrid Area A, 2201 Heck Ave, Neptune City, NJ 07753

Design

Design	Dept of Public Works
DC Nameplate	44.7 kW
AC Nameplate	36.5 kW (1.23 DC/AC)
Last Modified	Tom Brys (05/10/2018)

Project Location

Components

Component	Name	Count
Inverters	SB4000TL-US-22 (208V) (SMA)	9 (36.5 kW)
Strings	10 AWG (Copper)	18 (918.2 ft)
Module	Trina Solar, TSM-PEG14 315W (315W)	142 (44.7 kW)

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	5°	109.772°	0.7 ft	1x1	142	142	44.7 kW

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	5-11	Along Racking

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Detailed Layout

Hackensack-Meridian University Medical Center Neptune Microgrid Area A, 2201 Heck Ave, Neptune City, NJ 07753

Design

Design	Hackensack-Meridian University Medical Center
DC Nameplate	493.0 kW
AC Nameplate	400.0 kW (1.23 DC/AC)
Last Modified	Tom Brys (Today at 11:40 AM)

Project Location

Components

Component	Name	Count
Inverters	Sunny Central SC 100 outdoor HE (SMA)	4 (400.0 kW)
Strings	10 AWG (Copper)	84 (29,089.9 ft)
Module	Trina Solar, TSM-PEG14 315W (315W)	1,565 (493.0 kW)

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	5°	170.942°	0.7 ft	1x1	284	284	89.5 kW
Field Segment 2	Fixed Tilt	Landscape (Horizontal)	5°	170.942°	0.7 ft	1x1	120	120	37.8 kW
Field Segment 3	Fixed Tilt	Landscape (Horizontal)	5°	170.942°	0.7 ft	1x1	94	94	29.6 kW
Field Segment 4	Fixed Tilt	Landscape (Horizontal)	5°	170.942°	0.7 ft	1x1	370	370	116.6 kW
Field Segment 5	Fixed Tilt	Landscape (Horizontal)	5°	170.942°	0.7 ft	1x1	130	130	41.0 kW
Field Segment 6	Fixed Tilt	Landscape (Horizontal)	5°	170.942°	0.7 ft	1x1	85	85	26.8 kW
Field Segment 7	Fixed Tilt	Landscape (Horizontal)	5°	170.942°	0.7 ft	1x1	482	482	151.8 kW

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	13-19	Along Racking

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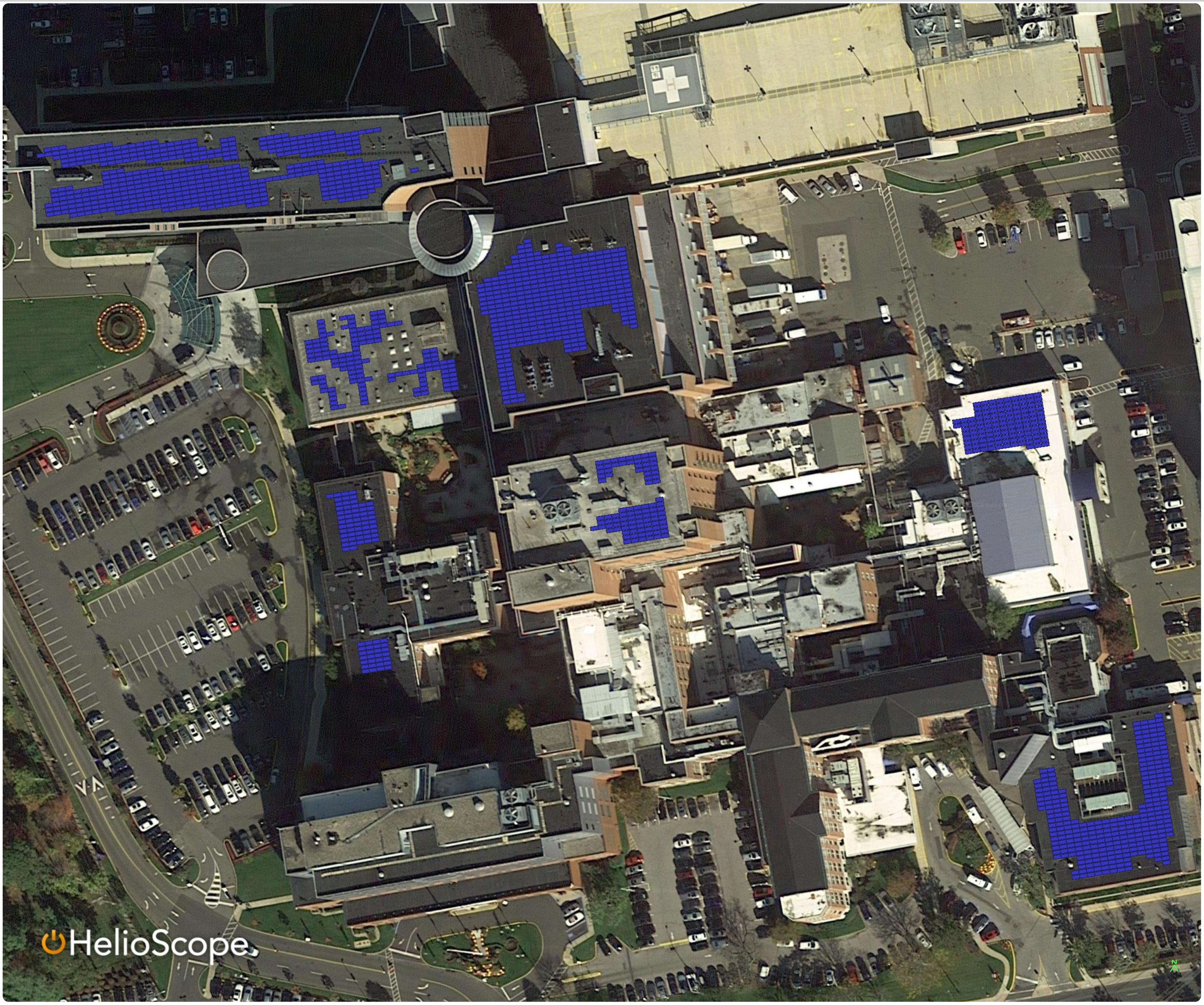
Detailed Layout



Neptune High School Neptune Microgrid Area A, 2201 Heck Ave, Neptune City, NJ 07753

Design

Design	Neptune High School
DC Nameplate	484.5 kW
AC Nameplate	400.0 kW (1.21 DC/AC)
Last Modified	Tom Brys (05/10/2018)

Project Location

Components

Component	Name	Count
Inverters	Sunny Central SC 100 outdoor HE (SMA)	4 (400.0 kW)
Strings	10 AWG (Copper)	78 (18,280.8 ft)
Module	Trina Solar, TSM-315 PD14 2014_05 (315W)	1,538 (484.5 kW)

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Upper Roof	Fixed Tilt	Landscape (Horizontal)	5°	185.578°	0.7 ft	1x1			0
Mid Roof	Fixed Tilt	Landscape (Horizontal)	5°	185.578°	0.7 ft	1x1	761	761	239.7 kW
Lower Roof	Fixed Tilt	Landscape (Horizontal)	5°	185.578°	0.7 ft	1x1	403	403	126.9 kW
mid roof 2	Fixed Tilt	Landscape (Horizontal)	5°	185.578°	0.7 ft	1x1	374	374	117.8 kW

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	13-21	Along Racking

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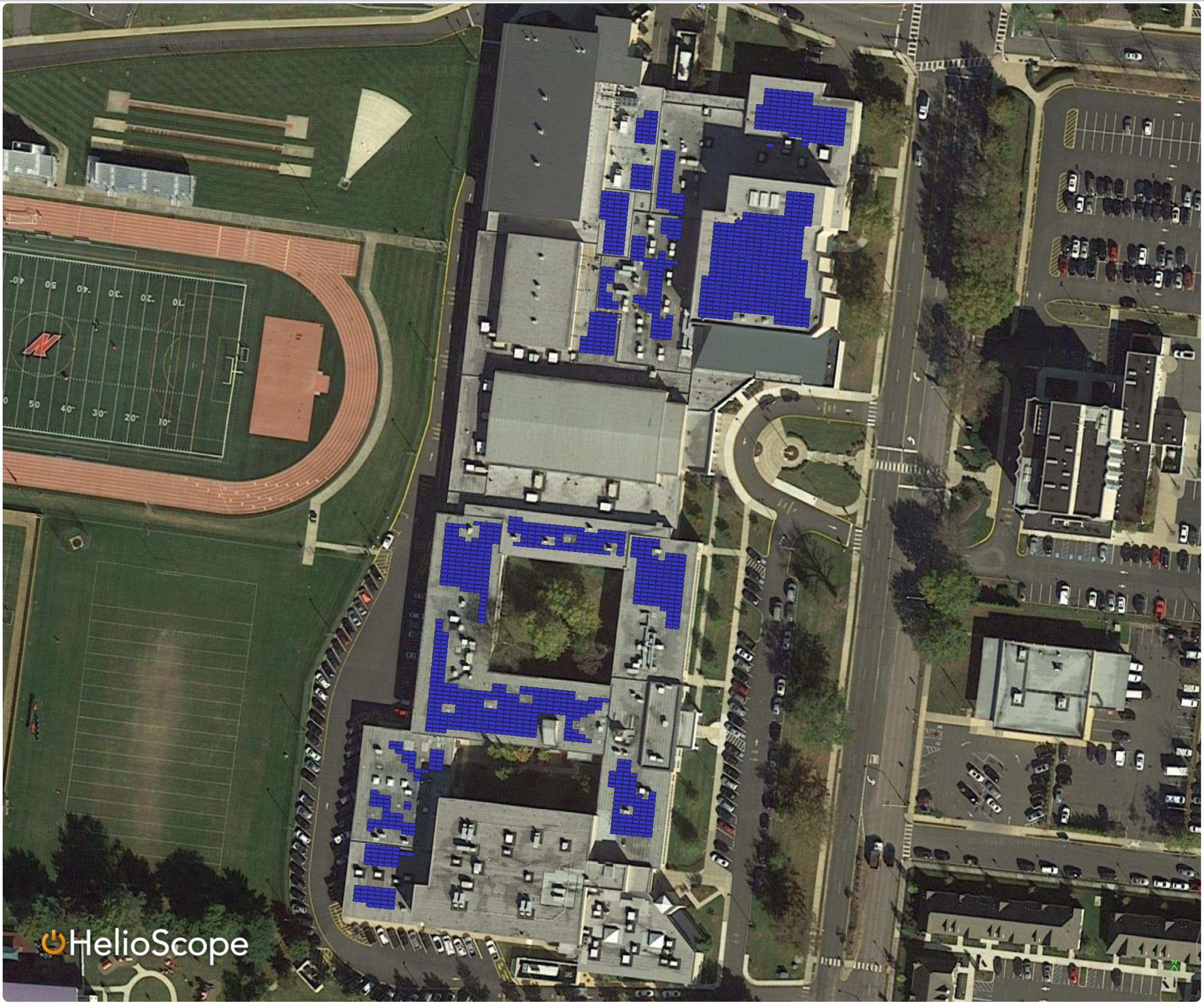
Detailed Layout



Neptune Aquatic Center Neptune Microgrid Area A, 2201 Heck Ave, Neptune City, NJ 07753

Design

Design	Neptune Aquatic Center
DC Nameplate	120.6 kW
AC Nameplate	100.0 kW (1.21 DC/AC)
Last Modified	Tom Brys (05/10/2018)

Project Location

Components

Component	Name	Count
Inverters	STP 50-40 (SMA)	2 (100.0 kW)
Strings	10 AWG (Copper)	21 (1,630.2 ft)
Module	Trina Solar, TSM-315 PD14 2014_05 (315W)	383 (120.6 kW)

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Upper Roof	Fixed Tilt	Landscape (Horizontal)	5°	185.578°	0.7 ft	1x1			0
Mid Roof	Fixed Tilt	Landscape (Horizontal)	5°	185.578°	0.7 ft	1x1			0
Lower Roof	Fixed Tilt	Landscape (Horizontal)	5°	185.578°	0.7 ft	1x1			0
mid roof 2	Fixed Tilt	Landscape (Horizontal)	5°	185.578°	0.7 ft	1x1			0
Aquatic Center	Fixed Tilt	Landscape (Horizontal)	5°	185.578°	0.7 ft	1x1	383	383	120.6 kW

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	14-21	Along Racking

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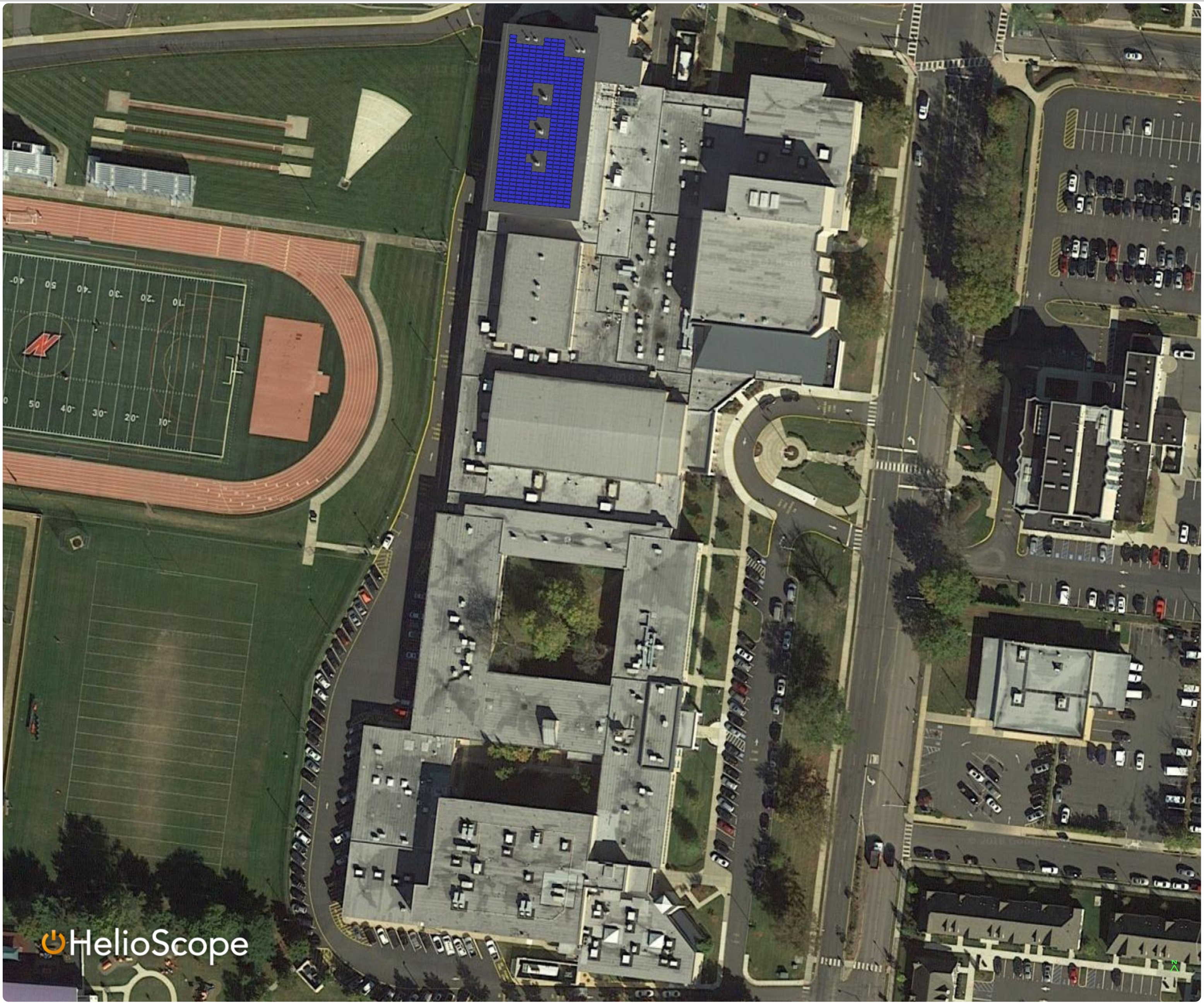
Detailed Layout



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Monmouth County Academy of Allied Health & Science Neptune Microgrid Area A, 2201 Heck Ave, Neptune City, NJ 07753

Design

Design	Monmouth County Academy of Allied Health & Science
DC Nameplate	186.2 kW
AC Nameplate	150.0 kW (1.24 DC/AC)
Last Modified	Tom Brys (05/10/2018)

Project Location

Components

Component	Name	Count
Inverters	STP 50-40 (SMA)	3 (150.0 kW)
Strings	10 AWG (Copper)	33 (4,946.9 ft)
Module	Trina Solar, TSM-PEG14 315W (315W)	591 (186.2 kW)

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Lower Roof	Fixed Tilt	Landscape (Horizontal)	5°	109.772°	0.7 ft	1x1	385	385	121.3 kW
Upper Roof	Fixed Tilt	Landscape (Horizontal)	5°	109.772°	0.7 ft	1x1	206	206	64.9 kW
Obstruction	Fixed Tilt	Landscape (Horizontal)	5°	109.772°	0.7 ft	1x1			0

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	15-19	Along Racking

Detailed Layout

Neptune Middle School Neptune Microgrid Area A, 2201 Heck Ave, Neptune City, NJ 07753

Design

Design	Neptune Middle School
DC Nameplate	323.8 kW
AC Nameplate	300.0 kW (1.08 DC/AC)
Last Modified	Tom Brys (05/10/2018)

Project Location

Components

Component	Name	Count
Inverters	Sunny Central SC 100 outdoor HE (SMA)	3 (300.0 kW)
Strings	10 AWG (Copper)	52 (13,437.0 ft)
Module	Trina Solar, TSM-315 PD14 2014_05 (315W)	1,028 (323.8 kW)

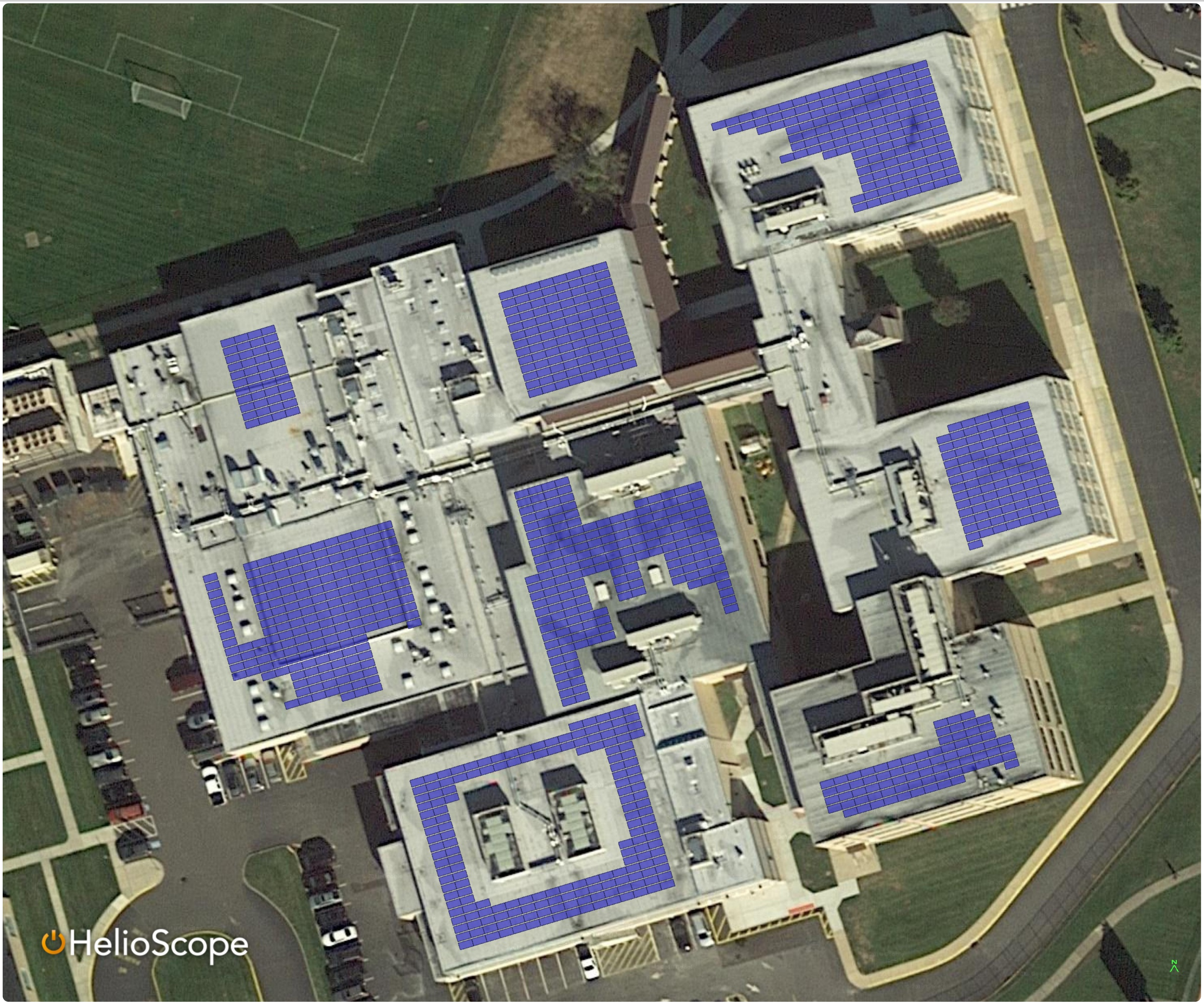
Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Neptune Middle School	Fixed Tilt	Landscape (Horizontal)	5°	163.411°	0.7 ft	1x1	1,028	1,028	323.8 kW

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	13-21	Along Racking

Detailed Layout



Gables Elementary School Neptune Microgrid Area A, 2201 Heck Ave, Neptune City, NJ 07753

Design

Design	Gables Elementary School
DC Nameplate	167.0 kW
AC Nameplate	150.0 kW (1.11 DC/AC)
Last Modified	Tom Brys (05/10/2018)

Project Location

Components

Component	Name	Count
Inverters	STP 50-40 (SMA)	3 (150.0 kW)
Strings	10 AWG (Copper)	27 (5,325.5 ft)
Module	Trina Solar, TSM-315 PD14 2014_05 (315W)	530 (167.0 kW)

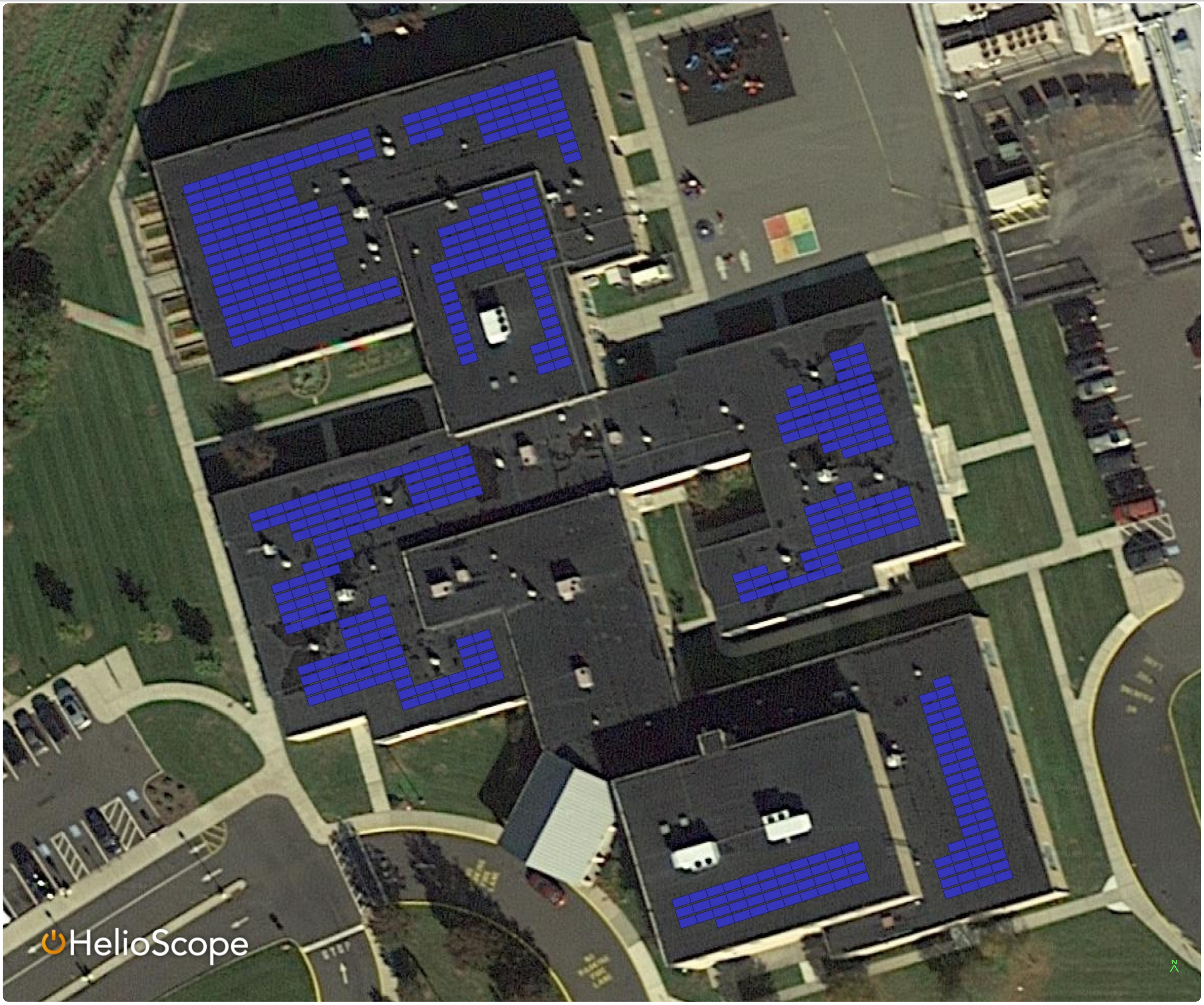
Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Lower Roof	Fixed Tilt	Landscape (Horizontal)	5°	162.474°	0.7 ft	1x1	488	488	153.7 kW
Upper Roof	Fixed Tilt	Landscape (Horizontal)	5°	162.474°	0.7 ft	1x1	42	42	13.2 kW

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	14-21	Along Racking

Detailed Layout



Brookdale Community College Neptune Microgrid Area B, 1905 NJ-33, Neptune City, NJ 07753

Design

Design	Brookdale Community College
DC Nameplate	16.6 kW
AC Nameplate	14.0 kW (1.19 DC/AC)
Last Modified	Tom Brys (05/07/2018)

Project Location

Components

Component	Name	Count
Inverters	Sunny Boy 2000 (SMA)	7 (14.0 kW)
Strings	10 AWG (Copper)	7 (0.0 ft)
Module	Trina Solar, TSM-PD14 320 (May16) (320W)	52 (16.6 kW)

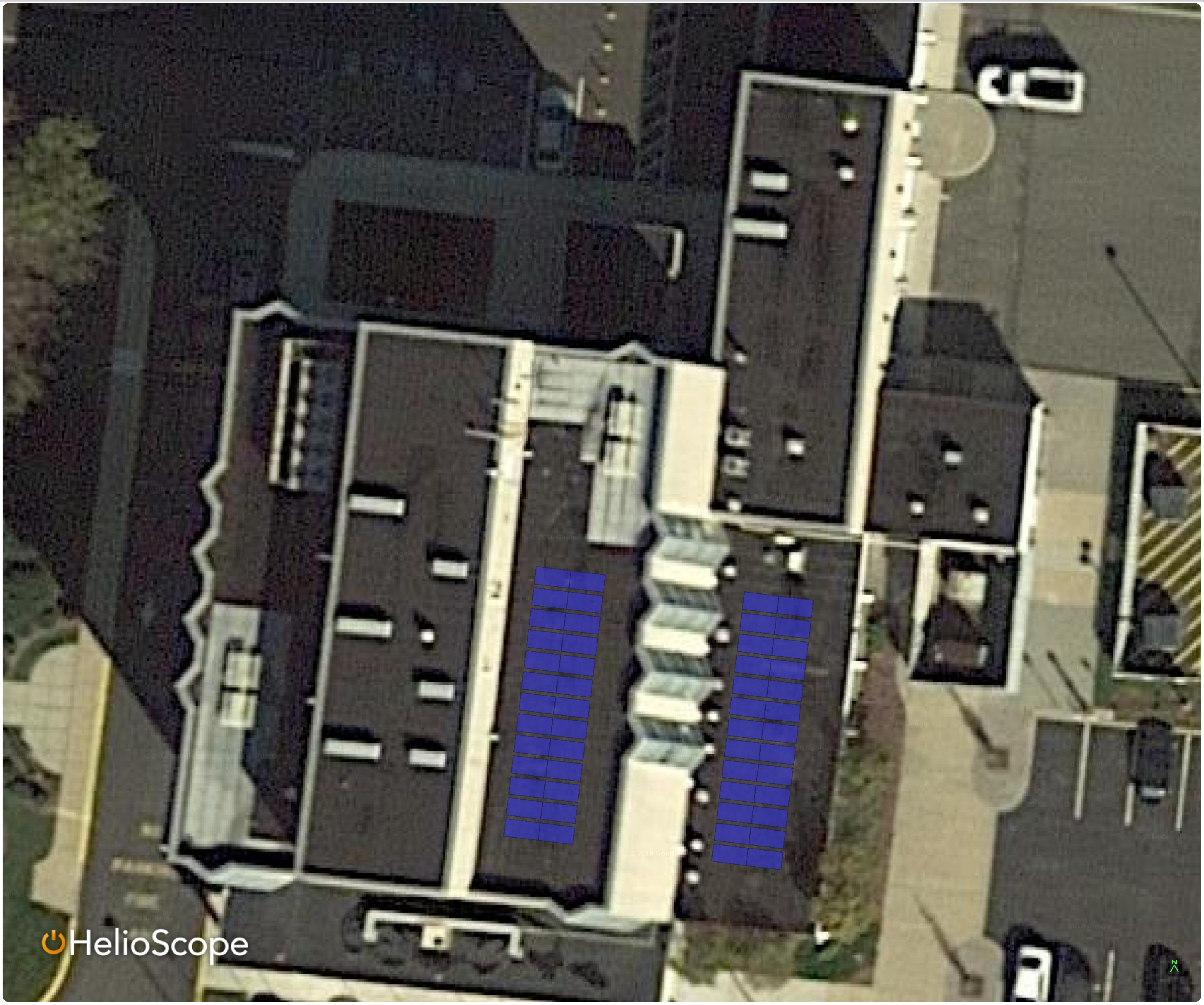
Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
BCC	Fixed Tilt	Landscape (Horizontal)	5°	186.934°	0.7 ft	1x1	52	52	16.6 kW

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	4-11	Along Racking

Detailed Layout



Vocational School Neptune Microgrid Area A, 2201 Heck Ave, Neptune City, NJ 07753

Design

Design	Vocational School
DC Nameplate	86.9 kW
AC Nameplate	72.9 kW (1.19 DC/AC)
Last Modified	Tom Brys (05/10/2018)

Project Location

Components

Component	Name	Count
Inverters	SB4000TL-US-22 (208V) (SMA)	18 (72.9 kW)
Strings	10 AWG (Copper)	36 (4,111.6 ft)
Module	Trina Solar, TSM-PEG14 315W (315W)	276 (86.9 kW)

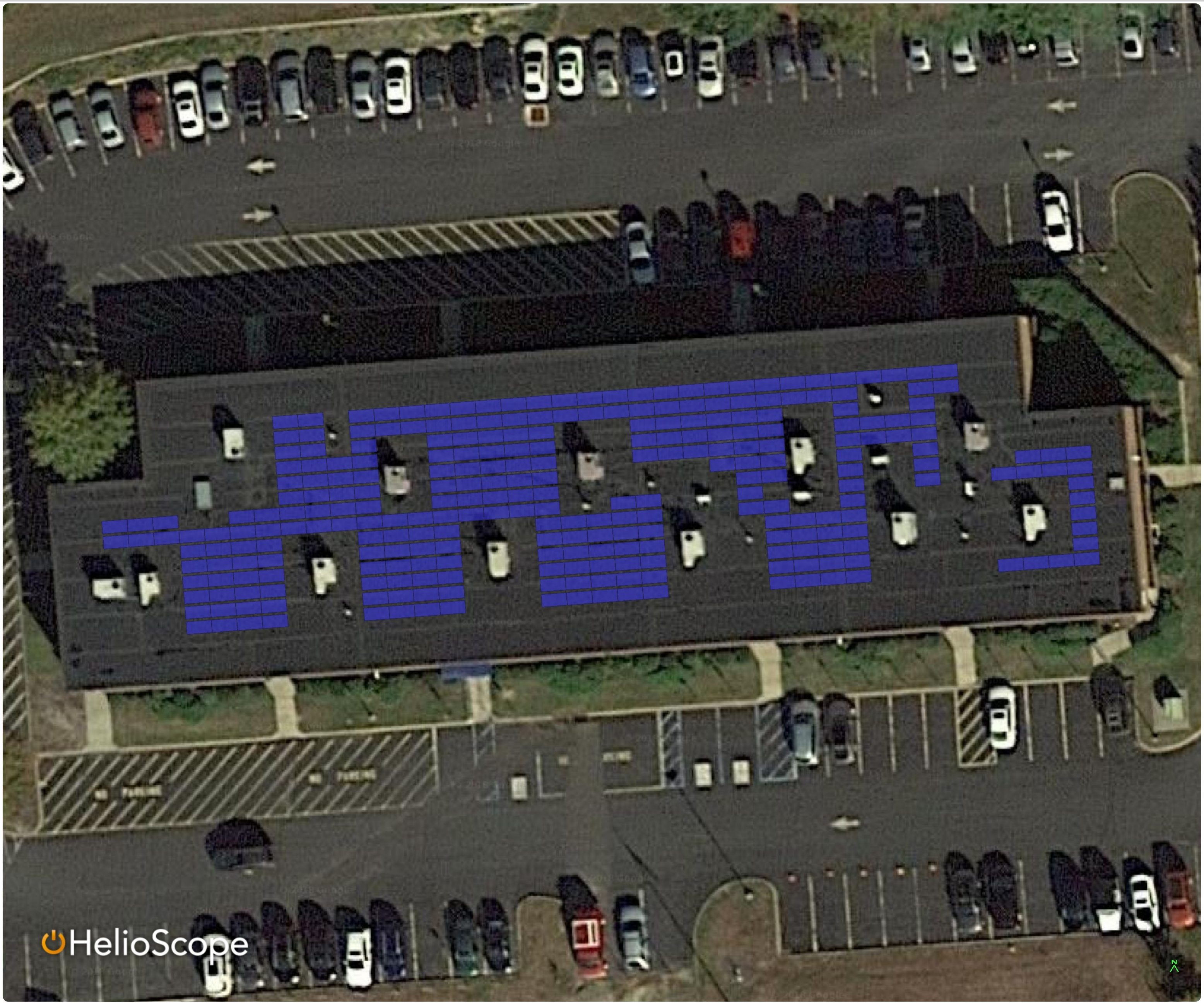
Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Vocational School	Fixed Tilt	Landscape (Horizontal)	5°	175.601°	0.7 ft	1x1	276	276	86.9 kW

Wiring Zones

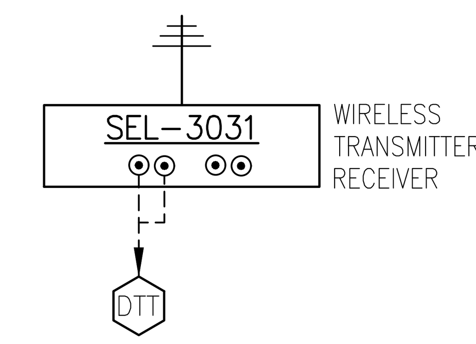
Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	5-11	Along Racking

Detailed Layout



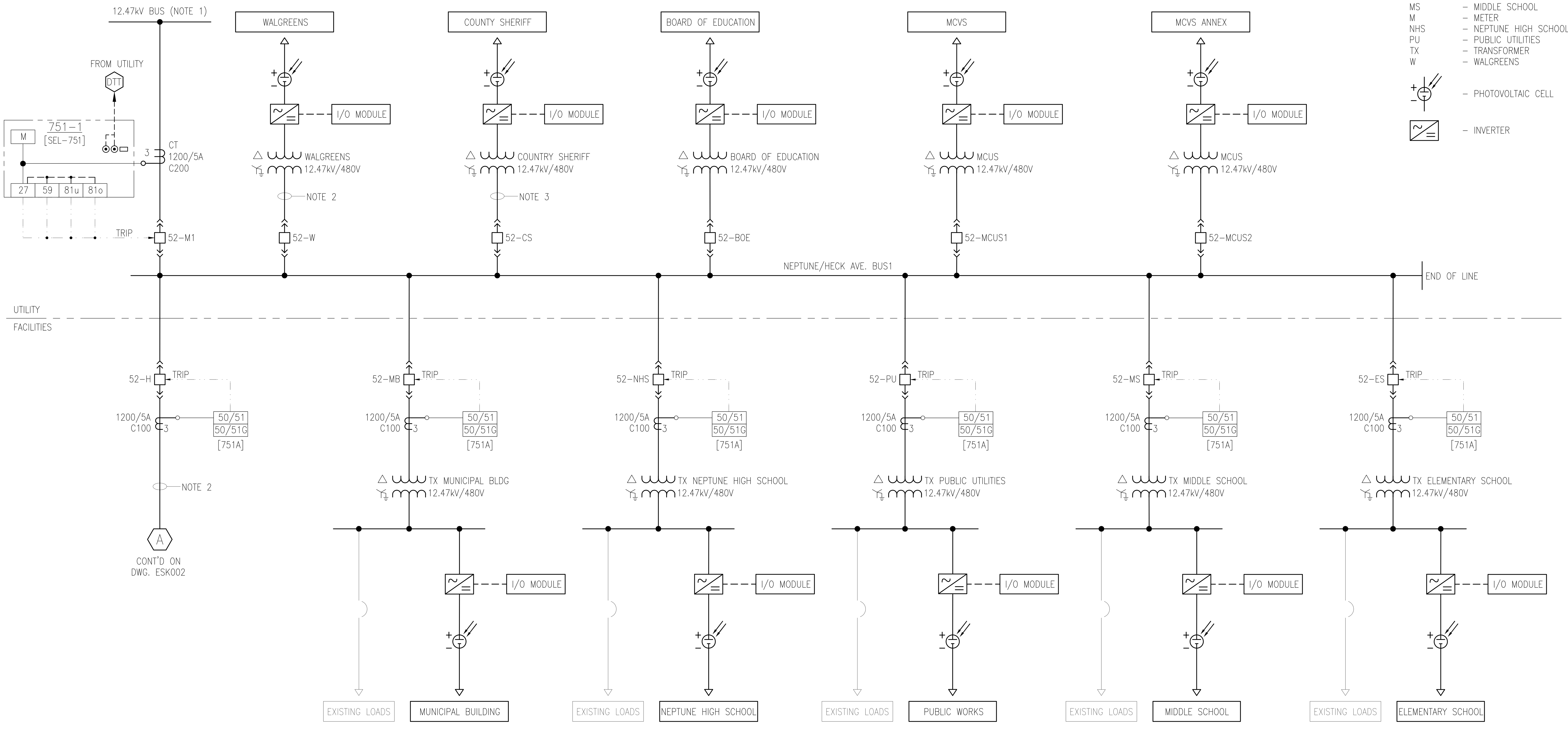
Appendix D – One-Line Diagram of Area A

NOTES:
1. CLIP WIRES AT CORLIES AVE (JC2044NPT & WALGREENS).
2. NEW UNDERGROUND LINE FROM THE HOSPITAL TO WALGREENS NEW SUBSTATION.
3. NEW UNDERGROUND CABLE TO COUNTY SHERIFF BUILDING.



LEGEND:

27	– UNDERVOLTAGE RELAY
52	– CIRCUIT BREAKER
50/51	– PHASE INSTANTANEOUS & TIME OVERCURRENT RELAY
50/51G	– GROUND PHASE INSTANTANEOUS & TIME OVERCURRENT RELAY
59	– OVERVOLTAGE RELAY
81u	– UNDER FREQUENCY RELAY
81o	– OVER FREQUENCY RELAY
BOE	– BOARD OF EDUCATION
CS	– COUNTY SHERIFF
DTT	– DIRECT TRANSFER TRIP
ES	– ELEMENTARY SCHOOL
H	– HOSPITAL
MB	– MUNICIPAL BUILDING
MCUS	– MONMOUTH COUNTY VOCATIONAL SCHOOL
MS	– MIDDLE SCHOOL
M	– METER
NHS	– NEPTUNE HIGH SCHOOL
PU	– PUBLIC UTILITIES
TX	– TRANSFORMER
W	– WALGREENS
(PV symbol)	– PHOTOVOLTAIC CELL
(inverter symbol)	– INVERTER



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NEPTUNE TOWNSHIP ADVANCED MICROGRID

No.	Submittal / Revision	App'd	By	Date
PA	Issued for	SK	MS	MM/DD/18

OVERALL SINGLE LINE DIAGRAM AREA A

Designed By:	Drawn By:	Checked By:
SK	MS	SK
Issue Date:	Project No:	Scale:
MM/DD/2018	33808	NONE

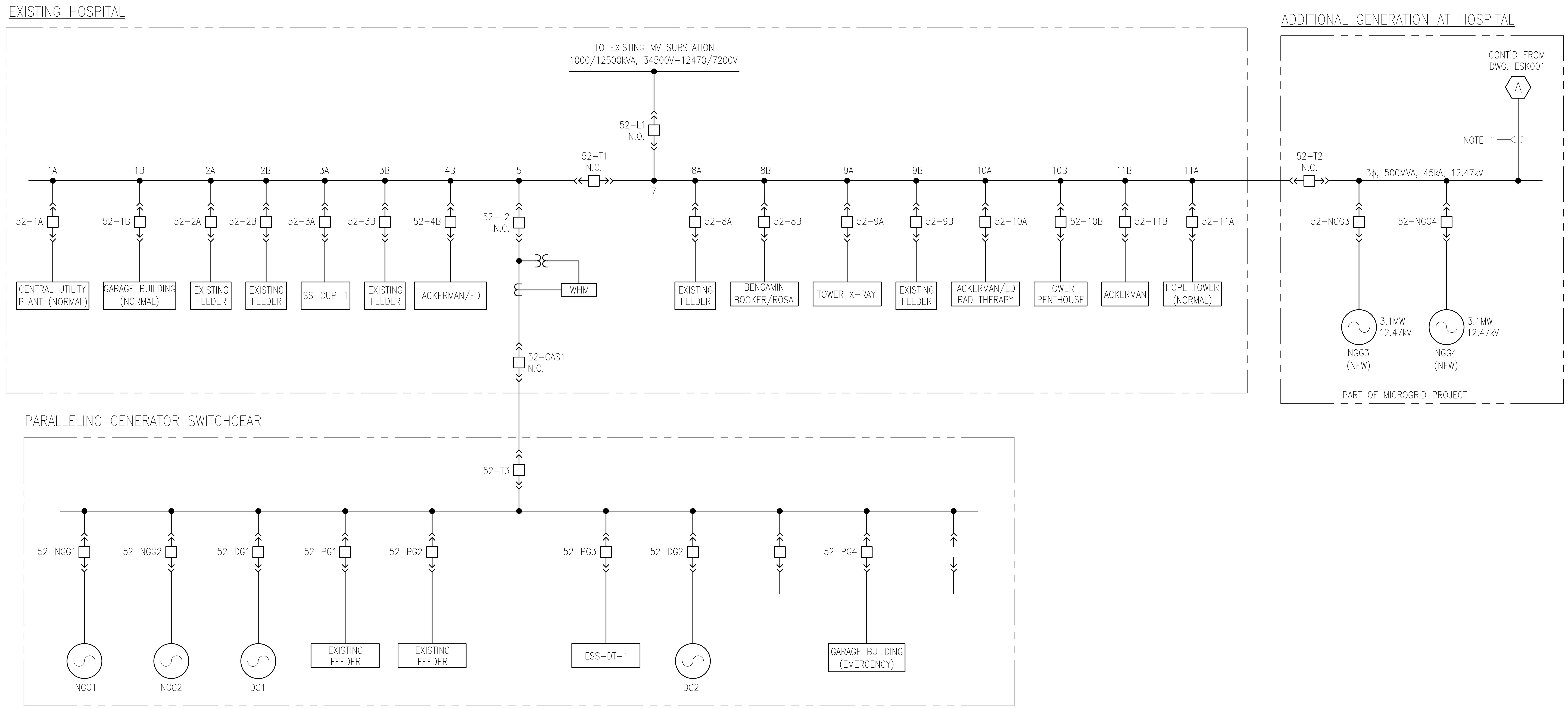
Drawing No:

ESK001

NOTES:
1. NEW UNDERGROUND LINE FROM THE HOSPITAL TO WALGREENS NEW SUBSTATION.

LEGEND:

52	– CIRCUIT BREAKER
50/51	– PHASE INSTANTANEOUS & TIME OVERCURRENT RELAY
50/51G	– GROUND PHASE INSTANTANEOUS & TIME OVERCURRENT RELAY
DS	– DIESEL GENERATOR
NGG	– NATURAL GAS GENERATOR



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NEPTUNE TOWNSHIP
ADVANCED MICROGRID

No.	Submittal / Revision	App'd	By	Date
PA	Issued for	SK	MS	MM/DD/18

HOSPITAL SINGLE LINE DIAGRAM AREA A

Designed By:	Drawn By:	Checked By:
SK	MS	SK
Issue Date:	Project No:	Scale:
MM/DD/2018	33808	NONE

Drawing No:

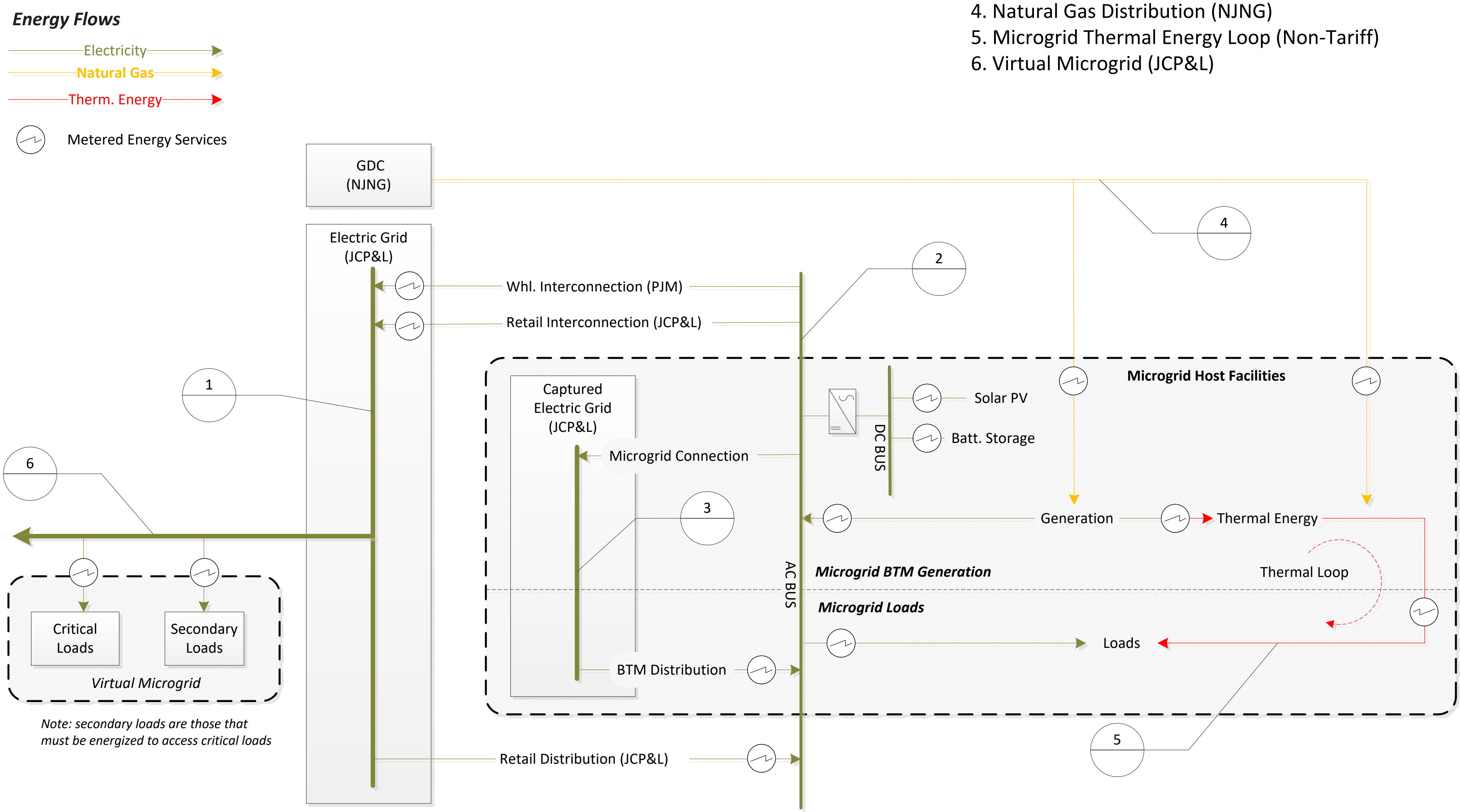
ESK002

Appendix E – NTAM Tariff Model

FIGURE 1:
Neptune Township Advanced Microgrid
"Unbundled Utility" Tariff Structure

The NTAM Tariff Structure

1. Distribution Grid (JCP&L/PJM)
2. Microgrid Generation Bus (Non-Tariff)
3. Captured JCP&L Distribution Grid (Non-Tariff)
4. Natural Gas Distribution (NJNG)
5. Microgrid Thermal Energy Loop (Non-Tariff)
6. Virtual Microgrid (JCP&L)



Note: secondary loads are those that must be energized to access critical loads

Contact: Matthew Brener, BRS, Inc., (267) 688-7301 |matthew@brsinc.com

Appendix F – DER CAM Microgrid Modelling Detail

The Microgrid solution discussed for Area A was simulated in DER-CAM. DER CAM is a Microgrid optimization software developed by the Lawrence Berkley National Lab.

The simulation included the following Microgrid facilities: Neptune Municipal Building (which includes the Police Department and Library), Hackensack-Meridian University Medical Center, Neptune Department of Public Works, Gables Elementary School, Neptune High School (including the Aquatic Center), Neptune Middle School, BoE / Brookdale Community College, Monmouth County Academy of Allied Health & Science, and Monmouth County Vocational School: Neptune Annex.

Energy Cost Modeling

To determine the baseline annual energy expenditures for the Microgrid, the Medical Center was modelled separately to reflect energy costs that are different than the rest of Area A. This facility pays an average price of $0.10/kWh year-round. The schools and municipal buildings were modelled using an average New Jersey commercial electricity rate of $0.13/kWh. The final Microgrid model, which connects the Medical Center to the rest of the Microgrid facilities through a new electric connection, used a $0.1059/kWh weighted average electricity cost (this is due to DER CAM's limit of one all-in electric price). The total non-hospital annual electricity load is 12.6 GWh while the hospital annual electricity use is 51.5 GWh per year. The increased volume of energy consumed by the Hospital contributes to the relatively lower cost of electricity. Fuel costs were uniform throughout ($0.74/therm converted to $0.0252/kWh for DER CAM).

Load profiles for facilities (hospital, secondary school, small office, etc.) were selected within DER CAM which most closely resembled the use type of each Microgrid facility. Maryland most closely reflected the energy use profile of New Jersey from those available in the software and was used as a proxy climate. DER CAM scales these load profiles based on the actual total natural gas and electricity use of the building. We used actual utility bills to determine each buildings' total annual energy use, which DER CAM then scaled to the applicable facility load profile.

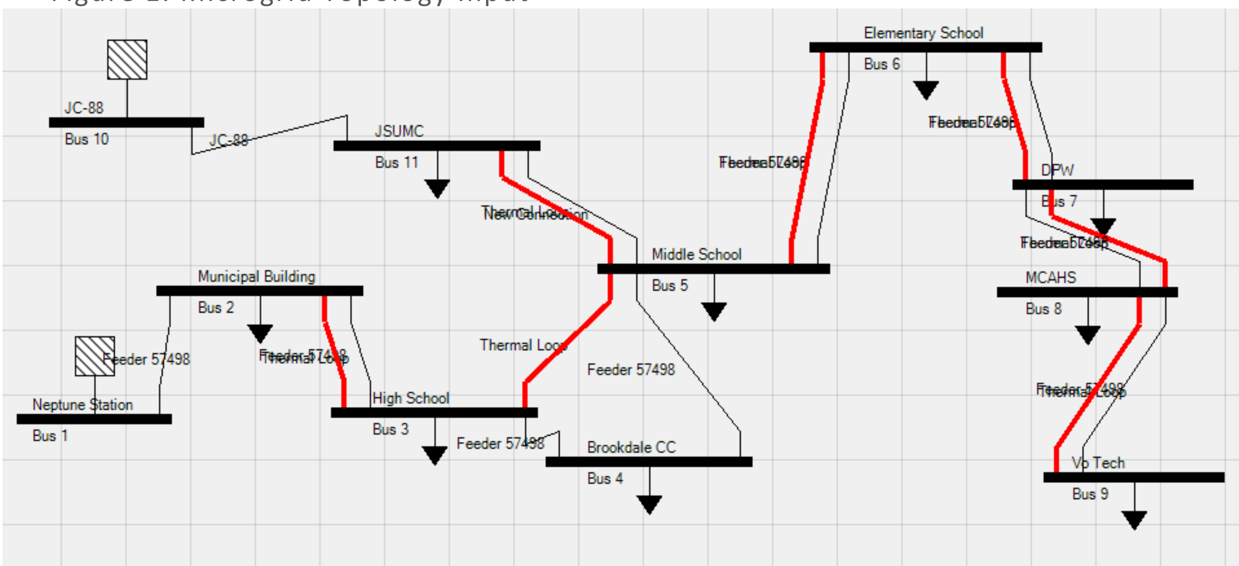
Inclusion of existing generation

The hospital uses an existing 3.6 MW RICE CHP plant. This CHP plant was modelled within the base case for continuous daily operations. The emergency generators, a 200-kW generator at the middle school, 100-kW generator at the Elementary School, and 150-kW generator at the Board of Education offices, were included as back-up generation only. There were no pre-existing renewable energy generation or energy storage technologies to include for any of the sites.

Microgrid topology mapping

All facilities and their respective electrical connections were mapped to demonstrate the physical make-up of the Microgrid. This includes each facility and the two feeder substations included in this Microgrid configuration. Additional thermal loop infrastructure and the Medical Center-to-Feeder 57498 line were mapped on top to complete the Microgrid configuration. The thermal loop in this model runs from the Medical Center to Neptune Middle School and takes two paths: 1) to Gables Elementary School, Department of Public Works, Monmouth County Academy of Allied Health & Science, and Monmouth County Vocational School: Neptune Annex; 2) to Neptune High School and on to the Neptune Municipal Building. Although there is an existing geothermal heating and cooling pump at the Neptune High School, this facility was included for thermal offtake to serve the Aquatic Center and domestic hot water loads. The hospital-to-Feeder 57498 electric line is detailed in the Microgrid proposal, and serves to electrically connect the hospital to the rest of the Microgrid during a contigency event.

Figure 1. Microgrid Topology Input



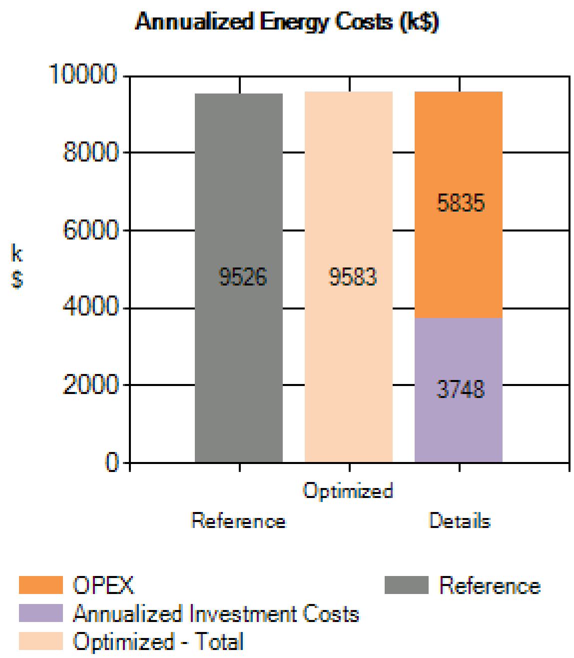
Generation investment modelling

This final Microgrid configuration was modelled including the additional 6.2 MW CHP systems recommended for the hospital, and the following PV investments:

Location	**kW Installation**
Jersey Shore University Medical Center	0
Monmouth County Academy of Allied Health & Science	140
Neptune Municipal Building (incl. PD & Library)	48
Neptune Department of Public Works	32
Gables Elementary School	120
Neptune Middle School	240
Brookdale Community College	0
Monmouth County Vocational School	64
Neptune High School	380
Neptune Aquatic Center	96
Total	**1,120**

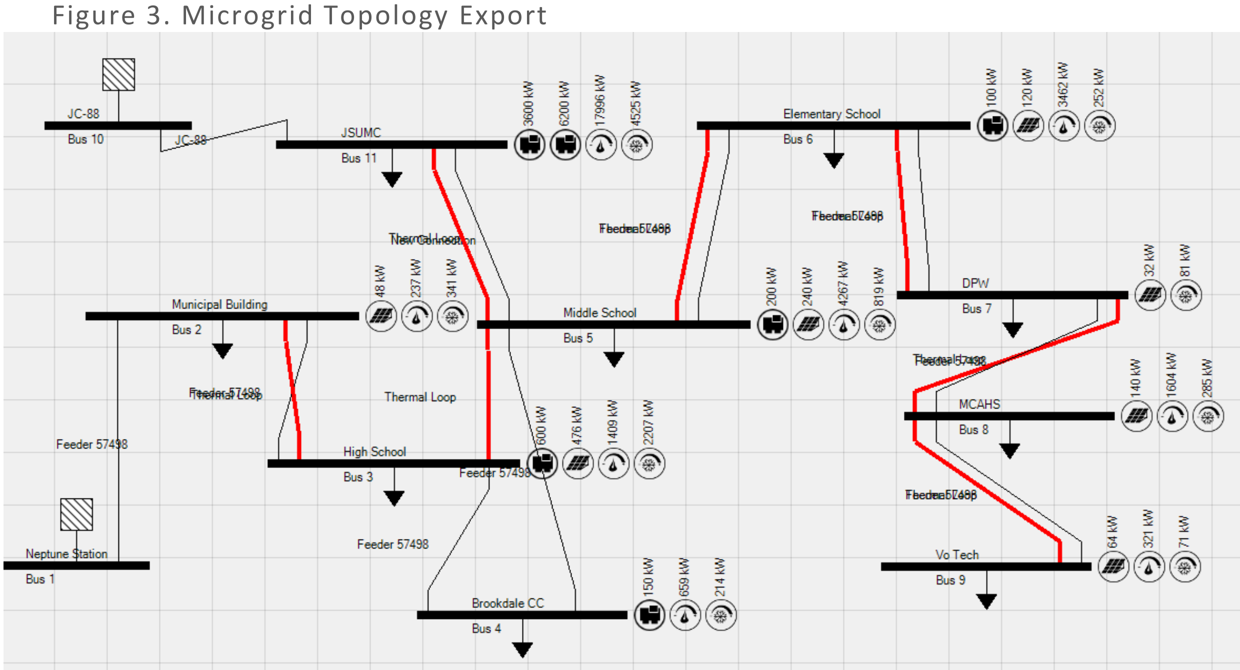
DER CAM confirmed that this configuration was feasible and determined that the additional annualized capital cost and electricity sales cost was $9,583,000, only 0.6% more than the reference case (DER CAM does not consider the cost of adding distribution infrastructure in its final output). This means that, using a creative financing approach, this project would be able to bring energy costs to Microgrid facilities down to or very close to, the current unit cost of energy.

Figure 2. Annualized Energy Cost Comparison



Below is the final Microgrid topology after the DER CAM optimization.

Figure 3. Microgrid Topology Export



The below load profiles demonstrate a daily generation profile for the entire Microgrid in January and August, as calculated by DER CAM:

Figure 4. January Electricity Load Profile

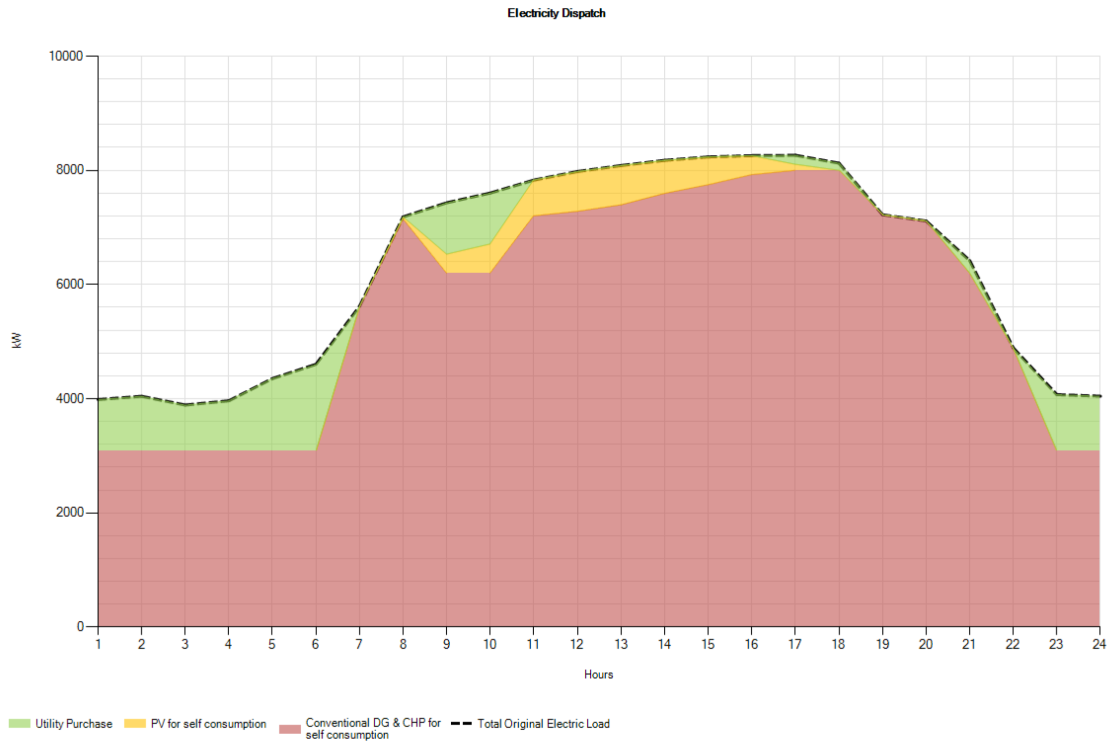
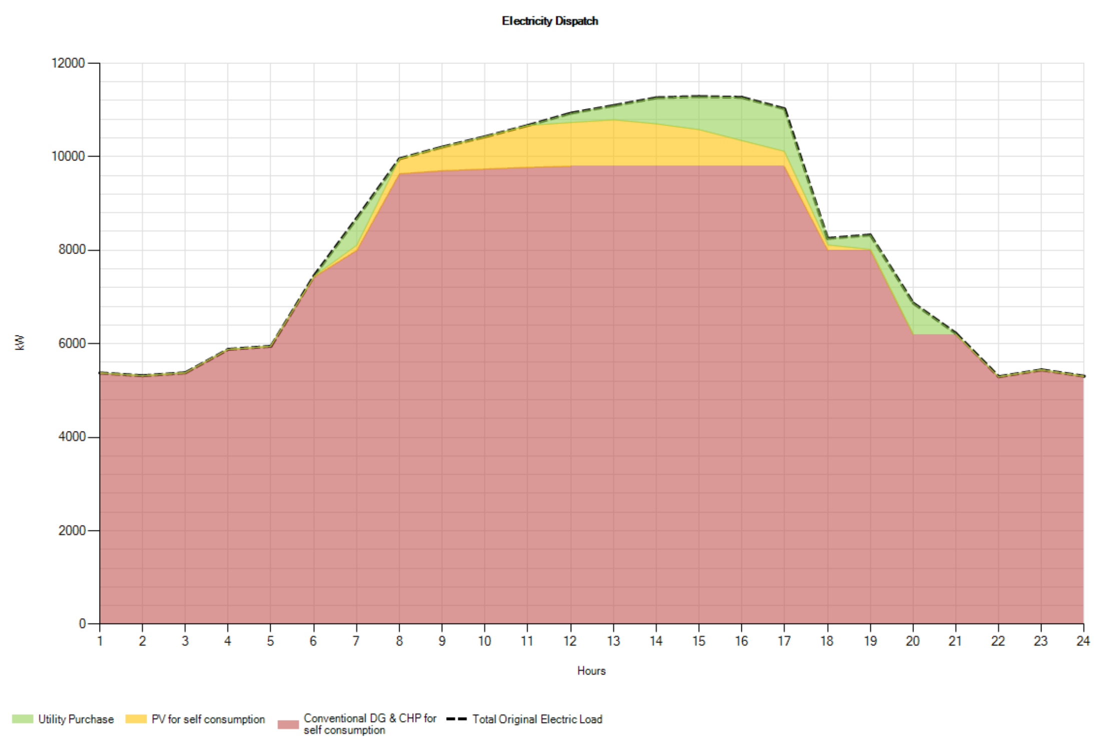


Figure 5. August Electricity Load Profile



Appendix G - Timeframe for Completion

NTAM Implementation Timeline for Completion

	2018					2019												2020											
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prepare Final Feasibility Study Report	■																												
Submit Final Report to BPU	■																												
Present Final Report to Stakeholders		■																											
Review and Accommodate BPU Comments	■	■																											
Submit BPU Investment-grade Planning Application				■	■																								
Prepare Implementation Plan						■	■	■	■	■																			
Prepare 70% Design Documents								■	■	■																			
Apply for Cooperative Contracting Unit / MUA						■	■																						
Perform Interconnection Study						■	■	■																					
Design Interconnection Facilities									■	■																			
Coordinate Utility Tariff Development						■	■	■	■	■																			
Facilitate Letter of Intent (LOI) with Project Operator										■																			
Serve Utility Accounts with Master Procurement Portfolio								■																					
Prepare Design, Build, Own, Operate and Maintain Contract							■	■	■																				
Submit Draft Implementation Plan to BPU											■																		
Review and Accommodate BPU Comments											■	■																	
Prepare 100% Design Documents												■	■	■															
Submit for Local and State Approvals														■	■														
Begin Construction																■													
Implement Energy Conservation Measures																■	■	■	■	■	■	■	■	■	■	■			
Install EV Charging Stations																					■	■	■						
Install PV and Electric Storage																					■	■	■	■	■	■			
Install CHP / Prime mover(s)																			■	■	■	■	■	■	■	■	■		
Install Thermal Distribution Piping																						■	■	■	■		■		
Install Thermal Storage																				■	■	■							
Complete Utility Interconnection																							■						
Complete Equipment Commissioning																											■		
Commercial Operation																												■	