Integrated CHP Systems Corp.
Princeton, NJ

Township of Montclair Microgrid Pilot Study Report

Montclair

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Princeton, NJ

Prepared for:	Township of Montclair
Funding Provided by:	New Jersey Board of Public Utilities Town Center Distributed Energy Resource Microgrid Feasibility Study Incentive Program
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Issue Date:	December, 2018

Acknowledgements

The development and completion of this study would not have been possible without the participation and cooperation of dozens of people. The following provides a short list of those who contributed to the development of this report and to whom we are indebted.

New Jersey Board of Public Utilities

We are indebted to the New Jersey Board of Public Utilities and their staff for providing the funding and opportunity to study microgrid feasibility as a method for increasing power resiliency in the post-Sandy era. Former President Richard Mroz and current President Joseph Fiordaliso and Commissioners Uprenda Chivulkula, Bob Gordon, Many-Anna Holden and Diane Solomon are providing leadership for addressing critical resiliency issues within New Jersey. Mike Winka, Mike Hornsby and Secil Onat of the BPU staff provided ongoing guidance, and occasional prodding, to keep us both on topic, and on schedule.

Township of Montclair

The government of the Township of Montclair entrusted us with the time and knowledge base of its many employees by authorizing our participation in the project. Montclair has been, and remains, a leader in both the state of New Jersey, and nationally, in being at the forefront of implementing forward thinking environmental initiatives for the benefit of its citizens. Township leadership to whom we are grateful for their confidence include Mayor Robert Jackson, Deputy Mayor Sean Spiller and Councilpersons Renee Baskerville, William Hurlock, Rich McMahon, Robert Russo and Robin Schlager.

The administration within the Township provided cooperation and much assistance in navigating the processes in applying for the grant, securing energy load data, and finalizing the many contractual matters concerning this study. We are grateful to Township Administrator Timothy Stafford, Deputy Township Manager Brian Scantelbury, Chief Financial Officer Padmaja Rao, Purchasing Agent Edward Cho, Director of Planning and Community Development Janice Tulley and Director of Parking, Water and Sewer Utilities Gary Obszarny

Mr. Gray Russell is Montclair's Sustainability Officer and the point person for all things related to environmental sustainability within the Township. Gray has worked throughout the development of this study with the authors and acted as the Township's project manager. His support of the project and his assistance in making contacts within the Township, coordinating contractual issues and his countless suggestions and guidance were instrumental in generating interest, sponsorship and cooperation from all facets of the Township.

Public Service Electric & Gas

The incumbent host utility for all facilities on the microgrid is Public Service Electric and Gas Company. Securing the cooperation of PSE&G was critical in developing a workable microgrid and many people within PSE&G provided timely and accurate information and guidance on numerous issues such as facility loads, demand, costs, distribution infrastructure and interconnection requirements. Tim Fagan, John Shertel, Mike Kowal, Mike Henry, Everton Scott, Chavon Kearney, Allison Soltyps, Mark Pintauro and Mike Kayes provided countless details on our inquiries in a professional manner allowing us to address the multiple interconnection and load issues for the facilities on the microgrid.

New Jersey Transit

NJ Transit provided extensive input and direction with our inclusion of their Bay Street Station in the microgrid. We also worked closely with both the energy and real estate departments within NJT in evaluating the feasibility and cost of utilizing their rail right-of-way for routing microgrid conductors and control wires. Thanks specifically to Steve Jenks and Gerry Fahey, as well as several NJ Transit electricians who patiently provided answers on the existing electrical distribution for the train station and parking deck during one very hot and humid July afternoon.

Norfolk Southern Railroad

Kontessa Lemons and Alicia Ruscitto of the Norfolk Southern Railroad were helpful in considering routing options using the inactive Norfolk Southern right-of way which branches off from the NJ Transit line and runs adjacent to the hospital complex.

Mountainside Hospital

Mountainside Hospital and its parent organization at Hackensack Meridian play a key role in the Montclair Town Center Microgrid. The most viable Montclair alternatives considered for a microgrid began and ended with Mountainside Hospital as the anchor facility. Our involvement with Mountainside Hospital occurred early in the application funding process and their involvement was preceded only by that of the Township. Hospital cooperation came from many parties including CEO John Fromhold, Chief Operating Officer Tim O'Brien, Chief Financial Officer Al Aboud, Administrator Tom Nobile, Director of Engineering Dan Deighan, Executive Assistant Kathi Learned and Facility Engineers Mike Locke, Barry Moosa and Rick Tonsic.

Montclair Board of Education

The Montclair Board of Education and its staff were instrumental in allowing us to understand the layout, loads and infrastructure at Glenfield Middle School. This included coordinating several site visits while school was in session to ensure as little interruption as possible to the important work of teachers and staff. We thank Superintendent Kendra Johnson, her predecessor Interim Superintendents Ron Bolandi and Barbara Pinsak, and their very capable staff at the central office and at Glenfield. At Glenfield, Principal Anthony Grosso, Secretary Mary Nippes ,and Facility Engineers Luis Solis and Juan Pinto acted as gracious hosts, allowing us to secure the information we needed. At the central office the assistance of Business Administrator and Board Secretary Emidio D'Andrea, Director of Buildings and Grounds John Eschmann and administrative assistant Caroline Bosher are also most appreciated.

United Methodist Communities

Cindy Jacques, Vice President of Housing and Community Initiatives for United Methodist Communities was extremely supportive in our efforts to include their senior living facility, Pine Ridge of Montclair, in our design. Housing Administrator LaRonda Dingle and Building Superintendent Tim Foster generously provided their time and expertise as they accompanied us locally on our on-site evaluation tours of Pine Ridge's building and energy infrastructure.

Montclair Fire Department

We spent many hours with Deputy Fire Chief Brian Wilde meeting and touring the various components of Montclair's Fire Headquarters and Emergency Operations Center to trace service entrances and to determine building loads and power distribution within the building. We thank both Brian and Fire Chief John Herrmann for allowing us to utilize department time and resources.

Subcontractors & Vendors

A study such as this requires the know-how and experience from engineering professionals in a variety of disciplines including accurate and timely equipment technical data which is critical to the development of performance data and accurate financial analysis. We were fortunate to have had many capable subcontractors on our team whose real-life experience base and technical knowledge allowed us to prepare our report. Engineering companies and vendors who provided valuable assistance on this report include Ron Regan, Rob Corson and their team at Triad Consulting Engineers, Maggie Clout, Ph.D., Microgrid Business Development at Siemens, Lou Ianniello of EZnergy, Scott Yappen of Foley Power Systems and Jeffrey Glick of Tecogen.

We are indebted to these people and their organizations for the support, time, funding and cooperation they provided in the preparation of this report.

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1. General Overview

The Montclair Town Center Microgrid is proposed in response to the recent solicitation by the New Jersey Board of Public Utilities' Office of Clean Energy (OCE) for resilient microgrids that are capable of serving critical facilities in both parallel and isolation from the local distribution grid. The Montclair microgrid will serve eight facilities, all within a half mile radius of the central location. A hospital and fire headquarters incorporating a regional emergency management office are part of the microgrid and are categorized as FEMA Level IV (most critical) facilities. The microgrid also includes a school that will serve as an emergency public shelter and a mass transit facility both of which are categorized as FEMA Level III facilities.

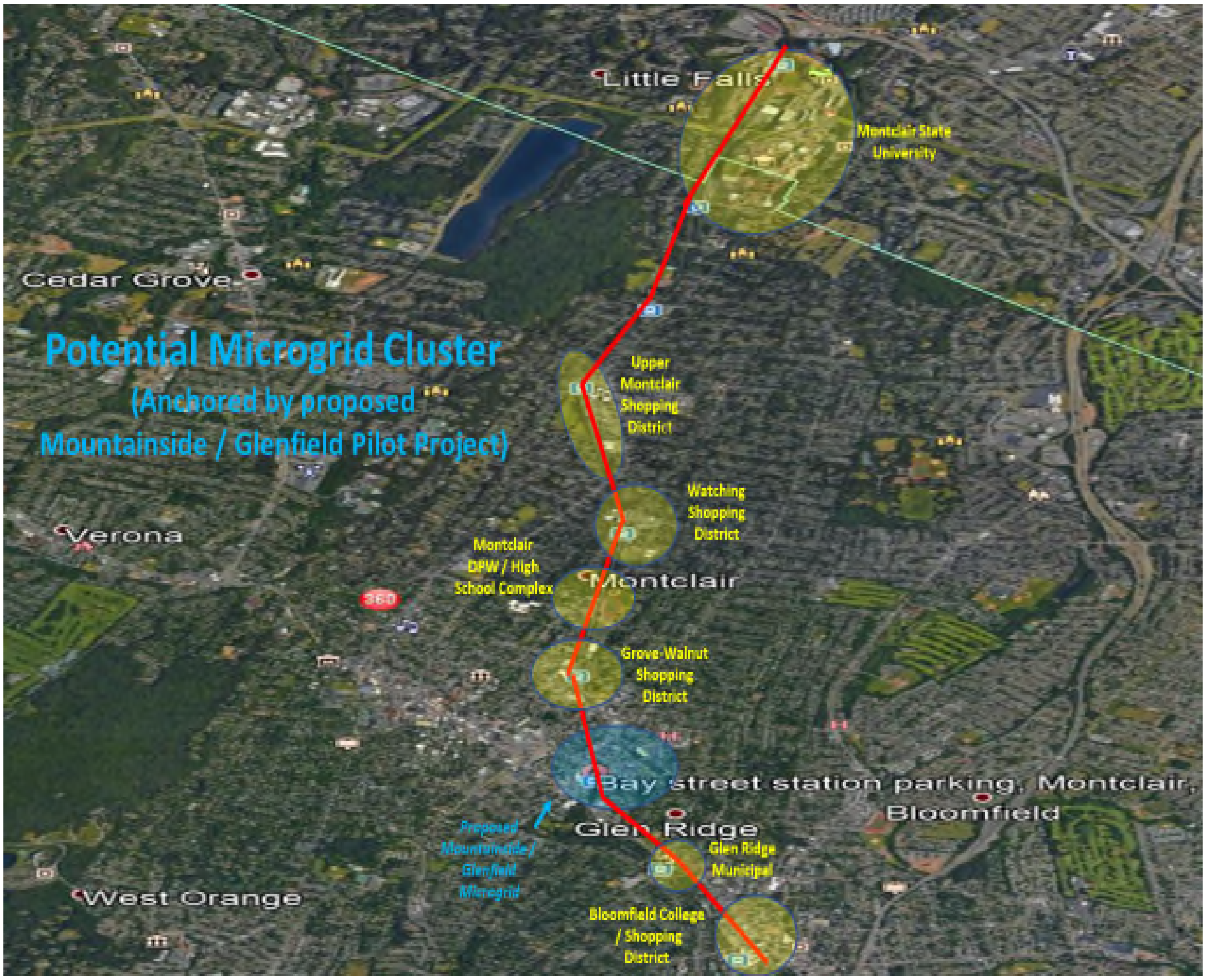
The Montclair Town Center Microgrid has all the attributes desired by the OCE as a demonstration site that will provide the context and experience necessary to further develop microgrids as a means to provide resilient, clean and economical energy to critical facilities.

The Montclair Microgrid incorporates multiple distributed energy resources (DER) including two combined heat and power plants (located at the hospital and the school), three photovoltaic arrays (Pine Ridge, Fire Headquarters and Glenfield School), one battery energy storage system at the Fire Headquarters and four electric vehicle charging stations at the Pine Street Parking Garage. These technologies provide sufficient power generation resources to maintain 'near normal' operations at all microgrid connected facilities in the event of a grid outage while optimizing energy production efficiency, minimizing the microgrid greenhouse gas footprint, reducing normal operating costs and providing resilient transportation for essential services.

The Montclair Microgrid (MMG) will operate as a single entity relative to the electric grid with its multiple power generation sources, battery and multiple loads. All MMG loads, generating assets and batteries are interconnected electrically to each other via a new power cable that will provide both normal and emergency power to each facility. The MMG will be interconnected to the local utility grid at the existing hospital interface. A new switchgear lineup will be provided as part of the MMG project that will allow for connection of the existing hospital facility load bus, the 2 MW CHP plant and the MMG feeder to the remaining facilities. The interconnection will be at 13,200 V which is the rating for the existing Hospital facility bus and the new 2 MW CHP plant.

A unique aspect of the Montclair Town Center Microgrid is its planned utilization of the NJ Transit catenary system along their rail right-of-way as the primary method of routing the microgrid power distribution backbone which interconnects all facilities on the microgrid. This routing is most economical and has the added benefit of providing NJ Transit with incremental annual revenue in the form of compensation for utilization of the right of way and catenary. Alternatives to this distribution design include burying distribution cable along the rail right-of-way or traditional street routing, both of which would increase the overall project costs as detailed in this study by approximately $2 million.

Another advantage of using routing on the existing rail right-of-way is that the microgrid could potentially be expanded to pick up other critical facilities throughout much of Montclair and adjacent communities, while providing additional revenue for NJ Transit in the form of additional distribution and/or leasing fees. A cluster of seven microgrids could conceivably run from Montclair State University at the Little Falls – Montclair border in the north, to Bloomfield Center, an area that includes Bloomfield College to the south, passing through much of Montclair, Glen Ridge and the primary business district of Bloomfield as shown below.



2. **Financial Overview**

For purposes of analyzing the microgrid from a financial perspective, we have assumed that it will be developed using a public-private-partnership. An investor will provide the equity capital to complete the overall financing of the project. Total cost for the microgrid inclusive of a 10% contingency and NJ sales and use tax is approximately $16.5 million. After utilization of current NJ BPU OCE incentive programs for cogeneration and EV chargers, plus federal tax incentives in the form of a 10% investment tax credit, a balance of approximately $13.25 million would remain to complete the project. The remaining balance is assumed to be sourced from commercial debt in the amount of $6.5 million and equity investment from a public-private-partner in the amount of $2.8 million. We have assumed the balance of $3.95 million will be sourced from a yet to be established incentive program specifically aimed at assisting in the development of Town Center microgrids. A microgrid development grant of $3.95 million in the case of Montclair's proposal would constitute approximately one third of the total capital required for the microgrid after utilization of existing incentives, which is consistent with programs offered in other northeast jurisdictions such as Connecticut and New York.

Pricing for energy off-takers on the microgrid is assumed to be equal to that of their current costs of energy from PSE&G electric, self-generated thermal or other sources while gaining the added advantage of resiliency with no capital investment required. Over the course of the years, off-takers will gain economy by avoiding anticipated increases in utility distribution and transmission costs which are anticipated to increase at a higher rate than other energy-related costs. For purposes of our financial analysis, revenues from the microgrid include those from electric sales, thermal sales and solar renewable energy credits

Our base case provides an after-tax internal rate of return to an equity investor of 10% putting their pre-tax IRR in the low to mid-teens. depending on their tax bracket. This is fair compensation for the risks inherent in an investment of this nature given the operating challenges and credit risk of the off-takers.

3. Compelling Attributes of the Montclair Microgrid

Meeting OCE and NJIT Criteria - *<u>The proposed Montclair microgrid satisfies all criteria for desired microgrid pilot projects as articulated in the original OCE RFP and the NJIT report.</u>* While Montclair was not one of the Town Centers identified in the original NJIT Report it meets criteria specified in the NJIT report and cited by the Office of Clean Energy as mandatory for consideration as a pilot site including having at least two Category III or IV facilities within ½ mile of each other and having a facility with an energy usage of approximately 90,000 BTU's per square foot. The MMG incorporates a hospital, a fire station with a regional emergency communications center and a school facility that provides a place of refuge. In addition, the MMG supports local area transportation and supports the water supply system.

Cooperation of Host Sites and Off-Takers - A significant barrier to the timely development of any microgrid will be attaining the consent and cooperation of all potential energy off-takers and generation host sites whose loads are critical to the economics of the project. Senior officials from each of the entities having ownership control of the facilities on the Montclair microgrid have been fully involved since the inception of grant application process and have given their ongoing, full support to participation in the pilot study. Building owners have demonstrated strong interest in taking energy that can be competitively produced by the microgrid and are very much in favor of the benefits a microgrid will afford in terms of resiliency and a cleaner environment. *<u>The significant challenges of gaining host site and off-taker cooperation in a project such as this are</u>*

not an issue in Montclair. The next phase in development of a Montclair microgrid can begin immediately under the understanding and terms and conditions that have been clearly and consistently communicated between the critical parties since its inception.

Validity of Financial Assumptions - The project offers a financial structuring that has been tested and implemented previously in the investor / capital markets. *It does not include overly optimistic or unrealistic assumptions.* It is grounded in practicality, the tangible prior experience of the authors and the precedents of prior successful government incentive programs.

No Technology "Leaps of Faith" - The project uses commercially proven technologies. *There are no early-adopter or unvalidated generation, control, storage or distribution technologies incorporated into the initial design.* Construction of the microgrid is straightforward as the design, project delivery system, financial structure and construction techniques mirror hundreds of cogeneration, PV and distributed generation installations that have been installed in the United States over decades.

One Point of Interconnection with the grid - The design contemplates taking all non-hospital facilities off of PSE&G's service so that they will get their power distribution from the microgrid. *The microgrid will operate as a single entity relative to the electric grid with multiple power generation sources, a battery and multiple loads.* The only point of connection with PSE&G for the buildings on the microgrid will be through a single point of common coupling at the hospital, eliminating any concerns about triggering multiple PSE&G network faults.

Environmental Activism of Sponsoring Municipality – Montclair is recognized as one of the most racially and economically diverse towns in the United States with an educated and activist population who are aware of, and concerned with, issues such as the environment, sustainability and the health, safety and welfare of all of its residents. Its government and administration have been involved in the development of the microgrid proposal since the early days of the initial grant application development. With a long history of cooperation and participation in BPU/OCE energy efficiency and clean energy programs going back to 2003, *Montclair is recognized as a leader in clean energy initiatives.* Montclair won the first-ever BPU Clean Energy Leadership Award, was a founding member of Sustainable Jersey and received one of the first certifications as a Sustainable Community. Montclair has been designated as a Climate Showcase Community by the U.S. EPA.

Representative of "Home" to Large Portions of NJ Residents – An estimated 73% of New Jersey's population reside in communities like Montclair with either town or suburban characteristics. *Montclair is an ideal location for a viable demonstration project that can serve as a resiliency model applicable to over two-thirds of New Jersey's residents.*

Potential for future implementation of Microgrid "Clusters" - Montclair is unique in its layout as a representative town with distinctive multiple town centers concentrated in and around seven operating rail stations on the NJ Transit Montclair-Boonton lines. *Montclair's multiple town centers and the close proximity of similar centers in Glen Ridge and Bloomfield, provide many* *integrated, but compact relationships between critical facilities that represent a typical New Jersey town or suburb which could be integrated into a larger cluster with relatively little effort if that becomes an objective of the BPU.*

Ability to provide new sources of income for NJ Transit – NJ Transit rail operations work with a large burden of "fixed costs" whether its trains are at full capacity or relatively empty. Any initiative which provides additional revenues to offset their substantial fixed costs should be attractive and utilized. *Leasing or distribution fees for use of their rail right-of-way represents an innovative and attainable method for generating additional NJ Transit revenue.*

The Montclair microgrid is practical and buildable in the immediate term – The MMG offers the BPU a workable site that provides rational context on the regulatory, technical, economic and operational issues that need to be considered in the development of a viable microgrid program. *The study demonstrates a technically practical approach that achieves the goals of the TCDER microgrid program at a reasonable cost.*

Section II: TC DER MG Stakeholders

1. **Project Description & Stakeholder Identification**

The Montclair Town Center Microgrid is situated primarily in the Township of Montclair, a suburban town in Essex County with a population of just over 39,000. Montclair was first settled long ago in 1679 at the foot of the Watchung Mountains and eventually developed from a mountainous rocky community of grazing land for cows and sheep, into a “bedroom community” for many of the financial and banking leaders of the industrial revolution. Montclair, originally part of neighboring Bloomfield, became its own township in 1868. It has been characterized as a gracious residential community with several distinct ‘town-centers” within its borders. These town centers are primarily centered around an extensive network of Erie-Lackawanna commuter train stations which provide service into New York City and Newark. Each of these distinctive neighborhoods have single and multi-family homes, schools, retail shopping, churches, parks and other public buildings and spaces interspersed within walkable distances.

Today Montclair has many municipal amenities including its own salaried police force, a full time, salaried fire department which serves both Montclair and the neighboring town of Glen Ridge, and a school district consisting of seven elementary schools, three middle schools and a high school. It is recognized as one of the most racially and economically diverse towns in the United States with an educated and activist population who are well aware of, and concerned with, issues such as the environment, sustainability and the health, safety and welfare of all of its residents. Hackensack UMD Mountainside Hospital (Mountainside) lies on the eastern border of Montclair sharing a substantial contiguous site with the neighboring Borough of Glen Ridge.

In the 1980’s Montclair changed from Mayor-Council to a Manager-Council form of government. Montclair is also one of the few school districts in New Jersey with a Board of Education that is appointed by its Mayor as opposed to being elected by voters.

During the development of the Montclair Town Center Microgrid application, nine potential locations within Montclair were evaluated, each which contained buildings that substantially satisfied the screening criteria for town center microgrids as set forth in the NJIT report. All of the potential sites were judged for proximity to Mountainside Hospital and their ability to be integrated into a more substantial microgrid over time by interconnecting with one another. Montclair is long and narrow in its shape and the nine sites considered for the microgrid included in the original application spanned the entire seven-mile length of Montclair from Upper Montclair near the Clifton/Little Falls border in the north, to the South End shopping district near the East Orange/Glen Ridge border.

During the evaluation of sites that would be suitable for the Town Center Microgrid Pilot Project, the proposing team were concerned not only with meeting NJIT criteria, but also in selecting a site that was capable of being developed, not just on paper, but in reality. The selection of buildings is limited to quantities and locations that would lend themselves to development of a microgrid in a reasonable amount of time. Almost all evaluated sites contained dozens of potential buildings which could be incorporated into a microgrid but in order to propose an economically viable project, Montclair has kept the proposed microgrid simple, with a manageable number of buildings that can be interconnected without onerous site control issues or distribution complexities that can exponentially increase project costs, and development complexity in dense urban settings.

The site ultimately selected for incorporation into this application is the Glenfield / Fire Headquarters site. It consists of eight (8) facilities critical to operation of township emergency and medical services, with additional capability to incorporate many more facilities (gas stations, multi-family housing, food retail, etc.) into the base original layout. The site has the added functionality of being able to link up easily with future microgrids into a microgrid cluster if the program were to be expanded in the future. Our base case design which utilizes the rail right-of-way for the NJ Transit commuter line that runs throughout town could also facilitate the future inclusion of critical infrastructure throughout Montclair and parts of neighboring Little Falls and Glen Ridge.

The Glenfield / Fire Headquarters site initially includes: 1) Montclair's Fire Headquarters and Emergency Dispatch Center which handles all 911 calls and also serves as a data center for all servers used in township business; 2) Glenfield School, a 5-8 grade middle school directly across Bloomfield Avenue from Fire Headquarters which can serve as an emergency shelter or public meeting space in the event of a prolonged power outage; 3) Pine Ridge of Montclair, a senior living residential building serving low income residents of Montclair, owned and operated by non-profit United Methodist Communities; 4) Mountainside Hospital including the Harris Pavilion, a 365-bed community hospital, also designated as a Primary Stroke Center by the NJ Department of Health & Senior Services and licensed by NJ to perform emergency angioplasty; 5) Mountainside Hospital Parking Garage which has an independent connection to the utility grid; 6) NJ Transit's Bay Street Station which serves as the link in the "Montclair Connection" which interconnected NJT's Montclair and Boonton lines for service into New York City; 7) the Parking Garage at Pine Street Station which is owned and operated by the Township of Montclair; and 8) one of the three community water supply pumping station owned and operated by the Montclair Water Bureau and located in Glenfield Park.

Figure 1 provides a plan of the area covered by the proposed microgrid indicating the individual facilities connected to and served by the microgrid and Appendix 1 provides an expanded version of the microgrid layout.

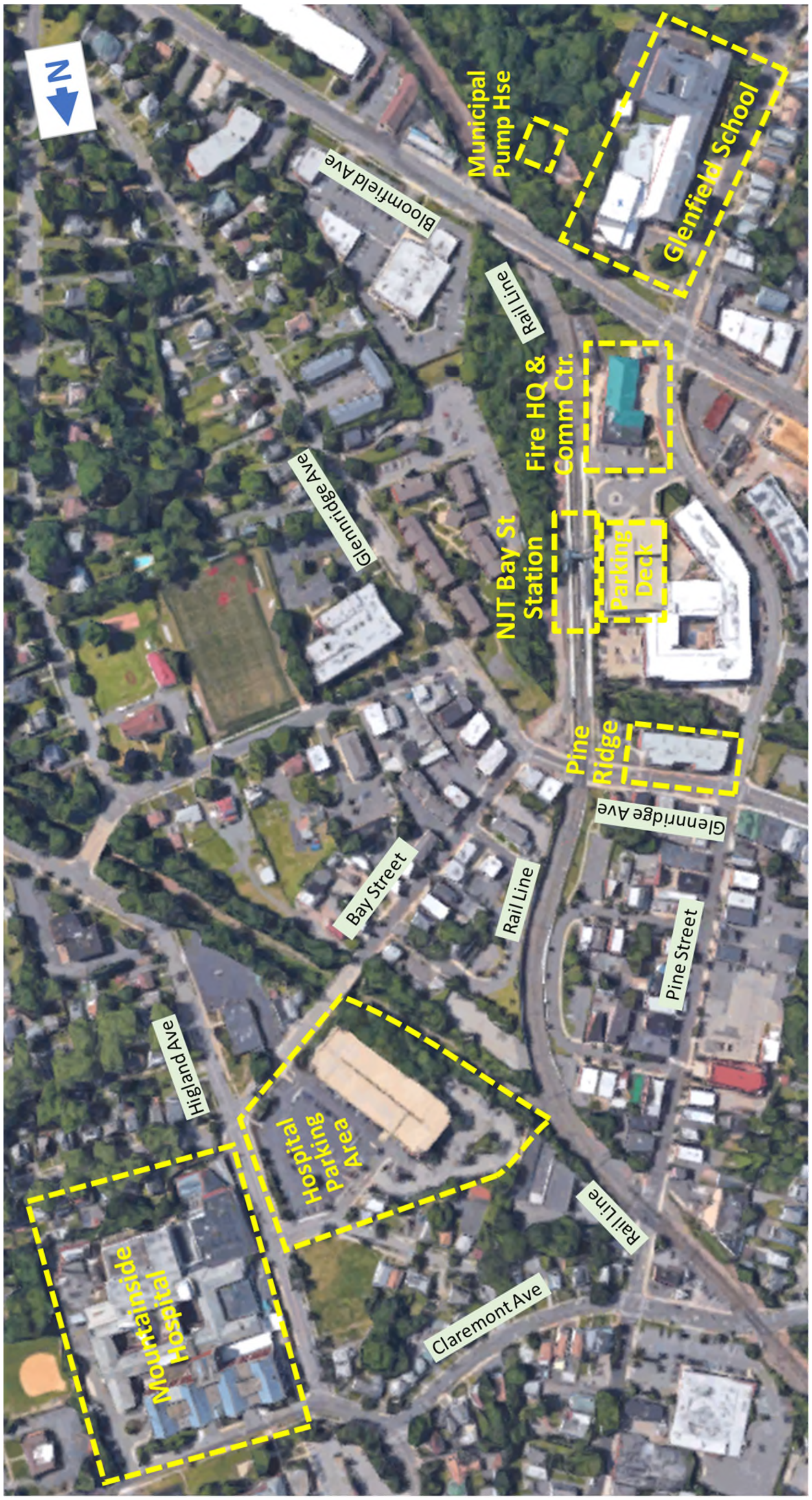


Figure 1: Glenfield / Fire HQ Microgrid Outline

Table 1 provides an overview of the main facilities in terms of their electric and thermal loads, physical size and energy intensity in accordance with 2017 utility billing data. Note that the hourly model energy demand and use models vary slightly from utility billing data which contains numerous estimated readings and anomalies. However, for the purposes of annual utilization both the utility billing data and model data are closely aligned. Mountainside Hospital and Pine Ridge have undergone Level II Energy Audits. Glenfield School, Fire Headquarters and Bay Street Station have not yet completed energy audits although all routinely replace energy infrastructure as needed with the most current technology.

Facility	Annual Electric Consumption (kWh)	Annual Natural Gas Consumption (Therms)	Facility Footprint (Sq. Ft.)	Energy Intensity (kBtu/SF)
Fire HQ	400,826	19,369	36,500	90.6
Glenfield School	770,475	40,745	270,000	24.8
Pine Ridge	366,124	20,995	48,400	69.2
Hospital incl Harris	21,768,964	824,662	860,000	182.3
Hospital Park Deck	399,654	-	185,000	7.4
Bay St Station	113,520	-	4,000	96.8
Pine St Park Deck	259,440	-	120,000	7.4
Pump House	69,861	-	1,044	227.2
Total:	24,148,864	905,771	1,524,944	

Table 1: Montclair Microgrid Facility Descriptions

Table 2 provides the FEMA[1] classification for each facility as well as proximity to adjacent facilities. Pine Ridge is the most centrally located building to the other facilities that comprise the proposed microgrid. The proposed design incorporates designating Glenfield School as an

[1] The Federal Emergency Management Agency (FEMA) defines criticality in facilities and buildings based on their centrality for life safety. In general, Category I buildings include buildings and structures whose failure would represent a low hazard to human life. Category II buildings are those not included in Risk categories I, III or IV. Category III includes buildings with a higher concentration of occupants such as schools, college, adult education and daycare facilities. Category IV buildings and structures are the most critical for life safety. These include facilities such as hospitals, fire and police stations, rescue and other emergency service facilities, water supply facilities and others. For further definition of FEMA Risk Categories based on International Building Code (IBC) classifications, see Appendix 3.

emergency shelter. All of the remaining facilities are within 1,500 feet of Pine Ridge, providing a compact, but comprehensive collection of critical facilities that can be serviced by the microgrid.

Facility	FEMA Classification	Closest Adjacent Microgrid Facility	Distance to Closest Other Microgrid Facility (Feet)
Fire HQ	IV	Bay St Station	350
Glenfield School	IV	Fire HQ	400
Pine Ridge	II	Bay St Station	350
Hospital	IV	Pine Ridge	1,500
Hospital Park Deck	II	Hospital	500
Bay St Station	II	Pine Ridge	350
Pine St Park Deck	II	Bay St Station	50
Pump House	II	School	200

Table 2 Montclair Microgrid Facility Classification

When integrating the individual facilities connected to the proposed microgrid, the various facility power demands are not necessarily coincident. Based on an integrated hourly model of individual facility power demand for a full year, Table 3 provides the estimated electric profile for the consolidated microgrid.

	Annual Electric Consumption (kWh)	Peak Electric Demand (kW)	Average Electric Demand (kW)	Minimum Electric Demand (kW)
Consolidated Microgrid	24,281,456	4,011	2,772	1,479

Table 3 Montclair Microgrid Electric Profile

2. Satisfactory Compliance with NJIT Screen Criteria

Montclair is not one of the Town Centers identified in the NJIT Report however it meets criteria from the NJIT report and cited by the Office of Clean Energy as mandatory for consideration as a pilot site. Those being:

- Having at least two (2) Category III or IV facilities within ½ mile of each other
- Having a facility with an energy usage of approximately 90,000 BTU's per square foot

Table 4: FEMA Categorical Classification of Facilities and BuildingsTable 4 provides the FEMA Categorical Classification of Facilities and Buildings for each of the facilities incorporated in the Montclair microgrid based on energy consumption and criticality.

Principal Building Activity	Energy Consumption (000's of BTU's per sq ft)	Energy Consumption Classification	Criticality Classification
Service	77	1	1
Education	83.1	2	3
Office	92.9	3	2
Public Assembly	93.9	4	3
Public Safety & Order	115.8	5	4
Inpatient Health Facility	249.2	6	4

Table 4: FEMA Categorical Classification of Facilities and Buildings

The Montclair Microgrid is anchored by Mountainside Hospital. As proposed, it incorporates eight facilities including the hospital, the hospital parking deck, the Fire Headquarters Building (which serves both Montclair and Glen Ridge as well as housing Montclair's emergency dispatch and its central data center which serves all components of Township services), Glenfield Middle School, Pine Ridge multi-family senior residence, Bay Street Train Station, Pine Street Parking Garage and the Glenfield Water Pumping Station. Mountainside Hospital and the Fire Headquarters including emergency communications center are Level IV facilities in terms of criticality. Glenfield School is a Level III facility or a Level IV facility when designated as an emergency shelter. Pine Ridge, Bay Street Station and Glenfield Pump House are considered Level II facilities.

Figure 1 above provides an aerial view of the entire microgrid site which shows the location of the two Level IV facilities – Mountainside Hospital and the Fire Headquarters. The direct distance between both facilities is approximately 1,600 feet and the electrical distribution cable route between them would be less than ½ mile whether the wires are routed through public streets or on the commuter rail line right-of-way. The Glenfield / Fire Headquarters site meets all criteria for criticality and maximum distances between buildings as prescribed by NJIT, FEMA and the Office of Clean Energy.

In terms of meeting the requirements for energy intensity, Mountainside Hospital has an energy usage of 182,262 BTU's per square foot, and Fire Headquarters has an energy usage of 90,537 BTU's per square foot, both in excess of the 90,000 BTU's per square foot threshold required by the NJIT criteria.

3. Existing Energy Profiles

3.1. Introduction

All facilities connected to the proposed microgrid are currently provided electric power from the PSE&G distribution grid. Each of the facilities is connected to a utility meter that records power use as the basis for their electric bills. All facilities are on standard PSE&G electric tariff rates which includes Societal Benefits Charges on all power throughput. All facilities requiring natural gas are provided natural gas service through the PSE&G gas distribution grid. Each of the facilities with gas service is connected to a utility gas meter that records natural gas use as the basis for their gas bills. All facilities are on standard PSE&G natural gas tariff rates which includes Societal Benefits Charges on all gas throughput.

The development of equipment and accessory sizing and operating protocols in the design of the proposed microgrid need to be based on historically accurate facility loads. Depending on the account and tariff option, billing demand and usage data was supplied by PSE&G for all accounts in either fifteen-minute, half-hour, hourly or monthly intervals. Data was acquired for most of 2016, all of 2017 and 2018 through October.

Ideally, and in most cases, billing data should accurately reflect the actual usage and demand for the periods being reported but in practice, there can be billing errors or long periods of estimated usage that compromised the accuracy of the billing data. For example, for the Harris Pavilion which is an out-patient facility at Mountainside Hospital offering ambulatory care, on its monthly invoices, kWh usage was estimated for eight months in a row which had the effect of underreporting usage in the estimated months, and then overreporting in the month in which a meter reading was taken to reconcile estimated usage with actuals.

Another example occurs at the main Mountainside Hospital account where on November 5, 2017 there were four or five consecutive 15-minute interval readings on demand early in the morning, (around 1 AM) that exceeded all prior peak demand figures by over 500 kW, or over double all other demand readings over the course of the year. At the end of these "outlier" interval readings, the demand reverted to levels one would expect given the extensive history at the facility. Consultation with hospital management revealed no reason for this spike in demand with the only likely conclusion being that it was a meter reading or billing error. This was adjusted and accounted for in our analysis and design.

At the Pine Ridge Senior Living Facility, demand for electricity in common areas was historically never more than approximately 100 kW but for some reason in October of 2018 billing demand was reported in excess of 500 kW. Conversation with local facility management at Pine Ridge revealed no justification for a demand reading so much in excess of traditional levels and as such it was assumed to be a billing error which we accounted for in our design.

Billing data for the Hospital Parking Deck for 2017 reflects a similar trend where total energy use recorded for the year results in an average power demand that actually exceeds the recorded peak demand for the same period. The Pine Street Parking Deck utility billing data also exhibits an unusually high load factor of 69% for a facility of this type.

In order to develop a technically coherent study for the Montclair Microgrid, an 8760-hour model has been developed for all loads included in the study using 2017 as the baseline year. While in the vast majority of the analysis, the loads and usage shown in our model data are based on actual historical data, in the instances where anomalies were present in the billing data, modeling data was adjusted to remove such anomalies. Where utility data only provided monthly intervals, estimates were made on hourly profiles that were both in alignment with the type of facility being considered as well as the monthly and annual billing data. When monthly utility data was based on estimates, allowances were made to reflect actual operating profiles. However, care was taken to be sure that modeling data was logical and representative of the type of usage the facilities on the microgrid and overall loads and annual usage do not vary materially from reported billing data.

3.2. Summary of Facilities on the Microgrid

There are seven separate operations included in the Montclair Microgrid Proposal comprising nine structures.

The Main Hospital Complex, the Harris Pavilion and the Parking Deck make up the structures at Mountainside Hospital. For purposes of this study, the main electric account at Mountainside Hospital and the electric account at Harris Pavilion have been combined to reflect the designer's intention to combine these two services into one when the microgrid is developed. The Parking Deck at Mountainside Hospital remains on its own independent service.

The other facilities are Pine Ridge Senior Living, NJ Transit's Bay Street Station, the Parking Deck at Bay Street Station (owned and operated by the Township of Montclair and also referred to as the Pine Street Garage), Fire Headquarters, Glenfield Middle School and the Glenfield Water Pumping Station (also referred to in this report as the "Pump House").

Table 5 provides the energy intensity for each of the eight facilities on the microgrid based on the annual utility billing data.

Total electric usage for all facilities on the microgrid is over 24 million kWh and the average cost using pricing for the past 12 months (November 2017 through October 2018) is $0.1062 per delivered kWh. Total electric expenditures for all facilities on the microgrid are approximately $2.6 million. Table 6 provides the monthly and annual aggregated microgrid power use and cost based on the utility billing data.

Energy Use BTU's per Square Foot

	MMBTU's Electric	MMBTU's Gas	MMBTU's Total	Square Feet	BTU / Sq. Foot
Mountainside including Harris	74,278.8	82,466.4	156,745.2	860,000	182,262
Mountainside Parking Deck	1,363.7	-	1,363.7	185,000	7,371
Pine Ridge	1,249.3	2,099.5	3,348.8	48,400	69,190
Bay Street Station	387.3	-	387.3	4,000	96,825
Pine Street Parking Deck	885.2	-	885.2	120,000	7,377
Fire Headquarters	1,367.7	1,936.9	3,304.6	36,500	90,537
Glenfield Middle School	2,629.0	4,074.5	6,703.5	270,000	24,828
Pump House	237.2	-	237.2	1,044	227,203
Totals:	82,398.2	90,577.3	172,975.5	1,524,944	113,430

Table 5 Facility Energy Use Intensity

Total Microgrid	kWh	Cost/kWh	Monthly Cost
Jan	1,826,950	$0.1795	$327,945
Feb	1,700,227	$0.0982	$166,883
Mar	1,868,600	$0.0994	$185,800
Apr	1,922,639	$0.0897	$172,527
May	2,020,915	$0.0770	$155,666
Jun	2,205,388	$0.1097	$241,881
Jul	2,387,209	$0.1149	$274,248
Aug	2,307,306	$0.1107	$255,380
Sep	2,156,787	$0.1061	$228,803
Oct	2,127,770	$0.0956	$203,518
Nov	1,760,748	$0.0953	$167,782
Dec	1,799,170	$0.0988	$177,782
Total / Max	24,083,709	$0.1062	$2,558,214

Table 6 Facility Energy Use, Demand and Cost

Microgrid electric usage is driven primarily by the main electric account at Mountainside Hospital which has the highest kWh usage and kW demand by far of any facility on the microgrid.

Usage, demand and cost history for each of the facilities on the microgrid are discussed in more detail in the sections which follow. Usage and demand data are from 2017 billing data obtained from PSE&G and pricing is from the current annual period starting in November of 2017 and ending in October of 2018. The estimated monthly budgets are the product of the 2017 usage and demand data and the most recent 12 month pricing.

3.2.1. Mountainside Hospital and Harris Pavilion

Mountainside Medical Center has been serving Montclair and its surrounding New Jersey communities since 1891. Today, nearly 130 years later, Mountainside Medical Center is still carrying out that mission. With 365 beds and 800,000 square feet in total, Mountainside Medical Center is located on the border of Montclair and Glen Ridge, Hackensack Meridian Health Mountainside Medical Center continues to provide world-class health care in a community setting. The medical center has successfully transitioned from a stand-alone facility to being part of Hackensack Meridian Health, among the most comprehensive and truly integrated network in the state of New Jersey.

As with most hospitals that have been in the same location for decades, Mountainside has been expanded and added to in increments many times since its inception. The Main Hospital consists of several buildings that are interconnected and provide patient rooms, operating rooms, laboratory facilities, reception, waiting rooms, a chapel, administrative services, emergency room facilities and plant facilities such as a laundry, boiler room, electric switch room, etc. The main hospital covers approximately 800,000 square feet of interior space. It has its own electric service from PSE&G and the boiler house provides both steam and hot water for heating and domestic purposes.

The Main Hospital complex is supplemented by the adjacent and interconnected Richard F. Harris Ambulatory Care Pavilion a 62,800 square foot facility that brings together the hospital's outpatient services into one state-of-the-art facility. Harris Pavilion provides medical care, registration, and laboratory and radiologic studies, all performed from one location. Pre-admission lab work, x-rays and electrocardiograms are accomplished just a few steps away from the registration area.

The Pavilion unites Mountainside Hospital's comprehensive cancer care, including diagnostic and treatment services, in one facility. The Women's Health Center brings together many of the hospital's diagnostic, prevention, and educational services, including the most modern breast care screening and diagnostic technologies, osteoporosis screening and prevention, diagnostic radiology, and ultrasound services.

The Same Day Surgery Center at Harris Pavilion contains 29 beds for patients requiring the full range of anesthesia. The Physical Medicine and Rehabilitation Center features a spacious gym, a suite where patients receive occupational therapy, private treatment rooms, a closed-circuit monitoring system for observation of speech therapy sessions, and a hearing aid dispensary and hearing booths for diagnostic testing.

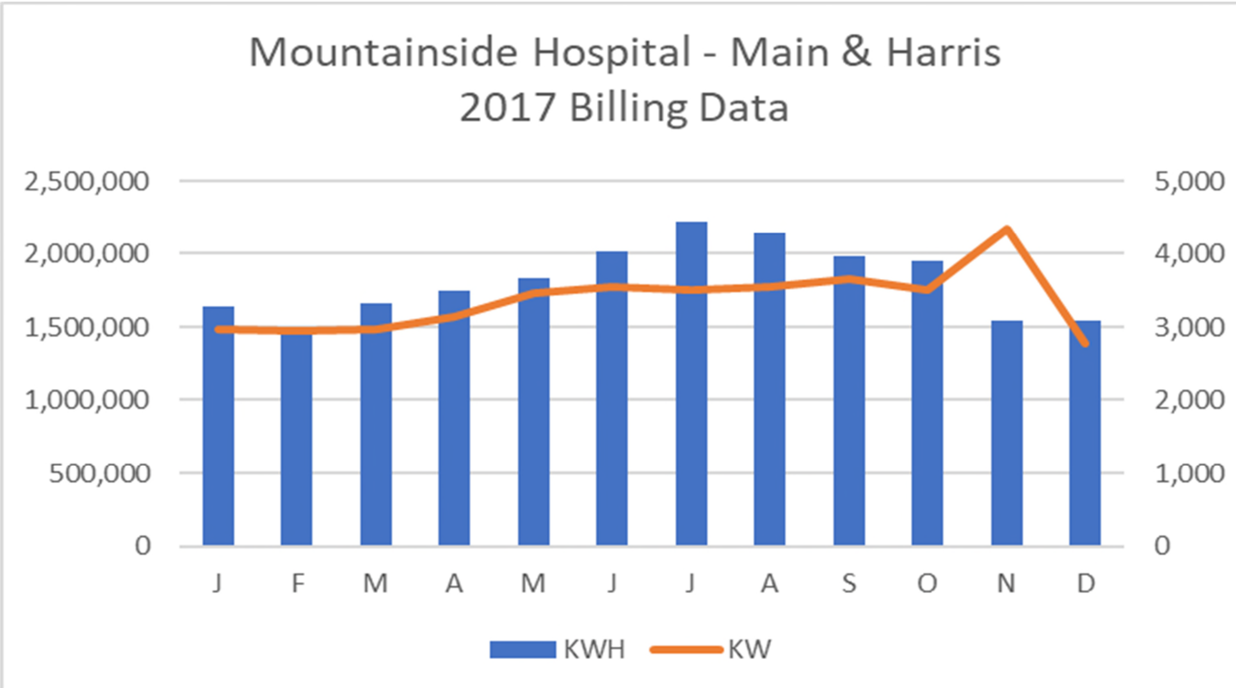
Currently the Harris Pavilion has a separate electric service from PSE&G but if a microgrid project is undertaken the design contemplates the consolidation of Harris service with that of the Main Hospital. Unless otherwise noted in this report, references to electrical usage and demand for Mountainside Hospital will contain the consolidated totals from the current "main" Service and Harris Pavilion.

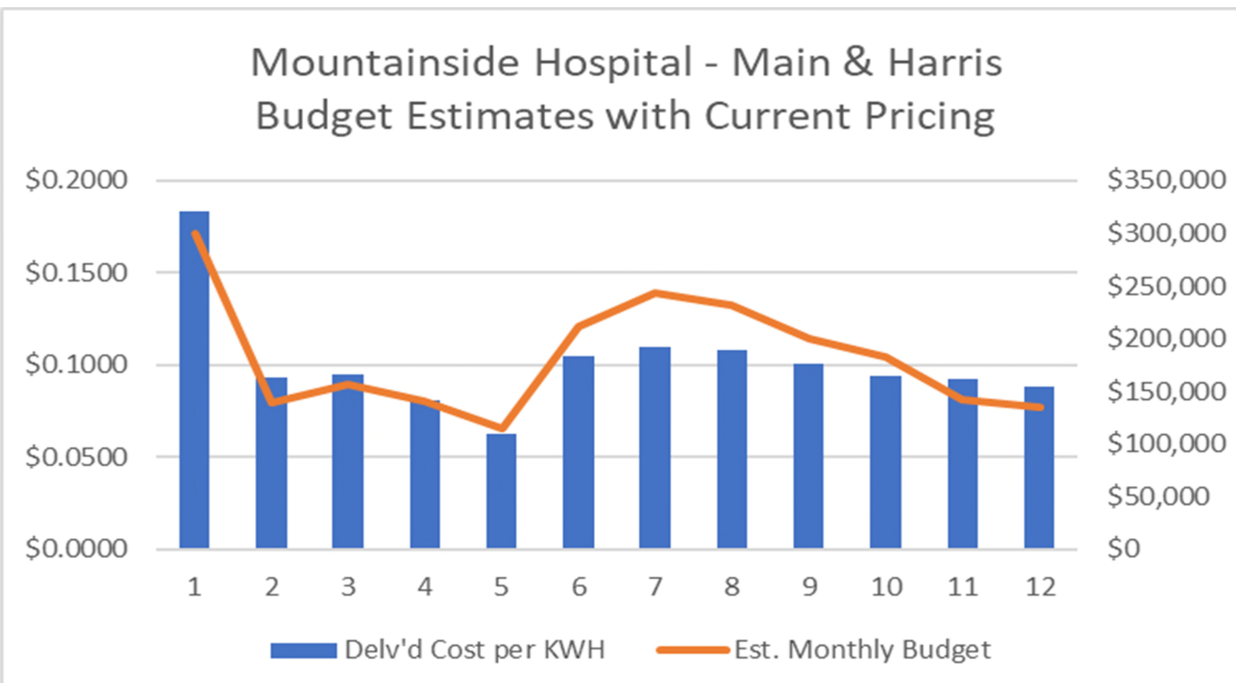
Electrical loads are relatively consistent with what would be expected for a health care facility located in the Northeast, peaking in the summer months and reverting to lower levels in the heating season. Monthly peak demands were relatively stable throughout the year in the range of just under 3 MW up to slightly over 3.5 MW after adjusting for a billing error that occurred in 2017 of November which erroneously increased peak demand by close to 500 kW. Chilled water is generated by three 770 ton electric chillers located in a centralized chilled water plant which serves all hospital loads via a chilled water distribution system.

Natural Gas is used to generate steam using a centralized on-site boiler plant which consists of two 800 HP steam boilers. Steam is piped throughout the facility and converted to hot water at various locations to provide space heating and reheats as well as generate domestic hot water. One of the principal buildings served by the steam network is the North Tower which represents a significant portion of the hospital's thermal load.

The hospital meets current emergency power requirements with two 565 kW, one 800 kw and one 1,050 kw diesel generators that are connected to various emergency loads within the facility via a series of automatic transfer switches that will transfer load from the utility supply to the diesel generators in the event of a grid power loss.

All electric accounts are serviced by PSE&G. The Main and Harris Pavilion accounts are on tariffs LPL-P and GLP respectively. Billed utility usage and demand by month for all electric usage for the Main and Harris electrical accounts combined are shown below:


Mountainside Hospital - Main & Harris
2017 Billing Data
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
5,000
4,000
3,000
2,000
1,000
0
J F M A M J J A S O N D
KWH
KW


Mountainside Hospital - Main & Harris
Budget Estimates with Current Pricing
$0.2000
$0.1500
$0.1000
$0.0500
$0.0000
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
1 2 3 4 5 6 7 8 9 10 11 12
Delv'd Cost per KWH
Est. Monthly Budget

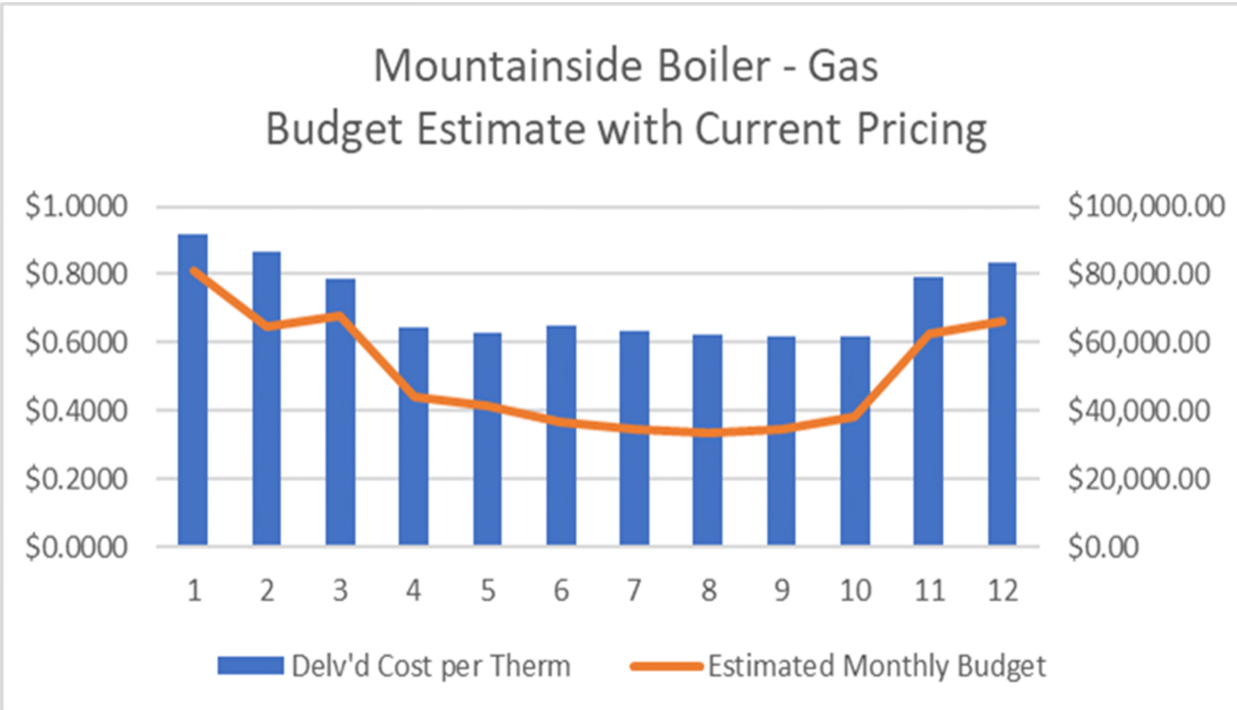
Load data from 2017 and cost data from 2018 are summarized below:

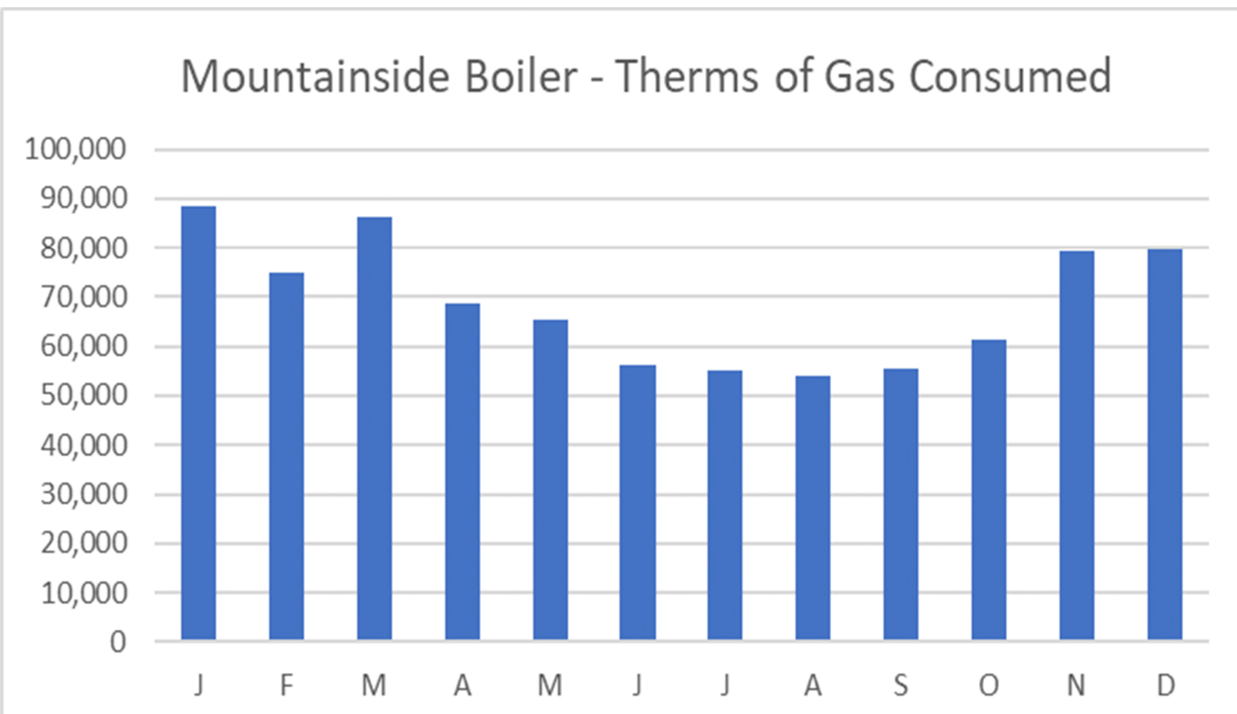
Mountainside - Main and Harris Combined					
		kWh	kW	Cost/kWh	Monthly Cost
	J	1,639,673	2,961	$0.1831	$300,240
	F	1,496,237	2,937	$0.0928	$138,905
	M	1,657,072	2,958	$0.0945	$156,589
	A	1,746,213	3,149	$0.0805	$140,508
	M	1,834,554	3,471	$0.0628	$115,171
	J	2,018,185	3,542	$0.1047	$211,392
	J	2,215,466	3,506	$0.1100	$243,704
	A	2,141,467	3,542	$0.1080	$231,346
	S	1,988,542	3,662	$0.1006	$199,951
	O	1,946,092	3,503	$0.0940	$182,991
	N	1,543,299	4,336	$0.0925	$142,825
	D	1,542,164	2,782	$0.0879	$135,522
	Total / Max	21,768,964	4,336	$0.1010	$2,199,145

The following table provides both gas usage in therms by month and estimated monthly gas cost based on the most recent pricing from November of 2017 through October of 2018.

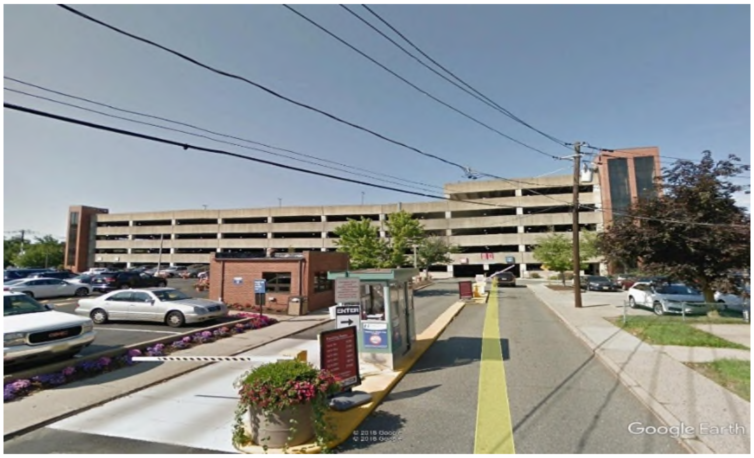
				2017-2018	
		Base year		Current	Representative
		2017		All-in	Monthly
		Therms	MMBTU's	Cost/Therm	Cost
Mountainside - Gas					
	J	88,308	8,830.8	$0.9182	$81,084.54
	F	74,794	7,479.4	$0.8663	$64,793.76
	M	86,319	8,631.9	$0.7873	$67,959.12
	A	68,748	6,874.8	$0.6441	$44,280.68
	M	65,454	6,545.4	$0.6309	$41,294.77
	J	56,248	5,624.8	$0.6488	$36,493.70
	J	55,168	5,516.8	$0.6314	$34,832.98
	A	53,914	5,391.4	$0.6207	$33,464.30
	S	55,477	5,547.7	$0.6199	$34,390.27
	O	61,405	6,140.5	$0.6203	$38,089.69
	N	79,217	7,921.7	$0.7923	$62,763.97
	D	79,612	7,961.2	$0.8349	$66,467.65
	Total:	824,664	82,466.4	$0.7347	$605,915.43

Gas service is currently billed on the LVG tariff from PSE&G. Monthly natural gas use, pricing and estimated budget cost are shown on the following graphs:





3.2.2. Mountainside Hospital Parking Deck

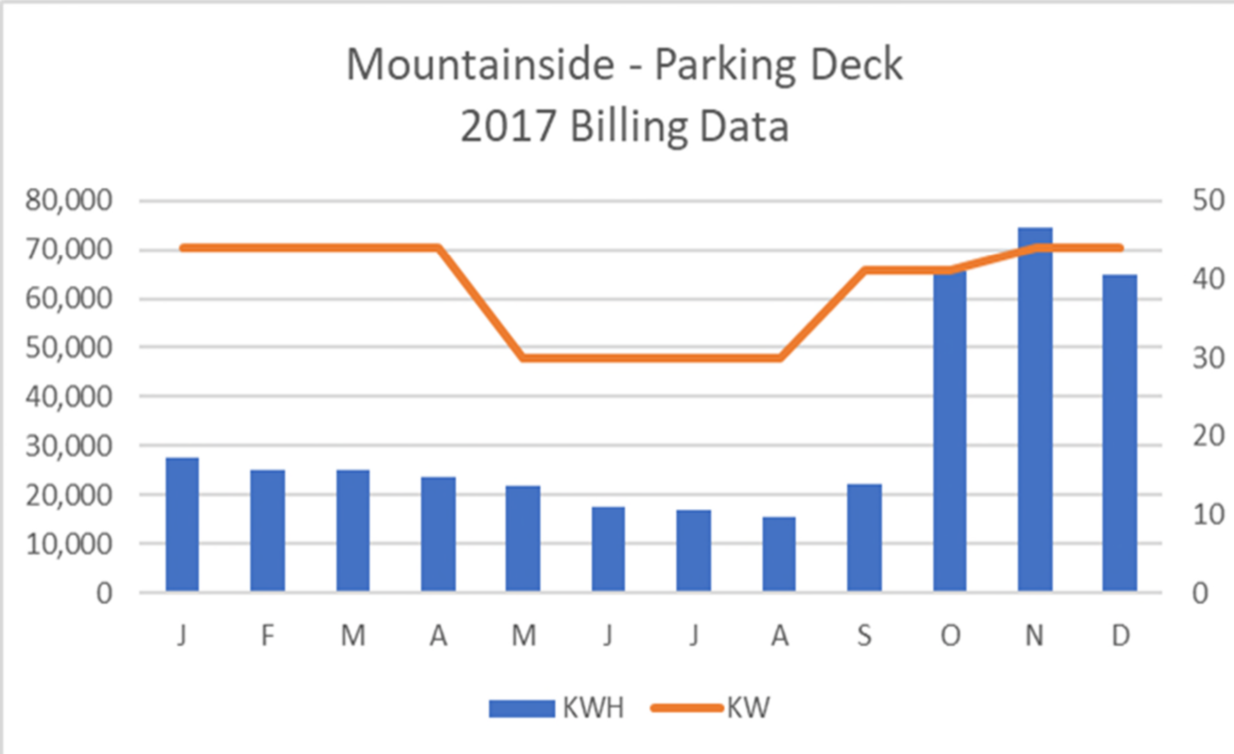


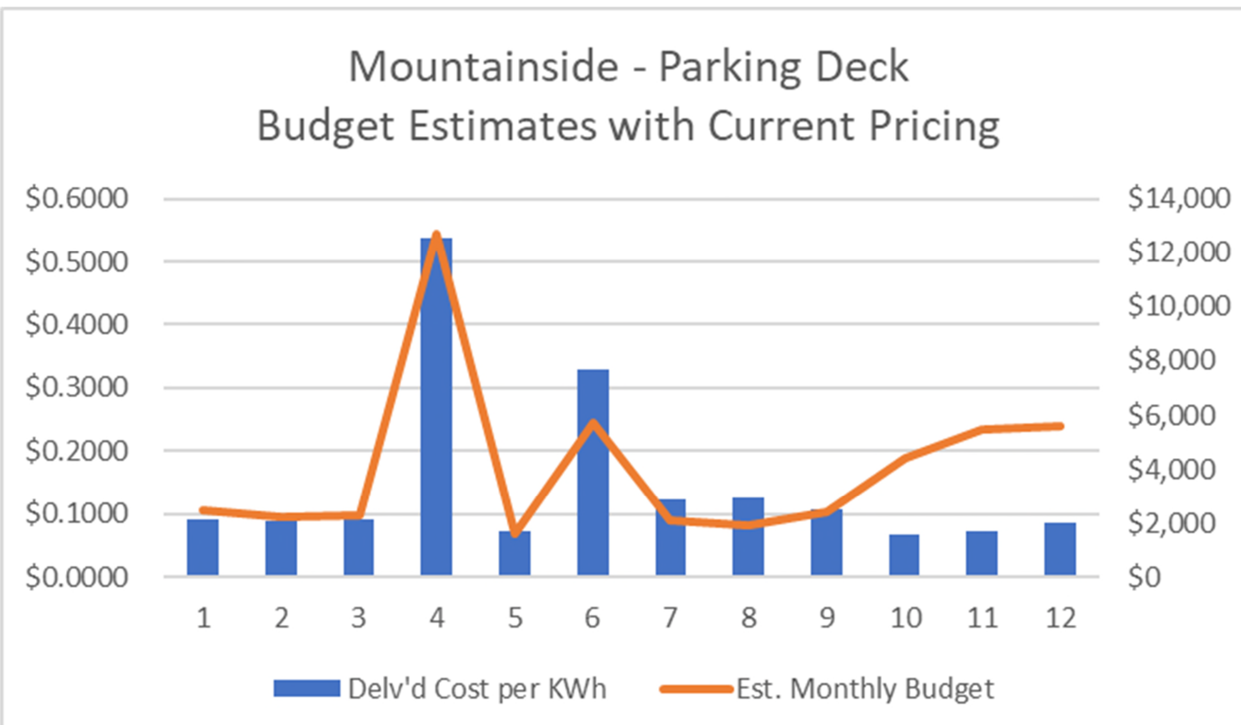
Main hospital parking is provided in a 5-story parking deck on Highland Avenue directly across from the Harris Pavilion and the Emergency Room entrance. The deck can accommodate approximately 600 cars and is open 24 hours a day, 365 days a year. It has two elevator banks at both the northwest and southwest corners of the parking deck. There is electric service to the parking deck providing power for lighting, elevators and security at entrances and egress. There is no gas service to the deck.

The Mountainside parking Deck is on PSE&G's GLP tariff and in 2017 utilized approximately 400,000 kWh with a maximum demand of 44 kW.

Usage and demand for the 2017 base year and cost per delivered kWh using the most recent 12-month pricing from PSE&G bills, as well as an estimated annual electric budget for the Mountainside Parking Deck are shown on the following table and graphs:

Mountainside - Parking Deck				
	kWh	kW	Cost/kWh	Monthly Cost
J	27,486	44	$0.0906	$2,490
F	25,020	44	$0.0895	$2,239
M	25,200	44	$0.0915	$2,306
A	23,598	44	$0.5369	$12,670
M	21,690	30	$0.0734	$1,592
J	17,388	30	$0.3280	$5,703
J	16,866	30	$0.1237	$2,086
A	15,246	30	$0.1249	$1,904
S	22,266	41	$0.1081	$2,407
O	65,556	41	$0.0675	$4,425
N	74,538	44	$0.0734	$5,471
D	64,800	44	$0.0859	$5,566
Total / Max	399,654	44	$0.1223	$48,860


Mountainside - Parking Deck
2017 Billing Data
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
50
40
30
20
10
0
J
F
M
A
M
J
J
A
S
O
N
D
KWH
KW


Mountainside - Parking Deck
Budget Estimates with Current Pricing
$0.6000
$0.5000
$0.4000
$0.3000
$0.2000
$0.1000
$0.0000
$14,000
$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
$0
1
2
3
4
5
6
7
8
9
10
11
12
Delv'd Cost per KWh
Est. Monthly Budget

3.2.3. Pine Ridge

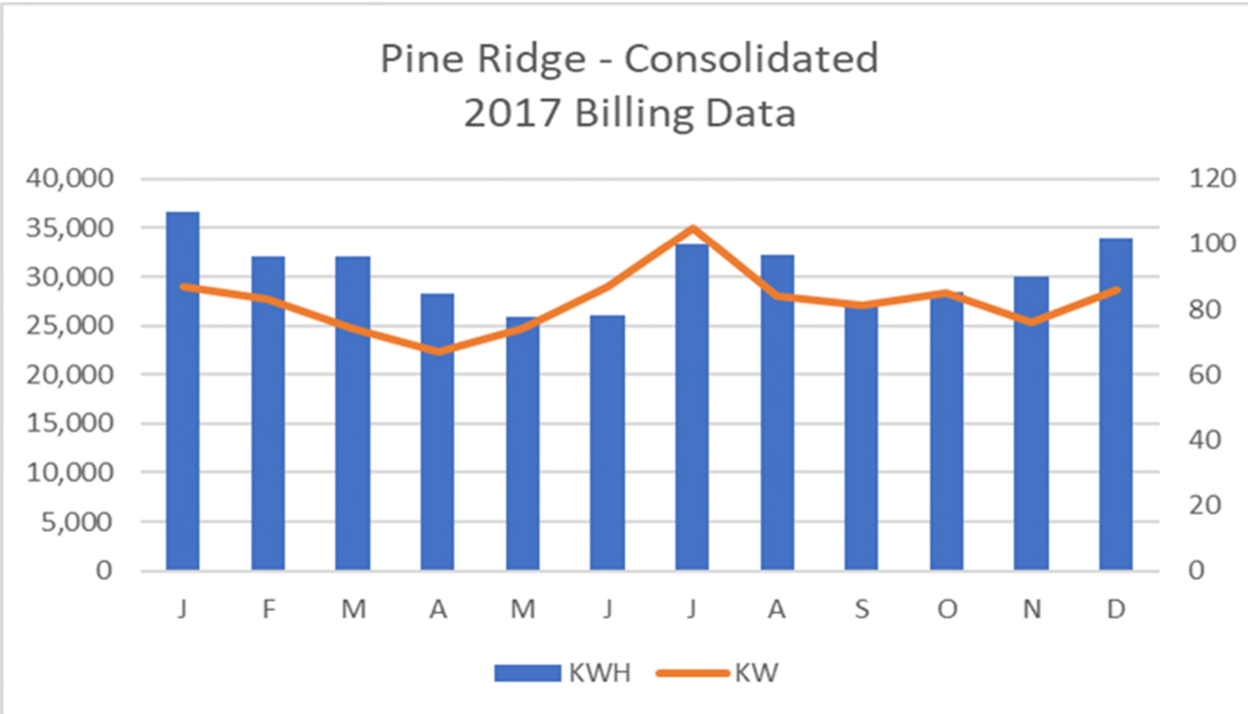
Pine Ridge is a four story, 48-unit senior apartment building. The facility is owned by the non-profit organization United Methodist Communities and is an age-restricted facility. The building is approximately 48,400 square feet and was constructed in 2002.

Pine Ridge common areas consist of a first-floor lobby area, management offices, community room and a kitchen. A common coin operated laundry is located on each floor. The residential units are located on floors 1 through 4, each having one bedroom and approximately 750 square feet of total living space. The building operates 24/7 with office operating hours from 8:30AM through 4:30 PM, Monday through Friday.

Pine Ridge has separate electric meters for common areas, the superintendent's apartment and each of the 48 resident apartments. Actual billing data was obtained for the common area and superintendent apartments. Given the number of individual resident accounts, usage and demand were estimated for the resident apartments. Their usage was estimated using NREL representative data for multifamily apartments located in Newark, NJ.

Power to the common areas and individual residential apartments is fed from a single utility service and step-down transformer located in the first floor of the building. Pending further review, it is assumed that all residential usage can be incorporated into the microgrid. Since the overall energy usage for the residential apartments is relatively minimal when considered as a component of the overall demand capacity for the microgrid, inclusion or exclusion of these loads will not significantly affect the design considered here. There is no emergency power generator or other non-utility power source currently provided to the building.

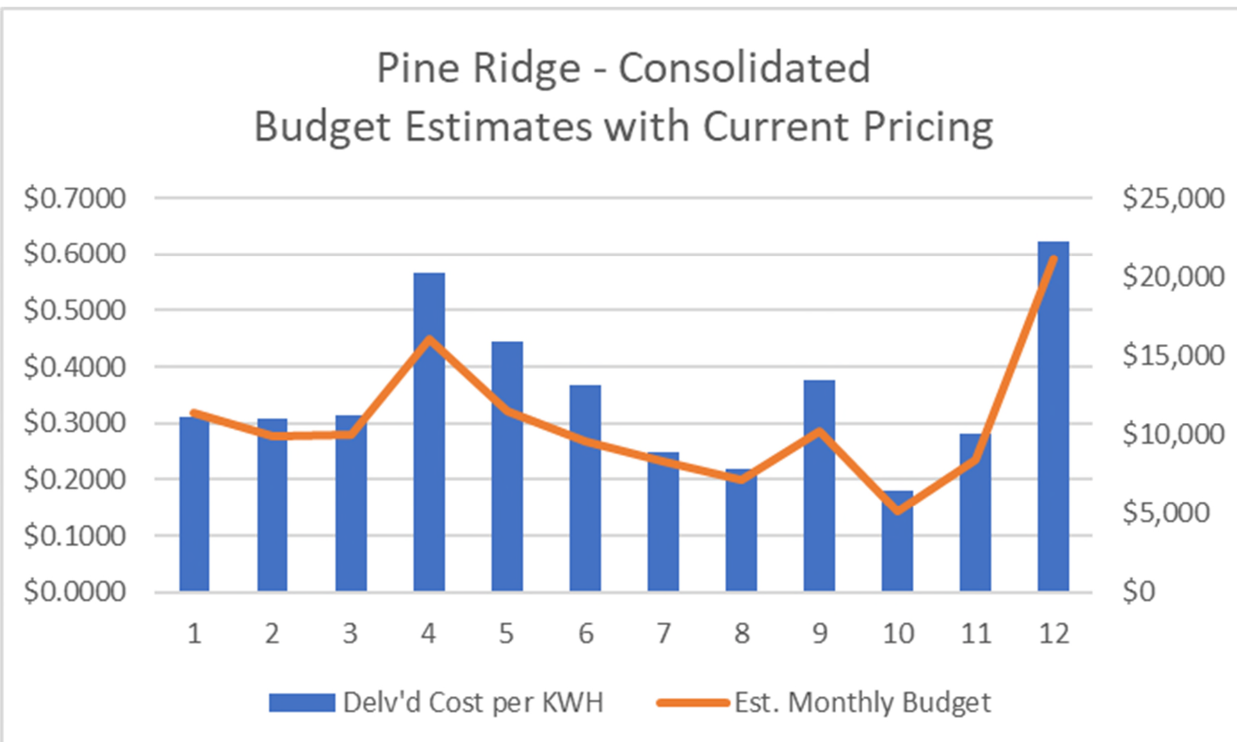
All electric accounts are serviced by PSE&G. The Common Area, Superintendent's Apartment and Resident Apartment accounts are on tariffs GLP, RS and RS respectively. Usage and demand by month for all electric usage at Pine Ridge is shown below:



Electric cost per kWh for Pine Ridge reflects a situation where for modeling purposes it was necessary to use non-billing data for modeling the microgrid. As previously mentioned, the usage for the resident accounts were estimated off of an NREL database and the cost per kWh was assumed to be equal to that of the superintendent's apartment for which we had actual billing data. Unfortunately, the superintendent had a very low usage pattern which when superimposed with the fixed capacity and customer charges in the RS tariff, produced a cost per kWh that was in excess of thirty cents which is not realistic for projecting residential costs for the balance of the building.

Using the invoice information, electric billings are estimated to total $128,561 over the course of a year when budgeting using the most recent pricing data:

Pine Ridge Consolidated (Common, Super and Residents)					
		kWh	Kw	Cost/kWh	Monthly Cost
	J	36,652	87	$0.3100	$11,363
	F	32,004	83	$0.3087	$9,879
	M	32,010	74	$0.3124	$9,999
	A	28,241	67	$0.5670	$16,012
	M	25,946	74	$0.4433	$11,501
	J	26,005	87	$0.3658	$9,514
	J	33,343	105	$0.2484	$8,281
	A	32,274	84	$0.2196	$7,086
	S	27,259	81	$0.3753	$10,231
	O	28,440	85	$0.1797	$5,111
	N	30,028	76	$0.2803	$8,416
	D	33,922	86	$0.6240	$21,169
	Total / Max	366,124	105	$0.3511	$128,561

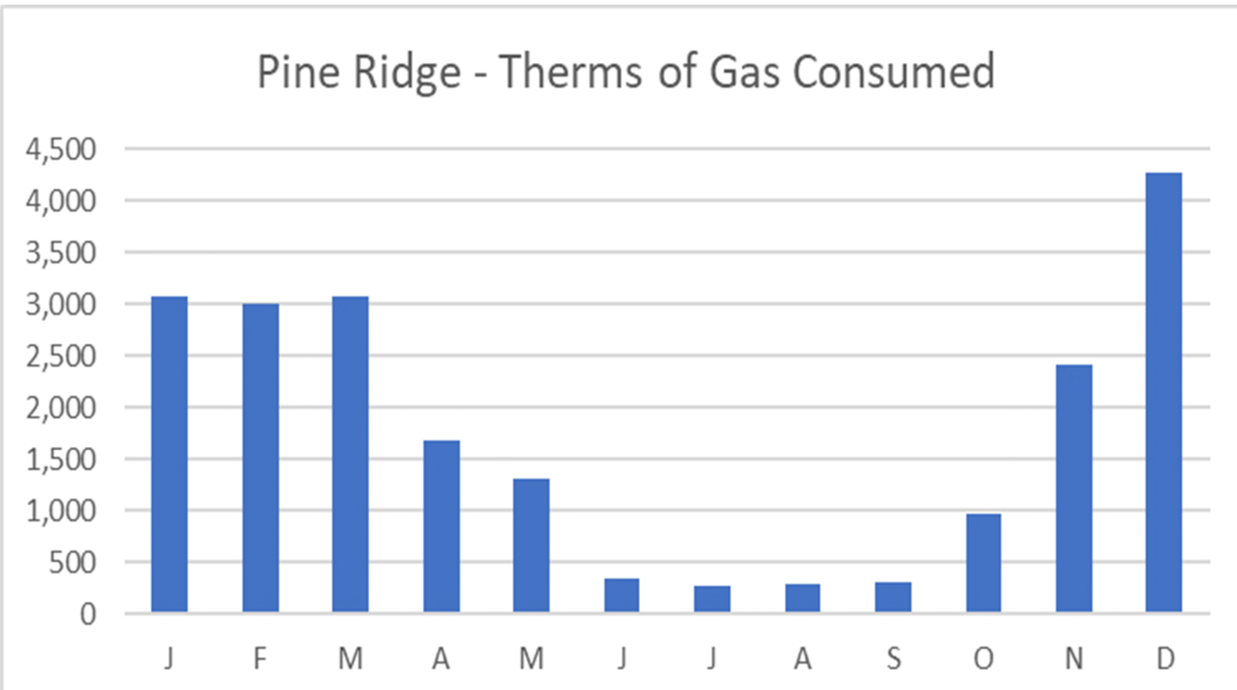


With regard to gas usage, the building illustrates a typical utility cost structure for a senior building where heating is supplied from a common boiler plant. Resident A/C is supplied by individual PTAC units in each apartment. The high cost per kWh for the building seems to be a function of low electric usage in the superintendent and resident accounts spread over the fixed cost pricing elements in the RS tariff.

Pine Ridge provides space heating using four Slant Fin Caravan modular gas fired hot water boilers located in a common boiler room. These boilers provide heat for most common areas and all apartments. Each of these boilers are rated at 375 MBH. Domestic hot water is provided by two gas fired 365 MBH (fuel input), 85-gallon A.O. Smith non-condensing hot water heaters in the boiler room.

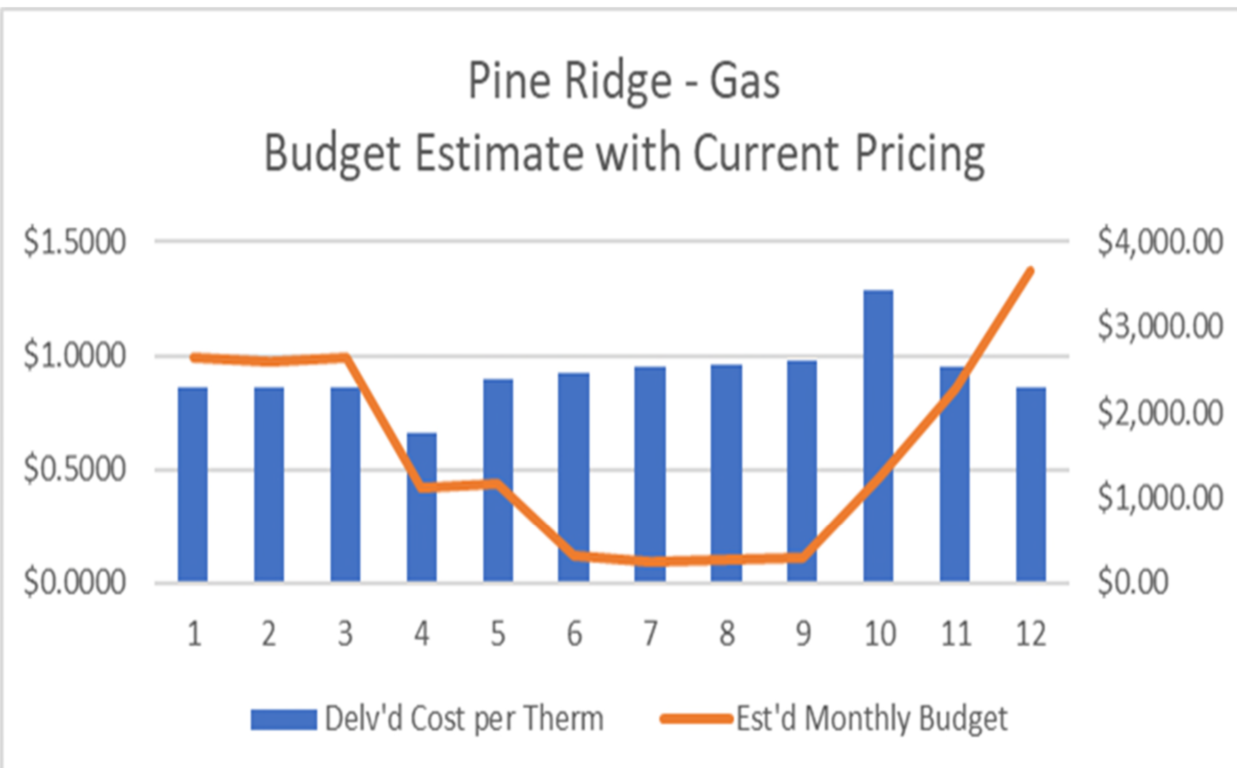
Natural gas is supplied by PSE&G for both the boilers and hot water heaters on tariff LVG.

The following graph illustrates natural gas consumption for the building over the course of the year.



Gas pricing and monthly cost are illustrated in the table and graph which follow:

Pine Ridge - Gas		Therms	MMBTU's	Cost/Therm	Cost
	J	3,079	307.9	$0.8600	$2,647.82
	F	3,009	300.9	$0.8600	$2,588.00
	M	3,082	308.2	$0.8600	$2,650.55
	A	1,679	167.9	$0.6600	$1,107.90
	M	1,305	130.5	$0.9000	$1,174.20
	J	337	33.7	$0.9200	$309.69
	J	271	27.1	$0.9500	$257.14
	A	282	28.2	$0.9600	$270.70
	S	309	30.9	$0.9800	$302.96
	O	965	96.5	$1.2900	$1,244.58
	N	2,411	241.1	$0.9500	$2,290.82
	D	4,267	426.7	$0.8600	$3,669.84
		20,995	2,099.5	$0.8818	$18,514.19



3.2.4. Bay Street Station

Bay Street is a New Jersey Transit station on Pine Street between Bloomfield and Glenridge Avenues in Montclair, along the Montclair-Boonton Line. The station is served by all trains on the line, including all ten weekend trains. The first station of seven in Montclair, Bay Street is the southernmost, servicing the downtown district. The station was built originally in 1981 to replace the Lackawanna Terminal built near Grove Street in 1913 as a part of creating the Montclair Connection. Upon its opening on February 27, 1981, Bay Street was a lone platform with a single shelter. In 2002, as part of the Montclair Connection, Bay Street was completely rebuilt to standards for ADA accessibility, including two high-level platforms and a new elevator for a bridge crossing the tracks.

The station has two high-level side platforms to serve passengers on its two tracks. The platforms themselves are connected by a crossover bridge with elevators and have ticket vending machines.

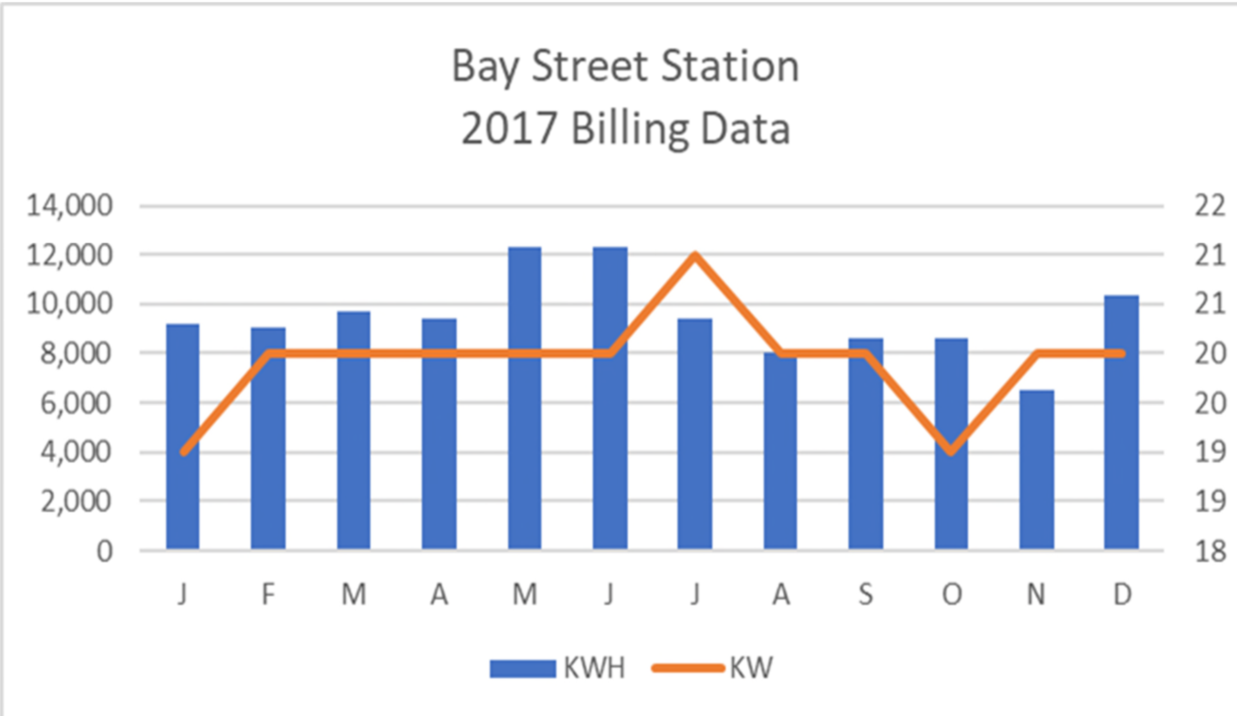
On July 11, 2010, the New Jersey Department of Transportation announced that Montclair had been designated as a transit village. Transit villages are designated to provide residents and people public transit with public services including new residences and stores. Montclair was given high regard for the work done at Bay Street Station to make it possible, including a new parking deck, and a complex of seven residential units along Pine Street. Although Montclair's transit village is mostly built at Bay Street, the township also serves five other stations, all in walkable distance from residences.

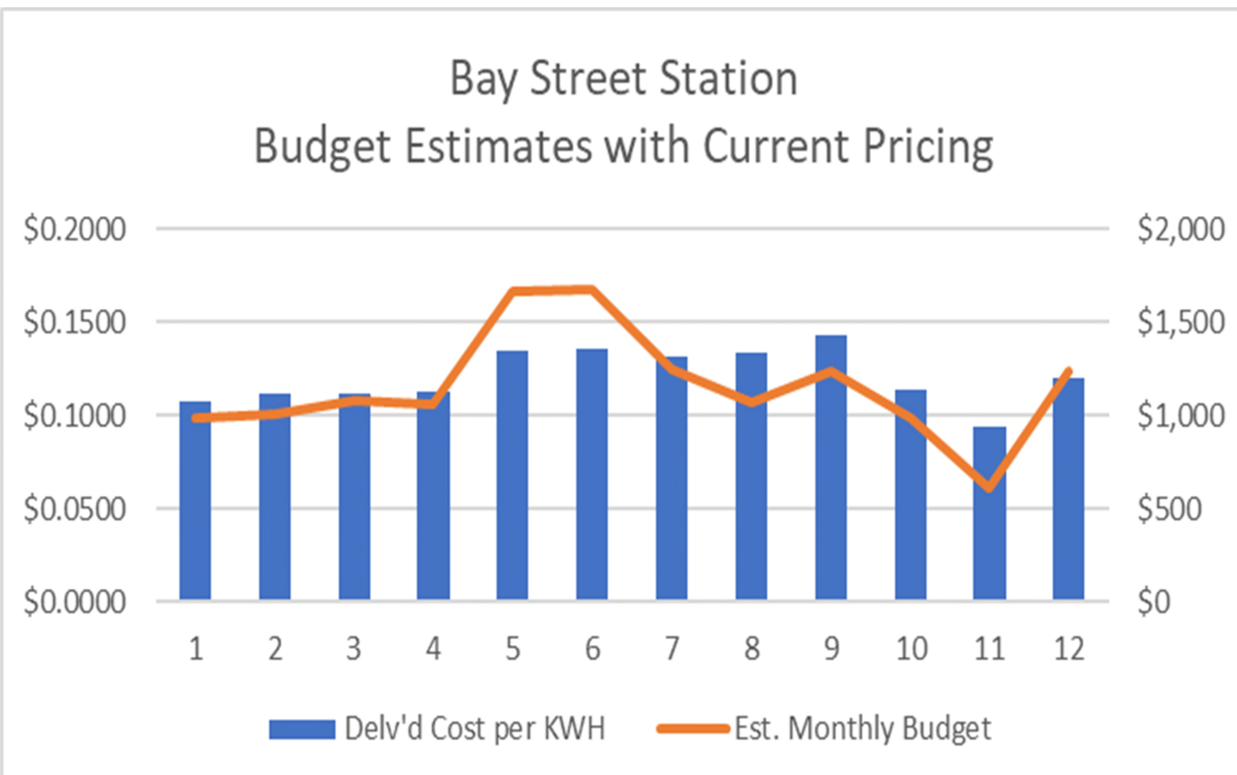
While Bay Street Station is an integral part of Montclair’s ground-breaking transit village, its electric usage is relatively minor when compared to other facilities on the proposed microgrid. None the less its central location directly adjacent to Fire Headquarters and the Pine Street Parking Deck, along with its proximity to Pine Ridge and importance given the proposed NJ Transit right of way routing for the microgrid distribution wires, makes Bay Street Station an important component of the Montclair microgrid.

Bay Street Station is an all-electric facility with approximately 4,000 square feet of enclosed space. It is owned and operated by NJ Transit. Electric service from PSE&G is utilized to provide lighting in the station and on the platform, and spot heating and air conditioning for the enclosed shelter building. Peak electric loads are fairly steady throughout the year ranging from 19 to 21 kW. Annual kWh consumption in the base year of 2017 was slightly over 113,000. The station is on PSE&G's GLP tariff.

Usage and demand for the 2017 base year and cost per delivered kWh using the most recent 12-month pricing from PSE&G bills, as well as an estimated annual electric budget for the Bay Street Station are shown on the following table and graphs:

Bay Street Station				
	kWh	Kw	Cost/kWh	Monthly Cost
J	9,200	19	$0.1070	$984
F	9,040	20	$0.1114	$1,007
M	9,680	20	$0.1118	$1,082
A	9,440	20	$0.1121	$1,058
M	12,320	20	$0.1348	$1,661
J	12,320	20	$0.1356	$1,671
J	9,440	21	$0.1318	$1,244
A	8,000	20	$0.1332	$1,066
S	8,640	20	$0.1432	$1,237
O	8,640	19	$0.1139	$984
N	6,480	20	$0.0933	$605
D	10,320	20	$0.1197	$1,235
Total / Max	113,520	21	$0.1219	$13,834


Bay Street Station
2017 Billing Data
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
22
21
21
20
20
19
19
18
J F M A M J J A S O N D
KWH
KW


Bay Street Station
Budget Estimates with Current Pricing
$0.2000
$0.1500
$0.1000
$0.0500
$0.0000
$2,000
$1,500
$1,000
$500
$0
1 2 3 4 5 6 7 8 9 10 11 12
Delv'd Cost per KWH
Est. Monthly Budget

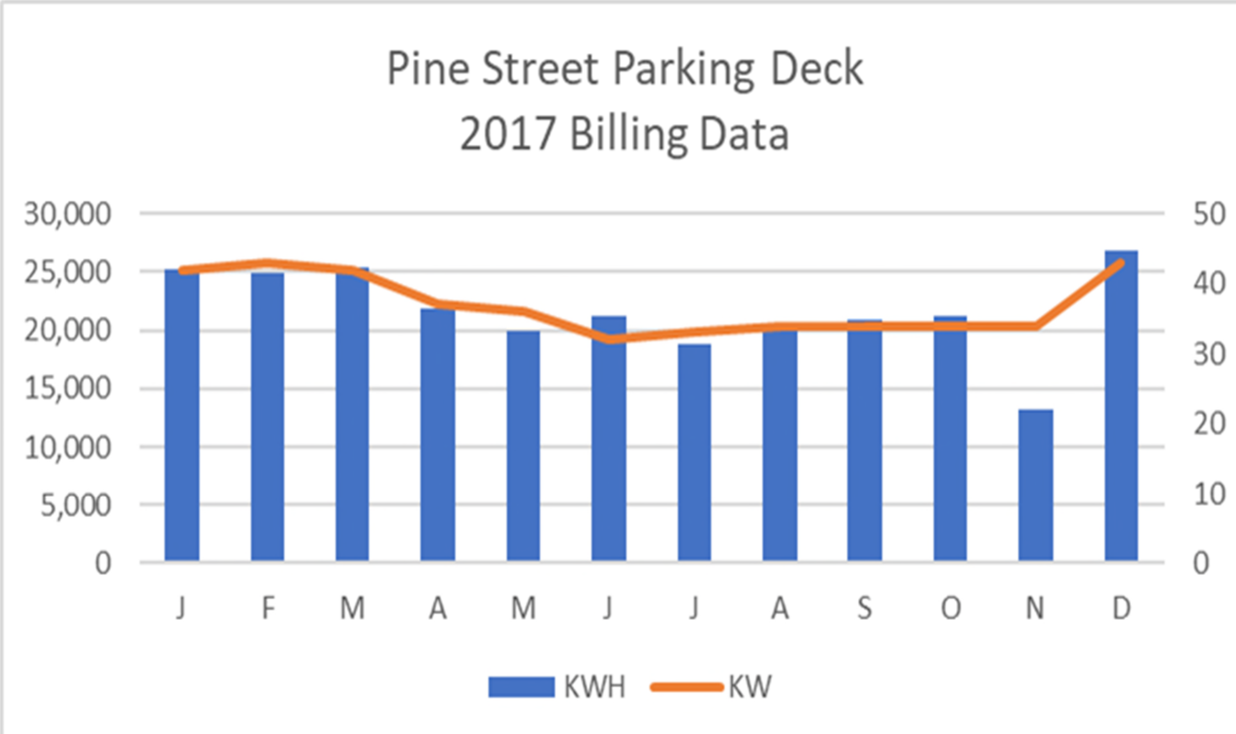
3.2.5. Pine Street Parking Garage

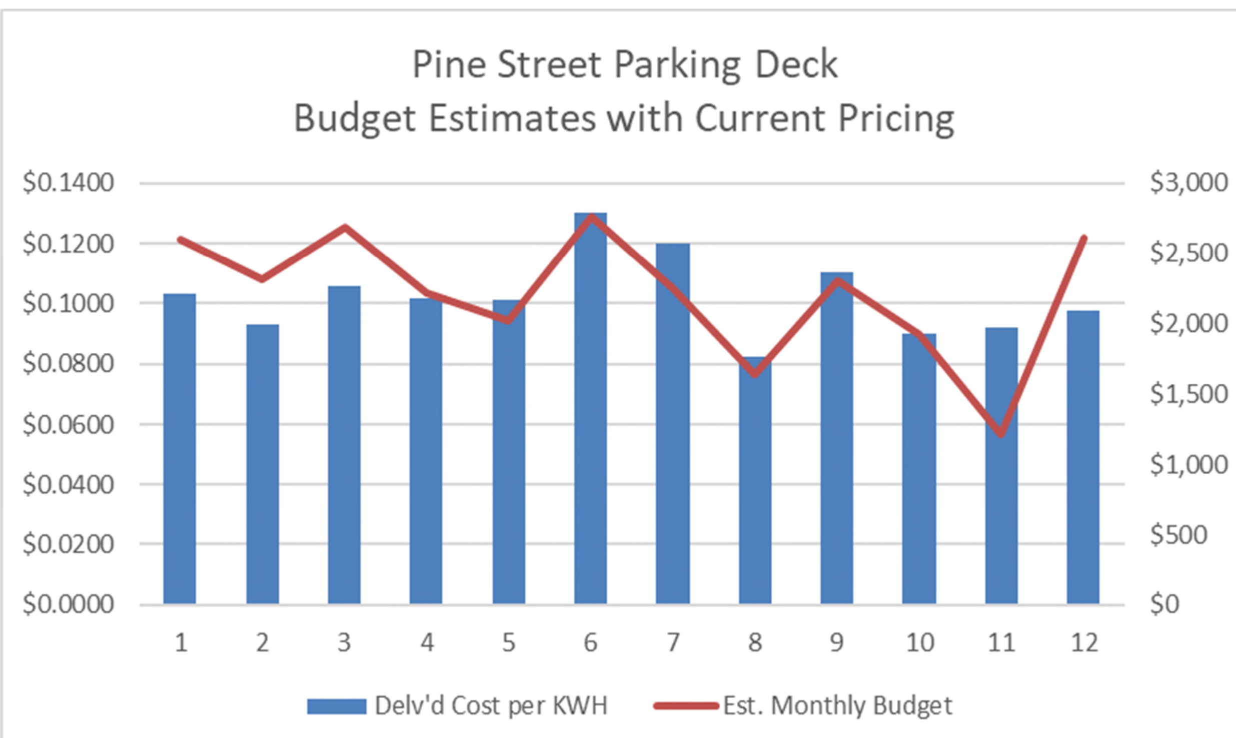
The Pine Street Parking Garage is a 4-story, 248-space parking deck that is interconnected with NJ Transit's Bay Street Station. It neighbors Montclair's Fire Headquarters and is a few hundred feet from Pine Ridge Senior Residence. The garage is owned, operated and maintained by the Montclair Parking Authority, an agency of the Township of Montclair. The deck is open 24 hours a day, 365 days a year. It has a bank of two elevators that provide access to the pedestrian bridge at Bay Street Station which allows commuters to cross over the tracks when arriving or departing on northbound trains. As part of the microgrid project, it is proposed to add to two Electric Vehicle charging stations each with two charging ports in the garage that are designated for commuter use during normal times and for emergency only electric vehicles during emergencies.

Electric service from PSE&G to the parking garage provides power for lighting, elevators and security at entrances and egress. There is no gas service to the parking garage. The Pine Street Parking Garage is on PSE&G's GLP tariff and in 2017 utilized approximately 260,000 kWh with a maximum demand of 43 kW.

Usage and demand for the 2017 base year and cost per delivered kWh using the most recent 12-month pricing from PSE&G bills, as well as an estimated annual electric budget for the Pine Street Parking Garage are shown on the following table and graphs:

Pine Street Parking Deck				
	kWh	Kw	Cost/kWh	Monthly Cost
J	25,200	42	$0.1034	$2,606
F	24,880	43	$0.0930	$2,314
M	25,360	42	$0.1059	$2,686
A	21,840	37	$0.1015	$2,217
M	20,000	36	$0.1013	$2,026
J	21,200	32	$0.1304	$2,764
J	18,800	33	$0.1200	$2,256
A	19,920	34	$0.0825	$1,643
S	20,960	34	$0.1102	$2,310
O	21,280	34	$0.0902	$1,919
N	13,200	34	$0.0921	$1,216
D	26,800	43	$0.0976	$2,616
Total / Max	259,440	43	$0.1024	$26,572


Pine Street Parking Deck
2017 Billing Data
30,000
25,000
20,000
15,000
10,000
5,000
0
50
40
30
20
10
0
J F M A M J J A S O N D
KWH
KW


Pine Street Parking Deck
Budget Estimates with Current Pricing
$0.1400
$0.1200
$0.1000
$0.0800
$0.0600
$0.0400
$0.0200
$0.0000
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
1 2 3 4 5 6 7 8 9 10 11 12
Delv'd Cost per KWH
Est. Monthly Budget

3.2.6. Montclair Fire Headquarters

Montclair has a full-time fire department which is housed in three separate fire stations covering the north (Upper Montclair), central (Headquarters) and southern (South End) sections of the township. The Fire Headquarters is located in the central station at the corner of Bloomfield Avenue and Pine Street. Built in 2003, it is the newest and largest of the three stations and houses administrative offices for the Chief and Deputy Chiefs, conference and training facilities, meeting rooms, and typical amenities included in most modern fire stations such as dormitories, locker rooms, showers and a fitness gym.

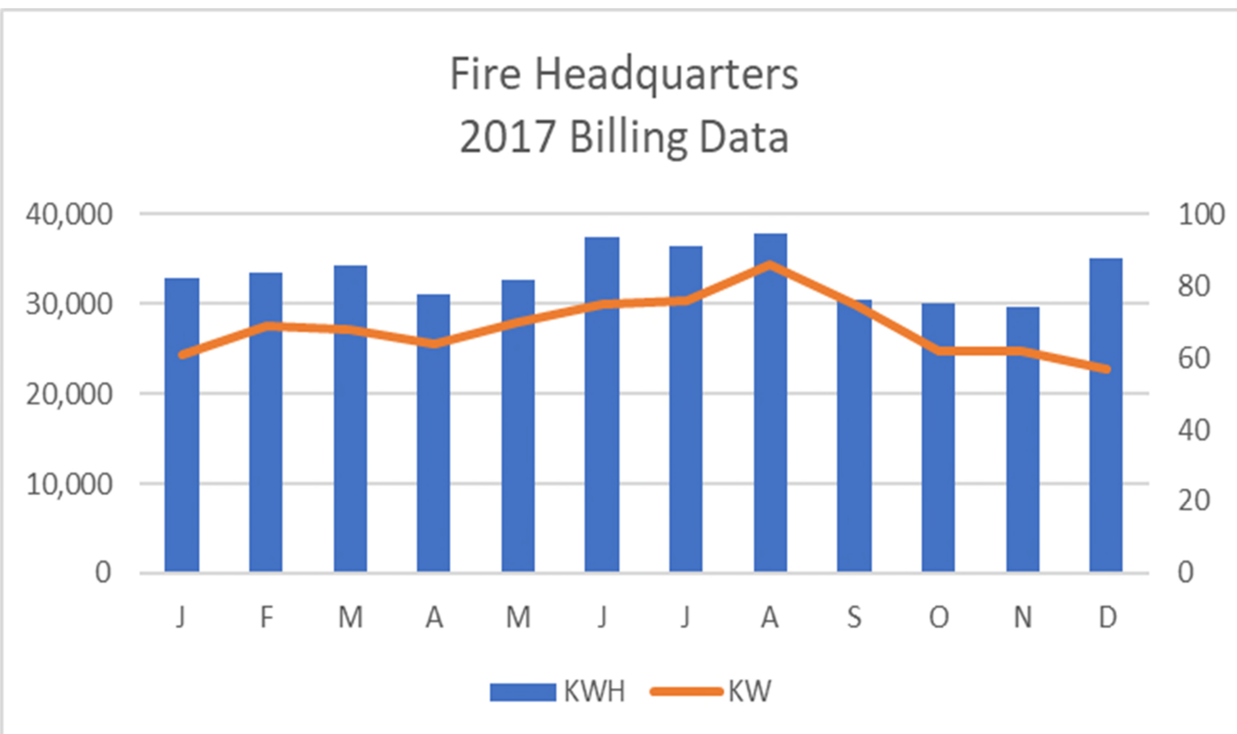
Co-located at the Fire Headquarters is the Emergency Management Office and regional 911 Call Center. In times of need the Fire Headquarters acts as the township emergency response center with facilities for government, public safety and emergency response teams to coordinate and communicate with resources in the field. The Headquarters fire station also provides fire protection for the neighboring borough of Glen Ridge. The building is occupied and operates 24 hours a day, 365 days a year.

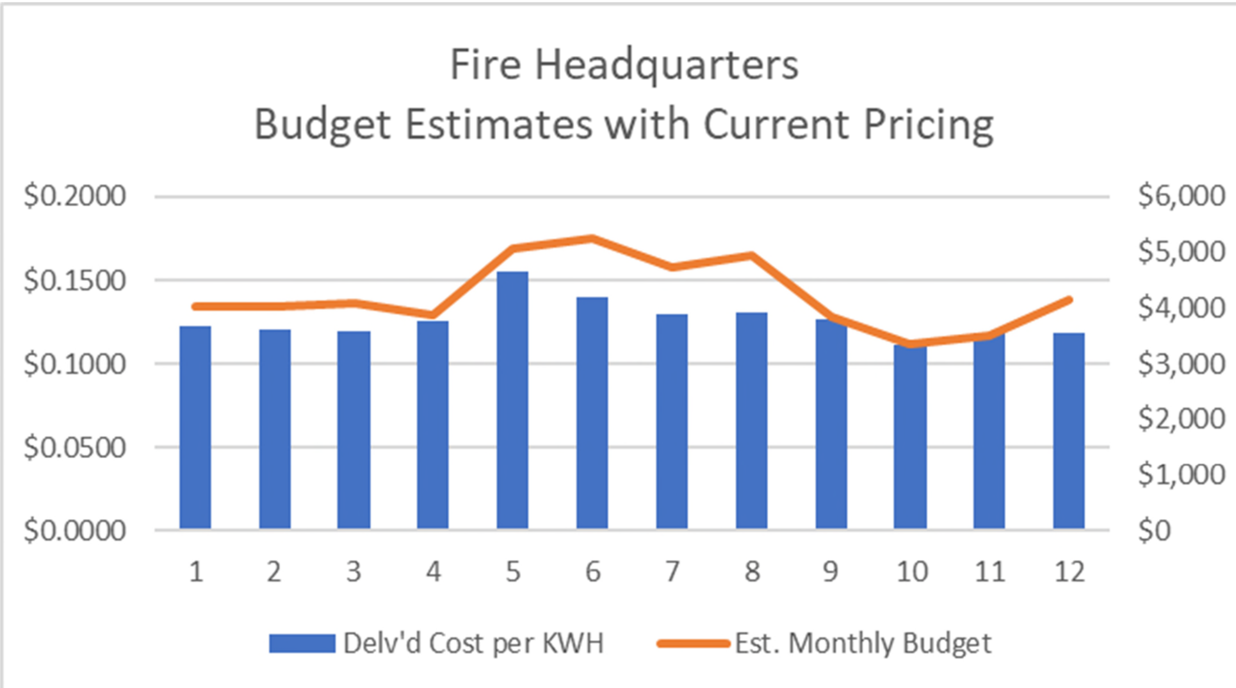
The Montclair Fire Headquarters is a two-story building of approximately 36,500 square feet. It is fully air conditioned and is heated by natural gas boilers making hot water heat. Because of the critical nature of the operations at Fire Headquarters, it is also served by a 125 kW diesel fueled emergency generator.

Electric service is provided by PSE&G on tariff GLP. In 2017 Fire Headquarters used just over 400,000 kWh of electricity and had a peak demand of 86kW.

Usage and demand for the 2017 base year and cost per delivered kWh using the most recent 12-month pricing from PSE&G bills, as well as an estimated annual electric budget for Fire Headquarters are shown on the following table and graphs:

Fire Headquarters				
	kWh	Kw	Cost/kWh	Monthly Cost
J	32,906	61	$0.1224	$4,028
F	33,415	69	$0.1204	$4,023
M	34,137	68	$0.1199	$4,093
A	30,920	64	$0.1253	$3,874
M	32,540	70	$0.1555	$5,060
J	37,420	75	$0.1400	$5,239
J	36,359	76	$0.1300	$4,727
A	37,829	86	$0.1304	$4,933
S	30,480	75	$0.1264	$3,853
O	30,059	62	$0.1118	$3,361
N	29,663	62	$0.1180	$3,500
D	35,098	57	$0.1185	$4,159
Total / Max	400,826	86	$0.1269	$50,849




Fire Headquarters
Budget Estimates with Current Pricing
$0.2000
$0.1500
$0.1000
$0.0500
$0.0000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
1 2 3 4 5 6 7 8 9 10 11 12
Delv'd Cost per KWH
Est. Monthly Budget

3.2.7. Glenfield Middle School

Glenfield Middle School is one of three middle schools in the Township of Montclair serving students in grades 6 through 8. It is the Visual and Performing Arts school in Montclair's innovative magnet school program which was implemented in the mid 1970's and has become a model for school systems throughout the United States. Students have choices and real options that promote excellence in living, as well as learning. Glenfield Middle School strives to reflect the energy, sense of possibility and engagement that define the adolescents it serves.

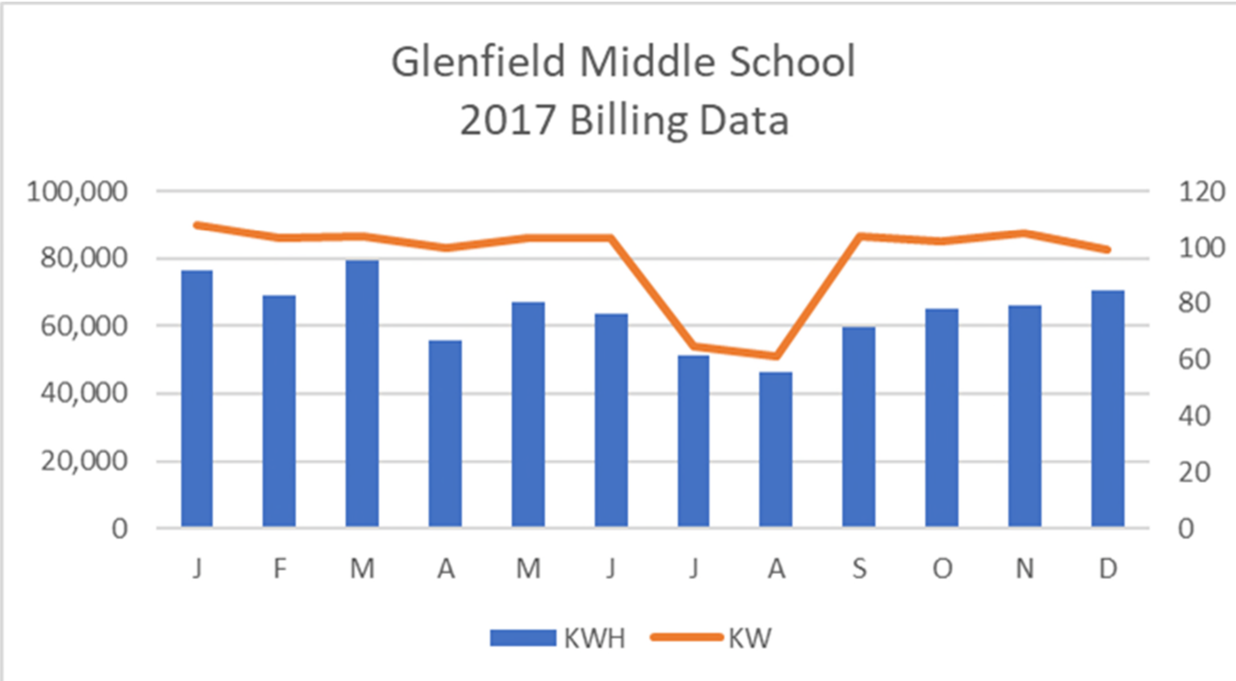
Glenfield Middle School sits in Glenfield Park and is over 100 years old with a rich history inclusive of several renovations. Additions have included a 600-seat auditorium, planetarium, gymnasium, climbing gym and outdoor lunchtime facility. Connected to the magnet theme Glenfield has 3 visual art rooms, a dance studio, culinary arts kitchen and 3D printing studio. The school has 3 technology labs and library utilized for curriculum enhancement and also offers a breakfast and lunch program in accordance with Montclair's district food policy.

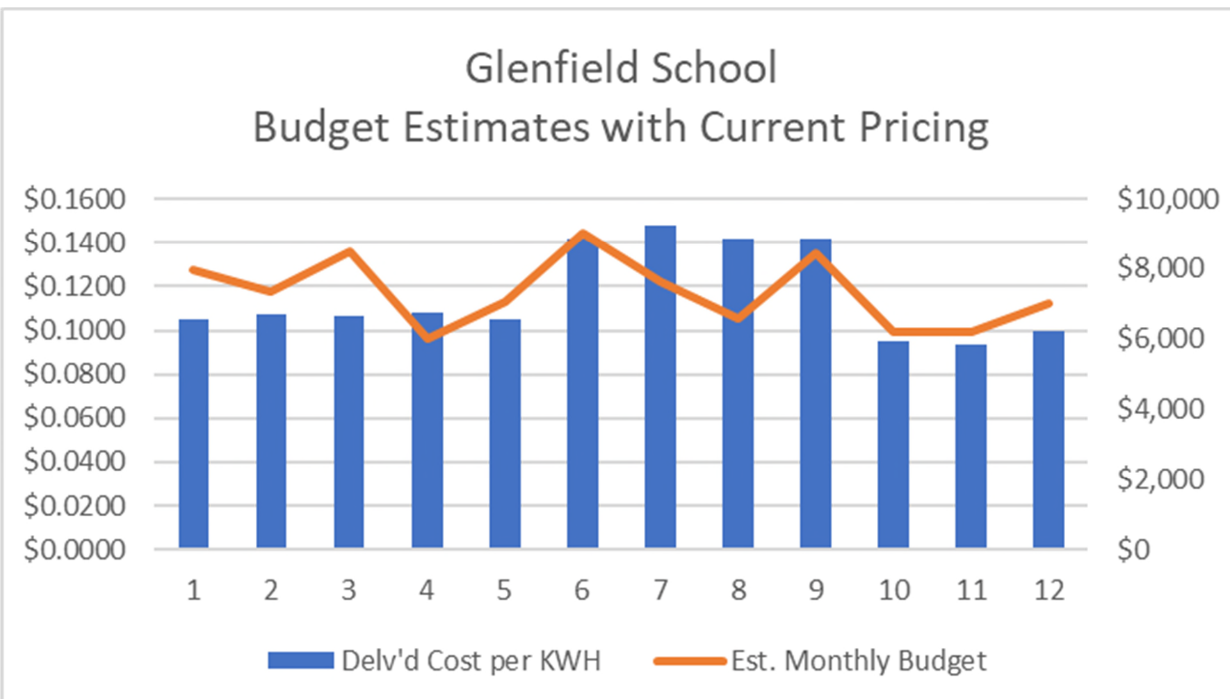
Glenfield is under the management of the Montclair Board of Education which is one of only a handful of Boards in the state of New Jersey that are appointed by the Mayor as opposed to being elected by voters.

The school facility includes approximately 270,000 square feet of space with electric and gas service from PSE&G. There is no central air conditioning, but heating and domestic hot water are provided by an in-house boiler plant running on natural gas. The boiler plant consists of three natural gas fired AERCO Benchmark 3000 condensing hot water boilers rated for 2.79 MMBtu per hour max output with a turndown ration of 15:1. The building is occupied year-round although the summer months represent a much lower level of classroom usage reflecting only the optional courses and programs offered to students during the traditional summer break. The school has traditional operating hours from 8AM to 4PM, September through June and often has extracurricular or after-school activities that extend the day well into the evening. Currently there is no emergency generator or other non-utility power supply resource at the school.

Electric service is provided by PSE&G on tariff LPL-S. During 2017 Glenfield used over 770,000 kWh with a peak demand of 108 kW. The following table and graphs summarize Glenfield's electric usage, demand and estimated budget for electricity:

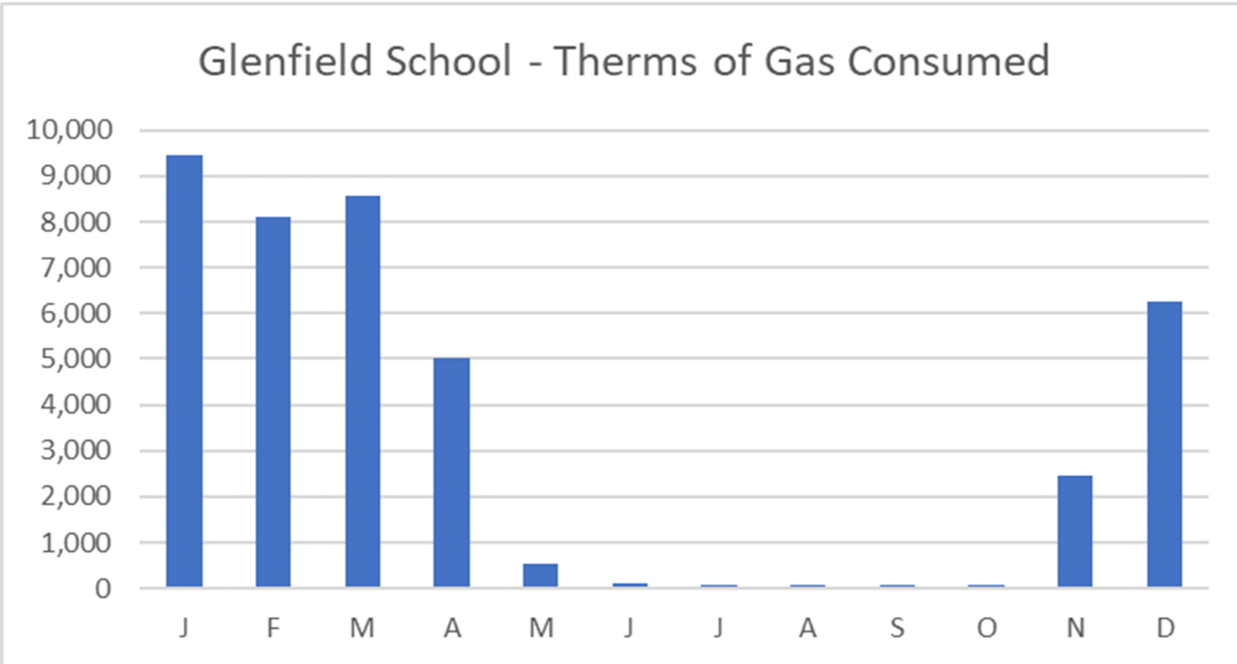
Glenfield School					
		kWh	Kw	Cost / kWh	Monthly Cost
	J	76,305	108	$0.1047	$7,989
	F	68,850	103	$0.1071	$7,374
	M	79,615	104	$0.1068	$8,503
	A	55,565	100	$0.1078	$5,990
	M	67,177	103	$0.1053	$7,074
	J	63,614	103	$0.1416	$9,008
	J	51,547	65	$0.1477	$7,613
	A	46,331	61	$0.1417	$6,565
	S	59,661	104	$0.1419	$8,466
	O	65,350	102	$0.0950	$6,208
	N	66,147	105	$0.0937	$6,198
	D	70,313	99	$0.0997	$7,010
	Total / Max	770,475	108	$0.1142	$87,998

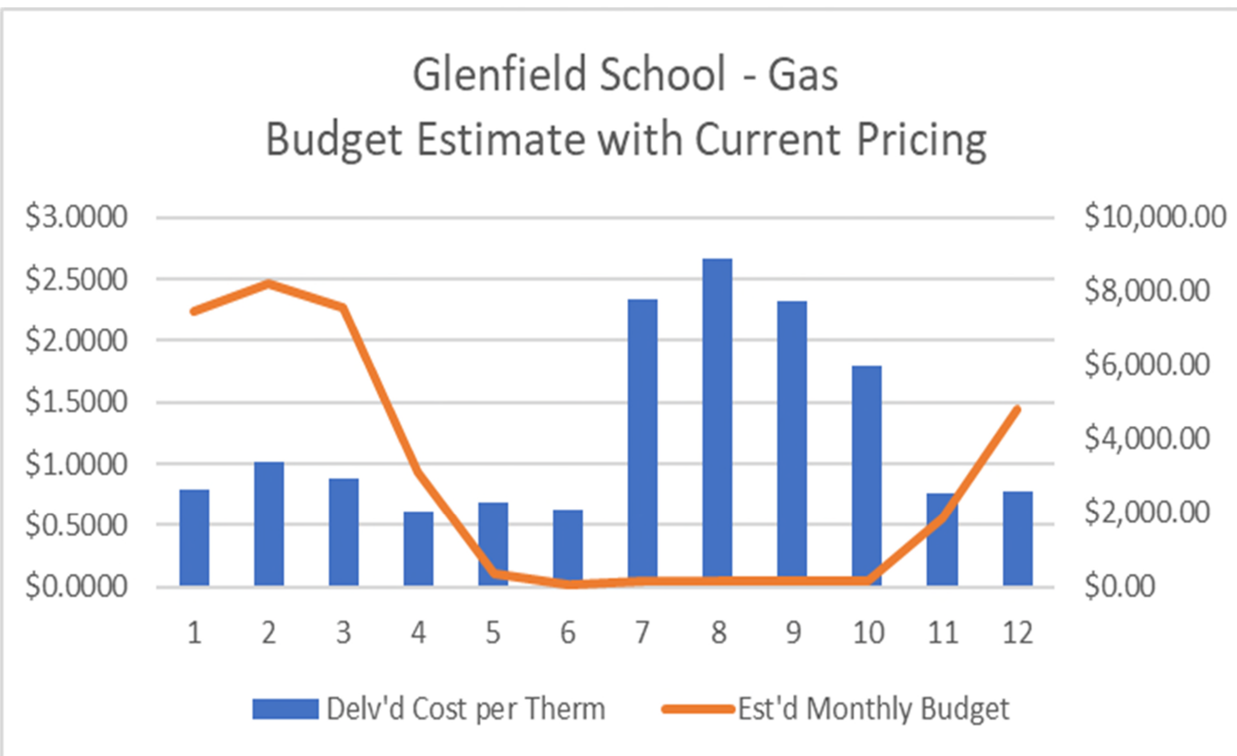

Glenfield Middle School
2017 Billing Data
100,000
80,000
60,000
40,000
20,000
0
120
100
80
60
40
20
0
J F M A M J J A S O N D
KWH
KW


Glenfield School
Budget Estimates with Current Pricing
$0.1600
$0.1400
$0.1200
$0.1000
$0.0800
$0.0600
$0.0400
$0.0200
$0.0000
$10,000
$8,000
$6,000
$4,000
$2,000
$0
1 2 3 4 5 6 7 8 9 10 11 12
Delv'd Cost per KWH
Est. Monthly Budget

Natural gas service is provided by PSE&G on tariff LVG. During 2017 Glenfield used approximately 41,000 therms of natural gas for heating and domestic hot water needs. The following table and graphs summarize Glenfield's natural gas, cost per MMBTU and estimated budget for natural gas:

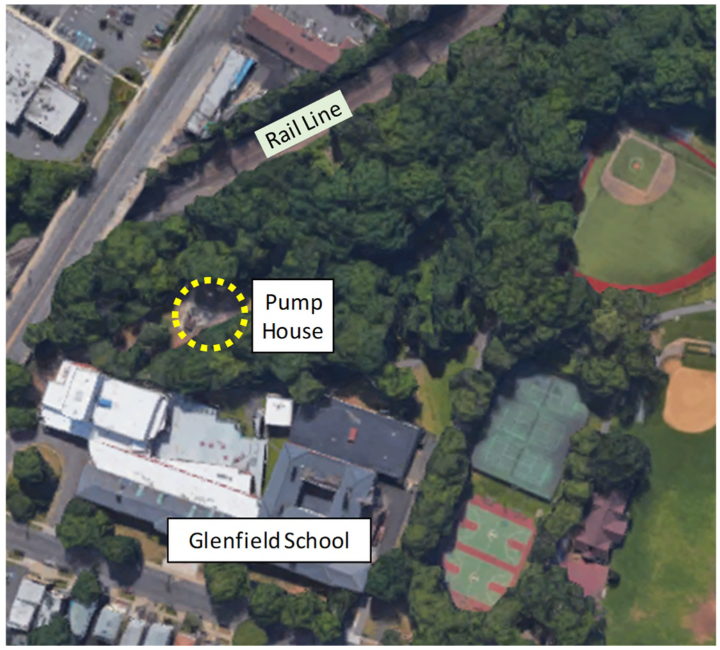
Glenfield School - Gas					
				2017-2018	
		Base year		Current	Representative
		2017		All-in	Monthly
		Therms	MMBTU's	Cost/Therm	Cost
	J	9,457	945.7	$0.7880	$7,451.78
	F	8,089	808.9	$1.0143	$8,204.30
	M	8,551	855.1	$0.8832	$7,551.78
	A	5,021	502.1	$0.6168	$3,096.96
	M	536	53.6	$0.6864	$368.06
	J	105	10.5	$0.6175	$64.81
	J	73	7.3	$2.3347	$170.85
	A	63	6.3	$2.6605	$166.72
	S	57	5.7	$2.3239	$133.48
	O	89	8.9	$1.8006	$160.00
	N	2,444	244.4	$0.7590	$1,854.82
	D	6,260	626.0	$0.7715	$4,829.76
		40,745	4,074.5	$0.8358	$34,053.33


Glenfield School - Therms of Gas Consumed
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
J F M A M J J A S O N D


Glenfield School - Gas
Budget Estimate with Current Pricing
$3.0000
$2.5000
$2.0000
$1.5000
$1.0000
$0.5000
$0.0000
$10,000.00
$8,000.00
$6,000.00
$4,000.00
$2,000.00
$0.00
1 2 3 4 5 6 7 8 9 10 11 12
Delv'd Cost per Therm
Est'd Monthly Budget

3.2.8. Glenfield Pump House

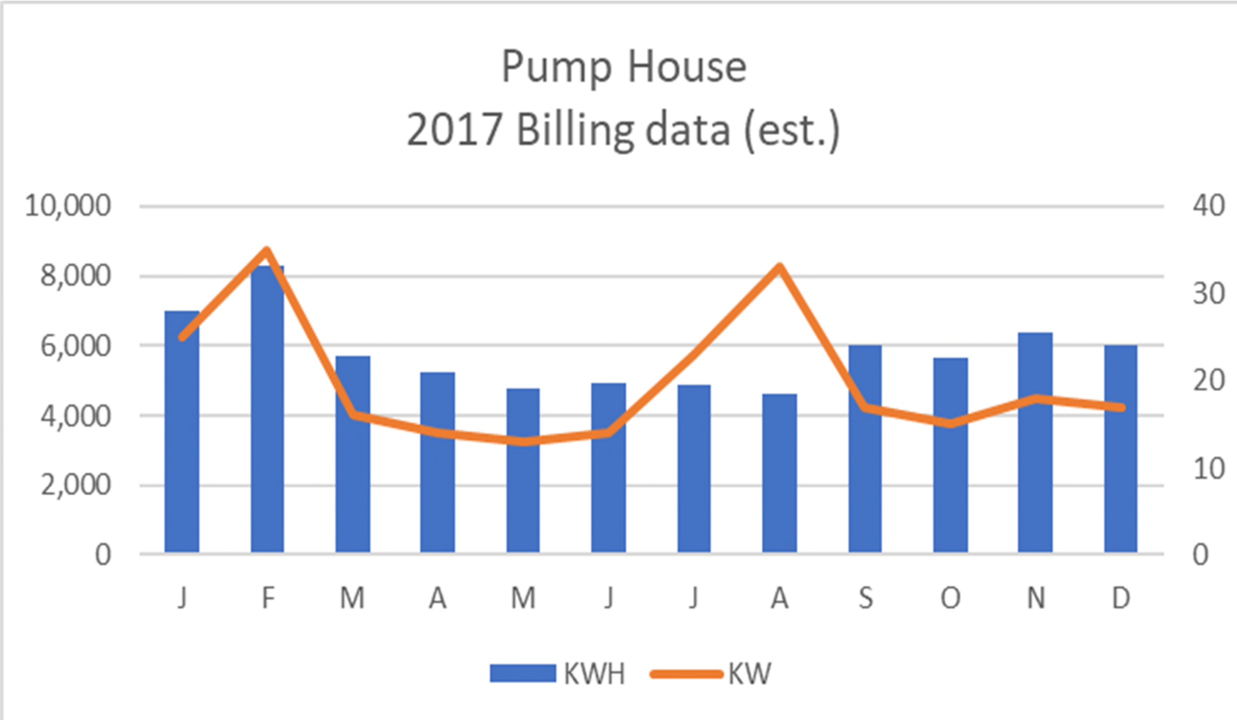
In Montclair, the water is supplied by the North Jersey District Water Supply Commission (NJDWSC), which owns and operates the 29.6 billion-gallon Wanaque Reservoir and Treatment Plant and the seven-billion-gallon Monksville Reservoir, both located in Passaic county.

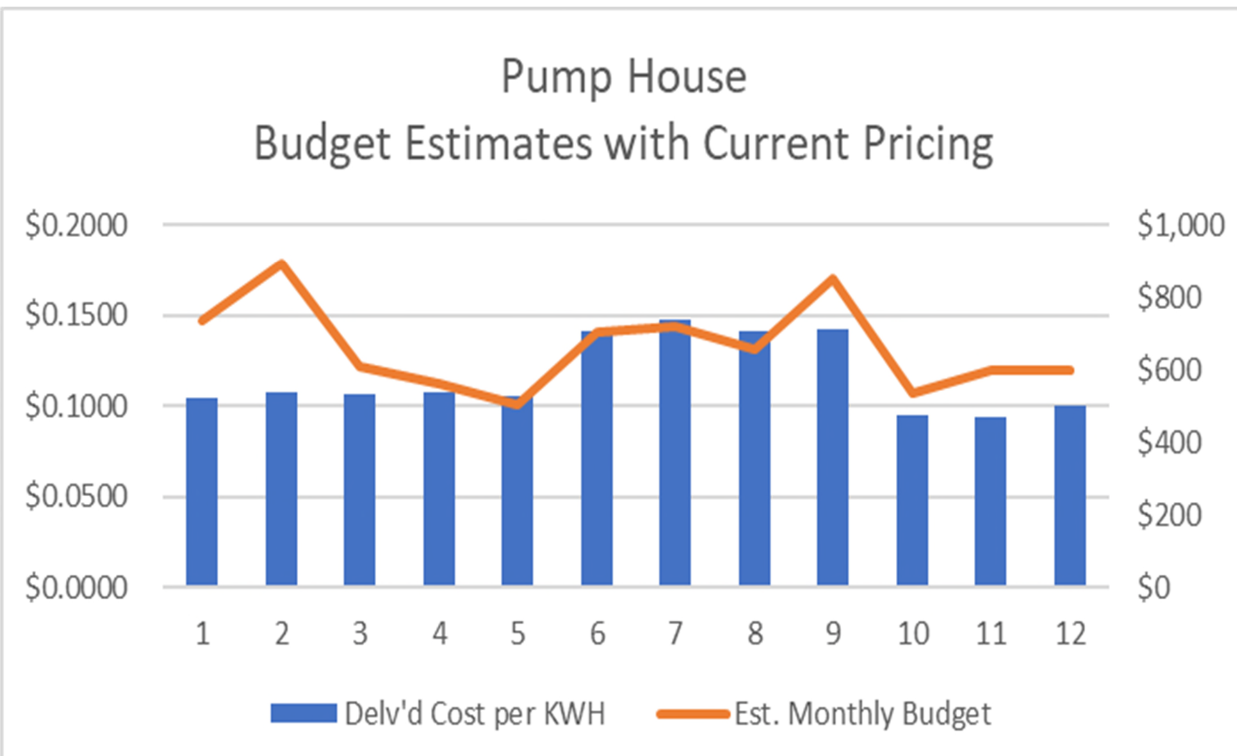


The water is received by Montclair through its Grove Street Pumping Station and is pumped throughout Montclair. The Montclair system also includes 3 municipal wells, one in each of the 3 pressure zones. One municipal well is located in Glenfield Park just east of Glenfield Middle School and west of NJ Transit's rail line.

At the request of Township management, the Pump House was a late addition to the Montclair microgrid design. The pump house's primary electrical usage is for the large pumps which pump domestic water from the well to the locations included in its pressure zone. Usage and demand for the Pump House were estimated based on an LGEA audit done for a similar pump house in Livingston, NJ. The power to the pump house is supplied by PSE&G on tariff LPL-S.

Pump House					
		KWH	Kw	Cost/KWh	Cost
	J	7,014	25	$0.1047	$734
	F	8,315	35	$0.1071	$891
	M	5,706	16	$0.1068	$609
	A	5,220	14	$0.1078	$563
	M	4,780	13	$0.1053	$503
	J	4,954	14	$0.1416	$701
	J	4,866	23	$0.1477	$719
	A	4,619	33	$0.1417	$655
	S	5,999	17	$0.1419	$851
	O	5,643	15	$0.0950	$536
	N	6,375	18	$0.0937	$597
	D	6,015	17	$0.0997	$600
	Total / Max	69,506	35	$0.1145	$7,959


Pump House
2017 Billing data (est.)
10,000
8,000
6,000
4,000
2,000
0
40
30
20
10
0
J F M A M J J A S O N D
KWH
KW


Pump House
Budget Estimates with Current Pricing
$0.2000
$0.1500
$0.1000
$0.0500
$0.0000
$1,000
$800
$600
$400
$200
$0
1 2 3 4 5 6 7 8 9 10 11 12
Delv'd Cost per KWH
Est. Monthly Budget

4. Procurement Issues

While the microgrid as proposed currently consists of nine facilities which will be consolidated to eight when combining the electric services for Mountainside's main hospital and Harris Pavilion accounts, the ownership of these facilities is confined to only four entities as outlined in Table 7.

Facility	Owner
Mountainside Hospital and Harris Pavilion	Hackensack Meridian Health
Hospital Parking Deck	Hackensack Meridian Health
Fire Headquarters	Montclair Township
Bay Street Station	NJ Transit
Pine Street Parking Garage	Montclair Township
Glenfield Pump Station	Montclair Township
Glenfield Middle School	Montclair Township
Pine Ridge	United Methodist Communities

Table 7: Facility Ownership Matrix

A significant barrier to the timely development of any microgrid will be attaining the consent and cooperation of all potential energy off-takers. Fortunately, senior officials from each of the entities with ownership control of the initial facilities on the Montclair microgrid have been fully involved since the inception of grant application process and have given their ongoing, full support to participation in the pilot study. Letters confirming their support and interest in the project were included with the Township's initial application and are included here as Appendix 4. Building owners have demonstrated strong interest in taking energy that can be competitively produced by the microgrid and are very much in favor of the benefits a microgrid will afford in terms of resiliency and a cleaner environment.

It should be noted that in recent experience developing microgrids in the state of Connecticut (who have an early and groundbreaking microgrid program) and elsewhere, it has been observed that everyone is in favor of being on a microgrid provided they aren't required to pay a significant premium over their current energy costs for the environmental and resiliency benefits a microgrid offers. Unfortunately, most view resilient energy as a "new and improved product feature" on a standard fungible commodity. As many of the likely early participants are government or non-profit entities, this customer class has historically been very careful not to throw caution to the wind by jumping on board before understanding what resilient power will mean to their operating budgets. In other words, government and non-profits are all in favor of resilient power, provided it isn't appreciably more expensive than what they pay from current conventional sources.

We have had many discussions with the facility owners on the proposed Montclair microgrid concerning the conditions under which they would: 1) Offer their facilities as host sites for microgrid generation, and; 2) Contract to take power or thermal energy from the microgrid. For each, their primary drivers are economic and by economic they primarily mean "economy" in operating costs and secondarily, "economy" that comes from eliminating the effects of potentially crippling power outages at their facilities. This second economy which has been referred to as "value of lost load" is a difficult thing to quantify and even more difficult to convincingly articulate to a Board contemplating investment, although all recognize that it exists.

Given this, we would suggest that the Board of Public Utilities work under the assumption that unless microgrid energy (power and thermal energy) is available to participants at a cost that is at, or close to, parity with conventional supply options, it will be very difficult to recruit off-takers, particularly if initial pilot program funding is restricted to government or non-profit customers.

This brings us to the second "procurement hurdle" that being the capital requirements to build a microgrid and accompanying generation. The facilities on the Montclair microgrid are all government or non-profit owned which are entities that are notoriously short, or conservative with their capital spending.

Complicating this further, contractual arrangements with participants who are host sites for cogeneration facilities on the microgrid would ideally like to enjoy the full value of the savings afforded from cogeneration thermal credits without having to share its value with other off-takers. Similarly, facilities which are host sites for solar PV installations should likewise prefer to enjoy the value of any economy accruing as a result of their hosting these facilities without sharing.

The ultimate cost for energy being generated from facilities on the microgrid and distributed to off-takers by the microgrid wires, will be a function of many items. Obviously, fuel and O&M costs for both generation and distribution infrastructure will be in the mix. Recovery of the cost of project capital will also be a component of the overall cost of microgrid energy. This would include any debt service on loans as well as an acceptable return to any investors in the project. There will also be a relatively minor administrative fee for the party who administers the microgrid operation.

From these obvious fixed and variable costs of production, deductions for thermal credits from cogenerated energy, savings from renewable generation and deductions for any revenues from BPU, state, federal, utility or independent system operator programs should be taken into account to arrive at the true net cost of microgrid power. Only then can the true cost of microgrid energy be realistically compared to the base case of "business as usual", demonstrating both the economical and functional benefits of a microgrid.

Other than the hospital, few if any of the facilities on the Montclair microgrid could develop an economical standalone resilient generation installation. By economic we mean an installation that could generate enough resilient electricity at a net cost that is equal to, or less than, what they would play for conventional supply from a utility and/or third-party retail supplier after all costs including capital recovery are considered.

One of the issues that needs to be considered is why a facility like the hospital who provides the majority of load and opportunity for generation cost reduction via the use of cogeneration, not object to sharing these attributes with others on the microgrid (e.g. Pine Ridge or the Pump Station)? They could conceivably just build a cogeneration plant for their own loads with black start and get the full benefits of their unique and favorable site and load characteristics. We believe the answer lies in their not having to use their own funds to achieve:

- Relatively lower energy costs;
- An increased level of power resiliency, and;
- Significant contributions to a cleaner environment.

Hospitals have many demands for capital and most often projects that can generate the greatest levels of additional revenue while covering their costs (and then some) take priority over projects which just lower costs or increased functionality. A new wing with additional beds, the latest MRI machine or an additional operating room catering to a new medical specialty, offer a better project on an ROI-basis than purchasing a new boiler or installing cogeneration. This is one of the reasons that hospitals which are invariably bright and modern in their public spaces, often have antiquated energy infrastructure such as boilers, emergency generators, or switchgear that are only replaced or upgraded when they break down, are well beyond their useful life, or when generous grant or incentives programs are available for replacement from outside sources.

Providing new non-medical, but essential infrastructure, such as that contemplated in the microgrid project is attractive to off-takers when they can realize cost savings, increased resiliency and environmental benefits, without having to make large capital commitments from their own resources. The type of ownership offered by a third-party ownership structure or a public-private-partnership can address this reluctance to undertake non-core capital investments like a microgrid, provided the structure can offer some economy, full resilience and environment benefits.

We have structured the capital structure for our microgrid base case under the assumption that it will be funded with some combination of grant / low cost debt from the BPU, EDA, PSE&G or some other public entity, and along with private investment.

As the private investor(s) will potentially own the microgrid and associated generation, the private investor(s) will have more latitude to "democratize" the benefits of the microgrid via pricing that is attractive to all facilities on the microgrid without having to skew the benefits in pricing to the largest facilities since the larger facilities will be getting the largest benefit of avoided or deferred capital requirements.

The financial analysis included in Section VII: of this pilot study is based on the assumptions that:

- All facilities on the microgrid will be getting microgrid energy at costs that are approximately equal to, or less than, what they would be able to get from conventional supply sources (1) and:
- They will not be required to contribute to the capital requirements needed to develop and construct the microgrid and associated generation as this will come from third party investment and some form of public subsidy (2).

(1) For the time being, we have ignored any economic benefit from the “value of lost load”.

(2) This is not to assume that facilities on the microgrid such as the township, hospital or New Jersey Transit are precluded from being that third-party investor in whole or in part. Their appetite for this type of investment will be explored after BPU/Utility incentive participation is more defined allowing for a better forecast of third party returns on the balance of investment required.

Given the above cited assumptions, we do not foresee any other issues in procuring host site, or off-taker participation in the project.

Section III: Montclair TC DER Microgrid Overview

1. Introduction

The proposed Montclair microgrid (MMG) incorporates multiple generation assets, an electric battery energy storage system, a central controller and a single point of connection with the electric utility grid. The generation assets are interconnected with seven separate loads located within a half-mile radius of the central point. The interconnection cable and fiberoptic communications network is purpose built to facilitate the MMG and crosses multiple existing rights of way if street routing were to be used. Using the NJ Transit rail line right of way, allows for only one physical street crossing requiring excavation at Highland Avenue which bisects the property housing facilities owned and controlled by Mountainside Hospital. The system is designed to operate in both grid parallel mode when the utility grid is available as well as in ‘grid island’ mode when the utility grid is not available. Total system generation capacity is 2,274 kW including natural gas fueled CHP generators and photovoltaic arrays.

The proposed MMG offers a unique approach to interconnection of the supported facilities by utilizing the New Jersey Transit (NJT) catenary system to rout the power and fiberoptic control cable from the hospital utility interconnection point at one end of the cable to the school at the other end. This unique approach provides a feasible cable route along NJT’s right of way that not only reduces project development costs, but also provides for a practical resiliency approach that can be implemented with minimal time consuming, and potentially contentious negotiations with various stakeholders or potential intervenors.

2. Layout Summary

The MMG generation capacity is anchored by a 2 MW CHP plant located at Mountainside hospital and incorporates a second 125 kW CHP system located at the school. The microgrid will also have 139 kW of solar photovoltaic generation sited at various facilities. Planned installations are for 50 kW-DC at Pine Ridge, 75 kW-DC at Glenfield, 20 kW-DC at the Fire Headquarters which results in a total of 145 kW-DC or 142 kW-AC. A 100 kW battery will be located at Fire Headquarters where township and emergency services communications as well as 911 communications are located and four electric vehicle (EV) charging stations will be located in the Pine St Parking Deck.

Each of the MMG connected facilities is linked via a new power cable and a new control and communications fiberoptic network. The microgrid has a single point of coupling to the utility grid at Mountainside hospital where the main hospital utility service currently exists. All connected facilities are to be removed from their existing individual utility feeds and repowered via the new power cable. This is required in order to enable grid isolation mode operation for all facilities.

Two options for routing the power and fiberoptic cables have been assessed as shown in Figure 3. The first route is along existing roadways which requires trenching and burial of the cables in the street. The second rout utilizes the adjacent NJ Transit catenary system to support the power and fiberoptic cables. Each route offers advantages and disadvantages and were assessed mainly on the basis of cost to complete. Based on the cost estimations together with other advantages, the NJ Transit (NJT) catenary system route was considered to have significant advantages over the street route. The catenary system is cheaper to install, easier to maintain and provides for a way to cost effectively provide medium voltage electric power and communications cables along the route between the Hospital Parking Deck and Glenfield School. Use of the catenary system has been reviewed by NJT who would be required to provide planning and engineering review and approval. Initial discussions indicate that NJT would allow use of the catenary system and costs are included in the proposal for engineering review and continuing use fees due to NJT. The catenary system is available for use by third parties and a fee schedule is set by NJT for such use. This approach is commonly used by cable companies who run wires on catenary systems and this study incorporates a catenary based design in line with NJT technical requirements for installation of power and communications cables.

Figure 2 NJ Transit Catenary System

There are two options on location of the main MMG control center. The controller could be located at Mountainside Hospital or at the Fire HQ. In either scenario, a second system interface can be located at the other location so that facility personnel are fully informed of MMG status and operations. Location of the MMG controller would be made based on ownership decisions as well as input from the various stakeholders.

Both proposed CHP systems will run on natural gas and will be interconnected to the gas utility system at the respective locations. Currently all facilities except the parking decks are connected to the utility gas supply.

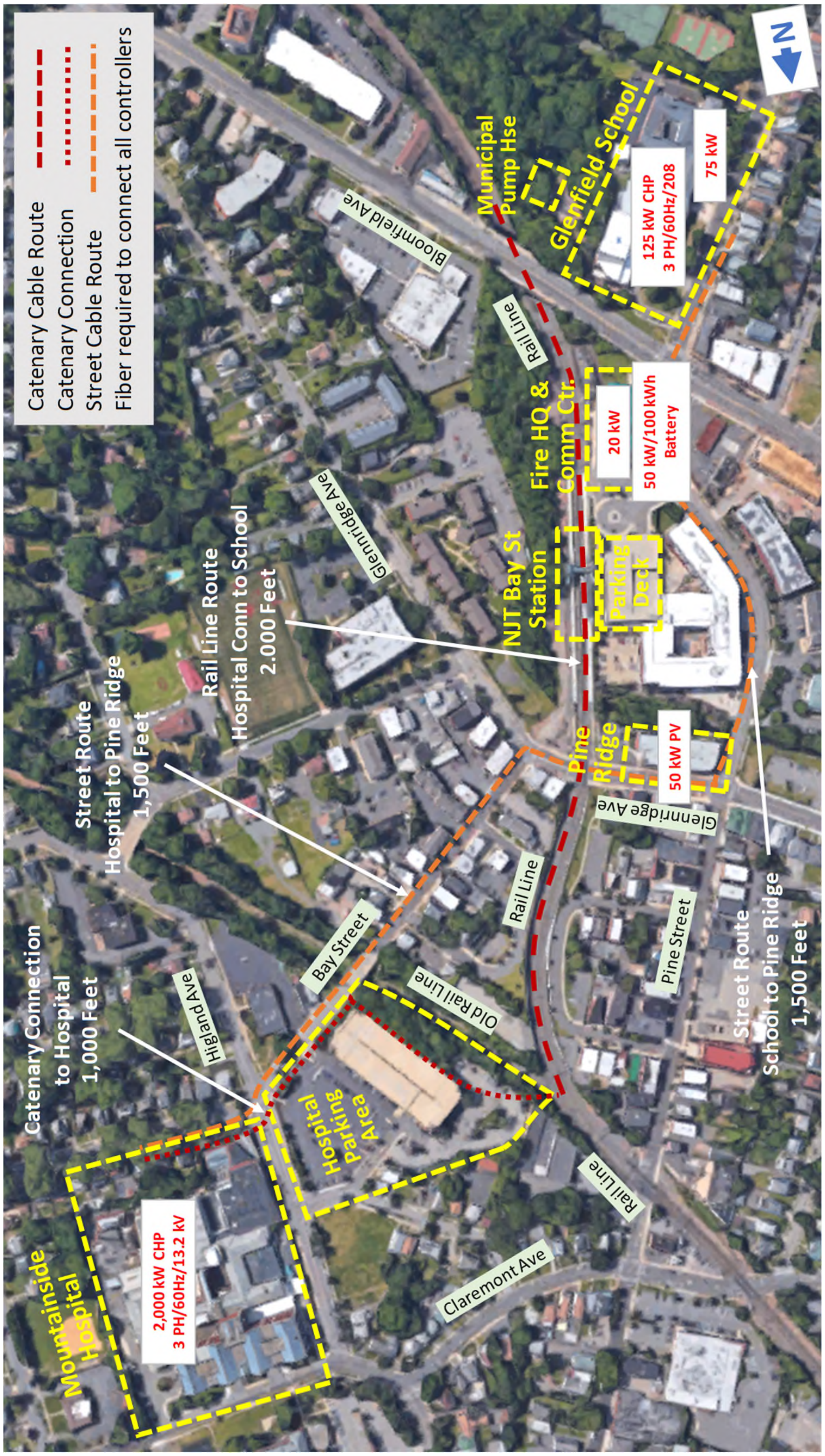


Figure 3: Montclair Microgrid Cable Routes

3. Consolidated Microgrid Load Analysis

Each of the existing facilities proposed to be connected to the MMG have existing electric power supplies from the utility and most of the facilities have natural gas supply. For the purposes of development of the MMG, the individual facility electric services will be consolidated into a new single microgrid utility connection. The proposed CHP plants will provide thermal energy to both Mountainside Hospital and Glennfield School individually so there will not be consolidation of thermal loads as part of the MMG development. The individual montly electric and thermal loads have been outlined in Section II:3 above. For the purposes of providing guidance on the consolidated MMG electric load, interval data for the individual facilities where available has been obtained and reviewed. Where interval data does not exist as is typical for smaller facilities, this data has been estimated to facilitate a complete analysis of the consolidated loads. The interval data used is for the period from January 1 2017 to December 31 2017. It should be noted that there are inconsistenties between monthly modeled data, which is based on an 8,760-hour interval model, and monthly utility billing data for many of the facilities. This is in large part due to estimated readings used for utility billing purposes which are not reflective of actual usage. However, in general total usage and peak demand are consistnet for each individual facility over the annual period reviewed.

The 8,760-hour model for 2017 includes hourly electric demand data for all original nine electric services. When developing a microgrid, demand on the consolidated electric system is a critical design element requiring an understanding of concurrent demands to enable proper system sizing. Currently there are nine individual electric metered services that will be integrated into the microgrid. Mountainside hospital and the Harris Pavilion are connected to the utility grid with separate services. As part of the infrastructure development work to be carried out under the proposed project, the Harris Pavilion will be removed from its existing utility service and connected to a new breaker in the new incoming switchgear at the hospital. The existing power service to the hospital parking deck will remain as a separate MMG connection. Therefore the number of facility services that constitute the MMG will be reduced from nine to eight.

Mountainside Hospital including the Harris Pavilion is by far the largest electric load on the microgrid representing 90% of all electric utilization and 88% of peak load contribution. The Glenfield School is the next most significant load at 3.2% of total energy use and 4.7% of peak load contribution. The two parking decks combined represent 3.3% of energy use and 3.9% of peak load contribution. Pine Ridge apartments and the Fire HQ combined represent 3.1% of energy use and 2.6% of peak load contribution. The NJ Transit Station and Water Pump Station are relatively insignificant loads from an energy and demand perspective.

Figure 4 provides a chart of the electric demand hourly interval data for the consolidated microgrid for the period January 1, 2017 to December 31, 2017. Figure 5 provides a comparison of the hospital including Harris Pavilion profile with all other loads for the same period. Figure 6 provides a breakout of the various non-hospital load profiles for the same period.

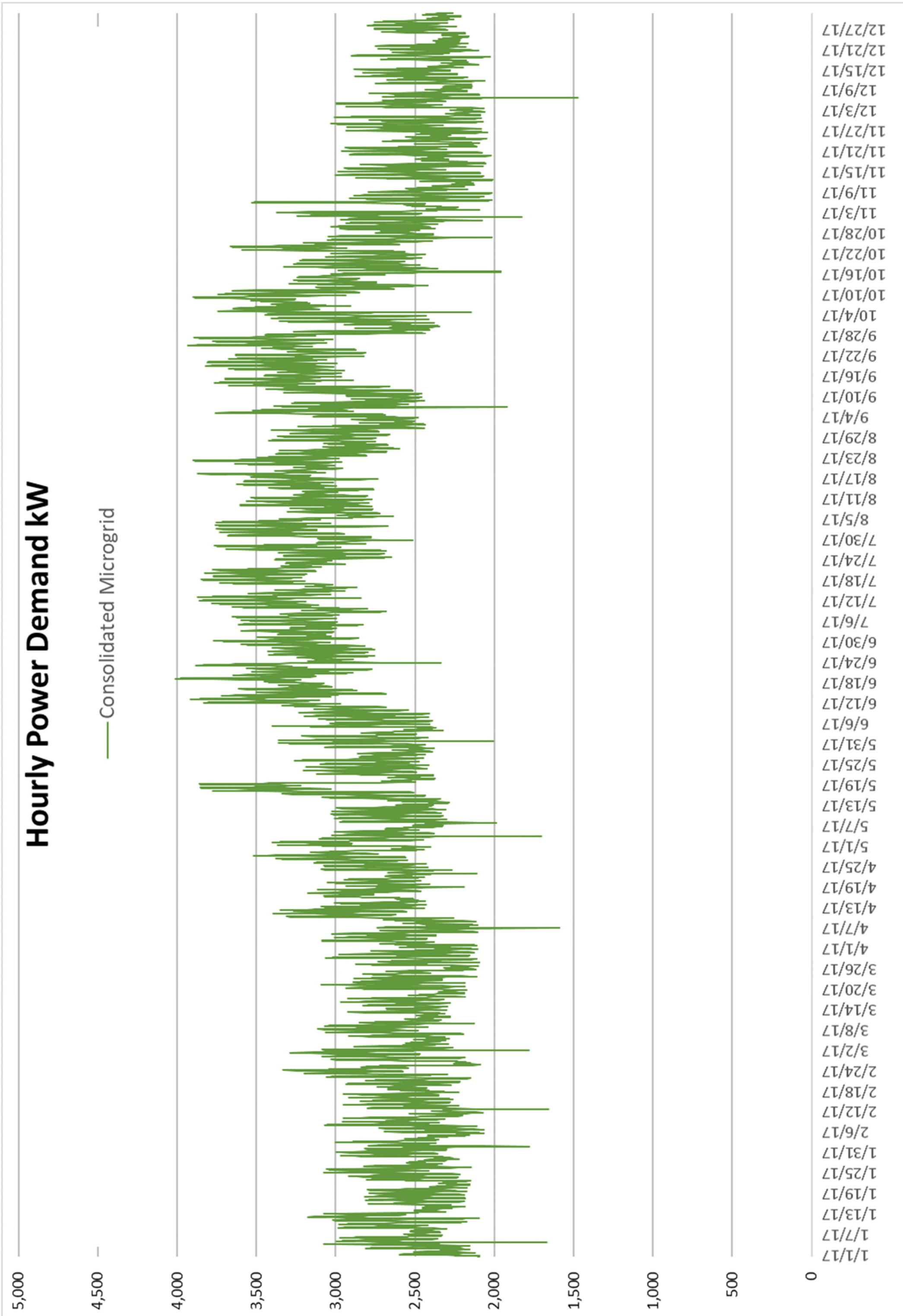


Figure 4 MMG Consolidated Electric Load Profile

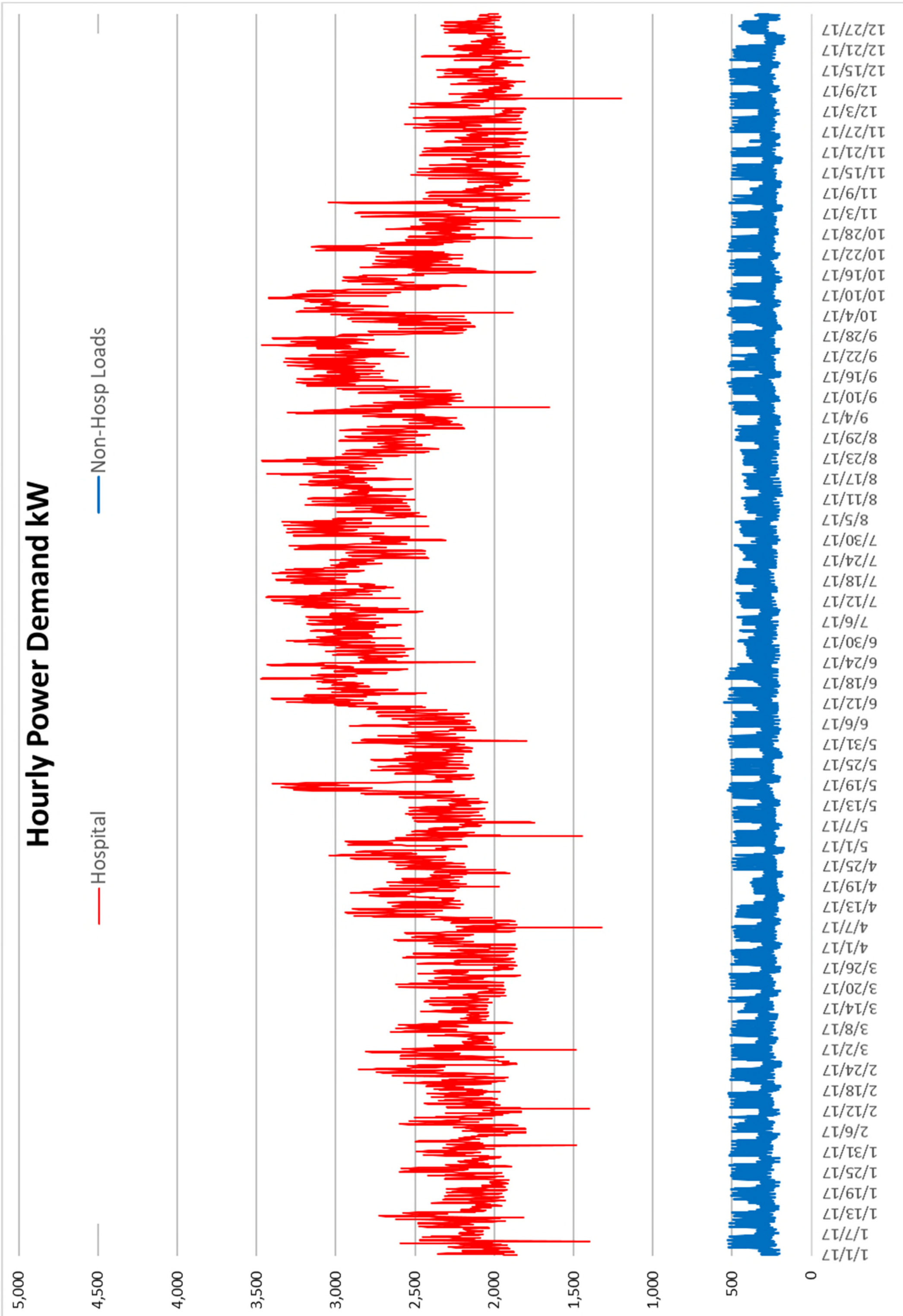


Figure 5 MMG Hospital versus Non-Hospital Load Profiles

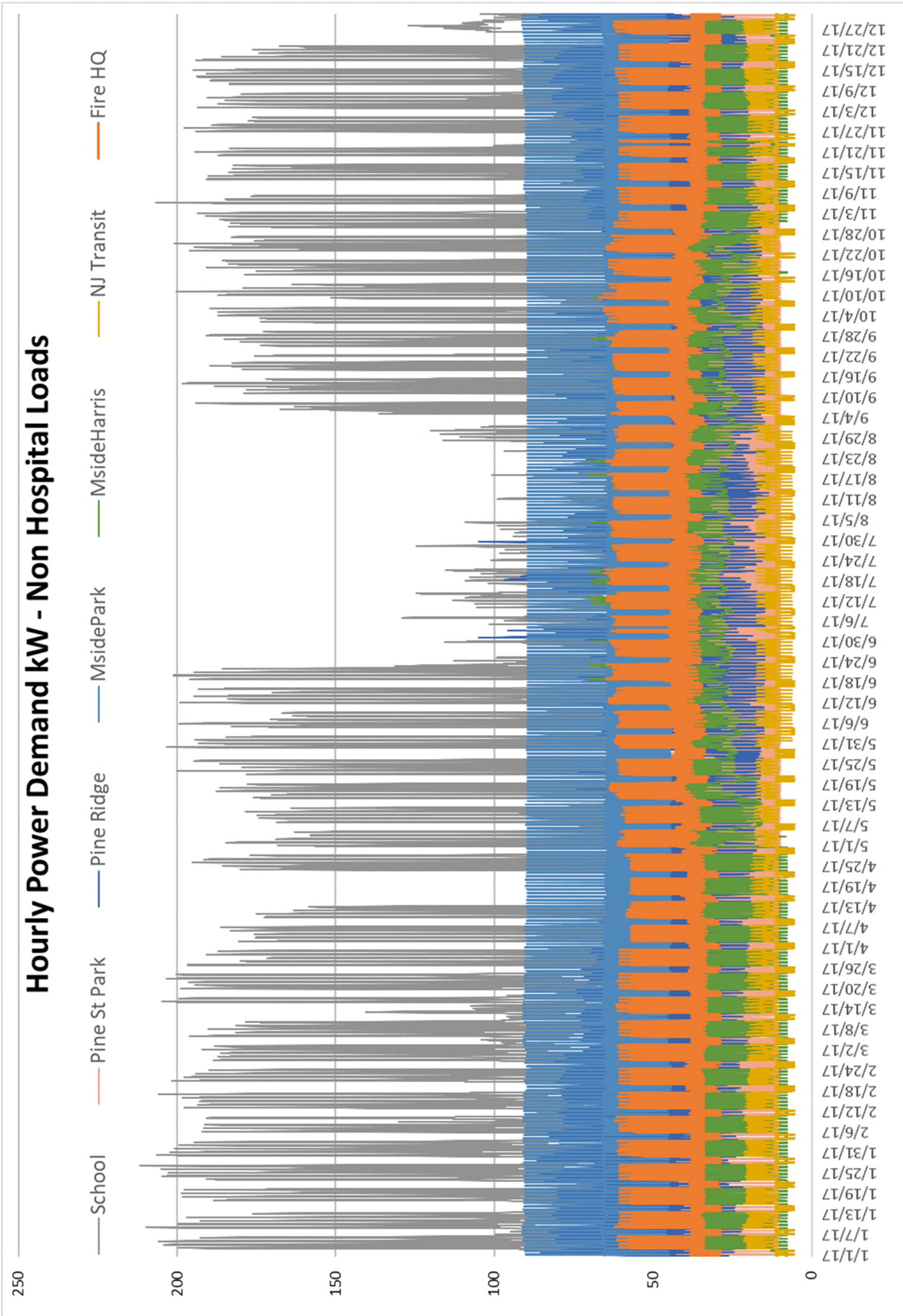


Figure 6 MMG Non-Hospital Load Profiles

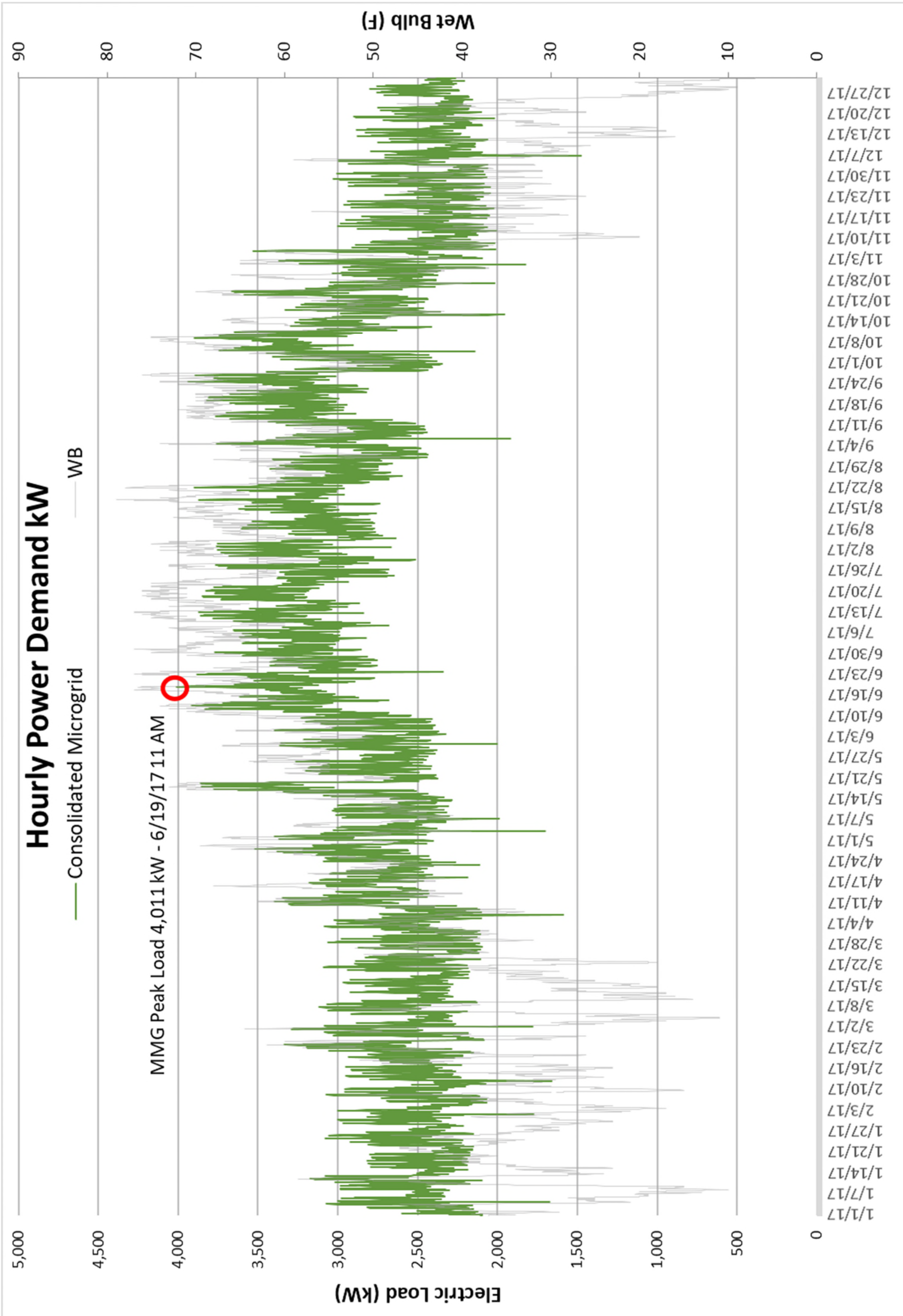


Figure 7 MMG Electric Demand versus Wet Bulb Temp

While the facilities outside of the hospital represent a relatively insignificant load on the system, their significance in terms of resilience and importance during a major disruptive event is high. It is important to understand the nature of these loads and accommodate the demands on the microgrid to the fullest extent during a grid outage. Figure 6 extracts these facilities and presents their individual electric load profiles on a larger scale.

Glenridge School electric load profile depicted in Figure 8 for shows a typical school load profile with high usage during occupied hours which is commensurate with usage during a long-term grid outage when the school could be used as a place of refuge and municipal HQ. A second CHP plant is added to the school in order to provide resilience and is sized at the baseload during high occupancy hours. The addition of solar PV adds to the facility resilience capacity to handle high occupancy levels in the event of a grid outage.

The Fire HQ incorporates a critical communications center for Montclair and Glenridge emergency services, 911 calls and the municipality. The Fire HQ load profile has a current baseload of approximately 35 kW which is anticipated to grow as communications services are expanded. A 100 kW capacity battery with an 85 kWh energy storage capacity is added to the Fire HQ to provide for a third level of resilience at this critical facility – primary power is provided by the microgrid with full backup capacity provided by an existing diesel generator.

The Pine Ridge which is an age-restricted apartment building, the NJ Transit rail station and adjacent parking deck as well as the water pump station will be backed up with the microgrid power resources.

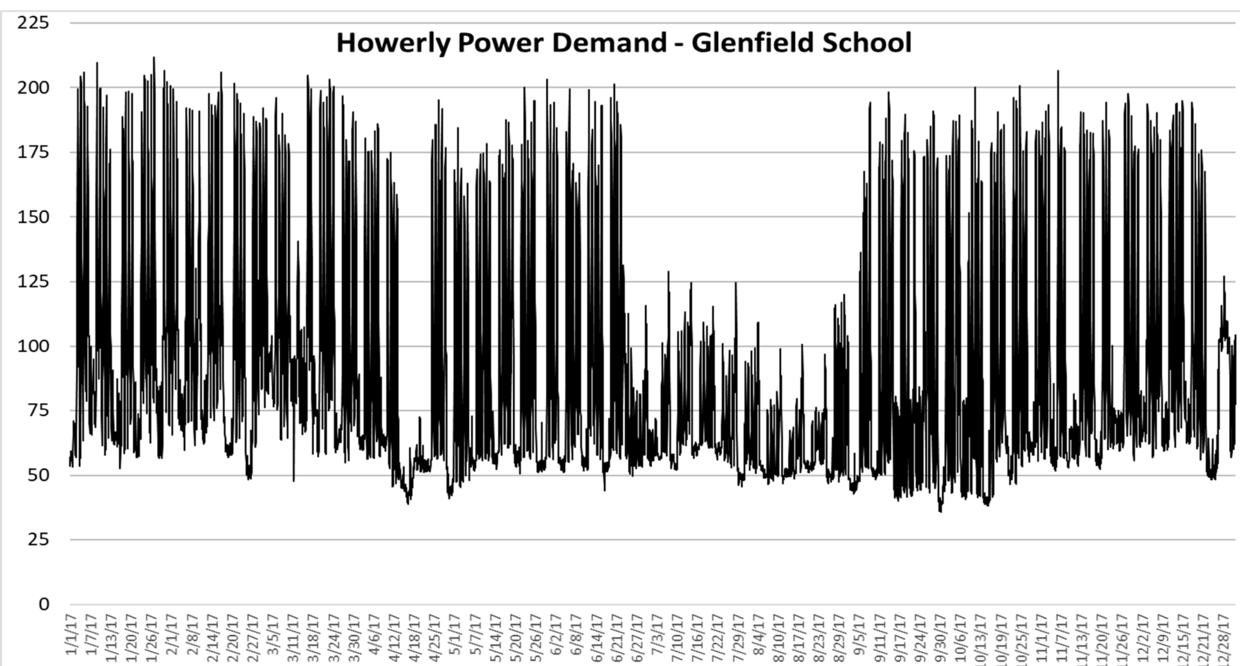
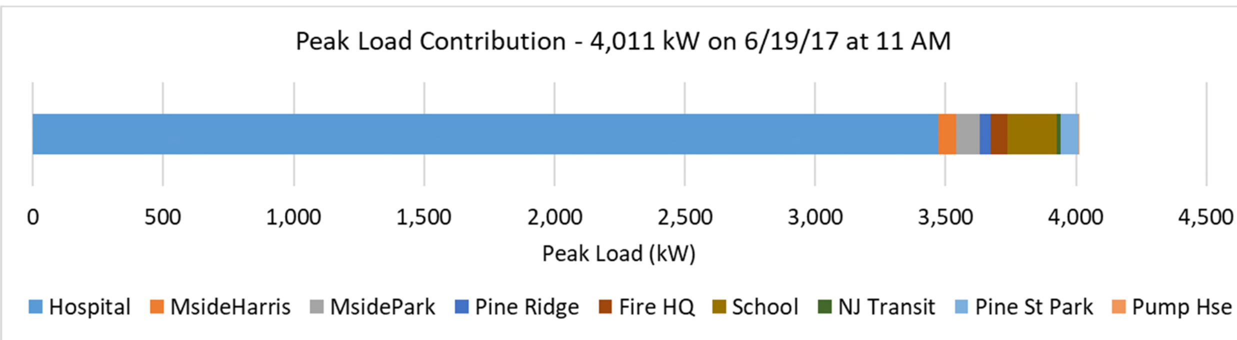


Figure 8 Glenfield School Electric Load Profile

The combined load profile is calculated on an hourly basis to provide an integrated microgrid load profile. Figure 4 provides the annual profile for the aggregated loads connected to the MMG. Annual electric energy utilization on the microgrid is projected to be 24,281 MWh and the peak demand is projected to be 4.01 MW. The average projected load on the microgrid is 2.77 MW leading to a load factor of 69% for the MMG which is reasonably high for this type of installation and supports the economic viability of the project. The minimum projected load is 1,479 kW which occurs during testing of diesel generators at the hospital. Based on the consolidated hourly interval data for 2017, the peak load occurred at 11 AM on 6/19/17 when the hospital and school were in full operation during high ambient wet bulb conditions (see Figure 7). Figure 9 provides a graphical representation of the peak load contribution from each of the services connected to the MMG.



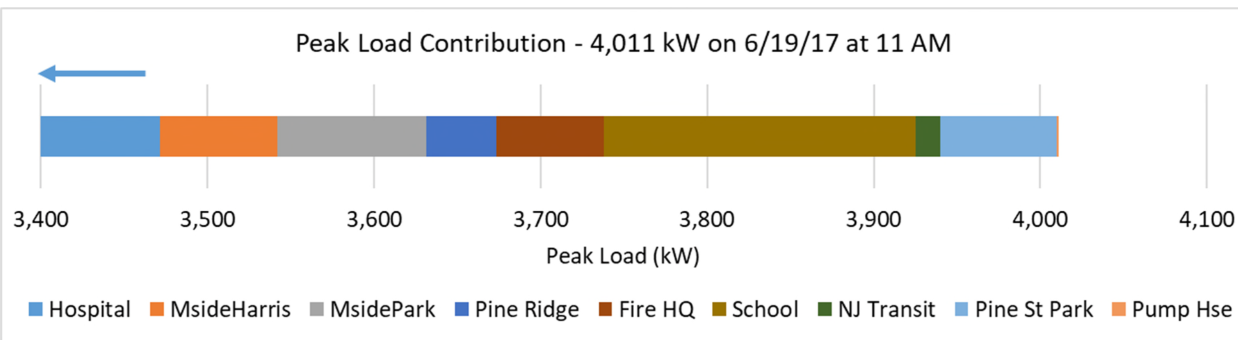


Figure 9 MMG Peak Load Contribution

As discussed above, the hospital represents the majority of the energy use and demand on the microgrid system. The hospital also has multiple standby generators that will be leveraged to support the microgrid in a long-term grid outage. Currently the hospital has 4 emergency diesel generators installed totaling 2,980 kW of nameplate capacity rated for 480 V. These generators serve multiple emergency load buses within the facility. It is assumed for the purposes of this study and subject to confirmation in the next phase of development, that these generators are or can be connected to emergency loads totaling 50% of the generator rated capacity or 1,490 kW of total load. The total MMG new generation added to the system is 2,274 kW which is comprised of 2,132 kW of dispatchable CHP and 142 kW of PV. The Hospital based CHP plant also includes an absorption chiller which can provide effective electric load relief of an additional 115 kW.

Combined these resources have the capacity to provide 3,879 kW which amounts to 99% of the peak anticipated microgrid load.

Figure 10 shows the load duration curve for the integrated microgrid. Based on all loads being applied, the new microgrid natural gas CHP and PV assets alone will provide 100% operational capacity for 15% of the time, 90% operational capacity for 30% of the time or 65% operational capacity for all hours. In actual operation, shedding of non-essential loads and leveraging of existing diesels will allow for 'near normal' operation of all facilities through all seasons while maintaining adequate spinning reserves to handle load fluctuations.

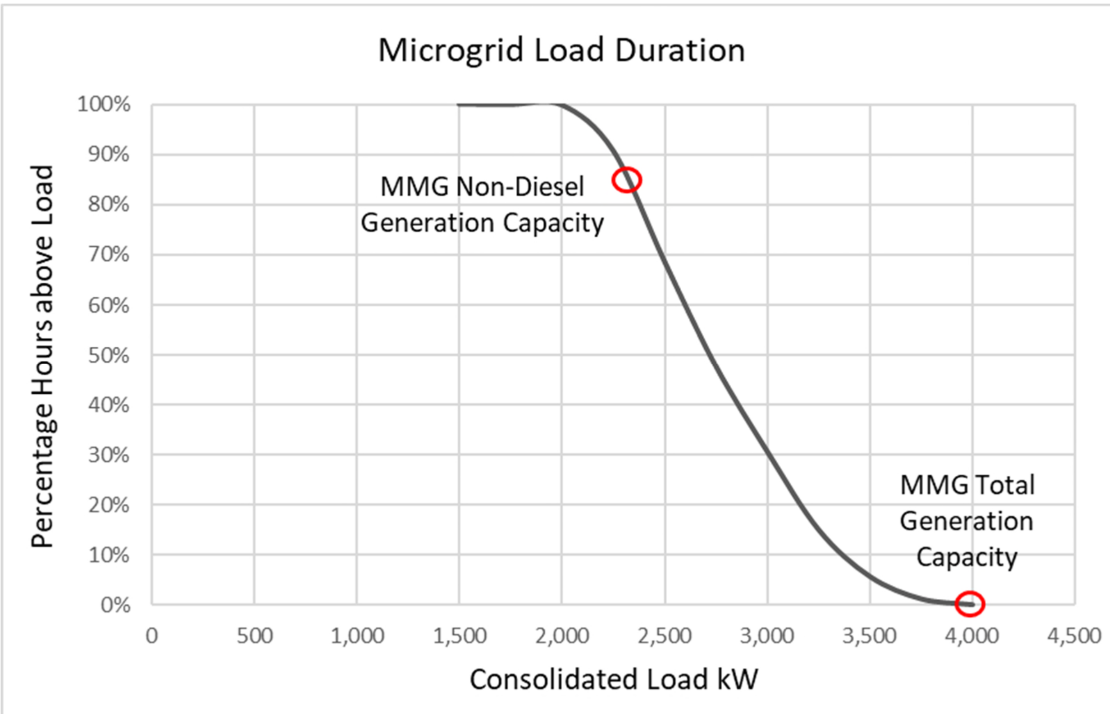


Figure 10 Microgrid Load Duration Curve

Section IV: DER Technology Description & Interconnection

The Montclair Microgrid incorporates multiple distributed energy resources (DER) including two combined heat and power (CHP) plants based on reciprocating engine generators, three photovoltaic (PV) arrays, one battery energy storage system (BESS) and four electric vehicle (EV) charging stations. These technologies provide sufficient power generation resources to maintain 'near normal' operations at all microgrid connected facilities in the event of a grid outage, optimize energy production efficiency, minimize the microgrid greenhouse gas footprint, reduce normal operating costs and provide resilient transportation for essential services. A key component of the microgrid is the control and communication system that integrates all the DER into a single electric energy system with respect to the grid.

1. Generation Assets – CHP & PV

1.1. Mountainside Hospital 2 MW CHP Plant

The proposed CHP plant for Mountainside Hospital is based on a 2 MW natural gas fired reciprocating engine-generator with a nominal efficiency of 43.5% at a power factor of 1.0. The unit will be provided with a selective catalyst reduction system to reduce NOx emissions to NJ DEP acceptable levels for stationary continuous-duty spark ignited engine-generators. The engine-generator will operate 24/7 when available and will generate 60 Hz power at 13,200 V. The engine-generator system will be provided with jacket water, oil cooler and 1st stage inlet air cooler heat recovery, exhaust heat recovery and a nominal 200 ton absorption chiller to convert hot water to chilled water during summer operation.

The hot water recovered from the engine-generator will be used to provide space heating to the North Tower, preheat boiler feedwater and generate domestic hot water from October through April. The hot water generated by the JW/OC/1st IAC heat recovery system will be used to generate chilled water with a single-stage absorption chiller from May through September. Exhaust heat will be recovered in a heat recovery steam generator which will provide year-round steam to the existing steam header.

Availability for the proposed reciprocating engine based CHP system is 95% according to Department of Energy data and it is designed to run continuously at or close to full capacity all available hours. Heat recovery utilization is modeled against the hospital's thermal loads based on boiler gas usage as well as estimated chiller plant loads during May through September. Steam, hot water and chilled water produced by the CHP plant will be base loaded throughout the year with the utility providing supplemental power and natural gas to boilers. Natural gas to the CHP plant will be provided by the utility. While it is intended that the 2 MW CHP plant will be connected to the full microgrid with most of the power and all of the thermal energy going to the hospital, for preliminary modeling purposes, the proposed CHP plant is modeled for performance against the existing electric and thermal loads for the hospital including Harris Pavilion only. Based on applying the Caterpillar G3516H and making allowances for 1% electric output degradation and adjustments for fuel input and thermal recovery tolerances, Table 8 provides the nominal and annualized performance data based on the ASHRAE CHP Analysis Tool.

Nominal CHP System Performance			Annualized CHP System Performance		
System Type		Recip Engine	Exhaust Use		Steam
Electric Power Output	kW	2,007	Chiller Use		Cooling
Electric Efficiency	LHV	43.5□	Chiller Output Temp		□40 F
Exhaust HR Efficiency	LHV	14.9□	Chiller Capacity	Tons	192
Jacket HR Efficiency	LHV	20.8□	Annual Net Power Output	kWh	15,297,116
Fuel Input (LHV)	MBtu	15,751	Annual Useful Thermal	MMBtu	27,074
Exhaust HR	MBtu	2,344	Annual Useful Cooling	Ton-hr	628,706
Jacket Water HR	MBtu	3,284	Annual Heat Utilization	MMBtu	37,852
CHP System Efficiency	LHV	79.2□	Annualized CHP Efficiency	LHV	73.5□

Table 8 Hospital 2 MW Performance Data

Figure 11 provides the energy balance diagram for the proposed 2 MW hospital CHP plant including power and heat recovery loops. See Appendix 5 for engine-generator technical specifications.

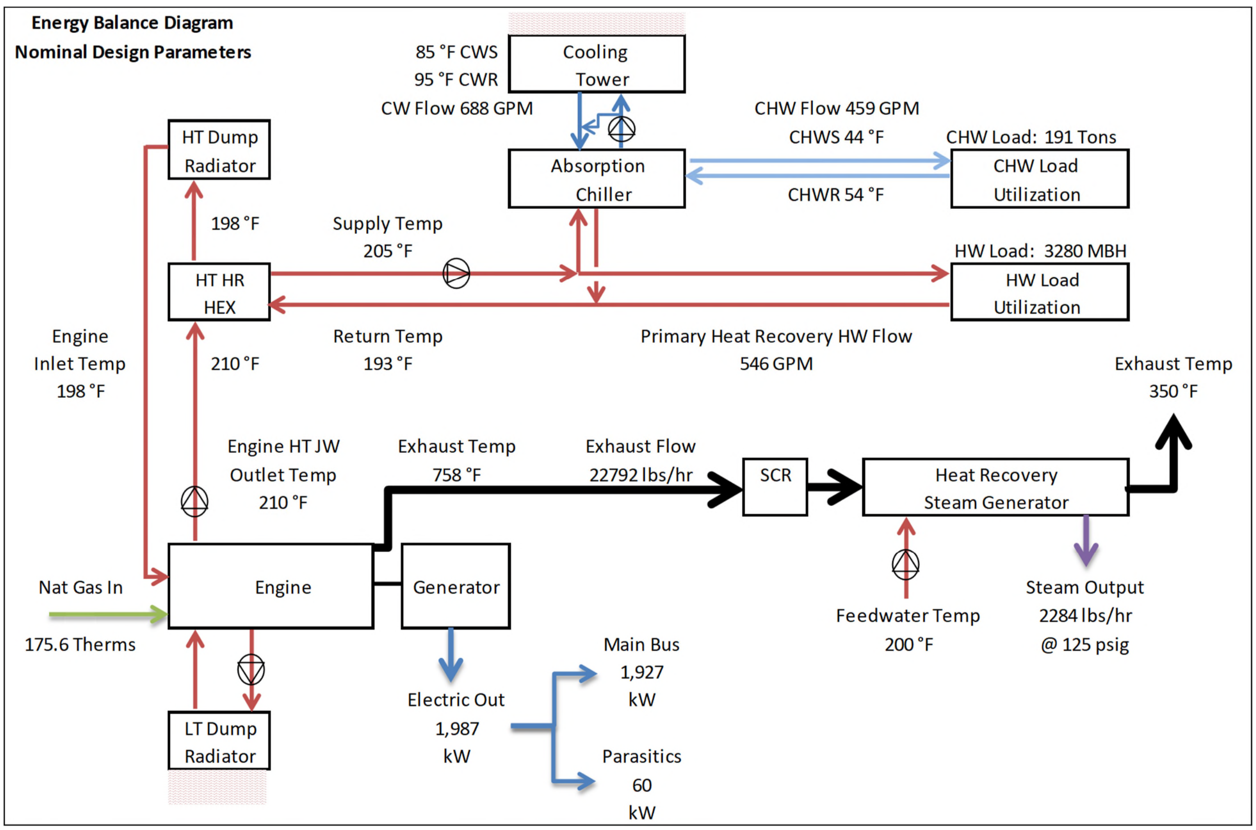


Figure 11 Energy Balance Diagram - 2 MW CHP

1.2. Glenfield School 125 kW CHP Plant

The proposed CHP plant for Glenfield School is based on a 125 kW natural gas fired reciprocating engine-generator with a nominal full load efficiency of 32.4%. The proposed unit is based on an ultra-low emission variable speed inverter based unit that complies with California NO_X emissions limits of 0.07 lbs/MWh and is exempt from NJDEP air permitting requirements due to its low emissions and size. The engine-generator will operate during normal school operating hours when available and will generate 60 Hz power at 208 V. The engine-generator system will be provided with jacket water, oil cooler and exhaust heat recovery. The hot water recovered from the engine-generator will be used to supplement the existing hot water space heating loop during all operating hours.

Glenfield Middle School exhibits a typical school load profile (see Figure 8 above) with high power usage during school hours and relatively low usage during non-school hours including much of the summer period. As the selected engine-generator is a variable speed inverter based unit, it has good turndown capacity and maintains high efficiency through all operating conditions. Based on an analysis of the school's utility interval data for 2017, Figure 12 provides the load duration curve which indicates the proposed CHP generator can run between 75 kW and 125 kW for 46% of all hours or 4,027 hours per year based on electric output.

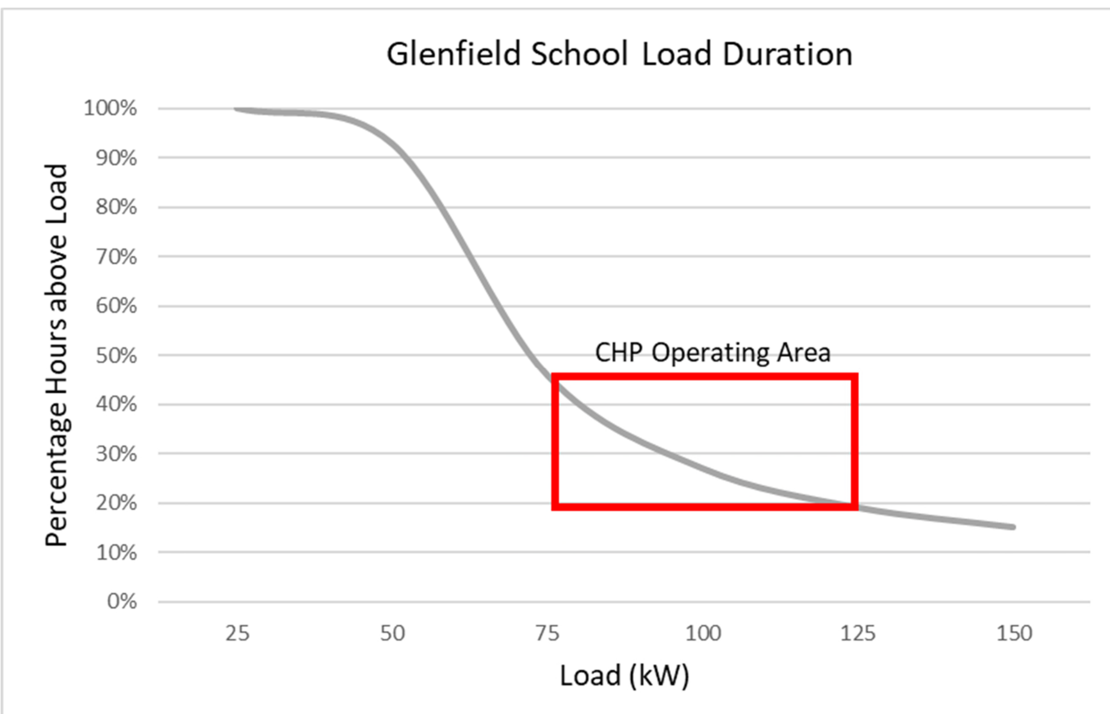


Figure 12 Glenfield School Load Duration

However, as the school does not include a central cooling system, the CHP plant is configured to provide heat only. Therefore the system will be schedule to only run during the heating season from October 15th through April 15th and only be available during the rest of the year for emergency purposes or as a dispatchable resource for ancillary services and demand response. Based on further analysis of the load interval data for the school only during the operating season, the CHP plant would run 2,507 hours per year and provide 260,095 kWh annually for an average engine load factor of 83% during operating hours. The CHP engine-generator remains available during non-operating hours for emergency or economic dispatch.

The school has a centralized hot water loop that provides space heating to the facility. The CHP plant will be used to preheat return water and offset boiler gas input. The CHP plant output will be fully utilized during peak winter months and with a reduction in utilization during shoulder season months resulting in an estimated heat utilization of 75% during the full operating period. The CHP plant will be base loaded from October 15th through April 15th with the utility providing supplemental power and natural gas to boilers. Natural gas to the CHP plant will be provided by the utility.

For preliminary modeling purposes, the proposed CHP plant is modeled for performance against the existing electric and thermal loads for the school only. The 125 kW CHP plant will be connected to the full microgrid with most of the power and all of the thermal energy going to the school. Based on applying the Tecogen Inverde-e+, Table 9 provides the nominal and annualized performance data based on the ASHRAE CHP Analysis Tool and an operating schedule of 2,507 hours per year. While the projected run hours are lower than the requirements to participate in the current NJ BPU CHP Program, the facility will be designated as an emergency shelter and as such should qualify for exemption on minimum run hours to allow for CHP grant funding. In addition, as stated above, the school CHP plant will be connected to the microgrid and more detailed integrated modeling may allow for considerably more run hours as the full microgrid electric load is available. Limitation of normal run time will be based on availability of thermal load at the school.

Nominal CHP System Performance			**Annualized CHP System Performance**		
System Type		Recip Engine	Exhaust Use		Hot Water
Electric Power Output	kW	125	Chiller Use		None
FL Electric Efficiency	LHV	32.4□	Chiller Output Temp		□40 F
Exhaust HR Efficiency	LHV	0.0□	Chiller Capacity	Tons	0
Jacket HR Efficiency	LHV	59.2□	Annual Net Power Output	kWh	260,095
FL Fuel Input (LHV)	MBtu	1,317	Annual Useful Thermal	MMBtu	1,623
Exhaust HR	MBtu	0	Annual Useful Cooling	Ton-hr	0
Jacket Water HR	MBtu	780	Annual Heat Utilization	MMBtu	1,217
CHP System Efficiency	LHV	91.6□	Annualized CHP Efficiency	LHV	76.4□

Table 9 School 125 kW Performance Data

Figure 13 provides the energy balance diagram for the proposed 125 kW school CHP plant including power and heat recovery loop. See Appendix 6 for engine-generator technical specifications.

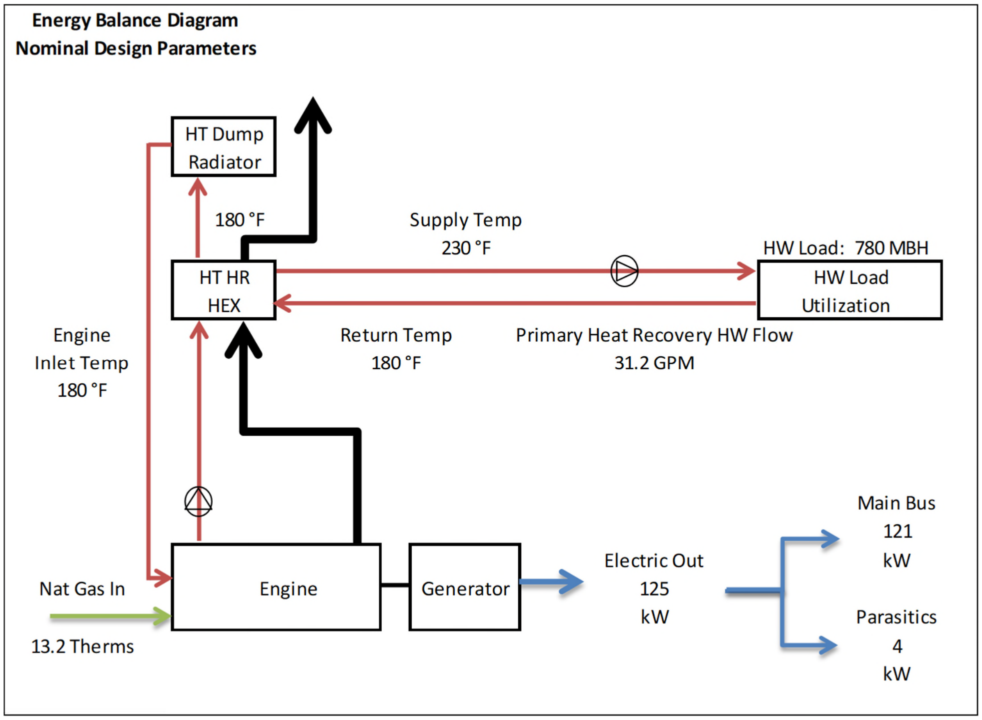


Figure 13 Energy Balance Diagram – 125 kW CHP

1.3. Solar Photovoltaic Arrays

The proposed microgrid includes solar photovoltaic (PV) arrays located on roof tops at three connected facilities – Pine Ridge, Fire HQ and Glenfield School. Appendix 7 provides the proposed layouts for each of the three facilities. The selected solar arrays are based on the Trinasolar 365 monocrystalline split modules combined with SolarEdge inverters and power optimizers including Ethernet connectivity and surge protection. Systems are designed for three phase 208V and 277/480V grids and are suitable for outdoor location.

Pine Ridge will be provided with 137 standard fixed-mounted modules rated at 365 watts each for a total nominal power rating of 50.005 kW DC. The modules will be located on the building's flat roof and arranged to allow for access space to the modules as well as existing roof-top mounted equipment. An inverter will be included to allow connection of the PV system to the main facility bus at 230 V.

The Fire HQ will be provided with 55 standard fixed-mounted modules rated at 365 watts each for a total nominal power rating of 20.075 kW DC. The modules will be located on the building's south facing gable roof. An inverter will be included to allow connection of the PV system to the main facility bus at 230 V.

Glenfield School will be provided with 206 standard fixed-mounted modules rated at 365 watts each for a total nominal power rating of 75.19 kW DC. The modules will be located on two flat roofs which are on the southern facing side of the facility. The proposed microgrid incorporates an inverter based CHP engine-generator which can accommodate additional DC connections. The school's PV system will be connected directly to the CHP inverter and will therefore not require an independent inverter.

The design basis for the solar PV arrays include high efficiency inverters with optimization delivering 98% conversion efficiency, standard fixed modules with a 5 degree tilt angle and system losses of 11.42% including soiling, wiring, degradation and availability. The Fire HQ system is located on the southern facing slope of a gable roof resulting in a tilt angle of 40 degrees. Based on an analysis of the three PV arrays using NREL's PV Watts calculator, Table 10 provides the individual facility and combined system performance. Appendix 8 provides the proposed PV system technical data and results from the PV Watts analysis for each facility.

	PV Rating kW DC	PV Power Output kW AC	Module Type	Array Type	Array Tilt Deg	Azimuth Deg	Solar Radiation kWh/M^2/day	Annual Production kWh
Pine Ridge	50.005	49.005	Standard	Fixed	5	215	4.28	61,493
Fire HQ	20.075	19.674	Standard	Fixed	40	125	4.47	25,934
Glenfield School	75.190	73.686	Standard	Fixed	5	135	4.27	92,229
Total:	145.3	142.4						179,656

Table 10 MMG Solar PV Array Performance

2. **Storage – BESS, EV Charging Stations**

The proposed microgrid includes a battery energy storage system (BESS) located at the Fire HQ that provides an additional layer of power backup at this critical facility as well as providing the microgrid with renewable energy storage, grid ancillary services and peak shifting capabilities. Electric vehicle charging stations are provided at the Pine Street Parking Deck adjacent to the Fire HQ to allow for microgrid enabled transportation intended for use by emergency service vehicles in the event of a major grid outage.

2.1. Battery Energy Storage System

The BESS is based on an NEC Energy Solutions 2-bay outdoor (NEMA 4 enclosure) storage system utilizing lithium-ion batteries and including a remote-mounted power conversion module (PCS) and Ethernet communications. The system has an energy storage capacity of 85 kWh and a power rating of 100 kW and is designed for connection to the Fire HQ main incoming power bus. Figure 14 provides a simplified single-line diagram for the integration with the facility bus and Appendix 9 provides the proposed system technical data. The PCS unit incorporates the ability for the BESS system to support islanding/grid-forming functionality, enabling off-grid, back-up power, and similar application scenarios.

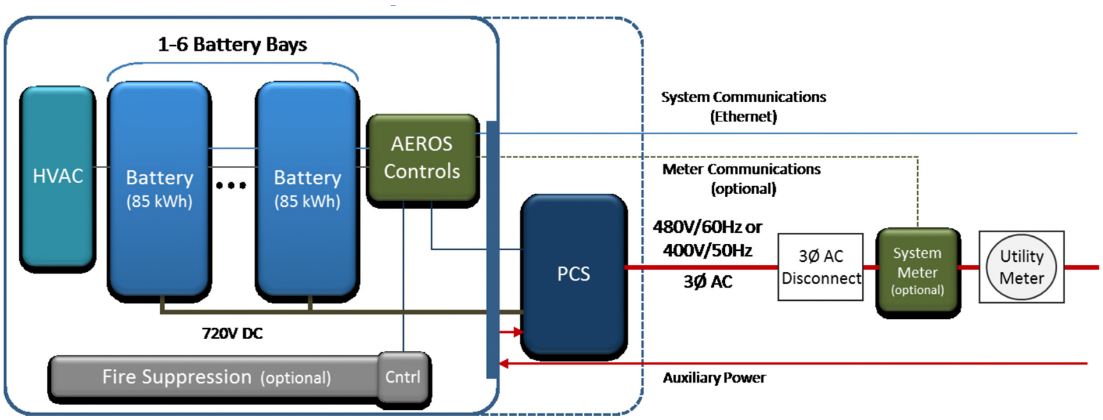


Figure 14 BESS Block Diagram

The selected BESS controls system will support the microgrid controller interface, secure remote access, monitoring and data logging functions. The control system also provides the following functions:

- P/Q dispatch system operation and manual command and control
- Setting system set points through user defined schedules (real power charge, discharge and reactive power)
- Secure access and communications, using industry standard protocols, including Modbus/TCP and DNP 3.0.
- Frequency Response (Frequency-Watt function, local grid frequency monitoring)
- Frequency Regulation (various algorithms optimized for regionally specific frequency regulation rules, typically based on grid-operator provided signal)
- Renewable Ramp Management (Rate of change of power)
- Load Limiting (limiting real power at ESS connection point or at substation meter)
- Current limiting (limiting of maximum phase current)
- Voltage Regulation
- Reactive Power Compensation
- Power factor correction

2.2. Electric Vehicle Charging Stations

Two dual-port electric vehicle (EV) charging stations are provided in the Pine Street Parking Garage to provide EV charging for commuters from the microgrid and to accommodate emergency vehicles during emergency events. Each dual-port charging station provides two standard Level 2 charging ports with locking holsters with each port supplying up to 7.2 kW to facilitate charging of any EV at a rate of up to 25 RPH (miles of range per hour). The selected stations are ChargePoint® CT4000 wall mounted units to be located on the ground level of the parking deck. The stations include web connectivity making the stations visible to EV drivers in the region. Figure 15 provides a picture of a dual-port unit and Appendix 10 provides the technical specifications for the CT4000 units proposed.

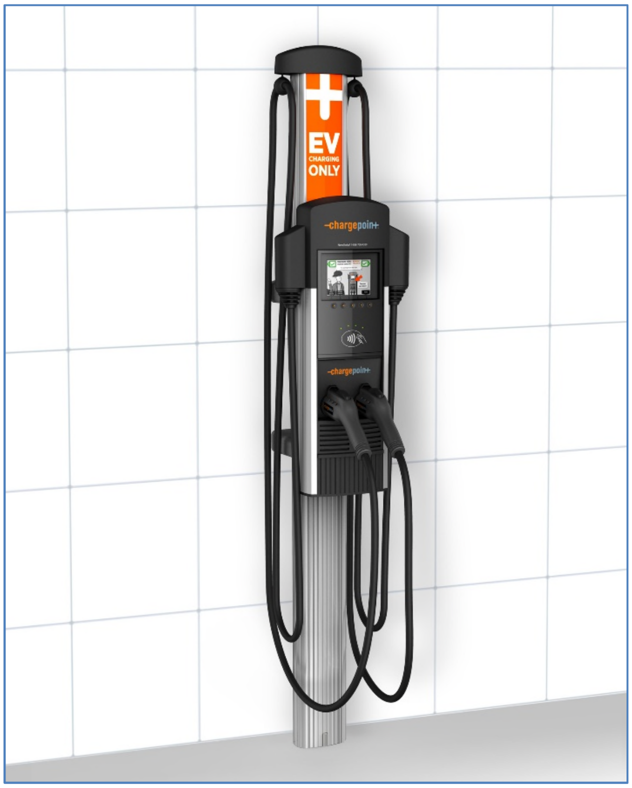


Figure 15 Dual-Port EV Charging Station

3. Control & Communications

A key component to successful operation of the microgrid is the control and communications system that is at the heart of the operation. It is important that the MMG controller provide a high level of communication flexibility due to the variation in supplier and age of existing building control and backup generation assets as well as provide a secure communications and control environment with remote web access to facilitate, not only the existing security concerns, but also to provide for multiple ownership/control scenarios.

The MMG controller is based on the Siemens SICAM MGC (microgrid controller) which is component in the Siemens remote terminal unit (RTU) family of products and which has been deployed on multiple sites throughout the world. The SICAM microgrid controller was developed to provide supervisory control for smaller microgrids such as the MMG. It provides flexible communication, seamless transition from grid connected to islanding, secured control, and flexibility and scalability for future microgrid expansion. It can integrate with existing building automation and equipment control systems, allows direct connection of new devices and sensors and incorporates comprehensive cyber security features. The microgrid control design also incorporates Siemens Scalance X-200 Ethernet switches at each connected facility to provide a fully integrated high-speed communications and control architecture. See Appendix 11 for microgrid controller and switch technical data. The MGC will be used to provide the following:

- Asset monitoring
- Blackout detection, black start and automated grid modes
- Automatic start of CHP generators
- Monitoring of backup generators
- Control of automatic transfer switches
- Grid connected power import balancing
- Islanding load and asset management
- Reserve management
- Peak shaving
- State of BESS charge management
- Economic and environmental indices
- Weather forecast integration

All MMG connected facilities will be networked using fiberoptic cable with adequate capacity for addition of new facilities and devices. All network devices incorporated in the control and communications network are layer-2 managed network switches.

An interface will be developed for existing legacy devices for outage detection or intended islanding critical to the operation of microgrid. All current protection relays and localized controllers of the medium voltage distribution network will be upgraded as required to provide suitable networking capabilities. In order to support the new microgrid operational modes including grid connected and islanding, all connected devices will be remotely controlled using IEC-61850 / DNP3.0 or Modbus TCP/IP.

In case of communication failure (loss of heart beat), critical functions such as start/stop, GCB and MCB position, status etc., control of the generator can be maintained using local controllers or using digital and analog dry contacts direct to generator controller.

The microgrid controller can be located at either the Montclair's Fire HQ and Communication Center or at the Mountainside Hospital. Location of the controller will be defined once an ownership model has been selected. A second system data interface would be located at the non-control center location so that facility personnel are fully informed of MMG status and operations.

Figure 16 provides an overview of the microgrid controller architecture. The HMI (human machine interface) for the SICAM MGC is preconfigured and ready to use to optimize operations in microgrid systems. The clear, user-friendly display of equipment operating states is helpful to new users. Appendix 12 provides the communications architecture diagram for the proposed system.

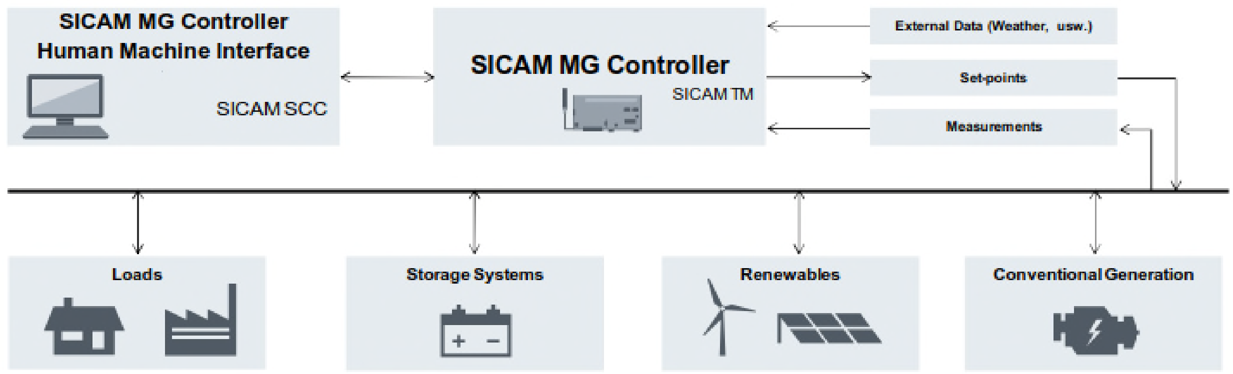


Figure 16: Siemens SICAM Microgrid Controller Structure

The controller clearly displays the status of all renewable and conventional generators as well as the loads. Event lists and the graphical energy model show specific attributes of all components in control and monitoring mode. This enables precise control and lets the operator quickly identify disturbances, states and conditions of the microgrid – for maximum operational safety. The dashboard views provide intuitive overviews about the microgrid key performance indicators including:

- General status (e.g. voltage, frequency, power exchange)
- Weather (e.g. wind direction, wind speed, temperature) (subject to local weather station interface availability)
- Costs and carbon footprint
- Power balance
- Power generation and consumption
- Grid status

Figure 17 through Figure 20 provide examples of the proposed microgrid controller screens.

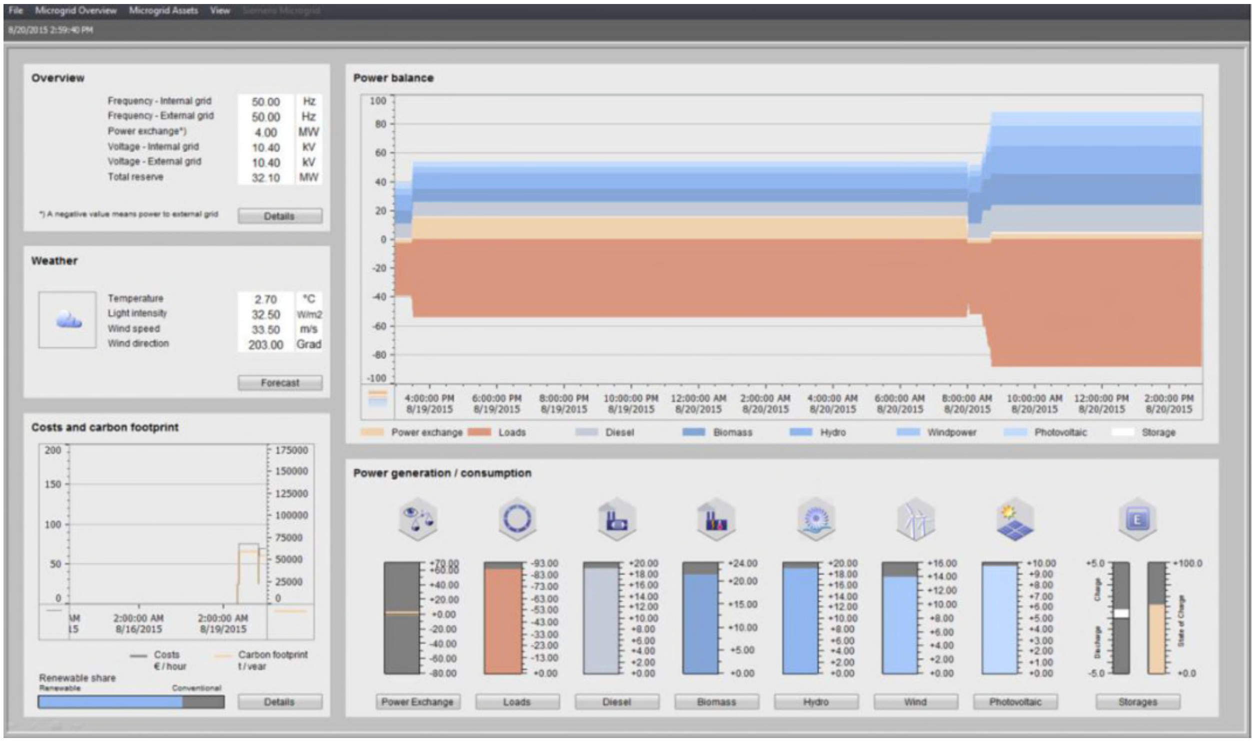


Figure 18 Microgrid Overview

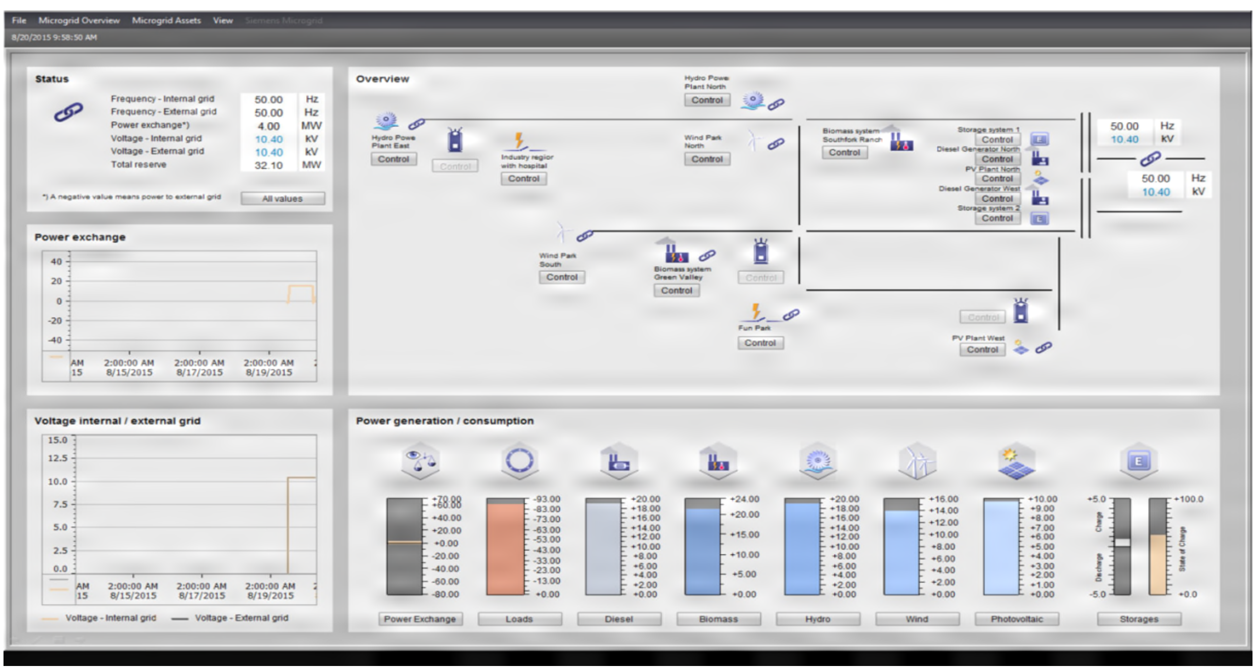


Figure 17 Assets & Devices Overview

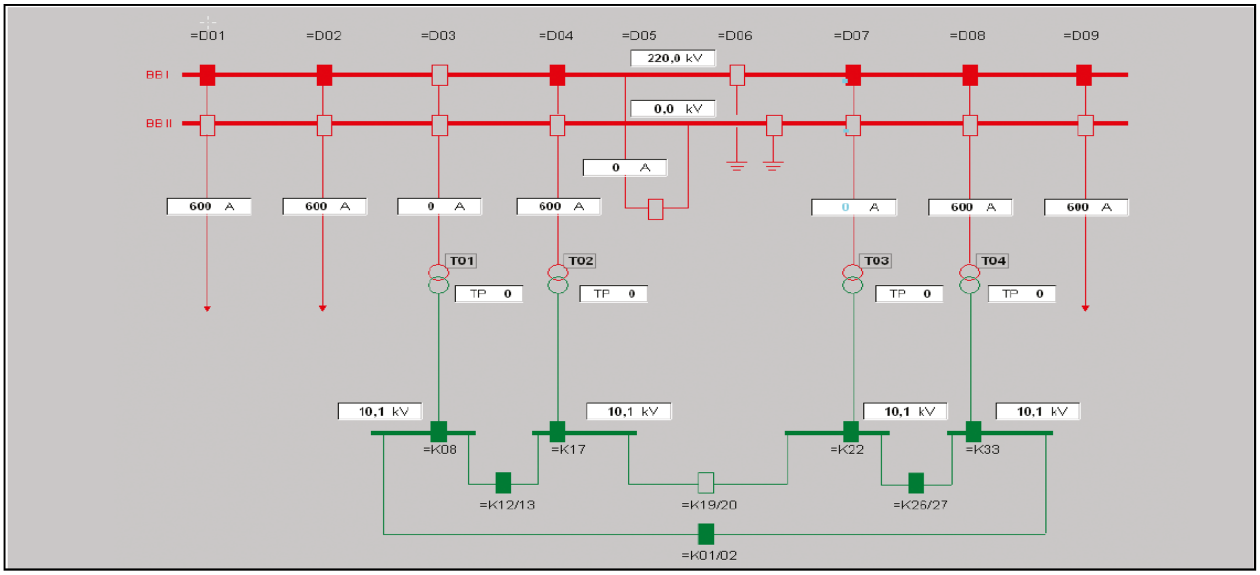


Figure 19: Station Diagram

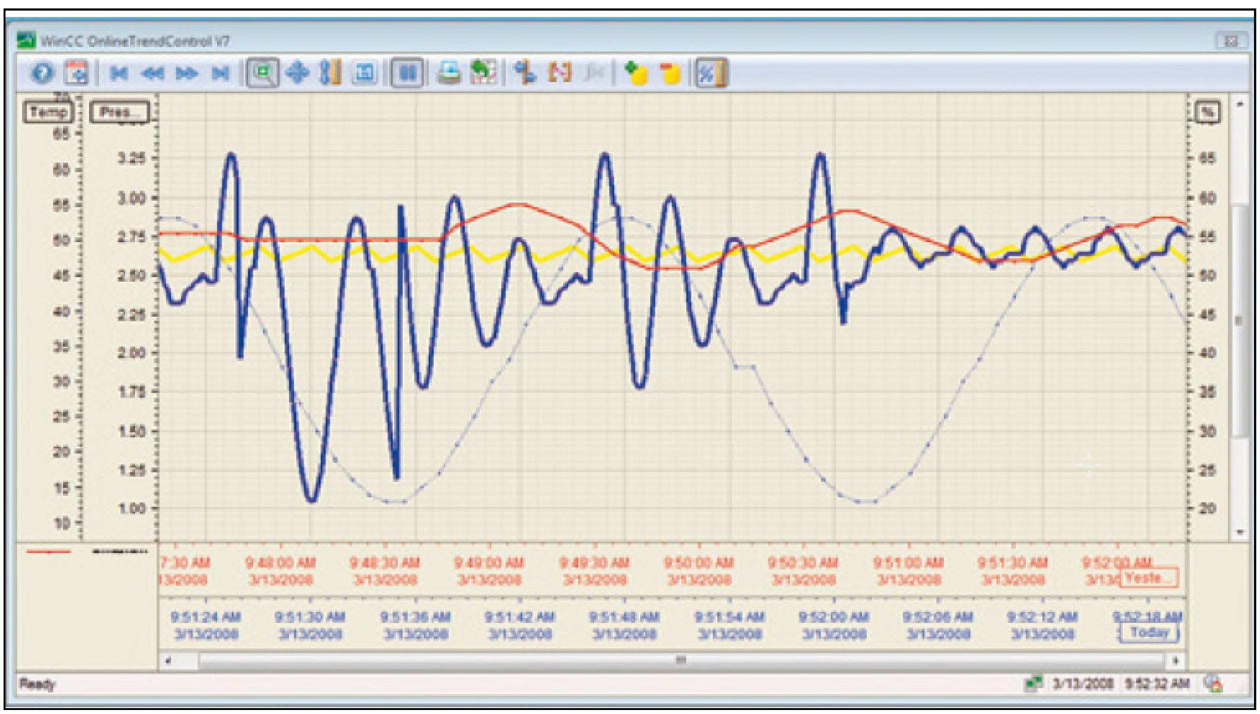


Figure 20: Trend Display

4. Interconnection

The Montclair Microgrid (MMG) will operate as a single entity relative to the electric grid with multiple power generation sources, a battery and multiple loads. All MMG loads, generating assets and batteries are interconnected electrically to each other via a new power cable that will provide both normal and emergency power to each facility. The MMG will be interconnected to the local utility grid at the existing Hospital grid interface. A new switchgear lineup will be provided as part of the MMG project that will allow for connection of the existing Hospital facility load bus, the 2 MW CHP plant and the MMG feeder to the remaining facilities. The interconnection will be at 13,200 V which is the rating for the existing Hospital facility bus and the new 2 MW CHP plant.

The proposed microgrid will separate each of the connected facilities from their current utility service and reconnect them to a single point of coupling with the utility at the hospital. The new microgrid load represents an increase of 15.5% in peak demand from the current main hospital peak demand of 3.47 MW to a microgrid peak demand of 4.01 MW. The microgrid utility connection will be made at the existing service to the hospital and is well under the 5 MW threshold for 13.2 kV service. This PSE&G service is currently provided by two 13.2 kV feeders in an A or B configuration. The proposed microgrid layout and loads have been preliminarily reviewed by PSE&G and no major technical hurdles have been identified.

Natural gas is required at the Hospital and the School to provide fuel for the new CHP systems. Both facilities are currently connected to the natural gas grid to supply fuel for existing boilers and for other purposes. Pressure requirements for the new 2 MW CHP plants is typically 5 psig and throughput requirements are 175 therms per hour at full load. The new 125 kW CHP plant at the School typically requires 0.5 psig with a peak load throughput of 15 therms per hour.

Each generating asset controller, battery controller, main load breakers and protection devices, and the main grid interconnection switchgear together with various electric system sensors will be interconnected via a new digital network using IEC-61850 / DNP3.0 or Modbus TCP/IP. Interfaces with network capability for existing equipment including diesel generators and automatic transfer switches as well as building automation systems will be developed to allow for operation and control of legacy equipment and devices necessary to operation of the microgrid. In case of failure of the network communications and control system, new and existing assets, circuit breakers, switches and ancillary equipment shall be operable using the local controller provided with the equipment.

Section V: Microgrid Operation

The 2 MW CHP engine-generator at Mountainside Hospital and the 125 kW engine-generator at Glenfield School will have black start capability. Both CHP units will operate at full capacity to meet baseloads under normal condition. The Hospital system will operate 24/7 while the School system will operate under normal conditions during school operating hours. When the grid is unavailable and the School is being used as a place of refuge and municipal operations, the School system will operate at full output.

The PV system at the Fire HQ will be connected to the DC bus of the battery system which will control PV and battery system charging/output and interaction with the microgrid controller. The PV system at the School will also be connected to the DC bus of the selected inverter based CHP plant such that the CHP plant controller will manage both CHP and PV output and interaction with the microgrid controller. The PV system at Pine Ridge multi-family facility will be connected to the microgrid via a dedicated inverter. A local weather station interface and weather forecast service will be arranged by the MMG operator to enable PV production forecast and battery storage optimization.

While operating in grid parallel mode, the microgrid controller will monitor the point of common coupling (PCC) with the electric grid and local demand, in order to determine the financial benefit of participating to the market such as leveraging battery as a frequency response asset. At this time, it is not the intention for the microgrid to export power to the grid. However, if and when the market condition change in favor of export in the future, the microgrid controller shall be able to expand its functionality to enable the export of the power.

Upon detection of utility disturbance, the main protection relay will signal to the microgrid controller an outage condition. The microgrid controller will initiate island mode operation and as such will disconnect and isolate the distribution network, i.e. all microgrid loads from the local utility power grid. The microgrid controller can reconnect the load back to the utility grid when the protection relay identifies stable grid after an emergency situation.

The proposed microgrid is designed to operate as an integrated system of software and hardware to ensure the highest levels of reliability and performance in all operating modes. During grid parallel mode, generation assets will operate fully synchronized with the utility grid under the provisions for interconnecting distributed resources with electric power systems. Power generated either by the rotating sources (e.g. CHP generator set) or static resource such as inverter based energy sources (e.g. PV) will be synchronized with the main grid – that is, the AC voltage from DER assets will lock the output frequency and phase of the AC voltage to power quality and power delivery.

1. **Grid Parallel Mode of Operation**

Under normal operational condition, both CHP units will be running at or close to 100% capacity and supplying power to the microgrid while also supplying thermal energy to the host sites. The PV at each site will also be connected to the microgrid and allowed export power from one facility to another within the microgrid as long as there is a minimum import from the grid to the combined loads on the microgrid in accordance with current interconnection rules. In case when the aggregated microgrid loads are less than the combined output of PV and CHP, the CHP plants shall be turned down by the controller to maintain the minimum import from the grid.

The battery at the Fire HQ/Communication Center will be used for demand reduction and load shifting. Siemens Microgrid Controller MGC will schedule battery charging and discharging based upon the various market signals as well as maintain a minimum state of charge for resilience purposes.

During normal operation when the microgrid is connected to the public grid, the microgrid controller is able to manage the dispatch of both the active power (P) and the reactive power (Q) at the tie-line in order to support power quality on the utility grid. The set-point for P and Q can be entered manually at the user interface or it is possible to select a desired power factor which will be maintained by the microgrid controller. This function leverages the microgrid generation assets to balance the microgrid system load instead of having to rely on the grid. This would potentially reduce the grid stability impact created by microgrid load fluctuation.

2. Island Mode of Operation

In designing this microgrid operational scheme, normal islanding procedure is initiated by the operator manually once they have confirmed with the utility the need to engage island mode. However, there are cases where other islanding processes may be warranted. The microgrid controller is designed to have the capability of managing microgrid islanding under the following three conditions:

- Intentional islanding
- Automatic islanding
- Preemptive islanding

Intentional islanding takes place when the grid is down (voltage drops to zero at the PCC) and the operator initiates grid islanding procedure to take the microgrid into island mode of operation.

There are occasions, when automatic islanding may be needed considering this particular microgrid design and operational scheme. This function enables the microgrid to go into island mode of operation without any operator intervention. It is essential to have this “last resort” islanding capability in case there is an emergency and the microgrid needs to go into island mode but for some reason, the operator is not available.

Intentional and automatic islanding occurs when there is no power from the local utility being detected. The islanding process follows the following procedure:

- Existing emergency diesel generators at the Hospital and Fire HQ will automatically switch on via ATS to energize the emergency buses
- All Hospital and Fire HQ emergency loads will be powered by the emergency bus
- The microgrid controller will isolate the medium voltage (MV) loop connecting the various microgrid facilities and disconnect solar PV
- The controller will initiate the black start sequence for the 2MW CHP unit located at the Hospital
- While step loading the 2 MW CHP engine-generator, the controller will determine what hospital non-critical loads can be brought back (close CBs to the loads) to power based upon the available generation capacity while observing the desired spinning reserve
- The controller will then close the breakers at the school nursing home to reconnect power at those two facilities.
- The School CHP plant will be started and synchronized with the 2 MW CHP plant to increase the spinning reserve
- The controller will then connect the Fire HQ including battery and connected PV and utilize the battery to help stabilize the microgrid
- Once the microgrid is stabilized, the controller will reconnect all the solar PV
- The controller can then choose to bring selected emergency loads at the hospital and Fire HQ into the microgrid while leaving the remaining emergency loads on the diesel backups
- Once all desired loads at the hospital are restored, based upon the remaining available generation capacity, the controller will decide to move critical loads at the Hospital and Fire HQ still powered by the emergency diesel generators back to the main microgrid bus now powered by CHP and PV
- During islanding process, the controller is monitoring in real time the total generation capability available and the microgrid loads in order to maintain microgrid system stability
- Once in island mode, the controller will droop control the voltage and frequency within acceptable limits.

When there is an anticipated grid outage due to forecasted severe weather, a planned utility outage or other reasons, the microgrid operator can prepare to take the microgrid system into island mode in advance of the anticipated outage. Under preemptive islanding, the microgrid will switch to islanding mode while the grid is still available and prior to a larger grid outage that would leave the microgrid area without power. Preemptive islanding is one of the important islanding functions that will significantly reduce the "rush" during the islanding operation. Once adequate spinning reserves are synchronized with the grid and each other, the system is considered ready to implement islanded operation and will begin opening the incoming utility line breakers. As peak load at the time of preemptive islanding could be greater than the total capacity of microgrid generation assets, and in order to maintain the load during the transition to island mode, non-essential loads may have to be shed, or emergency loads moved to the existing emergency diesel generators.

Once the microgrid is stabilized, all the diesel standby generators could potentially be turned off if not all non-critical loads are required to be restored. If the total power output of the combined CHP units, solar and battery is sufficient based upon the total load demand (some non-critical loads will not be powered up), the controller will be instructed to move all loads to the microgrid bus and shut down the diesel generators. This strategy is employed to preserve microgrid generation assets in case of a long duration outage and to provide the cleanest power available.

3. **Resynchronization**

When power returns to the utility grid, the microgrid controller will coordinate a safe and orderly re-connection to the larger grid. Synchronization is managed by the microgrid operator who will contact the utility to confirm that it is okay to synchronize and then initiate the procedure via the microgrid controller. This interaction between the operator and the utility is an important consideration given that, sometimes when the grid is first restored, there may still be some issues with grid stability which could adversely impact the microgrid equipment or force a return to island mode. It is also beneficial for the utility given the fact that when the grid is first restored from an outage, especially an unplanned one, there might be a capacity shortage on the network. By remaining in island mode, the microgrid can help alleviate network stress.

Upon initiation of the resynchronization command, the microgrid controller will send the command to the generators and main utility connection breaker to reconnect. Grid synchronization is achieved by the microgrid equipment protection relays with synchro-check function which equalizes the values of the microgrid assets with grid values using Load Frequency Control (LFC) and Automatic Voltage Control (AGC) modules. Once frequency and voltage have been synchronized, the main breaker will be allowed to close.

In summary, two conditions have to be met in order for the microgrid system to be synchronized back to the main utility grid.

- Stable grid - The protection relay monitoring the utility side of the main interconnecting breaker is used to determine that the measure frequency and voltage at the PCC is within microgrid equipment operable limits.
- A synchro-check relay is required at each generation asset side to release the CLOSE command.

Automatic resynchronization is also available through the microgrid controller where the system first waits a predefined, configurable time period to ensure power is permanently restored and then automatically commences resynchronization to the utility power supply.

4. **Additional Microgrid Operating Functions**

Load Frequency Control (LFC) restores the system frequency and power flow in the microgrid system to their value before a change in load. In grid island mode LFC uses the actual frequency value to detect the actual power demand. Depending on the frequency deviation, LFC will increase or decrease the power set-points for generators, batteries and other energy sources. In grid connected mode LFC will regulate the active power at the PCC to a user-defined set-point. In both modes LFC derives a value for "total desired active power generation" that is subsequently shared by the "Load Sharing" function between all available generation units.

Automatic Voltage Control (AVC) restores a certain bus voltage and the re-active power flow in the microgrid system to their value before a change in load. In grid island mode AVC is looking at the actual voltage at a certain bus. Depending on the voltage deviation AVC increases or decreases the reactive power for generators, batteries or other energy sources. In grid connected mode AVC regulates the re-active power at the PCC to a user-defined set-point or, if activated, according power factor regulation. In both modes AVC is deriving a value for "total desired reactive power generation". As with LFC, this value is subsequently shared by the "Load Sharing" function between all available generation units.

Load Shedding (LS) commands provide for instructions from the microgrid controller to mechanical and thermal systems to shed load. Where mechanical and HVAC loads are managed by an existing building automation system (BAS), the demand of these loads can be set by the microgrid controller using a priority table that sends a target load reduction to the BAS based on available spinning reserve. Load shedding would be triggered by a potential overload of the DER during grid island operation. LS commands can be automated and start with shedding the lowest priority loads. In case there is still a potential over-load situation LS continues with the next load after an adjustable delay time. As a first step in grid islanding and after detection of a blackout, all non-emergency controllable loads will be shed immediately in preparation for restart of the microgrid. The availability and priority of impactful loads that can be shed will be determined in collaboration with the hospital, township and other stakeholders.

Load Restoration (LR) will restore all loads which were online before the blackout based upon a pre-defined load restoration sequence once the microgrid has stabilized and spinning reserve is sufficient to meet the loads.

Battery Control (BC) allows use of the Fire HQ battery for multiple functions depending on the operating goal of the microgrid. It can support Fire HQ resilience by using the connected PV array to charge the battery. For microgrid economic optimization the BC function can leverage the high regulating speed of the battery for grid ancillary services where the controller will provide positive and negative real power (P) and reactive power (Q) set-points to the battery inverter. BC can also be used for peak load shifting to minimize microgrid peak demand on the grid. Available BC control functions are as follows:

- Mode A – Battery is acting as backup for PV generator
- Mode B – Battery is providing regulating energy (droop mode)
- Mode C – Battery is used for peak shaving

Photovoltaic Control (PVC) allows control of PV systems within the microgrid to optimize economic operation or prioritize resilience or maintain microgrid asset performance within acceptable limits. Available PVC control functions are as follows:

- Interconnected mode: The PV inverter is always online and is converting all available energy.
- Island mode: The PV inverter is always online. Only in periods of very low load the PV is switched off in order to avoid running DERs at bad operating conditions.
- Solar battery mode: In case of surplus of PV generated power, the battery storage system is charged. If more power is required than the PV can provide the battery storage system is discharging in order to supply the local loads. The microgrid will also import any additional power needed from utility grid.

Peak Load Control (PLC) can be initiated by the microgrid controller and requires the battery control module to be in "Peak Shaving" mode. PLC allows for the ability to control the consumption from the energy supplier during intervals of high demand, in order to limit or reduce demand and transmission charges for the billing period. When power at the utility grid PCC is below a certain predetermined limit, the microgrid controller will charge the battery. If power consumption at the grid PCC is greater than a predetermined limit, the microgrid controller will discharge the battery to maintain grid demand at the maximum limit.

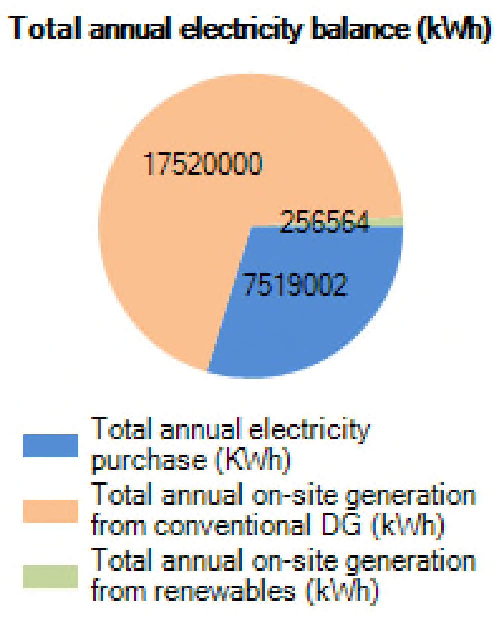
State of Charge (SOC) allows the microgrid controller logic to keep the SOC as high as possible in order to provide sufficient regulating reserve. Optionally load shedding can be initiated in case SOC falls under a certain limit.

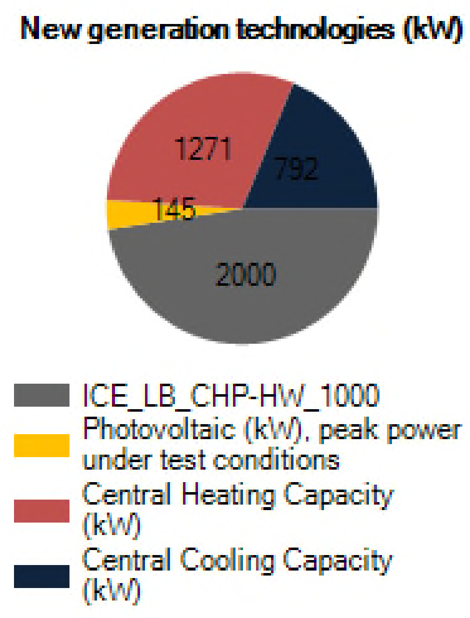
Section VI: Microgrid Operation and Performance Analysis

The basis for selection of the proposed generation equipment is actual site energy use and cost data for each of the 8 individual facilities that are incorporated in the Montclair Microgrid. Economic and performance evaluations are taken from various models constructed by the authors as well as input from various commonly used modeling tools including LBNL's DER-CAM, ASHRAE's CHP Analysis Tool and US EPA's CHP Energy & Emissions Savings Calculator. In addition, data was submitted to Rutgers University to allow for review of the microgrid's interaction with the utility grid.

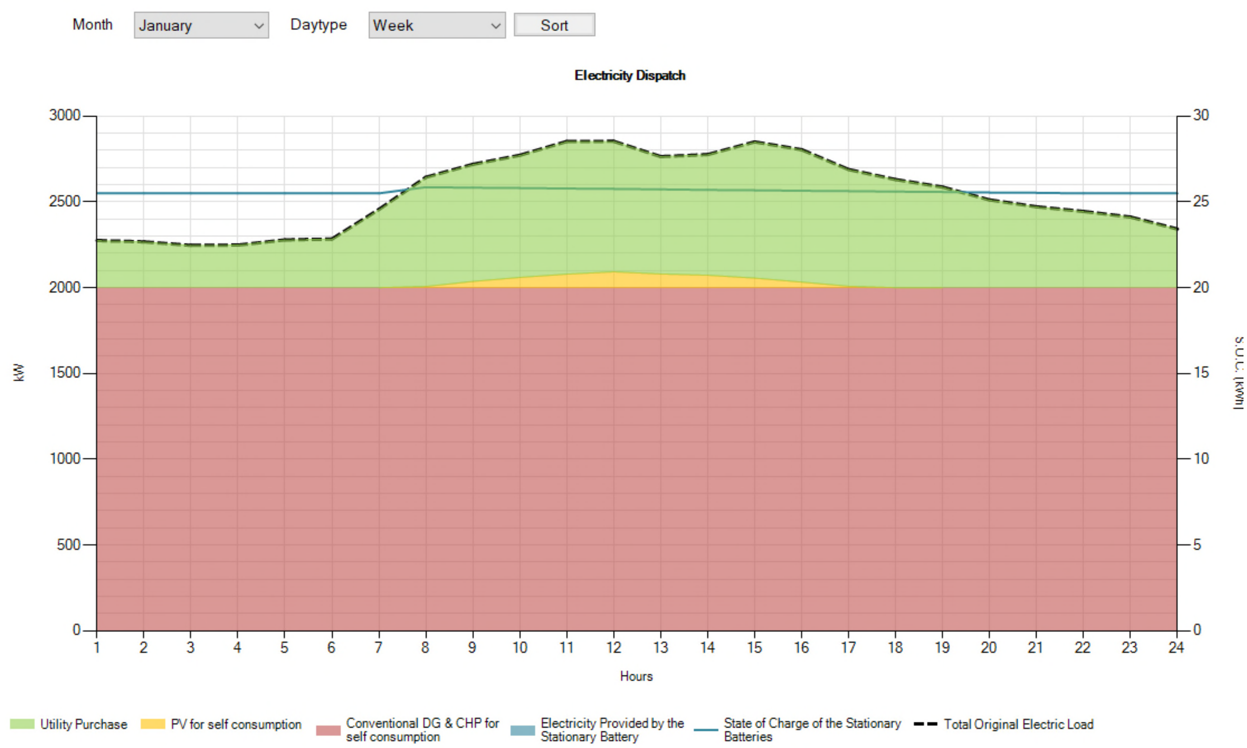
1. **DER-CAM Results**

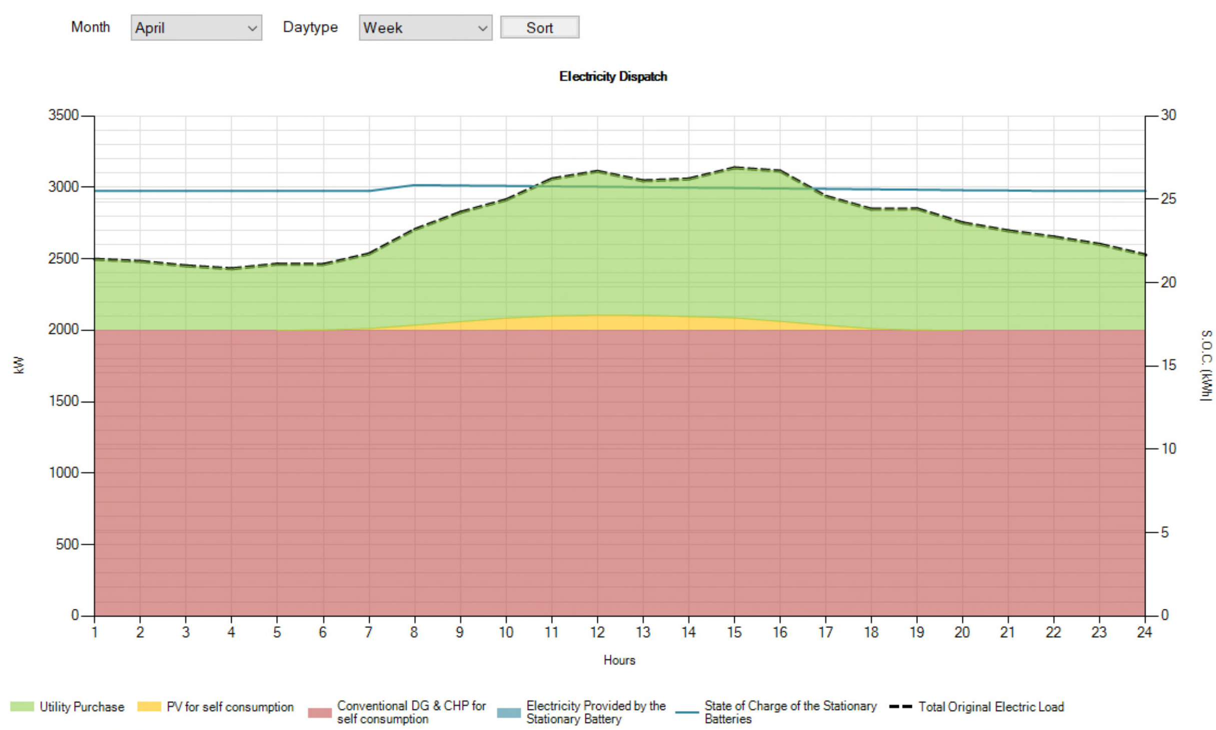
The DER-CAM analysis demonstrated the viability of the proposed distributed energy resources for the existing combined microgrid load. It should be noted that the DER-CAM tool does not provide the same level of performance sensitivity relative to the combined loads as that provided by the individual modeling of the various technologies at the respective sites. The DER-CAM analysis provides a high level statement of approximate performance results.

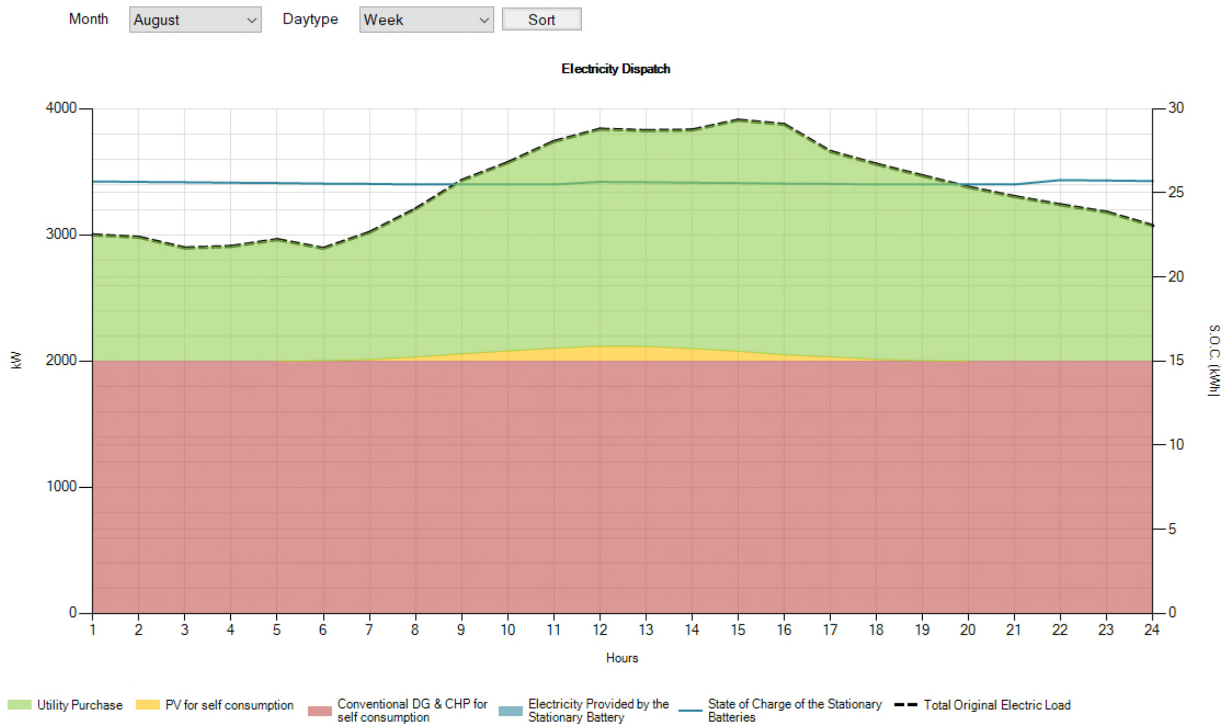




DER-CAM provides monthly dispatch sequences demonstrating for the given parameters how the various energy resources on the microgrid are dispatched for optimized economic performance. These dispatch sequences will be refined in the final design and may be altered from those provided by DER-CAM. Operating sequences during typical week day operation for a winter month (January), a shoulder month (April) and a summer month (August) are provided below.


Month
January
Daytype
Week
Sort
Electricity Dispatch
kW
S.O.C. (kWh)
Hours
Utility Purchase
PV for self consumption
Conventional DG & CHP for self consumption
Electricity Provided by the Stationary Battery
State of Charge of the Stationary Batteries
Total Original Electric Load


Month
April
Daytype
Week
Sort
Electricity Dispatch
kW
S.O.C. (kWh)
Hours
Utility Purchase
PV for self consumption
Conventional DG & CHP for self consumption
Electricity Provided by the Stationary Battery
State of Charge of the Stationary Batteries
Total Original Electric Load



2. EPA CHP Energy & Emissions Savings Calculator

USE EPA through their EPA/CHP Partnership provides a tool for calculating the energy and emissions savings for CHP relative to the local ISO sub grid emissions. For the 2 MW CHP plant proposed for Mountainside Hospital, the calculator demonstrates a net fuel consumption savings of 26% versus grid based power and natural gas fuel input to local boilers as indicated below:

	CHP System	Displaced Electricity Production	Displaced Thermal Production	Fuel Savings	Percent Savings
Fuel Consumption (MMBtu/year)	143,813	152,907	40,638	49,732	26□
Equal to the annual energy consumption of this many passenger vehicles:				786	
Equal to the annual energy consumption from the generation of electricity for this many homes:				502	

Emissions reductions are calculated using the tool versus the Emissions & Generation Resource Integrated Database (eGRID) for the North American Electric Reliability Corporation (NERC) Subregion RFC East in which New Jersey is located. The following table provides the specific emissions results in alignment with EPA methodology.

	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions Savings	Percent Savings
NO_x (tons/year)	3.44	3.05	2.03	1.63	32□
SO_2 (tons/year)	0.04	0.15	0.01	0.12	74□
CO_2 (tons/year)	8,406	8,955.35	2,375	2,924.81	26□
CH_4 (tons/year)	0.16	0.31	0.04	0.20	55□
N_2O (tons/year)	0.02	0.04	0.00	0.03	62□
Total GHGs (CO_2e tons/year)	8,414	8,973.52	2,378	2,937.07	26□
Equal to the annual GHG emissions from this many passenger vehicles:				570	
Equal to the annual GHG emissions from the generation of electricity for this many homes:				399	

The installation of the proposed 2 MW CHP plant at the hospital would result in a reduction in emissions equivalent to removing 570 passenger vehicles off the road or the equivalent of the emissions from 399 homes. The results printout is provided in Appendix 13.

3. **RU LESS**

Data was submitted through the RU LESS tool and via email on loads and distributed energy resources for the eight facilities included in the microgrid with a single slack node located at Mountainside hospital. Data also included the microgrid power cable characteristics, new and existing energy equipment efficiencies, and distances between connected facilities.

ID	Facility	From Node	Distance (M)
Node 1	Mountainside Hospital		
Node 2	Hospital Parking Deck	Node 1	200
Node 3	Fire Headquarters	Node 4	75
Node 4	Bay Street Station	Node 5	50
Node 5	Pine Street Parking Garage	Node 8	100
Node 6	Glenfield Pump Station	Node 3	150
Node 7	Glenfield Middle School	Node 6	200
Node 8	Pine Ridge	Node 2	400
			1175

Section VII: Montclair TC DER Microgrid Cost Benefit Analysis

1. Introduction

The benefits of a town center microgrid fall into several categories. Among these are operational benefits in the form of O&M savings when compared to conventional ways of sourcing power, steam, hot water and air conditioning. There is the benefit of resiliency or the ability to withstand interruptions in power supply due to weather or other events which effect the utility grid. The increased efficiency when both cogeneration and solar generation are used provides environmental benefits such as reduced greenhouse gas emissions. Finally, the incentives from the federal, state and utility provide economic incentives for development of a microgrid which will in turn provide the operational, environmental and resiliency benefits. This section of Montclair Microgrid study will discuss each of these benefits in more detail.

2. Proposed MG Capital and O&M Costs

2.1. Overview

Capital costs for the microgrid including electrical, controls, equipment and installation costs have been developed from estimates solicited and received from contractors and equipment suppliers specifically related to the Montclair microgrid design. Engineering costs, construction management, development, financial fees, legal and other professional fees are based on recent experience with similar projects including NJ EDA Energy Resilience Bank program financed projects and Microgrid Pilot Program projects developed in Connecticut administered by the Connecticut Department of Energy and Environmental Protection.

A contingency of 10% of all equipment, installation and fee elements is included and NJ sales and use tax (SUT) is included at 7% on all costs and fees. Given that the development model for the microgrid is third-party financing and ownership, sales and use tax exemptions have not been implemented in this analysis.

2.2. Capital Cost

The total estimated capital cost of the proposed Montclair Town Center Microgrid is $16,449,467 inclusive of all equipment outlined in this report, contingency and NJ SUT. The capital cost estimate is based on using the NJ Transit catenary system to run power and communications cables from the Mountainside Hospital Parking Deck to Glenfield School. The estimated capital cost basis for the proposed project is summarized in Table 11 and a more detailed cost breakout is provided in Appendix 14.

Capital Item	Amount
Electrical Switchgear Upgrades – Hospital	$697,000
CHP Package-Hospital	$3,780,000
Mechanical Equipment – Hospital	$1,110,000
PV Systems – Glenfield, Fire HQ and Pine Ridge	$396,858
Battery Storage System – Fire HQ	$114,900
CHP Package – Glenfield School	$388,500
Electric Vehicle Charging Stations-Pine Street Parking Garage	$33,000
Microgrid Controller	$365,500
Microgrid Power and Communications Backbone	$2,800,000
Facility Power Connections	$430,000
Engineering	$1,525,000
Construction Management	$480,000
Fees, Bonds and Insurance	$500,000
Project Development	$675,000
Legal	$230,000
Misc. Cost (General Conditions, Mobilization, Other)	$450,000
Contingency	$1,397,576
NJ Sales and Use Tax	$978,303
Total Capital Cost:	**$16,449,467**

Table 11 MMG Capital Cost Summary

2.3. Operation & Maintenance Costs

Operating and Maintenance (O&M) costs for the microgrid include natural gas fuel for the cogeneration installations at Mountainside Hospital and Glenfield School, annual maintenance costs for all equipment, insurance, administrative costs, standby service from PSE&G and a distribution charge from NJ Transit for using their catenary right-of-way for routing the microgrid distribution lines.

All O&M costs have been escalated at 3% per year as has the selling price for both power and thermal energy going to the various off-takers on the microgrid.

3. **Resilience Benefits**

Grid downtime, natural disasters, weather events and the increasing occasion for external attacks, are increasing the need for grid-connected critical facilities such as hospitals, shelters and mass transit to become more independent. Energy resilience describes the ability of an energy supply system to withstand or bounce back from an outage. Often this is an intangible in the minds of energy users who don't always consider the cost of downtime even though power outages create financial losses that can be quantified. However, the BPU recognizes the resilience benefits offered by a microgrid and supports the efforts to facilitate municipal level microgrids in order to improve energy security as well as to avoid such financial losses. While there are no acceptable methods of evaluating resilience financial benefits for most entities, the commonly used term describing the value of resilience is the 'value of lost load' or VoLL. VoLL will vary depending not only on the type of outage considered, but also on the type of entity suffering the outage. Guidance is provided by the US EPA who must provide economic justification for the cost of implementation of rules using a methodology that is somewhat similar to the required to develop VoLL. VoLL is also a term used by utilities in their own analysis of outage costs and in this circumstance, it is an expression of the loss of value or profit from the loss of supply of power. This does not adequately compensate for damage and mitigation costs from a user or community perspective and care needs to be taken to ensure that VoLL incorporates the true societal value of an outage to the community that is evaluating a microgrid. Another term that is widely used when calculating resilience value is 'willingness to pay' or WTP that is also used in the EPA methodology and perhaps more accurately describes the societal value of lost load or resilience.

Generally, there are three broad classes of outage that can occur on an electricity grid: (1) large-scale, long-term outages in which power is interrupted across a wide area for days, or even weeks due to an event that causes a system-wide blackout and requires system restart and in many cases, extensive infrastructure repairs (e.g. Superstorm Sandy); (2) more localized outages in which electricity service is unavailable for hours at a time (e.g. as a result of a distribution service event or a more localized weather event such as a microburst); and (3) targeted, short duration outages of select customer over a more discrete timeframe such as rotating outages that would be instituted by the local utility or independent system operator to prevent a system-wide blackout.

The traditional calculation of VoLL for non-residential entities incorporates direct losses including opportunity cost of idle labor, damage to capital goods and health and safety costs; indirect losses such as delayed delivery of services; and mitigation costs such as emergency services costs and procurement of standby generation. For Montclair, mitigation costs are most likely going to be the higher cost as, during a grid outage, it can be expected that circumstances forcing this outage may require additional emergency response resources and that the hospital may be at maximum capacity. Neither of these services can be delayed and so loss of energy must be mitigated. Long duration, system-wide outages will have the highest VoLL as the indirect and mitigation costs of an outage increase over time. A recent study by London Economics International, of VoLL in the United States puts the load-weighted average value of VoLL in the $30,000 to $40,000 per MWh range.

While the existence of VoLL is real and tangible, there currently is no consensus on how to incorporate VoLL into a justification for resiliency initiatives. At this point there is little conformity on methods to monetize VoLL and we have elected to not include VoLL in our economic justification of the Montclair Microgrid. We encourage the BPU/OCE to develop a uniform method of measuring or ascribing values to VoLL for the type of facilities encountered in Town Center Microgrids. In the event VoLL becomes important criteria for selection of microgrid pilot projects for additional funding, we will review the parameters of any VoLL model to confirm uniformity and its ability to facilitate a true apples-to-apples comparison of proposed projects.

4. Environmental Benefits

The microgrid as designed has several environmental benefits. Among these are the increased conversion efficiency from natural gas fuel to useful end use energy. According to the U.S. Department of Energy, conversion efficiency from a naturally gas-fueled, combined cycle utility electric plant when allowing for losses in transmission and distribution is approximately 35%. This assumed 45% efficiency at the generator, 7% transmission losses and 16% distribution losses. In contrast, the annualized efficiency of the planned microgrid on an HHV basis is approximately 67%, or almost double that of utility supplied electric. Microgrid efficiency is helped by the use of renewable energy with the solar PV installations, and the use of cogeneration which utilizes the waste heat from the combustion of natural gas fuel to provide heating and hot water via the use of heat exchangers, and cooling via the use of absorption chilling. According to the U.S. Environmental Protection Agency's GHG Equivalency Calculator, the increase in efficiency as a result of implementation of the proposed microgrid reduces greenhouse gas by 3,226 tons per year, or the equivalent of removing 627 passenger vehicles from the road. Carbon sequester effects are the equivalent of that which could be provided by 75,867 tree saplings grown for ten years.

5. Federal, State, Utility Incentives

5.1. Capital Cost Incentives

Our analysis assumes that the developers of the microgrid will take advantage of all existing incentives that are available from the Board of Public Utilities or their Office of Clean Energy. This includes existing cogeneration incentives on both the hospital and Glenfield cogeneration investments, the battery installation at Fire Headquarters and existing incentives for the Electric Vehicle Charging Station which is to be installed at the Pine Street Parking Garage. We have included SREC revenue at an assumed value of $250 per MW not as a grant but rather in the revenue section of our P&L Statement. We have also assumed that there will be a new incentive to promote the development of Town Center Microgrids and have estimated that incentive as the amount needed to provide a private investor in the microgrid an after-tax internal rate of return of 10%. The methodology for determining the internal rate of return and the amount of microgrid subsidy that is needed is explained further in the section that reports on our financial analysis for the project.

5.2. Net/Virtual Net Metering

We have not included the use of net metering or virtual net metering in our analysis although it could be utilized in addition to, or in place of, the microgrid grant we are assuming in our analysis. Virtual Net Metering is an incentive that has been used in other states to spur the development of microgrids. As resiliency is the key objective of microgrid development, the excessive cost of building a separate distribution network and providing enough generating capacity to service the peak load of all energy off-takers on the microgrid, makes an economic justification for these projects much more challenging. Virtual net metering would allow the microgrid generation to produce to its capacity at all times rather than turning up, or down to satisfy the immediate power needs for the facilities on the microgrid at a specific point in time. By utilizing virtual net metering, a larger quantity of produced kilowatt-hours is available to absorb the substantial fixed costs of the debt used to finance the project, thereby reducing the all-in cost per kWh of production. The higher kWh production also results in a lower O&M cost per kWh although that expense does rise in absolute dollars when virtual net metering is utilized. Since we have assumed that our cogeneration plants will be running at base load, with any peaking required in the case of a grid outage being provided by the existing emergency diesel generators at various locations within the microgrid, we do not have the larger capital cost for new generators that would be required if program rules required a non-diesel alternative for generation. If the program evolves to require non-diesel generation exclusively, or limits the amount of diesel generation, virtual net metering could potentially provide another level of financial support that may be required to make microgrid investment attractive to potential investors.

5.3. Resilience Credits

Our base assumption is that there will need to be a new grant offered by the BPU or some other state or regional organization, that would enhance the economic viability of microgrid development. That incentive is treated in the same manner as cogeneration incentives in that it is a grant that reduced that amount of capital an investor would have to borrow or fund with equity. An alternative to a grant program would be a program similar to the Solar Renewable Energy Certificate (SREC) program here in New Jersey where the utilities have a renewable portfolio standard that they must meet each year. In the absence of having the prescribed proportion of utility supplied electricity coming from renewable sources, they must buy SREC's in an amount sufficient to satisfy their renewable portfolio standard. If resiliency is an energy policy objective, a similar program could be designed whereby utilities would be required to have a certain percentage of their customers using generation that is classified as resilient, or able to run in the absence of grid power. Failure to meet those goals would require the utility to purchase a financial instrument similar to an SREC to meet its resiliency obligation. The proceeds from selling these Resilient Distributed Energy Certificates (RDEC's) would be used to fund the incentives required to make investment in a microgrid worthwhile. Although we have opted to look at additional financial incentives to spur resilient generation as a straight grant, we have considered what pricing for RDEC's would look like if it were used to spur the Montclair microgrid's development. In the financial analysis section of this study we have indicated what these certificates might sell for to offset the grant required for the Montclair Town Center Microgrid. The value of these certificates would vary with the number of years that a utility would be required to meet a resiliency portfolio standard with the longer the period, the lower the RDEC cost.

5.4. Other Subsidies/Assistance Programs

The MMG analysis assumes that investors will be utilizing two federal tax-related incentives to enhance the return on the microgrid project. The first is the investment tax credit which we have assumed to be 10% on the net cost of the project after deducting for cogeneration, battery, electric vehicle charging and microgrid grants. The other federal tax enhancement is accelerated depreciation. There are two options for accelerated depreciation, one is that standard Modified Accelerated Capital Recovery System (MACRS) for investment in the microgrid which we assume would be classified as 5-year property for MACRS. The other depreciation option is to utilize Bonus Depreciation which was extended as part of the new tax legislation enacted in 2017. This option allows the investor to take 100% of the depreciation in year one as opposed to spreading it out over a longer period allowed by MACRS. While utilization of the Bonus Depreciation option results in an investor having to put less equity into the project, over the course of the project life, because of the absence of annual depreciation cash flow after year one, it results in lower cash flow to the investor on a year in, year out basis. This results in a longer payback period for the investor versus using MACRS. Bonus Depreciation also requires a smaller grant from the state to achieve our targeted 10% after-tax IRR because of the large slug of cash flow that it creates in the earlies year of the investment before lower discount factors work to reduce the discounted cash flow. While there are tradeoffs with using either Bonus Depreciation or MACRS, we have assumed in our base case that we will use MACRS to account for microgrid depreciation and cash flows. We have included the P&L and Cash Flow sections of our financial analysis for both out base case using MACRS, and the option case using Bonus Depreciation as part of our study in the financial analysis section.

6. **Financial Analysis**

For purposes of analyzing the microgrid from a financial perspective, we have assumed that it will be developed using a public-private-partnership. That is, an investor will provide the equity capital to complete the overall financing of the project.

A public–private partnership is a cooperative arrangement between one or more public entities (typically the owner or host site(s) and another (typically private sector) entity to design, build, finance, and at times operate and maintain, the project for a specified term on behalf of the owner.

In order to provide private capital, the cash flow from the project needs to be sufficient to offset the perceived risks for the project. As the operation of the microgrid is fairly straight forward, and the energy off-takers are generally municipal or hospital facilities which have a relatively attractive credit profile, the principal risks inherent in the microgrid project are relatively low. None the less a private investor will be looking for an after-tax return (Internal Rate of Return) in the high single, or low double-digit range on their investment over the life of the project.

For financial analysis purposes for the project we have assumed that the investor would need a 10% after-tax return and have backed into the capital structure for the project in order to provide that 10% return.

The "capital stack" for the project assumes that the developer would take advantage of all existing tax and energy-related incentives from the state or federal government and any BPU or utility programs. This would include any incentives for solar, battery, electric vehicle charging stations or cogeneration. We further assumed that any capital required beyond that which is provided by tax and incentive programs would be funded with a 70/30 split between conventional project debt and investor equity.

Plugging all of these items into an IRR model which considers project funding at time zero, and operating cash flows over a twenty (20) year life of the project, we solved for the after-tax IRR. If the after-tax IRR was less than our targeted 10%, we assumed that the debt and equity contributions would be reduced by a new subsidy that would be specifically targeted to microgrid projects in New Jersey.

Operating cash flow is computed making the following assumptions:

- Pricing for microgrid electricity to the various off-takers was assumed to be equal to each facility's current cost per kWh that they are paying to PSE&G and assuming they are on BGS.
- Delivered natural gas cost to the CHP burner tip is $6.00 for the hospital and $6.50 for Glenfield School
- All incentives for CHP from the BPU will be included in the funding
- Solar PV incentives in the form of SREC's were assumed to be $250 per MWh for the entire 20-year life of the project and are shown on our financial analysis as revenue, not a grant.
- Current market pricing was used in year one for the following microgrid cost or expense line items
    - O&M
    - Insurance
    - Administration
    - Standby
- Microgrid distribution charges assumed to be $0.005 per kWh
- All cost or expense items were escalated at 3% over the 20 -year life of the project
- Electric and thermal revenue pricing was escalated at 3% over the 20-year life of the project
- Depreciation schedules assume 20-year straight line for book and 5-year MACRS for tax
- Any project debt was amortized over 15 years at a 5% interest rate

For operating cashflow we first calculated pre-tax income before depreciation which was the sum of revenues from electric and thermal energy sales plus SREC revenue, less the sum of fuel costs, O&M expenses, Insurance, Administration, NJ Transit Microgrid Distribution charges, standby charges, and interest. From the pre-tax income before depreciation we calculated cash flow by deducting tax depreciation to arrive at pre-tax income. We then calculated tax paid in the current period using an assumed 28.11% effective tax rate (21% federal and 9% state) and deducted tax paid from pre-tax income to get net income. To net income we added back tax depreciation and deducted principal repayments to get cash flow for the period. This is illustrated below:

	Revenues	
Less	**Costs:**	
		Fuel Costs
		Operation and Maintenance Expenses
		Insurance
		Administrative Fee
		Microgrid Distribution Charges to NJ Transit
		Standby Charges
Equals	**EBITDA**	
Less	Interest	
Equals	**Pre-Tax Income before Depreciation**	
Less	Tax Depreciation	
Equals	**Pre-Tax Income**	
Less	Taxes paid in period	
Equals	**Net Income**	
Plus	Tax Depreciation	
Equals	**Cash Flow from Operating Activities**	
Less	Principal Payments to Lender	
Equals	**Net Cash Flow for the period**	

An investor in the project will have the option of using either the Bonus Depreciation or Modified Accelerated Cost Recovery System (MACRS) accelerated depreciation methods given current tax law. With the Bonus Depreciation option, the investor is allowed to deduct 100% of his cost or obligation in the investment in year one. With MACRS, depreciation is likewise accelerated versus straight book depreciation, but this is done over a number of years based on the property class as opposed to only the one year that Bonus Depreciation allows. We have elected to utilized MACRS for purposes of our financial analysis. Depending upon which method of accelerated depreciation is used, other project capital structure items are affected. In this case the affected capital structure items include the investment tax credit, commercial debt, investor equity and the anticipated new microgrid grant. We have chosen to utilize MACRS as opposed to Bonus Depreciation because it ultimately requires less equity investment from a public-private-partner in order to attain the targeted after-tax IRR of 10%. We believe the lower equity requirement will make it easier to attract equity investors in the project.

The total estimated project cost for the microgrid, all new generation, a battery and electric vehicle charger, including a 10% contingency and NJ SUT is $16,449,467. The resulting capital structure for our project to achieve our targeted 10% after-tax IRR given depreciation for tax purposes using either the optional Bonus Depreciation or 5-year MACRS treatment is shown on Table 12 and results in the requirement of an additional societal contribution of up to $3,950,000 in the form of a new "microgrid grant".

Funding Source to Achieve 10% A.T. IRR	Bonus Depreciation		5 Year MACRS Depreciation	
	Amount	% of Total	Amount	% of Total
EV Charging Station Incentive	$10,000	0.1%	$10,000	0.1%
OCE CHP Incentive BPU - Hospital	$2,000,000	12.2%	$2,000,000	12.2%
OCE CHP Incentive BPU - School	$139,050	0.8%	$139,050	0.8%
Investment Tax Credit	$1,120,042	6.8%	$1,035,042	6.3%
Debt	$7,056,263	42.9%	$6,520,763	39.6%
Investor Equity	$3,024,112	18.4%	$2,794,612	17.0%
Microgrid Grant from BPU	$3,100,000	18.8%	$3,950,000	24.0%
Total Funding	$16,449,467	100.0%	$16,449,467	100.0%
Simple Payback for Investor	16 Years		13 Years	
Grants or Incentives as % of Overall Capital Structure	31.9%		37.1%	

Table 12 MMG Funding Sources

The anticipated new "microgrid grant" is either 19% or 24% of total capital requirements depending upon which accelerated depreciation method is utilized. The new "microgrid grant" would represent 32% to 37% of required capital after utilizing all existing state and federal incentive programs and this level of subsidy is consistent with microgrid incentive programs offered in other states such as one currently being offered by Connecticut's Department of Energy and Environmental Protection and New York's NYSERDA.

Detailed financial statements reflecting the above cited assumptions are included for both the MACRS and Bonus Depreciation scenarios in Appendix 15 of this report.

The projected microgrid grant incentive to allow investors to achieve a 10% after-tax internal rate of return on their equity investment, after allowing for all existing Office of Clean Energy, BPU and Federal Tax Incentives is $3,950,000. This incentive is assumed to be a grant made available to developers, investors, host sites or off-takers at the initiation of engineering and construction. Funding of this grant could be achieved in a variety of ways.

One such way would be through the utilization of a new program modeled after the SREC program where an electric utility would have a "resiliency portfolio standard" whereby a percentage of electricity used by its customers would be mandated to come from generation that is classified as "resilient". Evidence of that resilience would be a Resilient Distributed Energy Certificate (RDEC) that would be issued upon the production of the equivalent of 1 MWh of resilient power. To fund the $3,950,000 grant assumed for the Montclair microgrid, These RDEC's could be required in any number of years based on the resilient kWh production from the microgrid generators. With the microgrid MWh production assumed to be 17,623 MWh's over the course of a year, depending on the number of years the RDEC program is in effect, the RDEC values would be as shown in the following table:

Grant Recovery Period	1 Year	5 Years	10 Years
Grant Value to be Recovered	**$3,950,000**	**$3,950,000**	**$3,950,000**
Annual MWH production from Microgrid	17,623	17,623	17,623
Total MWh produced over Recovery Period	17,623	88,115	176,230
Required RDEC Value	$224.14	$44.83	$22.41

Another option to fund the microgrid would be to include a 'resilience' charge in the tariffs paid by electric customers. Depending upon which set of electric consumers are included in the recovery of the grant through a tariff adder and, the number of years the adder is in effect, the per kWh adder and the annual increase in electric bills would be as shown on the following table:

Grant Recovery Period	1 Year	5 Years	10 Years
Grant Value to be Recovered	**$3,950,000**	**$3,950,000**	**$3,950,000**
Montclair Accounts Only[2]:			
# of Accounts	48,000	48,000	48,000
Avg Annual kWh consumption per account	12,000	12,000	12,000
Tariff Adder per kWh	$0.0069	$0.0014	$0.0007
Annual Increase in Electric Bill / Account	$82.29	$16.46	$8,23
All PSE&G Accounts[2]:			
# of Accounts	5,000,000	5,000,000	5,000,000
Avg Annual kWh consumption per account	10,000	10,000	10,000
Tariff Adder per kWh	$0.000079	$0.000016	$0.000008
Annual Increase in Electric Bill	$0.7900	$0.1600	$0.0800
All New Jersey Accounts[2]:			
# of Accounts	8,000,000	8,000,000	8,000,000
Avg Annual kWh consumption per account	10,000	10,000	10,000
Tariff Adder per kWh	$0.000049	$0.000010	$0.000005
Annual Increase in Electric Bill	$0.4937	$0.09875	$0.04938

[2] For illustration the number of Accounts and kWh consumption have been estimated.

Section VIII: Project Development

1. Introduction

The development process for a project such as a microgrid is something that occurs over a period of years. It began with the consultant's initial examination of critical facilities within the Township of Montclair that would lend themselves functionally and economically to a microgrid. This effort facilitated the consultant's ability to select both a site and, critical facilities within that site, that would address the requirements of the pilot program and satisfy the needs of the BPU. The process culminated with a grant application for the Board of Public Utilities Town Center Microgrid Pilot Study program. The application was subsequently selected for funding and this pilot study was completed.

As the microgrid initiative moves forward to the next stage which may be the selection of the most promising sites among the thirteen pilot studies for an in-depth engineering phase or perhaps engineering and construction in tandem, its progression along the development process will continue.

Projects such as a microgrid are not finished in a few months, they string out for several years or more while both anticipated, and unanticipated tasks, challenges and complications materialize that have to be dealt with.

There are also many parties who are involved and who are essential to the successful development of a microgrid but unfortunately few of these participants have common goals. This is illustrated in Figure 21.

Microgrid Project Players and Conflicting Goals

Player	Primary Objective
Host site for Generation	Minimum disruption of Core Business / Responsibilities
Energy Off-Takers	Reliability, Lowest Possible Cost
State / Regulatory Authority offering financial assistance	Meet Program Goals, e.g.: Reliable & clean, enhance political good will / capital
Local Electric Utility (LDC)	Minimal degradation of served load, No precedents that will harm future earnings, Safety
Owner(s) / Equity Source(s) for Generation / Storage	Return on Investment, reliability of expected cash flow
Owner(s) / Equity Source(s) for Distribution Infrastructure	Return on Investment, reliability of expected cash flow
Owner of Right of Way	No disruption to core business, Highest possible additional non-traditional revenue source
Design/Build Firm	Design and Construction of Project with Profit
Engineer	Professional Fees, Admirable / Elegant Design
Construction Manager	Fee-markup-profit, build it, and move on to the next one….
Permitting Authorities	Meet regulations, clean, safe, etc.
Fuel Supplier	Large volume, long contract, attractive price for fuel going to generation assets
Equipment Vendors	Sell equipment they have at highest possible price (whether or not it is right for the project)
O&M Service Companies	Sell services at highest possible price under a long term contract
Various Lawyers	Protection of their client's interest to detriment of others, billable hours
Lenders	Safety of principal, risk mitigation, credit of borrower and customer taking projects output
Host Towns where Microgrid Assets are Located	Increased Power Reliability for their Critical Facilities, Safe, Clean and Minimal Intrusion
Townspeople and other Stakeholders	Environmental neutrality or improvement (noise, emissions, safety, traffic, etc)
Developer / Project Manager / Owner's Rep	Develop both the asset and its value by assuring the ongoing resolution of conflicts among participants, achieving critical task milestones on budget and on schedule

Figure 21 MMG Project Constituents & Objectives

During the development of a project, many issues that arise can fall into gray areas as to who is responsible and motivated for resolving them. More importantly, there is often a genuine conflict of interest among the parties involved in the development of a microgrid that can bring the project to a quick halt. Often this type of issue or conflict can occur between one or more of the parties involved in project development, neither of which may have the time, or are being paid to resolve them. When these issues go unresolved, stretch out in conflict or are neglected, it can stall or halt the development of the project altogether making whatever investment or effort that was done previously, worthless. Figure 22 illustrates the conflicts of interest that can occur among just three of the many stakeholders in a microgrid project.

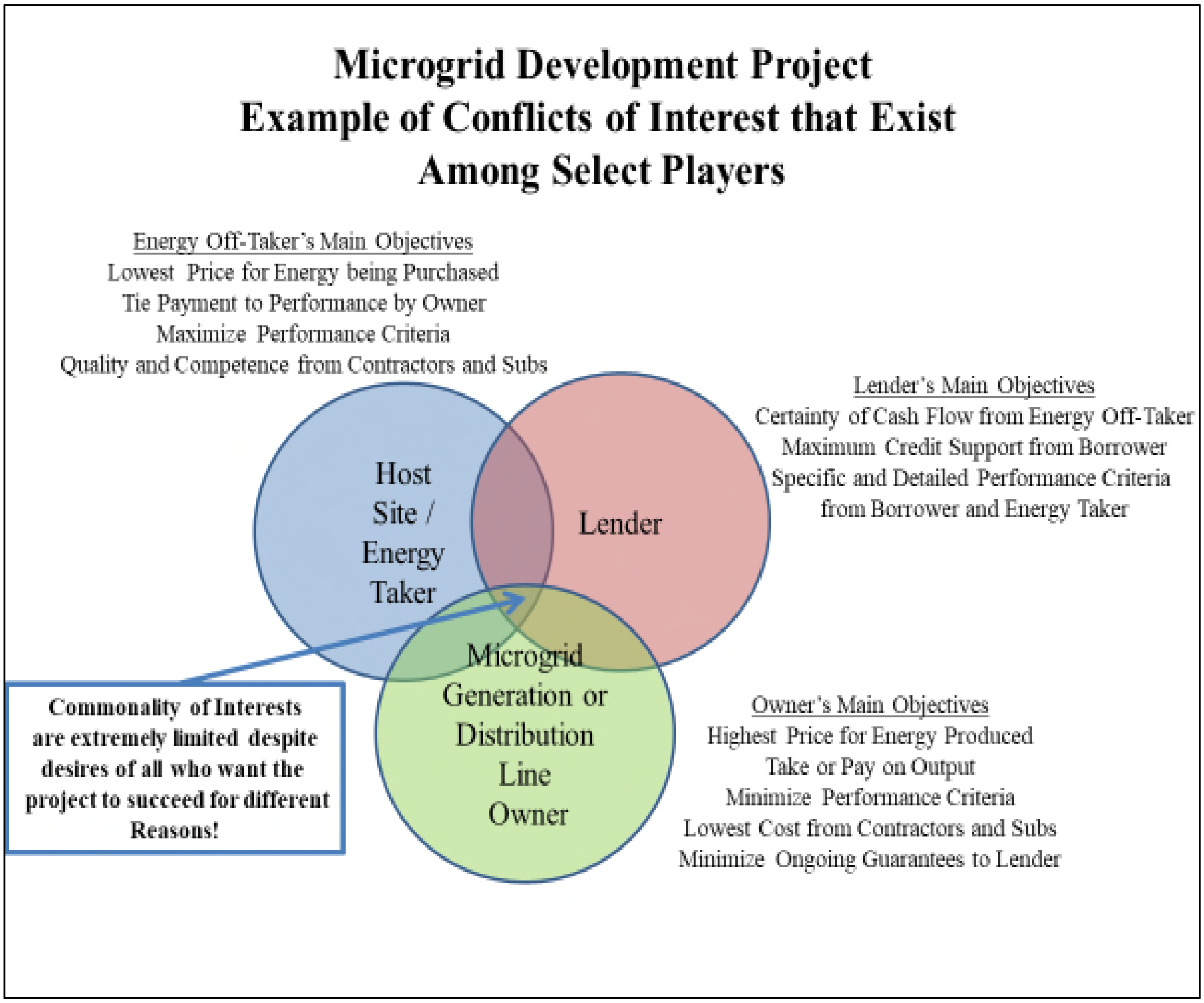


Figure 22 Potential Conflict Issues Diagram

In projects like a microgrid, the ones which eventually get built to correlate with the original project intent in terms of functionality, schedule, funder objectives, public policy goals and budget, inevitably have some party operating in the role of "developer", "owners rep" or "project manager". This role is much broader than that of a typical project manager who simply manages the construction or engineering portion of the project, or a lawyer who manages the contractual negotiations for any one of the parties involved in the transaction. Someone needs to be charged with the responsibility for being involved in all issues that evolve, assuring the resolution of critical tasks (planned and unplanned) and achieving project milestones.

This party can be generically referred to as the "developer". The developer must continually increase the value of the asset being developed. Figure 23 illustrates the role of the developer and draws an analogy to the real estate development process. It does not include all phases in our project but is useful in illustrating what a developer does and why he/she is important in projects such as this.

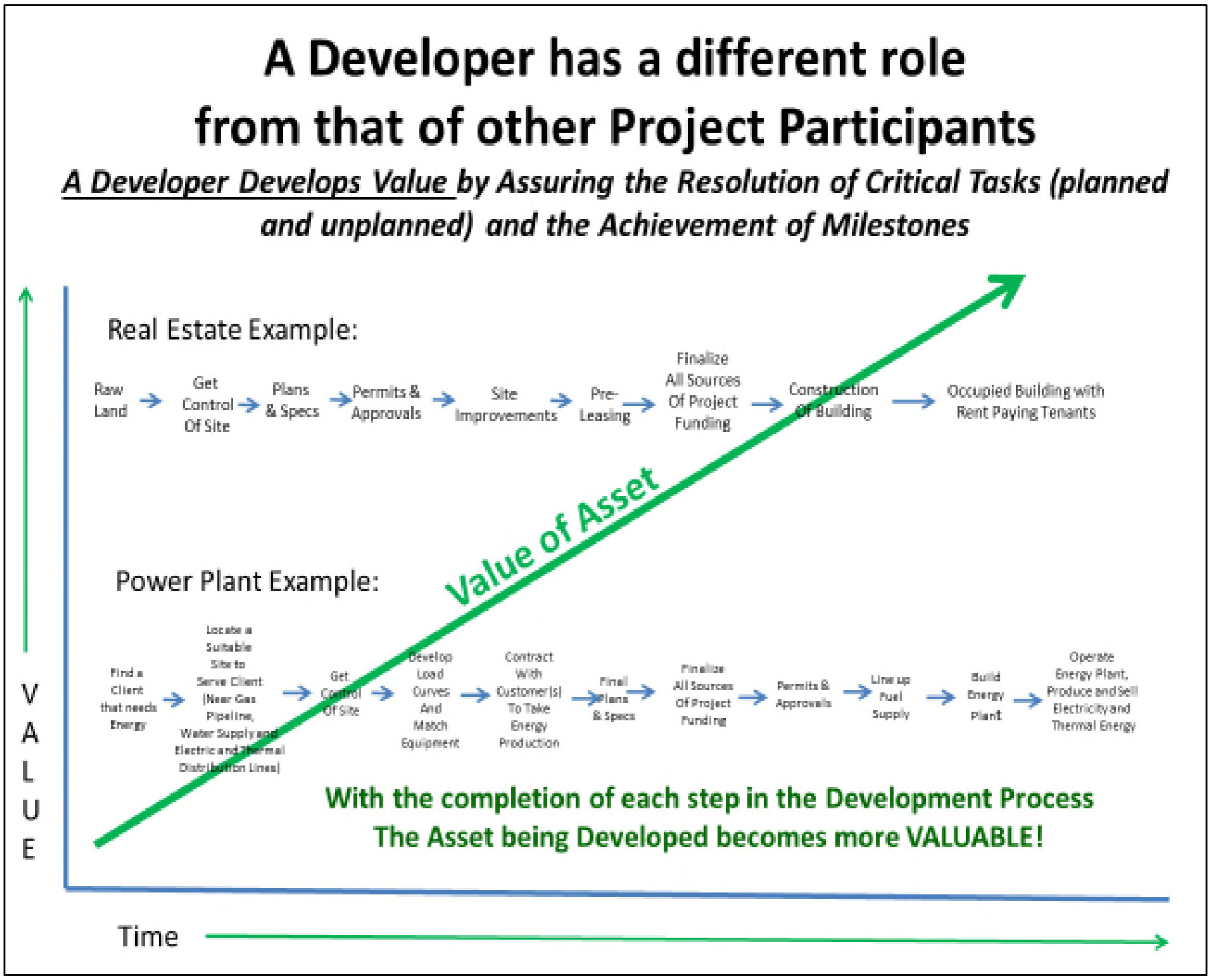


Figure 23 Developer Role

The developer should be capable of providing the technical expertise, business and contract acumen and project experience to ensure successful project outcomes. They must understand business and other objectives of all parties involved in the project and need to flexibly and continuously tailor strategy and tactics to meet expected project goals to keep the project on track.

The Developer functions as an extension of the project sponsor, host sites and investors through open collaboration and clear communication, tracking issues, facilitating solutions and delivering accurate and timely information throughout the lifecycle of the project. They should provide peace of mind to the sponsors, investors and host sites by allowing them to focus on their core functions while remaining confident that their interests are being protected.

Some of the routine functions performed by the developer would include:

Sourcing and Structuring Project Finance

- Coordination with BPU and or EDA on NJ State Incentive Programs
- Promotion of investment opportunity to the private sector for equity investment
- Working with investors to secure any needed non-public debt
- Ensure the use of all incentives, grants, low-interest loans, tax benefits, etc. in the financial structure for project funding
- Participate in the application for any funding and the negotiation of any terms and conditions

Engineering and Preconstruction

- Program development
- Developing a Project Team that covers all critical development functions and adequately represents all project stakeholders
- Sourcing and Qualifying potential Design/Build team including authorship of any RFI's, RFQ;s or RFP's used in the solicitation process
- Develop Design/Build Scope of the Project
- Publicize and Solicit bids for a Design/Build contractor
- Run pre-bid meetings and walk throughs, answer bidder/proposer questions
- Review bids and value engineer
- Provide recommendation for best fit

Construction Progress Oversight and Monitoring

- Contract negotiation and administration
- Observe construction work and monitor level of completion
- Interact and assure satisfaction of local distribution company (utility) and permitting authorities
- Assess general conformance with lenders and other funders understanding of the Design/Build contract
- Verify conformance with the provisions of the construction loan agreement
- Verify the adequacy of the contractor's application for payment
- Identify and determine the validity of construction changes and potential change orders
- Identify status of ordered equipment and materials and facilitate expediting when necessary
- Constantly assess conformance to the project schedule
- Verify and observe quality control measures and commissioning adequacy
- Assess adequacy of labor on site and address any potential work hinderances or stoppages

- Constantly evaluate the cash flow aspects of the project, i.e.: evaluate and assure the sufficiency of funds remaining to complete the project and provide recommendations as appropriate
- Confirm payment invoices and manage conditional and unconditional lien release

Most Importantly – Assume Responsibility for Solutions Management as Issues arise

- Address Project Issues, from all stakeholders, for any component of development (engineering, construction, conformance with funding requirements, securing all authorizations, contracts with various stakeholders, etc.) provide recommendations, and implement solutions.

If the Town Center Microgrid Pilot Program is to be successful in developing microgrid assets that address the Board's interest in resiliency, and the participant's interest in economy and functionality, the role of "developer" is critical. Costs for the development function should be budgeted in the soft costs of the project along with those representing legal, permitting and engineering costs and should normally represent from 2 – 3% of overall project costs.

2. Procurement Options

In the development of energy assets, funding is required to acquire the equipment and build the asset. Development, engineering, legal, permitting, financing and other soft costs will also need to be funded through any number of sources including grants from state or federal governments ro agents, investor equity, conventional lending sources and low-cost lending programs from state or federal agencies

The estimated probable cost for the development of the Montclair Microgrid Pilot Project is $16,449,467 including contingency and taxes which is broken out in Table 13.

Capital Item	Cost	% of Cost
Hospital CHP Infrastructure	$5,587,000	33.96%
Glenfield CHP Infrastructure	$388,500	2.36%
Solar PV Infrastructure at all Locations	$396,858	2.41%
Battery at Fire Headquarters	$114,900	0.70%
EV Charging Stations	$33,000	0.20%
Microgrid Distribution Infrastructure	$3,595,500	21.86%
Permitting, Fees, Bonds & Insurance	$500,000	3.04%
Engineering & CM	$2,005,000	12.19%

Development and Other Soft Costs	$905,000	5.50%
General Conditions & Mobilization	$450,000	2.74%
Contingency, Taxes	$2,473,709	15.04%
Total	$16,449,467	100.00%

Table 13: MMG Capital Cost Breakout

Construction of a microgrid is an expensive proposition when compared to traditional distributed generation, renewable generation or cogeneration. There are several reasons for this but much of the excess capital cost can be traced to the need to build a redundant power distribution system (the microgrid itself). Additionally, given the need for resiliency, these systems are generally built to provide enough power to service the critical peak load whenever that peak may occur. As a result, the capital costs for generation assets tend to be higher with a microgrid since capacity is some function of peak as opposed to base load. The cost of the microgrid's distribution system is an additional charge to the project cost which would not be present in traditional distributed generation, renewables or cogeneration.

At this time the Board of Public Utilities has not weighed in on whether they intend to offer any form of financial assistance to facilitate the development of these projects. None the less it will be assumed that there will be some financial assistance from the Board in the form of a grant for pilot projects which may be selected for construction. Assuming that grants will provide funding in an amount that is equal to other successful state programs, for discussion purposes we will use an assumed grant number that is in the range of 35% of overall project costs including existing clean energy incentives, IRS tax incentives and a new microgrid development grant. The balance of 65% must be raised from other sources, either investor equity, additional grants, conventional lending, or lending from a government agency or utility at below market rates.

Once a project is selected for the base grant (assumed to be 35% of project cost) a decision needs to be made as to who is to own the microgrid and associated generation assets. This party (or parties) could be one, or some combination of host sites or energy off-takers or a third-party investor.

2.1. Sources of Capital

The structuring of any project financing provides different levels of risk and return for the source of the debt or equity. When there is debt financing, the principal and interest due to the lender (debt source) have a preferred draw on available cash flow, what is left after the debt is serviced can be used as a dividend to the equity investors or can be retained in the project for future use or distribution.

The category of equity investor can often be further broken down or stratified into “preferred” or other forms of mezzanine financing that is distinguished by a higher priority on cash flow distributions from a base equity investor (but not as high as the primary lenders enjoy).

A project may end up having several levels of financing structure such as primary lender, mezzanine finance, preferred investor and straight equity investor. The equity investor should require the highest level of return, while the primary lender should require the lowest level of return since they get the first draw on cash flow and his risk is lower. Often structuring can be further complicated by offering convertible features (e.g. construction funding is convertible to permanent financing or even equity, or permanent loans are convertible to equity) at each point in time when funding is required. With debt funding, often there are two or more “tranches” of debt with differing draw schedules, coupon rates, terms, etc.

Many considerations go into deciding what level of return is suitable for a given project. Among the most important in evaluating the risk is the credit worthiness or long-term business prospects of the party who will be holding the energy purchase agreements (power and thermal energy customer) in the projects. An investor or lender wants to be certain the energy purchaser has the financial capability and expected life cycle to meet its obligations over the entire length of the contract. If not, owners and lenders may be faced with the expensive and time-consuming process of workouts which require them to either reposition the asset or locate another party to take the output at terms and conditions which may not be market based or as favorable as those in the original contract. One need only refer to the loan workouts many real estate lenders are currently undertaking under today’s suboptimal conditions, to understand how this possibility can severely impact the attractiveness of any project.

A project sponsor needs to take into account current market conditions in the financial market as it does its’ planning for project financing. Normally a debt to equity structure in the 70/30 (loan/equity) range is probably a good planning number. In markets favorable to borrowers this might increase to 80/20 and in conservative lending environments, this may decrease to 60/40. The amount of debt that can be borrowed is usually backed into using a minimum of a sustainable 1.5 coverage ratio (EBITDA / debt service) over the entire life of the project.

Fortunately, in the case of the Montclair Town Center Microgrid, the primary entities taking the energy from the project are the Township itself and the hospital which is owned by Hackensack / UMD. Given the relatively attractive risk profile of these entities, the cost of capital should be relatively low whomever the eventual owner of the microgrid is.

2.2. Third Party Asset Ownership and Contract Structures

Third Party Ownership and operation in these types of projects are very common and have been utilized successfully for years. The twin features of not having to front capital investment and having focused and professional management of the resulting utility systems have made Third Party Ownership a viable alternative for both public and private entities.

A Third Party Owner Operator ("TPOO") of energy assets, invests its own capital in designing, building, operating and maintaining an asset that is built to match the customer's (or host site) energy needs. Often times this structure is also called Build, Own, Operate and Maintain, or "BOOM".

A TPOO usually asks for a contractual commitment from the customers or host sites of 7-20 years whereby the customer would agree to take the energy output from the asset at a specified price. For a microgrid project a contract term of 15 to 20 years would be appropriate since it allows the TPOO to recover the cost of capital they have invested in the plant without making the resulting energy cost too unattractive to the customer (the longer the contract term, the less capital the TPOO needs to recover through its annual fees over the term of the contract).

The TPOO usually has to offer guarantees on several items to make the proposition attractive to customers and lenders. Among these guarantees are:

- Guarantees on construction cost
- Guarantees on building schedule
- Guarantees on plant availability (how many hours a year it will be producing energy);
- Guarantees on performance (parameters such as required fuel input or heat rate, required supplementary operating expenses, required energy output)
- Possibly guarantees on savings in energy costs versus other alternatives

Usually fuel cost is a pass through to the customer but a TPOO will take direction from the customer on where, when and at what price, they will be making fuel supply contract obligations.

The site for the asset is usually given or leased for a nominal amount to the TPOO by the customer.

The TPOO is responsible for design, permitting, engineering and construction to the customer's specifications. The TPOO owns, operates and maintains the asset (although sometimes the customer wants to use their existing workforce to operate it and this can often result in economies of scale which benefit both the TPOO and customer).

The customer usually makes provision for the supply of things like water and effluent discharge if they are required by the asset owned by the TPOO.

The document that governs the business relationship between the host site (e.g.: Mountainside Hospital or Glenfield School) and the Third Party Owner, is the Energy Supply Agreement. Minimum and maximum capacity for the converted energy (electric and thermal energy) are specified in the agreement (meaning the TPOO is responsible for providing a minimum amount of energy from the asset and there is also a cap on what the asset is contractually required to produce).

2.3. Third Party Ownership – Guidelines for Risk Assessment and Return Criteria

If the project sponsor is eventually considering a Third Party Owner (TPO) to design, build, own, operate, supply fuel and maintain the project, it needs to carefully evaluate who is going to fulfill this role. The sponsor should depend upon the Third Party Owner to add value in the form of their expertise and ideally, financial stability, which should take much of the risk out of the project. The following discussion identifies the risks associated with a Third Party Ownership (or Build, Own, Operate, Maintain) energy agreement and suggests ways in which a TPO will try to mitigate those risks.

Capital Costs – In a typical TPO project, the energy service agreement provides for the owner of the project to recover their capital investment through a long-term service fee. Typically, this fee would be negotiated in advance of construction and would be determined by the owner to provide the required return on its equity investment. On a risk-free basis (meaning the construction costs are known or there is an adjustment factor in the service fee price) it might be reasonable to expect a 10% return on invested capital after taxes. Any un-certainty in the costs to engineer, procure and construct (EPC) not mitigated by contingency, needs to be reflected in a higher return.

Construction Schedule – The risks associated with construction schedule are related to, but different than the capital cost risk. With regard to construction schedule risk, there are three components to consider. The first is interest during construction which is the interest being paid to the construction lender or equity investor during the construction period. This should be assessed and priced in the same manner as capital cost risks. The second risk is the impact of the construction schedule on the commercial operation date. That is to say if the project is supposed to be completed and running by July 1st and it doesn't get finished until January 1st, there are six months more of construction costs like interest during construction, and six months less of revenues from project output. If the construction schedule is not guaranteed by others, a TPO will assess the longest reasonable schedule anticipated, calculate the potential NPV impact on earnings, and include it in addition to capital when determining the service fee. The other risk is for damages from the client for late completion. Mitigation here requires indemnification for force majeure events as well as pass-through guarantees from subcontractors and suppliers.

Fixed Operating Costs – Fixed operating costs are those that are independent of the amount of energy generated and typically include operating labor, insurance, fees, assessments and/or property taxes and scheduled maintenance These costs can be estimated with a reasonable degree of accuracy for the first year of operation and with appropriate escalation factors chosen to protect the future returns, can provide a strong degree of risk mitigation to the TPO. Some of these costs which are less predictable (e.g. property tax, insurance) should be handled as a pass-through for pricing. The actual fixed operating cost a TPO includes in its pricing proposal will include a fee portion at least equal to the level of uncertainly in the estimated fixed operating cost.

Variable Operating Costs – Fuel is the most significant variable cost but others include things like water, chemicals, and variable maintenance. This could also include equipment replacement. With regard to fuel the TPO will price his variable energy component to be indifferent to fuel price. This can be done by care-fully selecting the index or escalation factors to track his fuel costs. Alternatively, fuel can be priced as a pass-through with the TPO taking conversion efficiency risk (attained heat rate) but the customer taking price risk. This can be extended to other consumables as well.

Plant Utilization Factor – Assuming the TPO can negotiate a contract with a fixed service fee that provides for his required return on equity, and a variable cost component that accurately reflects his true cost of operating the asset, the TPO is generally indifferent to the plant utilization factor. This assumes he is operating within the design range of the plant i.e. if a CHP plant is built which is 1 MW in capacity, it should be running it at between 800 kW and 1.0 MW. If the energy demand from the customer is far below the design conditions, the plant's conversion efficiency is adversely affected (heat rates rise as capacity utilization drops). This can be mitigated with contract language which provides for an adjustment to the fuel factor if the part load operation is significant enough to affect efficiency. Genset manufacturers can provide accurate estimates as to what their expected heat rate is at various turn down rates. Plant utilization is usually a customer's risk since it is within his control. However, if the TPO is required to accept plant utilization risk, the TPO will look to build minimum take requirements and lower efficiency guarantee factors into the Energy Supply Agreement to protect its return. The CHP plants proposed as part of the MMG are expected to have an annual load factor of 90% and 85% for the hospital and school respectively.

Plant Performance – In most TPO arrangements the owner would guarantee energy supply at a certain quality level, reflecting output, conditions and flow rates, as well as plant availability and efficiency. The TPO would also be expected to continuously meet permit and other regulatory requirements. To mitigate TPO's risk here, the forecast numbers they use for performance will be some percentage (e.g. 5%) more conservative than guaranteed. That would provide sufficient margin for performance deficiency as well as an up-side if they perform at the expected levels.

2.4. Construction Structures

Whether the sponsor elects to self-finance or use Third Party Ownership financing structures, it will still need to make a decision on how to deliver the project's construction. For a successful project, it is important for the owner and host sites, to select the right project delivery system. There are a wide-range of construction project delivery systems. Among the systems that are widely used in construction projects are: The Design-Build System; The Design-Bid-Build System; Construction Manager at Risk; Construction Manager-Program Manager, and; Early Contractor Involvement (ECI) with Target Pricing.

We believe that the most appropriate construction systems for the Montclair Microgrid to consider, given its complexity are probably the Design-Build, Design-Bid-Build or the Early Contractor Involvement systems. Each has their advantages and drawbacks which are discussed in more detail below.

2.4.1. Design-Build

In the Design/Build system the owner enters into a contract with a single entity that will assume the obligation of furnishing design, supervision and construction services during the project. It provides a single point of responsibility for design and construction. It has the advantage of taking the owner out of disputes between the contractor and design professionals.

Using this approach, the selection of the contractor is based upon qualifications, experience and team. The owner also gets the benefits of the contractor's experience in the design phase.

Design-Build has the disadvantage of eliminating the checks and balances which occur when the design and construction phase are contracted separately. The owner also loses significant control that he would have under the design-bid-build or ECI systems. The owner may also lose a portion of the direct advisory relationship with the design team that it has in the design-bid-build or ECI systems.

Generally, the speed to construction completion is faster with the design-build approach when compared to the design-bid-build, but slower when compared to the ECI system. It is also difficult for the owner to determine whether the best price has been achieved for the work they are getting done. The initial costs in Design-Build are usually higher than a Design-Bid-Build due to increased contractor risk, reduced competition in pricing of contractor overhead, fee and sub-contract costs. Changes may be difficult and expensive to make once construction begins, due to phased construction and cost driven, inflexible budgets. The over emphasis on price may compromise quality.

2.4.2. Design-Bid-Build

The Design-Bid-Build system is an approach that is widely used in both public and private construction. Under this system, the owner contracts separately for the design and construction of the project. The owner contracts directly with a design team for preparation of plans and specifications and assistance in the bidding stage. The design team may also provide oversight during the construction phase. The owner also enters into a separate contract with a General Contractor for the construction of the project. Under the design-bid-build delivery system, the owner retains responsibility for overall project management. The design of the project is complete before the contractor is selected and the contractor is selected through a competitive bid process with the assistance of design professionals.

The Design-Bid-Build approach provides checks and balances between the design and construction phase of the project. It is widely used and familiar to construction participants, and it is perceived to be a fair process in which the lowest most responsible contractor is selected for construction of the project.

The owner is able to provide significant input into the process during the design phase. With competent bidders on construction, the owner can normally rely upon the accuracy of the prices submitted and can make comparisons to obtain the best price.

Among the disadvantages of the Design-Bid-Build process is that it is a lengthy process, places the owner in the middle of disputes between the design team and contractor, the cost of construction is unknown until bids are final and it increases the occasion for change orders. The system requires the owner to complete the design before bidding for the project and because of this, often the bid construction costs exceed the owner's original budget which can result in project abandonment or redesign, further lengthening the development process.

2.4.3. Early Contractor Involvement (ECI) with Targeted Pricing

ECI is a hybrid design-build project delivery method involving qualifications-based design-builder selection and an open book target pricing system. With this system, the owner uses a qualification-based approach to select a contractor early in the project development process, when the owner only has conceptual plans and a desired or approved budget price. Once the contractor is selected, additional design and planning is performed with the input of the entire development team to establish a target price for the project.

Various mechanisms are incorporated throughout the design and construction process for the contractor to share in savings, and participate in any losses, realized when actual costs are compared to the target price.

The owner compensates the contractor for actual costs, based on open-book accounts and records, plus a fee. An incentive structure is also established to motivate the contractor to design and construct the project within budget.

The incentives involved in an ECI contract usually take the form of the following:

Design Bonus- If the contractor designs the project within the project budget (as indicated by comparing the forecast total project cost to the project budget) the contractor is paid a design bonus. If the forecast costs are greater than the project budget, the contractor does not receive a bonus, but also doesn't suffer any reduction in payment. If the owner proceeds with the project, the contractor still has the opportunity to earn incentives during the construction phase of the project.

Construction Bonus – During construction, the contractor is paid actual construction cost plus a fee. If at the end, the total of actual costs plus the contractors fee is less than the estimated cost (the initial target price adjusted for any compensation paid out during the design and construction) the contractor is paid a share of the savings using a formula set out in the contract. Similarly, the contractor would pay a share of any cost overruns.

Final Bonus – At the completion of the project, the owner will calculate a final bonus based on a comparison of contract budget to the total project expenditures they have incurred (including bonuses paid to the contractor and estimates of future costs not yet incurred). If the total expenditure is less than the contract budget, the contractor is paid a bonus percentage of the savings achieved on the contract budget. If the contract budget is exceeded, no final bonus is payable to the contractor however, the contractor does not share in any additional cost overruns other than what they may have already incurred in the construction cost share.

ECI has been used extensively and successfully in road and bridge construction projects. It has several advantages over design-build in a project such as a microgrid project. It allows the contractor's expertise to be introduced earlier in the development process. The bonus structure provides an incentive for the contractor to control costs and work within the target price established in the budget. Open book target pricing requires the contractor to operate in an open and collaborative way. The potential for overlapping design and construction phases may allow for faster project delivery. It also facilitates better communication between the contractor and the owner.

Disadvantages are that the absence of direct price competition may lead to overly conservative and easily achievable performance targets. The open book approach and risk sharing may deter potential bidders for the construction job and there are usually increased procurement costs.

2.5. Most Probable Project Delivery System - Design/Build

It is anticipated that the microgrid initiative will use the Design/Build process for the construction of the project. Due to the project's scope, specialization and complexity, the project sponsors will engage outside consultants as needed to provide the necessary procurement, design and construction oversight and commissioning support needed to deliver the project on time and within budget. All major steps in the process will be done in coordination with the Board of Public Utilities and their affiliates in order to comply with any grant/loan program requirements.

Program Definition – The project requirements will have been substantially established in terms of project size, performance requirements, quality standards for equipment and construction methods, regulatory requirements, requirements of funders, etc. This material will be incorporated initially into an RFQ and ultimately into an RFP for qualified design/build firms.

Pre-Qualification of Bidders – Based on the experience of staff and its consultants, an RFQ will be issued to parties who have experience in the design/build process for boiler house or similar facility construction including experience with power generation using rotating machinery and distribution of electricity from facility to facility. The RFP will include project design criteria, site information, contract requirements, selection criteria and proposal submittal requirements and will be provided to the BPU for approval prior to release. A review team consisting of sponsor construction project management representatives will receive and review qualification statements in response to the RFQ and will short list from 4 to 6 firms for receipt of an RFP.

Request for Proposals – The review team will solicit firm price cost proposals from the short-listed design-build firms or their teams in an RFP.

Pre-Bid Conference – A pre-bid conference will be held at a facility on the microgrid site early in the proposal preparation period to inform potential bidders of the project scope, BPU and any other pertinent terms and conditions including reporting and labor requirements will be presented and potential bidders will have the opportunity to ask questions, review the site and to request clarifications.

Proposal Submission and Evaluation – Once received, the review team will evaluate proposal on the basis of quality of response, bidding team qualifications, price and other predetermined factors (with a goal of selecting the proposal with the best value). Proposers may be requested to make in-person presentation to the sponsor, its consultants and BPU program manager(s) after which a proposer will be selected as the presumptive design-build firm.

Contract Award – The selected design-build firm will enter into a contract(s) with the appropriate authorities which will reflect the requirements and objectives of facility participants, funding sources, program objectives and regulatory authorities.

Documents / Construction – The selected design-build firm will complete design documents and initiate and resolve all permitting issues for the project. Upon completion and approval by the sponsors, construction will commence and equipment procurement will be finalized.

Commissioning and Turnover – A commissioning agent will have been selected and engaged prior to, or early in the construction period. The commissioning agent will be responsible for making sure that the project is built according to specifications, that operators and maintenance parties are trained on the ongoing operations and maintenance of the systems, that all system documentation, warranties, manuals are in hand and complete, that all components of the system have been tested under normal operating conditions and meet expectations, and that any requirements of third parties such as the local electric distributing company, permitting authorities, etc., have been satisfied. At that point the project will be turned over to sponsors for ongoing operation and maintenance.

3. **Construction Considerations**

3.1. Permitting

The project as contemplated includes the construction of new distributed generation in the form of natural gas fueled cogeneration at the hospital and the middle school using traditional reciprocating engines. Additional distributed generation in the form of solar photovoltaic panels are planned for Fire Headquarters, the Parking Deck, Glenfield Middle School and Pine Ridge. Battery storage will also be included at Fire Headquarters. A low voltage electric distribution line will run along the NJ Transit catenary from an area directly adjacent to the Pump House, under Bloomfield Avenue, pass Fire Headquarters, the Bay Street Rail Station and Parking Garage and Pine Ridge, continuing along the rail line to the northwest corner of the lot which is the site of the Mountainside Hospital parking deck. At that point the line will continue underground along the back of the parking deck lot to the southwest corner of the parking deck where it will turn east, proceed underground across Highland Avenue continuing underground to the adjacent Mountainside Hospital property where it will eventually enter the existing room which houses the current PSE&G service entrance that connects with existing hospital switchgear.

3.1.1. Local Permitting – Montclair

Cogeneration Units - The cogeneration units at Mountainside Hospital and Glenfield Middle School will both be housed inside the existing buildings. In the case of the hospital, the cogeneration unit will be housed at the eastern most portion of the main hospital lot in an area that previously served as a laundry facility. This area is adjacent to the existing boiler house and an exterior loading dock which provides good accessibility for equipment and service. For the middle school, the cogeneration unit will be located in the existing boiler room which has sufficient space to allow for installation of the proposed package.

Current Montclair codes do not require any additional permitting requirements or local approvals if the new facilities are internal to an existing building. Normal building permits that are customary with any construction or renovation project need to be applied for and the work will be subject to existing construction codes and standards administered by Montclair code enforcement officials including buildings and fire.

Solar Photo Voltaic Installations – Solar panels are to be installed at Fire Headquarters, Glenfield Middle School and Pine Ridge. In the case of all facilities the PV panels will be installed on the roofs of the facilities. As the solar installations will be on the exterior of the buildings, the capital project sponsors will need to go before the Montclair Planning Board for approval to make sure it is safely designed, blends in with the area, is not unsightly and is consistent with the overall Township's Master Plan.

Battery Installation – The battery installation proposed as a component of the microgrid will be located at Fire Headquarters and will be utilized in conjunction with the solar PV installation at that location. The battery installation will be located within the existing Fire Headquarters structure and as with the cogeneration units, current Montclair codes do not require additional permitting requirements or local approvals if the new facilities are internal to existing buildings. Normal building permits that are customary with any construction or renovation project need to be applied for and the work will be subject to existing construction codes and standards administered by code enforcement officials.

Electric Distribution Wires – From the Hospital Parking Deck, the power and cable connection to the main Hospital service requires crossing of Highland Avenue which will be required to be approved by local planning and transportation authorities.

3.1.2. Local Permitting – Glen Ridge

Cogeneration Unit - Mountainside Hospital is partially located in Glen Ridge so the same local permitting concerns of Montclair will be present with Glen Ridge Borough. The cogeneration units at Mountainside Hospital will be housed inside the existing building. The cogeneration unit at the hospital will be housed at the eastern most portion of the main hospital lot in an area that previously served as a laundry facility. This area is adjacent to the existing boiler house and an exterior loading dock.

Current Glen Ridge codes do not require any additional permitting requirements or local approvals if the new facilities are internal to an existing building. Normal building permits that are customary with any construction or renovation project need to be applied for and the work will be subject to existing construction codes and standards administered by Glen Ridge code enforcement officials.

Electric Distribution Wires – There is a small section of property that lies within the Borough of Glen Ridge which will need to be excavated for the installation of the distribution wires that are not part of the NJ Transit catenary. This area is at the back of the hospital parking deck that is adjacent to the NJ Transit right-of-way. At that point the distribution wiring will leave NJ Transit property and enter Mountainside property where it will be buried underground and routed along the back of the parking deck to its southern corner at which point it will turn east and continue under Highland Avenue to the eastern side of the main hospital property where it will run underground parallel to Laurel Place on hospital property until it enters the existing PSE&G service entrance and hospital switchgear room.

3.1.3. Air Emission Permitting

Mountainside Hospital – Mountainside Hospital currently operates a substantial boiler plant under a General permit authorized by the State of New Jersey's Department of Environmental Protection – Bureau of Stationary Sources. The Bureau of Stationary Sources is responsible for permitting stationary sources of air pollution – both old sources (those already constructed) and newer facilities. It operates to ensure that these sources of air pollution do not adversely affect air quality anywhere in the state. To accomplish this, the staff of the Bureau reviews air pollution control permit applications and evaluates air quality impact and health risks.

The General Permit is a pre-approved permit and certificate which applies to a specific class of significant emission sources. By issuing a General Permit, the Department of Environmental Protection (DEP) indicates that it approves the activities authorized by the General Permit, provided that the owner or operator of the source, registers with the DEP and meets requirement stated in the General Permit. If a source belongs to a class of sources which qualify for a General Permit and the owner or operator of the source registers for the General Permit, the registration satisfies the NJ requirements for a permit and certificate.

When a facility is operating under a General Permit but intends to add equipment such as the cogeneration plant contemplated here, the facility must report the possible change in emissions resulting from that new equipment to the DEP to determine if it still qualifies to operate under the General Permit or if additional emissions are such that it is moved to a "major source" category which requires a different permit identified as Title V. It is not anticipated that the emissions from the cogeneration plant will bump Mountainside Hospital up to Title V.

Once the project is approved, the developer will utilize the DEP's one stop permitting process to advise the DEP of the planned construction at the hospital and the anticipated net air emissions resulting from it. Given that the hospital is not currently classified as a major source, General Operating Permit (GOP-006) for Combined Heat and Power Stationary Spark Ignition

Reciprocating Engine(s) less than or equal to 65 MMBTU per hour will be adequate to account for the additional emissions. The hospital's General Permit will be updated and re-registered reflecting the new sources at the hospital. If it is determined that after adding CHP, the hospital will need to be upgraded to a major source requiring a Title V permit, the developer/hospital has twelve months after a new General Permit is approved, to submit an administratively complete Title V application. Until such time as it has been approved, the entire hospital facility including the cogeneration plant may continue to operate under the General Permit until the Title V operating permit is approved.

Glenfield Middle School –The proposed CHP unit at Glenfield is the Tecogen InVerde e+ 125 kW system. This unit was chosen because it meets the most stringent air emission requirements within the United States including those of California's South Coast Air Quality Management District and the New Jersey Department of Environmental Protection. The Tecogen InVerde unit includes an emissions control system that is air permit exempt in both California and New Jersey. The unit produces NOx/CO emissions levels that are lower than NJ DEP requirements as follows:

NOx < 0.07 lbs./MWh
CO < 0.2 lbs./MWh
VOC < 0.1 lbs./MWh

The contemporaneous permit exemption status for the Tecogen unit or its equivalent will be confirmed prior to procurement of equipment and will comply with any and all requirements that may be required for validation of the exemption. If permitting is determined to be required, a similar process as described in the hospital permitting section above will be followed.

3.1.4. NJ Transit Permitting and Approvals

The proposed microgrid layout is based on utilizing the NJ Transit catenary system to run the main microgrid power and communication cables from the Hospital Parking Deck to Glenfield School. This will require authorization and approval from NJ Transit.

Montclair's consultants have had extensive discussions with representatives and management of NJ Transit's energy, real estate, construction and engineering departments during the development of this proposal to confirm their willingness in offering their right-of-way as an alternative for the microgrid's power distribution backbone. NJ Transit has provided their regulations as specified in New Jersey Statutes Annotated (NJSA) chapter 27 dealing with Use or Occupancy of NJ Transit-owned property. Specifically, Paragraph 16:77 sections 1.1 to 1.8 prescribe the permit application procedure, criteria, requirements, conditions and fees that are required for authorization to use NJ Transit owned property including right-of-way(s). This document was the basis for subsequent budgetary discussions with the NJ Transit and became the catalyst for an assessment on the validity of using the base case rail right-of-way distribution alternative included in this proposal.

NJ Transit is a supporting member of the Montclair Microgrid project and based upon the initial review, the proposal to utilize the catenary system is acceptable and has precedent. Technical and contractual approval are required by NJ Transit including review and use fees which are incorporated in this study.

3.1.5. Utility Permits/Agreements

The proposed microgrid incorporates multiple distributed energy generation resources which will require technical approval and an interconnection agreement with PSE&G. The reconfiguration of the existing Mountainside Hospital incoming switchgear and connection of the microgrid cable and generation resources will require review and approval from PSE&G. New or upgrade of existing natural gas services to Mountainside Hospital and Glenfield School will be required to facilitate the connection of the proposed CHP plants.

Montclair's consultants have had multiple conferences and exchange of documents and designs with management and engineers from PSE&G's Distributed Generation team specifically to assess and understand the requirements for interconnecting the microgrid at a single point within the hospital's existing service entrance in order to comply with their safety, operating and maintenance requirements. These discussions together with past experience in utility interconnection requirements have resulted in the proposed design including replacement of the current hospital switchgear lineup. As the project progresses, PSE&G approvals will be contingent upon a formal engineering study which will validate the conditions and requirements that have been included in Montclair's proposal.

3.1.6. Department of Community Affairs

As the proposed Mountainside Hospital CHP system will not impact patient services and is external to healthcare services, it is anticipated that NJ Department of Community Affairs plan check review will not be required for the proposed project. This is in line with precedent for the NJ EDA's Energy Resilience Bank program which is installing similar CHP projects, and which are exempt from DCA review.

4. Project Schedule

It is anticipated that the Montclair Microgrid can be built and operating over a period of thirty-one months from the time of approval to move forward with the project. The calendar schedule provided assumes immediate authorization to move forward and does not incorporate time required to overcome any regulatory hurdles as it is not feasible to predict the schedule for such actions at this point. Figure 24 provides a Gantt Chart of the proposed microgrid project and Appendix 16 provides a larger format of the schedule.

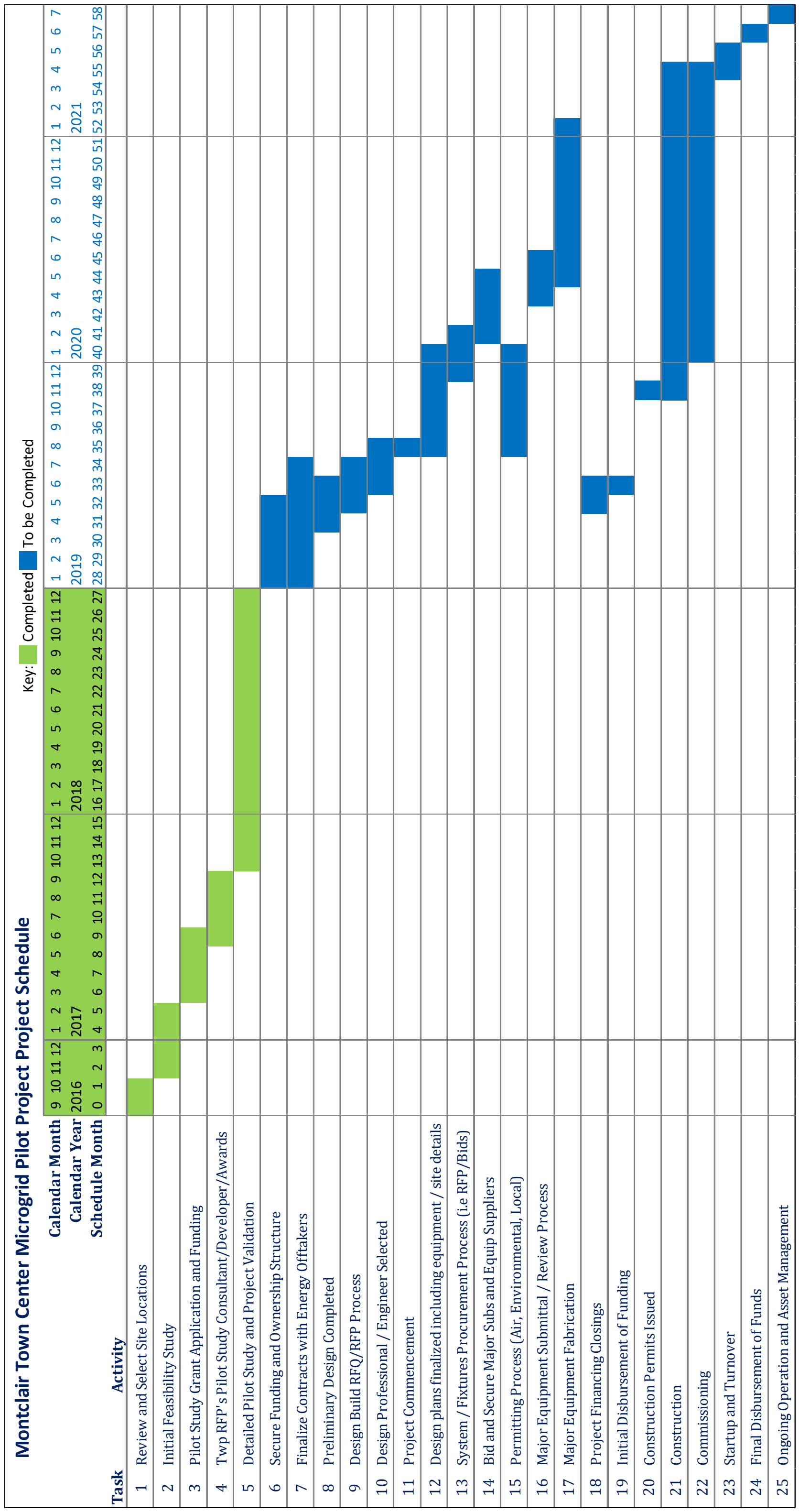


Figure 24 MMG Project Schedule

Section IX: Regulatory Analysis

The legality of development and operation of a microgrid is dependent on the state in which the microgrid is to reside and the specific legal and requirements in that state. For example, local and state regulations may require that the microgrid's owners or operators be the primary consumer of electricity the system produces. They may require that the plant be physically located or contiguous to the site where power is generated, or it may be limited in the number of off-takers it services.

In New Jersey "Public utility" or "utility" means an individual, co-partnership, association, corporation or joint stock company, their lessees, trustees or receivers appointed by any court whatsoever, their successors, heirs or assigns, that now or hereafter may own, operate, manage or control within this State any pipeline, gas, electricity distribution, water, oil, sewer, solid waste collection, solid waste disposal, telephone or telegraph system, plant or equipment for public use, under privileges granted or hereafter to be granted by this State or by any political subdivision thereof. This term shall include pipeline utilities as defined in N.J.S.A. 48:10-3, and municipally-operated utilities, insofar as the Board's jurisdiction is extended to them under the appropriate statutes.

Classification as a Public Utility - A risk that can potentially affect microgrid development is the potential for it to be regulated as a public utility by the BPU. If considered to be a public utility under existing state law, the Montclair microgrid would face significant barriers to implementation. Public utilities have their rates established by BPU. They also give the BPU significant control and oversight on financial operations, plant construction and other strategic initiatives. Utilities often have to comply with reliability standards and consumer protection laws which can be costly for an operation that deals only with a limited number of customers.

Franchise Rights – Utility and regulatory limitations may impair the functional access of a microgrid's ability to serve nearby buildings if power supply lines cross a street or public right of way. Microgrids that cross a public right of way with their transmission or distribution lines may trigger regulatory requirements under state and local law related to franchise rights. A microgrid that distributes power across a public street may violate the franchise rights granted to the incumbent utility. A franchise represents a contract between a utility and a local municipality (as in the case of cable service) or a state (as in the case of electric distribution). They are granted for specific geographic areas and remain in place for a specified period of time.

It is incumbent upon the developers of a microgrid, the franchise utility and the state to arrive at an understanding as to whether the planned microgrid would be in violation of local franchise law or existing agreements.

Montclair Microgrid's approach to Regulatory Issues - Despite these legacy regulations, in the interest of more timely facilitation of the development process, the MMG team have come up with a unique approach to building the proposed microgrid which may reduce concerns related to franchise rights and public utility classification by using the existing New Jersey Transit right of way to connect the various entities on the microgrid. While the NJT rail line crosses Bloomfield

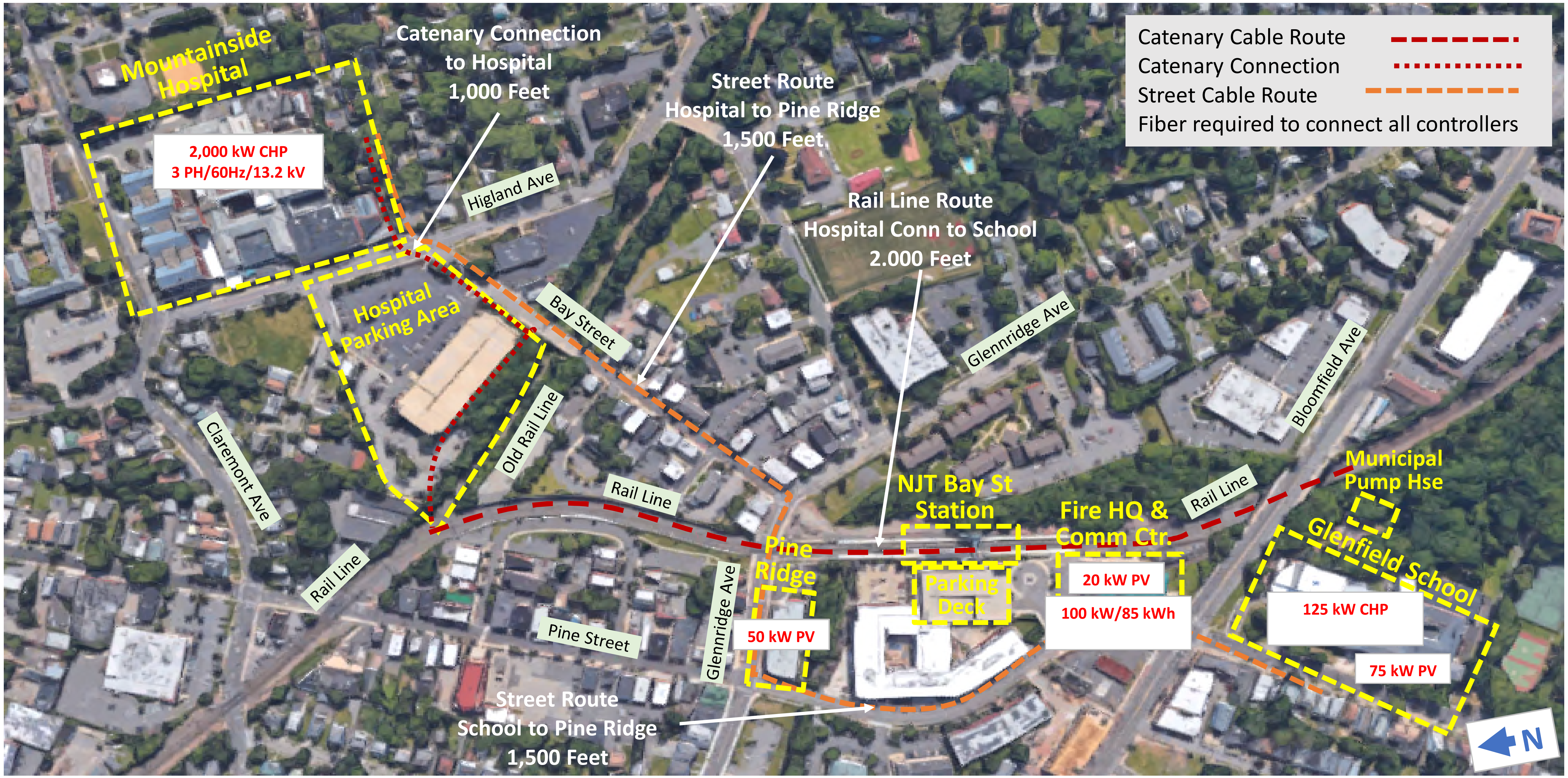
Avenue and Glenridge Avenue, the only street that is crossed by the microgrid that will service all seven facilities on the microgrid is Highland Avenue in Glen Ridge which bisects Mountainside Hospital facilities (the main hospital buildings and the hospital parking deck). The microgrid distribution system crosses Highland Avenue in order to connect the main hospital with the rest of the grid. All other facilities on the microgrid are accessible directly from the NJ Transit rail right of way, without having to cross any public streets.

Current BPU regulations disallow net-metering for PV systems when a CHP plant is also connected to the bus. In the case of the MMG, there are multiple PV and CHP systems on the microgrid bus. While this is not seen as a limiting factor for the proposed microgrid, it does serve to restrict the addition of more solar PV or other renewable resources in any future expansion of the microgrid.

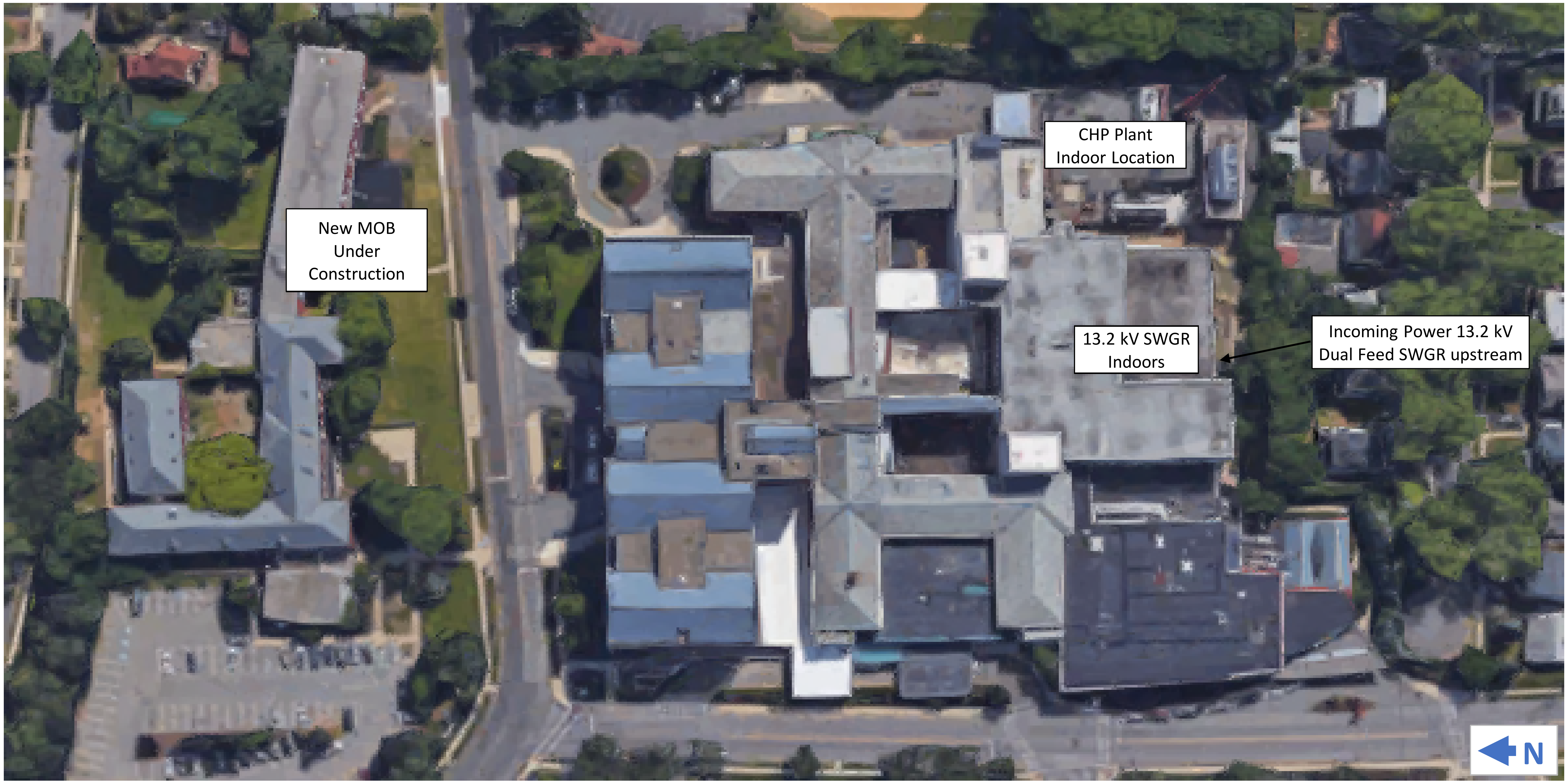
Section X: Appendices

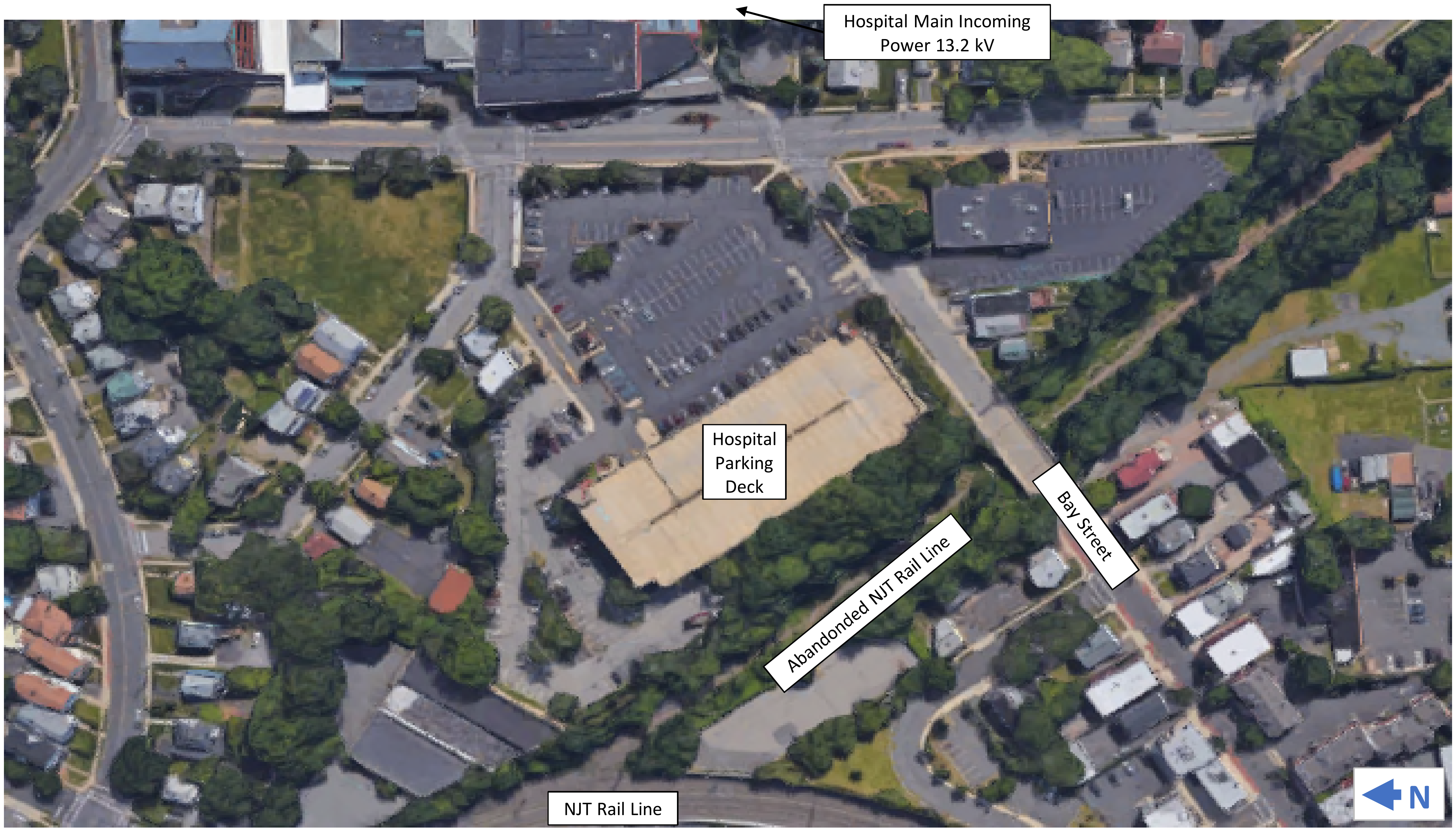
1. Microgrid Layout
2. Microgrid Single Line Diagram
3. FEMA Risk Categories
4. Letters of Support
5. 2 MW CHP Engine-Generator Technical Data
6. 125 kW CHP Engine-Generator Technical Data
7. Solar PV Layouts
8. PV Technical Data & PV Watts Analysis
9. BESS Technical Data
10. EV Charging Station Technical Data
11. Microgrid Controller & Switch Technical Data
12. Microgrid Controller System Architecture
13. EPA 2 MW CHP Analysis Results
14. MMG Capital Cost Breakout
15. MMG Financial Analysis
16. Project Schedule

Appendix 1

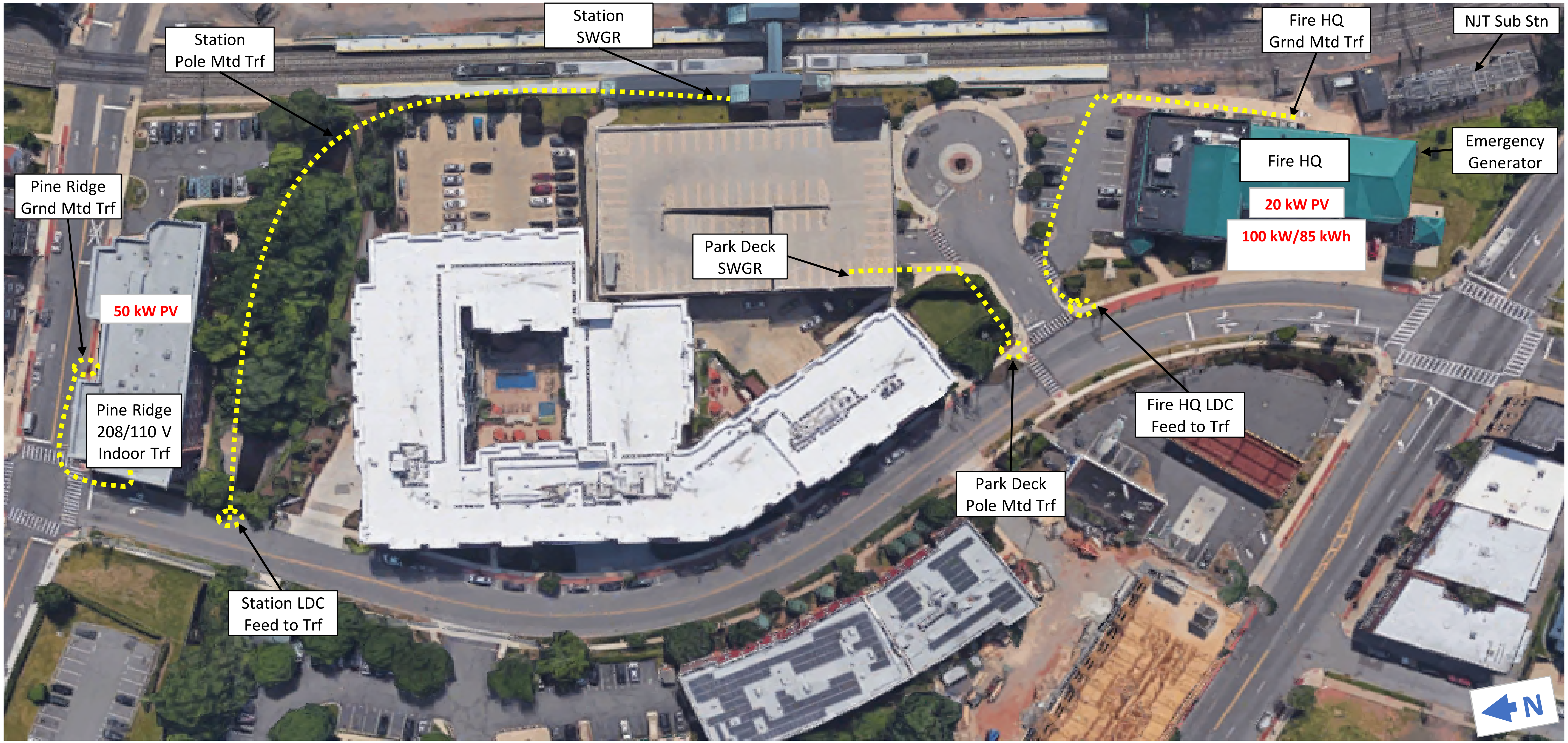


Catenary Cable Route
Catenary Connection
Street Cable Route
Fiber required to connect all controllers
Mountainside Hospital
2,000 kW CHP
3 PH/60Hz/13.2 kV
Catenary Connection to Hospital 1,000 Feet
Street Route Hospital to Pine Ridge 1,500 Feet
Rail Line Route Hospital Conn to School 2.000 Feet
Higland Ave
Hospital Parking Area
Bay Street
Glennridge Ave
Bloomfield Ave
Claremont Ave
Old Rail Line
Rail Line
Municipal Pump Hse
NJT Bay St Station
Fire HQ & Comm Ctr.
Glenfield School
Pine Ridge
Parking Deck
20 kW PV
100 kW/85 kWh
125 kW CHP
75 kW PV
50 kW PV
Rail Line
Pine Street
Glennridge Ave
Street Route School to Pine Ridge 1,500 Feet
N

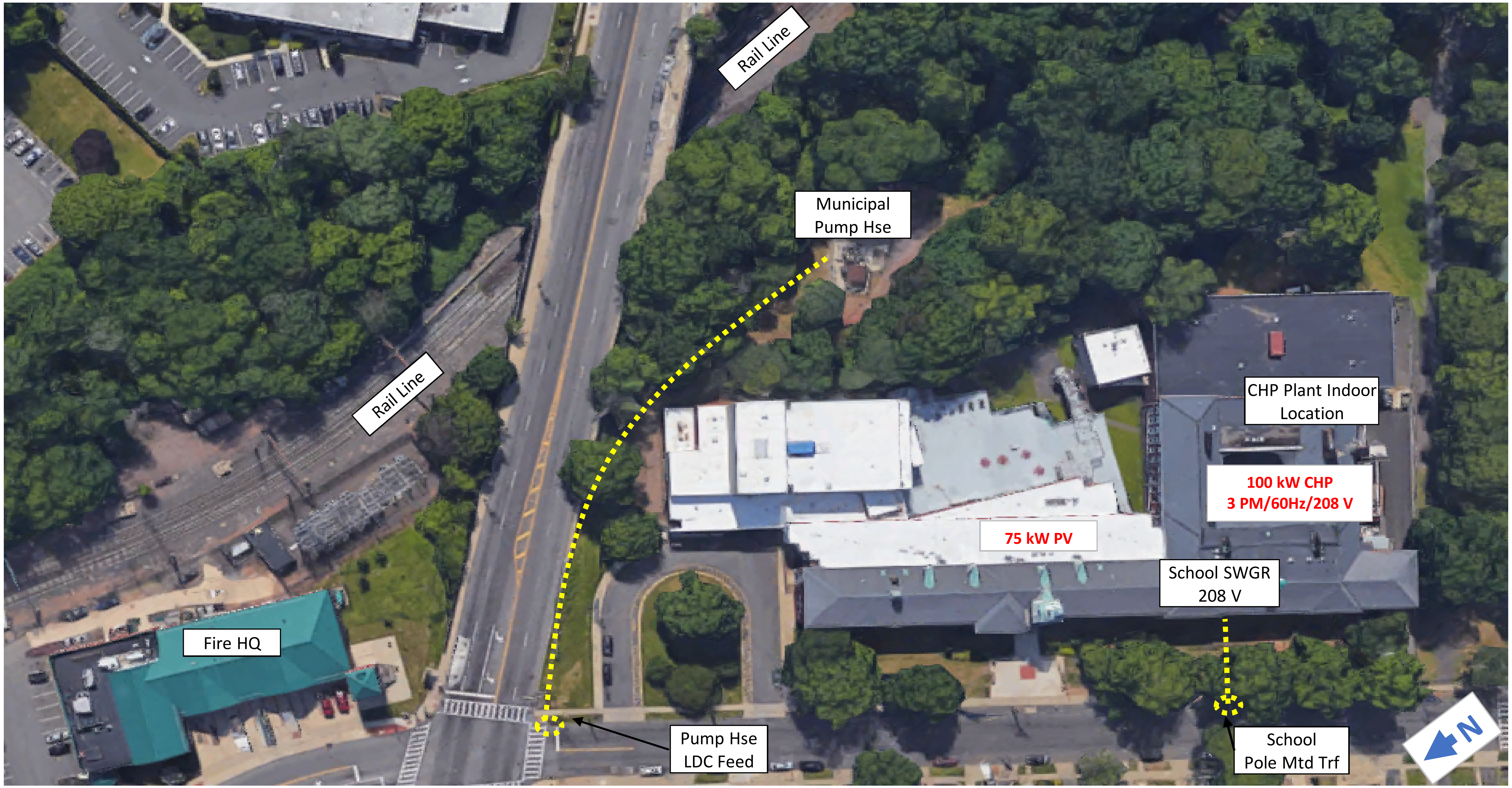

CHP Plant
Indoor Location
New MOB
Under
Construction
13.2 kV SWGR
Indoors
Incoming Power 13.2 kV
Dual Feed SWGR upstream
N

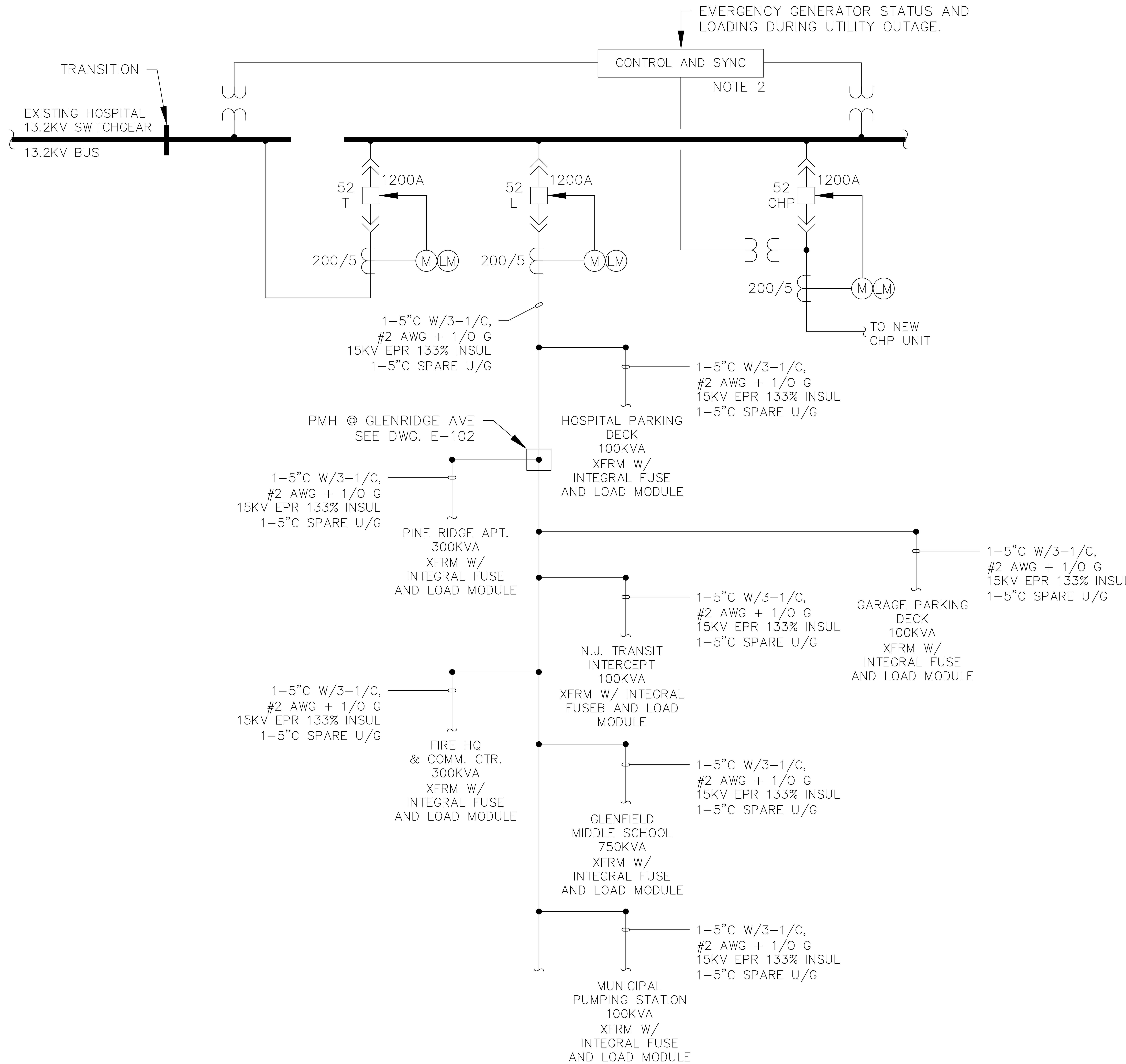


Hospital Main Incoming Power 13.2 kV
Hospital Parking Deck
Bay Street
Abandonded NJT Rail Line
NJT Rail Line
N



Station Pole Mtd Trf
Station SWGR
Fire HQ Grnd Mtd Trf
NJT Sub Stn
Emergency Generator
Fire HQ
20 kW PV
100 kW/85 kWh
Pine Ridge Grnd Mtd Trf
Park Deck SWGR
50 kW PV
Pine Ridge 208/110 V Indoor Trf
Fire HQ LDC Feed to Trf
Park Deck Pole Mtd Trf
Station LDC Feed to Trf
N


Rail Line
Municipal Pump Hse
Rail Line
CHP Plant Indoor Location
100 kW CHP
3 PM/60Hz/208 V
75 kW PV
School SWGR 208 V
Fire HQ
Pump Hse LDC Feed
School Pole Mtd Trf
N



NOTES:

1. SINGLE MODE 12 STRAND FIBER OPTIC CABLE ROUTING TO PARALLEL POWER DUCT BANK.
2. CONTROL MODULE SYNCHRONIZED SOURCES. MAXIMIZES POWER TO HOSPITAL AND CITY LOADS. IN THE EVENT OF UTILITY POWER FAILURE CONTROL ISLAND POWER PLANT FOR CITY LOADS. CONTROLS WILL ALLOW SUPERVISED RE-SYNC TO HOSPITAL BUS TO PICK UP SELECT LOADS NOT POWERED BY EMERGENCY GENERATORS.

LEGEND:

(M) SEL UTILITY GRADE PROTECTIVE RELAY WITH LOCAL LOAD READ OUT.

(LM) LOAD MODULE SENDS REAL TIME POWER INFORMATION TO CENTRAL CONTROL V, A, KW, KVA VIA FIBER.

RONALD R. REGAN
NJ PROFESSIONAL ENGINEER
N.J. LIC. 23587

TRIAD CONSULTING ENGINEERS INC.
ENGINEERS · DESIGNERS · CONSTRUCTION MANAGERS
2740 ROUTE 10 WEST, MORRIS PLAINS N.J. 07950
NEW JERSEY: 24GA28061300

PROJECT TITLE
TOWN OF MONTCLAIR
MONTCLAIR, NEW JERSEY 07042
MONTCLAIR TOWNSHIP MICROGRID

DATE 9/10/18		DRN BY	RJF
		CHK'D BY	R3
SCALE AS NOTED		APP BY	R3

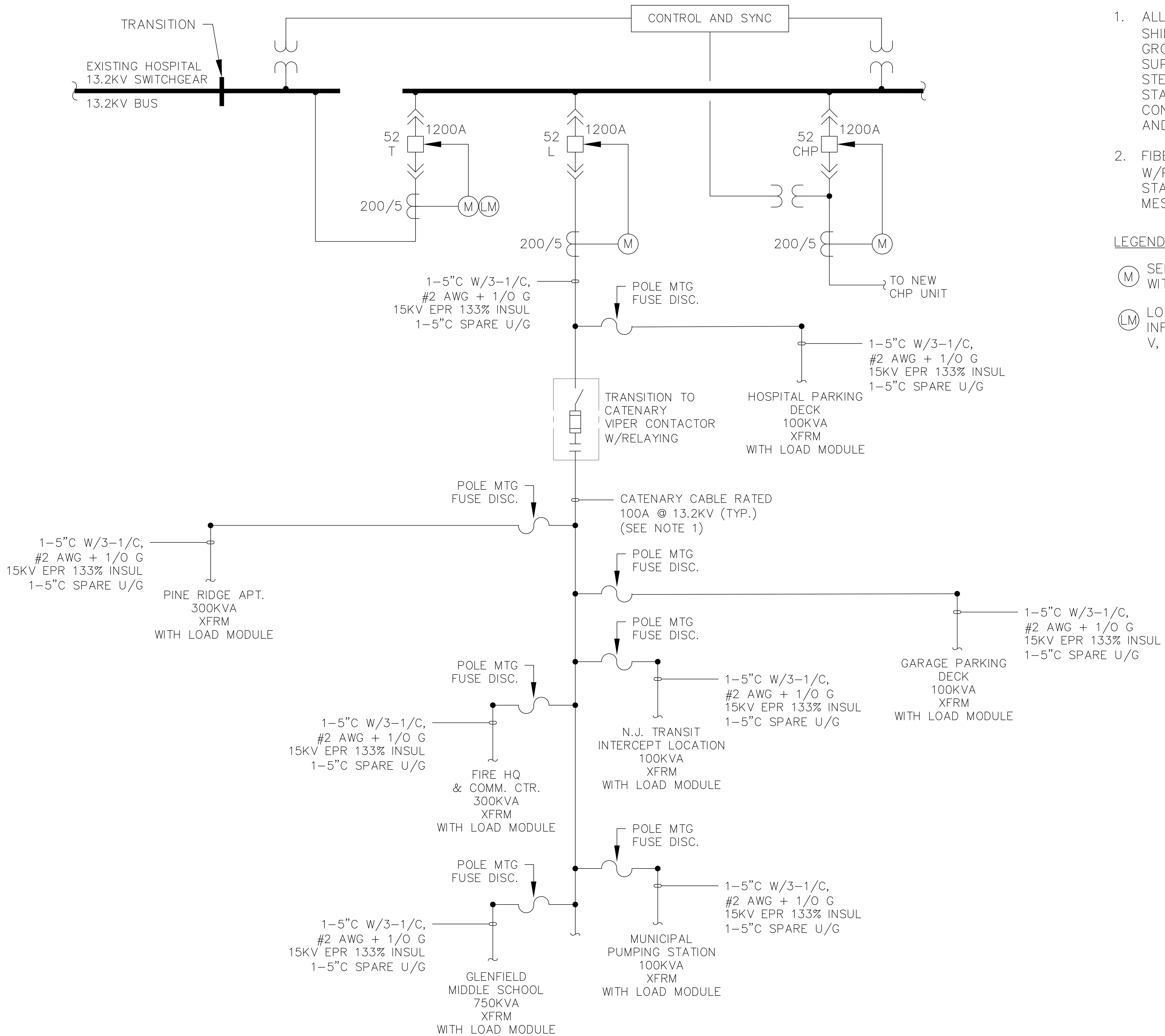
ISSUED	DATE
PROGRESS ISSUE – 50%	–
PROGRESS ISSUE – 75%	–
ISSUED FOR BID ONLY	–
ISSUED FOR PERMIT	–
ISSUED FOR CONSTRUCTION	–
ISSUED AS-BUILT	–

	REVISIONS	DATE
1	ISSUED W/REPORT	9/11/18
2	RE-ISSUED W/REPORT	12/10/18

DRAWING TITLE
ELECTRICAL
SINGLE LINE DIAGRAM FOR U/G DISTRIBUTION

CEI185051

E-100



NOTE:

1. ALL CATENARY CABLE TO BE 3/C 15KV SHIELDED CU #2AWG W/INTEGRAL GROUND ALUM. CLX & PVC JACKET SUPPORTED BY STRUCTURAL STAINLESS STEEL MESSENGER CABLE WITH STAINLESS STEEL CABLE TO MESSENGER CONNECTORS. ALL HURRICANE RATED AND APPROVED BY NJT.

2. FIBER OPTIC ALSO TO BE IN ALUM. CLX W/PVC JACKET SUPPORTED BY STAINLESS STEEL HURRICANE RATED MESSENGER SYSTEM.

LEGEND:

(M) SEL UTILITY GRADE PROTECTIVE RELAY WITH LOCAL LOAD READ OUT.

(LM) LOAD MODULE SENDS REAL TIME POWER INFORMATION TO CENTRAL CONTROL V, A, KW, KVA VIA FIBER.

NOTICE

RONALD R. REGAN
NJ PROFESSIONAL ENGINEER
N.J. LIC. 23587

TRIAD CONSULTING ENGINEERS INC.
ENGINEERS · DESIGNERS · CONSTRUCTION MANAGERS
2740 ROUTE 10 WEST, MORRIS PLAINS N.J. 07950

NEW JERSEY: 24GA28061300

PROJECT TITLE

**TOWN OF MONTCLAIR
MONTCLAIR,
NEW JERSEY 07042**

**MONTCLAIR TOWNSHIP
MICROGRID**

DATE 9/10/18		DRN BY	RJF
		CHK'D BY	R3
SCALE AS NOTED		APP BY	R3

◯	ISSUED	DATE
	PROGRESS ISSUE – 50%	–
	PROGRESS ISSUE – 75%	–
	ISSUED FOR BID ONLY	–
	ISSUED FOR PERMIT	–
	ISSUED FOR CONSTRUCTION	–
	ISSUED AS-BUILT	–

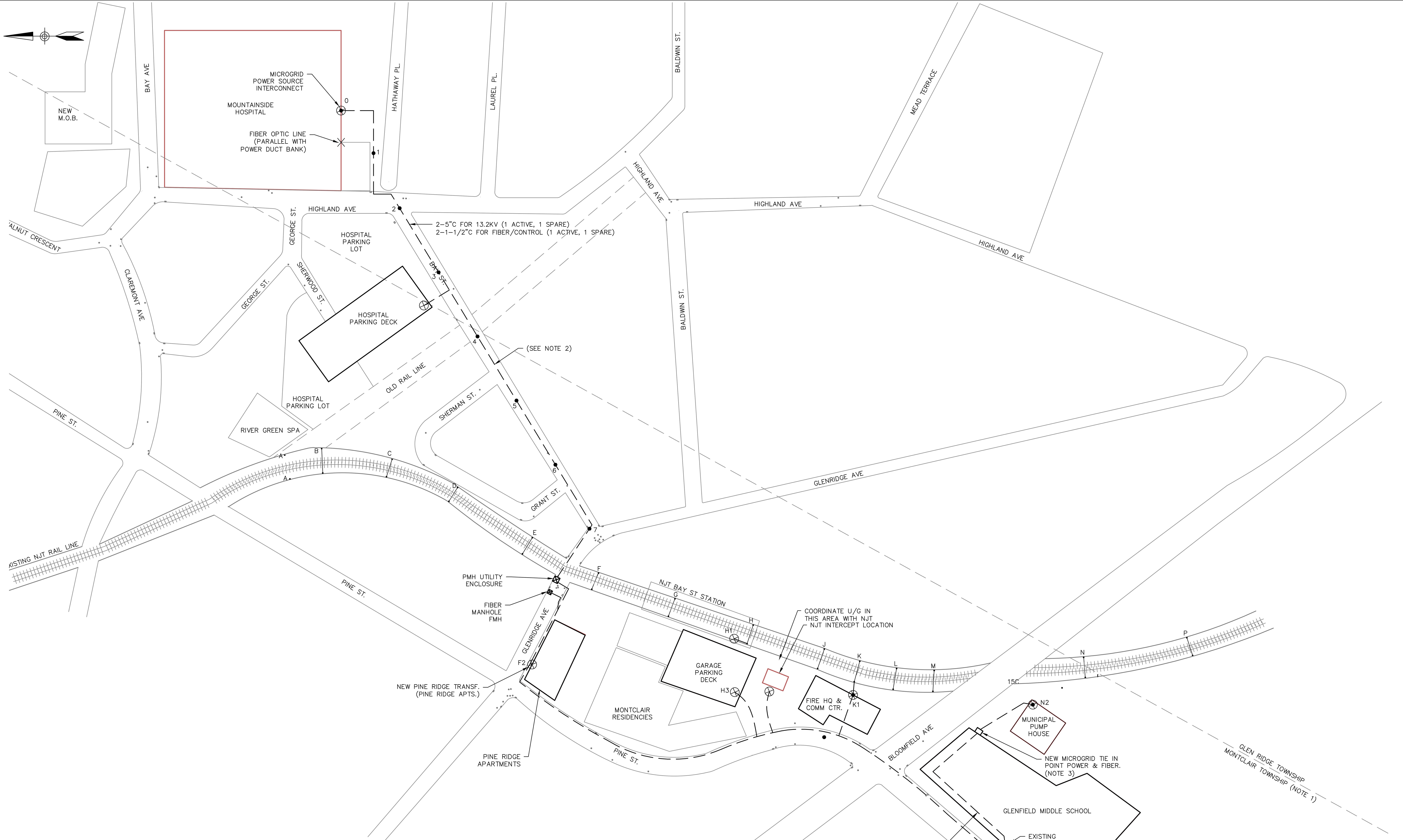
△	REVISIONS	DATE
1	ISSUED W/REPORT	9/11/18
2	RE-ISSUED W/REPORT	12/10/18

DRAWING TITLE

ELECTRICAL
**SINGLE LINE DIAGRAM
FOR ABOVE GROUND DISTRIBUTION**

CEI185051

E-101



LEGEND:

- ⊗ LOCATION OF EXISTING ELECTRICAL SERVICE AND APPROXIMATE LOCATION OF MICROGRID SYSTEM CONNECTION.
- ● DISTANCE STATION
- × SPLICE
- ——— OVERHEAD ROUTING
- — — UNDERGROUND ROUTING
- - - - TOWNSHIP LINE

NOTES:

1. TOWNSHIP BORDER IS APPROXIMATE, FINAL SITE MAP SHALL BE SURVEYED BY A PROFESSIONAL SURVEYOR LICENSED IN THE STATE OF NEW JERSEY.
2. CONTRACTOR TO INSTALL MANHOLE EVERY 200' +/- 50' BASED ON EXISTING OBSTRUCTION AND PULL CALCULATIONS. FIBER OPTIC BOX SHALL BE WITHIN 25' OF POWER MANHOLE.
3. NEW POWER DISTRIBUTION FROM INTERCONNECT POINT TO EXISTING POWER & FIBER PANELS WILL BE INSTALLED UNDER THIS CONTRACT.

1 / E-102 **PROPOSED 13.2KV UNDERGROUND DISTRIBUTION**

SCALE: 1"=125'

GRAPHIC SCALE

125 0 62.5 125 250 500

(IN FEET)
1 inch = 125'

NOTICE

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RONALD R. REGAN
NJ PROFESSIONAL ENGINEER
N.J. LIC. 23587

TRIAD CONSULTING ENGINEERS INC.
ENGINEERS · DESIGNERS · CONSTRUCTION MANAGERS
2740 ROUTE 10 WEST, MORRIS PLAINS N.J. 07950

NEW JERSEY: 24GA28061300

PROJECT TITLE

**TOWN OF MONTCLAIR
MONTCLAIR,
NEW JERSEY 07042**

MONTCLAIR TOWNSHIP MICROGRID

DATE 8/6/18		DRN BY	AG
		CHK'D BY	CHK'D
SCALE 1/128" = 1'-0"		APP BY	APP

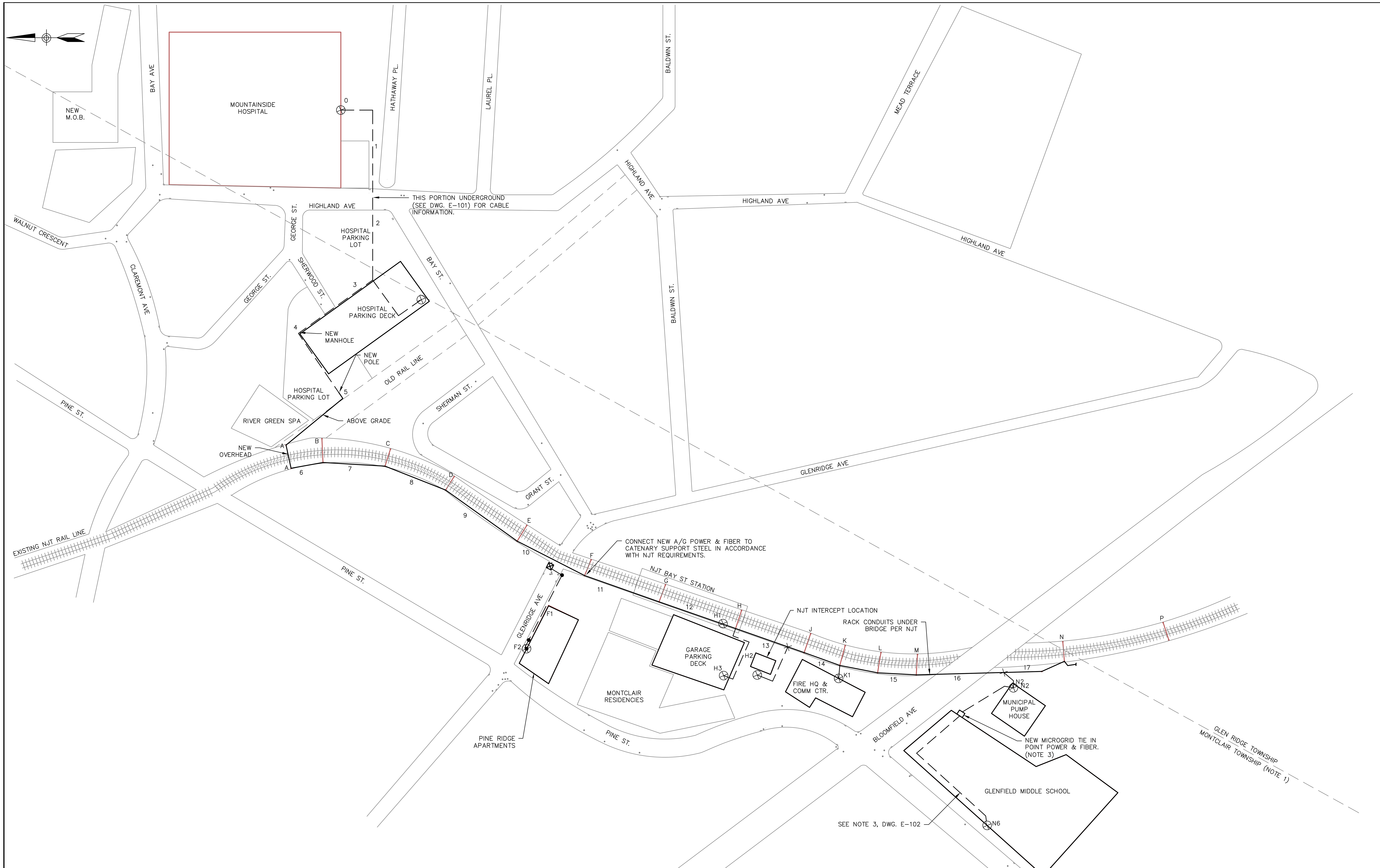
○	ISSUED	DATE
	PROGRESS ISSUE – 50%	–
	PROGRESS ISSUE – 75%	–
	ISSUED FOR BID ONLY	–
	ISSUED FOR PERMIT	–
	ISSUED FOR CONSTRUCTION	–
	ISSUED AS-BUILT	–

△	REVISIONS	DATE
1	ISSUED W/REPORT	9/11/18
2	RE-ISSUED W/REPORT	12/10/18

DRAWING TITLE

ELECTRICAL
PROPOSED 13.2KV UNDERGROUND DISTRIBUTION

CEI185051 **E-102**



LEGEND:

- ⨂ LOCATION OF EXISTING ELECTRICAL SERVICE AND APPROXIMATE LOCATION OF CONNECTION.
- ● DISTANCE STATION
- ✕ SPLICE
- ——— OVERHEAD ROUTING
- — — UNDERGROUND ROUTING
- – – TOWNSHIP LINE

NOTES:

1. TOWNSHIP BORDER IS APPROXIMATE, FINAL SITE MAP SHALL BE SURVEYED BY A PROFESSIONAL SURVEYOR LICENSED IN THE STATE OF NEW JERSEY.
2. INSTALL ON CATENARY STEEL PER NJT REQUIREMENTS.
3. REFER TO SINGLE LINE DIAGRAM E-100 FOR CABLE SIZE & TYPE U/G & A/G.
4. REFER TO DWG. E-104 FOR DETAILS.
5. SEE NOTE 3, DWG. E-102.

1 / E-103 **CATENARY DESIGN**
SCALE: 1"=125'

GRAPHIC SCALE
125 0 62.5 125 250 500
(IN FEET)
1 inch = 125'

RONALD R. REGAN
NJ PROFESSIONAL ENGINEER
N.J. LIC. 23587

TRIAD CONSULTING ENGINEERS INC.
ENGINEERS · DESIGNERS · CONSTRUCTION MANAGERS
2740 ROUTE 10 WEST, MORRIS PLAINS N.J. 07950

NEW JERSEY: 24GA28061300

PROJECT TITLE

TOWN OF MONTCLAIR
MONTCLAIR,
NEW JERSEY 07042

MONTCLAIR TOWNSHIP MICROGRID

DATE 8/6/18	DRN BY	AG
	CHK'D BY	CHK'D
SCALE 1/128" = 1'-0"	APP BY	APP

○	ISSUED	DATE
	PROGRESS ISSUE – 50%	–
	PROGRESS ISSUE – 75%	–
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	ISSUED FOR PERMIT	–
	ISSUED FOR CONSTRUCTION	–
	ISSUED AS-BUILT	–

△	REVISIONS	DATE
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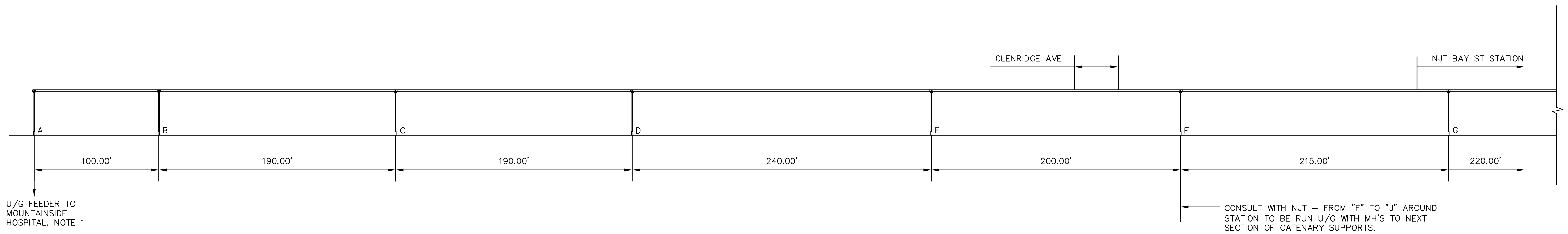
2	RE-ISSUED W/REPORT	12/10/18

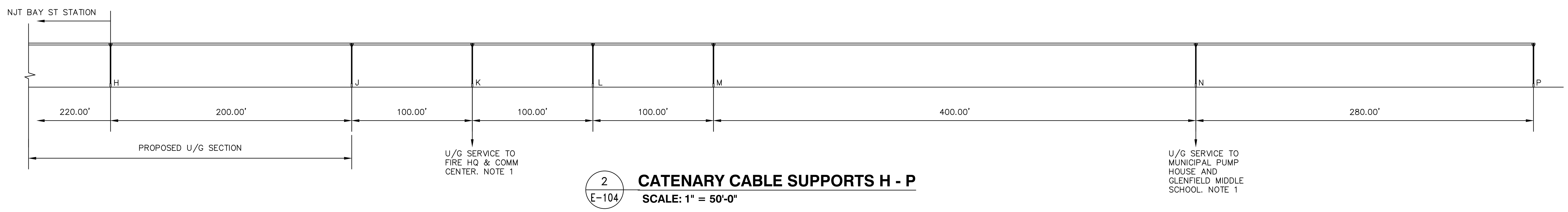
DRAWING TITLE

ELECTRICAL
PROPOSED 13.2KV ABOVE GROUND DISTRIBUTION

CEI185051 **E-103**



1 / E-104 **CATENARY CABLE SUPPORTS A - G**
SCALE: 1" = 50'-0"



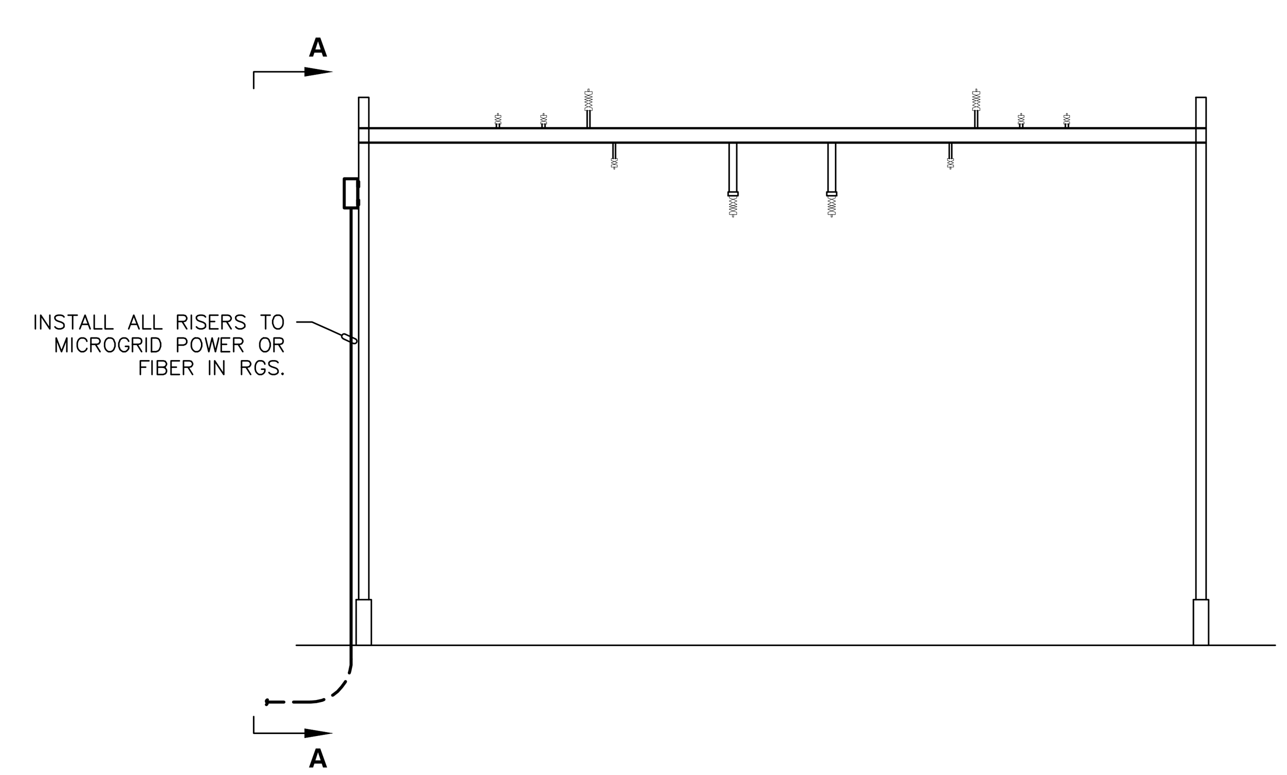
2 / E-104 **CATENARY CABLE SUPPORTS H - P**
SCALE: 1" = 50'-0"

NOTES:

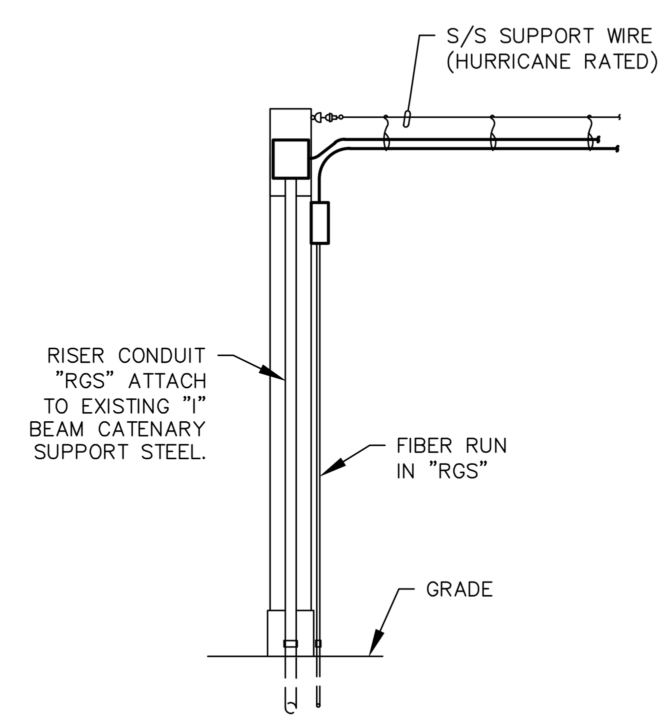
1. REFERENCE DRAWING E–103 FOR UNDERGROUND ROUTING.

GRAPHIC SCALE
50 0 25 50 100 200
(IN FEET)
1 inch = 50'

CATENARY O/H LENGTH		
FROM	TO	LENGTH (FEET)
A	B	100
B	C	190
C	D	190
D	E	240
E	F	200
F	G	215
G	H	220
H	J	200
J	K	100
K	L	100
L	M	100
M	N	400
N	P	280
TOTAL		2535



3 / E-104 **EXISTING CATENARY SUPPORT DETAIL (TYPICAL) WITH NEW MICROGRID POWER**
SCALE: 1" = 10'-0"



SECTION A-A
SCALE: 1" = 10'-0"

GRAPHIC SCALE
10 0 5 10 20 40
(IN FEET)
1 inch = 10'

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RONALD R. REGAN
NJ PROFESSIONAL ENGINEER
N.J. LIC. 23587

TRIAD CONSULTING ENGINEERS INC.
ENGINEERS · DESIGNERS · CONSTRUCTION MANAGERS
2740 ROUTE 10 WEST, MORRIS PLAINS N.J. 07950
NEW JERSEY: 24GA28061300

PROJECT TITLE
TOWN OF MONTCLAIR MONTCLAIR, NEW JERSEY 07042
MONTCLAIR TOWNSHIP MICROGRID

DATE 8/6/18 | DRN BY AG
CHK'D BY CHK'D
SCALE AS NOTED | APP BY APP

ISSUED	DATE
PROGRESS ISSUE – 50%	–
PROGRESS ISSUE – 75%	–
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	REVISIONS	DATE
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DRAWING TITLE
ELECTRICAL
ABOVE GROUND DESIGN DETAILS

CEI185051 **E-104**

2012 IBC (International Building Code) Section 1604, General Design Requirements

Table 1604.5 Risk Category of Buildings and Other Structures

RISK CATEGORY	NATURE OF OCCUPANCY
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: • Agricultural facilities. • Certain temporary facilities. • Minor storage facilities.
II	Buildings and other structures except those listed in Risk Categories I, III and IV
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing elementary school, secondary school or day care facilities with an occupant load greater than 250. • Buildings and other structures containing adult education facilities, such as colleges and universities, with an occupant load greater than 500. • Group I-2 [c] occupancies with an occupant load of 50 or more resident care recipients but not having surgery or emergency treatment facilities. • Group I-3 [d] occupancies. • Any other occupancy with an occupant load greater than 5,000 [a]. • Power-generating stations, water treatment facilities for potable water, waste water treatment facilities and other public utility facilities not included in Risk Category IV. • Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the International Fire Code; and Are sufficient to pose a threat to the public if released [b].
IV	Buildings and other structures designated as essential facilities, including but not limited to: • Group I-2 occupancies having surgery or emergency treatment facilities. • Fire, rescue, ambulance and police stations and emergency vehicle garages. • Designated earthquake, hurricane or other emergency shelters. • Designated emergency preparedness, communications and operations centers and other facilities required for emergency response.

	• Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures. • Buildings and other structures containing quantities of highly toxic materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the International Fire Code; and Are sufficient to pose a threat to the public if released [b]. • Aviation control towers, air traffic control centers and emergency aircraft hangars. • Buildings and other structures having critical national defense functions. • Water storage facilities and pump structures required to maintain water pressure for fire suppression.

a. For purposes of occupant load calculation, occupancies required by Table 1004.1.2 to use gross floor area calculations shall be permitted to use net floor areas to determine the total occupant load.

b. Where approved by the building official, the classification of buildings and other structures as Risk Category III or IV based on their quantities of toxic, highly toxic or explosive materials is permitted to be reduced to Risk Category II, provided it can be demonstrated by a hazard assessment in accordance with Section 1.5.3 of ASCE 7 that a release of the toxic, highly toxic or explosive materials is not sufficient to pose a threat to the public.

c. Institutional Group I-2

This occupancy shall include buildings and structures used for medical care on a 24-hour basis for more than five persons who are incapable of self-preservation. This group shall include, but not be limited to Foster care facilities, Detoxification facilities, Hospitals, Nursing homes and Psychiatric hospitals.

d. Institutional Group I-3

This occupancy shall include buildings and structures that are inhabited by more than five persons who are under restraint or security. An I-3 facility is occupied by persons who are generally incapable of self-preservation due to security measures not under the occupants' control. This group shall include, but not be limited to Correctional centers, Detention centers, Jails, Prerelease centers, Prisons and Reformatories.

March 20, 2017

New Jersey Board of Public Utilities
Office of Clean Energy
44 South Clinton Avenue
PO Box 350
Trenton, NJ 08625-03500

RE: Town Center Distributed Energy Resource Microgrid Pilot Study

To Whom It May Concern:

Please be advised that Hackensack UMC Mountainside expresses our interest and support in being included in the Township of Montclair's application for the Town Center Distributed Energy Resource Microgrid Pilot Study Incentive Pilot Program.

We have made our history of electric and thermal loads available to be included in the design of the proposed microgrid and have opened our facilities for touring by Montclair's consultants in this study. We will be offering our cooperation to Montclair and its consultants in the development of a microgrid which will seek to markedly increase our electric resiliency in the event of future long-term power interruptions while providing both economy and efficiency from combined heat and power to our hospital.

Hackensack UMC Mountainside recognizes that we are consenting to be part of the initial study (funded in total by the grant from the BPU's Office of Clean Energy's Town Center Distributed Energy Resource Feasibility Study Pilot Incentive Program), and makes no commitment, is under no obligation, financial or otherwise, to the Office of Clean Energy, the Township of Montclair, Montclair's consultants or to any party, in the event the pilot study proves feasible, to participate in any way other than our initial consent and support as demonstrated by this letter. We are however, hopeful that the study proves feasible and development can become a reality.

Sincerely,

Al Aboud, CFO
HackensackUMC Mountainside

United Methodist Communities
Abundant Life for Seniors

Home Office

March 24, 2017

New Jersey Board of Public Utilities
Office of Clean Energy
44 South Clinton Avenue
PO Box 350
Trenton, NJ 08625-03500

RE: Town Center Distributed Energy Resource Microgrid Pilot Study

To Whom It May Concern:

Please be advised that United Methodist Homes (dba United Methodist Communities), owners and operators of Pine Ridge located at the corner of Glen Ridge Avenue and Pine Street in Montclair, New Jersey, is writing to express our interest and support in being included in the Township of Montclair's application for the Town Center Distributed Energy Resource Microgrid Pilot Study Incentive Pilot Program.

We will be making our history of electric and thermal loads available to be included in the design of the proposed microgrid and will be offering our cooperation to Montclair and its consultants in the development of a workable microgrid which would also include our neighbors at Montclair's Fire Headquarters, Glenfield School and Mountainside Hospital.

United Methodist Homes (dba United Methodist Communities) makes no commitment, and is under no obligation, financial or otherwise, to the Office of Clean Energy, the Township of Montclair, Montclair's consultants or to any party, in the event the pilot study proves feasible, to participate in any way other than our initial consent and support as demonstrated by this letter. We will review the results of the study when complete, and will only then make a decision as to whether further participation in this effort is beneficial to Pine Ridge.

Very truly yours,

Cynthia Jacques
Vice President – Housing & Community Initiatives

Chris Christie, Governor
Kim Guadagno, Lieutenant Governor
Richard T. Hammer, Commissioner
Steven H. Santoro, Executive Director

NJ TRANSIT

One Penn Plaza East
Newark, NJ 07105-2246
973-491-7000

New Jersey Board of Public Utilities
Office of Clean Energy
44 South Clinton Avenue
PO BOX 350
Trenton, NJ 08625-03500

RE: Town Center Distributed Energy Resource Microgrid Pilot Study

To whom it may concern:

Please be advised that NJ TRANSIT, owners of the Bay Street station on Pine Street between Bloomfield and Glenridge Avenues in Montclair, is writing to express our interest and support in being included in the Township of Montclair's application for the Town Center Distributed Energy Resource Microgrid Pilot Study Incentive Pilot Program. The Bay Street station is served by all trains on the Montclair-Boonton line, including all ten weekend trains.

We will be making our history of electric and thermal loads available to be included in the design of the proposed microgrid and will be offering our cooperation to Montclair and its consultants in the development of a workable microgrid which would also include our neighbors at Montclair's Fire Headquarters, Glenfield School and Mountainside Hospital.

NJ TRANSIT makes no commitment, and is under no obligation, financial or otherwise, to the Office of Clean Energy, the Township of Montclair, Montclair's consultants or to any party, in the event the pilot study proves feasible, to participate in any way other than our initial consent and support as demonstrated by this letter. We will review the results of the study when complete, and will only then make a decision as to whether further participation in this effort is beneficial to NJ TRANSIT.

Sincerely,

Steven Jenks
Manager, Energy and Sustainability Programs

Gray Russell
Sustainability Officer
Township of Montclair
Office of Environmental Affairs
Department of Health and Human Services
205 Claremont Avenue, Montclair, NJ 07042

March 16, 2017

Dear Mr. Russell,

Due to perpetual concerns about the safety and security of our residents and properties, more municipalities are now making plans for their communities to become more resilient. By planning for future emergencies, either from catastrophic storms and intense weather events, or from human-caused disruptions and power outages, it is the responsibility of cities and towns to explore and develop smart methods of preparedness.

The Montclair Environmental Commission (MEC) fully supports the Township of Montclair's application to the NJ Board of Public Utilities' Office of Clean Energy for the Town Center Distributed Energy Resource Microgrid Feasibility Study.

MEC appreciates the multiple sustainability benefits that would result from a town center microgrid, including not just security and resilience but also improved energy efficiency and the resulting reduction of our municipal carbon footprint. These benefits can in turn help to prevent some of the causes of possible disruptions.

MEC will be eager to support the study by providing input and advice on the selection of preferred locations for placement of a distributed energy resource, and by sharing the progress of the project with the Montclair community.

Please keep the Montclair Environmental Commission informed with updates as you move forward with this admirable project.

Sincerely,

Lyle Landon

Co-Chair, Montclair Environmental Commission

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

PSEG

March 9, 2017

Ms. Janice E. Talley, PP/AICP
Director of Planning and Community Development
Township of Montclair
205 Claremont Avenue
Montclair, NJ 07042

Dear Ms. Talley:

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

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

- PSE&G will provide building load data for all buildings included in your microgrid feasibility study, contingent on receiving approval from the owners of each of the buildings to release its electric and gas load data to you or your consultant.

- PSE&G will provide technical support to you and your consultant in the development of your feasibility study. Release of any confidential or proprietary technical information will require the execution of a Non-Disclosure Agreement between all parties.

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

Sincerely,

Michael Henry
Distribution Business Team Leader

G3516H

GAS ENGINE SITE SPECIFIC TECHNICAL DATA
Integrated CHP Systems
CHP Project - G3516H - 2MW

GENSET APPLICATION

ENGINE SPEED (rpm):	1500
COMPRESSION RATIO:	12.1
AFTERCOOLER TYPE:	SCAC
AFTERCOOLER - STAGE 2 INLET (°F):	118
AFTERCOOLER - STAGE 1 INLET (°F):	198
JACKET WATER OUTLET (°F):	210
ASPIRATION:	TA
COOLING SYSTEM:	JW+OC+1AC, 2AC+GB
CONTROL SYSTEM:	ADEM4 W/ IM
EXHAUST MANIFOLD:	DRY
COMBUSTION:	LOW EMISSION
NOx EMISSION LEVEL (g/bhp-hr NOx):	1.0
SET POINT TIMING:	22

RATING STRATEGY:	HIGH EFFICIENCY
RATING LEVEL:	CONTINUOUS
FUEL SYSTEM:	CAT LOW PRESSURE WITH AIR FUEL RATIO CONTROL

SITE CONDITIONS:

FUEL:	Nat Gas
FUEL PRESSURE RANGE(psig): (See note 1)	1.5-5.0
FUEL METHANE NUMBER:	84.7
FUEL LHV (Btu/scf):	905
ALTITUDE(ft):	500
MAXIMUM INLET AIR TEMPERATURE(°F):	77
STANDARD RATED POWER:	2785 bhp@1500rpm
POWER FACTOR:	1.0
VOLTAGE(V):	480-13800

			MAXIMUM RATING	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE		
RATING	NOTES	LOAD	100%	100%	75%	50%
GENSET POWER (WITH GEARBOX, WITHOUT FAN)	(2)(3)	ekW	2007	2007	1505	1003
GENSET POWER (WITH GEARBOX, WITHOUT FAN)	(2)(3)	kVA	2007	2007	1505	1003
ENGINE POWER (WITHOUT GEARBOX, WITHOUT FAN)	(3)	bhp	2785	2785	2095	1407
INLET AIR TEMPERATURE		°F	77	77	77	77
GENERATOR EFFICIENCY	(2)	%	97.5	97.5	97.2	96.5
GENSET EFFICIENCY (ISO 3046/1)	(4)(5)	%	45.0	45.0	44.0	41.7
THERMAL EFFICIENCY	(4)(6)	%	37.2	37.2	38.9	41.7
TOTAL EFFICIENCY	(4)(7)	%	82.2	82.2	82.9	83.4
ENGINE DATA						
GENSET FUEL CONSUMPTION (ISO 3046/1)	(8)	Btu/ekW-hr	7579	7579	7762	8179
GENSET FUEL CONSUMPTION (NOMINAL)	(8)	Btu/ekW-hr	7840	7840	8029	8461
ENGINE FUEL CONSUMPTION (NOMINAL)	(8)	Btu/bhp-hr	5648	5648	5768	6035
AIR FLOW (@inlet air temp, 14.7 psia) (WET)	(9)	ft3/min	4963	4963	3681	2513
AIR FLOW (WET)	(9)	lb/hr	22004	22004	16320	11141
FUEL FLOW (60ºF, 14.7 psia)		scfm	290	290	223	156
INLET MANIFOLD PRESSURE	(10)	in Hg(abs)	131.4	131.4	96.9	66.2
EXHAUST TEMPERATURE - ENGINE OUTLET	(11)	°F	758	758	818	899
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia) (WET)	(12)	ft3/min	12135	12135	9462	6880
EXHAUST GAS MASS FLOW (WET)	(12)	lb/hr	22792	22792	16926	11567
MAX INLET RESTRICTION	(13)	in H2O	10.04	10.04	5.62	2.51
MAX EXHAUST RESTRICTION	(13)	in H2O	20.07	20.07	11.23	5.37
EMISSIONS DATA - ENGINE OUT						
NOx (as NO2)	(14)(15)	g/bhp-hr	1.00	1.00	1.00	1.00
CO	(14)(15)	g/bhp-hr	1.66	1.66	1.57	1.57
THC (mol. wt. of 15.84)	(14)(15)	g/bhp-hr	2.60	2.60	2.53	2.52
NMHC (mol. wt. of 15.84)	(14)(15)	g/bhp-hr	0.44	0.44	0.43	0.43
NMNEHC (VOCs) (mol. wt. of 15.84)	(14)(15)(16)	g/bhp-hr	0.42	0.42	0.40	0.40
HCHO (Formaldehyde)	(14)(15)	g/bhp-hr	0.18	0.18	0.18	0.20
CO2	(14)(15)	g/bhp-hr	390	390	393	413
EXHAUST OXYGEN	(14)(17)	% DRY	10.0	10.0	9.6	9.1
HEAT REJECTION						
LHV INPUT	(18)	Btu/min	262207	262207	201396	141492
HEAT REJ. TO JACKET WATER (JW)	(19)	Btu/min	26450	26450	22366	17853
HEAT REJ. TO ATMOSPHERE	(19)	Btu/min	4265	4265	3561	2858
HEAT REJ. TO LUBE OIL (OC)	(19)	Btu/min	10216	10216	9199	7941
HEAT REJECTION TO EXHAUST (LHV TO 350°F)	(19)	Btu/min	39390	39390	35338	29188
HEAT REJ. TO A/C - STAGE 1 (1AC)	(19)(20)	Btu/min	20885	20885	11152	3752
HEAT REJ. TO A/C - STAGE 2 (2AC)	(19)(20)	Btu/min	11875	11875	7922	4533
HEAT REJECTION FROM GEARBOX (GB)	(19)	Btu/min	1075	1075	808	543
COOLING SYSTEM SIZING CRITERIA						
TOTAL JACKET WATER CIRCUIT (JW+OC+1AC)	(21)	Btu/min	63283	63283		
TOTAL STAGE 2 AFTERCOOLER CIRCUIT (2AC+GB)	(21)	Btu/min	13597	13597		
HEAT REJECTION TO EXHAUST (LHV TO 350°F)	(21)	Btu/min	43329	43329		
A cooling system safety factor of 0% has been added to the cooling system sizing criteria.						
MINIMUM HEAT RECOVERY						
TOTAL JACKET WATER CIRCUIT (JW+OC+1AC)	(22)	Btu/min	51819	51819		
TOTAL STAGE 2 AFTERCOOLER CIRCUIT (2AC+GB)	(22)	Btu/min	12302	12302		
HEAT REJECTION TO EXHAUST(LHV TO 350°F)	(22)	Btu/min	35412	35412		

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Maximum rating is the maximum capability at the specified aftercooler inlet temperature for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

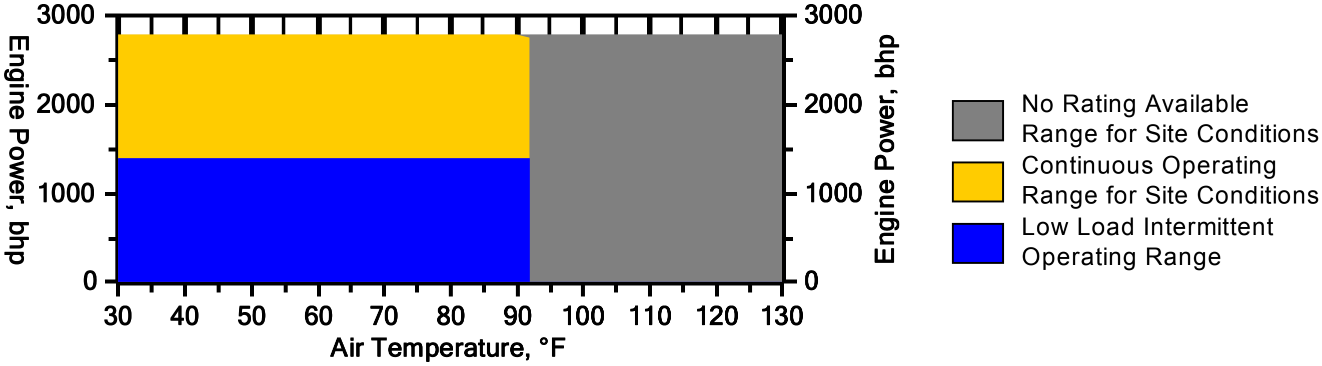
PREPARED BY: Scott Yappen, Foley Power Systems

For notes information consult page three.

GAS ENGINE SITE SPECIFIC TECHNICAL DATA
Integrated CHP Systems
CHP Project - G3516H - 2MW

Engine Power vs. Inlet Air Temperature

Data represents temperature sweep at 500 ft and 1500 rpm



GAS ENGINE SITE SPECIFIC TECHNICAL DATA
Integrated CHP Systems
CHP Project - G3516H - 2MW

CATERPILLAR®

NOTES

1. Fuel pressure range specified is to the engine fuel control valve. Additional fuel train components should be considered in pressure and flow calculations.

2. Generator efficiencies, power factor, and voltage are based on specified generator. [Genset Power (ekW) is calculated as: (Engine Power (bkW) - Gearbox Power (bkW)) x Generator Efficiency], [Genset Power (kVA) is calculated as: (Engine Power (bkW) - Gearbox Power (bkW)) x Generator Efficiency / Power Factor]

3. Rating is without engine driven water pumps. Tolerance is (+)3, (-)0% of full load.

4. Efficiency represents a Closed Crankcase Ventilation (CCV) system installed on the engine.

5. Genset Effieciency published in accordance with ISO 3046/1.

6. Thermal Efficiency is calculated based on energy recovery from the jacket water, lube oil, 1st stage aftercooler, and exhaust to 350ºF with engine operation at ISO 3046/1 Genset Efficiency, and assumes unburned fuel is converted in an oxidation catalyst.

7. Total efficiency is calculated as: Genset Efficiency + Thermal Efficiency. Tolerance is ±10% of full load data.

8. ISO 3046/1 Genset fuel consumption tolerance is (+)5, (-)0% at the specified power factor. Nominal genset and engine fuel consumption tolerance is ± 1.5% of full load data at the specified power factor.

9. Air flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 5 %.

10. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.

11. Exhaust temperature is a nominal value with a tolerance of (+)63°F, (-)54°F.

12. Exhaust flow value is on a "wet" basis. Flow is a nominal value with a tolerance of ± 6 %.

13. Inlet and Exhaust Restrictions are maximum allowed values at the corresponding loads. Increasing restrictions beyond what is specified will result in a significant engine derate.

14. Emissions data is at engine exhaust flange prior to any after treatment.

15. NOx tolerance's are ± 18% of specified value. All other emission values listed are higher than nominal levels to allow for instrumentation, measurement, and engine-to-engine variations. They indicate the maximum values expected under steady state conditions. Fuel methane number cannot vary more than ± 3. THC, NMHC, and NMNEHC do not include aldehydes

16. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ

17. Exhaust Oxygen level is the result of adjusting the engine to operate at the specified NOx level. Tolerance is ± 0.5.

18. LHV rate tolerance is ± 1.5%.

19. Heat rejection values are representative of site conditions. Tolerances, based on treated water, are ± 10% for jacket water circuit, ± 50% for atmosphere, ± 20% for lube oil circuit, ± 10% for exhaust, ± 5% for aftercooler circuit, and ± 5% for Gearbox.

20. Aftercooler heat rejection is nominal for site conditions and does not include an aftercooler heat rejection factor. Aftercooler heat rejection values at part load are for reference only.

21. Cooling system sizing criteria represent the expected maximum circuit heat rejection for the ratings at site, with applied plus tolerances. Total circuit heat rejection is calculated using formulas referenced in the notes on the standard tech data sheet with the following qualifications. Aftercooler heat rejection data (1AC & 2AC) is based on the standard rating. Jacket Water (JW), Oil Cooler (OC), and Gearbox (GB) heat rejection values are based on the respective site or maximum column. Aftercooler heat rejection factors (ACHRF) are specific for the site elevation and inlet air temperature specified in the site or maximum column, referenced from the table on the standard data sheet

22. Minimum heat recovery values represent the expected minimum heat recovery for the site, with applied minus tolerances. Do not use these values for cooling system sizing.

Constituent	Abbrev	Mole %	Norm
Water Vapor	H2O	0.0000	0.0000
Methane	CH4	92.2700	92.2700
Ethane	C2H6	2.5000	2.5000
Propane	C3H8	0.5000	0.5000
Isobutane	iso-C4H1O	0.0000	0.0000
Norbutane	nor-C4H1O	0.2000	0.2000
Isopentane	iso-C5H12	0.0000	0.0000
Norpentane	nor-C5H12	0.1000	0.1000
Hexane	C6H14	0.0500	0.0500
Heptane	C7H16	0.0000	0.0000
Nitrogen	N2	3.4800	3.4800
Carbon Dioxide	CO2	0.9000	0.9000
Hydrogen Sulfide	H2S	0.0000	0.0000
Carbon Monoxide	CO	0.0000	0.0000
Hydrogen	H2	0.0000	0.0000
Oxygen	O2	0.0000	0.0000
Helium	HE	0.0000	0.0000
Neopentane	neo-C5H12	0.0000	0.0000
Octane	C8H18	0.0000	0.0000
Nonane	C9H20	0.0000	0.0000
Ethylene	C2H4	0.0000	0.0000
Propylene	C3H6	0.0000	0.0000
TOTAL (Volume %)		100.0000	100.0000

Fuel Makeup:	Nat Gas
Unit of Measure:	English

Calculated Fuel Properties

Caterpillar Methane Number:	84.7
Lower Heating Value (Btu/scf):	905
Higher Heating Value (Btu/scf):	1004
WOBBE Index (Btu/scf):	1168
THC: Free Inert Ratio:	21.83
Total % Inerts (% N2, CO2, He):	4.38%
RPC (%) (To 905 Btu/scf Fuel):	100%
Compressibility Factor:	0.998
Stoich A/F Ratio (Vol/Vol):	9.45
Stoich A/F Ratio (Mass/Mass):	15.75
Specific Gravity (Relative to Air):	0.600
Fuel Specific Heat Ratio (K):	1.313

CONDITIONS AND DEFINITIONS

Caterpillar Methane Number represents the knock resistance of a gaseous fuel. It should be used with the Caterpillar Fuel Usage Guide for the engine and rating to determine the rating for the fuel specified. A Fuel Usage Guide for each rating is included on page 2 of its standard technical data sheet.

RPC always applies to naturally aspirated (NA) engines, and turbocharged (TA or LE) engines only when they are derated for altitude and ambient site conditions.

Project specific technical data sheets generated by the Caterpillar Gas Engine Rating Pro program take the Caterpillar Methane Number and RPC into account when generating a site rating.

Fuel properties for Btu/scf calculations are at 60F and 14.696 psia.

Caterpillar shall have no liability in law or equity, for damages, consequently or otherwise, arising from use of program and related material or any part thereof.

FUEL LIQUIDS

Field gases, well head gases, and associated gases typically contain liquid water and heavy hydrocarbons entrained in the gas. To prevent detonation and severe damage to the engine, hydrocarbon liquids must not be allowed to enter the engine fuel system. To remove liquids, a liquid separator and coalescing filter are recommended, with an automatic drain and collection tank to prevent contamination of the ground in accordance with local codes and standards.

To avoid water condensation in the engine or fuel lines, limit the relative humidity of water in the fuel to 80% at the minimum fuel operating temperature.

InVerde e+®

Inverter-Based Cogeneration

Tecogen's Unequaled Ultra-Low Emissions CHP Unit

Key Features & Benefits

Ultera
EMISSION CONTROL

- ***33% Electrical Efficiency (94% overall) - Best in Class!***
- Produce your own electricity 24/7 at half the cost of utility power
- **InVerde e+ patented variable speed operation allows for 10 kW to 125 kW output**
- Fully scalable from 10kW to multi-MW
- **Rapid black-start for Type 10 Emergency Power Supply System (EPSS),** with grid-independent operation (125 kVA)
- **Superior part load efficiency with turndown to 10% load**
- Ultra-low emissions levels, SCAQMD compliant and NJDEP exempt
- Inverter-based streamlined utility interconnection, UL1741 certified for safe utility connection
- Microgrid compatible with licensed CERTS power balancing control software
- **4" WC gas pressure requirement, no costly gas booster needed**
- **Cloud-based, real-time performance monitoring available via Tecogen's CHP Insight**
- **Demand response input for automated dispatching**
- Streamlined multi-unit controls for lowest in class installation cost
- Available with indoor or outdoor acoustic enclosure
- **DC input feature for seamless battery and solar PV integration**
- Provides additional LEED points (Optimize Energy Performance)
- UL1741 certified for standardized and safe utility interconnection
- Smallest footprint and lowest cost per kW

Renewable Energy Compatible,
a Clean Energy Solution for Today & Tomorrow

INTERTEK
C ETL US
LISTED

NYSIR Certified

CSA C22.2 #100 Certified

UL 2200 Certified

CSA C22.2 #14 Certified

UL 1741 Certified

Tecogen products are covered under one or more of the following U.S. patents: 8,578,704 · 7,239,034 · 7,243,017 and other patents pending

Tecogen Inc. • 45 First Avenue, Waltham, MA 02451 • 781-466-6400 • www.tecogen.com

Inverter-Based Cogeneration

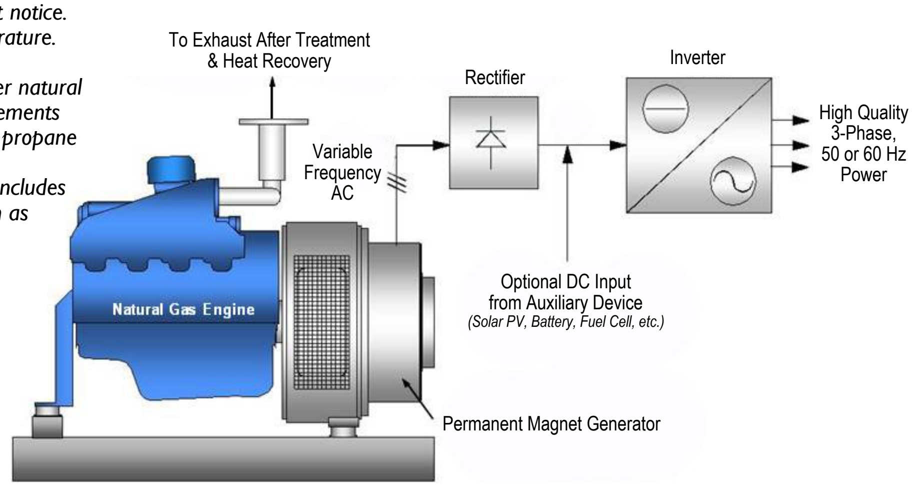
Specifications: [1, 2]

Engine	*Proven Low-Emission Industrial Natural Gas V-8 Engine, 700-2400 rpm*
Generator	*Water-Cooled Permanent Magnet Generator*
Inverter	*Customized Power Electronics with Patented Topology for Variable Speed and Standby Operation*
Controls	*TecoNet™ Microprocessor-Based System, Fully Automatic, Fault Monitoring, Lead/Lag Multiple Unit Control, Modbus / BACnet Networking & Remote Ethernet Communications*

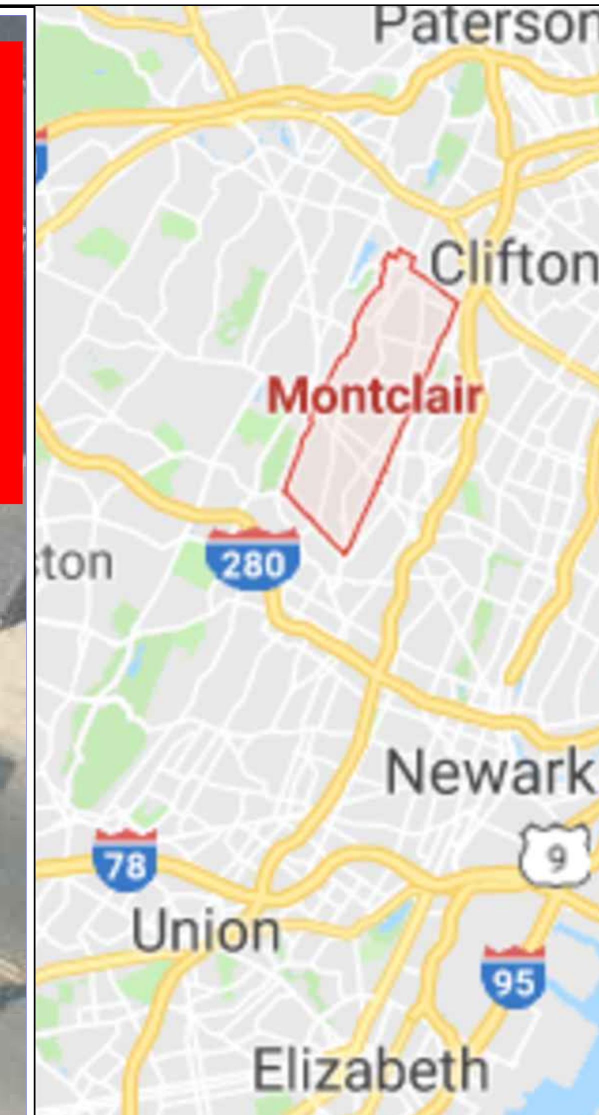
Electric Output (kW)	75	100	125
Standalone Electric Capacity[3]	100 kW / 125 kVA		
Emergency Power Rating[4]	TYPE 10 EPSS Approved		
Thermal Output			
Engine (Jacket/Exhaust/Oil))	466,000 Btu/hr	613,000 Btu/hr	780,000 Btu/hr
Generator/Power Electronics	20,000 Btu/hr	27,000 Btu/hr	31,000 Btu/hr
Total	486,000 Btu/hr	640,000 Btu/hr	811,000 Btu/hr
Gas Input	876 scfh	1152 scfh	1455 scfh
Electrical Efficiency			
@LHV of 905 Btu/scf	32.3%	32.7%	32.4%
@HHV of 1020 Btu/scf	28.6%	29.0%	28.4%
Overall Efficiency			
@LHV of 905 Btu/scf	93.5%	94.1%	93.6%
@HHV of 1020 Btu/scf	83.0%	83.5%	83.0%
Required Gas Pressure (when operating at full load)	4 - 12" WC		
Hot Water Flow	30 gpm		
Maximum Leaving Water Temperature	230 °F		
Maximum Entering Water Temperature	180 °F		
Air Emissions (SCAQMD & NJ DEP Compliant)[5]			
• **NOx**	< 0.07 lb/MWh		
• **CO**	< 0.2 lb/MWh		
• **VOC**	< 0.1 lb/MWh		
Electrical Service	480 V, 3 PH, 3-wire		
Operating & Storage Temperature Range	-4° to 104° F (-20° to 40° C)		
Acoustic Level	66 dBa @ 20'	67 dBa @ 20'	69dBa @ 20'
Weight (indoor / outdoor)	4,300 lb / 4,800 lb		
Dimensions (indoor / outdoor)	7'6"L x 4 0"W x 5'9"H / 7'10"L x 4'11"W x 6'4"H		

ETL Listed - Labeled for compliance with UL 1741- Utility Interactive; Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, UL 2200 - Stationary Engine Generator Assemblies, CSA C22.2 #100 - Motors and Generators and CSA C22.2 #14 - Industrial Control Equipment
NYSIR Certified - NY Department of Public Service, New York Standardized Interconnection Requirements

1. *All specifications are +/- 5% and are subject to change without notice.*
2. *Above performance data is valid up to 104° F ambient temperature.*
3. *Standalone capacity is the lesser of 100 kW or 125 kVA.*
4. *The **InVerde e+,** can act as an emergency generator wherever natural gas is an approved emergency fuel source. Fuel storage requirements can be satisfied by utilizing propane; automatic changeover to propane from natural gas available upon request.*
5. *Emission limits are based on the Ultera Emissions option and includes 60% system efficiency (HHV) credit for Distributed Generation as per SCAQMD Rule 1110.2.*



Tecogen®
Advanced Modular CHP Systems



PROJECT INFORMATION			
Project Latitude	----	Min. Ambient Temperature	----
Project Longitude	----	Max. Ambient Temperature	----
Utility Name	----	Meter Number	----
Wind Exposure Category	----	Wind Speed	----
Risk Category	----	North Direction	----
Interconnection Voltage	----	AHJ	----

ARRAY INFORMATION			
ARRAY 1			
Module Name	TSM-365DE14A (II)		
Inverter	SOLAREDGE		
Tilt Angle 5.0°	No. of Modules 137	DC String Length ----	No. of Strings ----
ARRAY 2			
Module Name			
Inverter			
Tilt Angle	No. of Modules	DC String Length	No. of Strings
ARRAY 3			
Module Name			
Inverter			
Tilt Angle	No. of Modules	DC String Length	No. of Strings

EZNERGY
Solar Energy Solutions

Rev	Description	Date	Drawn By
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Engineering Stamp

Company Contact Info

Company Name: ----
Company Address: ----
Company Phone: ----
Company FAX: ----
Company E-mail: ----

COMPANY LOGO

Customer ----

Project ----

Location ----

---- ----

Sheet Name
ARRAY LAYOUT

Designed By ----

Sheet Title PV E2.1

Project number ----

Sheets ----

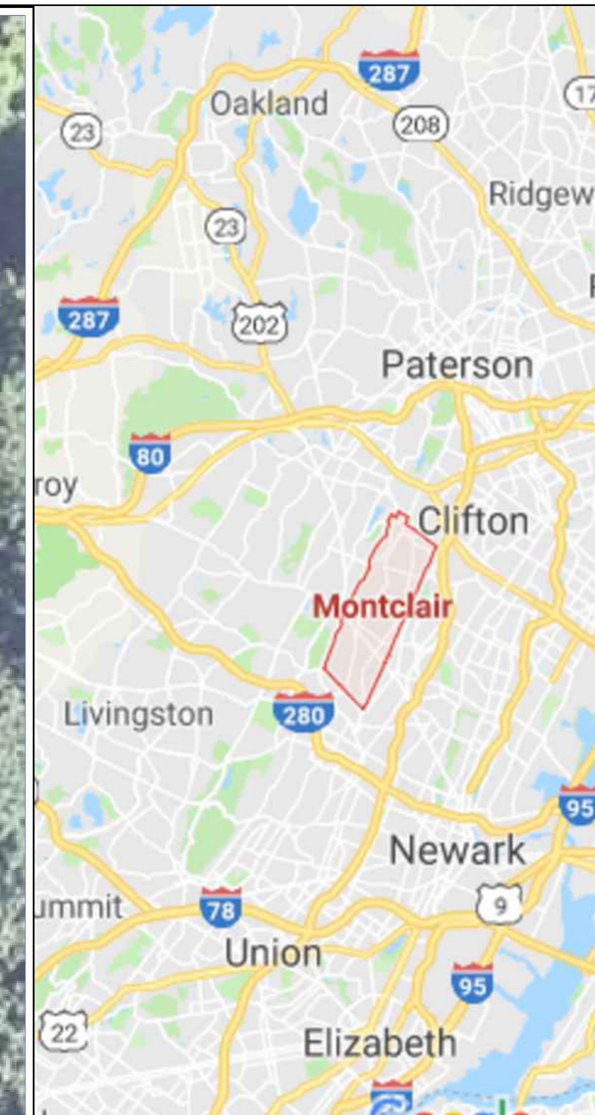
Issue

Sheet Number

FIRE HQ

1 PINE ST, MONTCLAIR, NJ 07042

TOTAL SYSTEM SIZE: 20.075 kW-DC
TOTAL MODULES: 55 X 365 WATTS EACH



PROJECT INFORMATION			
Project Latitude	----	Min. Ambient Temperature	----
Project Longitude	----	Max. Ambient Temperature	----
Utility Name	----	Meter Number	----
Wind Exposure Category	----	Wind Speed	----
Risk Category	----	North Direction	----
Interconnection Voltage	----	AHJ	----

ARRAY INFORMATION			
ARRAY 1			
Module Name	TSM-365DE14A (II)		
Inverter	SOLAREDGE		
Tilt Angle 25°	No. of Modules 55	DC String Length ----	No. of Strings ----
ARRAY 2			
Module Name			
Inverter			
Tilt Angle	No. of Modules	DC String Length	No. of Strings
ARRAY 3			
Module Name			
Inverter			
Tilt Angle	No. of Modules	DC String Length	No. of Strings

EZNERGY
Solar Energy Solutions

Rev	Description	Date	Drawn By
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Engineering Stamp

Company Contact Info

Company Name: ----
Company Address: ----
Company Phone: ----
Company FAX: ----
Company E-mail: ----

COMPANY LOGO

Customer ----

Project ----

Location

---- ----

Sheet Name
ARRAY LAYOUT

Designed By ----

Sheet Title PV E2.2

Project number ----

Sheets ----

Issue

Sheet Number

PROJECT INFORMATION			
Project Latitude	----	Min. Ambient Temperature	----
Project Longitude	----	Max. Ambient Temperature	----
Utility Name	----	Meter Number	----
Wind Exposure Category	----	Wind Speed	----
Risk Category	----	North Direction	----
Interconnection Voltage	----	AHJ	----

ARRAY INFORMATION			
ARRAY 1			
Module Name	TSM-365DE14A (II)		
Inverter	SOLAREDGE		
Tilt Angle 5.0°	No. of Modules 206	DC String Length ----	No. of Strings ----
ARRAY 2			
Module Name			
Inverter			
Tilt Angle	No. of Modules	DC String Length	No. of Strings
ARRAY 3			
Module Name			
Inverter			
Tilt Angle	No. of Modules	DC String Length	No. of Strings

EZNERGY
Solar Energy Solutions

Rev	Description	Date	Drawn By
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Engineering Stamp

Company Contact Info

Company Name: ----
Company Address: ----
Company Phone: ----
Company FAX: ----
Company E-mail: ----

COMPANY LOGO

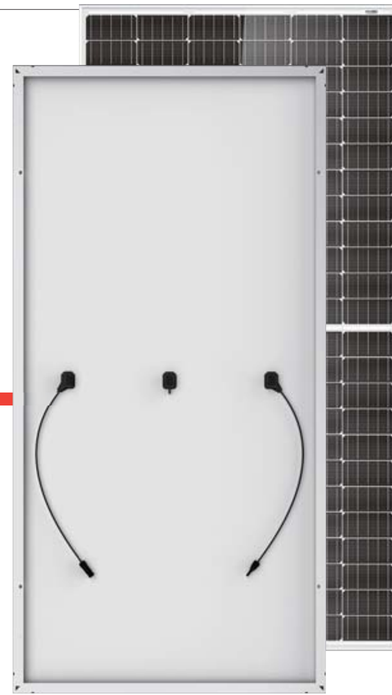
Customer ----
Project ---- ----
Location ---- ---- ---- ---- ----

Sheet Name: ARRAY LAYOUT

Designed By ----	Sheet Title PV E2.3			
Project number ----	Sheets ----	Issue	Sheet Number	

THE SPLITMAX

FRAMED 144-CELL MODULE (1500V)



144 CELL
MONOCRYSTALLINE MODULE

350-380W
POWER OUTPUT RANGE

19.2%
MAXIMUM EFFICIENCY

0~+5W
POSITIVE POWER TOLERANCE

Founded in 1997, Trina Solar is the world's leading comprehensive solutions provider for solar energy. we believe close cooperation with our partners is critical to success. Trina Solar now distributes its PV products to over 60 countries all over the world. Trina is able to provide exceptional service to each customer in each market and supplement our innovative, reliable products with the backing of Trina as a strong, bankable partner. We are committed to building strategic, mutually beneficial collaboration with installers, developers, distributors and other partners.

Comprehensive Products And System Certificates

IEC61215/IEC61730/UL1703/IEC61701/IEC62716
ISO 9001: Quality Management System
ISO 14001: Environmental Management System
ISO14064: Greenhouse gases Emissions Verification
OHSAS 18001: Occupation Health and Safety Management System

TÜV NORD | ISO 9001 | CE | RECYCLABLE PACKAGING | EU-28 WEEE COMPLIANT | PV CYCLE

Trinasolar

Ideal for large scale installations

- Reduce BOS cost by connecting more modules in a string
- 1500V IEC certified

Half-Cell design brings higher efficiency

- New cell string layout and split J-box location to reduct the energy loss caused by shading between modules
- LRF integrated to gain more power, need avoid light sensitive case
- Low thermal coefficients for greater energy production at high operating temperatures
- Low cell connection power lossing

Highly reliable due to stringent quality control

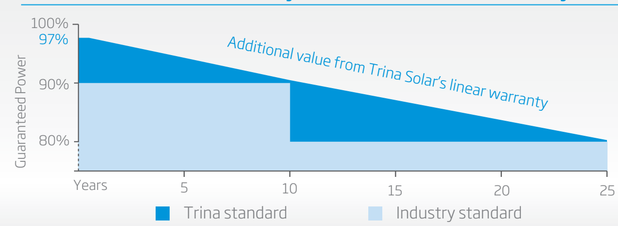
- Over 30 in-house tests (UV, TC, HF, and many more)
- In-house testing goes well beyond certification requirements
- PID resistant
- 100% EL double inspection

Certified to withstand the most challenging environmental conditions

- 2400 Pa negative load
- 5400 Pa positive load

LINEAR PERFORMANCE WARRANTY

10 Year Product Warranty · 25 Year Linear Power Warranty

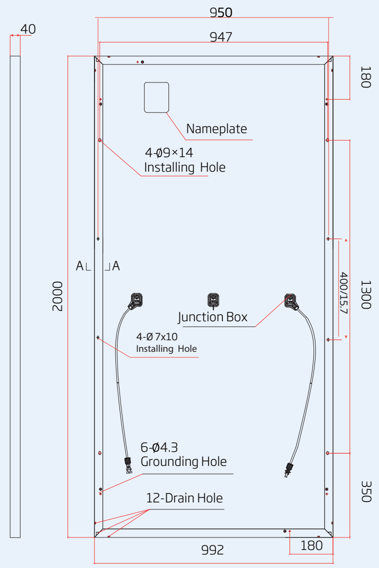


SPLITMAX

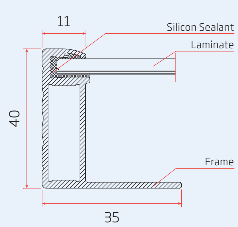
FRAMED 144-CELL MODULE (1500V)

PRODUCTS	POWER RANGE
TSM-DE14H(II)	350-380W

DIMENSIONS OF PV MODULE(mm)

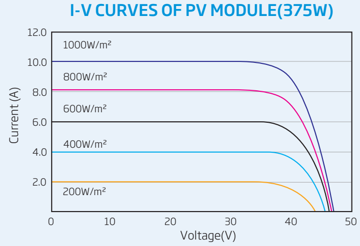


Back View

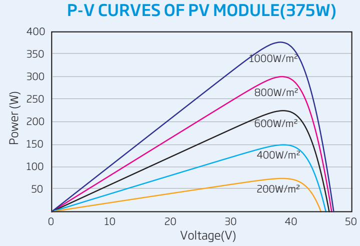


(A-A)

I-V CURVES OF PV MODULE(375W)



P-V CURVES OF PV MODULE(375W)



ELECTRICAL DATA (STC)

Peak Power Watts-P_{MAX} (Wp)*	350	355	360	365	370	375	380
Power Output Tolerance-P_{MAX} (W)	0 ~ +5						
Maximum Power Voltage-V_{MPP} (V)	38.4	38.6	38.8	39.0	39.2	39.4	39.6
Maximum Power Current-I_{MPP} (A)	9.13	9.21	9.28	9.37	9.44	9.52	9.60
Open Circuit Voltage-V_{OC} (V)	46.5	46.9	47.2	47.4	47.6	47.8	48.0
Short Circuit Current-I_{SC} (A)	9.60	9.68	9.73	9.83	9.88	9.93	9.99
Module Efficiency η_m (%)	17.6	17.9	18.1	18.4	18.6	18.9	19.2

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Measuring tolerance: ±3%.

ELECTRICAL DATA (NOCT)

Maximum Power-P_{MAX} (Wp)	260	263	267	271	271	278	282
Maximum Power Voltage-V_{MPP} (V)	35.6	35.8	36.1	36.2	36.5	36.7	36.9
Maximum Power Current-I_{MPP} (A)	7.29	7.35	7.39	7.47	7.51	7.57	7.63
Open Circuit Voltage-V_{OC} (V)	43.2	43.5	43.8	44.0	44.2	44.3	44.5
Short Circuit Current-I_{SC} (A)	7.75	7.82	7.86	7.94	7.98	8.02	8.07

NOCT: Irradiance at 800W/m², Ambient Temperature 20°C, Wind Speed 1m/s.

MECHANICAL DATA

Solar Cells	Monocrystalline 156.75 × 78.375 mm (6× 3 inches)
Cell Orientation	144 cells (6× 24)
Module Dimensions	2000× 992 × 40 mm (78.7 × 39.1 × 1.57 inches)
Weight	23 kg (50.7 lb) with 3.2 mm glass; 26.5 kg (58.4 lb) with 4.0 mm glass
Glass	3.2 mm (0.13 inches) for Std Mono; 4.0mm(0.16 inches) for Perc Mono High Transmission, AR Coated Tempered Glass
Backsheet	White
Frame	Silver Anodized Aluminium Alloy
J-Box	IP 67 or IP 68 rated
Cables	Photovoltaic Technology Cable 4.0mm² (0.006 inches²), Portrait: N 140mm/P 285mm((5.5/11.2inches) Landscape: N 1400 mm/P 1400 mm (55.1/55.1 inches)
Connector	Trina TS4

TEMPERATURE RATINGS

NOCT (Nominal Operating Cell Temperature)	44°C (±2°C)
Temperature Coefficient of P_{MAX}	- 0.39%/°C
Temperature Coefficient of V_{OC}	- 0.29%/°C
Temperature Coefficient of I_{SC}	0.05%/°C

MAXIMUM RATINGS

Operational Temperature	-40~+85°C
Maximum System Voltage	1500V DC (IEC)
Max Series Fuse Rating	15A

(DO NOT connect Fuse in Combiner Box with two or more strings in parallel connection)

WARRANTY

10 year Product Workmanship Warranty

25 year Linear Power Warranty

(Please refer to product warranty for details)

PACKAGING CONFIGURATION

Modules per box: 27 pieces

Modules per 40' container: 594 pieces

Trinasolar

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

Version number: TSM_EN_2018_A www.trinasolar.com

INVERTERS

SolarEdge Commercial Three Phase Inverters for the 277/480V Grid

for North America

SE66.6K-SE100K

Specifically designed to work with power optimizers

- Easy two-person installation – each unit mounted separately, equipped with cables for simple connection between units
- Balance of System and labor reduction compared to using multiple smaller string inverters
- Independent operation of each unit enables higher uptime and easy serviceability
- No wasted ground area: wall/rail mounted, or horizontally mounted under the modules (10˚ inclination)
- Integrated arc fault protection and rapid shutdown for NEC 2014 and 2017, per article 690.11 and 690.12
- Built-in module-level monitoring with Ethernet or cellular GSM
- Fixed voltage inverter for superior efficiency (98.5%) and longer strings
- Integrated DC Safety Switch and optional surge protection & DC fuses (plus & minus)
- Built-in RS485 Surge Protection Device, to better withstand lightning events

SolarEdge Commercial Three Phase Inverters for the 277/480V Grid for North America SE66.6K-SE100K

	SE66.6K	SE100K	
OUTPUT			
Rated AC Power Output	66600	100000	VA
Maximum AC Power Output	66600	100000	VA
AC Output Line Connections	4-wire WYE (L1-L2-L3-N) plus PE		
AC Output Voltage Minimum-Nominal-Maximum(1) (L-N)	244 - 277 - 305		Vac
AC Output Voltage Minimum-Nominal-Maximum(1) (L-L)	422.5 - 480 - 529		Vac
AC Frequency Min-Nom-Max(1)	59.3 - 60 - 60.5		Hz
Maximum Continuous Output Current (per Phase) @277V	80	120	A
GFDI Threshold	1		A
Utility Monitoring, Islanding Protection, Configurable Power Factor, Country Configurable Thresholds	Yes		
INPUT			
Maximum DC Power (Module STC)	90000 / 45000	135000 / 45000	W
Transformer-less, Ungrounded	Yes		
Maximum Input Voltage DC to Gnd	500		Vdc
Maximum Input Voltage DC+ to DC-	1000		Vdc
Nominal Input Voltage DC to Gnd	425		Vdc
Nominal Input Voltage DC+ to DC-	850		Vdc
Maximum Input Current	80	120	Adc
Maximum Input Short Circuit Current	120		Adc
Reverse-Polarity Protection	Yes		
Ground-Fault Isolation Detection	350kΩ Sensitivity per Unit		
CEC Weighted Efficiency	98.5		%
Nighttime Power Consumption	< 12		W
ADDITIONAL FEATURES			
Supported Communication Interfaces	RS485, Ethernet, Cellular GSM (optional)		
Rapid Shutdown	NEC2014 and NEC2017 compliant/certified, upon AC Grid Disconnect		
RS485 Surge Protection	Built-in		
DC SAFETY SWITCH			
DC Disconnect	1000V / 2 x 40A	1000V / 3 x 40A	
DC Surge Protection	Optional, Type II, field replaceable		
DC Fuses on Plus & Minus	Optional, 30A		
STANDARD COMPLIANCE(2)			
Safety	UL1741, UL1741 SA, UL1699B, UL1998, CSA 2.22		
Grid Connection Standards	IEEE 1547, Rule 21, Rule 14 (HI)		
Emissions	FCC part15 class A		
INSTALLATION SPECIFICATIONS			
Number of units	2	3	
AC Output Conduit Size / Max AWG / Max PE AWG	1.5" / 2/0 / 6	2" / 4/0 / 4	
DC Output Conduit Size / Terminal Block AWG Range / Number of Strings(3)	2 x 1.25" / 6-14 / 6 strings	2 x 1.25" / 6-14 / 9 strings	
Dimensions (H x W x D)	Primary Unit: 37 x 12.5 x 10.5 / 940 x 315 x 260; Secondary Unit: 21 x 12.5 x 10.5 / 540 x 315 x 260		in / mm
Weight	Primary Unit: 105.8 / 48; Secondary Unit 99.2 / 45		lb / kg
Operating Temperature Range	-13 to +140 / -25 to +60(4) (-40˚F / -40˚C option)		˚F / ˚C
Cooling	Fan (user replaceable)		
Noise	< 60		dBA
Protection Rating	NEMA 3R		
Bracket Mounted (Brackets Provided)			

(1) For other regional settings please contact SolarEdge support
(2) Pending
(3) Single input option per unit (up to 3AWG) available
(4) De-rating from 50˚C

CE

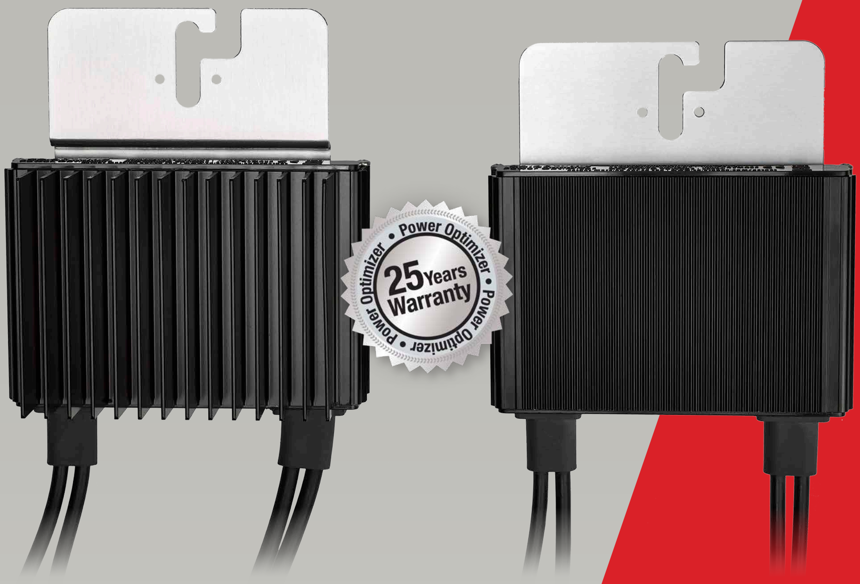
solaredge

SolarEdge Power Optimizer

Module Add-On For North America

P320 / P370 / P400 / P405 / P505

POWER OPTIMIZER



PV power optimization at the module-level

- Specifically designed to work with SolarEdge inverters
- Up to 25% more energy
- Superior efficiency (99.5%)
- Mitigates all types of module mismatch losses, from manufacturing tolerance to partial shading
- Flexible system design for maximum space utilization
- Fast installation with a single bolt
- Next generation maintenance with module-level monitoring
- Compliant with arc fault protection and rapid shutdown NEC requirements (when installed as part of the SolarEdge system)
- Module-level voltage shutdown for installer and firefighter safety

SolarEdge Power Optimizer

Module Add-On for North America

P320 / P370 / P400 / P405 / P505

OPTIMIZER MODEL (typical module compatibility)	P320 (for high-power 60-cell modules)	P370 (for higher-power 60 and 72-cell modules)	P400 (for 72 & 96-cell modules)	P405 (for thin film modules)	P505 (for higher current modules)	
INPUT						
Rated Input DC Power[1]	320	370	400	405	505	W
Absolute Maximum Input Voltage (Voc at lowest temperature)	48	60	80	125	83	Vdc
MPPT Operating Range	8 - 48	8 - 60	8 - 80	12.5 - 105	12.5 - 83	Vdc
Maximum Short Circuit Current (Isc)	11		10.1		14	Adc
Maximum DC Input Current	13.75		12.63		17.5	Adc
Maximum Efficiency	99.5					%
Weighted Efficiency	98.8				98.6	%
Overvoltage Category	II					
OUTPUT DURING OPERATION (POWER OPTIMIZER CONNECTED TO OPERATING SOLAREDGE INVERTER)						
Maximum Output Current	15					Adc
Maximum Output Voltage	60			85		Vdc
OUTPUT DURING STANDBY (POWER OPTIMIZER DISCONNECTED FROM SOLAREDGE INVERTER OR SOLAREDGE INVERTER OFF)						
Safety Output Voltage per Power Optimizer	1 ± 0.1					Vdc
STANDARD COMPLIANCE						
EMC	FCC Part15 Class B, IEC61000-6-2, IEC61000-6-3					
Safety	IEC62109-1 (class II safety), UL1741					
RoHS	Yes					
INSTALLATION SPECIFICATIONS						
Maximum Allowed System Voltage	1000					Vdc
Compatible inverters	All SolarEdge Single Phase and Three Phase inverters					
Dimensions (W x L x H)	128 x 152 x 28 / 5 x 5.97 x 1.1		128 x 152 x 36 / 5 x 5.97 x 1.42	128 x 152 x 50 / 5 x 5.97 x 1.96	128 x 152 x 59 / 5 x 5.97 x 2.32	mm / in
Weight (including cables)	630 / 1.4		750 / 1.7	845 / 1.9	1064 / 2.3	gr / lb
Input Connector	MC4[2]					
Output Wire Type / Connector	Double Insulated; MC4					
Output Wire Length	0.95 / 3.0	1.2 / 3.9				m / ft
Operating Temperature Range	-40 - +85 / -40 - +185					˚C / ˚F
Protection Rating	IP68 / NEMA6P					
Relative Humidity	0 - 100					%

[1] Rated STC power of the module. Module of up to +5% power tolerance allowed.

[2] For other connector types please contact SolarEdge

PV SYSTEM DESIGN USING A SOLAREDGE INVERTER[3][4]		SINGLE PHASE HD-WAVE	SINGLE PHASE	THREE PHASE 208V	THREE PHASE 480V	
Minimum String Length (Power Optimizers)	P320, P370, P400	8		10	18	
	P405 / P505	6		8	14	
Maximum String Length (Power Optimizers)		25		25	50[5]	
Maximum Power per String		5700 (6000 with SE7600H-US, SE10000H-US)	5250	6000	12750	W
Parallel Strings of Different Lengths or Orientations		Yes				

[3] For detailed string sizing information refer to: http://www.solaredge.com/sites/default/files/string_sizing_na.pdf.

[4] It is not allowed to mix P405/P505 with P320/P370/P400/P600/P700/P800 in one string.

[5] A string with more than 30 optimizers does not meet NEC rapid shutdown requirements; safety voltage will be above the 30V requirement

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

61,493 kWh/Year*

System output may range from 59,150 to 64,414 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	2.31	3,079	458
February	3.26	3,930	585
March	4.06	5,258	782
April	5.33	6,384	950
May	5.63	6,807	1,013
June	6.30	7,170	1,067
July	6.34	7,369	1,096
August	5.55	6,468	962
September	4.76	5,390	802
October	3.32	4,037	601
November	2.51	3,076	458
December	1.95	2,525	376
Annual	**4.28**	**61,493**	**$ 9,150**

Location and Station Identification

Requested Location	60 glenridge ave, montclair, nj 07042
Weather Data Source	Lat, Lon: 40.81, -74.22 0.6 mi
Latitude	40.81° N
Longitude	74.22° W

PV System Specifications *(Residential)*

DC System Size	50 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	5°
Array Azimuth	215°
System Losses	11.42%
Inverter Efficiency	98%
DC to AC Size Ratio	1.1

Economics

Average Retail Electricity Rate	0.149 $/kWh

Performance Metrics

Capacity Factor	14.0%

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

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The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

25,934 kWh/Year*

System output may range from 24,946 to 27,166 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.91	1,577	235
February	3.88	1,872	279
March	4.41	2,277	339
April	5.22	2,498	372
May	5.35	2,599	387
June	5.75	2,638	393
July	5.94	2,778	413
August	5.50	2,568	382
September	5.03	2,277	339
October	3.80	1,869	278
November	3.19	1,593	237
December	2.61	1,388	207
Annual	**4.47**	**25,934**	**$ 3,861**

Location and Station Identification

Requested Location	1 pine st, montclair, nj 07042
Weather Data Source	Lat, Lon: 40.81, -74.22 0.6 mi
Latitude	40.81° N
Longitude	74.22° W

PV System Specifications *(Residential)*

DC System Size	20.075 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	40°
Array Azimuth	125°
System Losses	11.42%
Inverter Efficiency	98%
DC to AC Size Ratio	1.1

Economics

Average Retail Electricity Rate	0.149 $/kWh

Performance Metrics

Capacity Factor	14.7%

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The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

92,229 kWh/Year*

System output may range from 88,715 to 96,610 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	2.27	4,541	676
February	3.23	5,859	872
March	4.05	7,878	1,172
April	5.31	9,565	1,423
May	5.65	10,289	1,531
June	6.31	10,806	1,608
July	6.36	11,116	1,654
August	5.57	9,759	1,452
September	4.75	8,098	1,205
October	3.28	6,010	894
November	2.48	4,569	680
December	1.93	3,739	556
Annual	**4.27**	**92,229**	**$ 13,723**

Location and Station Identification

Requested Location	25 maple ave, montclair, nj 07042
Weather Data Source	Lat, Lon: 40.81, -74.22 0.5 mi
Latitude	40.81° N
Longitude	74.22° W

PV System Specifications *(Residential)*

DC System Size	75.19 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	5°
Array Azimuth	135°
System Losses	11.42%
Inverter Efficiency	98%
DC to AC Size Ratio	1.1

Economics

Average Retail Electricity Rate	0.149 $/kWh

Performance Metrics

Capacity Factor	14.0%

NEC ENERGY SOLUTIONS

DSS®
Distributed Storage Solution

NEC Energy Solution's Distributed Storage Solution (DSS®) enables advanced energy management and resiliency services for commercial & industrial customers and the utilities that serve them.

The relationship between utilities and commercial & industrial customers is being transformed as enterprises produce as well as consume electricity and actively manage the amount and timing of their energy use. The fully integrated DSS® platform enables next-generation energy storage-based services on both sides of the electricity meter: reducing energy costs and increasing resiliency for commercial & industrial enterprises, while improving efficiency, predictability, and distributed resource dispatchability for utilities.

The DSS® platform integrates energy storage, power conversion and system controls into a range of flexible outdoor-rated configurations that are simpler, smarter, and safer than other point products. DSS® systems may operate autonomously, within an enterprise energy management system, under utility or local SCADA control, as part of an aggregator's virtual power plant, or any combination of these.

EXAMPLE APPLICATIONS

The DSS® platform allows integrators and service providers to deliver advanced energy management services to enterprises and/or utilities.

For commercial & industrial enterprises, DSS® systems support emerging 'behind-the-meter' services including:

- Demand charge management
- Demand response
- Power quality and resiliency
- Distributed/renewable generation integration
- Time-of-use management

For utilities, DSS® systems deliver distribution grid 'front-of-the-meter' services including:

- Dispatchable load and demand management
- T&D congestion relief and upgrade deferral
- Voltage support
- Renewable capacity firming/ramp management
- Distributed ancillary services

KEY FEATURES

2 BAY UNIT

ENERGY (kWh)	POWER (kW)
85	100
170	100
	280

4 BAY UNIT

ENERGY (kWh)	POWER (kW)
255	100
	280
340	100
	280
	710

6 BAY UNIT

ENERGY (kWh)	POWER (kW)
425	100
	280
	710
510	100
	280
	710

NOTES

- The 710kW option requires separate MV transformer (not included).
- In addition to PCS options shown above, DSS® systems are offered without a PCS enabling custom configurations. The AC interconnect is replaced by a 720V (nominal) DC bus.

Proven Battery Technology

The DSS® platform uses proven industry-leading lithium-ion battery storage technologies, leveraging years of operational experience of NEC Energy Solution's leading GSS® product lines. In the DSS® system, NEC Energy Solutions offers the optimal technology for typical demand charge management and similar peak shaving applications.

Flexible Power Conversion

Pre-integrated, 4 quadrant, bi-directional inverters are available within the DSS® systems. Choose from remote-mounted 100kW, 280kW, or 710W component PCS options, all provided as fully integrated, ready-to-install systems.

Powerful AEROS® Controls

NEC Energy Solution's AEROS® Controls, with C&I optimized Demand Charge Reduction, Peak Shaving, and Load Limiting applications, is provided with every DSS system. The complete AEROS® application suite, including functions for grid ancillary services, volt/VAR control, ramp rate management, and other applications is also available.

Pre-Engineered Environmental Control

Mechanical system optimization and serviceability is key to maximizing overall system life and availability. DSS pre-engineered systems leverage NEC Energy's years of experience developing systems used in harsh environments around the world.

Robust Safety

System safety can never be compromised, and DSS® systems use the same multi-level safety approach — at the cell, module, rack, and system level — for which NEC Energy Solutions is known. Integrated fire suppression is also available as an option.

Installation Simplicity

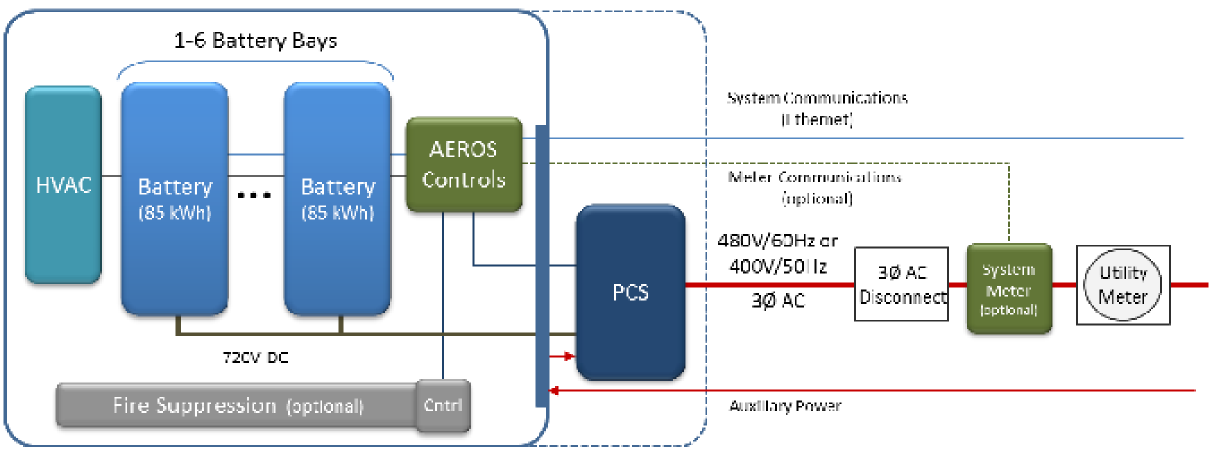
DSS® systems are designed for fast, straightforward installation by typical commercial electrical contractors. Power and communications connections are conventional and common to standard industrial grade facility products.

System Characteristics	
Energy Options	85, 170, 255, 340, 425 and 510 kWh
Power Conversion Options	100, 280, and 710 kW[1]
DC Voltage	720 V
Controls	AEROS® Applications Suite
AC Interfaces	480V / 60Hz or 400VAC / 50Hz 3Ø, 4 wire
Communications	Ethernet/IP HTTP/HTTPS Modbus (TCP/IP) Options for DNP3.0, IEC61850
Enclosures	NEMA 4 / IP65, in 2, 4 and 6 bay configurations Separate PCS cabinets rated IP54
Operating Temp	-25°C to 50°C
Standards and Compliance (partial list)	UL 9540, 1973, 1642 IEC 61508, 62040-1; UN 38.3, CE, NFPA 70 FCC CPR Part 15, Class A IEC 61000-6-2,4,5 & -7 PCS: UL 1741(SA), G59/3, IEEE 1547 Seismic: IEEE 693-2005

1. 100, 280 and 710 kW PCS options provided in separate, pre-integrated, remotely mounted cabinets.

EXAMPLE INSTALLATION

DSS® - Distributed Storage Solution



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NEC
NEC ENERGY SOLUTIONS

NEC Energy Solutions, Inc.
Phone: +1.508.497.7319
Web: **www.neces.com**

—chargepoin+

CT4000 Level 2 Commercial Charging Station

Specifications and Ordering Information

Ordering Information

Specify model number followed by the applicable code(s). The order code sequence is: **Model-Options**. **Software**, **Services** and **Misc** are ordered as separate line items.

Hardware

Description		Order Code
Model	1830 mm (6') Single Port Bollard Mount 1830 mm (6') Dual Port Bollard Mount	CT4011 CT4021
	1830 mm (6') Single Port Wall Mount 1830 mm (6') Dual Port Wall Mount	CT4013 CT4023
	2440 mm (8') Dual Port Bollard Mount 2440 mm (8') Dual Port Wall Mount	CT4025 CT4027
Options	Integral Gateway Modem - USA Integral Gateway Modem - Canada	-GW1 -GW2
Misc	Power Management Kit Bollard Concrete Mounting Kit	CT4000-PMGMT CT4001-CCM

Software & Services

Description	Order Code
ChargePoint Commercial Service Plan	CTSW-SAS-COMM-*n*[1]
ChargePoint Service Provider Plan	CTSW-SAS-SP-*n*[1]
ChargePoint Assure	CT4000-ASSURE*n*[2]
Station Activation and Configuration	CPSUPPORT-ACTIVE
ChargePoint Station Installation and Validation	CT4000-INSTALLVALID

Note: All CT4000 stations require a network service plan.

[1] Substitute *n* for desired years of service (1, 2, 3, 4, or 5 years).
[2] Substitute *n* for the duration of the coverage (1, 2, 3, 4, or 5 years).

Order Code Examples

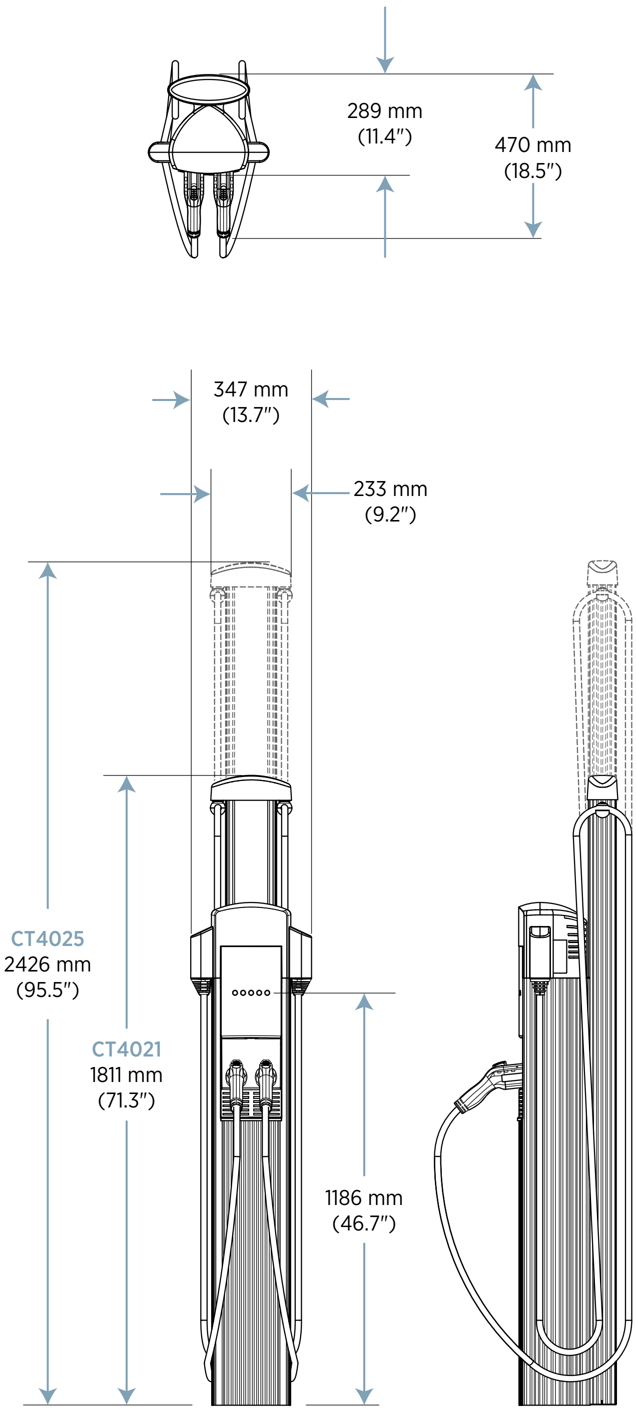
If ordering this	the order code is
1830 mm (6') Dual Port Bollard USA Gateway Station with Concrete Mounting Kit	CT4021-GW1 CT4001-CCM
ChargePoint Commercial Service Plan, 3 Year Subscription	CTSW-SAS-COMM-3
ChargePoint Station Installation and Validation	CT4000-INSTALLVALID
2 Years of Assure Coverage	CT4000-ASSURE2
1830 mm (6') Single Port Wall Mount Station	CT4013
ChargePoint Commercial Service Plan, 5 Year Subscription	CTSW-SAS-COMM-5
4 Years of Assure Coverage	CT4000-ASSURE4
Station Activation and Configuration	CPSUPPORT-ACTIVE

CT4021

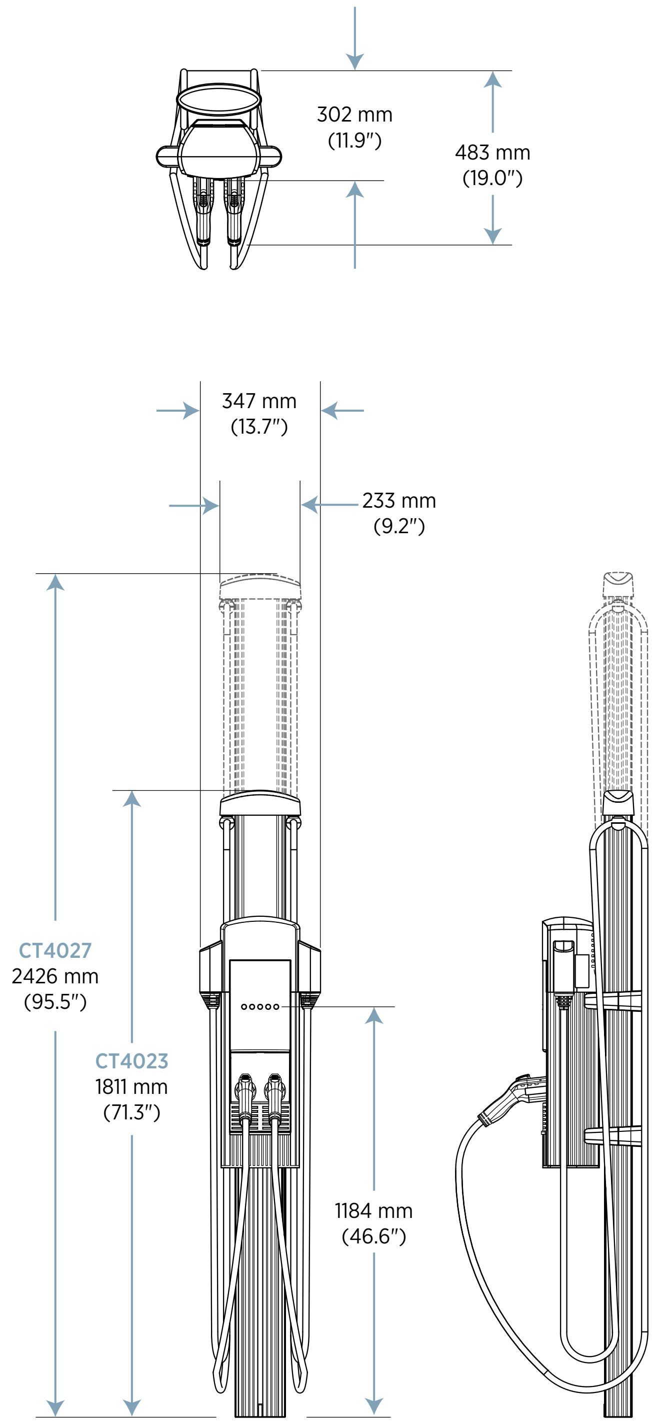
ENERGY STAR

The First
ENERGY STAR®
Certified EV Charger

CT4021 1830 mm (6′)
CT4025 2440 mm (8′)
Bollard



CT4023 1830 mm (6′)
CT4027 2440 mm (8′)
Wall Mount



CT4000 Family Specifications

Electrical Input	Single Port (AC Voltage 208/240V AC)			Dual Port (AC Voltage 208/240V AC)		
	Input Current	Input Power Connection	Required Service Panel Breaker	input Current	Input Power Connection	Required Service Panel Breaker
Standard	30A	One 40A branch circuit	40A dual pole (non-GFCI type)	30A x 2	Two independent 40A branch circuits	40A dual pole (non-GFCI type) x 2
Standard Power Share	n/a	n/a	n/a	32A	One 40A branch circuit	40A dual pole (non-GFCI type)
Power Select 24A	24A	One 30A branch circuit	30A dual pole (non-GFCI type)	24A x 2	Two independent 30A branch circuits	30A dual pole (non-GFCI type) x 2
Power Select 24A Power Share	n/a	n/a	n/a	24A	One 30A branch circuit	30A dual pole (non-GFCI type)
Power Select 16A	16A	One 20A branch circuit	20A dual pole (non-GFCI type)	16A x 2	Two independent 20A branch circuits	20A dual pole (non-GFCI type) x 2
Power Select 16A Power Share	n/a	n/a	n/a	16A	One 20A branch circuit	20A dual pole (non-GFCI type)
Service Panel GFCI	Do not provide external GFCI as it may conflict with internal GFCI (CCID)					
Wiring - Standard	3-wire (L1, L2, Earth)			5-wire (L1, L1, L2, L2, Earth)		
Wiring - Power Share	n/a			3-wire (L1, L2, Earth)		
Station Power	8W typical (standby), 15W maximum (operation)					

Electrical Output

Standard	7.2kW (240V AC @ 30A)	7.2kW (240V AC@30A) x 2
Standard Power Share	n/a	7.2kW (240V AC@30A) x 1 **or** 3.8kW (240V AC@16A) x 2
Power Select 24A	5.8kW (240V AC@24A)	5.8kW (240V AC@24A) x 2
Power Select 24A Power Share	n/a	5.8kW (240V AC@24A) x 1 **or** 2.9kW (240V AC@12A) x 2
Power Select 16A	3.8kW (240V AC@16A)	3.8kW (240V AC@16A) x 2
Power Select 24A Power Share	n/a	3.8kW (240V AC@16A) x 1 **or** 1.9kW (240V AC@8A) x 2

Functional Interfaces

Connector(s) Type	SAE J1772™	SAE J1772™ x 2
Cable Length - 1830 mm (6') Cable Management	5.5 m (18')	5.5 m (18') x 2
Cable Length - 2440 mm (8') Cable Management	n/a	7 m (23')
Overhead Cable Management System	Yes	
LCD Display	145 mm (5.7") full color, 640x480, 30fps full motion video, active matrix, UV protected	
Card Reader	ISO 15693, ISO 14443, NFC	
Locking Holster	Yes	Yes x 2

Safety and Connectivity Features

Ground Fault Detection	20mA CCID with auto retry
Open Safety Ground Detection	Continuously monitors presence of safety (green wire) ground connection
Plug-Out Detection	Power terminated per SAE J1772™ specifications
Power Measurement Accuracy	+/- 2% from 2% to full scale (30A)
Power Report/Store Interval	15 minute, aligned to hour
Local Area Network	2.4 GHz Wi-Fi (802.11 b/g/n)
Wide Area Network	3G GSM, 3G CDMA

Safety and Operational Ratings

Enclosure Rating	Type 3R per UL 50E
Safety Compliance	UL listed for USA and cUL certified for Canada; complies with UL 2594, UL 2231-1, UL 2231-2, and NEC Article 625
Surge Protection	6kV @ 3000A. In geographic areas subject to frequent thunder storms, supplemental surge protection at the service panel is recommended.
EMC Compliance	FCC Part 15 Class A
Operating Temperature	-30°C to +50°C (-22°F to 122°F)
Storage Temperature	-30°C to +60°C (-22°F to 140°F)
Non-Operating Temperature	-40°C to +60°C (-40°F to 140°F)
Operating Humidity	Up to 85% @ +50°C (122°F) non-condensing
Non-Operating Humidity	Up to 95% @ +50°C (122°F) non-condensing
Terminal Block Temperature Rating	105°C (221°F)
Charging Stations per 802.11 Radio Group	Maximum of 10. Each station must be located within 45m (150') "line of sight" of a gateway station.

ChargePoint, Inc. reserves the right to alter product offerings and specifications at any time without notice, and is not responsible for typographical or graphical errors that may appear in this document.

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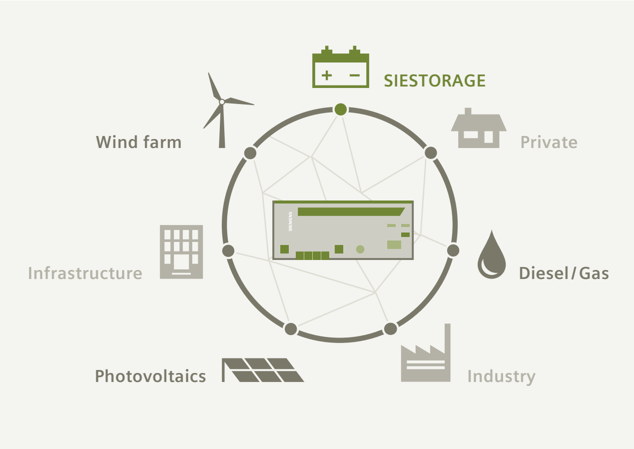
SIEMENS

siemens.com/smartgrid

SICAM Microgrid Controller – for reliable and economical control of microgrids

All applications in one common product concept



SICAM TM

Microgrids – the significant alternative for stand-alone grids

A high level of availability and power quality, and the potential for operation independent from the supply grid: Wherever a stand-alone grid is feasible or necessary, microgrids are a significant alternative. One of the most important challenges is monitoring and controlling the grid. The Siemens SICAM Microgrid Controller is ready for the task. It was developed and sucessfully tested within the IREN2 project in Wildpoldsried, Germany.

SICAM Microgrid Controller – part of Siemens RTU product family

As part of the continuation of the well-known Siemens RTU product family, the SICAM Microgrid Controller benefits from long-term experience and proven references world-wide. It provides flexible communication, seamless conti-nuity, maximum security, and no limitation during the migration. In short: You get all the applications you would expect in one common product concept, to ensure the optimized usage of your generation systems.

SICAM Microgrid Controller for mounting and communication

- Seamless integration in existing automation networks
- Easy interaction between automation and remote control
- Direct connection of actuators and sensors
- Consistency, from acquisition to output
- Functional safety in the process instrumentation

SICAM Microgrid Controller for monitoring and control

- Asset monitoring
- Blackout detection, black start and automated grid modes
- Automatic start of backup generators
- Generation offsetting and balancing
- Reserve management
- Peak shaving
- State of charge management
- Economic and environmental indices

SICAM Microgrid Controller – the applications in detail

Asset monitoring
- Integration of measurement and monitoring devices
- Automatic derivation of required system response

Blackout detection, black start and automated grid modes
- Blackout detection by evaluation of related measurements
- Automatic re-powering of the microgrid by execution of black start sequence
- Automatic re-synchronization to distribution grid after blackout
- Control of voltage and frequency to ensure network stability

Automatic start of backup generators
- Protection against short circuits and errors
- Reduced operating costs by using diesel generators mainly as backup

Generation offsetting and balancing
- Minimized fuel costs and challenges linked to fossil fuel supply
- Improved diesel generator performance
- Optimized diesel generator efficiency

Reserve management
- Stable grid operation through consideration of spinning reserve requirements
- Balance of fluctuations in renewable generation
- Shed of excess energy in response to voltage / frequency

Peak shaving
- Optimal shift or reduction of peak loads
- Storage of energy during low demand periods

State of charge management
- Storage of energy in case of excess renewable energy
- Ensure minimum energy content
- Charge / discharge schedules

Economic and environmental indices
- CO_2 avoided
- Fuel cost

SICAM Microgrid Controller – the highlights at a glance

- No limitation during the migration as a result of open interfaces and international standards
- Flexible communication thanks to compatible transfer media and protocols
- Easy maintenance through plug-and-play SD cards
- Seamless continuity via scalable base products
- Intuitive operation utilizing the SICAM Toolbox II and SICAM WEB
- Interdisciplinary engineering made possible by standardized configuration
- Maximum security with comprehensive cyber security features

Siemens AG
Energy Management Division
Freyeslebenstrasse 1
91058 Erlangen
Germany

Order No. EMDG-B10012-00-4A00 | Printed in Germany |
Dispo 6200 | HL 15071262 WS 09152.0 |

SIEMENS

SCALANCE X - Industrial Ethernet Switches

SIMATIC NET

Brochure

Edition September 2013

Answers for industry.

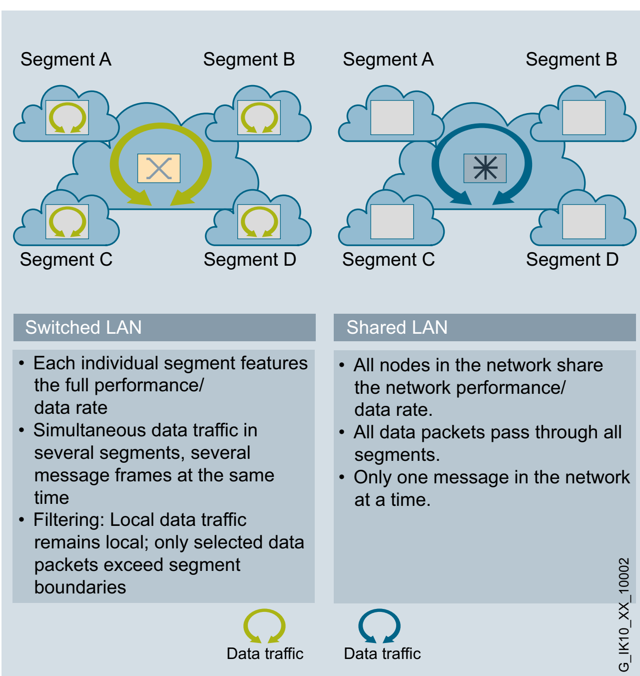
Industrial Ethernet

Advantages of the switching technology

Industrial Ethernet Switches are active network components that support the different network topologies:
Networks can be constructed with switches in electrical or optical line, star and ring topologyologies. These active network components specifically distribute data to the relevant addressees.

SIMATIC NET offers the right Industrial Ethernet switch or a component with switch functionality for every application:

- Compact Switch Modules (CSMs) for additional ports directly on SIMATIC
- Unmanaged and managed switches of the SCALANCE X product group, perfectly tuned to the respective automation and networking task for integration in PROFINET
- Communication processors (CPs) for SIMATIC and the PC that handle the switching of smaller network segments in addition to their actual task, supporting the CPU in communication tasks



Switched LAN

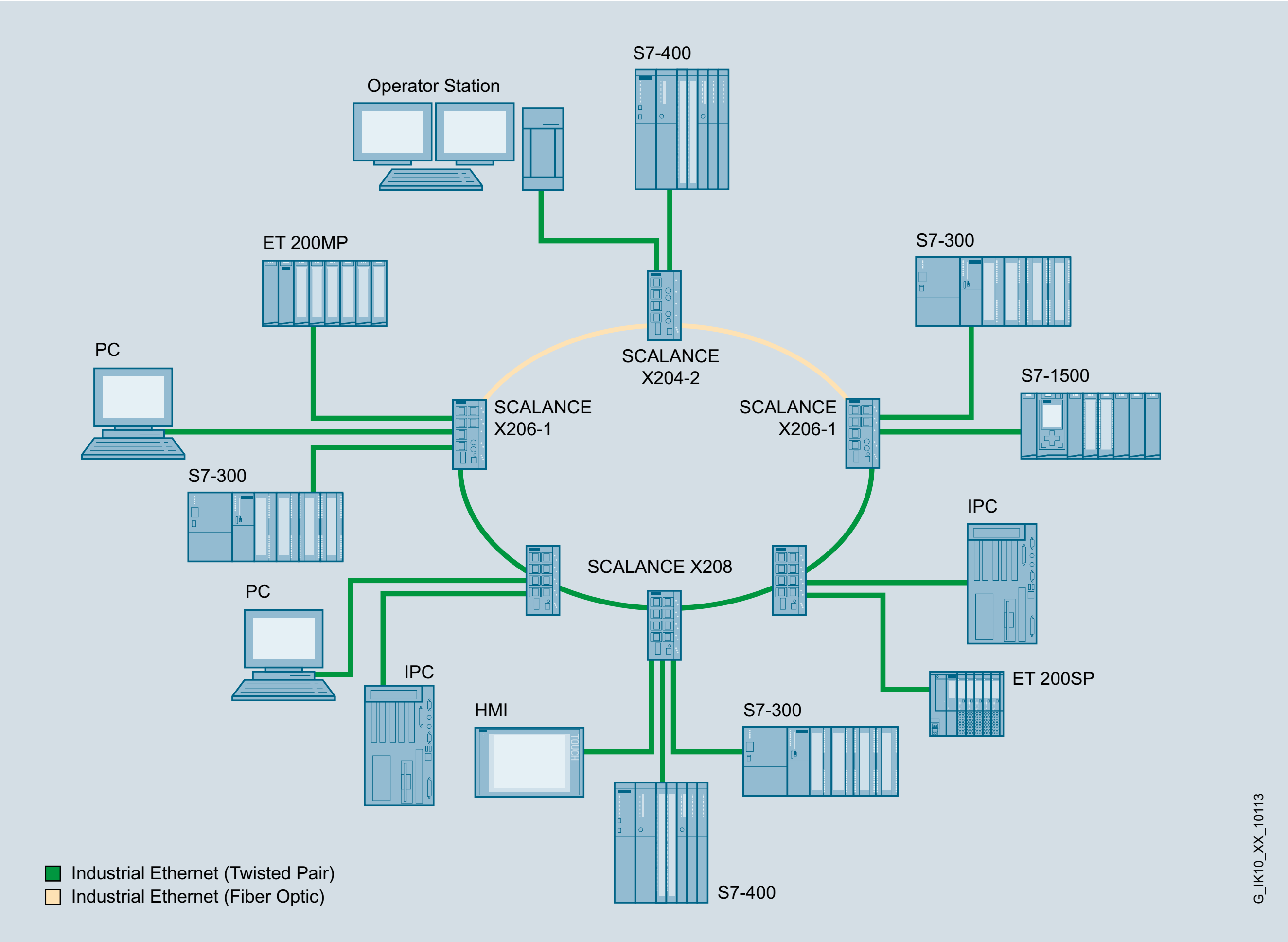
Electrical or optical cabling systems are used as the transmission medium between the switches. Terminal devices are connected electrically over twisted-pair cables.

The switching technology permits parallel communication, i.e. a network is divided into several segments, thereby resulting in load separation. Data communication is therefore possible in each individual segment independently of the other segments. This means that, throughout the network, multiple message frames can be in transit at the same time.
The performance gain is due to the simultaneity of several message frames.

The switching technology offers definite advantages over shared LAN

- Switches can be used to construct subnets and network segments
- Data throughput and network performance are increased by structuring data communication.
- The rules for network configuration are simple
- Network topologies with 50 switches in a ring and an overall extension of up to 150 km can be implemented without the need to take signal propagation times into account.
- Unlimited expansion of the network by connecting individual collision domains/subnets (beyond 150 km, the signal propagation times must be taken into account)
- Easy, reaction-free extension of existing networks is possible

SCALANCE X-200 managed



High speed redundancy in the ring with electrical and optical paths

The managed switches of the SCALANCE X-200 product range are very well suited for the setup of line, star, and ring topologies (10/100 Mbps).
Redundant ring topologies can be established via the SCALANCE X-200 switches.
On the failure of a transmission link or a SCALANCE X-200 switch in the ring, the transmission path is reconfigured within 200 ms.
With the C-PLUG swap medium, devices can be exchanged without a programming device; the configuration or application data are secured on the C-PLUG and can be implemented in another SCALANCE X-200 switch without special know-how.
Based on PROFINET, the switches of the SCALANCE X-200 product line can be easily integrated into the process and system diagnostics.

The SCALANCE X-200 switches are available in electrical and electrical/optical versions:

- SCALANCE X208 with eight electrical ports
- SCALANCE X204-2/X204-2LD with four electrical and two optical ports (BFOC)
- SCALANCE X206-1/X206-1LD with six electrical and one optical port (BFOC)
- SCALANCE X212-2/X212-2LD with 12 electrical and two optical ports (BFOC)
- SCALANCE X216 with 16 electrical ports
- SCALANCE X224 with 24 electrical ports

SCALANCE X Industrial Ethernet switches

SCALANCE X-200 managed/SCALANCE XF-200 managed

SCALANCE X-200PRO managed

Thanks to its rugged design, the SCALANCE X-200PRO Industrial Ethernet switch with IP65 degree of protection allows the setup of a star network topology outside the control cabinet. If needed, the network can be powered by 24 V DC, or with 230 V AC using the PS791-1PRO power supply.

PROFINET diagnostics can also be carried out with the SCALANCE X-200PRO.

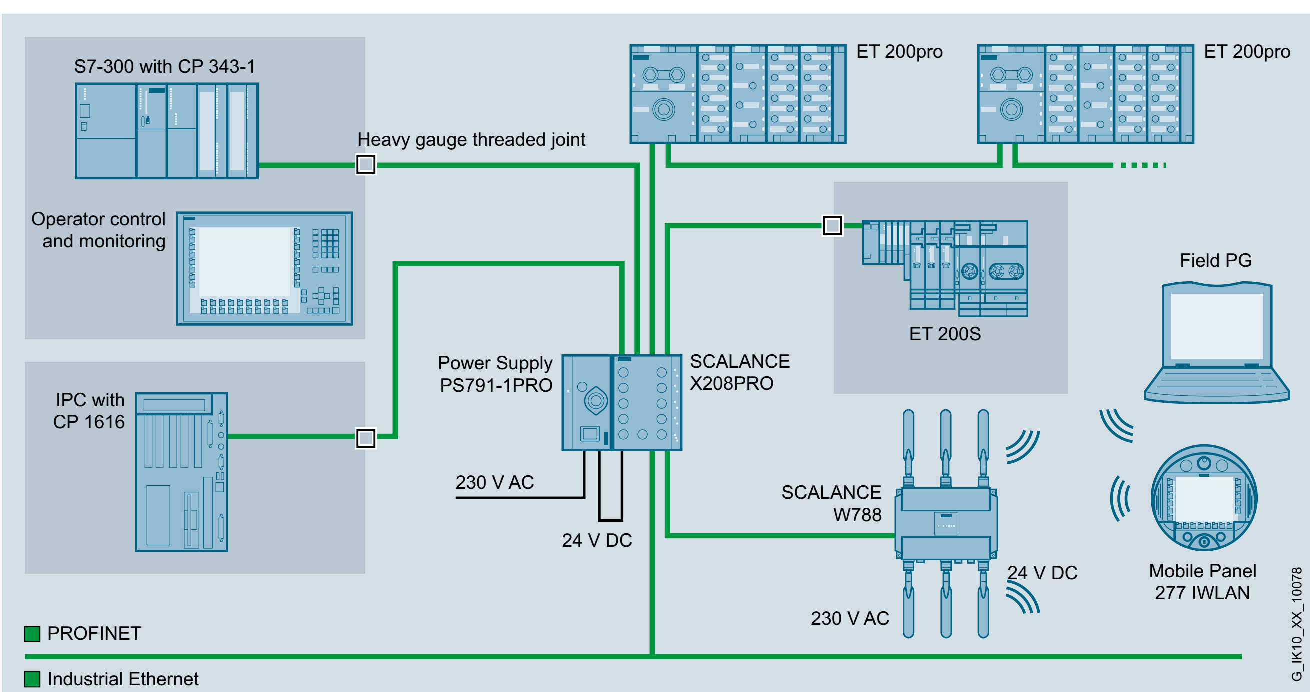
- SCALANCE X208PRO with eight electrical ports

SCALANCE XF-200 managed

The SCALANCE XF-200 switches have an extra-flat design. These industry-standard units with IP20 degree of protection and special port arrangement with angled cable outlet allows easy installation of the switches in the control cabinet or control box.
In addition, they offer an integrated redundancy manager function, which allows the network to be reestablished within milliseconds following a fault.

The SCALANCE XF-200 switches are available in electrical and electrical/optical versions:

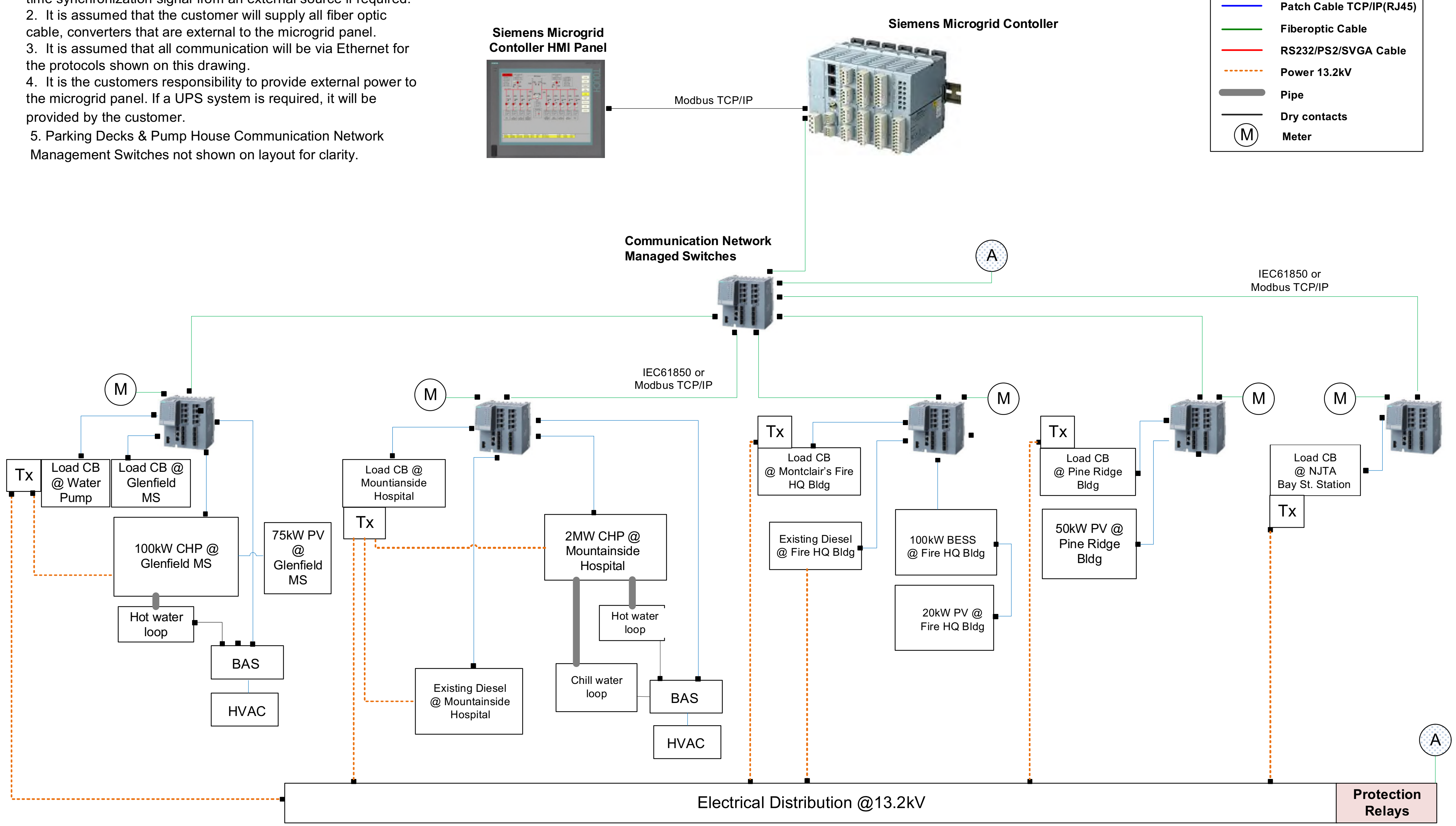
- SCALANCE XF204 with four electrical ports
- SCALANCE XF208 with eight electrical ports
- SCALANCE XF204-2 with four electrical and two optical ports (BFOC)
- SCALANCE XF206-1 with six electrical ports and one optical port (BFOC)



Configuration for cabinet-free setup with SCALANCE X208PRO with IP65 degree of protection

Notes/Assumptions

1. It is assumed that the customer will supply a separate NTP time synchronization signal from an external source if required.
2. It is assumed that the customer will supply all fiber optic cable, converters that are external to the microgrid panel.
3. It is assumed that all communication will be via Ethernet for the protocols shown on this drawing.
4. It is the customers responsibility to provide external power to the microgrid panel. If a UPS system is required, it will be provided by the customer.
5. Parking Decks & Pump House Communication Network Management Switches not shown on layout for clarity.



				Date	09/12/2018	System Architecture (Draft)	SIEMENS	Township of Montclair Microgrid	Project No. Siemens	P-USA20180604
				Drawn	M. Clout				Doc.-No.	SYS-0001
				Approved	N. Al-Khayat					
Revision		Remarks								

COMBINED HEAT AND POWER PARTNERSHIP

CHP Results

The results generated by the CHP Energy and Emissions Savings Calculator are intended for educational and outreach purposes only; it is not designed for use in developing emission inventories or preparing air permit applications.

The results of this analysis have not been reviewed or endorsed by the EPA CHP Partnership.

Table 1: Annual Energy Savings

	CHP System	Displaced Electricity Production	Displaced Thermal Production	Fuel Savings	Percent Savings
Fuel Consumption (MMBtu/year)	143,813	152,907	40,638	49,732	26□
Equal to the annual energy consumption of this many passenger vehicles:				786	
Equal to the annual energy consumption from the generation of electricity for this many homes:				502	

Table 2: Annual Emissions Savings

	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions Savings	Percent Savings
NO_x (tons/year)	3.44	3.05	2.03	1.63	32□
SO_2 (tons/year)	0.04	0.15	0.01	0.12	74□
CO_2 (tons/year)	8,406	8,955.35	2,375	2,924.81	26□
CH_4 (tons/year)	0.16	0.31	0.04	0.20	55□
N_2O (tons/year)	0.02	0.04	0.00	0.03	62□
Total GHGs (CO_2e tons/year)	8,414	8,973.52	2,378	2,937.07	26□
Equal to the annual GHG emissions from this many passenger vehicles:				570	
Equal to the annual GHG emissions from the generation of electricity for this many homes:				399	

Equal to the annual greenhouse gas emissions from 570 passenger vehicles.

Equal to the annual greenhouse gas emissions from the generation of electricity used by 399 homes.

COMBINED HEAT AND POWER PARTNERSHIP

CHP Results

The results of this analysis have not been reviewed or endorsed by the EPA CHP Partnership.

Table 3: CHP Technology and Generation Profile

CHP Technology:	Recip Engine - Lean Burn	
Fuel:	Natural Gas	
Unit Capacity:	2,000	kW
Number of Units:	1	
Total CHP Capacity:	2,000	kW
Operation:	8,322	hours per year
Heat Rate:	8,641	Btu/kWh HHV
CHP Fuel Consumption:	143,813	MMBtu/year
Duct Burner Fuel Consumption:	-	MMBtu/year
Total Fuel Consumption:	**143,813**	**MMBtu/year**
Total CHP Generation:	**16,644**	**MWh/year**
Useful CHP Thermal Output:	32,511	MMBtu/year for thermal applications (non-cooling)
	13,696	MMBtu/year for electric applications (cooling and electric heating)
	46,206	**MMBtu/year Total**

Table 4: Displaced Thermal Energy

Displaced On-Site Production for		Existing Gas Boiler
Thermal (non-cooling) Applications:	0.10	lb/MMBtu NOx
	0.00%	sulfur content
Displaced Electric Service (cooling and electric heating):	192	tons of cooling capacity from CHP system
CHP:	Single-Effect Absorption Chiller	
Replaces:	User Defined	
	6.06	COP

Table 5: Displaced Electricity

Displaced Electricity Profile:	eGRID Fossil Fuel (2016 Data)	
eGRID State:	RFCE East	
Distribution Losses:	9.2%	
Displaced Electricity Production:	16,644	MWh/year CHP generation
	431	MWh/year Displaced Electric Demand (cooling)
	-	MWh/year Displaced Electric Demand (electric heating)
	1,724	MWh/year Transmission Losses
	18,799	**MWh/year Total**

COMBINED HEAT AND POWER PARTNERSHIP

CHP Results

The results of this analysis have not been reviewed or endorsed by the EPA CHP Partnership.

Table 6: Annual Analysis for CHP

	CHP System: Recip Engine - Lean Burn	Duct Burners (if applicable)	Total Emissions from CHP System
NO_x (tons/year)	3.44	-	3.44
SO_2 (tons/year)	0.04	-	0.04
CO_2 (tons/year)	8,406	-	8,406
CH_4 (tons/year)	0.16	-	0.16
N_2O (tons/year)	0.02	-	0.02
Total GHGs (CO_2e tons/year)	8,414	-	8,414
Carbon (metric tons/year)	2,078	-	2,078
Fuel Consumption (MMBtu/year)	143,813	-	143,813

Table 7: Annual Analysis for Displaced Thermal Production (non-cooling)

	Total Displaced Emissions from Thermal Production
NO_x (tons/year)	2.03
SO_2 (tons/year)	0.01
CO_2 (tons/year)	2,375
CH_4 (tons/year)	0.04
N_2O (tons/year)	0.00
Total GHGs (CO_2e tons/year)	2,378
Carbon (metric tons/year)	587
Fuel Consumption (MMBtu/year)	40,638

Table 8: Annual Analysis for Displaced Electricity Production

	Displaced CHP Electricity Generation	Displaced Electricity for Cooling	Displaced Electricity for Heating	Transmission Losses	Total Displaced Emissions from Electricity Generation
NO_x (tons/year)	2.70	0.07	-	0.28	3.05
SO_2 (tons/year)	0.13	0.00	-	0.01	0.15
CO_2 (tons/year)	7,929	205.29	-	821.21	8,955
CH_4 (tons/year)	0.275	0.01	-	0.028	0.310
N_2O (tons/year)	0.033	0.00	-	0.003	0.038
Total GHGs (CO_2e tons/year)	7,945	206	-	823	8,974
Carbon (metric tons/year)	1,960	51	-	203	2,214
Fuel Consumption (MMBtu/year)	135,380	3,505	-	14,022	152,907

Table 9: Emission Rates for Displaced Electricity

	CHP System including Duct Burners	Recip Engine - Lean Burn Alone	Displaced Electricity Production
NOx (lb/MWh)	0.41	0.41	0.32
SO2 (lb/MWh)	0.01	0.01	0.02
CO2 (lb/MWh)	1,010	1,010	953

Table 10: Emission Rates for Displaced Thermal

	Displaced Thermal Production
NOx (lb/MMBtu)	0.10
SO2 (lb/MMBtu)	0.00059
CO2 (lb/MMBtu)	116.90

CHP Results

The results of this analysis have not been reviewed or endorsed by the EPA CHP Partnership.

Figure 1. Conventional Production Energy Flow Schematic

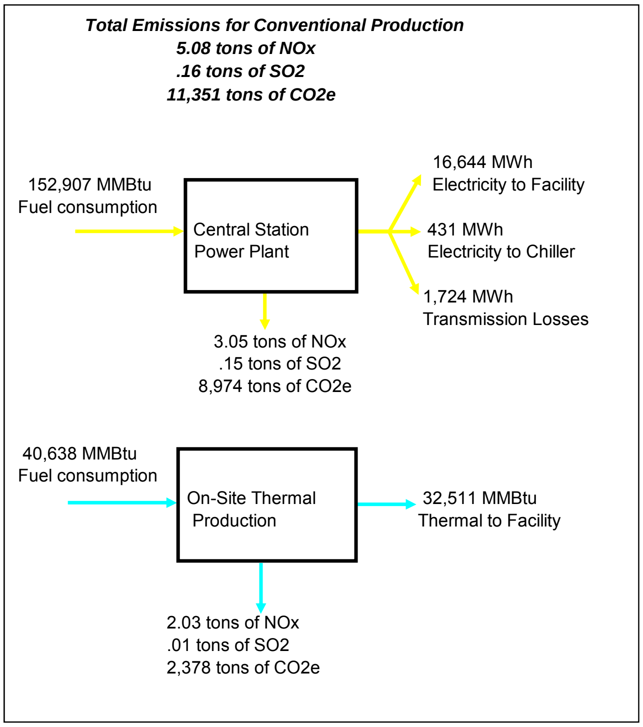
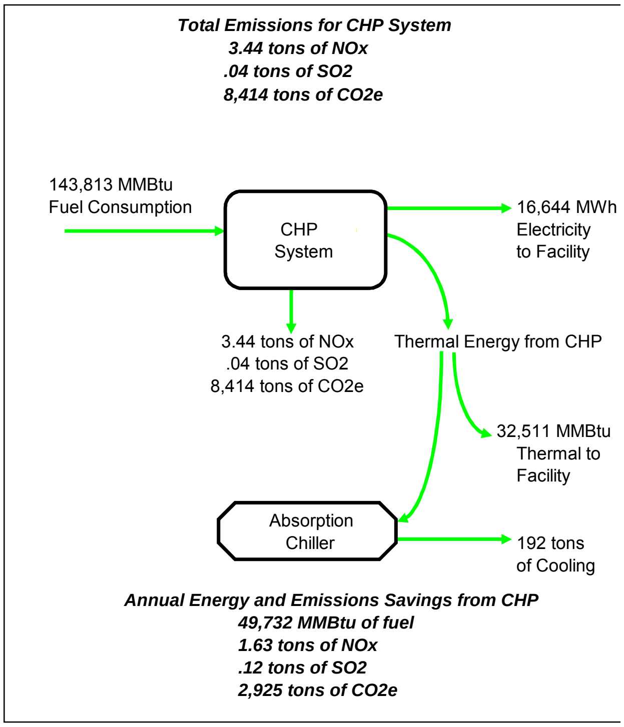


Figure 2. CHP System Energy Flow Schematic



Integrated CHP Systems Corp.

Opinion of Probable Costs	Sector Total	Sub Total
General		
Engineering	$3,860,000	$1,525,000
Mech/Plmb Design		
Structural Design		
Electric Design		
Control/Comm Design		
Geotech		
Commissioning Agent		
Construction Mgt		$480,000
Fees, Bonds & Insurance		$500,000
Permitting & Fees		
Bonds & Insurance		
Project Development		$675,000
Outline Design/IGA		
RFQ/RFP Development & Mgt		
Project Mgt		
Legal Fees		$230,000
Misc		$450,000
General Conditions		
Mobilization/Demob		
Other		
Hospital SWGR & CHP		
Electric SWGR Upgrades	$5,587,000	$697,000
New Outdoor Incoming 13.2 kV SWGR, DE/TB, 4 feeder CBs		
Utility Interconnection		
Hospital Bus Connection MV		
Harris Pavilion Pad Mtd Transformer		
Harris Pavilion Interconnection Conduit & Cable		
CHP MCC EM Bus Interconnection		
CHP Pkg		$3,780,000
2,000 kW NG Engine-generator, 45% LHV, 3 PH/13.2 kV/60 Hz		
Synchronous, Black Start, Gas Train, Oil Trf Pumps		
Acoustic Enclosure, service access, hoist, oil storage		
Jacket HR HEX, Exh HR HEX, SCR, Dump Raditors - HT & LT		
CHP SWGR & Controls		
MCC, External Sensors, Power & Ctrl Cable, Metering,		
Pkg installation & interconnection		
Structural - Pads & CT supports		
Absorption Chiller		
Cooling Tower		
BAS Controls Integration & Programming		
Testing & Commissioning		
Rigging		

Integrated CHP Systems Corp.

Opinion of Probable Costs

	Sector Total	Sub Total
Mech Equip		$1,110,000
Demo Laundry Room Space & Ventilation		
HW to Abs P,V&F, Insulation, Exp Tanks, Vents		
CHW P,V&F, Insulation, Exp Tank		
CW PV&F, Recirc loop, Exp Tanks		
Control Valves & Loops - HW & CW		
Sensors, Control Valves, Metering		
CHW & CW Duplex Pumps		
HR HW Piping CHP to North Tower, 6" Sch 40 steel		
North Tower HW Interconnection HEX w/ PVF		
Duplex HR Pumps, PVF, Sensors		
Natural gas supply piping		
Exhaust stack & breeching		
Dump radiator PV&F, installation, supports		
PV Systems		
Pine Ridge, Fire HQ, Glenfiled School	$396,858	$396,858
50 kW-DC, 20 kW-DC, 75 kW-DC PV Arrays		
LV Wiring & Inverters		
Installation		
Electric Integration w/ Bus		
Testing & Commissioning		
Battery Energy Storage System		
Fire HQ BESS	$114,900	$114,900
2-Bay BESS w/ PCS		
Pad & Installation		
Electric Integration w/ Bus		
Programming		
Testing & Commissioning		
Glenfiled School CHP		
CHP System	$388,500	$388,500
VSO Engine-Gen Set, 125 kW 3/230V/60Hz		
Inverter, Black Start, Gas Train		
Enclosure, HW Heat Recovery w/ Pump		
Controls, Monitoring, MCC		
Dump Raditors - HT & LT		
Natural Gas line		
Electric Integration		
Mech integration with HW Loop		
Pad/Structural		
Freight		
Rigging		
Testing & Commissioning		
Other		

Integrated CHP Systems Corp.

Opinion of Probable Costs

	Sector Total	Sub Total
Bay St Parking Deck		
Electric Vehicle Charging Stations	$33,000	$33,000
CT4000 Dual, Wall Mtd		
Installation		
Electric Integraton		
Programming/Activation		
Testing & Startup		
Controls & Communication		
Microgrid Controller	$365,500	$365,500
SICAM MG Controller w/ Enclosure		
HMI		
Ethernet Comm Switches		
Device Installation (not incl comm cable)		
Powr & Comm Interconnection		
Programming		
Testing & Commissioning		
MG Interconnection Infrastructure		
MG Power & Communications Backbone	$3,230,000	$2,800,000
Catenary Aerial Power System		
Fiber Comm Cable		
Testing & Commissioning		
Demo Existing Electric Infrastructure		
NJT Review		
Facility Power Connections		$430,000
13.2kV/480V Trf - Parking Deck 1 & 2, NJT Stn		
13.2kV/208V Trf - Pine Ridge, Fire HQ, School, Pump Hse		
Primary Wiring		
Secondary Wiring		
Demo/Strl		
Contingency @ 10%	$1,397,576	
Taxes - SUT	$1,076,133	
Total Probable Cost:	**$16,449,467**	

Schedule 1

Montclair Microgrid - Costs Of Production per KWH:

Costs of Production-		Fire Headquarters	Pine Street Garage	Pump House	Glenfield School	Glenfield School	Township Subtotal	Bay Street Station	Pine Ridge Senior Living	Mountainside and Harris Pav.	Mountainside Parking Deck	Distribution Infrastucture	Other Soft Costs	Microgrid Total
Mode of Distributed Generation or Energy Asset		Solar+Batt	EVCS		Cogeneration	Solar			Solar	Cogeneration				
Generation Capacity		19.7	0	0	125	73.7	218.4	0	49	2,007	0			2,274
HHV Heat Rate (if applicable)					11,675					8,704				
Assumed Delv'd NG Price					$6.00					$6.00				
O&M cost per KWH generated		$0.0125			$0.0250	$0.0125			$0.0125	$0.0205				
Standby Charge (if any)		$0.0000			$0.0000	$0.0000	$0.0000		$0.0000	$0.0000				
Distribution Charge to NJ Transit/kwh		$0.0050	$ 0.005	$0.0050	$0.0050	$0.0050		$0.0050	$0.0050	$0.0050	$0.0050			
Assumed Availability or Hours per Day		3.607	5		95%	3.4285			3.4383	95%				
Annual Production of KWH		25,936	0	0	741,000	92,228	859,164	0	61,494	16,702,254	0			17,622,912
Utilized Thermal Efficiency HHV					14.1%					33.5%				
MMBTU Useful Thermal Offset per Year					1,217		1,217			48,701				49,918
Boiler Efficiency Offset					80.0%					75.0%				
Total Capital Cost		$181,043	$33,000	$0	$388,500	$198,429	$800,972	$0	$132,286	$5,587,000	$0	$3,595,500	$3,860,000	$13,975,758
Contingency at 10% of Total Capital Cost		$18,104	$3,300	$0	$38,850	$19,843	$80,097	$0	$13,229	$558,700	$0	$359,550	$386,000	$1,397,576
Total Before SUT		$199,147	$36,300	$0	$427,350	$218,272	$881,069	$0	$145,515	$6,145,700	$0	$3,955,050	$4,246,000	$15,373,334
SUT @	7.0000%	$13,940	$2,541	$0	$29,915	$15,279	$61,675	$0	$10,186	$430,199	$0	$276,854	$297,220	$1,076,133
Total Capital incl. Contingency and SUT		$213,088	$38,841	$0	$457,265	$233,551	$942,744	$0	$155,701	$6,575,899	$0	$4,231,904	$4,543,220	$16,449,467
Less: Existing Incentive Grants from BPU/OCE		$0	$10,000	$0	$139,050	$0	$149,050	$0	$0	$2,000,000	$0	$0	$0	$2,149,050
Net Capital Cost after Existing Incentives		$213,088	$28,841	$0	$318,215	$233,551	$793,694	$0	$155,701	$4,575,899	$0	$4,231,904	$4,543,220	$14,300,417
Operating Costs														
Delv'd Cost of NG Fuel Used		0	0	0	$51,907	0	$51,907	0	0	$872,258.51	0			$924,166
O&M Cost		$324			$18,525	$1,153	$20,002		$769	$342,396				$363,167
Administrative Fee		$147	$0	$0	$4,205	$523	$4,875	$0	$349	$94,776	$0	$0	$0	$100,000
Standby Fee		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$81,878
Distribution Charge to NJ Transit		$130	$0	$0	$3,705	$461	$4,296	$0	$307	$83,511	$0	$0	$0	$88,115
Total Operating Costs of Production		$601	$0	$0	$78,342	$2,137	$81,080	$0	$1,425	$1,392,942	$0	$0	$0	$1,557,325
Cost per KWH for Facility Production		$0.0232			$0.1057	$0.0232	$0.0944		$0.0232	$0.0834				$0.0884
Thermal Credit					$9,128		$9,128			$389,609				$398,736
Net Cost per KWH after Thermal Credit		$0.0232	$0.0000	$0.0000	$0.0934	$0.0232	$0.0837	$0.0000	$0.0232	$0.0601	$0.0000	$0.0000	$0.0000	$0.0657

Schedule 2
Montclair Town Center Microgrid Pilot Project-
Capital Structure, Escalation and Depreciable Basis:

Assumptions

Escalation:	
Electric Pricing	3.00%
Thermal Pricing	3.00%
Natural Gas Pricing	3.00%
O&M Cost	3.00%
Administrative Fee	3.00%
Standby Charge (if any)	3.00%
Distribution Chg for NJ Transit /kwh	3.00%
SREC Revenue	0.00%
Effective Tax Rate (State & Federal)	28.11%

Capital Structure:

Total Capital	$ 16,449,467		
MG Subsidy	$ (3,950,000)	24%	
EV Chg Grant	$ (10,000)	0%	
CHP Grant-MH	$ (2,000,000)	12%	
CHP Grant-GS	$ (139,050)	1%	
Subtotal	$ 10,350,417	37%	
ITC	$ (1,035,042)	6%	
Cap Required	$ 9,315,375	57%	

		Rate	Years	Debt Svs.
70% Debt	$ 6,520,763	5%	15	$ (628,225)
30% Equity	$ 2,794,613			
Total Cap Req.	$ 9,315,375			

Depreciable Basis:

Total Capital	$ 16,449,467
MG Subsidy	$ (3,950,000)
EV Chg Grant	$ (10,000)
CHP Grant-MH	$ (2,000,000)
CHP Grant-GS	$ (139,050)
Subtotal	$ 10,350,417
1/2 of ITC	$ (517,521)
Depre Basis	$ 9,832,896

Depreciation Assumptions:

	Tax	Book
Useful Life	5	20
Convention	MACRS	Straight Line
Investment Tax Credit		10.00%
After Tax IRR to Investor		10.05%

Schedule 3

Montclair Town Center Microgrid Pilot
Loan Amortization and Depreciation Accounting (MACRS)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Loan Amortization Schedule:																					
Starting Balance	$6,520,763	$6,218,576	$5,901,279	$5,568,118	$5,218,299	$4,850,989	$4,465,313	$4,060,353	$3,635,146	$3,188,678	$2,719,886	$2,227,655	$1,710,813	$1,168,129	$598,310						
Principal Payment	$302,187	$317,296	$333,161	$349,819	$367,310	$385,676	$404,960	$425,208	$446,468	$468,791	$492,231	$516,842	$542,685	$569,819	$598,310						
Ending Balance	$6,218,576	$5,901,279	$5,568,118	$5,218,299	$4,850,989	$4,465,313	$4,060,353	$3,635,146	$3,188,678	$2,719,886	$2,227,655	$1,710,813	$1,168,129	$598,310	$0						
Interest Expense	$326,038	$310,929	$295,064	$278,406	$260,915	$242,549	$223,266	$203,018	$181,757	$159,434	$135,994	$111,383	$85,541	$58,406	$29,915						
Debt Service	$628,225	$628,225	$628,225	$628,225	$628,225	$628,225	$628,225	$628,225	$628,225	$628,225	$628,225	$628,225	$628,225	$628,225	$628,225						
Depreciation:																					
MACRS Factors (Bonus Depreciation taken)	20.00%	32.00%	19.20%	11.52%	11.52%	5.76%	0.00%	0.00%	0.00%	0.00%	0.00%										
MACRS Depreciation	$1,966,579	$3,146,527	$1,887,916	$1,132,750	$1,132,750	$566,375	$0	$0	$0	$0	$0										$9,832,896
Book Depreciation	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$9,832,896
MACRS Depreciation Expense	$1,966,579	$3,146,527	$1,887,916	$1,132,750	$1,132,750	$566,375	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Straight Line Depreciation Expense	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	
MACRS Excess / (Deficit)	$1,474,934	$2,654,882	$1,396,271	$641,105	$641,105	$74,730	-$491,645	-$491,645	-$491,645	-$491,645	-$491,645	-$491,645	-$491,645	-$491,645	-$491,645	-$491,645	-$491,645	-$491,645	-$491,645	-$491,645	
Assumed Effective Tax Rate	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	
Deferred Tax	$414,604	$746,287	$392,492	$180,215	$180,215	$21,007	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	
Deferred Tax on Balance Sheet	$414,604	$1,160,891	$1,553,383	$1,733,598	$1,913,812	$1,934,819	$1,796,618	$1,658,416	$1,520,215	$1,382,014	$1,243,812	$1,105,611	$967,410	$829,208	$691,007	$552,805	$414,604	$276,403	$138,201	$0	
Change in Deferred Tax for Cash Flow Calc.	$414,604	$746,287	$392,492	$180,215	$180,215	$21,007	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	-$138,201	

Schedule 4

Montclair Town Center Microgrid

Major Assumptions- Pricing, Revenue and Costs

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sales Pricing for Microgrid Production:																					
Electric	Hospital & Harris	$0.1010	$0.1040	$0.1072	$0.1104	$0.1137	$0.1171	$0.1206	$0.1242	$0.1279	$0.1318	$0.1357	$0.1398	$0.1440	$0.1483	$0.1528	$0.1574	$0.1621	$0.1669	$0.1719	$0.1771
	Hospital Parking	$0.1223	$0.1260	$0.1297	$0.1336	$0.1376	$0.1418	$0.1460	$0.1504	$0.1549	$0.1596	$0.1644	$0.1693	$0.1744	$0.1796	$0.1850	$0.1905	$0.1963	$0.2021	$0.2082	$0.2145
	Pine Ridge	$0.1800	$0.1854	$0.1910	$0.1967	$0.2026	$0.2087	$0.2149	$0.2214	$0.2280	$0.2349	$0.2419	$0.2492	$0.2566	$0.2643	$0.2723	$0.2804	$0.2888	$0.2975	$0.3064	$0.3156
	Bay Street Station	$0.1219	$0.1256	$0.1293	$0.1332	$0.1372	$0.1413	$0.1456	$0.1499	$0.1544	$0.1591	$0.1638	$0.1687	$0.1738	$0.1790	$0.1844	$0.1899	$0.1956	$0.2015	$0.2075	$0.2138
	Pine Street Garage	$0.1024	$0.1055	$0.1086	$0.1119	$0.1153	$0.1187	$0.1223	$0.1259	$0.1297	$0.1336	$0.1376	$0.1417	$0.1460	$0.1504	$0.1549	$0.1595	$0.1643	$0.1693	$0.1743	$0.1796
	Fire Headquarters	$0.1269	$0.1307	$0.1346	$0.1387	$0.1428	$0.1471	$0.1515	$0.1561	$0.1608	$0.1656	$0.1705	$0.1757	$0.1809	$0.1864	$0.1919	$0.1977	$0.2036	$0.2097	$0.2160	$0.2225
	Glenfield School	$0.1149	$0.1183	$0.1219	$0.1256	$0.1293	$0.1332	$0.1372	$0.1413	$0.1456	$0.1499	$0.1544	$0.1590	$0.1638	$0.1687	$0.1738	$0.1790	$0.1844	$0.1899	$0.1956	$0.2015
	Pump House	$0.1145	$0.1179	$0.1215	$0.1251	$0.1289	$0.1327	$0.1367	$0.1408	$0.1450	$0.1494	$0.1539	$0.1585	$0.1632	$0.1681	$0.1732	$0.1784	$0.1837	$0.1893	$0.1949	$0.2008
Revenue Schedule-		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Electric	Hospital & Harris	$1,637,805	$1,686,939	$1,737,547	$1,789,674	$1,843,364	$1,898,665	$1,955,625	$2,014,293	$2,074,722	$2,136,964	$2,201,073	$2,267,105	$2,335,118	$2,405,172	$2,477,327	$2,551,647	$2,628,196	$2,707,042	$2,788,253	$2,871,901
	Hospital Parking	$48,878	$50,344	$51,854	$53,410	$55,012	$56,663	$58,363	$60,113	$61,917	$63,774	$65,688	$67,658	$69,688	$71,779	$73,932	$76,150	$78,434	$80,787	$83,211	$85,707
	Pine Ridge	$10,747	$11,069	$11,401	$11,743	$12,095	$12,458	$12,832	$13,217	$13,613	$14,022	$14,443	$14,876	$15,322	$15,782	$16,255	$16,743	$17,245	$17,762	$18,295	$18,844
	Bay Street Station	$13,838	$14,253	$14,681	$15,121	$15,575	$16,042	$16,523	$17,019	$17,530	$18,056	$18,597	$19,155	$19,730	$20,322	$20,931	$21,559	$22,206	$22,872	$23,558	$24,265
	Pine Street Garage	$15,214	$15,671	$16,141	$16,625	$17,124	$17,637	$18,167	$18,712	$19,273	$19,851	$20,447	$21,060	$21,692	$22,343	$23,013	$23,703	$24,414	$25,147	$25,901	$26,678
	Fire Headquarters	$29,034	$29,905	$30,802	$31,726	$32,677	$33,658	$34,668	$35,708	$36,779	$37,882	$39,019	$40,189	$41,395	$42,637	$43,916	$45,233	$46,590	$47,988	$49,428	$50,910
	Glenfield School	$47,910	$49,348	$50,828	$52,353	$53,923	$55,541	$57,207	$58,924	$60,691	$62,512	$64,387	$66,319	$68,309	$70,358	$72,469	$74,643	$76,882	$79,188	$81,564	$84,011
	Pump House	$4,558	$4,694	$4,835	$4,980	$5,130	$5,284	$5,442	$5,605	$5,773	$5,947	$6,125	$6,309	$6,498	$6,693	$6,894	$7,101	$7,314	$7,533	$7,759	$7,992
	Total Electric	$1,807,983	$1,862,222	$1,918,089	$1,975,632	$2,034,901	$2,095,948	$2,158,826	$2,223,591	$2,290,299	$2,359,008	$2,429,778	$2,502,671	$2,577,751	$2,655,084	$2,734,736	$2,816,778	$2,901,282	$2,988,320	$3,077,970	$3,170,309
Thermal-Heat or Hot Water																					
	Hospital & Harris	$427,708	$440,540	$453,756	$467,369	$481,390	$495,831	$510,706	$526,027	$541,808	$558,062	$574,804	$592,048	$609,810	$628,104	$646,947	$666,356	$686,346	$706,937	$728,145	$749,989
	Glenfield School	$9,128	$9,401	$9,683	$9,974	$10,273	$10,581	$10,899	$11,226	$11,562	$11,909	$12,267	$12,635	$13,014	$13,404	$13,806	$14,220	$14,647	$15,086	$15,539	$16,005
	Total Thermal Heat or HW	$436,836	$449,941	$463,439	$477,342	$491,663	$506,413	$521,605	$537,253	$553,371	$569,972	$587,071	$604,683	$622,824	$641,508	$660,753	$680,576	$700,993	$722,023	$743,684	$765,994
Absorption Chiller Ton Hours per Year	Hospital & Harris	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706	628,706
Times: Offset KW per Ton Hour		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Equals: Offset KWH during Year		377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224	377,224
Times: Price per KWH from PSE&G		$0.1010	$0.1040	$0.1072	$0.1104	$0.1137	$0.1171	$0.1206	$0.1242	$0.1279	$0.1318	$0.1357	$0.1398	$0.1440	$0.1483	$0.1528	$0.1574	$0.1621	$0.1669	$0.1719	$0.1771
	Thermal - Absorption Chilling Revenue	$38,100	$39,243	$40,420	$41,632	$42,881	$44,168	$45,493	$46,858	$48,263	$49,711	$51,203	$52,739	$54,321	$55,951	$57,629	$59,358	$61,139	$62,973	$64,862	$66,808
	SREC Revenue	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915	$44,915
	Total Microgrid Revenue	$2,327,833	$2,396,321	$2,466,863	$2,539,521	$2,614,359	$2,691,443	$2,770,839	$2,852,616	$2,936,847	$3,023,605	$3,112,966	$3,205,008	$3,299,810	$3,397,457	$3,498,034	$3,601,627	$3,708,328	$3,818,231	$3,931,430	$4,048,026
Microgrid Production Shedule-																					
CHP Generator Production:		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Hospital & Harris	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254	16,702,254
	Glenfield School	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000	741,000
	CHP KWH Produced	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254	17,443,254
Solar Production:																					
	Pine Ridge	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494	61,494
	Fire Headquarters	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936	25,936
	Glenfield Schoo;l	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228	92,228
	Solar KWH Produced	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658	179,658
	Total KWH Production	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912	17,622,912
Fuel Costs-																					
Cost per MMBTU Delivered	Hospital & Harris	$6.00	$6.18	$6.37	$6.56	$6.75	$6.96	$7.16	$7.38	$7.60	$7.83	$8.06	$8.31	$8.55	$8.81	$9.08	$9.35	$9.63	$9.92	$10.21	$10.52
	Glenfield School	$6.50	$6.70	$6.90	$7.10	$7.32	$7.54	$7.76	$7.99	$8.23	$8.48	$8.74	$9.00	$9.27	$9.55	$9.83	$10.13	$10.43	$10.74	$11.07	$11.40
Natural Gas Costs																					
	Hospital & Harris	$872,259	$898,426	$925,379	$953,140	$981,735	$1,011,187	$1,041,522	$1,072,768	$1,104,951	$1,138,100	$1,172,243	$1,207,410	$1,243,632	$1,280,941	$1,319,369	$1,358,950	$1,399,719	$1,441,710	$1,484,962	$1,529,511
	Glenfield School	$56,233	$57,920	$59,657	$61,447	$63,290	$65,189	$67,145	$69,159	$71,234	$73,371	$75,572	$77,839	$80,174	$82,580	$85,057	$87,609	$90,237	$92,944	$95,732	$98,604
	Total Fuel Costs	$928,491	$956,346	$985,036	$1,014,587	$1,045,025	$1,076,376	$1,108,667	$1,141,927	$1,176,185	$1,211,470	$1,247,814	$1,285,249	$1,323,806	$1,363,521	$1,404,426	$1,446,559	$1,489,956	$1,534,654	$1,580,694	$1,628,115
O&M Expense:																					
	O&M Cost per KWH Produced																				
	CHP-Hospital	$0.0200	$0.0206	$0.0212	$0.0219	$0.0225	$0.0232	$0.0239	$0.0246	$0.0253	$0.0261	$0.0269	$0.0277	$0.0285	$0.0294	$0.0303	$0.0312	$0.0321	$0.0331	$0.0340	$0.0351
	CHP-Glenfield	$0.0250	$0.0258	$0.0265	$0.0273	$0.0281	$0.0290	$0.0299	$0.0307	$0.0317	$0.0326	$0.0336	$0.0346	$0.0356	$0.0367	$0.0378	$0.0389	$0.0401	$0.0413	$0.0426	$0.0438
	Solar	$0.0125	$0.0129	$0.0133	$0.0137	$0.0141	$0.0145	$0.0149	$0.0154	$0.0158	$0.0163	$0.0168	$0.0173	$0.0178	$0.0184	$0.0189	$0.0195	$0.0201	$0.0207	$0.0213	$0.0219
	O&M Expense																				
	CHP-Hospital	$334,045	$344,066	$354,388	$365,020	$375,971	$387,250	$398,867	$410,833	$423,158	$435,853	$448,929	$462,397	$476,268	$490,556	$505,273	$520,431	$536,044	$552,126	$568,689	$585,750
	CHP-Glenfield	$18,525	$19,081	$19,653	$20,243	$20,850	$21,476	$22,120	$22,783	$23,467	$24,171	$24,896	$25,643	$26,412	$27,205	$28,021	$28,861	$29,727	$30,619	$31,538	$32,484
	Solar	$2,246	$2,313	$2,382	$2,454	$2,528	$2,603	$2,682	$2,762	$2,845	$2,930	$3,018	$3,109	$3,202	$3,298	$3,397	$3,499	$3,604	$3,712	$3,823	$3,938
	Total O&M	$354,816	$365,460	$376,424	$387,717	$399,348	$411,329	$423,669	$436,379	$449,470	$462,954	$476,843	$491,148	$505,883	$521,059	$536,691	$552,791	$569,375	$586,456	$604,050	$622,172
Insurance Expense:		$106,697	$109,898	$113,195	$116,590	$120,088	$123,691	$127,402	$131,224	$135,160	$139,215	$143,392	$147,693	$152,124	$156,688	$161,388	$166,230	$171,217	$176,354	$181,644	$187,093
Administrative Fee:		$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477	$134,392	$138,423	$142,576	$146,853	$151,259	$155,797	$160,471	$165,285	$170,243	$175,351
Distribution Charge to NJ Transit:		$88,115	$90,758	$93,481	$96,285	$99,174	$102,149	$105,213	$108,370	$111,621	$114,970	$118,419	$121,971	$125,630	$129,399	$133,281	$137,280	$141,398	$145,640	$150,009	$154,509
Standby Charge:		$81,878	$84,335	$86,865	$89,471	$92,155	$94,920	$97,767	$100,700	$103,721	$106,833	$110,038	$113,339	$116,739	$120,241	$123,848	$127,564	$131,391	$135,333	$139,392	$143,574

Schedule 5
Montclair Town Center Microgrid
Financial Statements and Financial Analysis-

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Income Statement:																					
	Revenues	$2,327,833	$2,396,321	$2,466,863	$2,539,521	$2,614,359	$2,691,443	$2,770,839	$2,852,616	$2,936,847	$3,023,605	$3,112,966	$3,205,008	$3,299,810	$3,397,457	$3,498,034	$3,601,627	$3,708,328	$3,818,231	$3,931,430	$4,048,026
	Less: Fuel Costs	$928,491	$956,346	$985,036	$1,014,587	$1,045,025	$1,076,376	$1,108,667	$1,141,927	$1,176,185	$1,211,470	$1,247,814	$1,285,249	$1,323,806	$1,363,521	$1,404,426	$1,446,559	$1,489,956	$1,534,654	$1,580,694	$1,628,115
	Less: O&M Exp	$354,816	$365,460	$376,424	$387,717	$399,348	$411,329	$423,669	$436,379	$449,470	$462,954	$476,843	$491,148	$505,883	$521,059	$536,691	$552,791	$569,375	$586,456	$604,050	$622,172
	Less: Insurance	$106,697	$109,898	$113,195	$116,590	$120,088	$123,691	$127,402	$131,224	$135,160	$139,215	$143,392	$147,693	$152,124	$156,688	$161,388	$166,230	$171,217	$176,354	$181,644	$187,093
	Less: Admin Fee	$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477	$134,392	$138,423	$142,576	$146,853	$151,259	$155,797	$160,471	$165,285	$170,243	$175,351
	Less: Distribution Charge to NJ Transit	$88,115	$90,758	$93,481	$96,285	$99,174	$102,149	$105,213	$108,370	$111,621	$114,970	$118,419	$121,971	$125,630	$129,399	$133,281	$137,280	$141,398	$145,640	$150,009	$154,509
	Less: Standby Charge	$81,878	$84,335	$86,865	$89,471	$92,155	$94,920	$97,767	$100,700	$103,721	$106,833	$110,038	$113,339	$116,739	$120,241	$123,848	$127,564	$131,391	$135,333	$139,392	$143,574
	EBITDA	$667,836	$686,524	$705,772	$725,598	$746,018	$767,052	$788,716	$811,030	$834,013	$857,686	$882,069	$907,184	$933,052	$959,696	$987,140	$1,015,406	$1,044,521	$1,074,509	$1,105,397	$1,137,212
	Less: Interest	$326,038	$310,929	$295,064	$278,406	$260,915	$242,549	$223,266	$203,018	$181,757	$159,434	$135,994	$111,383	$85,541	$58,406	$29,915	$0	$0	$0	$0	$0
	Pre-Tax Income Before Depreciation	$341,798	$375,595	$410,708	$447,192	$485,103	$524,502	$565,450	$608,012	$652,256	$698,252	$746,075	$795,801	$847,511	$901,290	$957,224	$1,015,406	$1,044,521	$1,074,509	$1,105,397	$1,137,212
Cash Flow from Operating Activities- Tax																					
	Pre-Tax Before Depreciation	$341,798	$375,595	$410,708	$447,192	$485,103	$524,502	$565,450	$608,012	$652,256	$698,252	$746,075	$795,801	$847,511	$901,290	$957,224	$1,015,406	$1,044,521	$1,074,509	$1,105,397	$1,137,212
	Less: Tax Depreciation	$1,966,579	$3,146,527	$1,887,916	$1,132,750	$1,132,750	$566,375	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Pre-Tax Income	($1,624,781)	($2,770,932)	($1,477,208)	($685,558)	($647,646)	($41,873)	$565,450	$608,012	$652,256	$698,252	$746,075	$795,801	$847,511	$901,290	$957,224	$1,015,406	$1,044,521	$1,074,509	$1,105,397	$1,137,212
	Tax paid in this Period	($456,726)	($778,909)	($415,243)	($192,710)	($182,053)	($11,770)	$158,948	$170,912	$183,349	$196,279	$209,722	$223,700	$238,235	$253,353	$269,076	$285,431	$293,615	$302,045	$310,727	$319,670
	Deferred Tax	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total Tax	($456,726)	($778,909)	($415,243)	($192,710)	($182,053)	($11,770)	$158,948	$170,912	$183,349	$196,279	$209,722	$223,700	$238,235	$253,353	$269,076	$285,431	$293,615	$302,045	$310,727	$319,670
	Net Income-Tax Basis	($1,168,055)	($1,992,023)	($1,061,965)	($492,847)	($465,593)	($30,102)	$406,502	$437,100	$468,907	$501,974	$536,353	$572,101	$609,276	$647,937	$688,148	$729,976	$750,906	$772,465	$794,670	$817,541
	Plus: Tax Depreciation	$1,966,579	$3,146,527	$1,887,916	$1,132,750	$1,132,750	$566,375	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Plus: Deferred Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Cash Flow from Operating Activities-Tax Basis	$798,524	$1,154,504	$825,951	$639,902	$667,157	$536,273	$406,502	$437,100	$468,907	$501,974	$536,353	$572,101	$609,276	$647,937	$688,148	$729,976	$750,906	$772,465	$794,670	$817,541
Cash Flow from Operating Activities- Book																					
	Pre-Tax Before Depreciation	$341,798	$375,595	$410,708	$447,192	$485,103	$524,502	$565,450	$608,012	$652,256	$698,252	$746,075	$795,801	$847,511	$901,290	$957,224	$1,015,406	$1,044,521	$1,074,509	$1,105,397	$1,137,212
	Less: Book Depreciation	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645
	Pre-Tax Income	($149,847)	($116,050)	($80,937)	($44,453)	($6,541)	$32,857	$73,805	$116,367	$160,611	$206,607	$254,430	$304,156	$355,866	$409,645	$465,579	$523,761	$552,876	$582,864	$613,752	$645,567
	Tax paid in this Period	($456,726)	($778,909)	($415,243)	($192,710)	($182,053)	($11,770)	$158,948	$170,912	$183,349	$196,279	$209,722	$223,700	$238,235	$253,353	$269,076	$285,431	$293,615	$302,045	$310,727	$319,670
	Deferred Tax (accrued for future Pmt.)	$414,604	$746,287	$392,492	$180,215	$180,215	$21,007	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)
	Total Tax	($42,122)	($32,622)	($22,751)	($12,496)	($1,839)	$9,236	$20,747	$32,711	$45,148	$58,077	$71,520	$85,498	$100,034	$115,151	$130,874	$147,229	$155,413	$163,843	$172,526	$181,469
	Net Income-Book Basis	($107,725)	($83,428)	($58,185)	($31,957)	($4,703)	$23,621	$53,059	$83,656	$115,463	$148,530	$182,910	$218,658	$255,832	$294,494	$334,705	$376,532	$397,463	$419,021	$441,226	$464,098
	Plus: Book Depreciation	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645	$491,645
	Plus: Deferred Taxes	$414,604	$746,287	$392,492	$180,215	$180,215	$21,007	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)	($138,201)
	Cash Flow from Operating Activities-Book Basis	$798,524	$1,154,504	$825,951	$639,902	$667,157	$536,273	$406,502	$437,100	$468,907	$501,974	$536,353	$572,101	$609,276	$647,937	$688,148	$729,976	$750,906	$772,465	$794,670	$817,541

Financial Analysis-

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cash flow from Operations			$ 798,524	$ 1,154,504	$ 825,951	$ 639,902	$ 667,157	$ 536,273	$ 406,502	$ 437,100	$ 468,907	$ 501,974	$ 536,353	$ 572,101	$ 609,276	$ 647,937	$ 688,148	$ 729,976	$ 750,906	$ 772,465	$ 794,670	$ 817,541
Project Capital Cost all-In		$ (16,449,467)																				
BPU Grant for Hospital CHP		$ 2,000,000																				
BPU Grant for Glenfield CHP		$ 139,050																				
BPU Grant for Fire House Battery		$ 10,000																				
Subsidy for Microgrid		$ 3,950,000																				
Proceeds from LT Debt Financing		$ 6,520,763																				
Principal Repayments			$ (302,187)	$ (317,296)	$ (333,161)	$ (349,819)	$ (367,310)	$ (385,676)	$ (404,960)	$ (425,208)	$ (446,468)	$ (468,791)	$ (492,231)	$ (516,842)	$ (542,685)	$ (569,819)	$ (598,310)	$ -	$ -	$ -	$ -	$ -
Investment Tax Credit		$ 1,035,042																				
Cash Flow to Investor		$ (2,794,613)	$ 496,337	$ 837,208	$ 492,790	$ 290,083	$ 299,847	$ 150,597	$ 1,542	$ 11,892	$ 22,439	$ 33,182	$ 44,122	$ 55,259	$ 66,591	$ 78,118	$ 89,839	$ 729,976	$ 750,906	$ 772,465	$ 794,670	$ 817,541
Cumulative Cash Flow		$ (2,794,613)	$ (2,298,276)	$ (1,461,068)	$ (968,278)	$ (678,195)	$ (378,348)	$ (227,752)	$ (226,209)	$ (214,317)	$ (191,878)	$ (158,696)	$ (114,573)	$ (59,315)	$ 7,277	$ 85,395	$ 175,234	$ 905,209	$ 1,656,115	$ 2,428,580	$ 3,223,250	$ 4,040,791
After Tax Internal Rate of Return-	10.05%																					
Simple Payback occurs in year	13																					
Cash Flow to Investors		$ (2,794,613)	$ 496,337	$ 837,208	$ 492,790	$ 290,083	$ 299,847	$ 150,597	$ 1,542	$ 11,892	$ 22,439	$ 33,182	$ 44,122	$ 55,259	$ 66,591	$ 78,118	$ 89,839	$ 729,976	$ 750,906	$ 772,465	$ 794,670	$ 817,541
Times: Discount Factor @	10.05%	1.0000	0.9087	0.8257	0.7503	0.6817	0.6195	0.5629	0.5115	0.4648	0.4223	0.3837	0.3487	0.3168	0.2879	0.2616	0.2377	0.2160	0.1963	0.1783	0.1621	0.1473
Equals: Discounted Cash Flow		$ (2,794,613)	$ 451,003	$ 691,257	$ 369,719	$ 197,758	$ 185,744	$ 84,768	$ 789	$ 5,527	$ 9,476	$ 12,733	$ 15,385	$ 17,508	$ 19,172	$ 20,436	$ 21,356	$ 157,673	$ 147,380	$ 137,764	$ 128,779	$ 120,385
Cumulative Disct. Cash Flow		$ (2,794,613)	$ (2,343,609)	$ (1,652,352)	$ (1,282,634)	$ (1,084,875)	$ (899,131)	$ (814,363)	$ (813,574)	$ (808,047)	$ (798,571)	$ (785,838)	$ (770,453)	$ (752,945)	$ (733,773)	$ (713,337)	$ (691,982)	$ (534,308)	$ (386,928)	$ (249,164)	$ (120,385)	$ 0
Net Present Value at	10.05%	$0																				

Schedule 2-A
Montclair Towns Center Microgrid
Capital Stack and Depreciable Basis- Bonus Depreciation

Assumptions

Escalation:	
Electric Pricing	3.00%
Thermal Pricing	3.00%
Natural Gas Pricing	3.00%
O&M Cost	3.00%
Administrative Fee	3.00%
Standby Charge (if any)	3.00%
Distribution Chg for NJ Transit /kwh	3.00%
SREC Revenue	0.00%
Effective Tax Rate (State & Federal)	28.11%

Capital Structure:

	Total Capital	$16,449,467	
	MG Subsidy	-$3,100,000	18.85%
	EV Chg Grant	-$10,000	0.06%
	CHP Grant-MH	-$2,000,000	12.16%
	CHP Grant-GS	-$139,050	0.85%
	Subtotal	$11,200,417	31.91%
	ITC	-$1,120,042	6.81%
	Cap Required	$10,080,375	61.28%

			Rate	Years	Debt Svs.
70.00%	Debt	$7,056,263	5.00%	15	-$679,817
30.00%	Equity	$3,024,113			
	Total Cap Req.	$10,080,375			

Depreciable Basis:

Total Capital	$16,449,467
MG Subsidy	-$3,100,000
EV Chg Grant	-$10,000
CHP Grant-MH	-$2,000,000
CHP Grant-GS	-$139,050
Subtotal	$11,200,417
1/2 of ITC	-$560,021
Depre Basis	$10,640,396

Depreciation Assumptions:

	Tax	Book
Useful Life	10	20
Convention	MACRS	Straight Line
Investment Tax Credit		10.00%
After Tax IRR to Investor		10.07%

Schedule 3-A
Montclair Town Center Microgrid
Loan Amortizatin and Depreciation taking Bonus Depreciation instead of MACRS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Loan Amortization Schedule:																					
Starting Balance	$7,056,263	$6,729,259	$6,385,906	$6,025,385	$5,646,837	$5,249,363	$4,832,014	$4,393,799	$3,933,672	$3,450,539	$2,943,250	$2,410,596	$1,851,309	$1,264,058	$647,444						
Principal Payment	$327,003	$343,354	$360,521	$378,547	$397,475	$417,348	$438,216	$460,127	$483,133	$507,290	$532,654	$559,287	$587,251	$616,614	$647,444						
Ending Balance	$6,729,259	$6,385,906	$6,025,385	$5,646,837	$5,249,363	$4,832,014	$4,393,799	$3,933,672	$3,450,539	$2,943,250	$2,410,596	$1,851,309	$1,264,058	$647,444	$0						
Interest Expense	$352,813	$336,463	$319,295	$301,269	$282,342	$262,468	$241,601	$219,690	$196,684	$172,527	$147,162	$120,530	$92,565	$63,203	$32,372						
Debt Service	$679,817	$679,817	$679,817	$679,817	$679,817	$679,817	$679,817	$679,817	$679,817	$679,817	$679,817	$679,817	$679,817	$679,817	$679,817						
Depreciation:																					
Bonus Depreciation Factors	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%										
Bonus Depreciation	$10,640,396	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0										$10,640,396
Book Depreciation	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$10,640,396
Bonus Depreciation Expense	$10,640,396	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Straight Line Depreciation Expense	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	
Bonus Excess / (Deficit)	$10,108,376	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	-$532,020	
Assumed Effective Tax Rate	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	28.11%	
Deferred Tax	$2,841,465	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	
Deferred Tax on Balance Sheet	$2,841,465	$2,691,914	$2,542,363	$2,392,812	$2,243,262	$2,093,711	$1,944,160	$1,794,609	$1,645,058	$1,495,508	$1,345,957	$1,196,406	$1,046,855	$897,305	$747,754	$598,203	$448,652	$299,102	$149,551	$0	
Change in Deferred Tax for Cash Flow Calc.	$2,841,465	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	

Schedule 5-A
Montclair Town Center Microgrid
Income Statement and Cash Flow with Bonus Depreciation

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Income Statement:																						
	Revenues		$2,327,833	$2,396,321	$2,466,863	$2,539,521	$2,614,359	$2,691,443	$2,770,839	$2,852,616	$2,936,847	$3,023,605	$3,112,966	$3,205,008	$3,299,810	$3,397,457	$3,498,034	$3,601,627	$3,708,328	$3,818,231	$3,931,430	$4,048,026
	Less: Fuel Costs		$928,491	$956,346	$985,036	$1,014,587	$1,045,025	$1,076,376	$1,108,667	$1,141,927	$1,176,185	$1,211,470	$1,247,814	$1,285,249	$1,323,806	$1,363,521	$1,404,426	$1,446,559	$1,489,956	$1,534,654	$1,580,694	$1,628,115
	Less: O&M Exp		$354,816	$365,460	$376,424	$387,717	$399,348	$411,329	$423,669	$436,379	$449,470	$462,954	$476,843	$491,148	$505,883	$521,059	$536,691	$552,791	$569,375	$586,456	$604,050	$622,172
	Less: Insurance		$106,697	$109,898	$113,195	$116,590	$120,088	$123,691	$127,402	$131,224	$135,160	$139,215	$143,392	$147,693	$152,124	$156,688	$161,388	$166,230	$171,217	$176,354	$181,644	$187,093
	Less: Admin Fee		$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477	$134,392	$138,423	$142,576	$146,853	$151,259	$155,797	$160,471	$165,285	$170,243	$175,351
	Less: Distribution Charge to NJ Transit		$88,115	$90,758	$93,481	$96,285	$99,174	$102,149	$105,213	$108,370	$111,621	$114,970	$118,419	$121,971	$125,630	$129,399	$133,281	$137,280	$141,398	$145,640	$150,009	$154,509
	Less: Standby Charge		$81,878	$84,335	$86,865	$89,471	$92,155	$94,920	$97,767	$100,700	$103,721	$106,833	$110,038	$113,339	$116,739	$120,241	$123,848	$127,564	$131,391	$135,333	$139,392	$143,574
	EBITDA		$667,836	$686,524	$705,772	$725,598	$746,018	$767,052	$788,716	$811,030	$834,013	$857,686	$882,069	$907,184	$933,052	$959,696	$987,140	$1,015,406	$1,044,521	$1,074,509	$1,105,397	$1,137,212
	Less: Interest		$352,813	$336,463	$319,295	$301,269	$282,342	$262,468	$241,601	$219,690	$196,684	$172,527	$147,162	$120,530	$92,565	$63,203	$32,372	$0	$0	$0	$0	$0
	Pre-Tax Income Before Depreciation		$315,023	$350,061	$386,477	$424,329	$463,677	$504,583	$547,115	$591,340	$637,330	$685,159	$734,907	$786,654	$840,486	$896,493	$954,767	$1,015,406	$1,044,521	$1,074,509	$1,105,397	$1,137,212
Cash Flow from Operating Activities- Tax																						
	Pre-Tax Before Depreciation		$315,023	$350,061	$386,477	$424,329	$463,677	$504,583	$547,115	$591,340	$637,330	$685,159	$734,907	$786,654	$840,486	$896,493	$954,767	$1,015,406	$1,044,521	$1,074,509	$1,105,397	$1,137,212
	Less: Tax Depreciation		$10,640,396	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Pre-Tax Income		-$10,325,373	$350,061	$386,477	$424,329	$463,677	$504,583	$547,115	$591,340	$637,330	$685,159	$734,907	$786,654	$840,486	$896,493	$954,767	$1,015,406	$1,044,521	$1,074,509	$1,105,397	$1,137,212
	Tax paid in this Period		-$2,902,462	$98,402	$108,639	$119,279	$130,339	$141,838	$153,794	$166,226	$179,153	$192,598	$206,582	$221,128	$236,261	$252,004	$268,385	$285,431	$293,615	$302,045	$310,727	$319,670
	Deferred Tax		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total Tax		-$2,902,462	$98,402	$108,639	$119,279	$130,339	$141,838	$153,794	$166,226	$179,153	$192,598	$206,582	$221,128	$236,261	$252,004	$268,385	$285,431	$293,615	$302,045	$310,727	$319,670
	Net Income-Tax Basis		-$7,422,911	$251,659	$277,838	$305,050	$333,337	$362,745	$393,321	$425,114	$458,176	$492,561	$528,324	$565,526	$604,226	$644,489	$686,382	$729,976	$750,906	$772,465	$794,670	$817,541
	Plus: Tax Depreciation		$10,640,396	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Plus: Deferred Taxes		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Cash Flow from Operating Activities-Tax Basis		$3,217,486	$251,659	$277,838	$305,050	$333,337	$362,745	$393,321	$425,114	$458,176	$492,561	$528,324	$565,526	$604,226	$644,489	$686,382	$729,976	$750,906	$772,465	$794,670	$817,541
Cash Flow from Operating Activities- Book																						
	Pre-Tax Before Depreciation		$315,023	$350,061	$386,477	$424,329	$463,677	$504,583	$547,115	$591,340	$637,330	$685,159	$734,907	$786,654	$840,486	$896,493	$954,767	$1,015,406	$1,044,521	$1,074,509	$1,105,397	$1,137,212
	Less: Book Depreciation		$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020
	Pre-Tax Income		-$216,997	-$181,959	-$145,543	-$107,691	-$68,343	-$27,436	$15,095	$59,320	$105,310	$153,139	$202,887	$254,634	$308,467	$364,473	$422,747	$483,386	$512,501	$542,489	$573,377	$605,192
	Tax paid in this Period		-$2,902,462	$98,402	$108,639	$119,279	$130,339	$141,838	$153,794	$166,226	$179,153	$192,598	$206,582	$221,128	$236,261	$252,004	$268,385	$285,431	$293,615	$302,045	$310,727	$319,670
	Deferred Tax (accrued for future Pmt.)		$2,841,465	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551
	Total Tax		-$60,998	-$51,149	-$40,912	-$30,272	-$19,211	-$7,712	$4,243	$16,675	$29,603	$43,047	$57,032	$71,578	$86,710	$102,453	$118,834	$135,880	$144,064	$152,494	$161,176	$170,119
	Net Income-Book Basis		-$155,999	-$130,810	-$104,631	-$77,419	-$49,132	-$19,724	$10,852	$42,645	$75,707	$110,092	$145,855	$183,057	$221,757	$262,020	$303,913	$347,507	$368,437	$389,996	$412,201	$435,072
	Plus: Book Depreciation		$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020	$532,020
	Plus: Deferred Taxes		$2,841,465	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551	-$149,551
	Cash Flow from Operating Activities-Book Basis		$3,217,486	$251,659	$277,838	$305,050	$333,337	$362,745	$393,321	$425,114	$458,176	$492,561	$528,324	$565,526	$604,226	$644,489	$686,382	$729,976	$750,906	$772,465	$794,670	$817,541

Financial Analysis-

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cash flow from Operations			$3,217,486	$251,659	$277,838	$305,050	$333,337	$362,745	$393,321	$425,114	$458,176	$492,561	$528,324	$565,526	$604,226	$644,489	$686,382	$729,976	$750,906	$772,465	$794,670	$817,541
Project Capital Cost all-In		-$16,449,467																				
BPU Grant for Hospital CHP		$2,000,000																				
BPU Grant for Glenfield CHP		$139,050																				
BPU Grant for Fire House Battery		$10,000																				
Subsidy for Microgrid		$3,100,000																				
Proceeds from LT Debt Financing		$7,056,263																				
Principal Repayments			-$327,003	-$343,354	-$360,521	-$378,547	-$397,475	-$417,348	-$438,216	-$460,127	-$483,133	-$507,290	-$532,654	-$559,287	-$587,251	-$616,614	-$647,444	$0	$0	$0	$0	$0
Investment Tax Credit		$1,120,042																				
Cash Flow to Investor		-$3,024,113	$2,890,482	-$91,695	-$82,683	-$73,497	-$64,138	-$54,603	-$44,895	-$35,012	-$24,957	-$14,729	-$4,330	$6,239	$16,975	$27,875	$38,938	$729,976	$750,906	$772,465	$794,670	$817,541
Cumulative Cash Flow		-$3,024,113	-$133,630	-$225,325	-$308,008	-$381,506	-$445,643	-$500,246	-$545,141	-$580,154	-$605,110	-$619,839	-$624,169	-$617,930	-$600,955	-$573,080	-$534,142	$195,834	$946,740	$1,719,205	$2,513,875	$3,331,416
Aft Tax Internal Rate of Return	10.07%																					
Simple Payback occurs in year	16																					
Cash Flow to Investors		-$3,024,113	$2,890,482	-$91,695	-$82,683	-$73,497	-$64,138	-$54,603	-$44,895	-$35,012	-$24,957	-$14,729	-$4,330	$6,239	$16,975	$27,875	$38,938	$729,976	$750,906	$772,465	$794,670	$817,541
Times: Discount Factor @	10.07%	1.0000	0.9085	0.8254	0.7499	0.6812	0.6189	0.5623	0.5108	0.4641	0.4216	0.3830	0.3480	0.3162	0.2872	0.2609	0.2371	0.2154	0.1957	0.1778	0.1615	0.1467
Equals: Discounted Cash Flow		-$3,024,113	$2,626,003	-$75,682	-$62,000	-$50,069	-$39,695	-$30,702	-$22,934	-$16,249	-$10,522	-$5,642	-$1,507	$1,972	$4,876	$7,274	$9,231	$157,220	$146,930	$137,318	$128,339	$119,952
Cumulative Disct. Cash Flow		-$3,024,113	-$398,110	-$473,792	-$535,792	-$585,861	-$625,556	-$656,258	-$679,192	-$695,441	-$705,963	-$711,605	-$713,111	-$711,139	-$706,263	-$698,989	-$689,759	-$532,539	-$385,609	-$248,292	-$119,952	$0
Net Present Value at	10.07% $0																					

Montclair Town Center Microgrid Pilot Project Project Schedule