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Overview – Clarkson Avenue Medical Complex Microgrid

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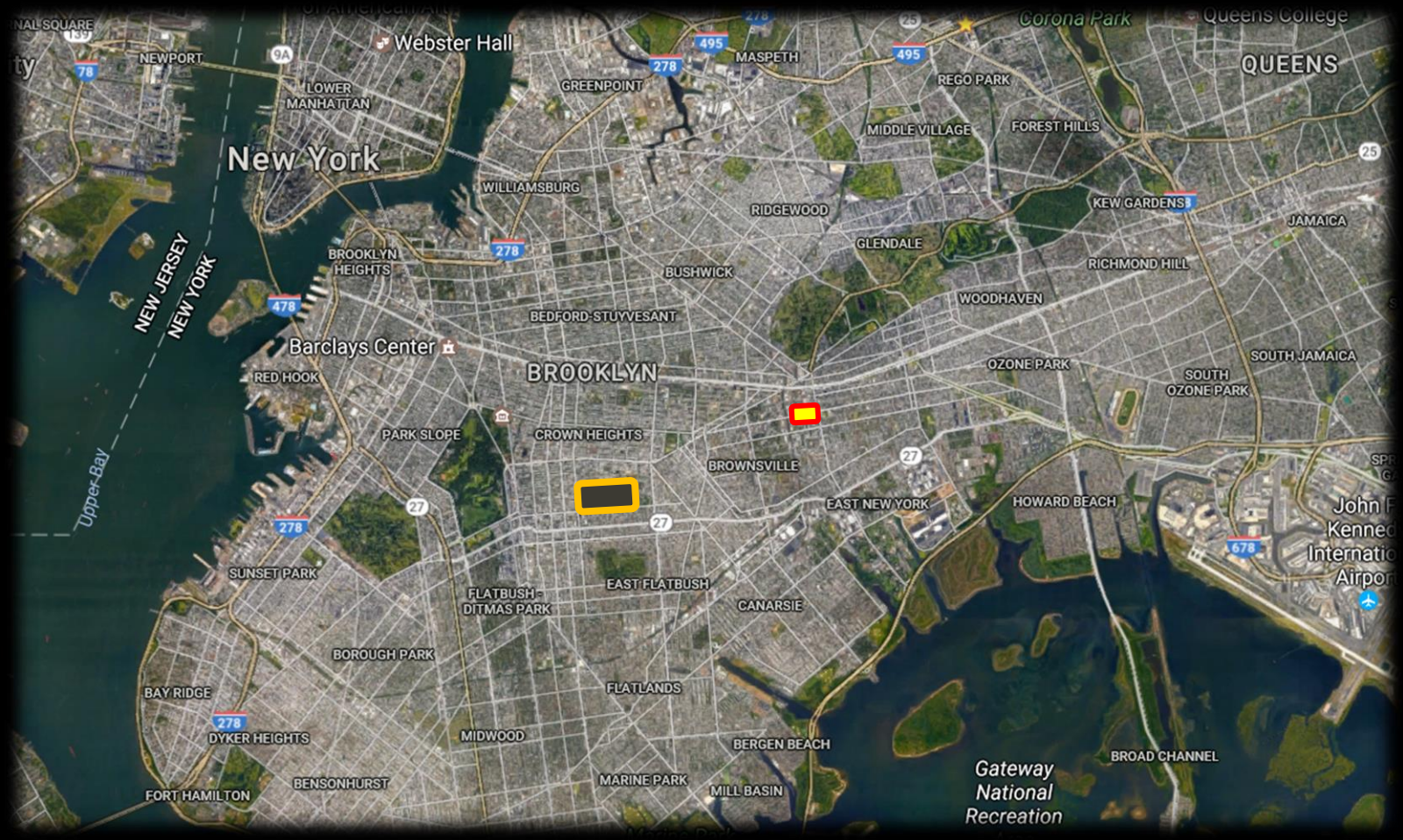
- Project Background & Design Objectives
- Major Challenges
- Distributed Energy Resources – Existing & Proposed
- Modifying and Utilizing Existing Generation Assets
- Microgrid Electrical Distribution Challenges
- Thermal Distribution Constraints
- Air & Construction Permitting Limitations



Project Background

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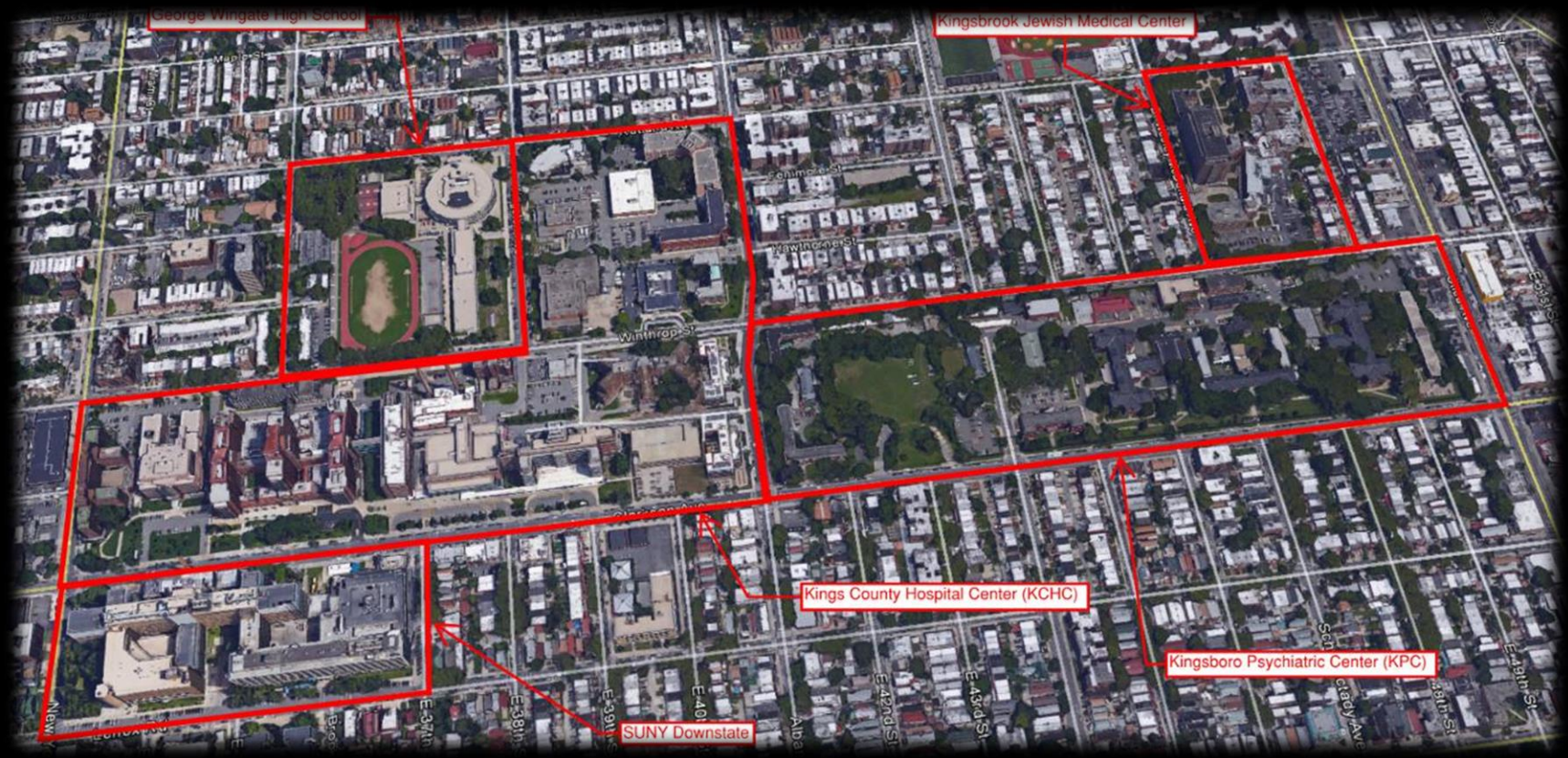
- NY Prize Community Microgrid - Awarded Stage 1 & Stage 2
- 4 Adjoining Medical Campuses in Heart of Brooklyn ~ 100 acres
  - SUNY Downstate Medical Center
  - Kingsboro Psychiatric Center
  - Kings County Hospital
  - Kingsbrook Jewish Medical Center
- Approx. 1500 beds total
- Serving population of 2.5 million
- 18 MW +/- peak load combined; 8 MW base load



Primary Microgrid Participant Loads

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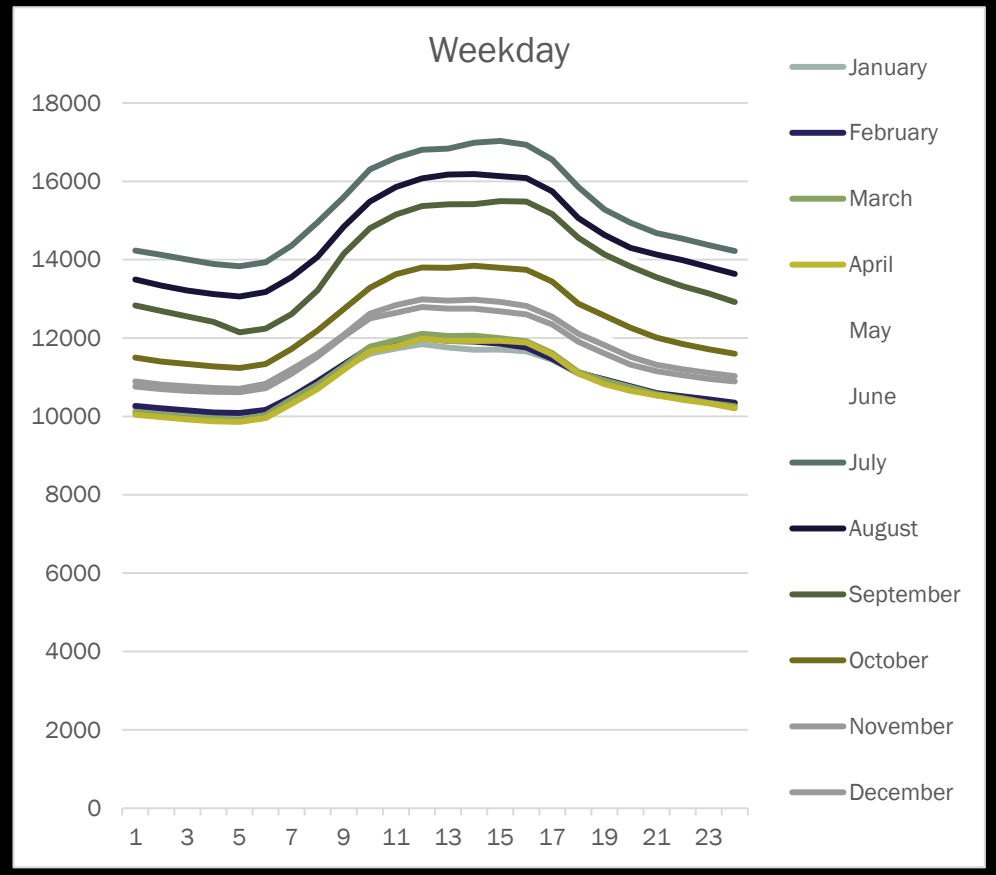
Monthly Electrical Peak Demand (kW)			
	Kingsboro Psychiatric	Kings County Hospital	SUNY Downstate Medical
Jan	862	6,406	6,178
Feb	844	5,074	6,292
Mar	826	5,074	6,119
Apr	790	5,976	6,658
May	1,029	6,772	7,231
Jun	1,232	7,876	7,999
Jul	1,311	8,722	7,939
Aug	1,140	7,916	7,546
Sep	1,159	8,346	7,676
Oct	946	7,300	6,914
Nov	823	6,330	6,456
Dec	856	5,390	6,067
Total	1,311	8,722	7,999



Primary Microgrid Participant Loads

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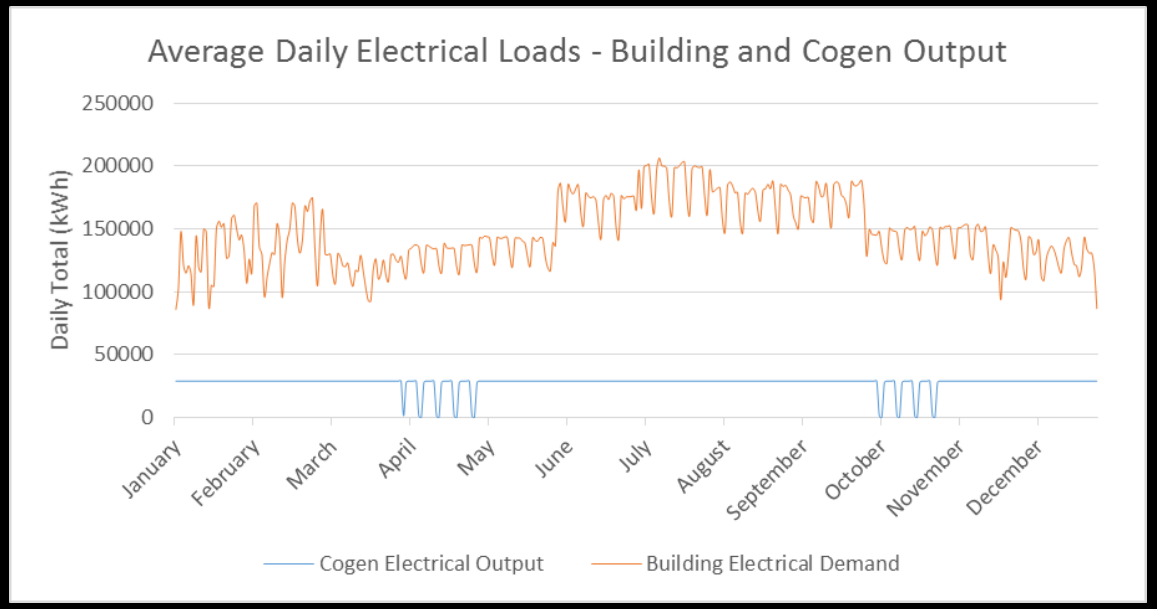

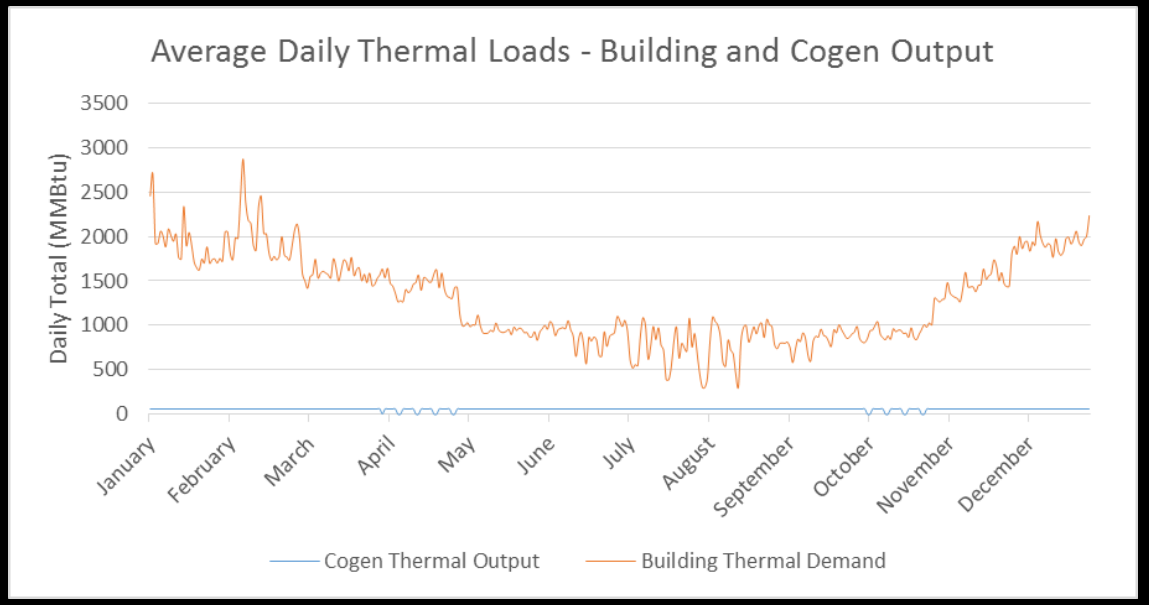

Project Design Objectives, Constraints & Challenges

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- Maintain full operational continuity during prolonged power grid failure lasting at least two weeks
  - If utilizing liquid fuels, incorporate fuel storage as needed to ensure 14 days of operation
- Maximize value of Microgrid to the local and regional electric grid
  - Participate in NYISO electric markets as possible/feasible to earn revenues to help drive favorable economic performance of the microgrid
- Minimize emissions-related environmental impact

Project Design Objectives, Constraints & Challenges

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- Leverage local electrical system infrastructure
- Implement energy efficiency & demand reduction to right size the microgrid

- Incorporate inno-vative technical & business model solutions that enhance scalability, operation and financial value of microgrids

Major Challenges

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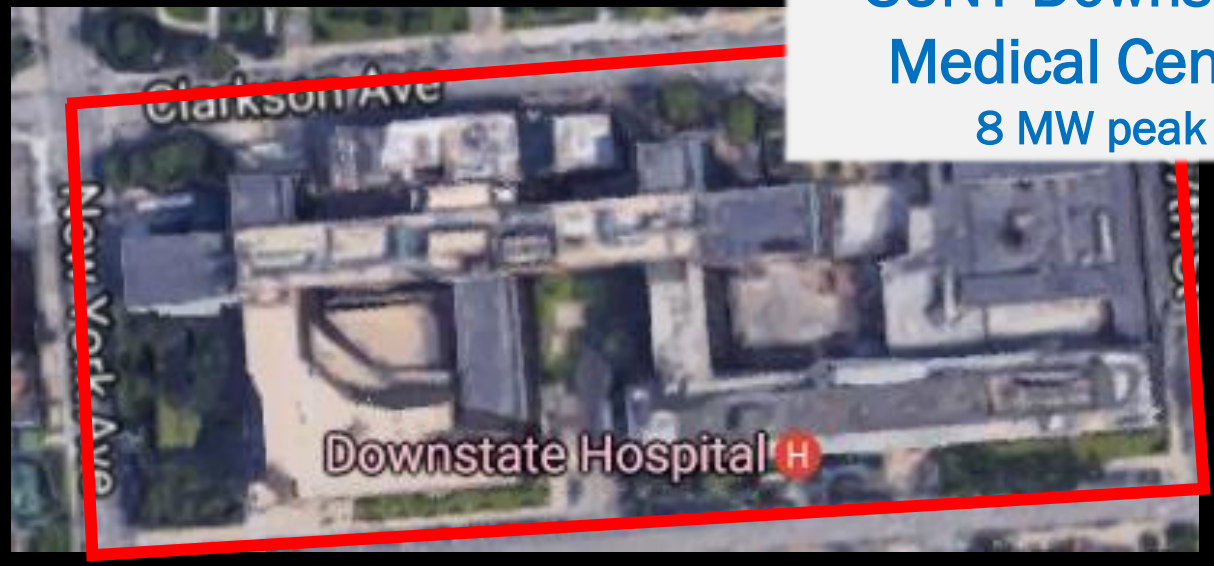
- Con Edison distribution grid in this area is underground and network architecture (vs radial)
  - For technical reasons Con Ed did not allow the microgrid to interconnect their “Clarkson Avenue feeder” that would have greatly simplified the project
  - Routing wires overhead was not feasible and was also discouraged by NYSERDA because or resiliency concerns



SUNY Downstate Medical Center
8 MW peak

- Implementing large cogeneration and a thermal distribution loop serving all sites was not possible due to cost, technical and air permitting constraints
- Solar PV options were limited due to cluttered rooftops, shading & low power density relative to high power consumption density of hospitals

Distributed Energy Resources – Existing & Proposed

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- Approximately 17 MW of existing emergency generation distributed throughout the campuses
- Proposed:
  - 8 MW of fuel cells for baseload generation
  - 300 kW of solar PV
  - 100 kW of battery storage
  - 1 MW of demand response

Modifying & Utilizing Existing Emergency Generation

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- Convert 8-9 MW of emergency diesel generation units to dual fuel capability
- Enables use of these assets to :
  - perform rapid transition to island operation,
  - load follow during prolonged island operation (minimum of 14 days
- Minimizes emissions

Ins

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Thermal Distribution Constraints Limited CHP Options

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- Centralized cogeneration with thermal distribution to the facilities was not economically feasible due to the high costs posed by tunneling under city streets
- This drove the decision to incorporate an array of Bloom Energy fuel cells with electric efficiency of 60%
- These units do not have heat recovery
- Con Edison is providing incentives for Bloom fuel cells related to offsetting loads at their nearby Brownsville substation

Electrical Distribution Challenges

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- Con Edison, the local distribution utility, determined that it was not feasible to utilize their feeders to connect the facilities and create the microgrid
- Directional drilling will enable cost-effective installation of dedicated feeders from the base load generation performed
  - $1/inch/foot
  - 10 inch diameter duct bank = $100/foot
  - Estimated cost = $1 million

Schematic of Clarkson Avenue Microgrid

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Electrical Schematic of Clarkson Avenue Microgrid

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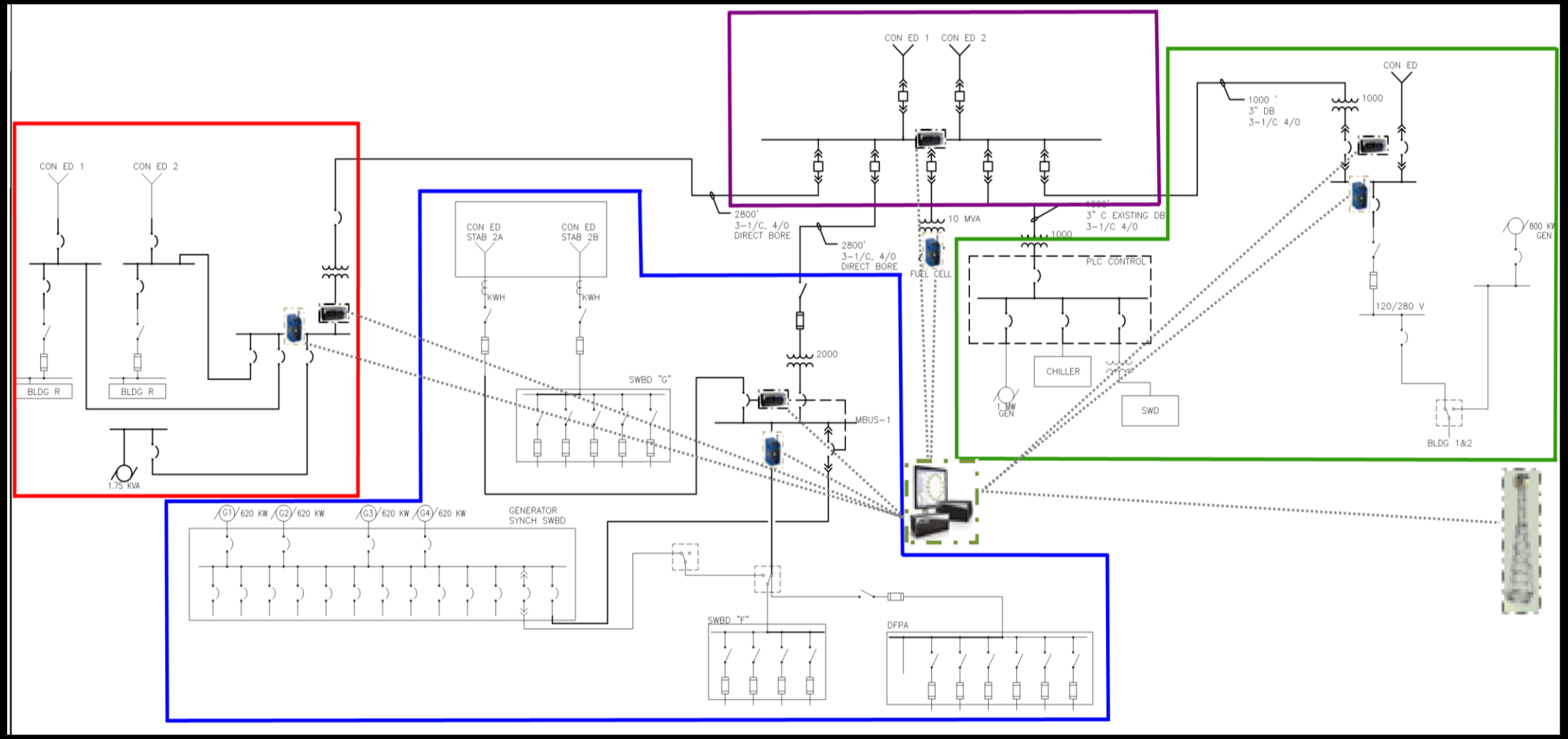

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Conclusion & Lessons Learned

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- Dense urban settings present unique challenges
- Creative solutions may enhance feasibility, and/or introduce areas of risk and uncertainty
- Take what the project gives you, and be clear-eyed about what is and is not possible/feasible