

MICROGRIDS AS RESILIENCY OPPORTUNITIES IN THE AFTERMATH OF SUPERSTORM SANDY

Joseph Sullivan

VP, Energy Policy & Development

Concord Engineering

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Major Power Failures

- 2003 Northeast Blackout (man-made crisis)
- Hurricane Ike
- Hurricane Irene
- Hurricane Katrina
- Super Storm Sandy 820 miles in diameter on 10/29/12
  - 21 states 8,100,000 homes lost power
  - Double the landfall size of Isaac & Irene combined
  - Caused 106 fatalities
- Total Sandy estimated cost:
  - $71 billion+ (dni lost business)
  - New York - $42 billion
  - New Jersey - $29 billion

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

What We Have Learned from Recent Events

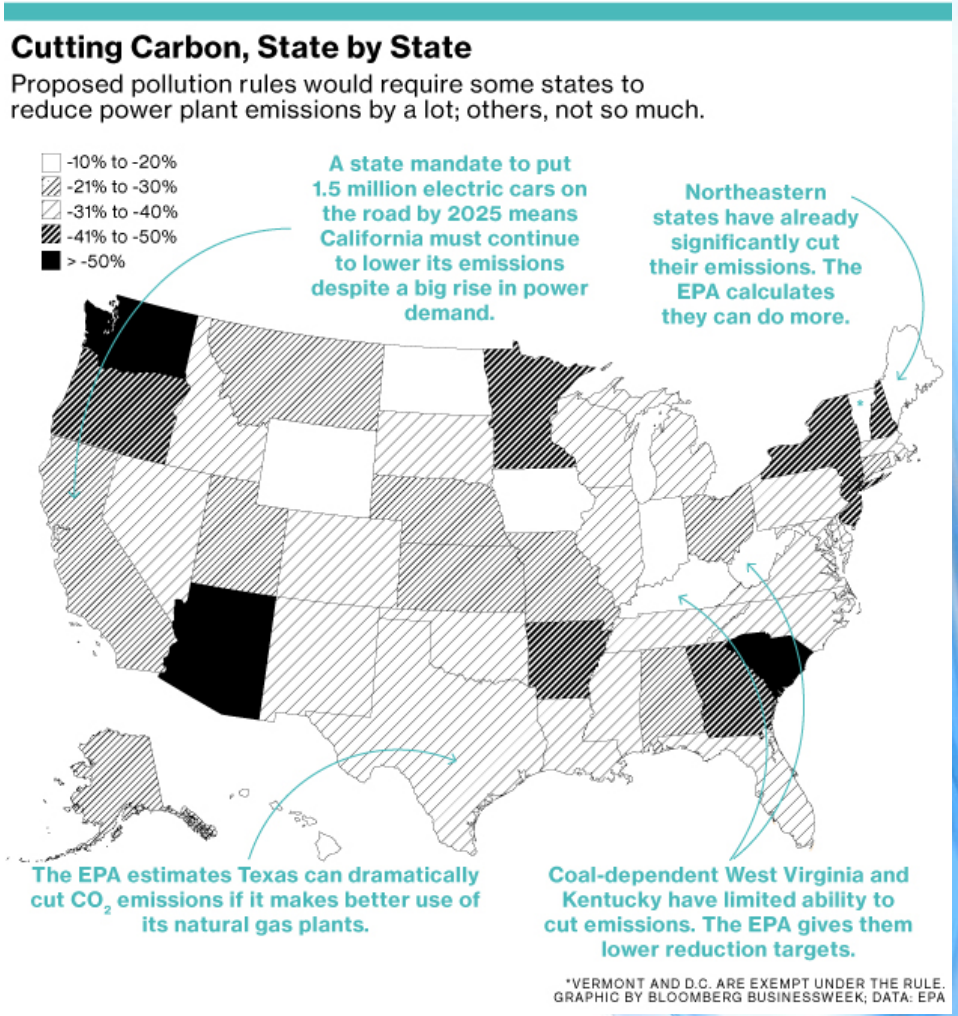
- Super Storm Sandy has shown that our electric power infrastructure has vulnerabilities.
- Objectively no system can be 100% safe against natural or manmade disasters.
- If correctly engineered, distributed generation (DG) and combined heat and power (CHP) can contribute to providing critical power during emergencies.
- This is particularly important for our hospitals and health care assets that simply cannot be allowed to suffer the kinds of long-term energy outages that we have repeatedly seen in recent years.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

EPA

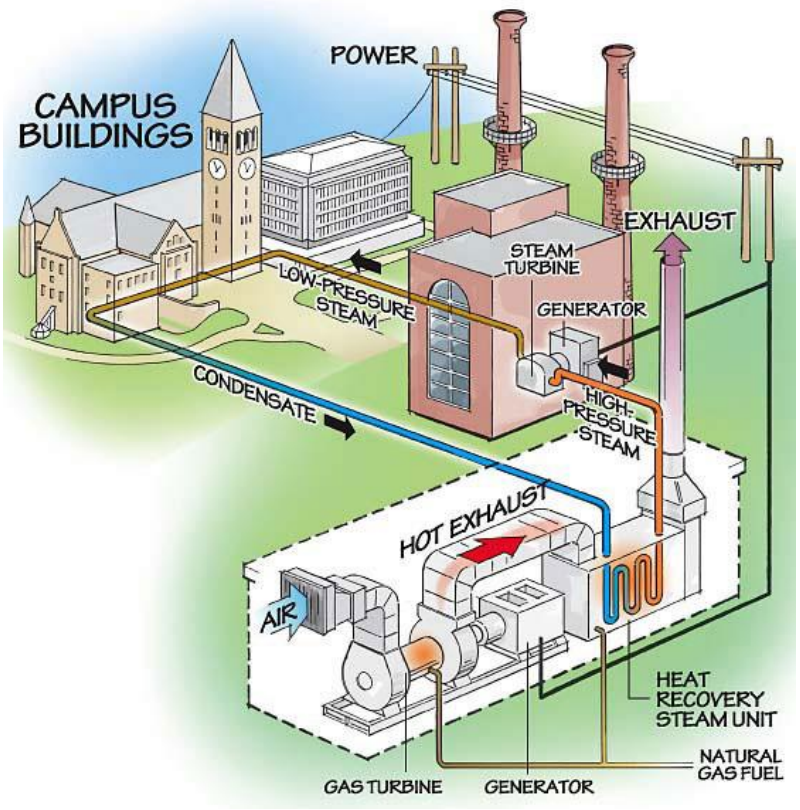
- Environmental Protection Agency's 2030 emissions reduction targets, assigns each state a emissions reduction target for carbon reductions without proscriptive implementation
- Currently PJM is expecting 19,000 MW of coal plants to retire from service



CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

WHY MICROGRIDS? (IT IS THE NEW BUZZ WORD)



- A microgrid is differentiated from a campus energy grid by being fully capable of black start and island operation
- Although reliable the grid is not 100% and natural disasters can cripple critical infrastructure
- Campus CCHP is a good example of a microgrid

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

DEFINITIONS

- **Combined Heat and Power (CHP)**
  - ✓ The production of electric power and thermal energy from one source of fuel
- **Distributed Generation**
  - ✓ Generation on-site can be CHP, generators w/emissions control, emergency generators, solar PV, battery Storage
- **Microgrid (DOE & EPRI)**
  - ✓ A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and that connects and disconnects from such grid to enable it to operate in both grid-connected or "island" mode
  - ✓ **MRC** adds that a microgrid also provides a significant amount of normal power on-site generation

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Is All Distributed Generation Created Equal?

- Grid connected distributed generation (DG) including combined heat and power (CHP) as well as solar photovoltaic (PV) and other assets do not necessarily function during a power emergency.

- Despite the investment of millions and millions of dollars, not one kilowatt of emergency power was generated by a PV system during or post Sandy.

- The additional millions of dollars to add battery storage to make this a viable emergency energy supply would not meet a critical facility such as a hospital's need for reliable power.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

MAJOR INITIATIVES

- NJT $400 Million Fed Grant for Linear Microgrid
- Hoboken Urban Microgrid
- NJ ERB $200 Million CHP Resilient On-site Power
- NY $40 Million NY Prize CHP/DG Microgrid
- NY Renewing the Energy Vision

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

SUPERSTORM SANDY PROMPTS NJ TRANSIT MICROGRID PROJECT

- The NJ Transit system is a critical transportation corridor and evacuation route for Manhattan. Superstorm Sandy, Hurricane Irene and other natural disasters have exposed the vulnerability of the transit system to power outages. The NJ TransitGrid, is considered critical for New Jersey's economy and emergency and evacuation-related activities.

- The DOE partnered with New Jersey Transit and the New Jersey Board of Public Utilities to assess NJ Transit's energy needs and help develop a conceptual design of an advanced microgrid system. $1.9 Million Study

- Part of the Obama Administration's ongoing efforts to provide support to communities affected by Superstorm Sandy, will see Sandia National Laboratories assist NJ Transit in its efforts to enhance the reliability and resiliency of electricity used for its rail and system operations.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

TRANSITGRID MISSION

- To provide a resilient energy supply for the critical portion of the passenger rail infrastructure, NJ TRANSIT proposes to construct a first-of-its-kind electrical microgrid capable of supplying highly reliable power during storms or other times when the centralized power grid is compromised.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

TRANSITGRID SCOPE

- NJ TransitGrid will provide resilient power to key NJ Transit facilities and portions of the Northeast Corridor, Morris & Essex Lines, Hudson-Bergen Light Rail Transit System, and the signal system on a portion of the Main Line.
- NJ TransitGrid traction power and certain elements of the key infrastructure will be powered by a central, natural gas power plant, with a proposed location in an industrial zone in Kearny, NJ, close to two substations that serve the M&E line and Northeast Corridor.
- Other elements of the project will be located at specific facilities serviced by those generation assets.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

NJ TransitGrid Objectives

- Maintain and enhance mobility and regional security in the event of power outages and emergency situations;
- Minimize disruptions to the regional workforce and economy;
- Enhance electric grid reliability by providing additional sources of efficient power;
- Minimize source pollutants by replacing older, less efficient energy generation with newer, cleaner generation technologies.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

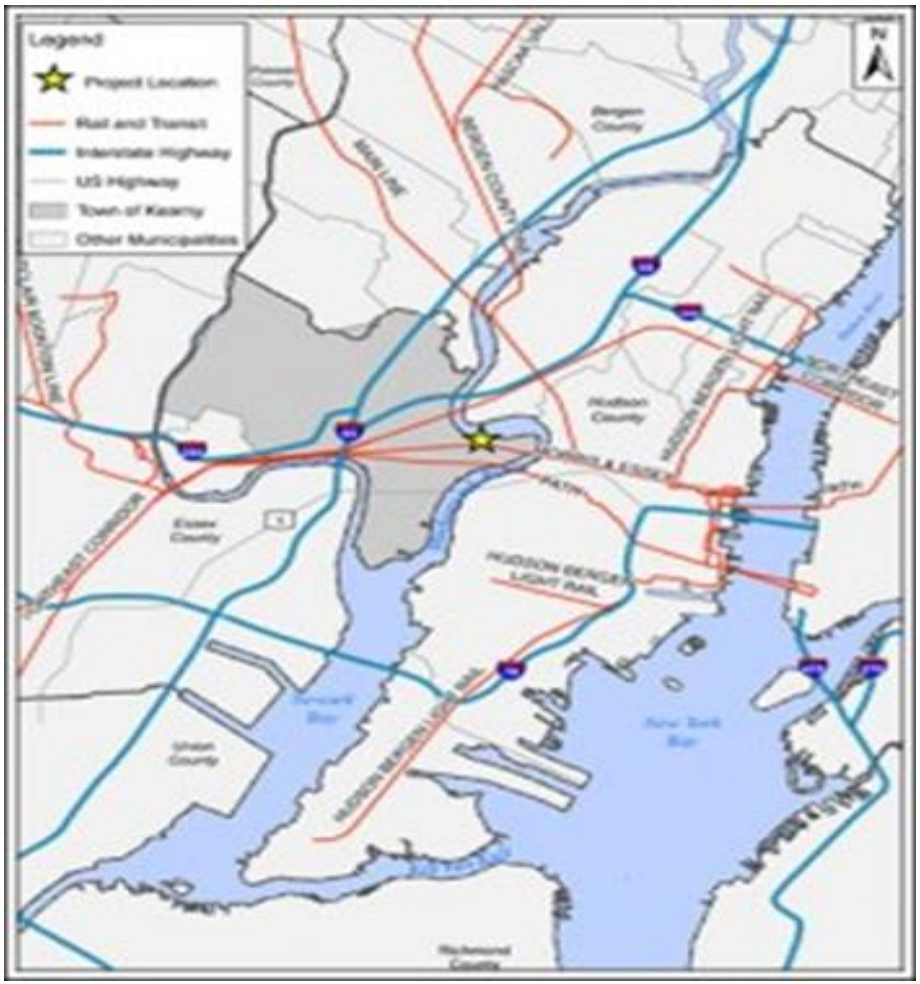
TRANSITGRID TRACTION POWER PROJECT

- Nominal 104 Megawatt Central, Natural Gas Power Plant
- PJM Interconnection
- Transmission lines to traction power substations that electrify the tracks and operating controls on portions of the NJ TRANSIT and Amtrak systems.
- 230 kV Substation
- 138 kV Frequency Converter

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Area Served



CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

OPERATIONS

- As proposed the facility will operate 24/7 and be sized to handle limited operations on the Northeast Corridor between New York's Penn Station and NJ TRANSIT's Jersey Avenue Station in New Brunswick; the Morris & Essex (M&E) line between Hoboken Terminal and Newark's Broad Street Station; the Hudson-Bergen Light Rail (HBLR) Transit System; and the signal system on a portion of the Main Line.

TransitGrid Distributed Generation

- NJ TransitGrid will incorporate renewable energy, distributed generation, and other technologies to provide resilient power to key NJ TRANSIT stations, maintenance facilities, bus garages, and other buildings. NJ TRANSIT will purchase electric, non-revenue vehicles to maximize energy storage.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Implementation Process

- NJ Transit has conducted a open competitive bid process to select two engineering teams for the Traction Power project and for the Distributed and Renewable Generation project.

- These teams will provide conceptual and preliminary design (20%)

- The 20% design documents will be utilized to issue RFP's for EPC projects to take this through final design and construction.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

STATUS

- NJ TransitGrid will advance as a result of a grant awarded by the Federal Transit Administration (FTA), through FTA's Emergency Relief Program for resiliency projects in response to Superstorm Sandy.

- FTA Grant Award $409,764,814

- Anticipated award and notice to proceed for Conceptual and Preliminary design Summer 2016

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

HOBOKEN URBAN MICROGRID

- As part of the Obama Administration's ongoing commitment to provide support to communities affected by Hurricane Sandy, the Energy Department partnered with the New Jersey Board of Public Utilities, City of Hoboken and Public Service Electric & Gas Company (PSE&G) to help assess and develop strategies for improving the reliability and resiliency of the local electric grid in Hoboken.

- The collaboration will help Hoboken in its efforts to rebuild and upgrade its electricity infrastructure by delivering a strategic design that identifies priority energy needs and energy system functions for various outage durations, evaluates potential system improvements, and estimates cost.

- $29 Million

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

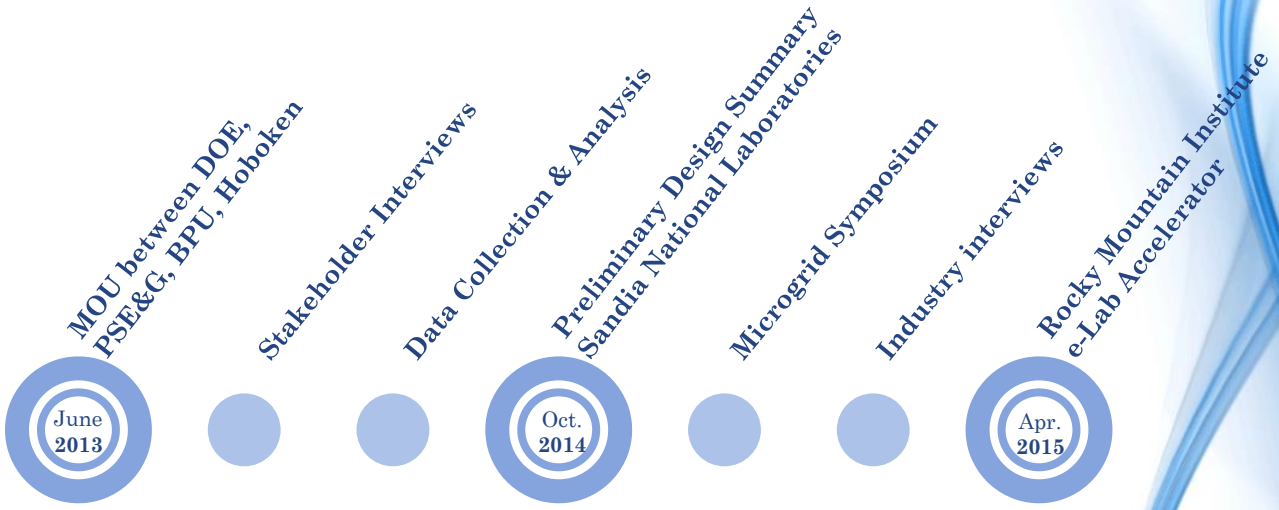
PROJECT DESCRIPTION

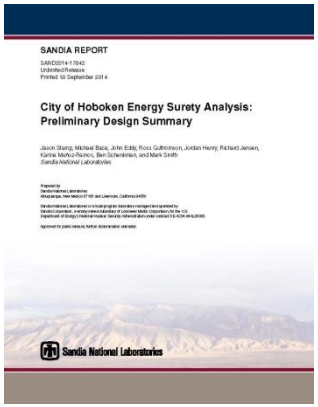
Project Name	Hoboken Microgrid Development
Project Objective	To develop and recommend pilot project design, financing, and ownership models for the City of Hoboken and the State of New Jersey to deploy microgrid solutions for critical facilities.
Project Description	Over 75% of Hoboken, NJ is located within a Special Flood Hazard Area. In 2012, Superstorm Sandy crippled the local power system by inundating sub-stations with coastal storm surge, plunging the City into darkness for over 7 days. This directly impacted thousands of residents sheltering in place, and greatly affected the ability for the city to recover following the storm. Recognizing the likelihood of future storms, power interruption, and the increasing cost of energy, the City partnered with the Department of Energy & Sandia National Laboratories to develop an energy security strategy. The resultant design solution powers up to 55 critical facilities by connecting multiple power generation assets via a new and resilient underground medium voltage distribution network.

CONCORD ENGINEERING

ROCKY MOUNTAIN INSTITUTE

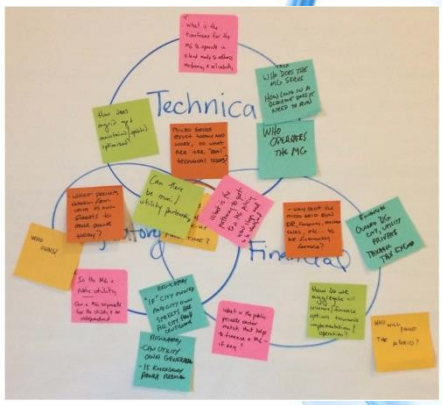
PROJECT DEVELOPMENT




SANDIA REPORT

City of Hoboken Energy Surety Analysis: Preliminary Design Summary

Sandia National Laboratories



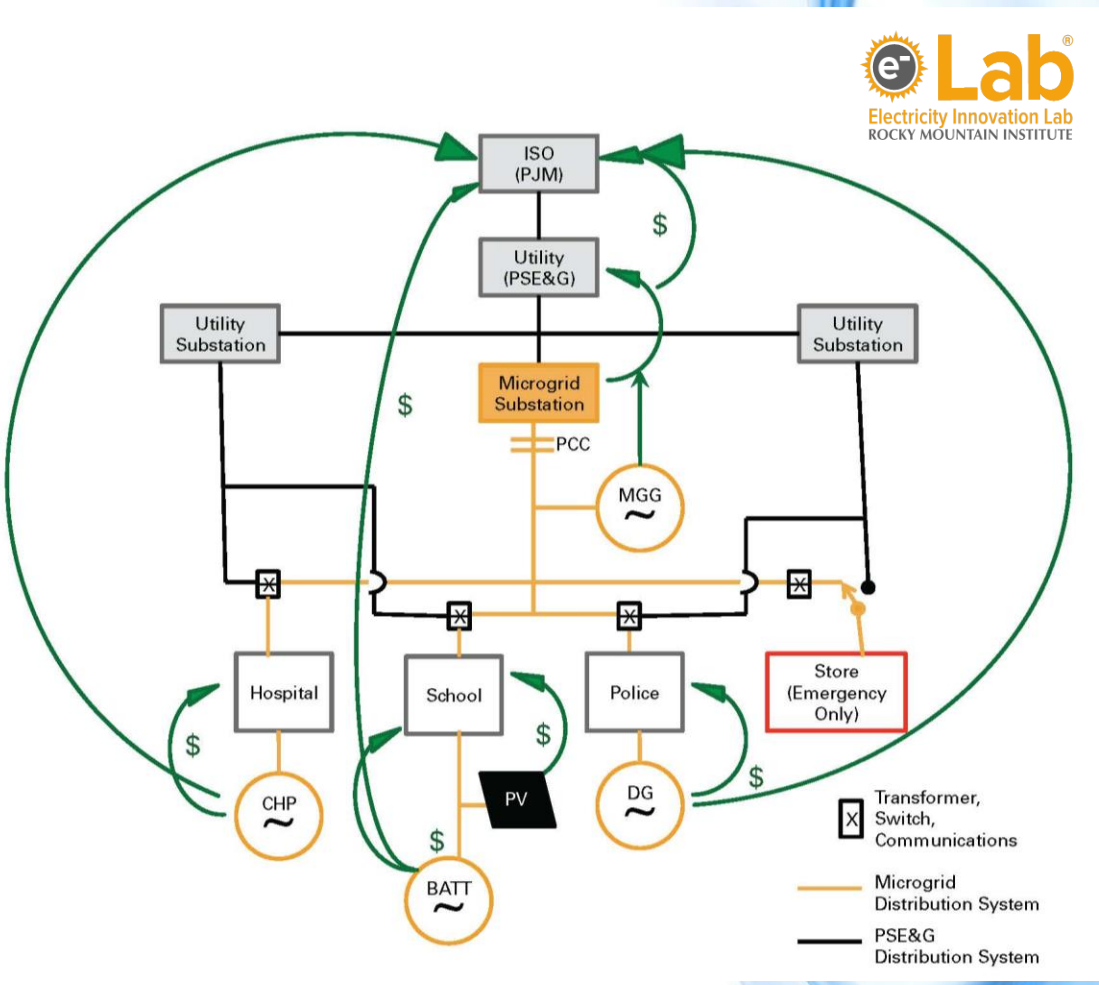
CONCORD ENGINEERING

ROCKY MOUNTAIN INSTITUTE

eLab Accelerator Project Evolution

The Hoboken Microgrid Business Model

While at e-Lab Accelerator, the team developed a microgrid business model for Hoboken that could be feasible within the current regulatory environment, and creates various opportunities for PSE&G to play a role in the development and operation of the microgrid. (Note: Several assumptions about this business model will need to be validated by PSE&G and/or the NJ BPU).



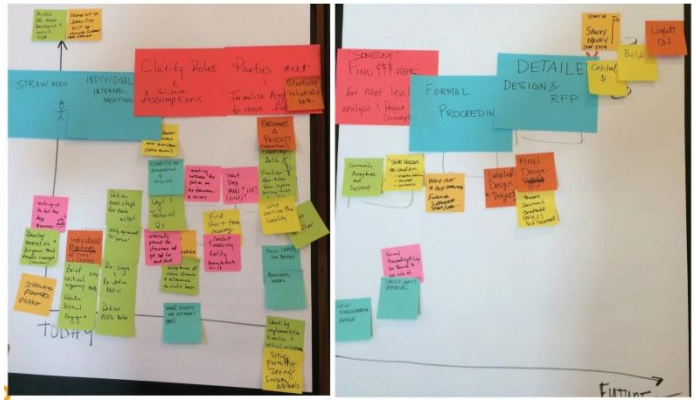
CONCORD ENGINEERING

ROCKY MOUNTAIN INSTITUTE

Post eLab Progress

1) Regulator, Utility & Sponsor Consensus

2) Actionable Next Steps & Project Timeline



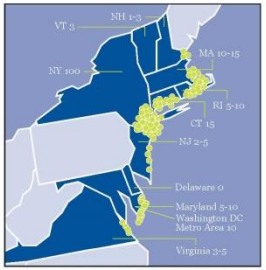
3) New Partnerships & Regional Support

MICROGRIDS MADE EASIER

Why a Microgrid?

In October 2012, Superstorm Sandy devastated the city of Hoboken: 500 million gallons of brackish water flooded its streets, homes and infrastructure (seventy percent of the city sits in a flood zone). Ninety percent of the city lost power, a dire situation that lasted for almost two weeks, making it an extremely stressful time for both residents and city administrators. The storm damaged critical infrastructure, hampered emergency response teams and left citizens cut off from key resources. Sandy sent a woefully clear message that Hoboken needed to enhance its resiliency before the next big storm.

Vowing "never again," Hoboken Mayor Dawn Zimmer conceived of establishing a self-contained microgrid for the City of Hoboken. The initial goals were to improve energy availability during emergencies, reduce pressure on the main power grid during peak hours and decrease emissions through the adoption of renewables. The city received a technical assistance grant from the Department of Energy to fund the initial analysis for the microgrid project. Brought in to do the analysis, Sandia National Labs identified 55 buildings – including police stations, fire departments, pharmacies, senior facilities and low-income housing – crucial to receive back-up power through a microgrid.



Greener by Design estimates that 150-175 microgrid projects already being planned or in development could make use of the Resilient Microgrids Toolkit.

The Problem: Complex Barriers

Hoboken had enlisted Greener by Design, a private firm, as an energy consultant, and Senior Project Manager Gail Lalla was tasked with turning the idea into a reality. Lalla sensed that to fully engage all the necessary stakeholders – time-strapped people without much experience implementing microgrids – an organizational tool would be crucial to make the job easier. She also recognized that not all microgrids are clean microgrids, so the tool would need to explain the benefits of this forward-looking approach. Greener by Design's goal was to ensure that a microgrid could become sustainable over time, if not from the start. Lalla faced the thorny challenge of making a case for the future cost efficiency of renewables in the face of up-front costs and a complicated path to monetizing environmental and social benefits. Thus, the seeds of the Resilient Microgrids Toolkit were sown.

About the City of Hoboken Incorporated in 1849, the City of Hoboken lies on the west bank of the Hudson River across from the island of Manhattan. Originally, Hoboken was developed as a waterfront resort town, and its spacious meadows were actually the location of the first organized baseball game. Because of its waterfront location, Hoboken has historically been a transportation hub and has drawn immigrants from a variety of different cultures. Covering just over a square mile and home to more than 50,000 residents, the city is densely populated and is one of the most walkable and transit-friendly cities in America.

The Solution: A Simple Toolkit

To create the toolkit, the City of Hoboken and Greener by Design enlisted the help of EDF Climate Corps, a program that trains and embeds graduate students within organizations to accelerate energy projects. EDF Climate Corps fellow Devashree Ghosh, a recent graduate of The New School who had previously worked on a cost-benefit analysis of the Hoboken microgrid, was the perfect candidate to focus on this project over the course of a summer fellowship.

Ghosh began her project by conducting a series of interviews. She wanted to determine which specific stakeholders would primarily use the toolkit, in what ways the toolkit could make the most impact and how the toolkit could scale and adapt to different buildings or other communities. She interviewed energy services companies, policy advisors and experts at Greener by Design and EDF to gain as much information as possible.

In order to develop a tool that specifically addressed Hoboken's needs, Ghosh then met with Stephen Marks, the municipal manager, and Caleb Stratton, the principal planner, to determine their priorities. In their opinion, a successful toolkit would need to:

- Benchmark different microgrid projects against each other
- Provide a scoring mechanism for benefits
- Prioritize energy efficiency

New Jersey Energy Resiliency Bank (ERB)

The ERB is funded under the Federal Community Development Block Grant (CDBG) Disaster Recovery Program funds allocated to New Jersey by the US Department of Housing and Urban Development (HUD). The plan proposes a $535 million investment in infrastructure which includes $200 million of funding to create an energy bank to fund resiliency projects. This first phase is $65 million for water and waste water facilities which would leave $135 million for the balance of the program.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

New Jersey Energy Resiliency Bank (ERB) Phase 1

- The first phase of the program provided $65 million for Water and Waste Water Treatment Utilities
- The ERB authorized combined grant and loans for Water and Waste Water Treatment plant resilient power project can receive a total of 40% in grant funds and the remaining 60% with a 2% loan.
- This represents a significant increase over the existing BPU Clean Energy Program Combined Heat and Power (CHP) grants for projects > 1 MW < 3 MW provide $550/kw which provides 20-30% of a project's cost. Grant cap is $3,000,000
- As authorized projects had to choose between the Clean Energy-funded CHP grants and the ERB as they cannot qualify for both.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

New Jersey Energy Resiliency Bank (ERB) Phase 2

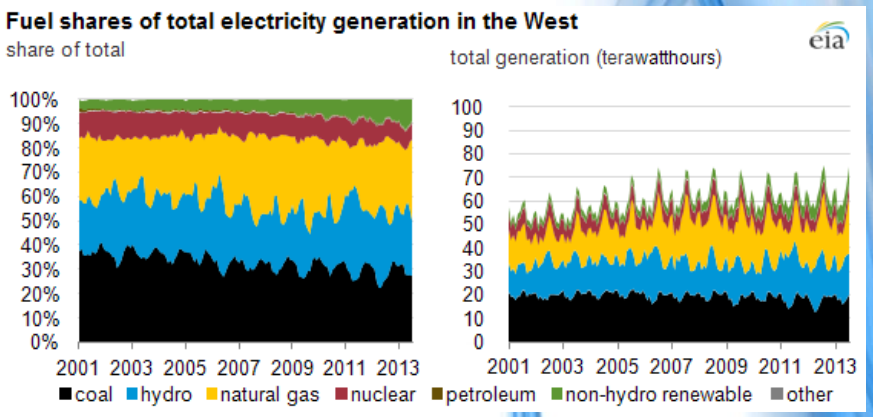
- On October 15, 2016 The NJDEA ERB authorized the second phase of the ERB for nonprofit hospitals.
- Initial funding has been set at $100,000,000 and can be increased based on availability of funding and project demands
- This can apply to an existing or new hospital project. It is scheduled to commit the available federal funds with completion dates by 2019.
- Application is open and is a two phase process starting with a intake qualification which if approved can advance to a full application.
- These projects may also under certain conditions also use BPU Societal Benefits funds to supplement the HUD funding which would extend this timeframe.
- A ERB Hospital projects are proposed to provide full unmet needs for qualifying projects
- Funding will be determined on a case by case basis however at a minimum Hospital projects can receive a total of 40% in grant funds and the remaining 60% with a 2% loan. These ratios can be increased depending on the applicants specific needs.

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

New York Reforming the Energy Vision (REV)

- New York's PSC Reforming the Energy Vision calls for an overhaul of the regulation of the state's distribution utilities to achieve five policy objectives:
  - ✓ Increasing customer knowledge and providing tools that support effective management of their total energy bill
  - ✓ Market animation and leverage of ratepayer contributions
  - ✓ System-wide efficiency
  - ✓ Fuel and resource diversity
  - ✓ System reliability and resiliency
- The traditional utilities would become Distributed System Platform Providers (DSPPs) and continue to provide continuity and essential services



CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

New York Prize

- New York will utilize federal funds from Superstorm Sandy to harden the State's existing electrical grid
- Create 10 Microgrids - $40,000,000
- Microgrids must be able to operate in tandem with existing power supply during normal conditions, but will disconnect and operate as an independent power system to keep the lights on during an emergency.
- Under an innovative program to create at least 10 "microgrids" (independent community-based electric distributions systems) statewide, the State will launch NY Prize, a $40 million competition to help build community-scale power grids for areas with approximately 40,000 residents.
- Initial study funds have been awarded to 83 projects. The projects selected form this group will advance to engineering development and actual project grants for the available funds will be made based on final review and ranking.

Thank You for Your Time Today - Questions?

Joe Sullivan, VP, Energy Policy & Development
Concord Engineering
(856) 427-0200
jsullivan@concord-engineering.com

CONCORD ENGINEERING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION