MICROGRID KNOWLEDGE
CONFERENCE SERIES

Microgrid 2018
CONFERENCE

Microgrids in Urban Redevelopment

Moderator:
Eliot Assimakopoulos, Microgrid Sales Leader, *GE*

Presentations:
Will Agate, President & Founder, *NetZero Microgrid Solutions*
Robert Morin, Senior Project Developer, *Ameresco*
Johanna Ghabour, Senior Project Manager, *Veolia*

Developing Economically Viable and Resilient Microgrids

GE Distributed Grid Solutions

Eliot Assimakopoulos
Microgrid Sales Leader

What's a Microgrid?

imagin

What about Grid Resilience?

re·sil·ience
riˈzilyəns/
noun

1. the ability of a substance or object to spring back into shape; elasticity.

2. the capacity to recover quickly from difficulties; toughness.

Grid Resilience…

The degree to which an electrical grid is reliable, recoverable, & efficient

Two ways of looking at resilience…

Tenacity

Wisdom

By wisely planning your energy system you can avoid being forced to rely on your capacity to react

Key Challenges in Developing Microgrids

Complexity

- Integration of DERs
- Multiple stakeholders

Economics

- Cost
- Business model
- Financing…particularly with multi-user microgrids

Utility / Market Interaction

- Potentially competes with utilities
- Utility business models

Technical

- Voltage & Frequency Control…managing stability
- Islanding & grid integration
- Protection & Control

Regulatory

- Nascent regulatory environment
- Fragmented regulations

An holistic approach is essential in developing economically viable microgrids

Monetized interaction are necessary in order to pay for resiliency premium & attract private investment

Utility Needs

- Reliability and Stability Improvement
- Reduce System Losses
- Situational Awareness
- Optimal balance (supply and demand) of distributed resources to enable reliable and economic operation

Microgrids need to:

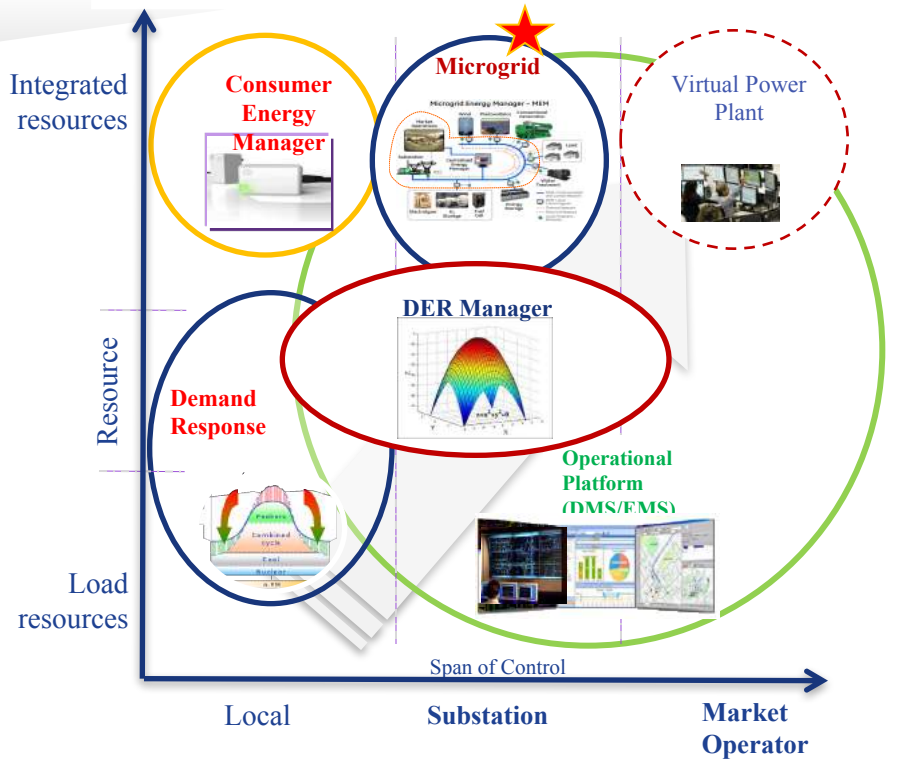
Provide solutions and services to plan, forecast, schedule, and dispatch

What

- *Load resources– dispatchable consumption*
- *Distributed generation - Renewable or non renewable generation*
- *Integrated resources – load and generation systems*

Where

- *Local – residential, commercial, and industrial*
- *Substation /Feeder – distribution system*
- *Market Operator – electricity and balancing market*



Innovative business models at each level will drive market transformation

GE imagination at work

Market segments and drivers will drive the value proposition

Energy Surety — **Sustainability** — **Economic Value**

MILITARY
Bases w/ Critical Infrastructure

INDUSTRIAL
Mining/Refineries
Ports

ISLANDS
Remote Grid
Communities

Institutional / District
University/labs
Hospitals
Utility Microgrids

DRIVERS			
BASE ISLANDING	CRITICAL INFRASTRUCTUR	FOSSIL FUEL DEPENDENCI	ENEWABLES INTEGRATIO
RENEWABLES INTEGRATIO	ENEWABLES INTEGRATIO	ENEWABLES INTEGRATIO	COE REDUCTION
ENERGY EFFICIENCY	ENERGY RELIABILITY	ENERGY RELIABILITY	ENERGY RELIABILITY
CRITICAL INFRASTRUCTURI	ENERGY EFFICIENCY	ENERGY SECURITY	RITICAL INFRASTRUCTUR
ENERGY SECURITY	ENERGY SECURITY	COE REDUCTION	ENERGY SECURITY
COE REDUCTION	COE REDUCTION	Industrial Efficiency	Microgrid R&D

Primary Drivers
Secondary Drivers

Convergence of environment, energy cost/efficiency, security, and system reliability prove to be the key drivers for Microgrids . . .

imagination at work

Correctly Design your Energy System Aligning

drivers, challenges, and resources to get to the correct type of system

End-user & Utility Challenges

Security

- Installation-wide energy & H2O security
- End-user operations resilience, assured fuel, reduced logistics tail, etc.
- Cyber security

Regulatory

- Compliance now & future planning
- Federal/state mandates & regulations, NetZero initiatives, carbon legislation

Financial

- Reduce cost through efficiency & intelligent system design
- Optimize energy-to-investment ratio
- Utility cost/benefit

End-user Drivers

1. Increased **energy independence** … leads to energy efficiency improvement projects
2. Multiple **recent regulations** instituted … forces planning for current/future regs
3. Growing **water scarcity** … drive water consumption reduction projects
4. Strong **operational performance** focus … need to optimize full life-cycle costs
5. Multiple other additional pressures …

End-user & utility energy objectives will drive whether you will have a:

- *Natural gas based microgrid*
- *Renewables based microgrid*

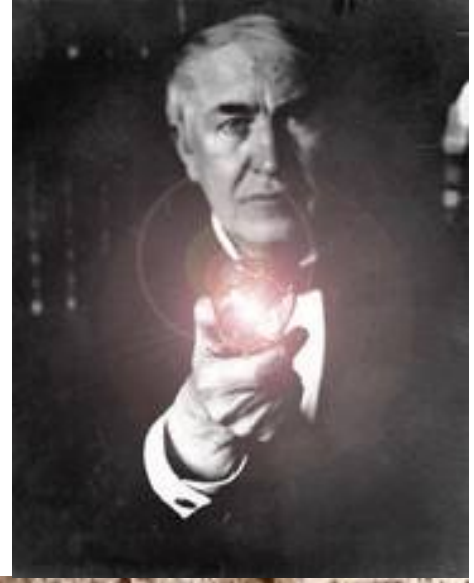
GE imagination at work

Leveraging microgrids as a foundation for economic development

Examples

Pearl Street Microgrid (1882)

- Primary driver was selling lightbulbs
- Ten 27 ton 100Kw steam generators
- DC Power Microgrid
- Served 59 Customers
- Islanded operation
- HMI enabled



GE imagination at work

Modern day example

Urban vertical farming

- Eastern Japan 2013, **25000** Sq. Ft.
- 18 racks each 15 levels, **17000** LED fixtures
- **10000** heads of Lettuce per day (100 fold density increase from outside)
- Grows **2.5X** faster than outside
- Waste from **50% to 10%** compared to outside
- **1%** of water usage compared to outside
- LED **40%** less power than florescent light

Key elements needed to successfully achieve economically viable microgrids

Energy Surety & Renewable Energy Objectives Require Differing Approaches

- **Energy Surety Goal:** Most cost effective method will lean towards natural gas generation microgrids
  - MG functionality: Islanding, fast load-shed, net metering, ancillary services
- **Renewable Energy Goal:** Most cost effective method will learn towards wind / biogas biomass/ landfill gas generation Microgrids
  - MG functionality: Optimal dispatch, firming, DSM, ancillary services

Utility Collaboration

- Microgrids need to interact and provide value to host utility
  - As well as supporting communities e.g. first responders, continuity of government, …
- Provide ancillary benefits (Supply/demand management, frequency regulation, …)
- Enable facility energy operator to contract with utility these services

Privatized & Monetized Structures

- ESCOs, IPPs, Utilities need to be able monetize the smart-grid features of the microgrid in order to offset cost of energy surety & attract investment
- Capitalization of existing assets can create opportunities for financial support

Unified Standards & Certification

- DOE needs to drive Microgrid/Smart Grid standards, interoperability, utility integration
- Cybersecurity & IT infrastructure standards
- Certification of technology, architecture, & functionality

Develop a long-term energy roadmap with off-ramps for incremental development

- Establish long-term vision with short-term requirements

Adoption, Policy, and Innovation Begins at the Local Level (You!)

"I'll be happy to give you innovative thinking. What are the guidelines?"

MICROGRID KNOWLEDGE
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Microgrid 2018
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PHILADELPHIA NAVY YARD MICROGRID AND PEAKING PLANT

MAY 9, 2018

ABOUT AMERESCO

We empower our customers with cost-effective, environmentally sustainable solutions.

Leading Energy Services Provider

- Implement efficient, energy and money-saving solutions, including retrofits
- Design, build and even operate client-owned renewable energy sources
- Tailor services to meet specific customer needs and sustainability goals

Trusted sustainability partner to public and private sectors

Socially responsible. Economically efficient.

Pioneering Developer of Renewable Power Projects

- Industry-leading expertise in solar and landfill gas
- Developed over 300 MW of renewable energy projects
- Over $200 Million in renewable power projects for customers

INDUSTRIES WE SERVE

AMERESCO
Green • Clean • Sustainable

SAVING ENERGY, AND SUPPORTING SUSTAINABILITY GOALS

Founded in
2000

OVER
$5 Billion
in energy solutions
delivered since inception
(including our predecessors)

$2.5 Billion
Project financing
sourced and raised

MORE THAN
1,000
employees

Structured to Deliver Customer Value

$1 Billion
bonding capacity with a
per project maximum
of $150 million

PUBLIC
2010
NYSE: AMRC

267MWe
of energy and landfill gas
generated by owned and
operated energy plants

$717.2 Million
annual revenue in 2017

PHILADELPHIA NAVY YARD
A COMMUNITY MICROGRID BUSINESS MODEL

Will Agate, LEED AP
President and Founder
NetZero Microgrid Solutions

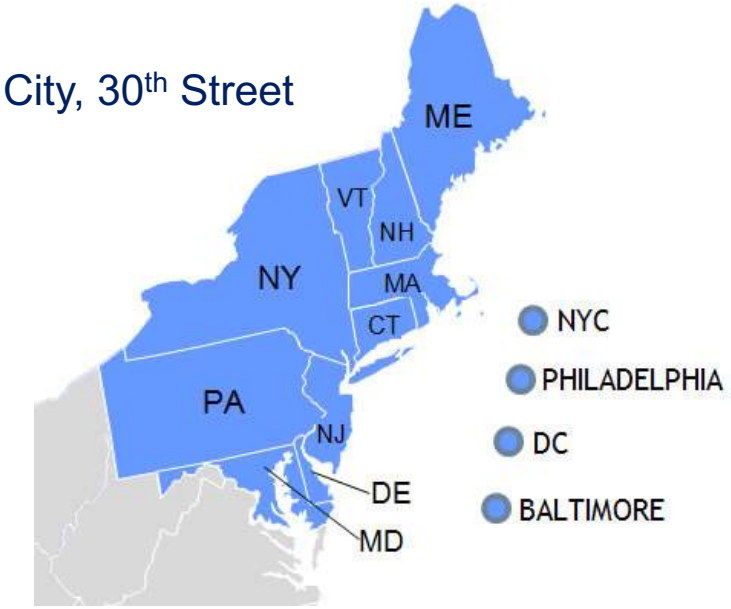
To lead customers in deploying microgrid and related smart electric distribution solutions for their communities.

Successes will be achieved by holistically collaborating with technology, financial, and public sector providers in order to integrate superior economic development and financial returns that dramatically reduce or eliminate harmful energy consumption and carbon footprint.

NET ZERO
MICROGRID SOLUTIONS

LOCATION: THE NAVY YARD

- Centralized location
- Access to:
  - Major highway
  - Intermodal freight system
  - International Airport
  - Center City, University City, 30th Street
  - Sports Complex



THE NAVY YARD THEN & NOW

Philadelphia Navy Yard 1999, source PIDC

- **3,000** employees
- **10** Companies
- Limited private investment
- **20+** years deferred infrastructure

Philadelphia Navy Yard Today, source PIDC

- **12,500** employees
- **150+** companies; **3** Navy activities
- **7.5 million** SF occupied real estate
  $750+ mil of private investment
- **$150+** mil of publicly funded infrastructure upgrades

A MANUFACTURING AND INDUSTRIAL CAMPUS

A HISTORIC PRESERVATION STORY

A MODERN, PROGRESSIVE AND SUSTAINABLE OFFICE CAMPUS

A SUSTAINABLE AND INNOVATIVE CAMPUS

Adaptive reuse | LEED rated buildings | Energy efficiency | EV charging stations

Storm water management | Bike lanes | Rain gardens | Permeable pavement

PROBLEM STATEMENT

- Growth at The Navy Yard driving increased demand
- Industrial load curves are peaky
- Aging infrastructure – existing external supply reaching limits to capacity

THE NAVY YARD ENERGY MASTER PLAN "CONSTITUTION"

The Five Point Action Plan

- ✓ **Infrastructure**: Capacity, Generation/Supply, Technology Microgrid
- ✓ **Business Model**: Forecasts, Tariffs, Procurement, O & M, Capital
- ✓ **Building Owner Opportunities**: DG, EE, DR – Programs & Partnership
- ✓ **Test Bedding Outreach and R&D**: Energy Innovation Campus
- ✓ **Carbon Reduction and Sustainability**: Reduce Carbon Intensity

SOLUTION OPTIONS

- Traditional “wires” option...new or upgraded substation
- Non-wires solution (NWS)
  - PIDC and Burns Engineering developed Energy Master Plan
  - Distributed Energy Resource (DER) - 6MW gas-fired peaking plant
  - Growth plans to 8MW - under contract, COD late 2018

THE NAVY YARD ENERGY MASTER PLAN AND GRID MODERNIZATION

- 1st Phase

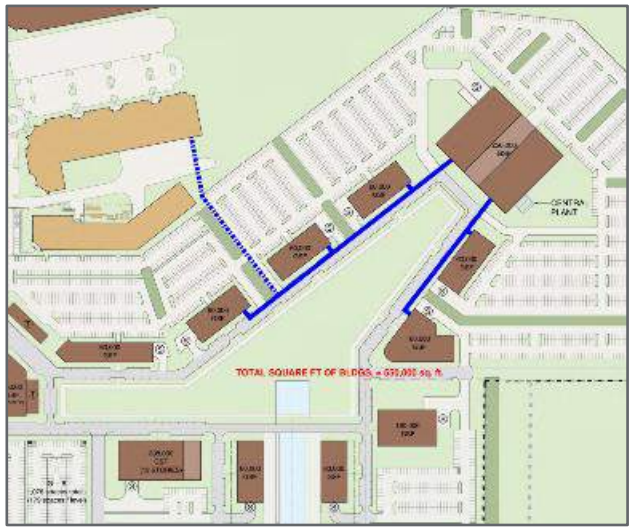
  Grid Modernization (2014-2017)

  - Approximate $33 million
  - Public and Private investments
  - Smart meters, communications

  On-Site Generation

  - 10 MW substation with PECO tie-ins
  - 6MW natural gas peak shaver/backup power
  - 1 MW on site solar generation

Creating 4 Microgrids

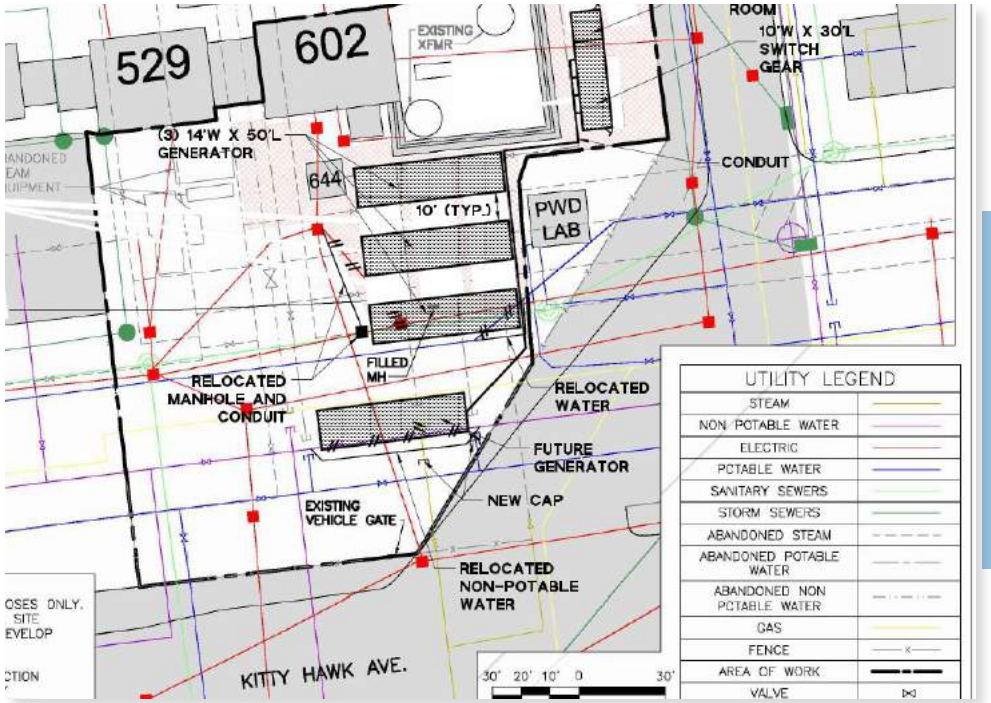


AMERESCO 6MW NATURAL GAS PEAKING PLANT

- Awarded project to Design, Build, Operate & Maintain 6MW natural gas-fired peaking plant
- Contracts and financing plan finalized – under construction.
  COD late 2017
- Primary component of The Navy Yard energy master plan:
  - Relieve high demand in industrial district and address near term demand growth
  - Allow PJM market participation and associated revenues
  - Able to provide resiliency services
  - Will become integral part of DOE funded advanced microgrid

PROJECT DETAILS

- Three (3) 2MW natural-gas fired reciprocating engines
- Infrastructure for expansion to four engines (total 8MW)
- Simple cycle - no heat recovery
- Permitted and expected to run approximate 1000 hours per year (SCR not required)
- Remotely dispatched and monitored utilizing Curtailment Service Provider (CSP)
- Integrated into Navy Yard's GridNOC
- Ameresco designed & built and holds 20-year O&M contract



VALUE PROPOSITION

- Wires solutions solves capacity constraint issue – otherwise a “dead” asset
- DER provides stacked value proposition
  - Solves capacity constraint
  - Generates revenue - PJM ancillary service and energy markets
  - Delivers capacity and transmission charge savings
  - Provides resiliency - black start & island mode capable

DISTRIBUTED RESOURCES DELIVER STACKED VALUE FOR A HAPPY CUSTOMER

- PJM Ancillary Service and Energy Markets
  - Synchronized Reserve – 10 minute response to PJM signal required
  - Economic Demand Response – dispatch decisions determined by day-ahead and same-day Locational Marginal Price (LMP)
- Reduce Peak Load Contribution (PLC)
  - Dispatch during predicted grid peak times (Jun 1 to Sept 30, typically afternoon)
- Resiliency payments for black start / island mode capability

CASE STUDY

PHILADELPHIA NAVY YARD, PA

TECHNOLOGY TYPE	NATURAL-GAS FIRED PEAKING PLANT MICROGRID INTEGRATION
CAMPUS SIZE	1,200 ACRES
ESTIMATED PROJECT SIZE	$11 MILLION
CAPABILITIES	PEAK MANAGEMENT ANCILLARY SERVICES RESILIENCY
CAPACITY:	6 MW

AMERESCO

A Power Plant with Style!

CREATING THE CONNECTION AT THE CORE:
THE NETWORK OPERATIONS CENTER FOR CUSTOMER ENGAGEMENT, R&D AND EDUCATION

- **Integrating** and **optimizing** on-site generation and storage with external supply
- Robust electric **customer engagement program** providing significant R&D, business outreach and national demonstration values
- **DOE Microgrid controller** funding and participation providing electric customer participation and economic benefits
- **PJM** participation with on-site personnel
- Adding the **Penn State Training NOC** and 7R-GridSTAR 2.0 CHP-based microgrid pilots
- **Scalable deployment** with Main Campus R&D faculty and collaborators

Communities – Positioned for this Change

SO WHAT…

- Scalable solutions
  - Many communities supply of electricity is constrained
  - Significant aging infrastructure
  - How to deploy radically higher concentrations of renewables and non-traditional solutions
- Scalable value propositions
  - Building the microgrid as a business platform
  - Participate in a new revenue model (e.g.: the PJM Ancillary Market, NY REV)
  - Create returns on investment
  - Offer customers sustainability solutions that beat the competition
- But most importantly…
  - It's not about the flow of electrons…
  - Economic development and Making Communities Stronger
  - Addressing climate adaptation and increasing resilience
  - Collaboration and building stronger communities (e.g. how is higher education included? how to build emergency resiliency? etc.)

THANK YOU

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Your Trusted Sustainability Partner

AMERESCO
Green • Clean • Sustainable

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A NEW MODEL: THE SMART CITY, A DIGITAL URBAN CAMPUS

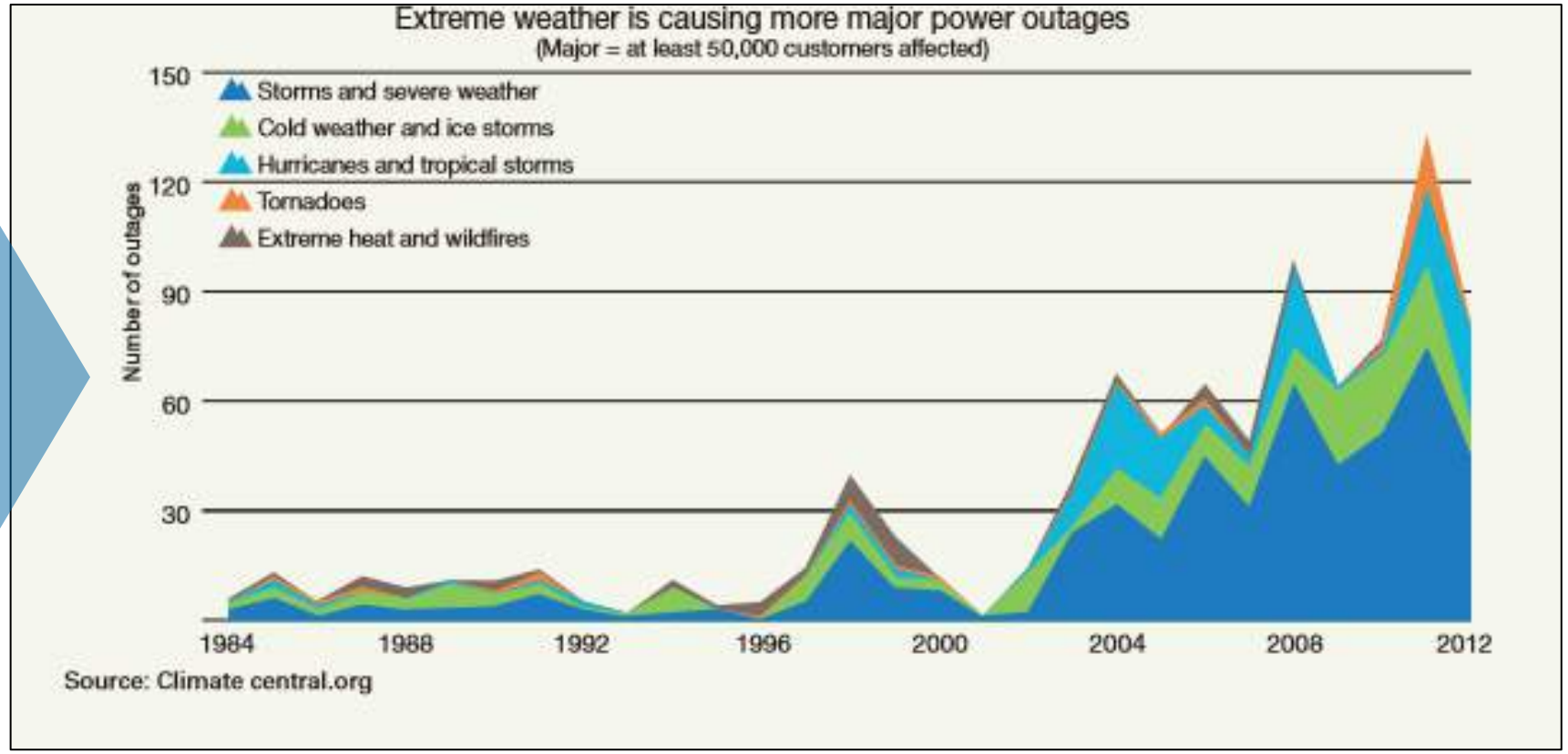
Vehicle Charging Stations

Community Solar

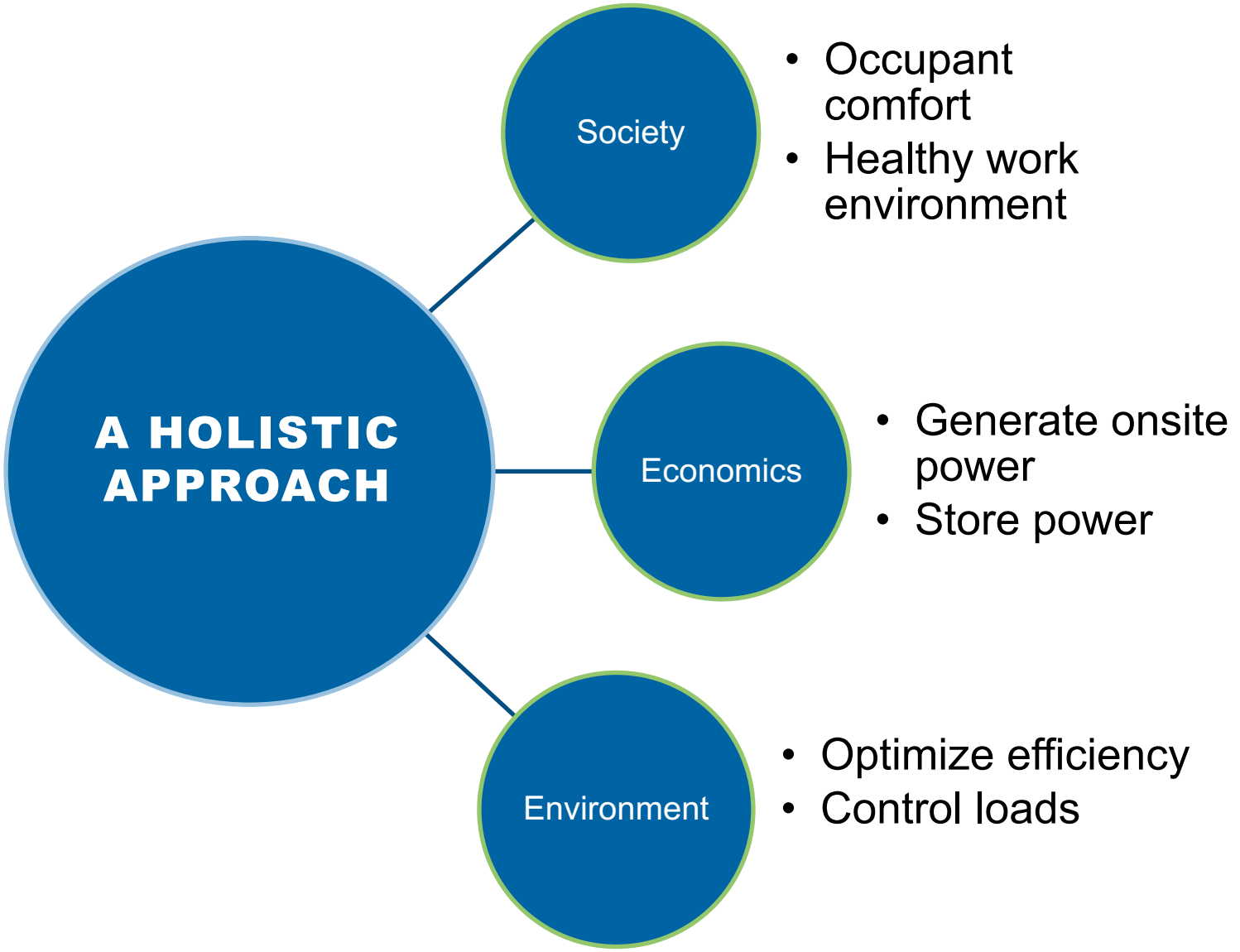
Fuel Cell

Storage Battery

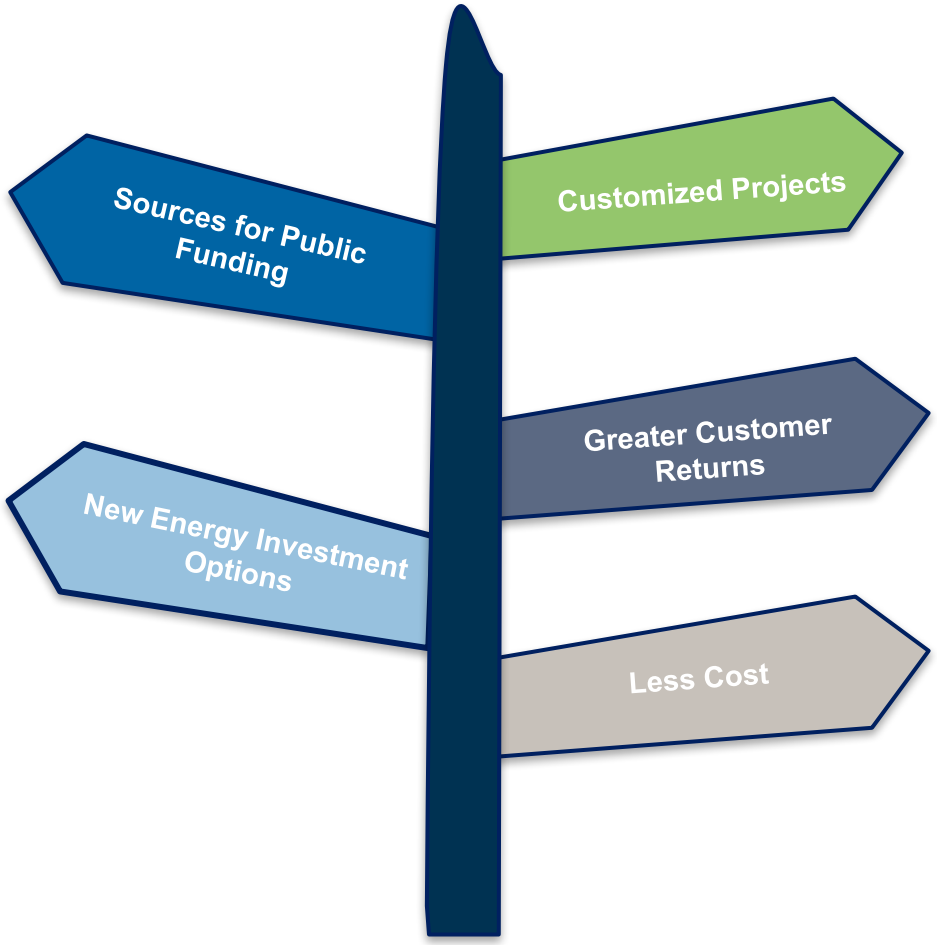
POWER OUTAGES CAUSED BY MAJOR WEATHER EVENTS



What is Missing…



CHALLENGES & OPPORTUNITIES



Commercialization of the microgrid business model

INTEGRATE NEW ENERGY INVESTORS AND TOOLS

MICROGRID KNOWLEDGE
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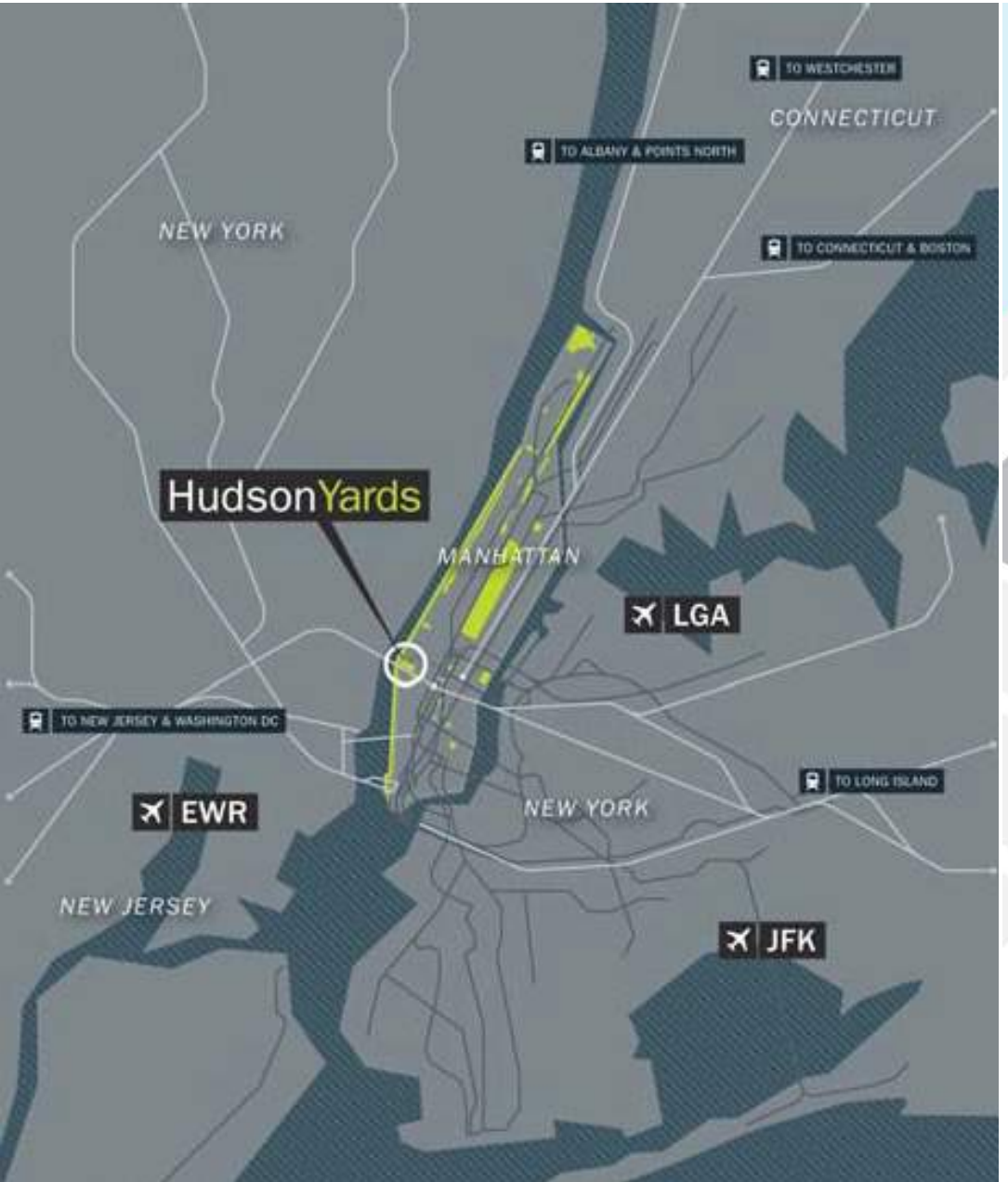
Micro-Grid in Urban Development

Hudson Yards: How Veolia Will Help Power 18 Million Square Feet in New York City's West Side

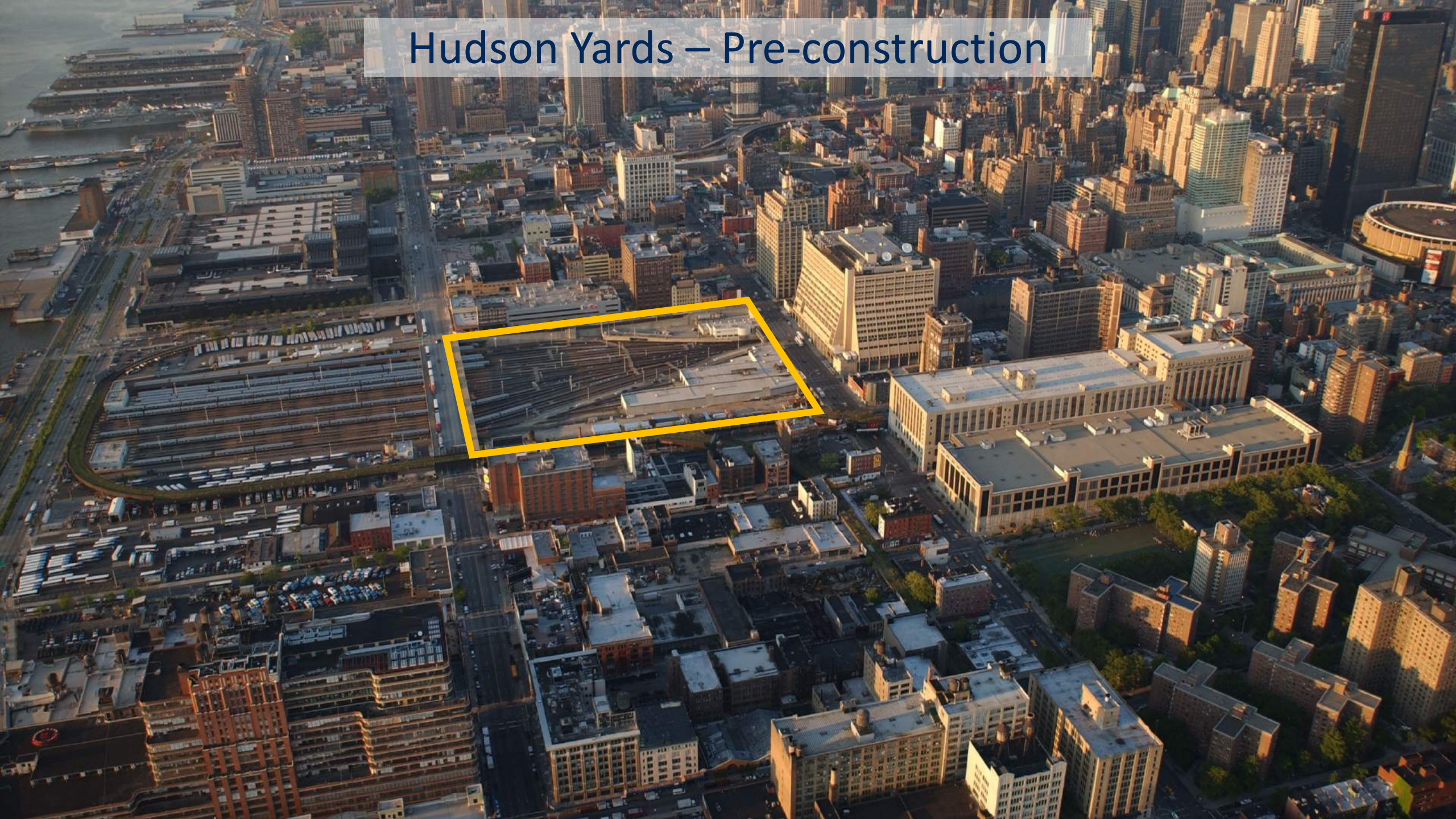
May 2018

Hudson Yards – Site Map



Hudson Yards – Pre-construction

Hudson Yards – Pre-construction



Hudson Yards – Site Overview

Hudson Yards – Site Overview

Hudson Yards – Site Overview

Photo via Tutor Perini

MicroGrid Introduction

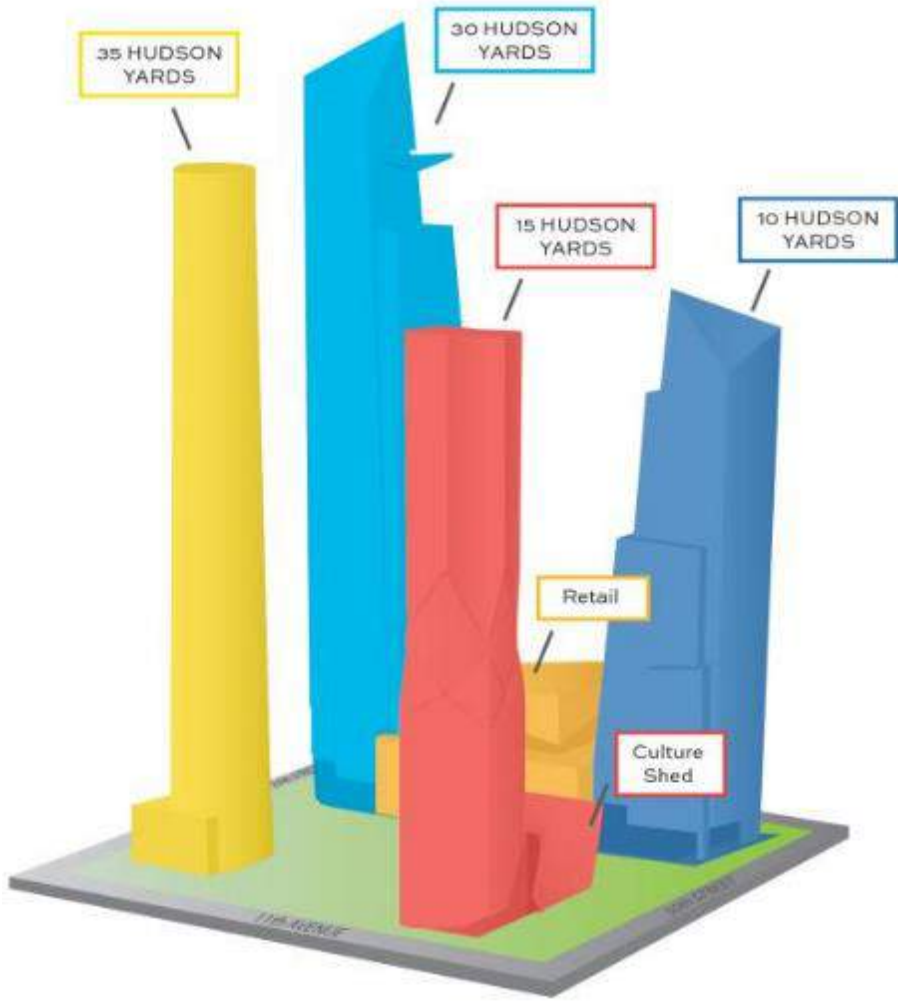
A Cogeneration (Cogen) Plant was designed to be installed on the roof of the Retail building at Hudson Yards

The Plant's main mechanical equipment is located on the roof (10th floor) and the electrical gear is located on the 8th floor.

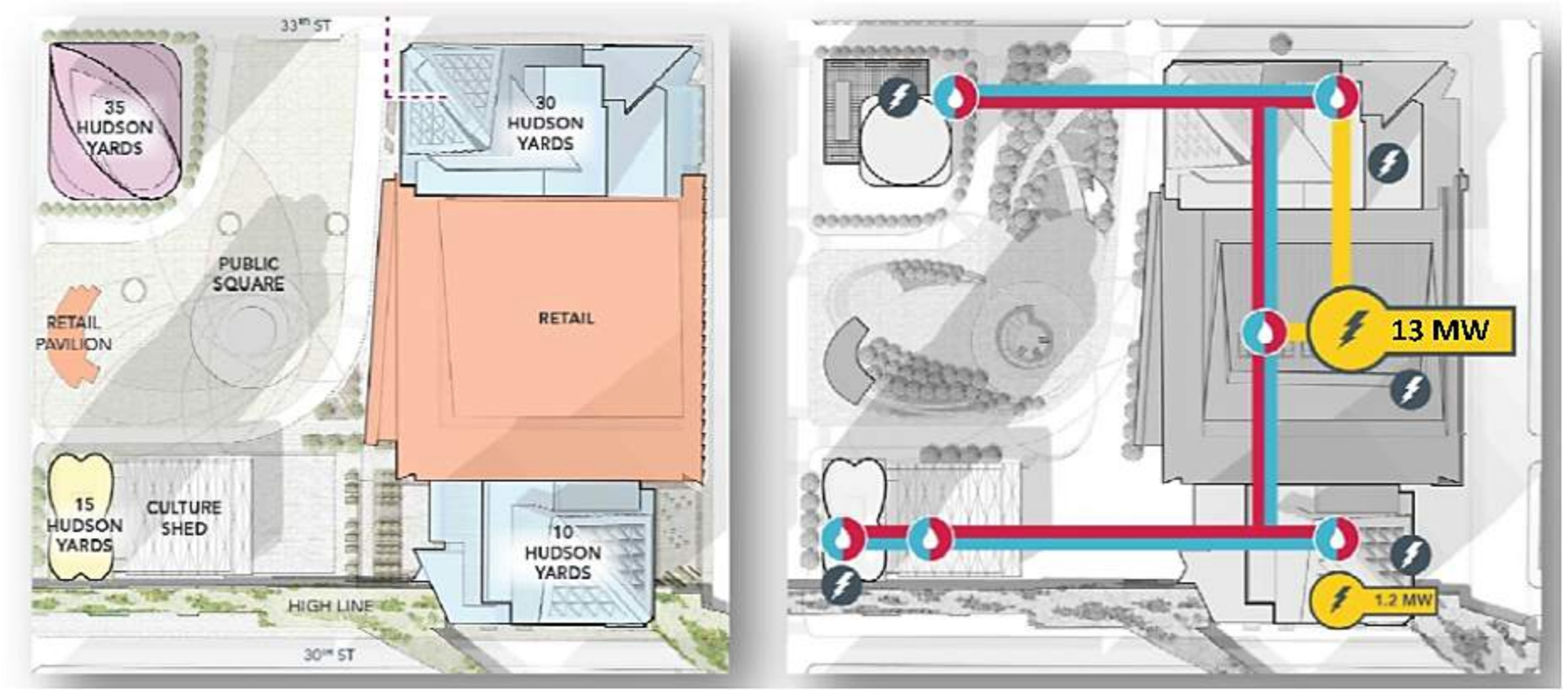
The Cogen plant generates electricity, hot water, and chilled water using four natural gas reciprocating engines

The Cogen plant is designed to operate even when the utility grid is down, providing power for business operations via a MicroGrid setup

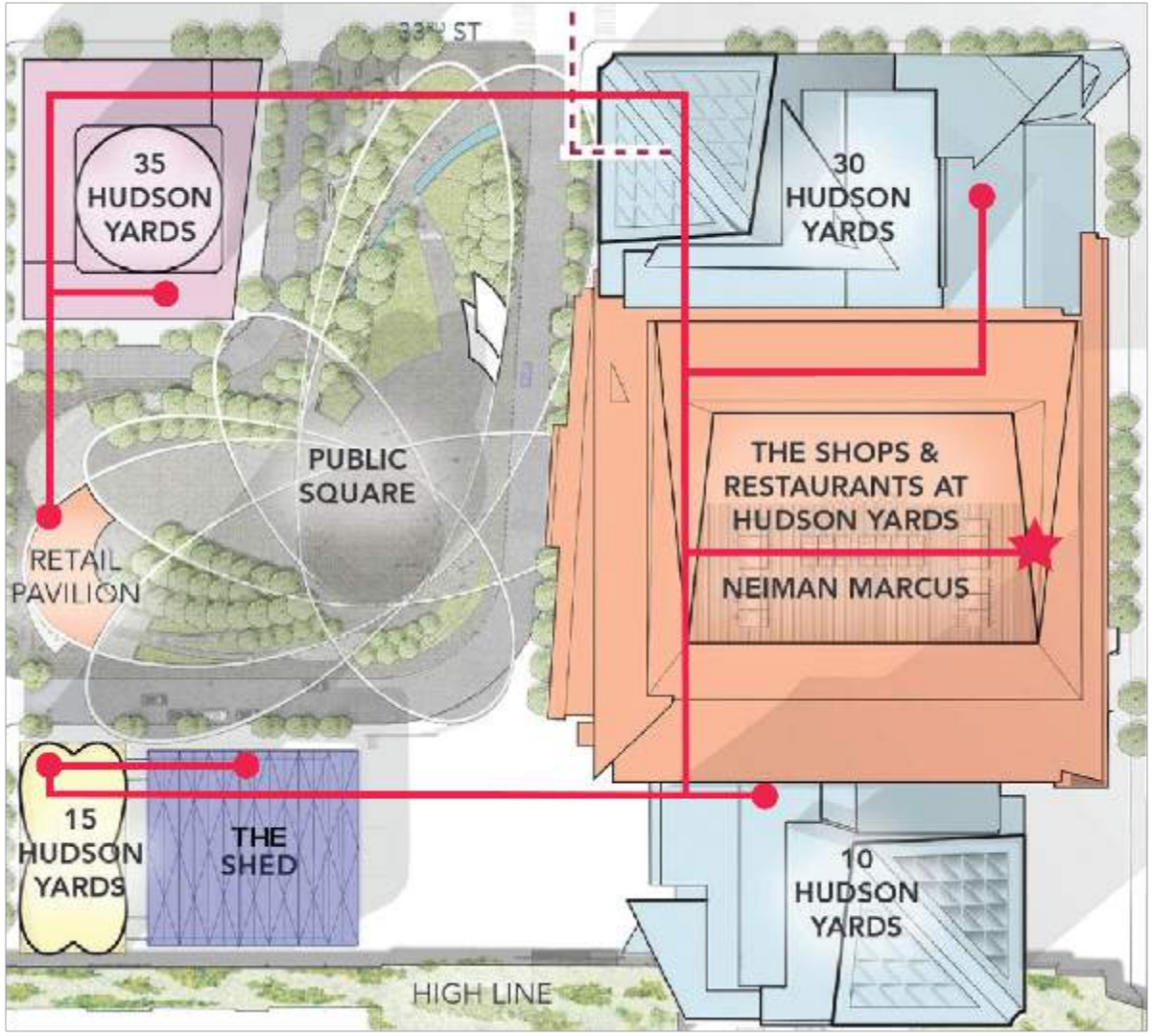
The Cogen plant is connected to a campus Thermal Loop which will provide each building access to hot water and chilled water



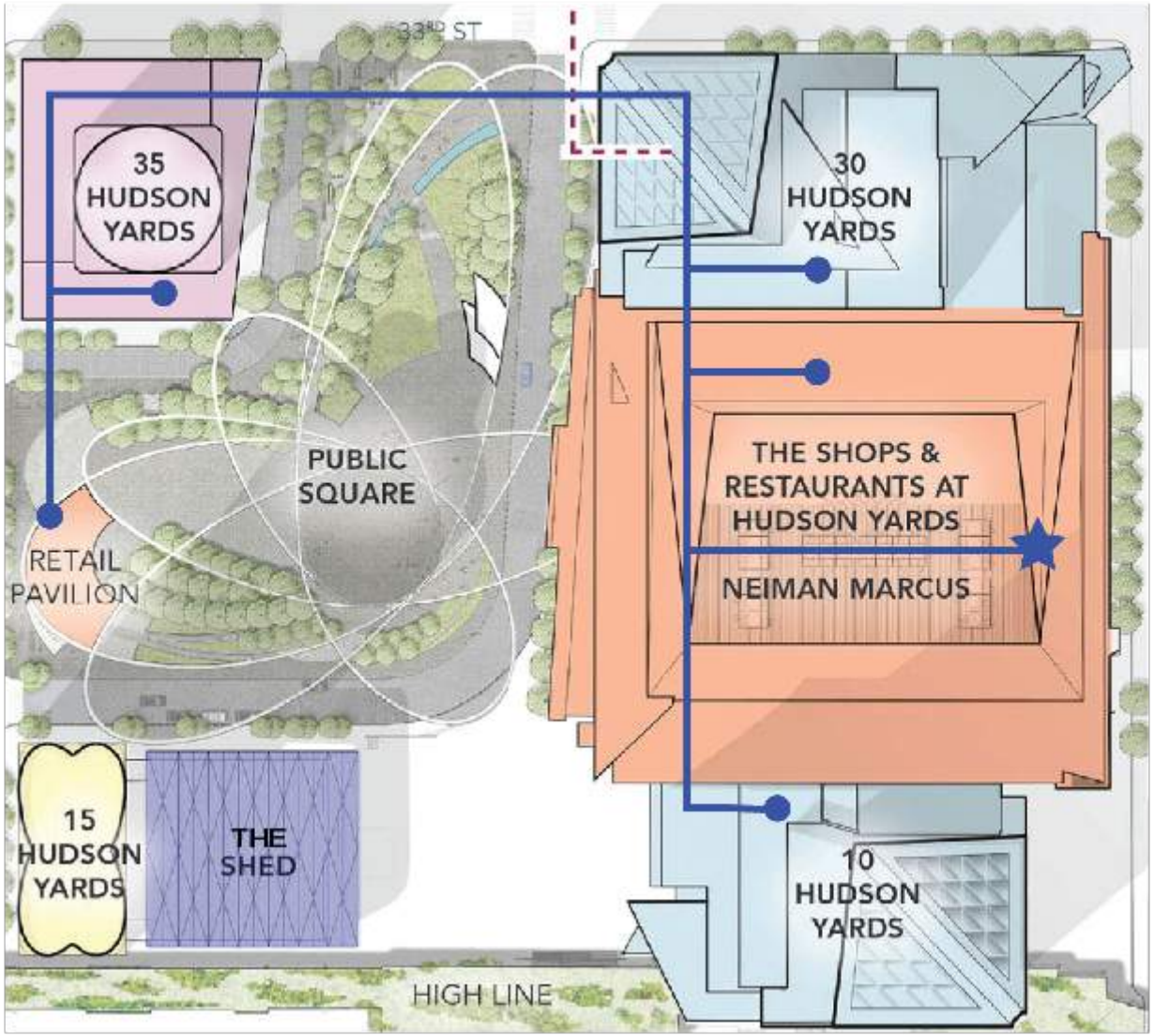
Hudson Yards – Site Overview



Hot Water Thermal Loop

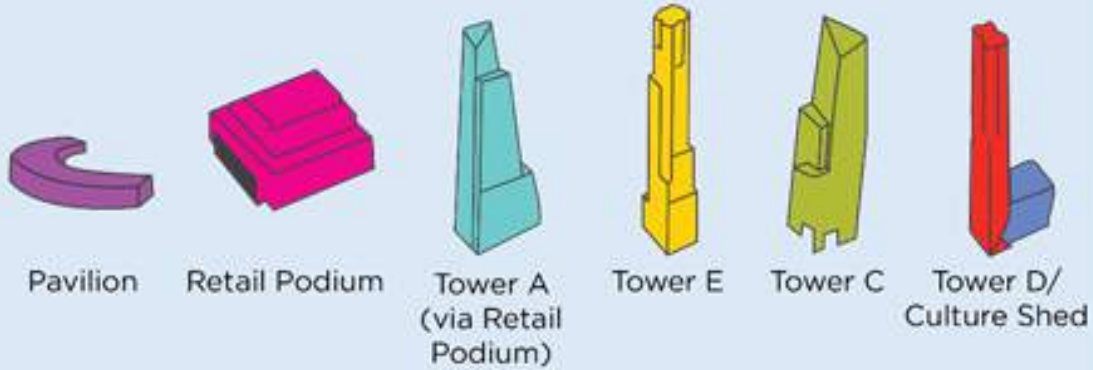


Chilled Water Thermal Loop



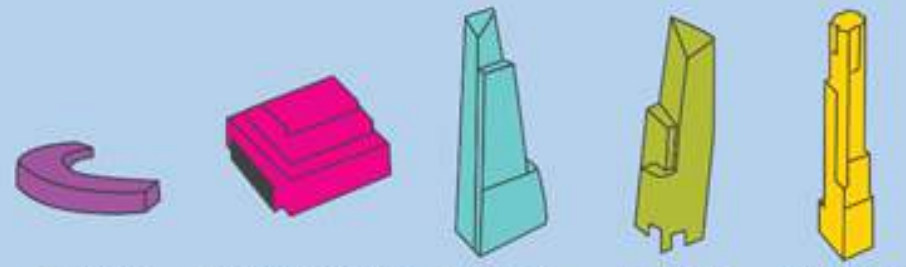
COGEN PLANT

HOT WATER



Pavilion | Retail Podium | Tower A (via Retail Podium) | Tower E | Tower C | Tower D/ Culture Shed

CHILLED WATER



Pavilion | Retail Podium | Tower A | Tower C | Tower E

POWER

Retail Podium | Tower A | Con Edison Grid

Project Team

- Related, Hudson Yards = Owner
- SourceOne, Veolia = Owner's Representative
  - Developed early feasibility study to meet Related's energy goals
  - Created Proforma model using energy load profiles to determine project profitability and sizing
  - Worked with the utility to negotiate tariffs & configure interconnect design
  - Negotiated interconnection agreement with utility
  - NYSERDA grant money
  - Coordinated design entities after selection of plant configuration and sizing
  - Pre-purchased engines and MV switchgear
- Design:
  - R.G. Vanderweil = Engineer of Record
  - Jaros Baum & Bolles = Cogen Site Integration Engineer
  - Kohn Pedersen Fox Associates = Architect
  - Thornton Tomasetti = Structural Engineer

Project Team

- Construction:
  - Northeast Energy / GE = Engine Vendor
  - Eaton = MV Electrical Equipment Manufacturer.
  - KSW = Trade Manager
- SourceOne, Veolia = Commissioning Agent

Drivers For Profitability

- Efficiency
- Lower cost of production
- Value of diverse generation source
- Capital avoidance of emergency generators, boilers, and chillers
- Space savings in buildings
- Operator savings
- Maintenance savings
- Efficiency of larger, better run units
- Greenhouse gas benefits – grant funding

Design Objectives

- Flood-proof design construction
- Microgrid: Interconnected to the utility and provide backup power via priority loading scheme
- Thermal loop interconnected with building plants
- Functional Occupancy for residential, restaurants and commercial base buildings
- Opt-in back up power for retail and commercial tenants
- 13.2 MW of Cogeneration
- Smart sub-metered buildings
- Energy Command Center
- Tier IV generators (demand response ready)
- Day 2 serviceability

ENGINEERED CITY

RESPONSIBLE + RELIABLE NEIGHBORHOOD

14.5 megawatts of cogen

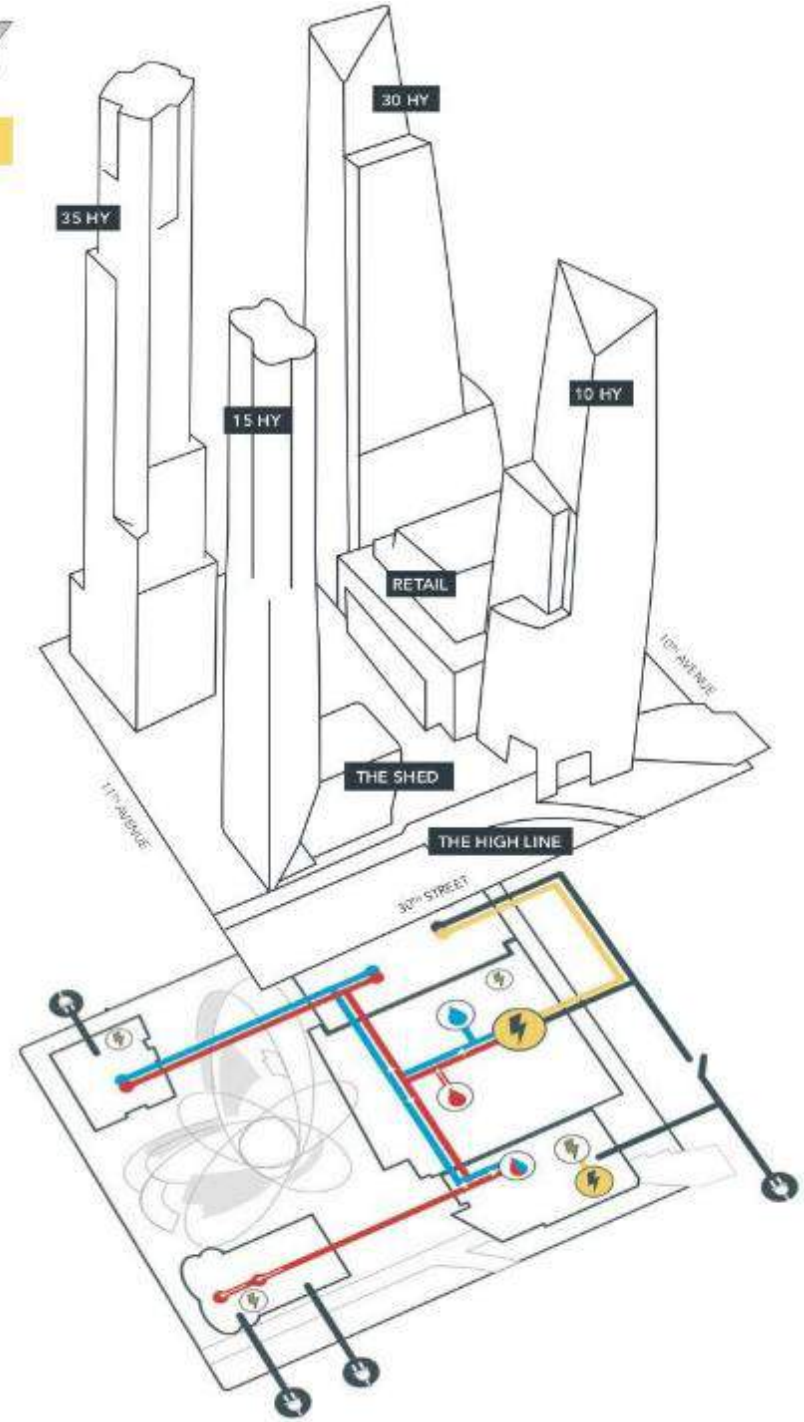
18 megawatts of Tier 4 diesel generators

Con Ed Utility Grid

Microgrid Breaker

Hot/Chilled water plant

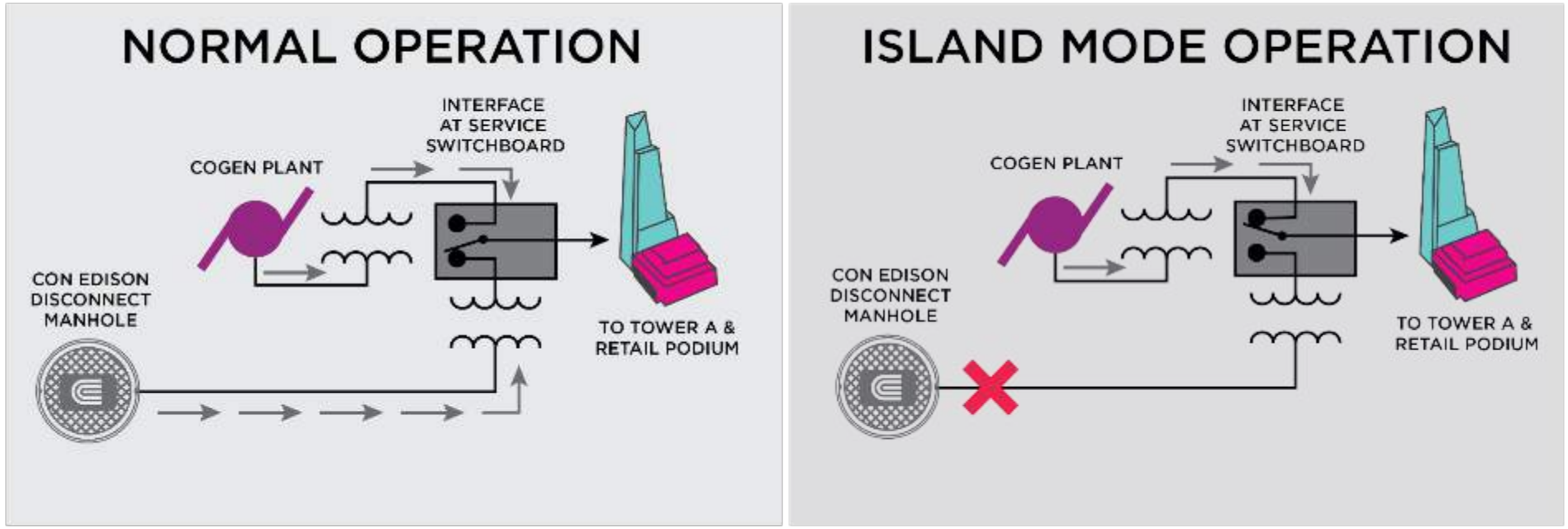
Hot/Chilled water line



HUDSON YARDS
NEW YORK

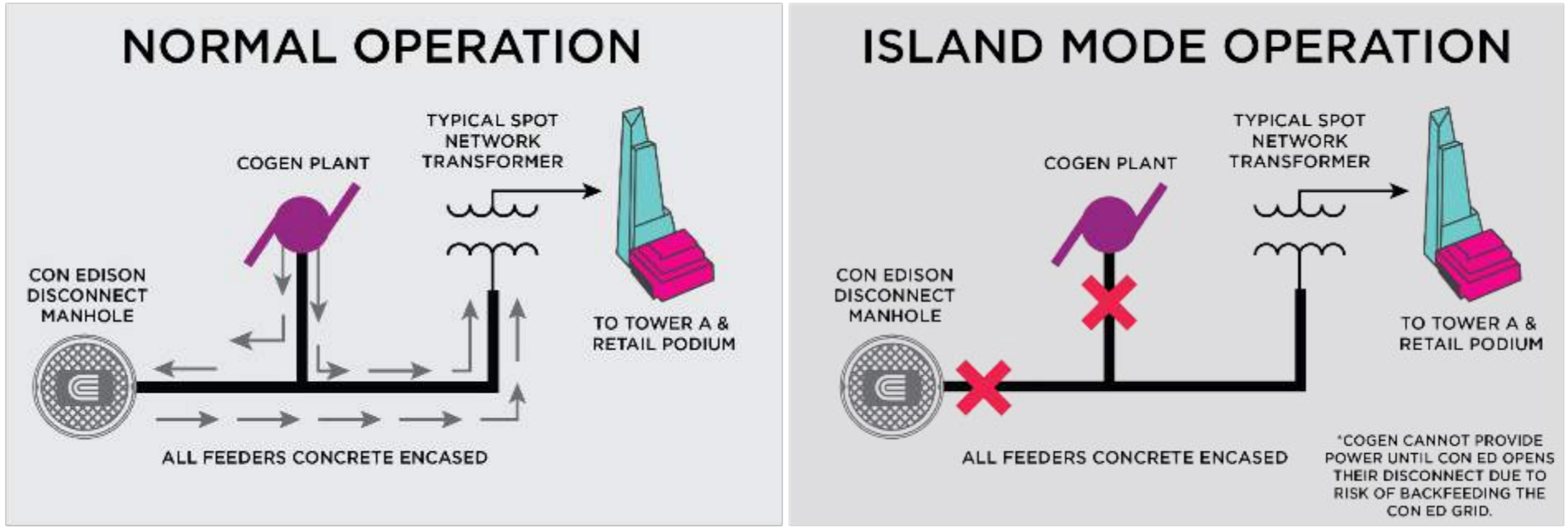
Con Edison Interface – Microgrid Evolution

Operation with 480 Volt Interface



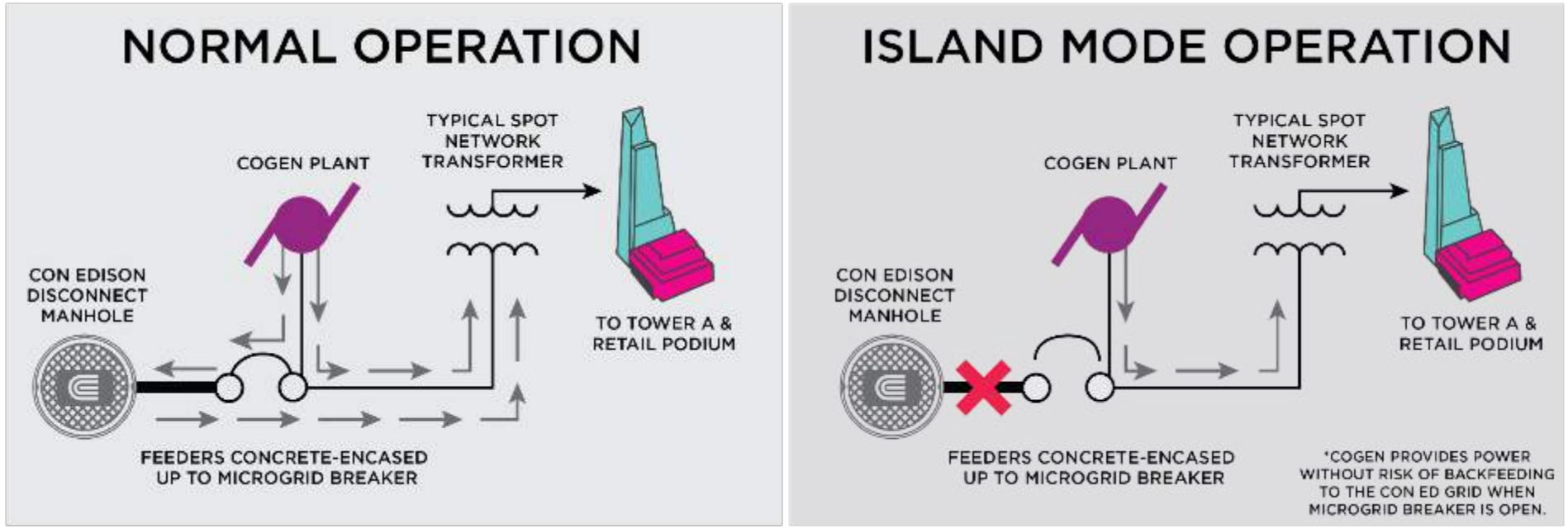
Con Edison Interface – Microgrid Evolution

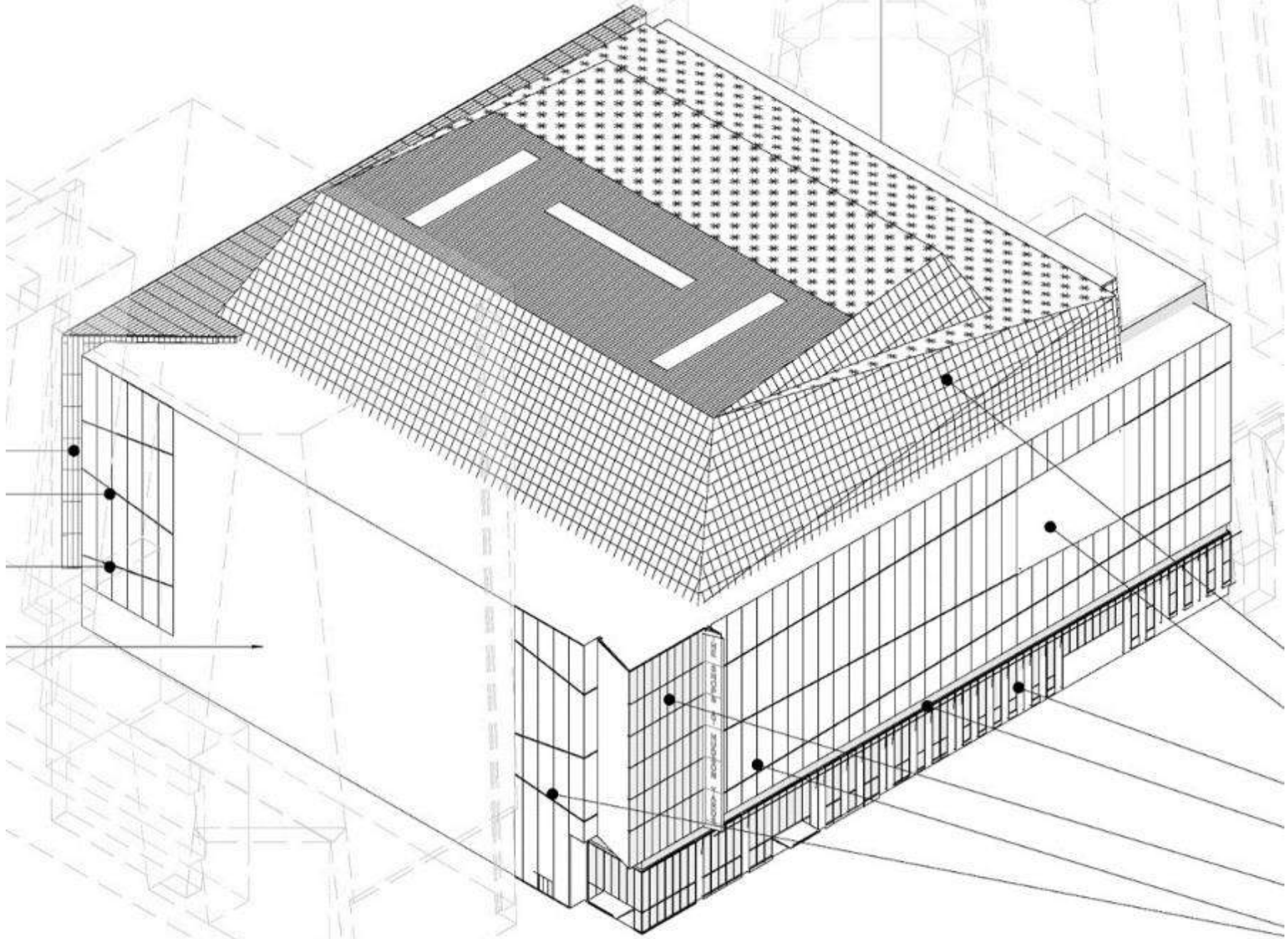
Operation with 13.2kV Utility Interface



Con Edison Interface – Microgrid Evolution

Operation with Microgrid Breaker





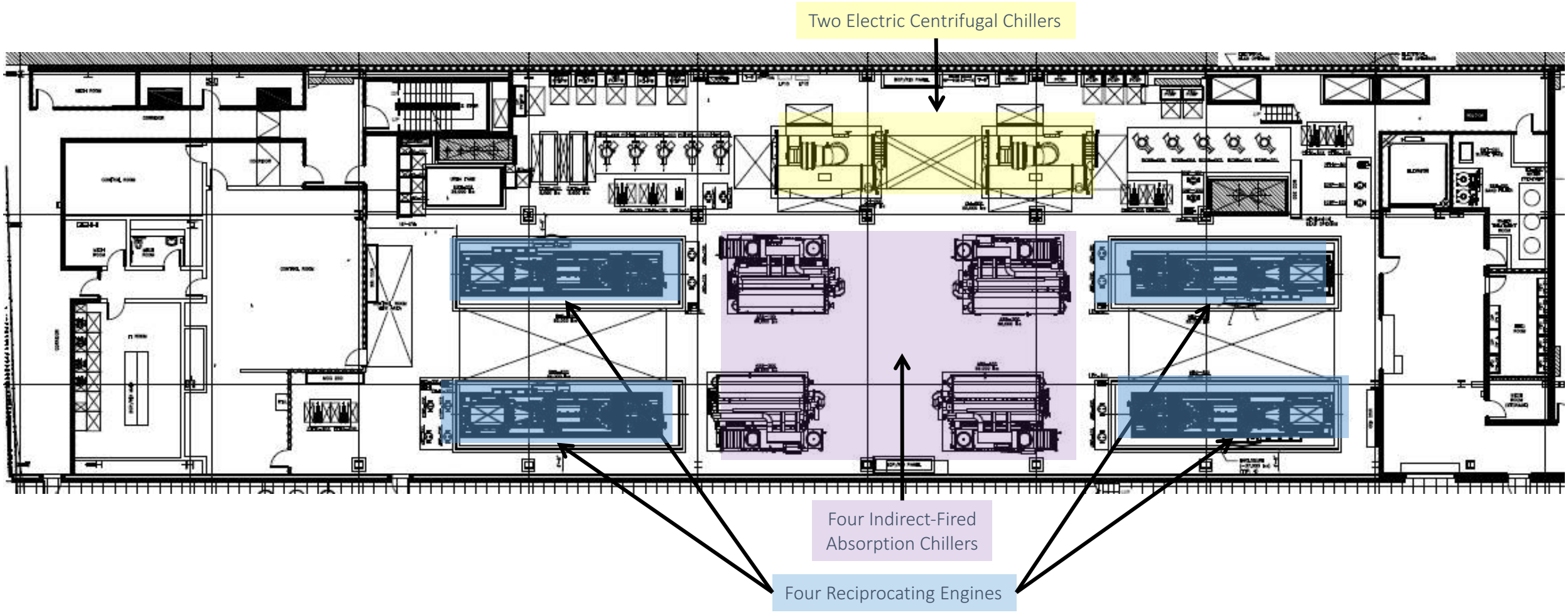
Plant Configuration

Electric Production: 13.3 MW

- 4 x 3.3MW GE Jenbacher Recip Engines

Thermal Production: 5,140 tons CHW, 42MMbtu/hr HW

- 4 x 690 ton Absorbers (Thermax)
- 2 x 1250 ton Electric Chillers (Trane)



Navigating Microgrid in Urban NYC

- Authorities having Jurisdiction:
  - NYC Department Of Buildings (DOB)
  - NYS Department of Environmental Conservation (DEC)
  - Fire Department of New York (FDNY)
  - NYC Department of Environmental Protection (DEP)
  - Con Edison (local utility)
  - NYC Electrical Advisory Board
- Utility Interconnection
- Tariff Negotiations
- Service Shutdowns
- Rigging on 10th Avenue / street shutdowns
- Construction Coordination with Railyard
- Tenant Occupancy during construction
- Commissioning


SCHOOL SCHOOL


GTI