Microgrids in Urban Redevelopment

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Developing Economically Viable and Resilient Microgrids

GE Distributed Grid Solutions

Eliot Assimakopoulos
Microgrid Sales Leader
What’s a Microgrid?

- It has to island!
- It should have renewables
- Gotta include batteries
- It needs to interact with the market
- Net-zero energy!
What about Grid Resilience?

re·sil·i·ence  
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
Market segments and drivers will drive the value proposition

**Energy Surety**
- MILITARY: Bases w/ Critical Infrastructure
- INDUSTRIAL: Mining/Refineries, Ports
- ISLANDS: Remote Grid Communities

**Sustainability**
- Institutional / District: University/labs, Hospitals, Utility Microgrids

**Economic Value**
- RENEWABLES INTEGRATION
- BASE ISLANDING
- CRITICAL INFRASTRUCTURE
- OSSIL FUEL DEPENDENCE
- COE REDUCTION

**Primary Drivers**
- ENERGY EFFICIENCY
- ENERGY SECURITY
- COE REDUCTION

**Secondary Drivers**
- RENEWABLES INTEGRATION
- ENERGY RELIABILITY
- COE REDUCTION

**Convergence of environment, energy cost/efficiency, security, and system reliability prove to be the key drivers for Microgrids . . .**
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
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
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?"
PHILADELPHIA NAVY YARD MICROGRID
AND PEAKING PLANT
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

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
SAVING ENERGY, AND SUPPORTING SUSTAINABILITY GOALS

- Founded in 2000
- $2.5 Billion: Project financing sourced and raised
- MORE THAN 1,000 employees
- OVER $5 Billion in energy solutions delivered since inception (including our predecessors)
- Structured to Deliver Customer Value
- 267MWe of energy and landfill gas generated by owned and operated energy plants
- $717.2 Million annual revenue in 2017
- $1 Billion bonding capacity with a per project maximum of $150 million
- PUBLIC 2010 NYSE: AMRC

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

DISTRIBUTED RESOURCES DELIVER STACKED VALUE FOR A HAPPY CUSTOMER
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

- Retirement Communities
- Colleges & Universities
- Towns & Municipalities
- Hospitals
- Real Estate Development
- Former Almon Site Now Hazelwood Green
- Luxury Resorts
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.)
A NEW MODEL: THE SMART CITY, A DIGITAL URBAN CAMPUS
POWER OUTAGES CAUSED BY MAJOR WEATHER EVENTS
What is Missing…

A HOLISTIC APPROACH

Society
- Occupant comfort
- Healthy work environment

Economics
- Generate onsite power
- Store power

Environment
- Optimize efficiency
- Control loads
CHALLENGES & OPPORTUNITIES
INTEGRATE NEW ENERGY INVESTORS AND TOOLS

Commercialization of the microgrid business model
Micro-Grid in Urban Development

Hudson Yards: How Veolia Will Help Power 18 Million Square Feet in New York City’s West Side
Hudson Yards – Pre-construction
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
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

NORMAL OPERATION

ISLAND MODE OPERATION

*COGEN PROVIDES POWER WITHOUT RISK OF BACKFEEDING TO THE CON EDISON GRID WHEN MICROGRID BREAKER IS OPEN.
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