District Energy/Microgrids: Resilient, Efficient Infrastructure


Boston, MA
December 21, 2012
• Formed in 1909 – 103 years in 2012
• 501(c)6 industry association
• 2000+ members in 26 nations
• 56% end-user systems; majority in North America; 44 states
• Most major public & private colleges and universities; urban utilities.
What is District Energy/Microgrid?

- Local “distributed” generation integrating CHP; thermal energy; electricity generation; thermal storage and renewables
- Located near load centers; customer density; often some mission-critical needs
- Robust, economic assets
- CHP interconnected with regional & local grid
- Able to “island” in the event of grid failure
Resilient Infrastructure for Local Clean Energy Economy

• Connects thermal energy users with sources
• Hardened distribution assets for higher reliability
• Urban infrastructure – hidden community asset
• Aggregates thermal loads for economies of scale
District Cooling Customer Electric Demand Profile

350,000 sf commercial office building built in 1965. Located in Cleveland. Two electric chillers displaced. Actual peak meter readings varied just 2%, Jan.-July.
Future Proofing A More Resilient City
Super Storm Sandy: By the Numbers

- 820 miles in diameter on 10/29/12
  - Double landfall size Isaac & Irene combined

- Caused 131 fatalities

- Total estimated cost to date - $71 billion+ (dni lost business)
  - New York - $42
  - New Jersey - $29

- Affected 21 states (as far west as Michigan)

- 8,100,000 homes lost power

- 57,000 utility workers from 30 states & Canada assisted Con Ed in restoring power
NYC Co-Op City
Bronx, New York

• “City within a city” - 60,000 residents, 330 acres, 14,000+ apartments, 35 high rise buildings
• One of the largest housing cooperatives in the world; 10th largest city in New York State
• 40 MW cogeneration plant maintained power before, during and after the storm (heat & power)

Mission-Critical Operations

- **Danbury Hospital** (Danbury, CT) – 4.5 MW CHP
  - supplies 371 bed hospital with power and steam to heat buildings, sterilize hospital instruments & produce chilled water for AC
  - $17.5 million investment, 3-4 year payback, cut AC costs 30%
- **Nassau Energy Corp.** (Long Island, NY) – 57 MW CHP
  - Supplies thermal energy to 530 bed Nassau University Medical Center, Nassau Community College, evacuation center for County
  - No services lost to any major customers during Sandy
- **South Oaks Hospital** (Long Island, NY) – 1.3 MW CHP
- **Hartford Hospital/Hartford Steam** (CT) – 14.9 MW CHP
- **Bergen County Utilities Wastewater** (Little Ferry, NJ) – 2.8 MW CHP (Process sewage for 47 communities)
Resilient University Microgrids

- The College of New Jersey (NJ) – 5.2 MW CHP
  - “Combined heat and power allowed our central plant to operate in island mode without compromising our power supply.” - Lori Winyard, Director, Energy and Central Facilities at TCNJ

- Fairfield, University (CT) – 4.6 MW CHP
  - 98% of the Town of Fairfield lost power, university only lost power for a brief period at the storm’s peak
  - University buildings served as area of refuge for off-campus students

- Stony Brook University (LI, NY) – 45 MW CHP
  - < 1 hour power interruption to campus of 24,000 students (7,000 residents)

- NYU Washington Square Campus (NY, NY) – 13.4 MW CHP

- Princeton University (NJ) – 15 MW CHP
  - CHP/district energy plant supplies all heat and hot water and half of the electricity to campus of 12,000 students/faculty
  - "We designed it so the electrical system for the campus could become its own island in an emergency. It cost more to do that. But I'm sure glad we did.” – Ted Borer, Energy Manager at Princeton University
Case Example District Energy/Microgrid: Princeton University

- > 150 Buildings; 12,000 people
  - Academic
  - Research
  - Administrative
  - Residential
  - Athletic
Production Capacity & Peak Demands
Princeton University

- **Electricity**
  - (1) Gas Turbine Generator
    - Rating: 15 MW
    - Peak Demand: 27 MW

- **Steam Generation**
  - (1) Heat Recovery Boiler
    - Rating: 180,000 #/hr
  - (2) Auxiliary Boilers
    - Rating: 300,000#//hr
      - Peak Demand: 240,000 #/hr

- **Chilled Water Plant**
  - (3) Steam-Driven Chillers
    - Rating: 10,100 Tons
  - (3) Electric Chillers
    - Rating: 5,700 Tons
      - Peak Demand: 11,800 Tons
  - (8) CHW Distribution Pumps
    - Rating: 23,000 GPM
      - Peak Demand: 21,000 GPM

- **Thermal Storage**
  - (2) Electric Chillers
    - Rating: 5,000 Tons
  - (1) Thermal Storage Tank
    - Rating: 40,000 Ton-hours
  - *peak discharge
    - Rating: 10,000 tons (peak)
  - (4) CHW Distribution Pumps
    - Rating: 10,000 GPM

- **Solar PV Farm**
  - Rating: 5.4 MWe
  - Panels: 16,500 panels
  - Area: 11 hectares
Princeton Micro-Grid Power Generation Dispatch To Optimize Savings – PJM Grid

[Graph showing power generation, campus demand, and power purchase over a period from 08 Jul 05 to 11 Jul 05.]
Princeton CHP/District Cooling Reduces Peak Demand on Local Grid
Princeton University PV Farm – Aug, 2012
16,500 PV panels generate up to 327 Watts each at 54.7 Volts DC
Princeton University 5.4 MW Solar Farm
Princeton University Microgrid
Benefit to Local Grid

During August peak: 100° deg F; 80% RH

- 2005 campus peak demand on grid 27 MW
- Implemented advance control scheme
- 2006 campus peak demand on grid 2 MW
- Microgrid “freed up” 25 MW to local grid
  - reduces peak load on local wires
  - avoids brownouts
  - enhances reliability
  - supports local economy
District Energy/Microgrids: Considerations

• Thermal energy also critical, not just electricity
• CHP is clean, proven, and competitive
• Robust assets, not “backup” systems
• Impediments: capricious standby charges; opaque interconnection process; value thermal
• Institutions driven by efficiency, climate action
• Governors/mayors seeking more resiliency
• Clean, reliable infrastructure drives economic growth
Thank you for your attention.

www.districtenergy.org

Rob Thornton
rob.idea@districtenergy.org

+1-508-366-9339
Princeton's Cogeneration Plant Provides Power During Hurricane
https://www.youtube.com/watch?feature=player_embedded&v=Wtjlj91imSQ

Forbes: Natural Gas: America's Future Electric Grid?

New York Times: How Natural Gas Kept Some Spots Bright and Warm as Sandy Blasted New York City

Lessons from Sandy: how one community in storm's path kept lights on
http://m.csmonitor.com/USA/2012/1115/Lessons-from-Sandy-how-one-community-in-storm-s-path-kept-lights-on/(page)/2

In Sandy's wake, clues to a more resilient transmission system emerge
http://www.eenews.net/climatewire/2012/11/15/3

Post-storm Prescription: Energy Reliability and Onsite Power

Lessons learned from Hurricane Sandy

Status of operations at Fairfield University due To Hurricane Sandy
Microgrids Keep Power Flowing Through Sandy Outages
http://www.technologyreview.com/view/507106/microgrids-keep-power-flowing-through-sandy-outages/

Combined Heat & Power Saver/Savior at TCNJ

More evidence of value of cogeneration during Sandy

Platts: Electric Utility Week - After Sandy, more thoughts turn to building up resiliency; answers are complex and elusive

Will Hurricane Sandy Change the Way We Distribute Power?
http://www.dailyfinance.com/2012/11/20/will-hurricane-sandy-change-the-way-we-distribute/

How to avoid the next Sandy meltdown

Microgrids Keep Power Flowing Through Sandy Outages
http://www.technologyreview.com/view/507106/microgrids-keep-power-flowing-through-sandy-outages/

How CHP Stepped Up When the Power Went Out During Hurricane Sandy
http://aceee.org/blog/2012/12/how-chp-stepped-when-power-went-out-d

Backup Generator Failures
Why Do Hospital Generators Keep Failing?

NYU Hospital Evacuated After Backup Generator Goes Down