District Energy/Microgrids: Resilient, Efficient Infrastructure

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Robert Thornton, President & CEO

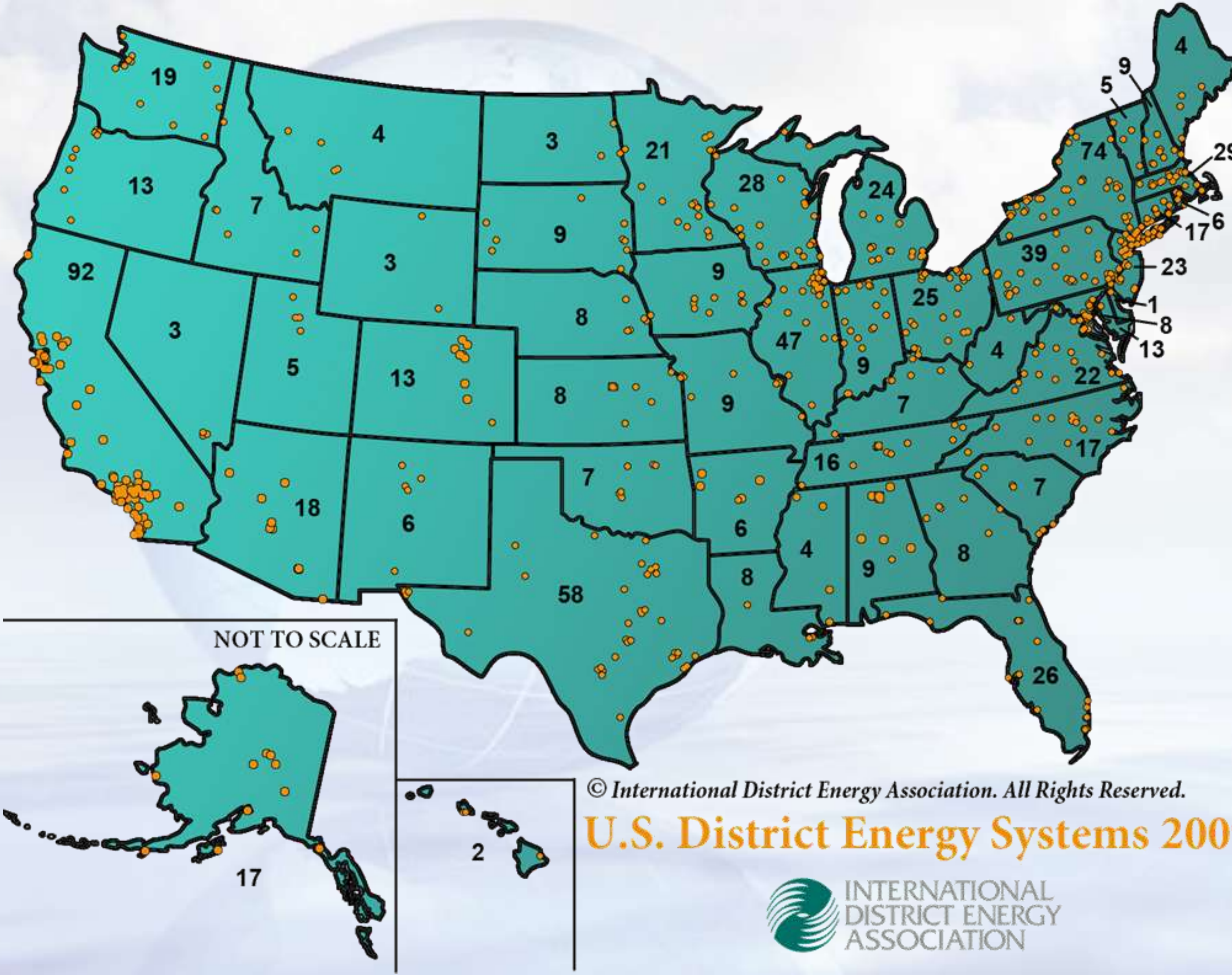
New England Electricity Restructuring Roundtable – "Bracing for Storms in New England"

Boston , MA

December 21, 2012

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

- **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.**



U.S. District Energy Systems 2009

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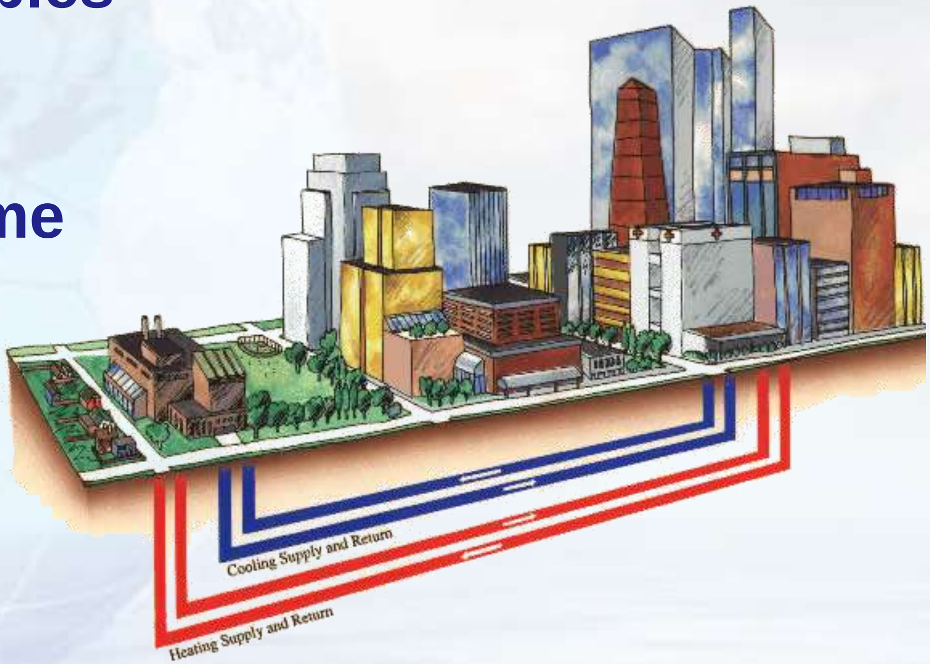
What is District Energy/Microgrid?

• Local "distributed" generation integrating CHP; thermal energy; electricity generation; thermal storage and renewables

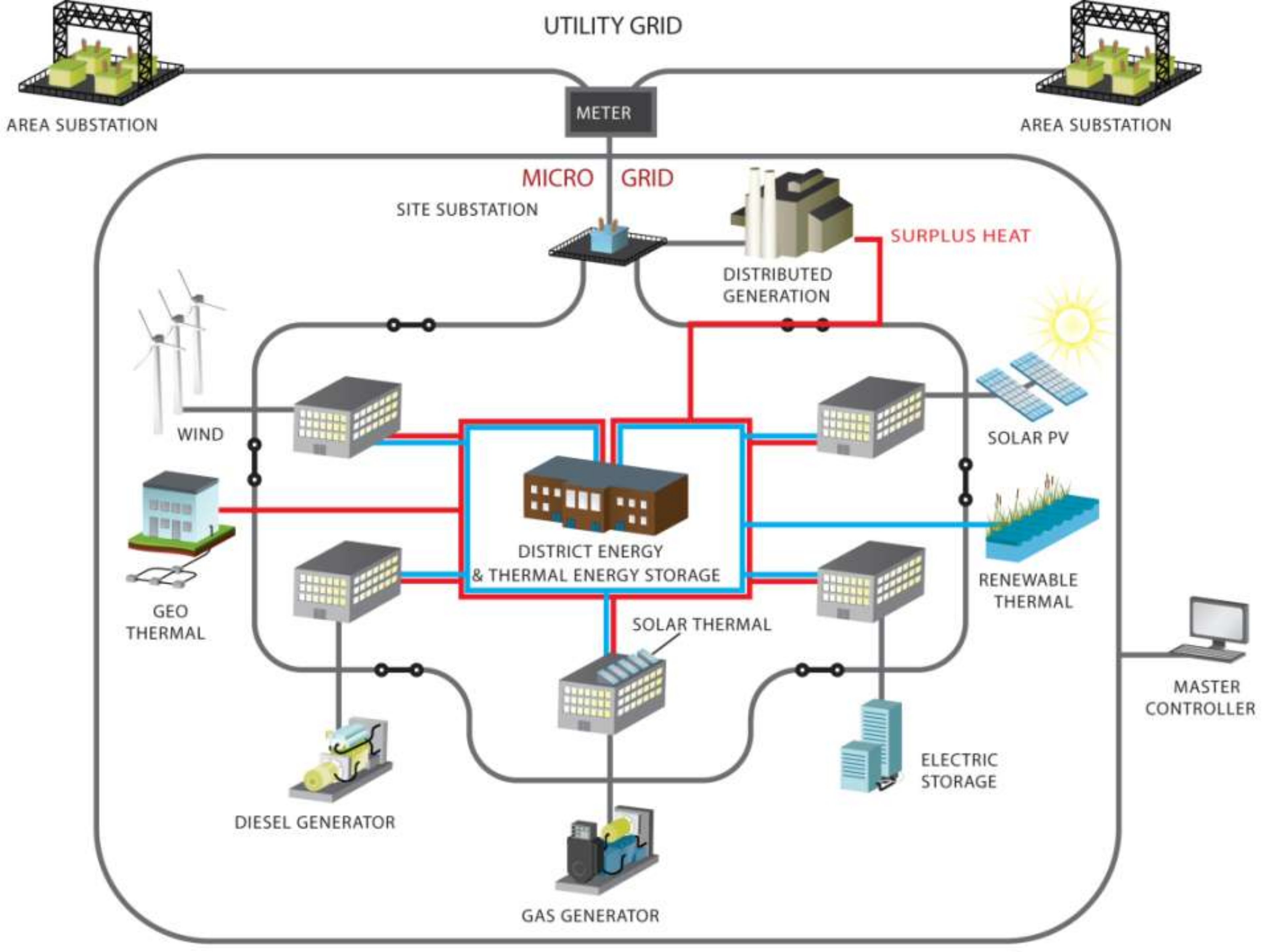
• Located near load centers; customer density; often some mission- critical needs

• Robust, economic assets

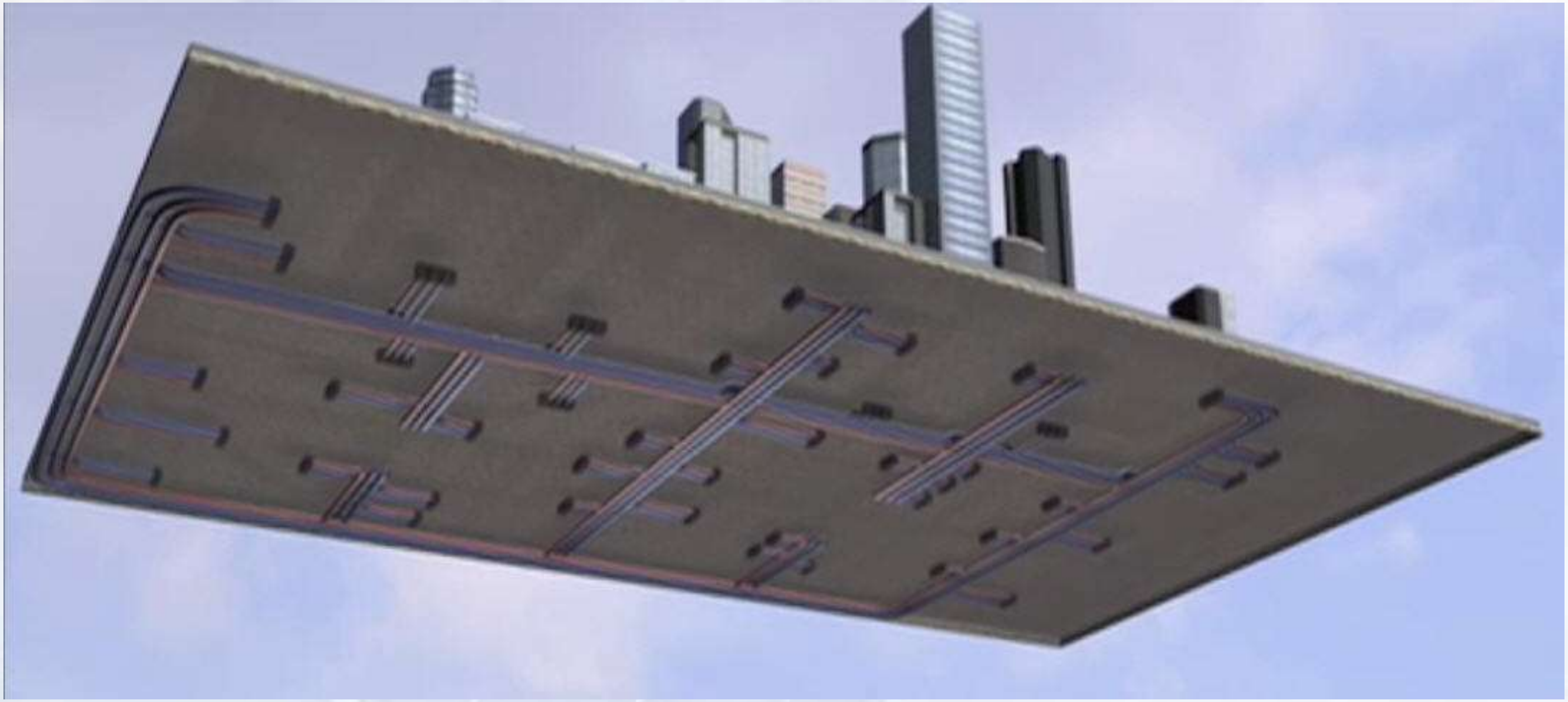
• CHP interconnected with regional & local grid



• Able to "island" in the event of grid failure


UTILITY GRID
AREA SUBSTATION
METER
AREA SUBSTATION
MICRO GRID
SITE SUBSTATION
SURPLUS HEAT
DISTRIBUTED GENERATION
WIND
SOLAR PV
GEO THERMAL
DISTRICT ENERGY & THERMAL ENERGY STORAGE
RENEWABLE THERMAL
SOLAR THERMAL
MASTER CONTROLLER
ELECTRIC STORAGE
DIESEL GENERATOR
GAS GENERATOR

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

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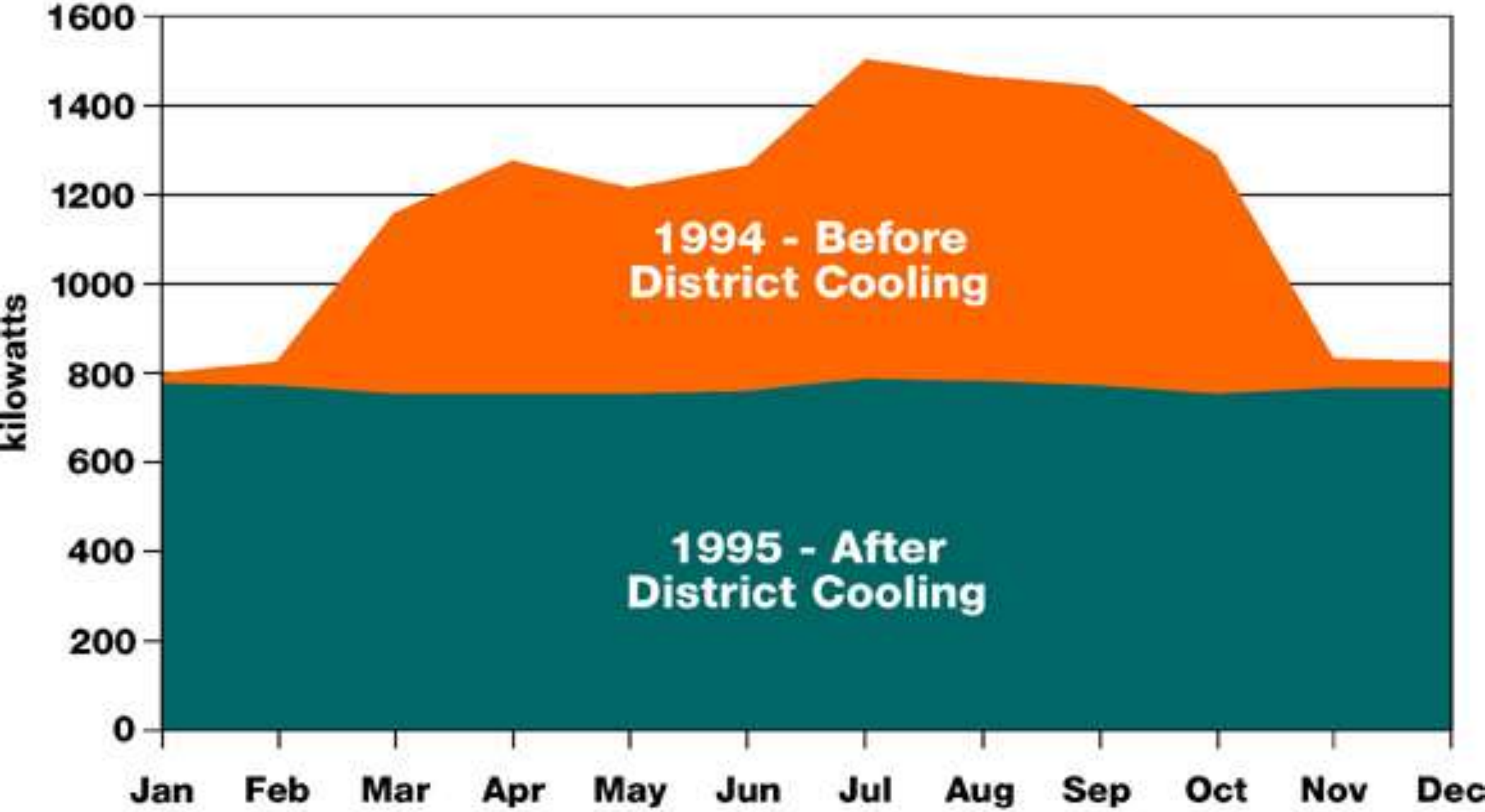
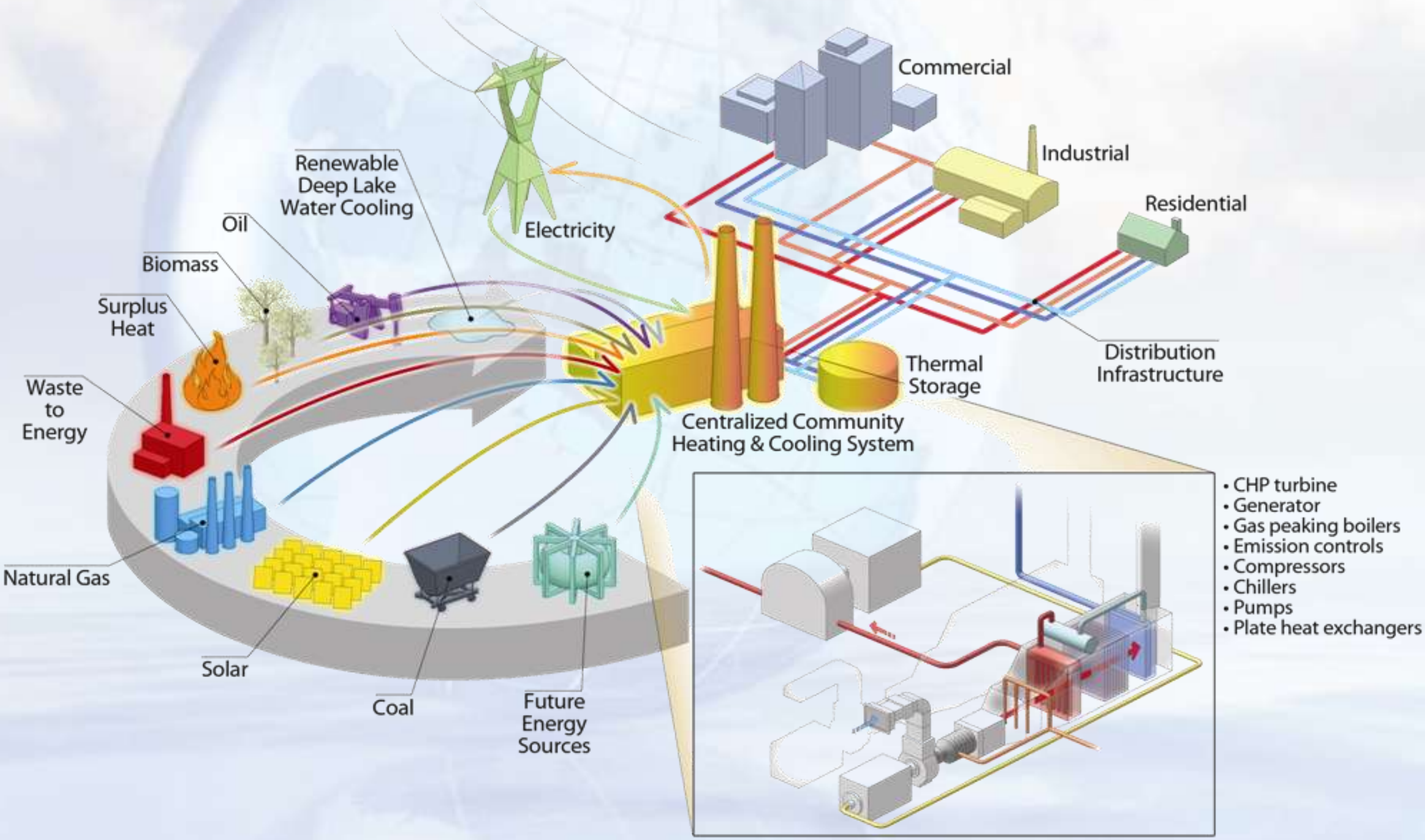
District Cooling Customer Electric Demand Profile



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 21states (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


Danbury , CT

Long Island, NY

Garden City, NY

Garden City, NY

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)**

http://www.forbes.com/sites/williampentland/2012/10/31/where-the-lights-stayed-on-during-hurricane-sandy/

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)**


Princeton University, NJ

Stony Brook Univ, NY

Fairfield, CT

Ewing, NJ

Resilient University Microgrids

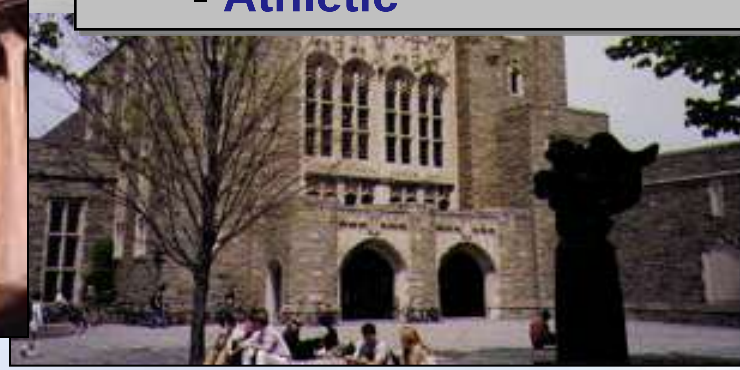
- **The College of New Jersey (NJ) – 5.2 MW CHP**
  - **"Combined heat and power allowed our central plant to operate in island mode without compromising our power supply."** ***- Lori Winyard, Director, Energy and Central Facilities at TCNJ***
- **Fairfield, University (CT) – 4.6 MW CHP**
  - **98% 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



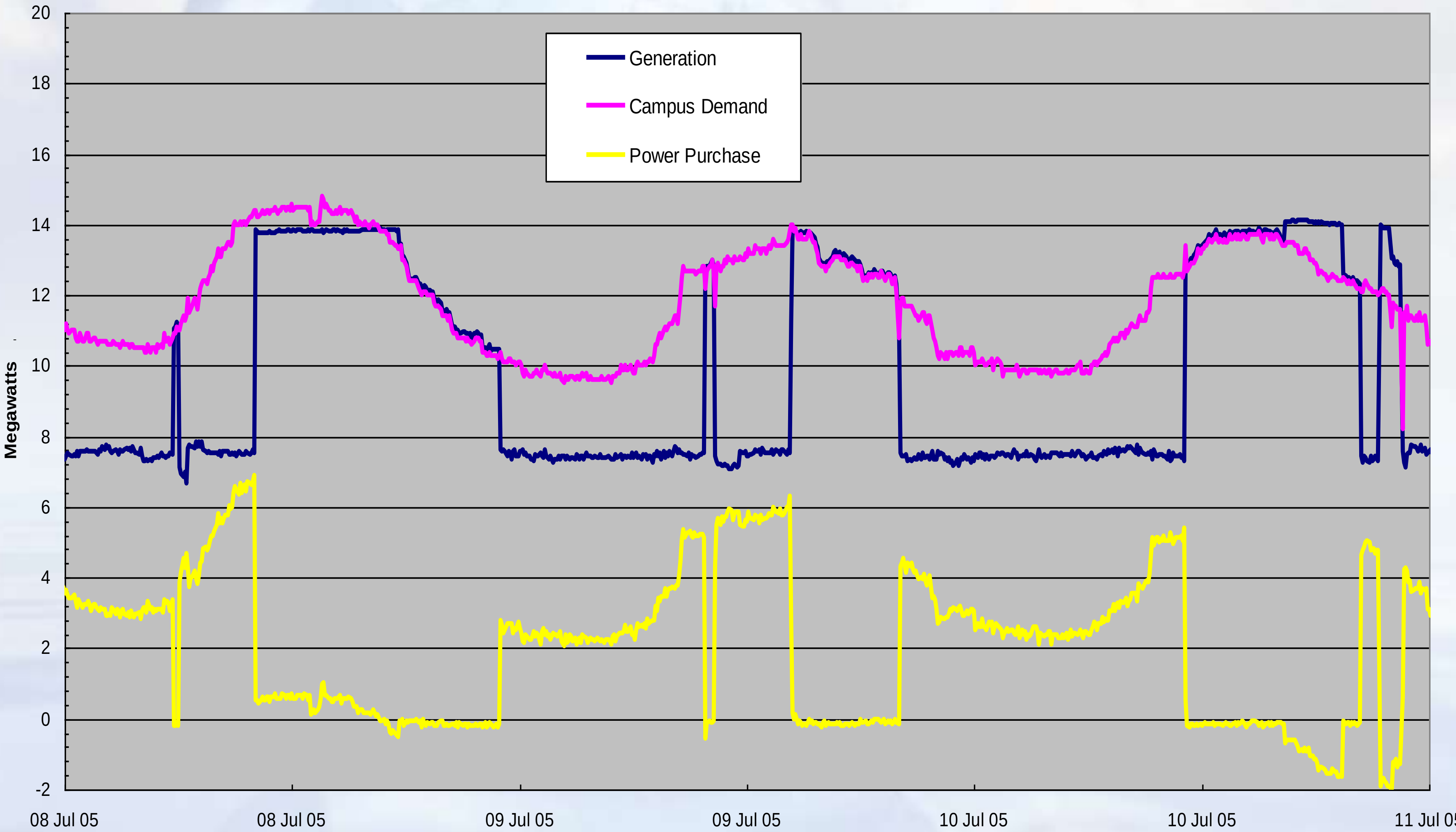




Production Capacity & Peak Demands Princeton University

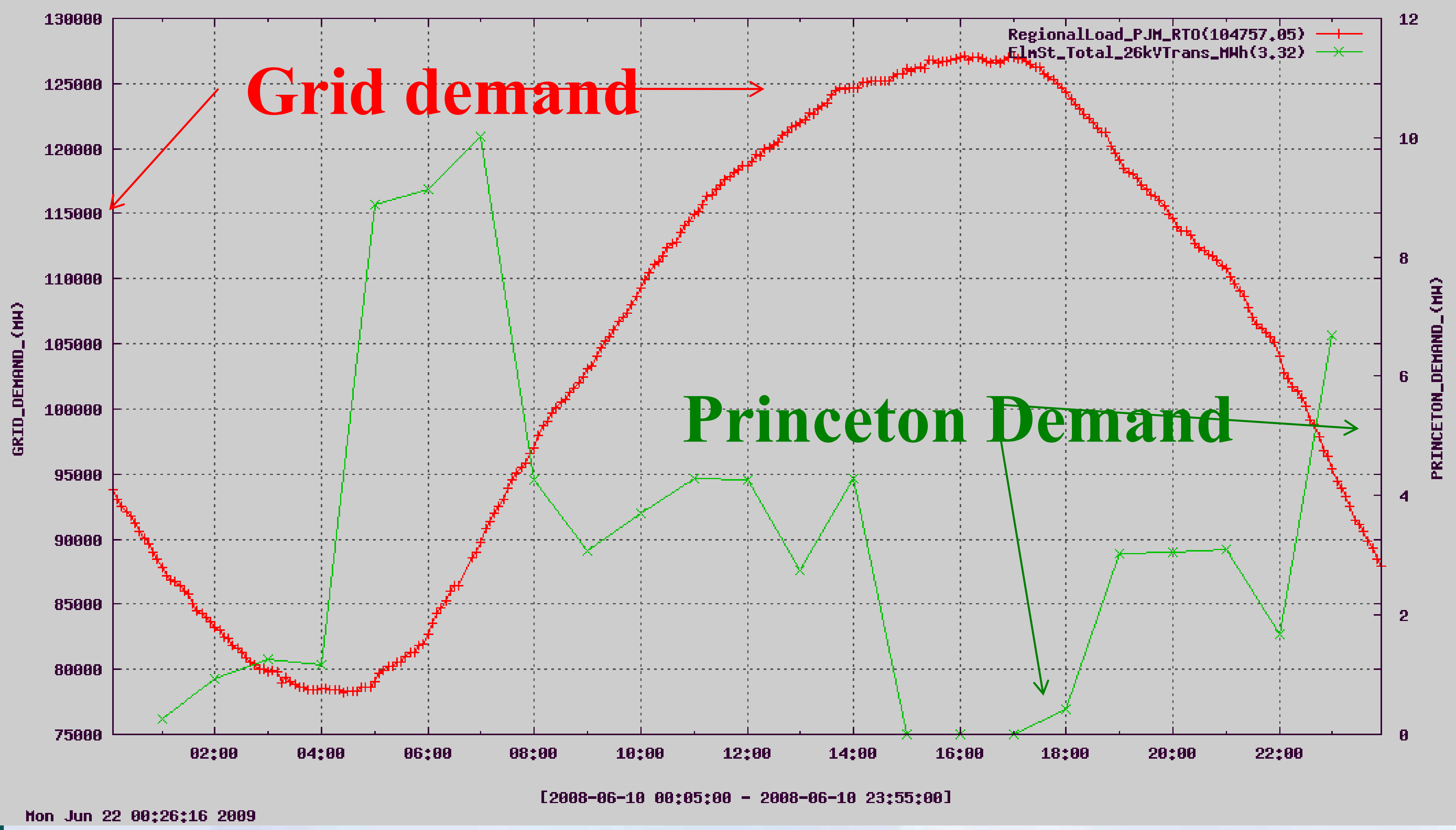
	Rating	Peak Demand
• **Electricity**		
– (1) Gas Turbine Generator	15 MW	27 MW
• **Steam Generation**		
– (1) Heat Recovery Boiler	180,000 #/hr	
– (2) Auxiliary Boilers	300,000#/hr	240,000 #/hr
• **Chilled Water Plant**		
– (3) Steam-Driven Chillers	10,100 Tons	
– (3) Electric Chillers	5,700 Tons	11,800 Tons
– (8) CHW Distribution Pumps	23,000 GPM	21,000 GPM
• **Thermal Storage**		
– (2) Electric Chillers	5,000 Tons	
– (1) Thermal Storage Tank	40,000 Ton-hours	
• *peak discharge	10,000 tons (peak)	
– (4) CHW Distribution Pumps	10,000 GPM	
• **Solar PV Farm**	5.4 MWe 16,500 panels 11 hectares	




Princeton Micro-Grid Power Generation Dispatch To Optimize Savings – PJM Grid

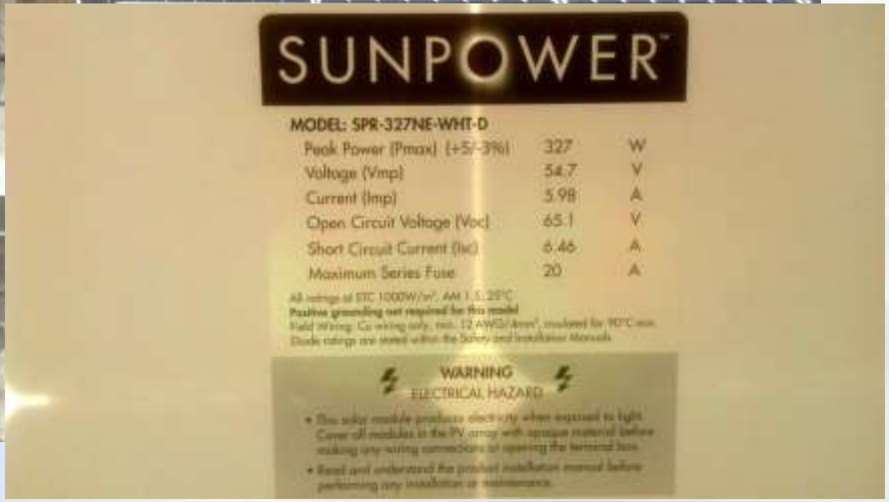


Princeton CHP/District Cooling Reduces Peak Demand on Local Grid



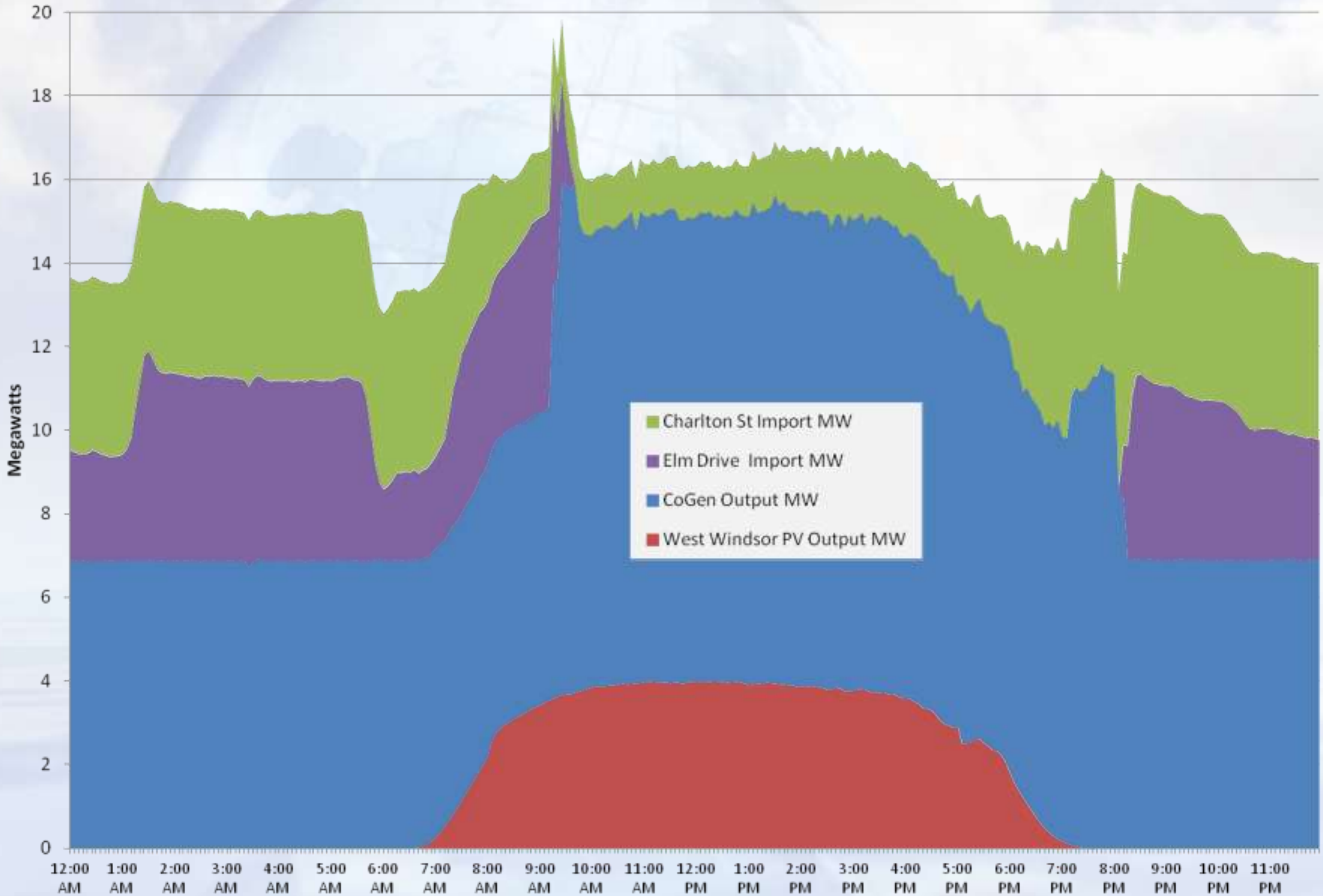
Princeton University PV Farm – Aug, 2012

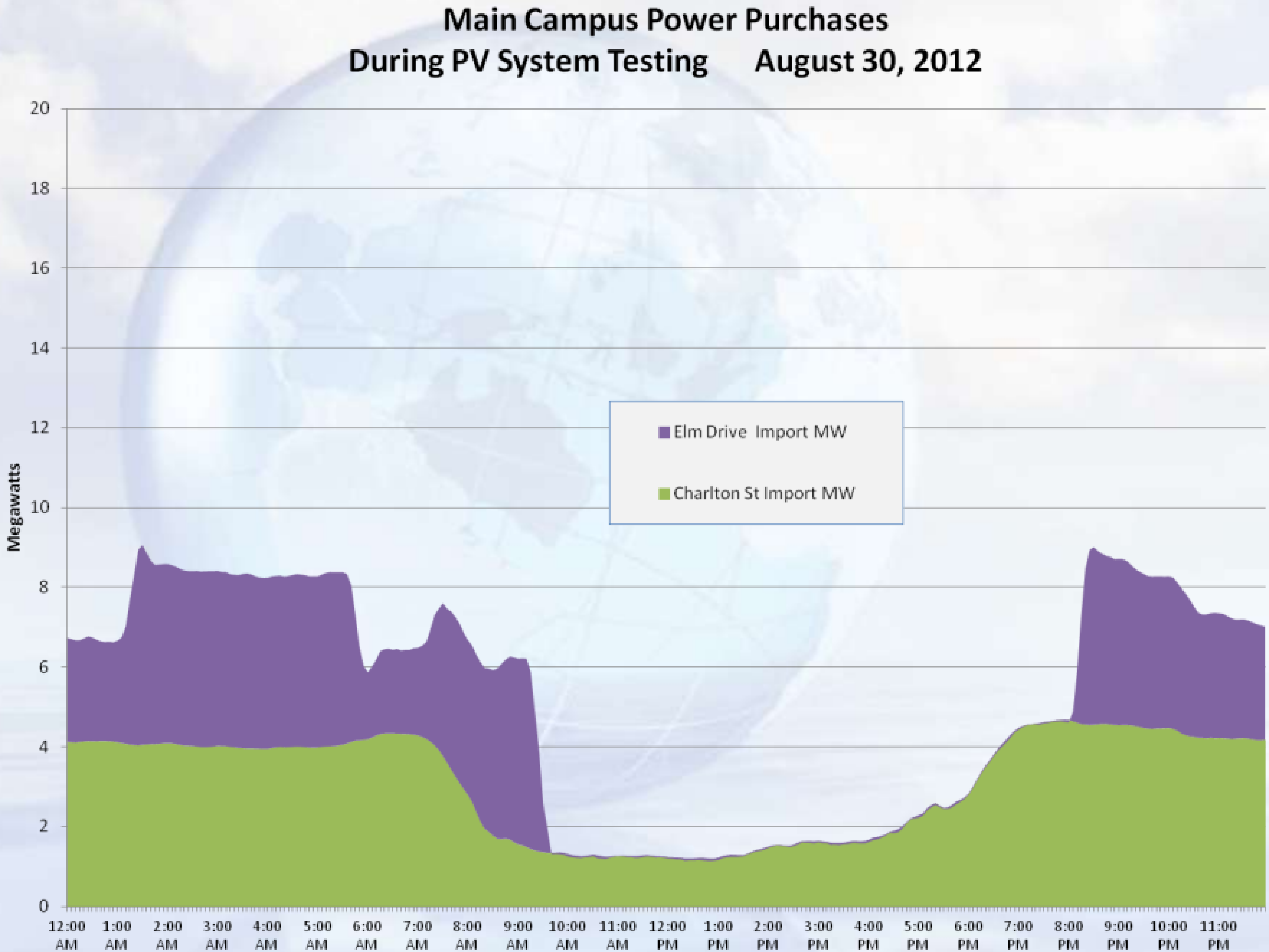
16,500 PV panels generate up to 327 Watts each at 54.7 Volts DC



Princeton University 5.4 MW Solar Farm

Main Campus Power, Generated & Purchased During PV System Testing August 30, 2012





Main Campus Power Purchases
During PV System Testing August 30, 2012
Megawatts
0
2
4
6
8
10
12
14
16
18
20
Elm Drive Import MW
Charlton St Import MW
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM

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.

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Princeton's Cogeneration Plant Provides Power During Hurricane
https://www.youtube.com/watch?feature=player_embedded&v=WtjIj91imSQ

Forbes: Natural Gas: America's Future Electric Grid?
http://www.forbes.com/sites/williampentland/2012/11/03/natural-gas-americas-future-electric-grid/

New York Times: How Natural Gas Kept Some Spots Bright and Warm as Sandy Blasted New York City
http://dotearth.blogs.nytimes.com/2012/11/05/how-natural-gas-kept-some-spots-bright-and-warm-as-sandy-blasted-new-york/

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
http://www.distributedenergy.com/DE/Blogs/1515.aspx

Lessons learned from Hurricane Sandy
http://www.cospp.com/content/cospp/en/articles/2012/11/lessons-learned-from-hurricane-sandy.html

Status of operations at Fairfield University due To Hurricane Sandy
http://www.minutemannewscenter.com/articles/2012/11/01/fairfield/news/doc5092a6d656fed649039295.prt

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
http://www.marketwatch.com/story/combined-heat-power-saversavior-at-tcnj-2012-11-14

More evidence of value of cogeneration during Sandy
http://www.cospp.com/articles/2012/11/more-evidence-of-value-of-cogeneration-during-sandy.html

Platts: Electric Utility Week - After Sandy, more thoughts turn to building up resiliency; answers are complex and elusive
http://sallan.org/pdf-docs/12NOV2012Electric-Utility-Week-Superstorm-CHP-article.pdf

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
http://tech.fortune.cnn.com/2012/11/26/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

<u>Backup Generator Failures</u>

Why Do Hospital Generators Keep Failing?
http://www.propublica.org/article/why-do-hospitals-generators-keep-failing

NYU Hospital Evacuated After Backup Generator Goes Down
http://newyork.cbslocal.com/2012/10/29/nyu-hospital-evacuated-after-backup-generator-goes-down/