Agenda

• Introductions – Carol Werner, EESI
• Industry Overview – Rob Thornton, IDEA
• Case Study, Resilient Institution: Princeton University – Ted Borer, Princeton University
• Case Study, Urban Efficiency & Reliability – Bill DiCroce, Veolia Energy NA
• The Case for Cutting Waste – Ken Smith, Ever-Green Energy
• Policy/Legislative Options - Mark Spurr, IDEA
• Q&A
“For the average coal plant, only 32% of the energy is converted to electricity; the rest is lost as heat.”

-Page VI, Executive Summary
### Efficiency of US Power Generation

#### U.S. Coal-Fired Power Plants Ranked by Efficiency

<table>
<thead>
<tr>
<th>Decile</th>
<th>No of units</th>
<th>Net nameplate capacity (GW)</th>
<th>Capacity factor</th>
<th>2007 total generation (BkWh)</th>
<th>2007 generation-weighted efficiency (HHV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>181</td>
<td>30</td>
<td>67%</td>
<td>177</td>
<td>26.5%</td>
</tr>
<tr>
<td>2</td>
<td>108</td>
<td>30</td>
<td>70%</td>
<td>180</td>
<td>30.0%</td>
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<tr>
<td>3</td>
<td>90</td>
<td>30</td>
<td>73%</td>
<td>189</td>
<td>31.0%</td>
</tr>
<tr>
<td>4</td>
<td>73</td>
<td>30</td>
<td>73%</td>
<td>189</td>
<td>31.7%</td>
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<tr>
<td>5</td>
<td>84</td>
<td>30</td>
<td>75%</td>
<td>194</td>
<td>32.4%</td>
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<td>6</td>
<td>75</td>
<td>30</td>
<td>69%</td>
<td>181</td>
<td>33.2%</td>
</tr>
<tr>
<td>7</td>
<td>79</td>
<td>29</td>
<td>71%</td>
<td>182</td>
<td>34.0%</td>
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<tr>
<td>8</td>
<td>70</td>
<td>30</td>
<td>70%</td>
<td>186</td>
<td>34.9%</td>
</tr>
<tr>
<td>9</td>
<td>57</td>
<td>29</td>
<td>72%</td>
<td>184</td>
<td>35.9%</td>
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<tr>
<td>10</td>
<td>46</td>
<td>30</td>
<td>74%</td>
<td>192</td>
<td>37.9%</td>
</tr>
<tr>
<td>Overall</td>
<td>863</td>
<td>297</td>
<td>71%</td>
<td>1,856</td>
<td>32.5%</td>
</tr>
</tbody>
</table>

Power Engineering Magazine, November 2009
Brayton Point Power Station, Somerset, MA – 1,537 MW
Pre-2011: Once-through cooling – Taunton River:Mount Hope Bay
Figure 12: Brayton Point Station Heat Rejection versus Time (1970 - 2000)


Total Heat Load (TBTU): 20, 22, 23.0, 22.0, 25.9, 26.2, 26.7, 25.5, 30.2, 32.9, 34.0, 33.8, 35.2, 41.1, 48.8, 49.5, 47.7, 41.6, 37.5, 38.9, 38.3, 38.6, 38.0, 41.0, 36.4, 36.1, 37.4

- Annual Total Heat Load
Brayton Point Cooling Towers – $570 Million in 2011

Total environmental compliance $1.1 billion since 2005.
Somerset power plant put up for sale

Dominion Loss on Write-Downs; Core Improves… *WSJ*, Jan 31, 2013

Energy company Dominion Resources posts 4Q loss – *The Virginian Pilot*, Jan 31, 2013

![2005-2011 Capacity Factor: Brayton Point 2](chart.png)
Heat Transmission Systems
The Greater Copenhagen DH System

18 municipalities
4 integrated DH systems
500,000 end-users
34,500 TJ (9,600 GWh, 32,700 GBtu)
Approx 20% heat demand in Denmark
World Class CHP – 90%+Efficiency
Avedore 1&2, Copenhagen

Unit 1 (810MW) – Coal; Unit 2 (900 MW) – Multi-Fuel (straw; biomass, etc)
Energy-Efficiency Comparisons

**Standard Power Plant**
- 100% Fuel Input
- 60% "Waste" heat rejected to environment
- 40% Useful energy produced for electricity

**District Energy/Combined Heat and Power Plant**
- 100% Fuel Input
- 20% "Waste" heat rejected to environment
- 40% Useful energy produced for heating and/or cooling via district energy system
- 40% Useful energy produced for electricity
What is a District Energy/Microgrid?

- Local “distributed” generation

- Robust, economic assets 24/7/365

- Generation located near load centers & customer density; often mission-critical

- Integrating CHP; thermal energy; electricity generation; thermal storage and renewables

- CHP generation interconnected with regional & local electricity grid

- Able to “island” in the event of grid failure
District Energy/Microgrid – Community Scale Energy Solution

• Underground network of pipes “combines” heating and cooling requirements of multiple buildings
• Creates a “market” for valuable thermal energy
• Aggregated thermal loads creates scale to apply fuels, technologies not feasible on single-building basis
• Fuel flexibility improves energy security, local economy
Infrastructure for Local Clean Energy Economy

- Connects thermal energy sources with users
- Urban infrastructure – hidden community asset
- Robust and reliable utility services
- Energy dollars re-circulate in local economy
Future Proofing A More Resilient City
District Energy Thermal Only: Excellent Near Term Opportunities for Microgrid/CHP Integration

• 300 District Heating systems; 56,000,000 MMBtu/Hr heat demand in:
  – Cities/Communities
  – Campuses
  – Airports
  – Military bases

• Represents approx. 11 GW near term CHP potential

• Aggregated customer thermal loads facilitates efficient, competitive CHP generation
District Energy/CHP/Microgrid
Local Opportunity Drivers

- Growing demand for greater grid reliability and resiliency
- Desire to expand local tax base & replace remote coal generation
- Tapping local energy supplies to improve trade balance & drive economic multiplier
- More sustainable energy sources to help compete for high quality employers, factories, tenants
- Cutting GHG emissions and addressing climate adaptation
- Local infrastructure advantages in extreme weather events
Super Storm Sandy: By the Numbers

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

• Caused 106 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

- **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

- **Marina Thermal** (Atlantic City) – 25,000 Tons; 335,000 #/hr, 8 MW

- **Danbury Hospital** (Danbury, CT) –
  - 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%

- **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 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 (NYC) – 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
Thank you for your attention.

www.districtenergy.org

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