Energy Efficient Infrastructure for More Resilient Local Economies

Princeton University Campus Microgrid

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International District Energy Association

Environmental and Energy Study Institute
Energy Demands at Princeton

- ~ 180 Buildings
  - Academic
  - Research
  - Administrative
  - Residential
  - Athletic
Energy Equipment & Peak Demands

- **Electricity**
  - (1) Gas Turbine Generator  15 MW  27 MW
  - Solar Photovoltaic System  5 MW

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

- **Chilled Water Production**
  - (3) Steam-Driven Chillers  10,100 Tons
  - (5) Electric Chillers  10,700 Tons  13,800 Tons

  - (1) Thermal Storage Tank  40,000 Ton-hours
    - *peak discharge  10,000 tons (peak)
Campus District Energy Systems
Economic Dispatch

- “ICETEC” Expert system recommends economic dispatch of all major assets
Campus Power During Hurricane Sandy

Megawatts

- Campus Demand MW
- Gen Output MW
- Charlton Street Purchased MW
- Backpressure Turbine MW
- Solar PV MW
- Elm Drive Purchased MW
Must Do
For Microgrid Reliability

• Base-load generators behind the meter
• Ability to run isochronous (off the grid)
• Black start capability
• Load-shed capability
Make Life Better Every Day

• CHP or combined cycle
  – not necessary in emergency response
  – make the equipment more cost-effective
  – Run more often, thus more reliable
  – Most problems happen in non-emergency situations

• Permitting for non-emergency use
  – not necessary for emergency response
  – more cost-effective by increasing capacity factor
  – run more often, thus more reliable
  – usually adds emissions controls

• Energy storage

• Underground utility distribution
Hurricane Sandy Student Video

# Net Result Of Cogeneration and District Energy

## Results Delivered
- High efficiency
- Clean
- Low Carbon Footprint
- Low Life-Cycle Cost
- Reliable
- Resilient
- Grid support

## Applicability
- Universities
- Healthcare
- Military bases
- Cities
- Industries, e.g., pharmaceutical and refining
Thank you