Advance Planning for Electric Reliability In Princeton University Campus Microgrid

Energy Planning for Resilient Communities – Best Practices
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Energy Demands at Princeton

- Approximately 180 Buildings
  - Academic
  - Research
  - Administrative
  - Residential
  - Athletic
Combined Cycle “Cogeneration”

- Air -> Gas Turbine
- Feed Water -> Boiler
- Fuel & Water
- Hot exhaust Gas -> CO Catalyst
- CO Catalyst
- Heat Recovery
- Steam
- Electric Generator
- AC Electricity
Campus District Energy Systems
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
Should Do
For Microgrid Reliability

- Fully commission complete systems
- Re-test periodically
- Test using realistic conditions
- Building-level load-shed capability
- Multiple fuel options
- Use emergency response teams periodically
- Plan for human needs
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
What It Takes

• A proactive time view of the horizon, not your feet
  – years
  – iterative projects

• Money, not necessarily yours
  – Loans, grants, tax credits, PPAs...

• Sweating the details

• Some smart people
  – Use outside experts as needed

• Passion and tenacity

• Permitting process has many challenges
  – Fed, State, local, making this streamlined, coordinated, predictable would be a big help

• For CHP
  – Size based on thermal load
  – Spark spread can be a strong motivator/anti-motivator
Benefits of Microgrids

• Lower life-cycle costs
• Options to generate or buy power based on economics and/or carbon footprint
• Reduce both energy *use* and peak *demand*
• Work well with CHP to greatly increase energy efficiency
• Provide self-sufficiency in emergencies
• Support places of refuge in an emergency

• Real-time power costs are set by the most expensive plant that is required to run. Microgrids lower energy cost for all customers.
• Microgrids distribute risk into smaller pieces so overall grid reliability is improved.
When it goes right...

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Hi Ted,

This is Peter Maag of the cross-country team. I was in contact last year to organize a power plant tour for the team over one of our breaks. I graduated this spring, but I happened to be on campus this past week throughout the storm. Just wanted to make sure you got at least one well-deserved fan letter for keeping the lights on.

When I saw the news that a 100 year storm was about to slam Princeton while I visited, I was immediately grateful that I would be on campus. I was pretty confident that it would be one of the most reliable places for power in the whole region. I had to work remotely for a couple days, so power was essential. Thanks for keeping the juice flowing throughout my stay!

By this point, you’ve probably realized that I have power now. It was the Princeton cogeneration plant. I’m assuming this is common. That being said, I’d love to hear a war story from a storm. Did anything out of the ordinary happen (other than my power)?

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Upendra J. Chivukula @UCHivukulaNJ

Did you know that @Princeton University ran on almost full power post-Sandy because of their combined heat and power system? #NJAssembly

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Hurricane Sandy Student Video

• http://youtu.be/Wtjlj91imSQ