Scalable Microgrids for Enhancing Energy System Resiliency and Efficiency

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April. 21, 2014
Storrs Campus Microgrid

- **A Co-Generation Plant**
  - 3 gas turbines of 7.2 MW each
  - 1 steam turbine 5 MW
  - 3 emergency diesels 4 MW

- **Energy efficiency**
  - The production of both electrical and steam allows over 80% of the fuel energy to be harnessed, versus 33% from a conventional power plant
  - Natural gas, a cleaner burning fuel, is used

http://energyservices.uconn.edu/SitePages/Home.aspx; User Name: FAS\PI, Password: Uconn2011
Enhanced electricity resiliency

Reduction of outage time by > 98%
Assuming UCONN CoGen availability: 98%
Utility grid availability: 99.5% (outage time 43.8 hrs)
\[ \Rightarrow \text{UCONN power supply availability: 0.9999\% (outage 0.88 hrs)} \]
UCONN Depot Campus Microgrid

- UCONN received $2.14M state funding to create a renewable microgrid in collaboration with Schneider Electric, ClearEdge Power, and A/Z Corporation
- Advancing Connecticut’s Energy Resiliency – First-in-the-Nation Statewide Microgrid Program
Energy Efficiency

- The fuel cell has generated 6215 MWh of electricity with a total efficiency of about 55%
- The PV panel has generated \(11.8888\) MWh of electricity with a total of 18168 lbs carbon offset
Courtesy: C. Schwaegerl and Liang Tao
Overview of Microgrid Benefits

Technical Benefits:
• Infrastructure resilience
• Energy loss reduction
• Improved power quality
• Congestion relief
• Stabilization of distribution and transmission

Economic Benefits:
• Initiator of local retail and service markets
• Hedging against risks- price volatility, outage, load growth...
• Aggregator of supply- and demand side- players
• Interest arbitrator for different stakeholders

Environmental and Social Benefits:
• Energy saving and carbon footprint reduction
• Job opportunities
• Electrification of remote area, transportation...

Courtesy: C. Schwaegerl and Liang Tao
Reliability benefit of microgrid options for selective locations (i.e., town centers or clusters of critical facilities)

Expected annual outage time under CAT3 storm (hours/year)

Expected annual outage time under CAT2 storm (hours/year)
Expected annual outage time under normal weather

Expected annual outage time under major storm

Expected annual outage time under CAT1 storm

Expected annual outage time under Tropical storm
Capabilities Covering Key Aspects of Microgrids

Theme 1: Seamless power flow and power management
Theme 2: Optimization of microgrid subsystems for efficiency and reliability
Theme 3: Micro/macro grid resilience & sustainability
Theme 4: System-level optimized planning/operation
Theme 5: Commercial viability studies and policy/regulatory research (in collaboration with CCAT)
Sample research thrusts

- Ultra-fast Programmable Communication Networks
- Optimal Power Flow in Microgrid
- Robust Integration of Intermittent Renewables
- Distributed Optimization of Microgrids Considering Demand Response
- Load/Generation Shedding for Microgrid Resilience
- Reliability Characterization of Microgrids
- Resilient DC Cabling Network
Enabling highly resilient and efficient microgrids through ultra-fast programmable networks

OpenFlow controller

Microgrid controller

PV

Load

Fuel Cell

Communication infrastructure

SDN Controller

SDN Switches

Visualization

Virtual EMS

UCONN Depot Campus microgrid

Hardware-in-the-loop Real time simulator to model UCONN microgrid
Thank you!