Community Energy and Microgrid Ownership Models

June 2016
Aurel Selezeanu PE, CEM, MBA
Agenda

- Duke University Model
- Other Models Overview
- Benefits & Costs
What to Look For

- Funding
- Fuel availability
- Inside expertise - Operation
- Grid reliability needs
- Cost of power
- Legislation
- Environmental Impact
Proposed Combined Heat & Power (CHP) Plant

Duke University Model
CHP Ownership Challenge

- **Reliability:**
  - Duke University electrical system total outage less than 6 seconds in 30 YEARS

- **Rate:**
  - Cost of electricity less than 8 cents per KWH

- **Cost:**
  - Large investment to build a CHP

- **Skills:**
  - No expertise to operate a large generating plant

- **Legislation:**
  - Change in the Power Company Rate Plan

- **Environmental Impact:**
  - Reduce carbon footprint

- **Island mode challenge:**
  - No reliability gain in “island mode” without using Duke Energy distribution system
Duke Energy will build, own and operate a Combined Heat and Power (CHP) plant on property leased from Duke University.

Duke Energy will send electricity back onto NC grid and we will continue to purchase electricity as we always have.

Duke University will buy the “waste” steam generated in the process at a rate that is significantly less than it costs us at our steam plants. The discounted steam rate would float with cost of natural gas.

The system will be constructed to allow Duke University to “island” in cases of emergency (power grid outage).
Combined Heat and Power Plant System Diagram

There are over 8,000 CHP’s across the US

Facilitates strategy of converting from steam to hot water distribution

Total energy cycle efficiency is projected to be 75-80% vs typical 40-45%

3rd source of steam increases reliability

Covers 25% of peak campus demand in island mode

Total energy cycle efficiency is projected to be 75-80% vs typical 40-45%
Benefits & Cost to Duke University

Benefits

- **Sustainability**
  - 13% reduction of the 2015 CAP-reported carbon footprint (DU & SOM) (coal move was 12% of 2008 CAP)
  - 24% reduction in total University & Medical Center energy-related carbon
  - DU contributing to local and regional environmental sustainability

- **Reliability**
  - Increased energy security for Duke campus
  - Additional generation on campus for emergencies (Island Mode)
  - Improved ability to continue operating during regional emergencies (hurricane, ice, etc.)

- **Savings**
  - Significant natural gas cost savings to the university ($2.5-$3.0M / yr)
  - Simple payback of 2-3 years

Costs

- Duke University would be leasing the land to Duke Energy for an extended period (35 years)
- In order to reliably operate our steam plants at a low load during summer, we would have to invest in modifications to the West Campus Steam Plant
- Project costs to connect the CHP plant to the campus utility infrastructure
- Total investment in plant modifications and infrastructure could range up to $7M
Proposed site next to Chilled Water Plant #1 and Substation #4
Microgrid Schematics

- Utility
- Local generating facility (CHP, PV, Wind)
- Distribution infrastructure
  - Utility Grid
  - Customer owned distribution system
- Connected load (customer load)
- Control Area / Substation/ Disconnect Location

Utility

Local Power Generation

Customer Load

Duke

Facilities Management
Utilities & Engineering Services
Duke University Microgrid Model

Utility

Substation

Utility Grid

Substation

Distribution

Customer Load

Local Power Generation

Substation

Utility

Substation
Duke University Microgrid Model

Utility
Power Generation
Ownership

Local Power Generation

Substation

Utility GRID

Distribution

Customer Load
Duke University Microgrid Model – Island Mode

Utility

Utility Power Generation Ownership

Local Power Generation

Utility Grid

Substation

Distribution

Customer Load

Substation
Single Owner / Single Operator - Microgrid Model

- Utility
- Substation
- Local Power Generation
- Customer Power Generation Ownership
- Substation
- Distribution
- Customer Load
Single Owner / Single Operator - Microgrid Model Island Mode

- Utility
- Substation
- Local Power Generation
- Customer Power Generation Ownership
- Substation
- Customer Load
Third Party Owner / Single Operator - Microgrid Model

Utility → Substation

Utility Grid

Local Power Generation → Substation

Third Party Power Generation Ownership

Customer Operated

Distribution

Customer Load

meter
Third Party Owner / Third Party Operator – Multiple Customers

- Utility
  - Substation
    - Third Party Power Generation Ownership
    - Local Power Generation
    - Third Party Operator
    - Substation
    - Customer Load
- Distribution
  - Customer Load
  - Customer Load
  - Customer Load

Duke Facilities Management Utilities & Engineering Services
Single Owner / Third Party Operator - Microgrid Model

- Utility
- Substation
- Local Power Generation Ownership
- Third Party Operator
- Customer Load
- Distribution Substation
- Customer Load Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substation
- Distribution Substitution
Third Party Owner / Third Party Operator - Microgrid Model

1. Utility
2. Substation
3. Local Power Generation
   - Ownership
4. Meter
5. Substation
6. Distribution
7. Customer Load
All Cases - Microgrid Model Island Mode

Utility → Substation → Local Power Generation → Substation → Substation → Distribution → Customer Load

Local Power Generation Ownership
Questions