MICROGRID for

DCO ENERGY LLC

MONTCLAIR STATE UNIVERSITY

IDEA – MARCH 2018
MICROGRID FOR MSU

PART I - The path to a MICROGRID
In 1993 MSU built its first Cogen in what was an existing Boiler House.

4.3 MW natural gas fired turbine with 23 MMBTU/Hr of heat recovery.

It was connected to the Campus’s existing steam and condensate system from the 50’s.

No Chilled Water distribution

Several small boilers and gas fired smaller units providing heat around the Campus.
The picture is a thermographic image of the typical steam line previously buried on the MSU Campus.

The Central Plant was operating at an efficiency rating of less than 50%.

Returning condensate was less than 20%, thermal losses were significant.

In 2009, as part of an Energy Master Plan, the University performed an analysis of potential upgrades to the Utility Systems.
In 2009 the NJ Economic Stimulus Act provided for the use of Public Private Partnerships (PPP) for Colleges and Universities.

The Montclair District Energy System was the first PPP utilized for Energy.

Project Financing Utilized:
- Taxable Bonds
- Tax-exempt Bonds

UMM Energy Partners and MSU signed an Agreement that included Design, Construction, Financing and Operations and Maintenance for 30 years. A long term partnership was born.
MICROGRID FOR MSU – Issues to be Addressed

- The entire steam distribution system was in such poor shape it had to be totally replaced.
- There was no chilled water distribution system, it had to be installed totally new.
- The Campus was expanding with new buildings and numerous renovations were being planned and underway, a comprehensive plan needed to be formulated.
- Distributed emergency generation was past it’s life expectancy.
- Temporary chillers where parked in multiple location around the Campus.
- Rocky terrain and numerous buried utilities needed to be considered, moved and maneuvered around.
MICROGRID FOR MSU – First the District Energy System

- Solar Taurus 60, 5.4 MW Gas Turbine, dual fuel, 29 MMBTU/hr heat recovery steam generator.
- Capable of satisfying 75% of campus electrical load and 100% of thermal load.
- 2 – 1200 HP NG Boilers, 42,000 lbs./Hr steam, each.
- 1 – York 2300 Ton/hr Steam Driven Chiller
- 1 – York 2000 Ton/hr Electric Chiller
MICROGRID FOR MSU – and the new distribution system

- 9,500 linear feet of trench
- 7.5 miles of Chilled Water, Steam and Condensate piping
- Supplying:
  - 100,000 LBM/hr Steam
  - 9,000 Tons/hr Chilled Water
MICROGRID FOR MSU – District System Performance

- Commercial September 2013
- 86% of electricity from Cogen
- Availability of 97.38%
  - .03% unscheduled
- Electricity 40% lower than Utility rates
- Saving on average $2.2 million annually on energy and taking into account debt service
- Estimated savings over the course of the contract (30 years) is expected to be approximately $66 million
PART II - The MICROGRID Arrives
MICROGRID FOR MSU – System Challenges
Why MICROGRID

- Utility Communication link trips Cogen (RFL).
- Load Shed Scheme not in place.
- Emergency Generation aging and in numerous locations.
- High Demand ratchet for supplemental power.
- Campus electric load growing.
- Reliability of Grid
“A small-scale power grid that can operate independently or in conjunction with the area’s main electrical grid. Any small-scale localized station with its own power resources, generation and loads and definable boundaries” qualifies.

Pairing a MICROGRID with Combined Heat and Power improves the efficiency and economic benefits of the MICROGRID system.
MICROGRID FOR MSU – What does the MICROGRID include?

- 2 X 2.6 MW GE Jenbacher JGS 616 natural gas fired reciprocating engine generators.
- A State of the Art Load Management System that provides the University with the ability to control every major end use breaker in the substation.
- Black Start Capability.
- Engine installation includes heat recovery.
- Total functionality with loss of Utility Grid.
- Permitted for approximately 2,000 hours of operation.
- System is export capable
MICROGRID FOR MSU – LOAD SHEDDING

- Peak Shaving Units
- Microgrid Management System
- Utility Feeders
- Redundant Feeders
- Campus Distribution System
- Load Management System
- CHP Plant Parasitic Loads
- CHP Generation
MICROGRID FOR MSU – Load Shedding Control
MICROGRID FOR MSU – Plant Layout

Main Operating Floor

Roof Plan
MICROGRID FOR MSU – Progress
System estimated cost approximately $9.4 million – Engines, controls, building and communications interface.

Provides two sources of major electric generation.

Controls system to seamlessly interface the multiple generating sources.

Initially provides approximately $298,491 (increases going forward) of additional savings.

Resolves outstanding challenges with Utility Grid interface.

Provides:

- LMP savings ($/kwh)
- Utility Demand savings ($/kw)
- PJM Capacity & Transmission savings ($/kw)
MICROGRID FOR MSU – The Supplemental Power Demand – The Economic Driver for the MICROGRID

- Economic Drivers
  - **LMP Price $/kwh (Locational Marginal Price):** Reviewed Energy Pricing an hourly $/kwh for summer and winter periods for MSU Zone
  - **Utility Peak Demand (PSEG):** Reviewed 15 minute demand data to determines supplemental power peak loads; year by year adjustment
    - Summer Peak $/kw
    - Annual Peak $/kw
  - **PJM Generation and Transmission Obligation $/kw:** Peak set based on highest 5 individual hours. This moves year to year and experience has shown that it occurs on the third weekday of + 90 degrees weather and high humidity. Year by year adjustment
## MSU Supplemental Power Demand

### Pre- Microgrid

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<tr>
<th>Month</th>
<th>Supplemental Peak Demand (KW)</th>
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<tbody>
<tr>
<td>May</td>
<td>4,871</td>
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<tr>
<td>June</td>
<td>4,761</td>
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<td>July</td>
<td>4,778</td>
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<tr>
<td>August</td>
<td>4,680</td>
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<tr>
<td>Sept</td>
<td>6,981</td>
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### Post - Microgrid

<table>
<thead>
<tr>
<th>Month</th>
<th>Supplemental Peak Demand (KW)</th>
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<tr>
<td>May</td>
<td>0</td>
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<tr>
<td>June</td>
<td>0</td>
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<tr>
<td>July</td>
<td>0</td>
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<tr>
<td>August</td>
<td>0</td>
</tr>
<tr>
<td>Sept</td>
<td>508</td>
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Average Summer Demand Reduction = 4,792 Kw  
90.4 % reduction
### MSU Supplemental Energy Usage

#### Pre- Microgrid

<table>
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<th>Month</th>
<th>Supplemental Peak Usage (Kwh)</th>
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<tr>
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<td>June</td>
<td>1,351,052</td>
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<td>July</td>
<td>1,710,979</td>
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<td>1,661,817</td>
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<td>Sept</td>
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#### Post - Microgrid

<table>
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<th>Month</th>
<th>Supplemental Peak Usage (Kwh)</th>
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<tr>
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<td>1,035,127</td>
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<td>July</td>
<td>1,295,311</td>
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<td>August</td>
<td>1,288,798</td>
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<tr>
<td>Sept</td>
<td>1,436,876</td>
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</table>

Usage Savings (KWH) = 2,543,276

28.68 % reduction
MICROGRID FOR MSU – Savings Comparison

- **PPP/DCO - Bond Financing Case**
  - Cost $9.4 M
  - Term 25 years
  - WCOC 8.5%
  - Natural Gas Bypass Rate
  - Annual Savings: $298,491
  - Payback = ∞ (no capital required)

- **Self Financing Case**
  - Cost $9.4 M
  - Term 25 years
  - WCOC – 4%
  - Natural Gas Bypass Rate
  - Annual Savings: $615,753
  - Payback = 15.27 years
Communications and controls are at the heart of the MICROGRID function. Installing those networks on the urban Campus is a challenge.

Providing the best possible fuel cost to power the MICROGRID is important to the economics, so opting for a utility bypass rate can be profitable.

Having a back up fuel source like LNG provides more reliability to the MICROGRID System.
MICROGRID FOR MSU - Conclusions

- The MICROGRID provides the ability for the University to remain operating during periods when the Utility Grid is not in service. *A safe haven for Faculty & Students during environmental events*
- The MICROGRID provides a measurable economic benefit to the institution as installed and in conjunction with the District Energy System and Combined Heat, Chilling and Power System.
  - **All forms of Energy provided during upset conditions – Both Electric & Thermal**
- The MICROGRID includes automatic functions; connect and disconnect from the grid, conducts load shedding and interconnectivity that allows for the interface with other systems when necessary. Two way communications is a basic requirement that supports full functionality.
- The MICROGRID supports the stability of the local utility network.
- Improves achieving sustainability goals by displacing the use of grid supplied power (coal and oil generation) during Peak Periods
- The MICROGRID is expandable in order to service Campus growth and can accommodate additional sources of generation including renewable sources.
Thank You for your attention!

Please contact DCO Energy, LLC for additional information about the MSU MICROGRID.

We can be reached at 609-837-8025 or,

At [www.dcoenergy.com](http://www.dcoenergy.com)