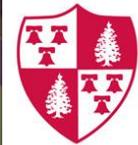




MICROGRID for



MONTCLAIR STATE
UNIVERSITY

BY DCO ENERGY, LLC

WEDNESDAY JUNE 28, 2017



MICROGRID FOR MSU

PART I - The path to a MICROGRID





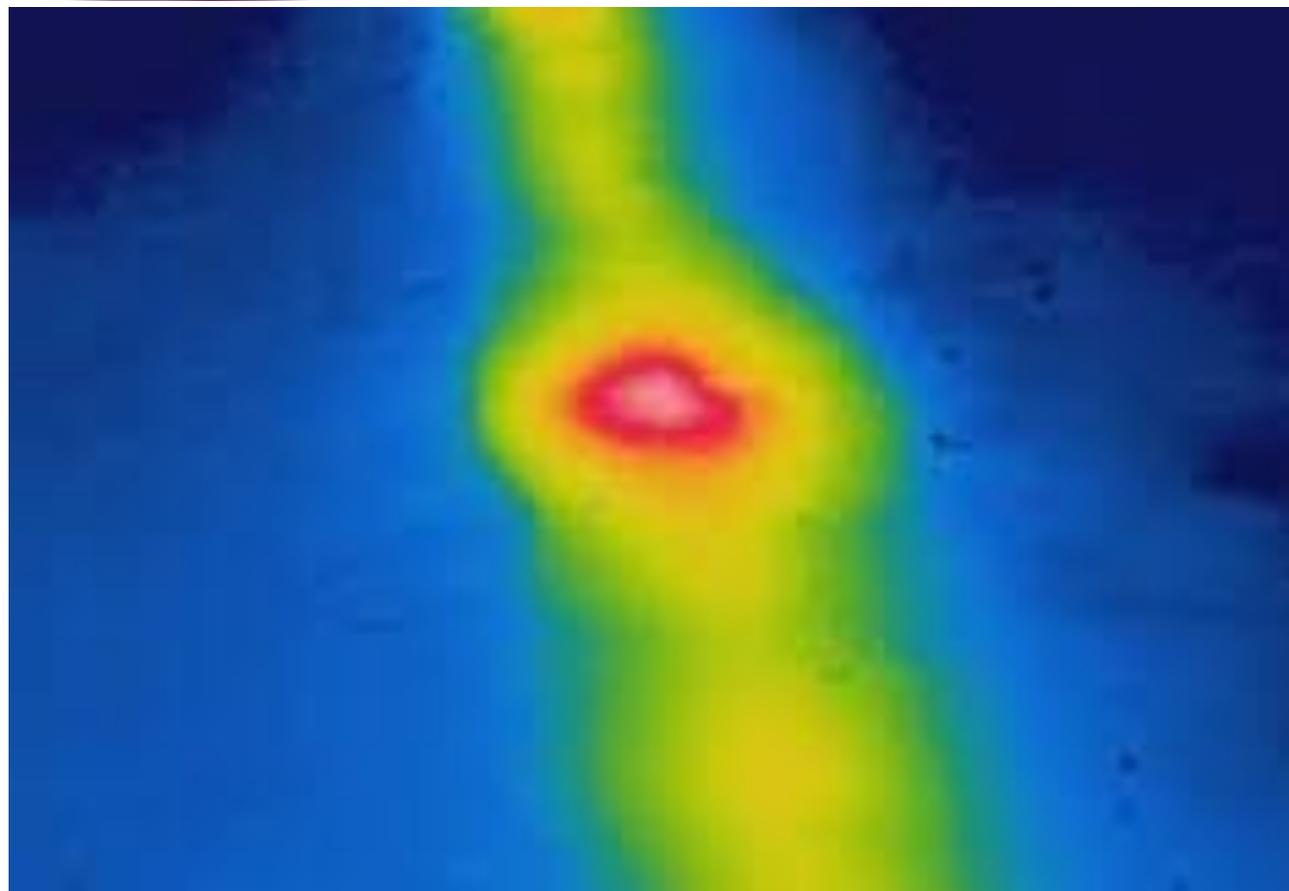
MICROGRID FOR MSU – Where it began

- ▶ 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.



MICROGRID FOR MSU – Action Required

- ▶ 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





MICROGRID FOR MSU – Partnership Formed

- ▶ 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 were parked in multiple locations 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





MICROGRID FOR MSU

PART II - The MICROGRID Arrives

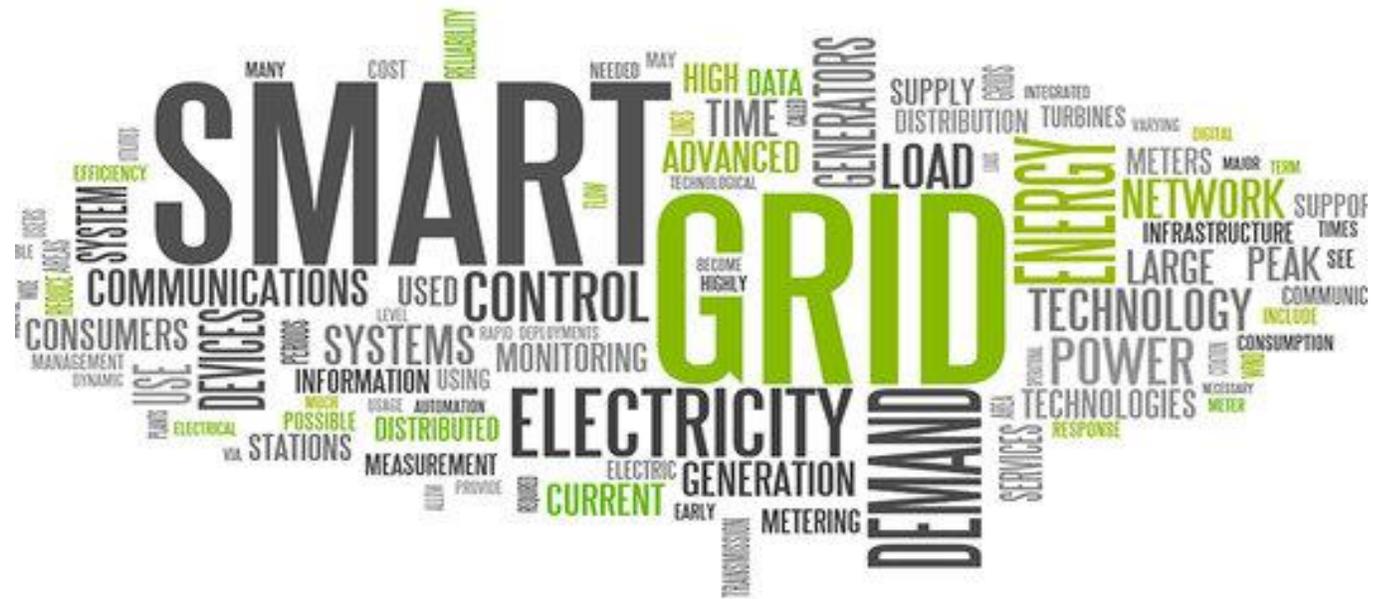




MICROGRID FOR MSU – System Challenges

Why MICROGRID

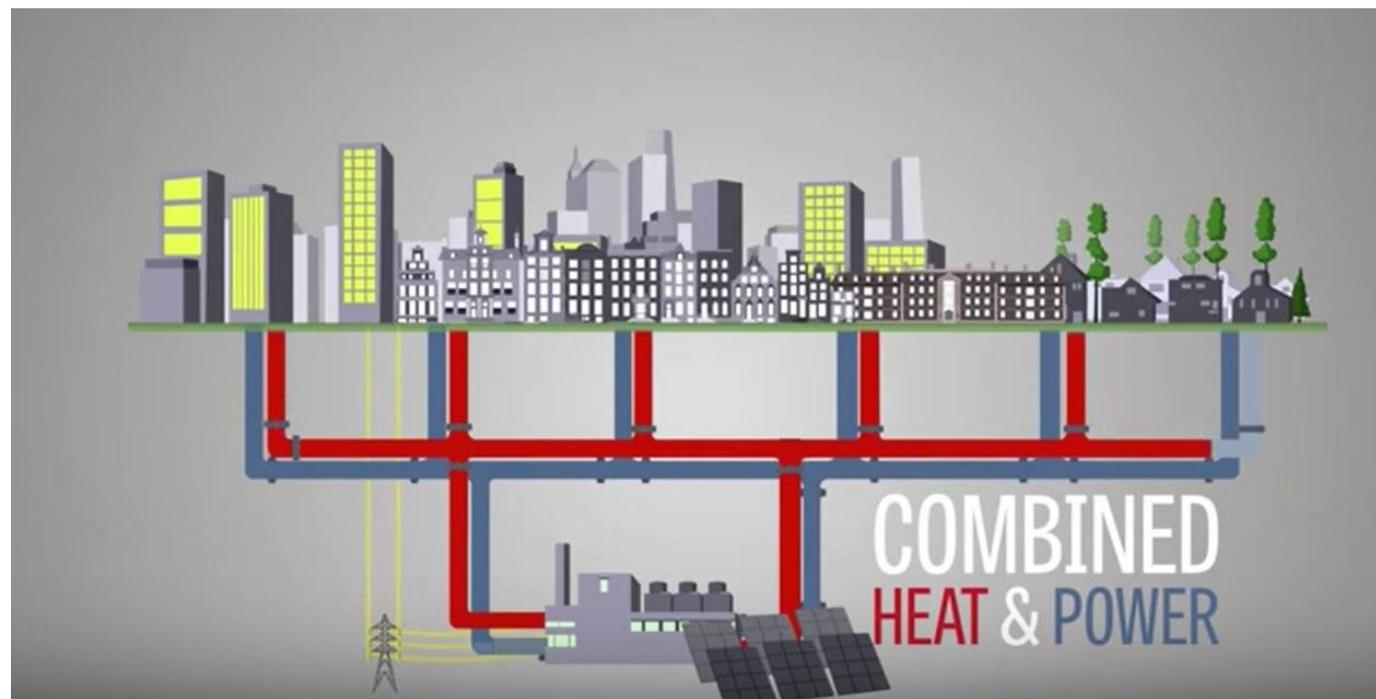
- ▶ Utility Communication link trips Cogen (RFL).
- ▶ Load Shed Scheme not in place.
- ▶ Emergency Generation aging and in numerous locations.
- ▶ High Demand ratchet for supplemental power.
- ▶ Campus electric load growing.





MICROGRID FOR MSU – What is a MICROGRID

- ▶ “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 it’s 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.





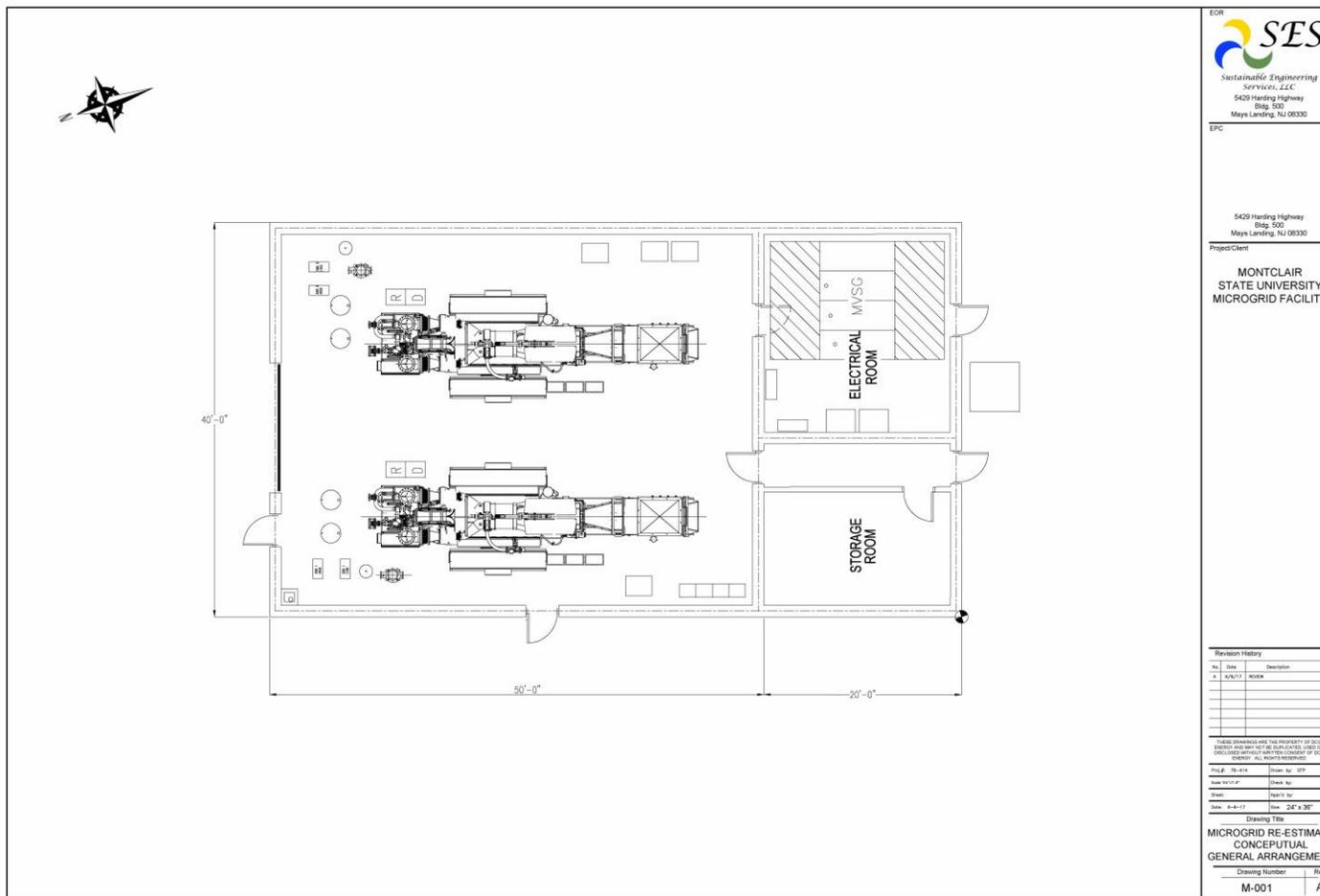
MICROGRID FOR MSU – What does the MICROGRID include?

- ▶ 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 – Plant Layout



EOR
SES
Sustainable Engineering
SERVICES, LLC
5429 Harding Highway
Bldg. 500
Mays Landing, NJ 08330

EPC
5429 Harding Highway
Bldg. 500
Mays Landing, NJ 08330

Project/Client
**MONTCLAIR
STATE UNIVERSITY
MICROGRID FACILITY**

| Revisions History | |
|-------------------|-------------|
| No. | Description |
| 1 | Issue |
| 2 | Revise |
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1:100 (Overall) and 1:50 (Generator) or 2:1 (Electrical) are the only scales to be used. All dimensions are in feet and inches. All dimensions are to the center of the object unless otherwise noted.

| | | | |
|--------|------------|------------|-----------|
| Proj.# | MS-414 | Drawn by | SPF |
| Scale | 1/4"=1'-0" | Checked by | SPF |
| Sheet | MS-414-1 | Revised by | SPF |
| Date | 8-2-17 | Date | 2-27-2017 |

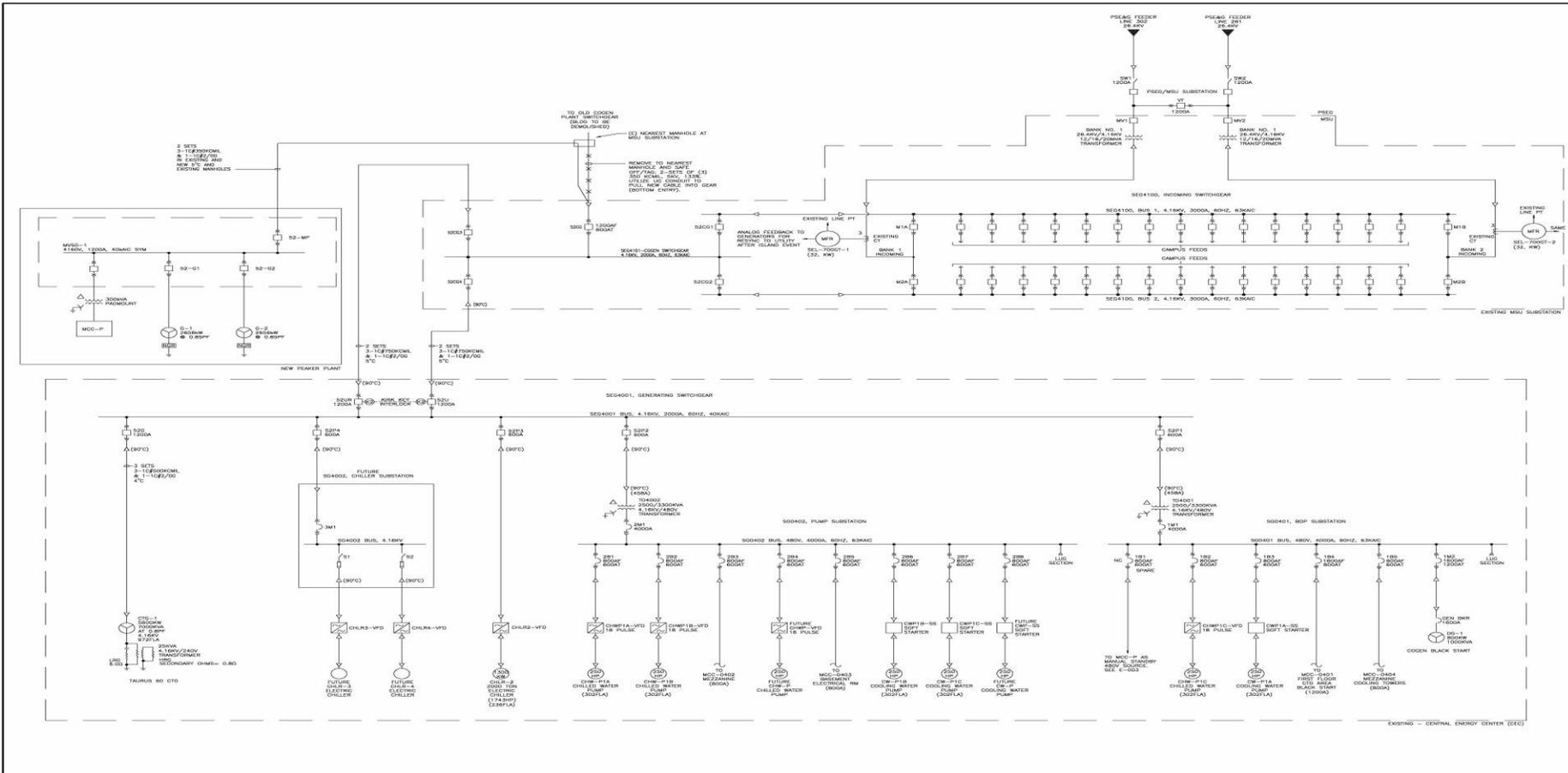
Drawing Title

**MICROGRID RE-ESTIMATE
CONCEPTUAL
GENERAL ARRANGEMENT**

| | |
|----------------|-----|
| Drawing Number | Rev |
| M-001 | A |



MICROGRID FOR MSU – LOAD SHEDDING



EOR

SES
Sustainable Engineering Services, LLC
5429 Harding Highway
Bldg. 500
Mays Landing, NJ 08330

Project/Client
DCO Energy
5429 Harding Highway
Bldg. 500
Mays Landing, NJ 08330

| Revision History | |
|------------------|--|
| No. | Description |
| A | 5/12/17 CONCEPTUAL ONE LINE |
| B | 5/31/17 REVISION TO ONE LINE AND ADD BREAKER |
| | |
| | |
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Scale: N/A Check by: KGS
Sheet: [] App'd by: KGS
Date: 12/14/16 Scale: 24" x 36"

Drawing Title
OVERALL ONE-LINE DIAGRAM

| Drawing Number | Rev |
|----------------|-----|
| E-001 | B |



MICROGRID FOR MSU – System Costs and Savings

- ▶ 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
 - ▶ Utility Demand savings
 - ▶ PJM Capacity savings





MICROGRID FOR MSU – Savings Comparison

▶ 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 – 8.5%
- ▶ Natural Gas Bypass Rate
- ▶ Annual Savings: \$615,753
- ▶ Payback = 15.27 years



MICROGRID FOR MSU – MICROGRID Challenges

- ▶ 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.
- ▶ 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.
- ▶ 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.
- ▶ The MICROGRID is expandable in order to service Campus growth and can accommodate additional sources of generation including renewable sources.

MICROGRID FOR MSU

- ▶ Thank You for your attention!
- ▶ Please contact DCO Energy, LLC for additional information about the MSU MICROGRID.
- ▶ We can be reached at 609-837-8045 or,
- ▶ At www.dcoenergy.com