Why a Microgrid Control System?

- Black Start Sequencing
- Parallel / Island Mode Operation
- Automatic Synchronization
- Power Import / Export Control
- Load Shed and Load Restoration
- Alarming and monitoring.
What is a Microgrid Control System?

- Industrial control systems - Programmable Logic Controller (PLC) based.
- Fast response time (in the millisecond range).
- Coupled with an industrial SCADA software package for operator interface and data acquisition purpose.
- Manual control panel(s) to provide control of the microgrid in the event of a loss of the PLC controller.
Key Design Considerations

- Response Time
- Level of Redundancy
- Operator Interface
- Manual Control
- Contractual / Interconnect Agreement with Utility Provider
FDA Campus
White Oak, MD
FDA Central Utility Plant (CUP)
CUP-2
(2) 7.5MW CTG’s
(1) 4.5MW CTG
(1) 5MW STG
(2) 2.25MW engine
(2) HRSG’s
(3) 2,250Ton Centrifugal Chillers
(1) 2,200Ton Centrifugal Chiller
(1) 2-Million Gal TES
(1) 25KPPH Steam Backup Boiler

CUP-1
(4) 4.5MW CTG
(1) 5.8MW engine
(2) 2MW engines
(2) 1,100Ton Absorption Chillers
(2) 1,100Ton Centrifugal Chillers
(2) 2,000Ton Centrifugal Chillers
(3) 14MMBtu/Hr. Waste Heat Boilers
(3) 10MMBtu/Hr. Backup Boilers

SE Quad
(19) Bldg. Breakers

www.thermosystems.com
Load Management System (LMS)
Power Management System (PMS)
Manual Control Panel
Building Load Shed Systems
LMS – Load Management System

- 13.8kV loss-of-source load shedding
- Restoration of 480V loads.
- Load imbalance load shedding at the 480V or 13.8kV level.
- Capacity based load shedding.
- Reactive tie line control.
- 480V breaker shed and restoration control at the building level (19 remote locations).
- Operator assigned breaker priority.
PMS Major Functions

PMS – Power Management System

- Black Start Sequencing.
- Parallel/Islanding Sequencing to automatically sequence breakers and generators.
- Automatic synchronization.
- Import / Export Control and Spinning reserve maintenance.
- Chiller load inhibiting.
- Inter CUP Load Sharing.
- Proactive Tie Line Control.
- Bumpless transfer between manual and automatic generator control.
- Manual synchronization.
Manual Control Panel

- Equipped with analog meters, status lights, and physical switches.
- Allows operators to perform manual breaker control and synchronization of generators, bypassing the LMS and PMS for added redundancy.
- Five (5) separate sections:
  - Main Synch Panel
  - CUP-1 Synch Panel
  - CUP-2 Synch Panel
  - CUP-1 Generator Panel
  - CUP-2 Generator Panel
1. CUP1 Generator Control
2. CUP1 Manual Sync Control
3. Main Sync Control
4. CUP2 Manual Sync Control
5. CUP2 Generator Control
Building Load Shed Control

- Nineteen (19) control panels located at each remote building.
- Communicates with PMS/LMS over an Ethernet Ring over Fiber.
- Trips and closes building level breakers based on load shed sequence logic resides in LMS/PMS.
- Each panel has its own PLC processor for added redundancy.
Summary of Microgrid Controls and Automation Equipment

- **Plant Control System (PCS) CUP-2:**
  - one (1) redundant ControlLogix PLC
  - four (4) remote IO (RIO) panels

- **PMS/LMS CUP-1:**
  - one (1) RIO panel (PMS)
  - one (1) ControlLogix PLC panel (LMS)

- **Manual Control Panel:**
  - Five (5) section enclosure
  - one (1) Redundant ControlLogix PLC panel (PMS)

- **PMS/LMS CUP-2:**
  - one (1) RIO panel (PMS)
  - one (1) ControlLogix PLC panel (LMS)

- **Remote Buildings:**
  - nineteen (19) CompactLogix PLC panels w/ local displays

- **CVG:**
  - one (1) CompactLogix PLC
Microgrid Controls Operator Interface
Microgrid Controls Operator Interface
Microgrid Controls Operator Interface
## Microgrid Controls Operator Interface

### Building Breaker Configuration

There are no stored records available.

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**Reconfig 400V Breakers Enb**

**Reconfiguration Enable**
- Enabled

**20 Min Load Restore Threshold**
- Pri: 14

**Sort Mode**
- Priority

**Service Name Descriptions**
- THERMO SYSTEMS

**www.thermosystems.com**
Case Study #2

University of Minnesota
Minneapolis, MN
- 25 MW Combustion Turbine Generator
- 13.8 kV Main Switchgear
- Eleven (11) 13.8kV feeder breakers to CHP plant and campus loads
- Connected to Utility (XCEL) via two (2) main breakers
- Load Management System (LMS)
- Power Management System (PMS)
- Synchronizing Panel
LMS – Load Management System

- 13.8 kV feeder breaker load shed control with priority assignment
- Bus and electrical load distribution connection state management
- Ampacity (A) based load shed response
- Frequency (Hz) based load shed response
- Capacity (kW) based load shed response
- Dead bus detection
PMS – Power Management System

- Manual restoration of feeder breakers after load shed event
- Feeder breaker restoration calculation – advisory only
- Plant kW export control with minimum generator load override
- Monitoring and alarming of main switchgear
Synchronizing Panel

- Monitoring and control of the medium-voltage distribution system and onsite generation system.
- Connect and integrate local control between the switchgear, generator, tie breakers, and CTG generator control panels.
- Provide manual and automatic synchronization of generator.
Summary of Microgrid Controls and Automation Equipment

- **Plant Control System (PCS):**
  - one (1) redundant ControlLogix PLC
  - Seven (7) remote IO (RIO) panels

- **PMS/LMS:**
  - one (1) enclosure housing both LMS and PMS ControlLogix PLCs

- **Synchronizing Panel:**
  - One (1) control panel with synchronizer and manual lights and switches.
Microgrid Controls Architecture

Load Management System IO Rack

ETAP

Open Port for Field Programming

To PCS BOP

UMI-PMU Local HMI

To PCS BOP

Power Management System IO Rack

Slot 15
Modbus TCP/IP Communication Module
Slot 16
GPS Time Synchronisation Module

ETAP

Modbus TCP/IP Switch

To PCS SCADA
PCS-BM-01
(See Note #2)

NIB COAX Cable
with BNC Connector

To UMinn Electrical
SCADA System GPS
Time Source

(See Note #1)

Notes:
1. IP addresses to be coordinated with UMinn Electrical SCADA system
2. Connection provides NTP time source to PCS domain controller which will propagate time to all other PCS servers and workstations.
3. All interconnect cables shown on this drawing is copper Cat5E unless otherwise noted.
• Systems can become very complex.

• Keeping it simple enough to operate, yet robust enough to handle many different operating and failure scenarios.

• Contractual/interconnect agreement with utility provider can become a constraint in the design of a microgrid control system.
Testing and commissioning of systems can be difficult to coordinate to cover all failure scenarios.

Requires partnership between in house electrical systems expertise and control systems vendors with microgrid and power management experience.
The addition of a LMS/PMS microgrid control system provides fast response to minimize generation overload and critical equipment power loss.

- PLC based LMS/PMS can respond quickly from detection of generation loss to shedding of breakers (< 50 msec). 

- Automatic breaker restoration control, if required, can ensure power to critical areas be restored within a short window (< 10 sec) of power loss.
• Manual Control Panel provides operational resiliency, allowing operators to control the generation manually, if required.

• Integration with all generators, protective relays and power meters into a single operator interface allows operators to monitor and operate the system efficiently and reliably.
Q & A