MICROGRID CONTROLS

IDEA 2016 ANNUAL CONFERENCE

THERMO SYSTEMS
INDUSTRIAL AUTOMATION & INFORMATION

www.thermosystems.com

AGENDA

- Overview
- Case Study #1 – FDA Campus
- Case Study #2 – University of Minnesota
- Challenges
- Recap/Takeaways

OVERVIEW

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.

OVERVIEW

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.

OVERVIEW

Key Design Considerations

- Response Time
- Level of Redundancy
- Operator Interface
- Manual Control
- Contractual / Interconnect Agreement with Utility Provider

Case Study #1

FDA Campus
White Oak, MD

FDA Central Utility Plant (CUP)

FDA White Oak Campus

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

SE Quad
(19) Bldg. Breakers

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

FDA Microgrid Control Systems

- Load Management System (LMS)
- Power Management System (PMS)
- Manual Control Panel
- Building Load Shed Systems

LMS Major Functions

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

Manual Control Panel

1. CUP1 Generator Control
2. CUP1 Manual Sync Control
3. Main Sync Control
4. CUP2 Manual Sync Control
5. CUP2 Generator Control

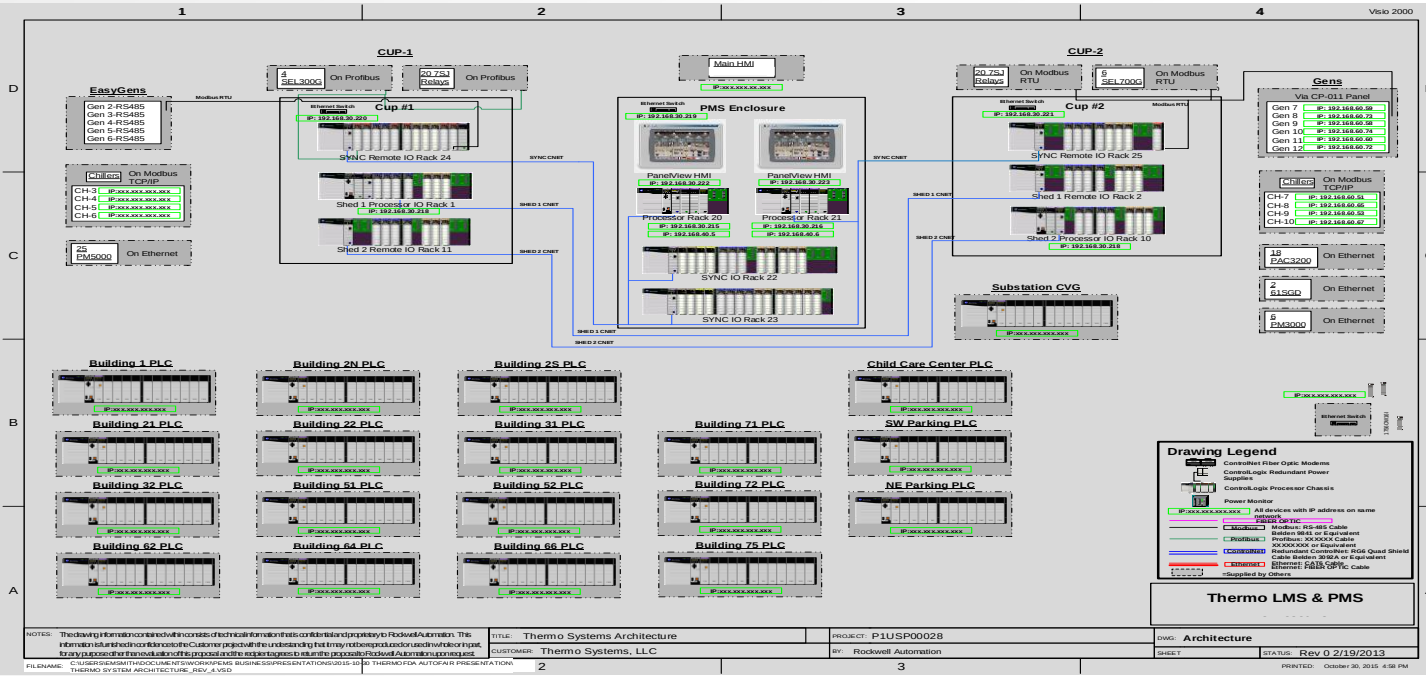
Building Load Shed Control

- 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.

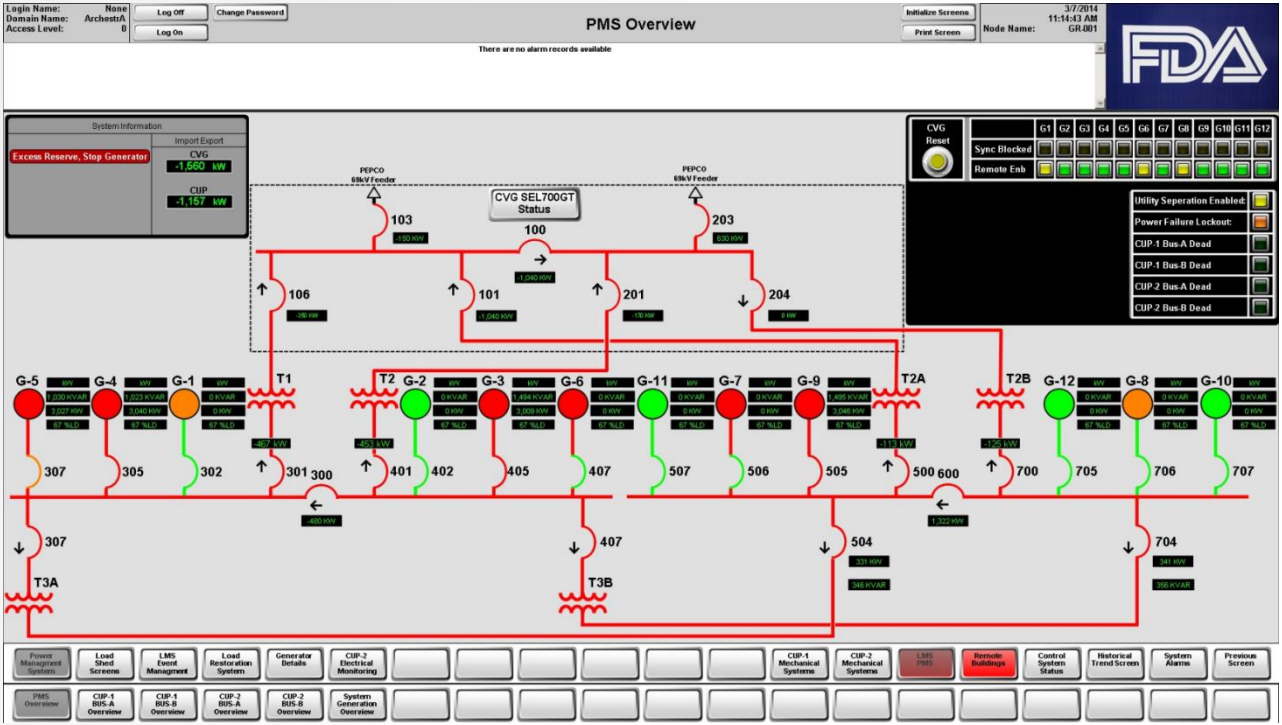
Summary of Microgrid Controls and Automation Equipment

- 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

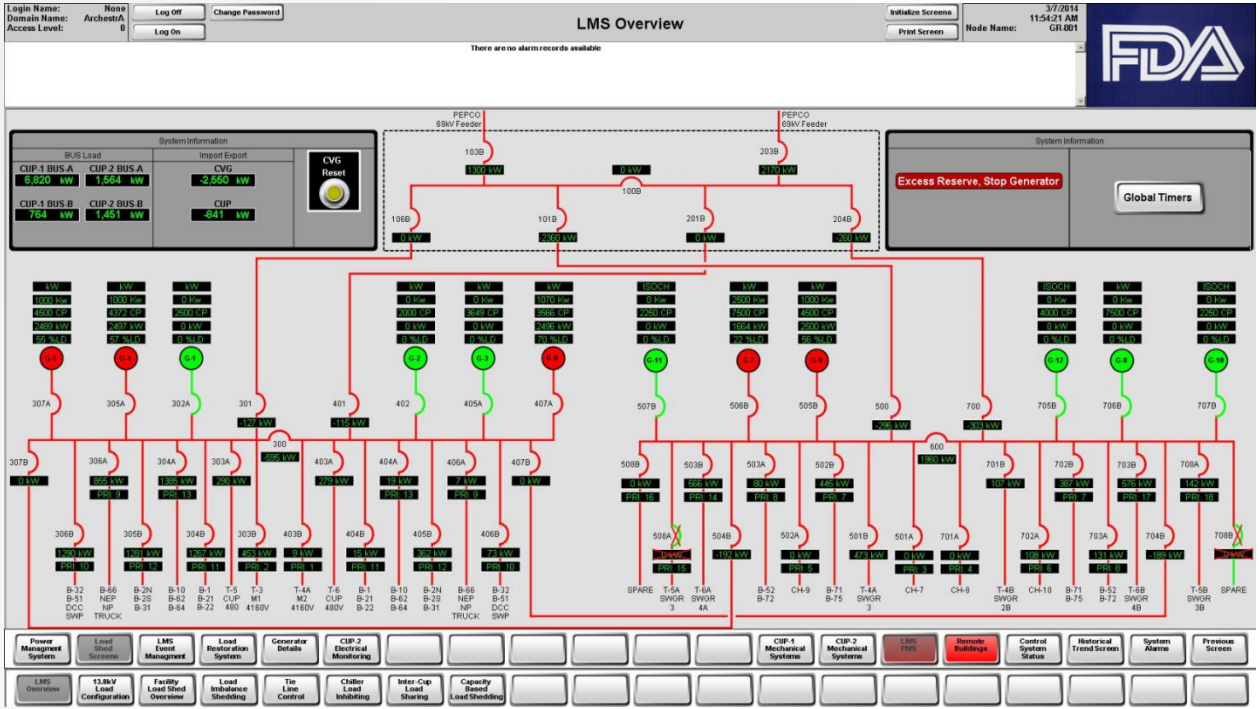
Microgrid Controls Architecture



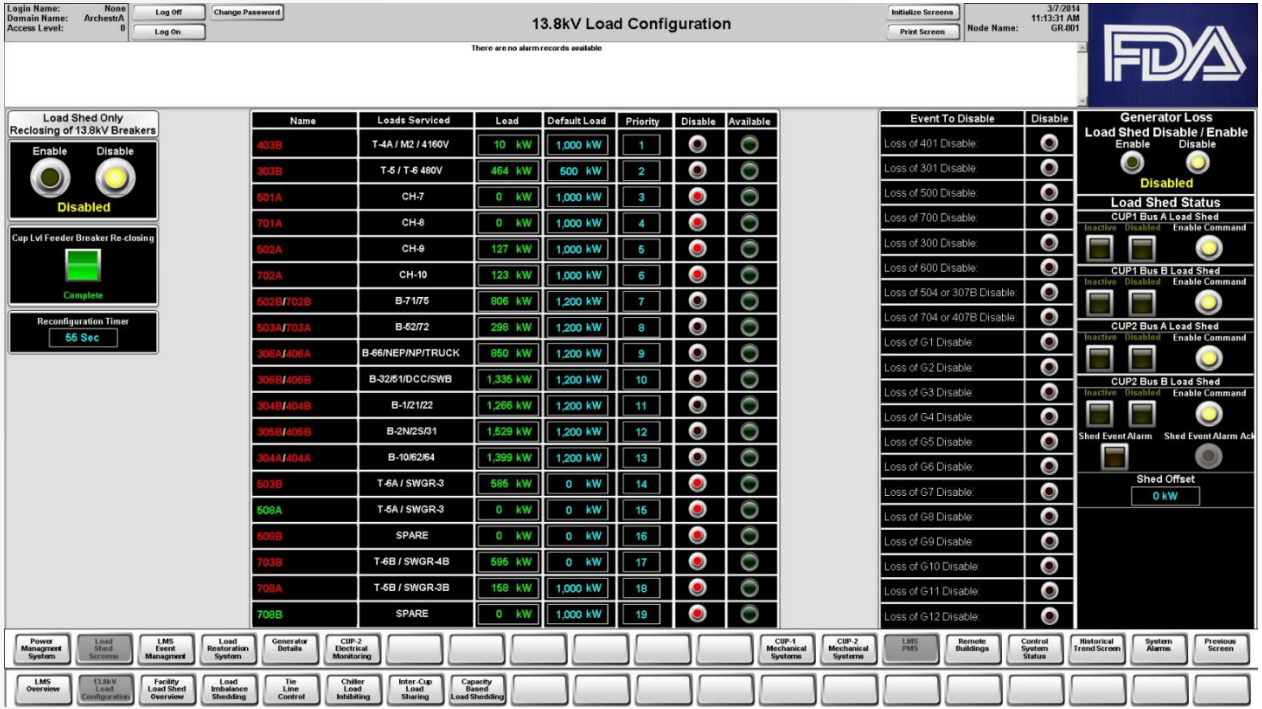
Microgrid Controls Operator Interface



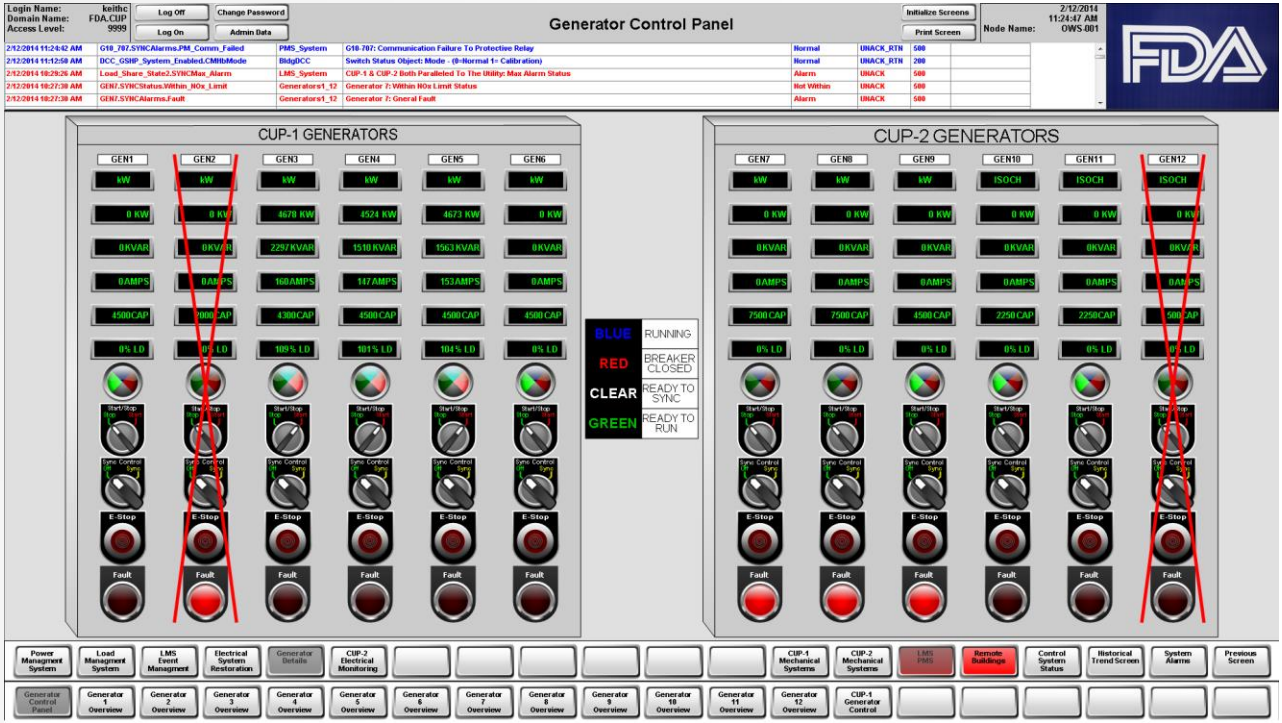
Microgrid Controls Operator Interface



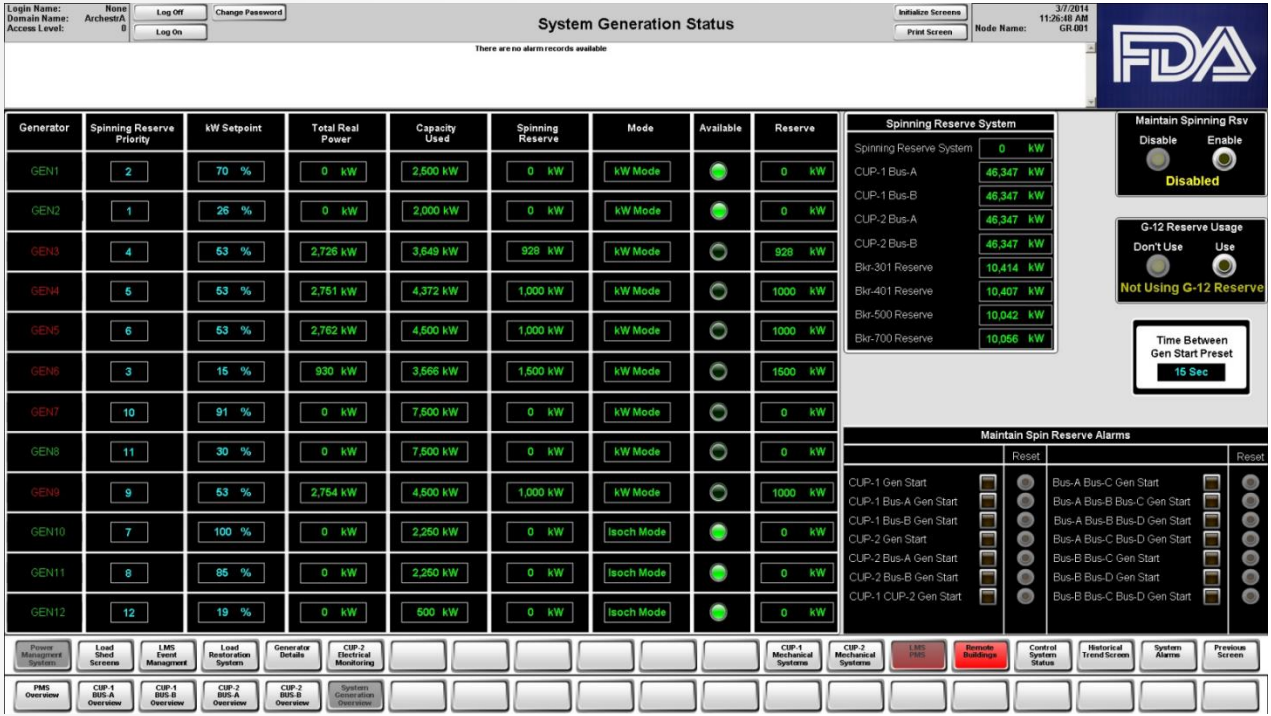
Microgrid Controls Operator Interface



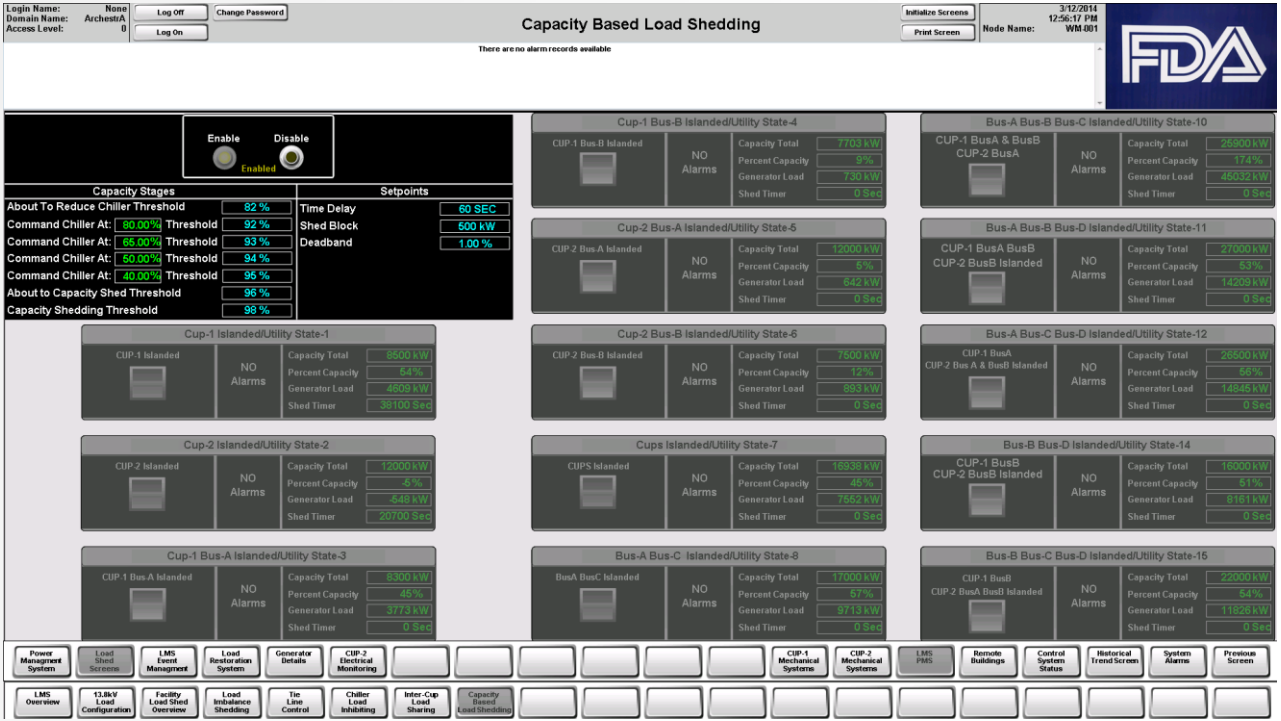
Microgrid Controls Operator Interface



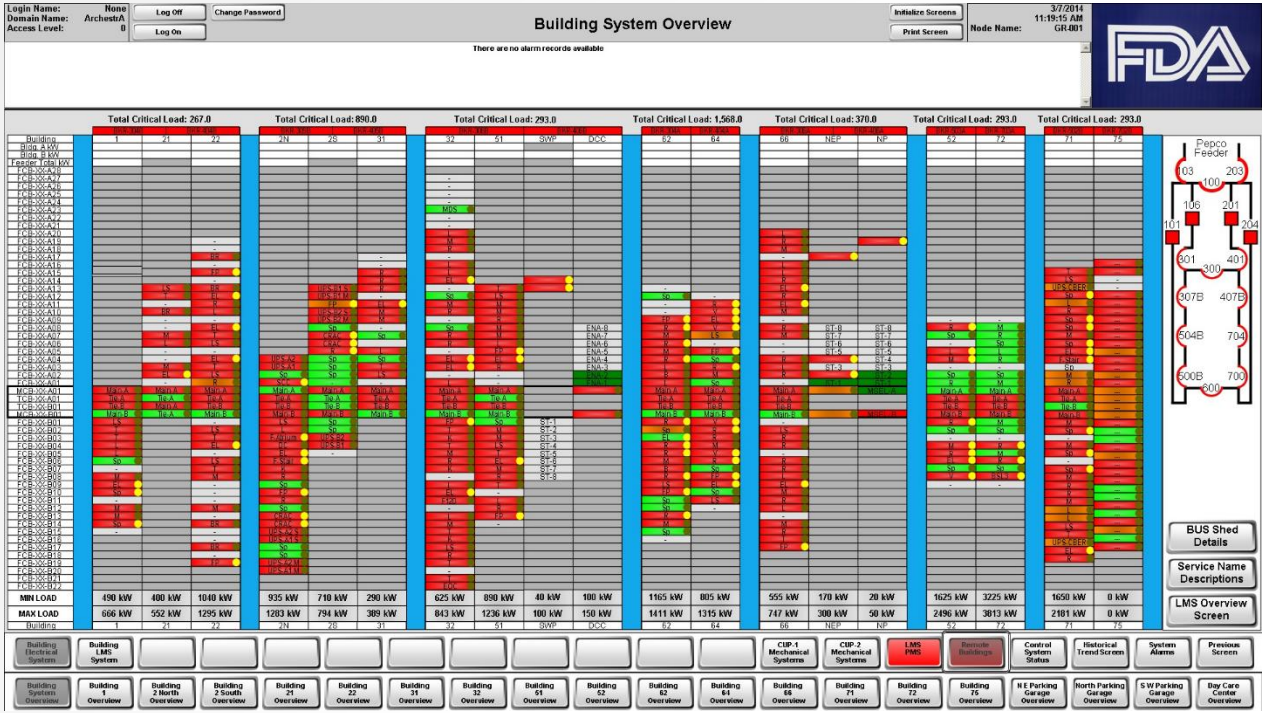
Microgrid Controls Operator Interface



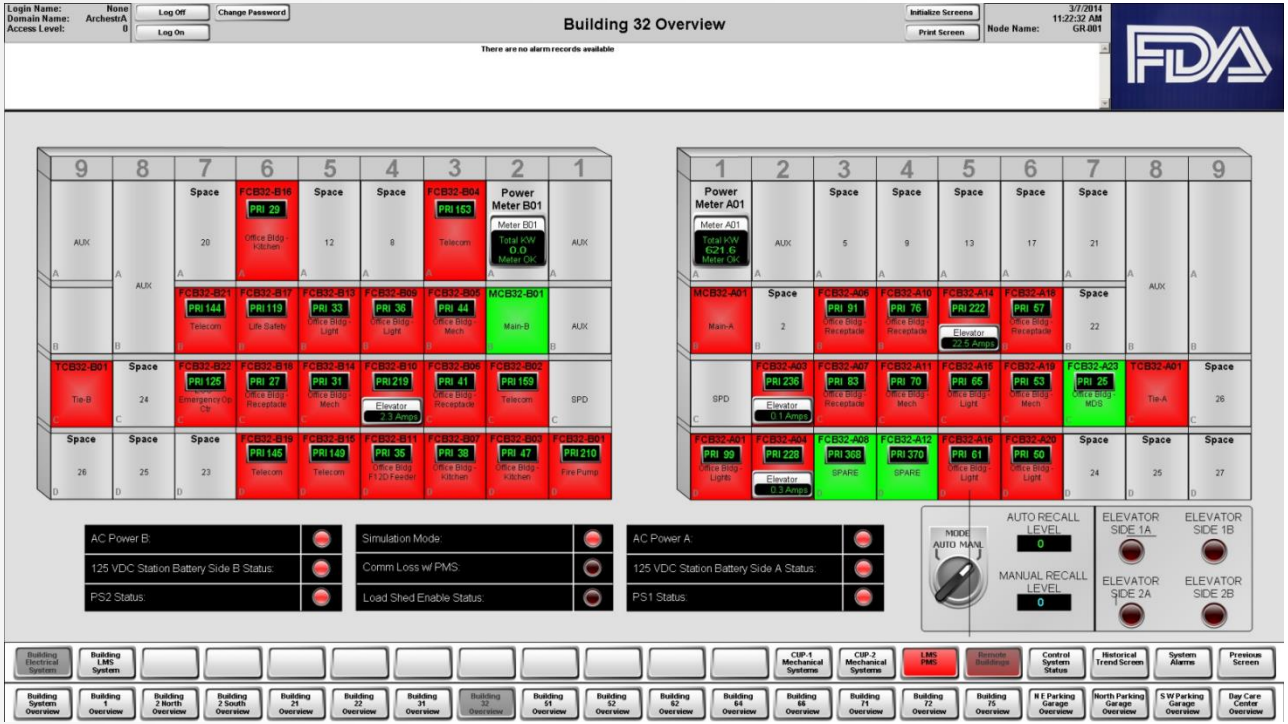
Microgrid Controls Operator Interface



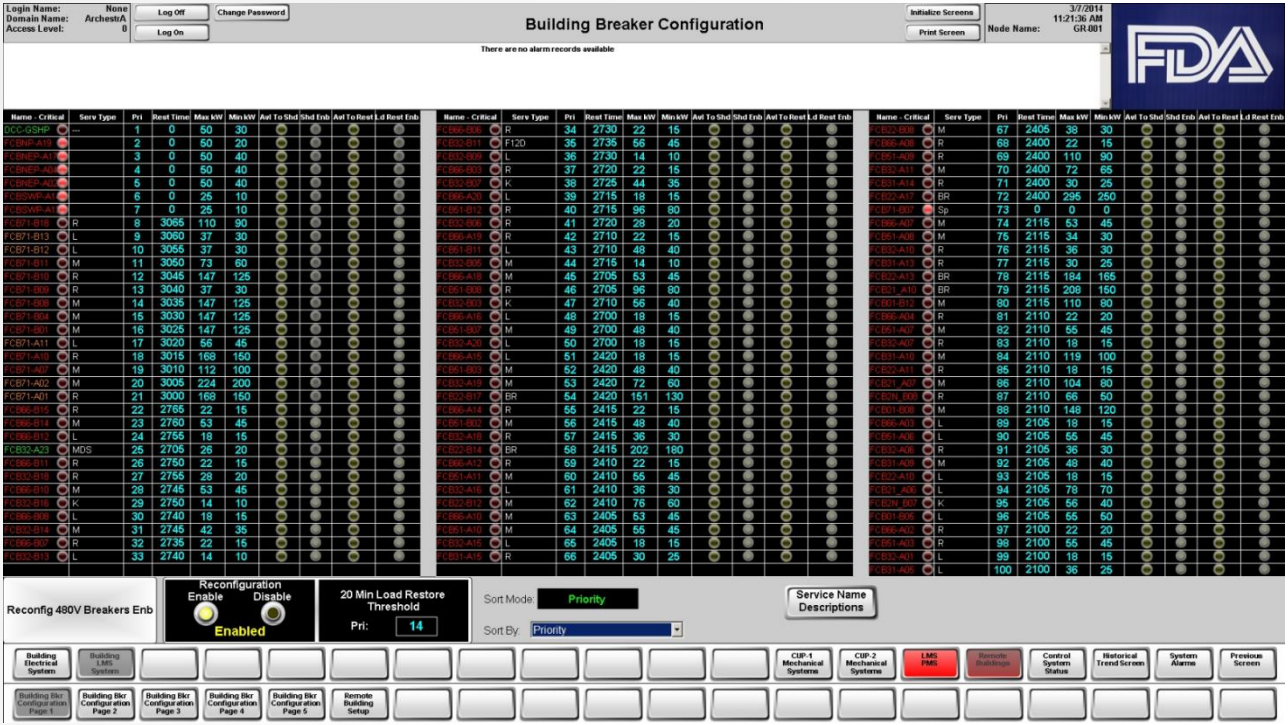
Microgrid Controls Operator Interface



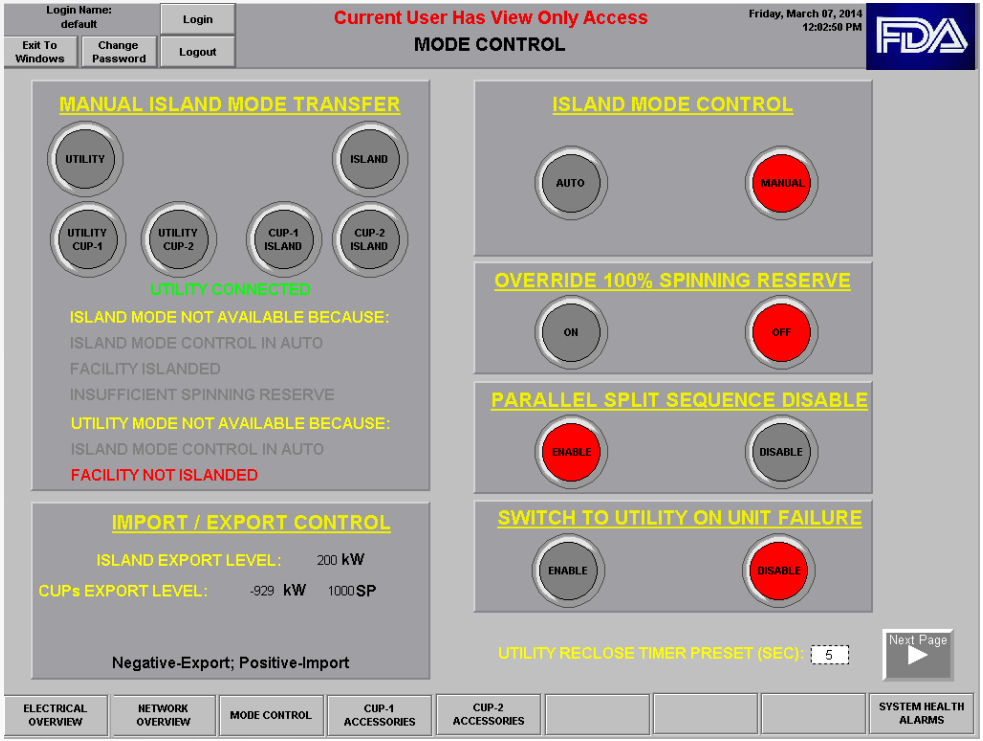
Microgrid Controls Operator Interface



Microgrid Controls Operator Interface



Microgrid Controls Operator Interface



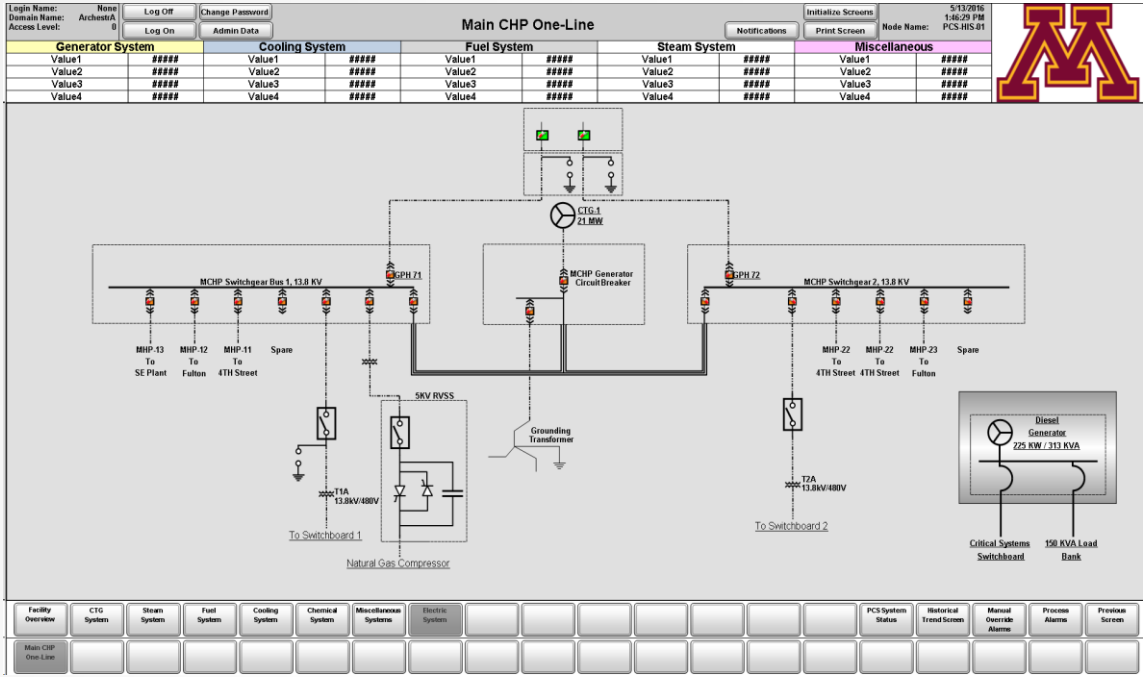
Case Study #2

University of Minnesota
Minneapolis, MN

U of Minn CHP System

- 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

Single Line Diagram



U of Minn Microgrid Control Systems

- Load Management System (LMS)
- Power Management System (PMS)
- Synchronizing Panel

LMS Major Functions

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 Major Functions

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

PMS Major Functions

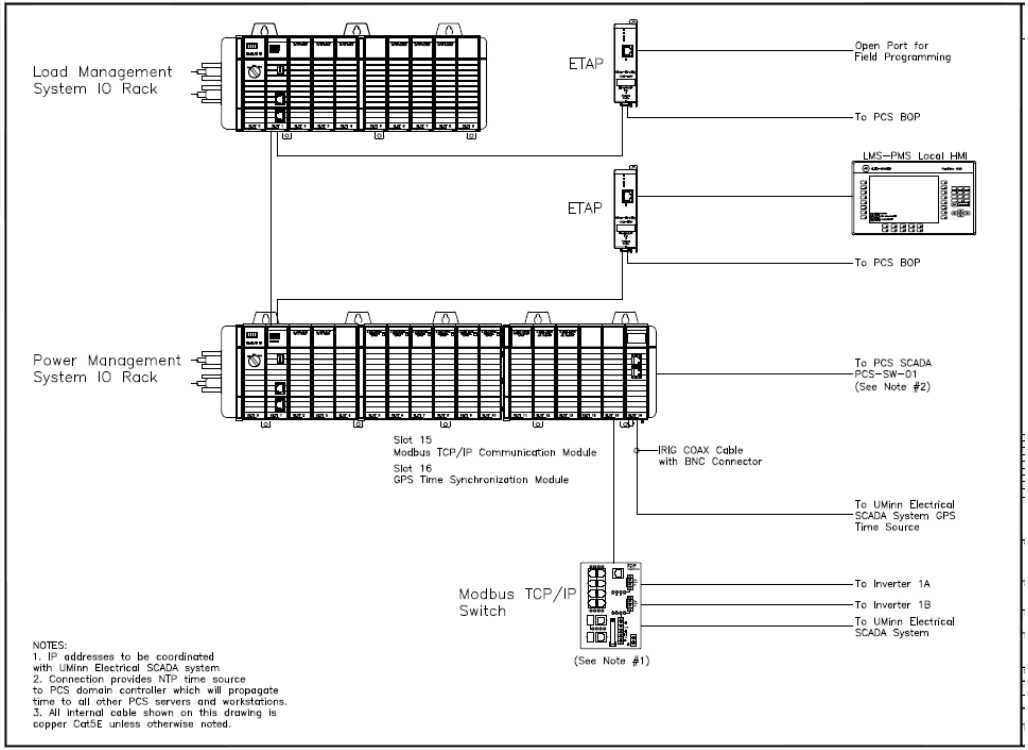
Synchronizing Panel

- 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



CHALLENGES

- 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.

CHALLENGES

- 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.

RECAP & KEY TAKEAWAYS

- 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.

RECAP & KEY TAKEAWAYS

- 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 operator the system efficiently and reliably.

Q & A