Penn State Health Milton S. Hershey's Medical Center

CHP Implementation Challenges

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design/construction solutions

Agenda

- Overview of Activities on Campus
- Physical Plant to Support
- Energy Profiles
- Project Objectives
- Introduction to HMC CHP Plant
- HMC Distribution System & CHP Interconnection Challenges
- Existing Switchgear Replacement
- 69kV Substation Existing Protection Upgrade
- CHP Electrical Design

Penn State Health Milton S. Hershey Medical Center

- Academic Medical Center
  - Hospital
    - Level 1 Trauma Center Adult & Pediatric
    - 548 Beds
  - College of Medicine
    - Medical Students (150 students/class)
    - Physicians Assistants
    - Graduate Degrees in medical research
    - $100 million in external research support

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Milton S. Hershey Medical Center

- 4.5M square feet of buildings
- 3.6M square feet of conditioned space
- 550 Acre Campus
- 112,000,000 kWh annually
- 573,000 MMBtu natural gas annually

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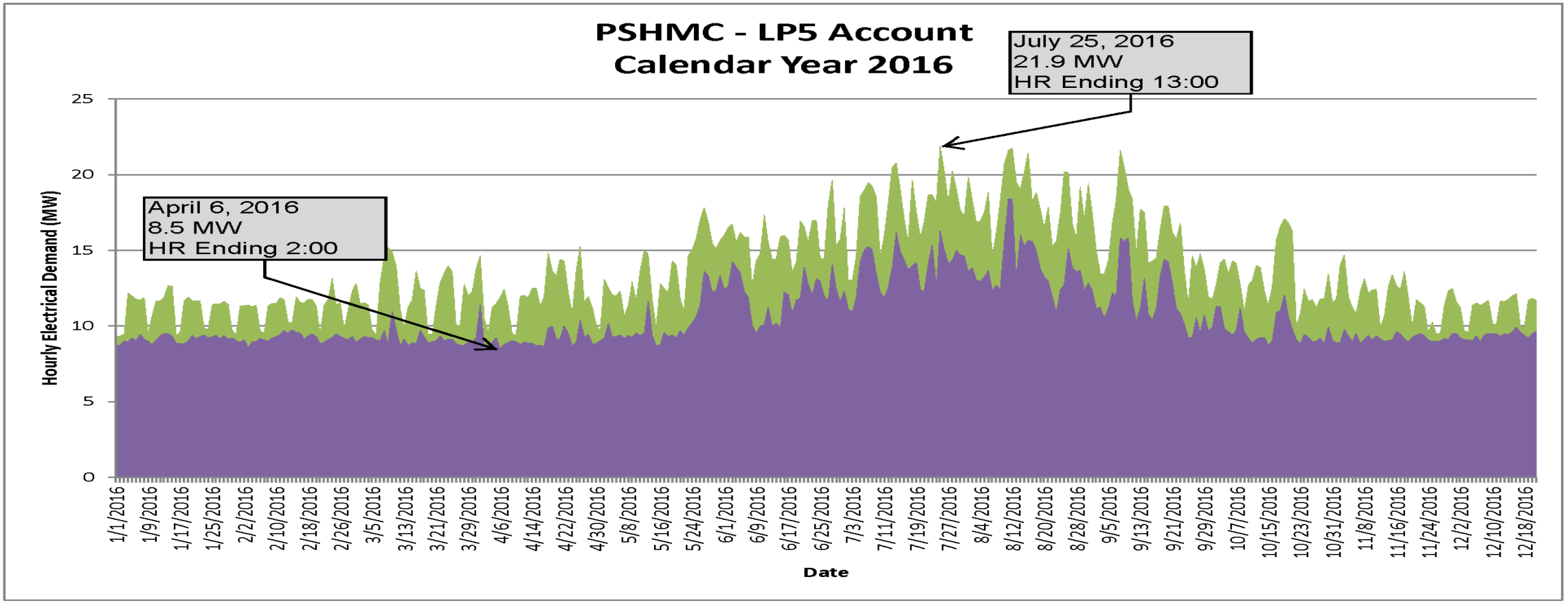
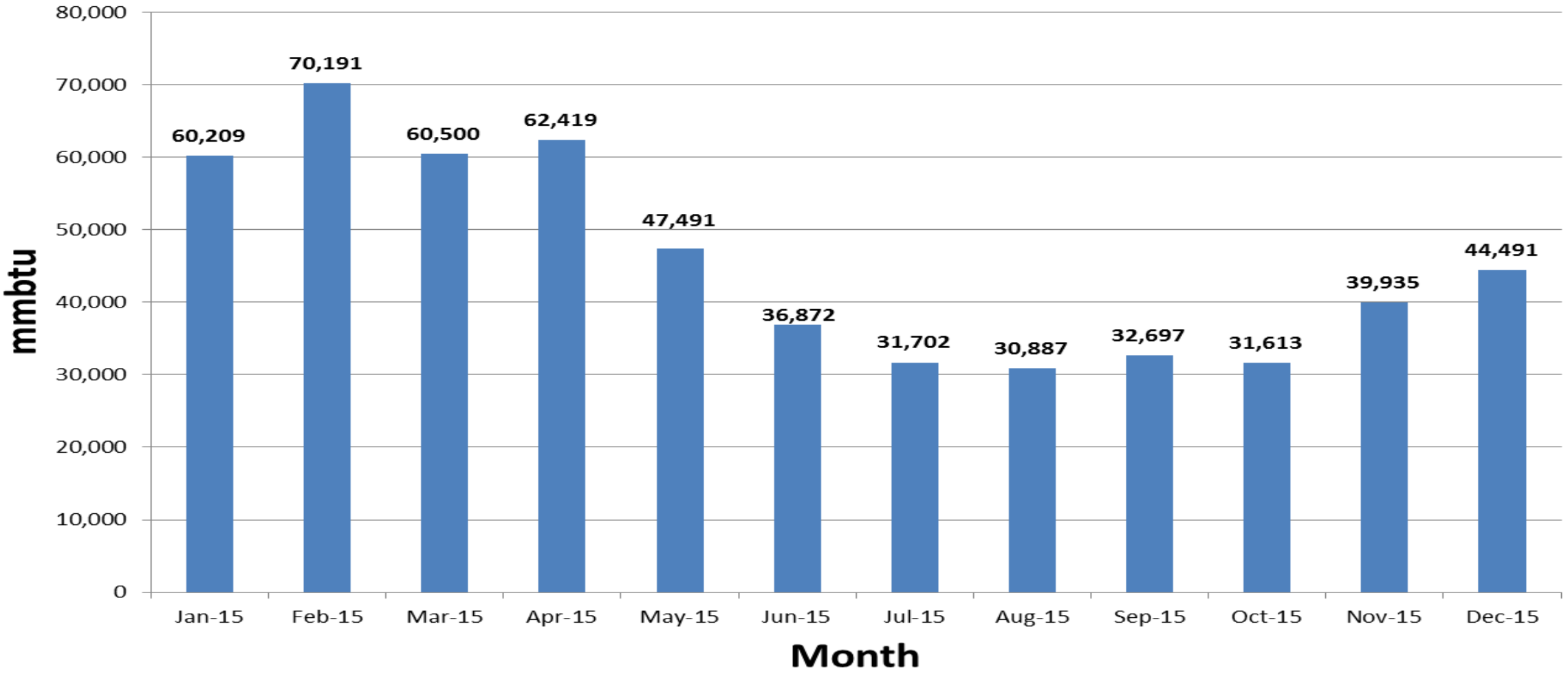
Electric Demand
Daily Max/Min



PSHMC Natural Gas



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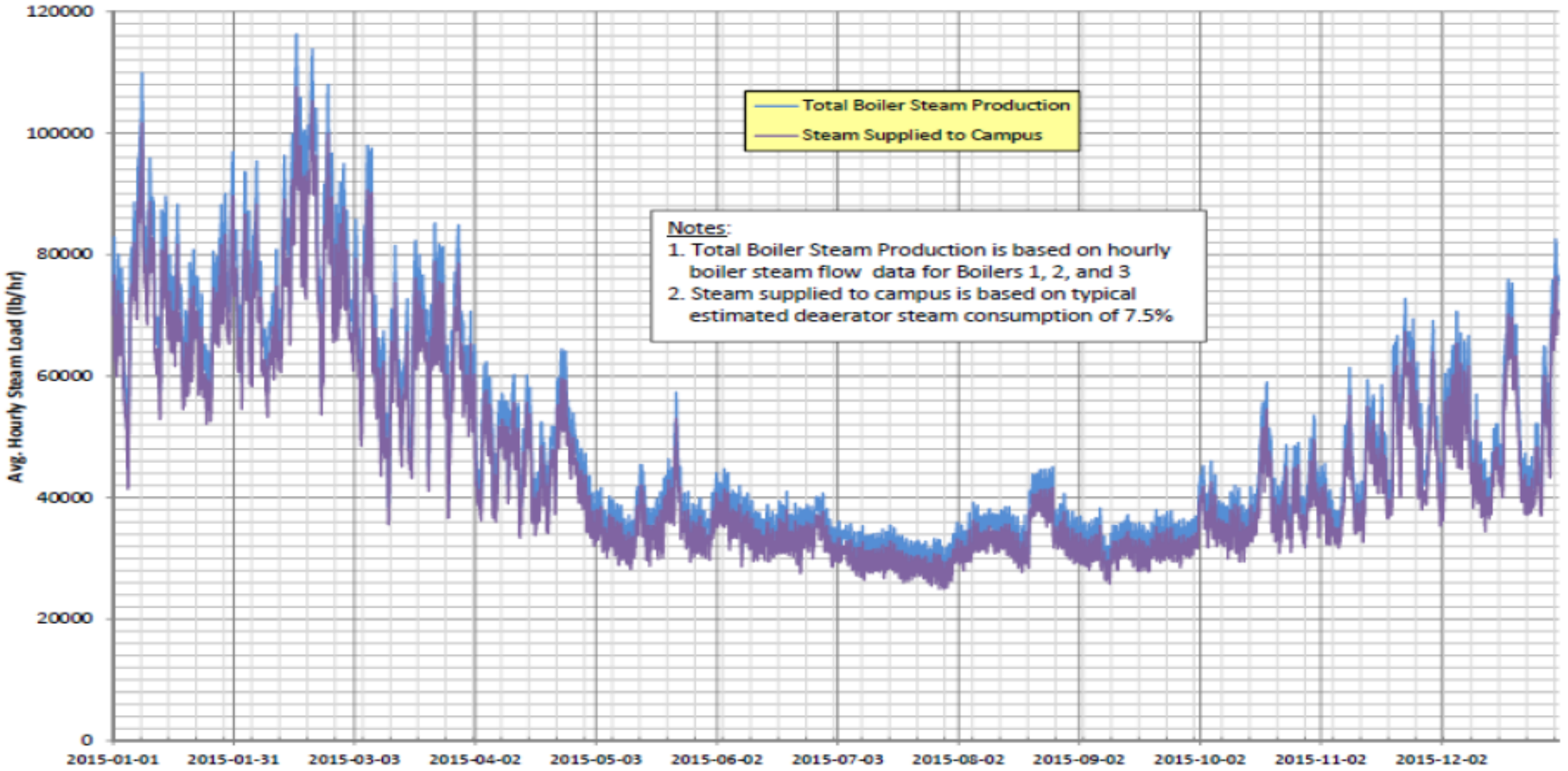
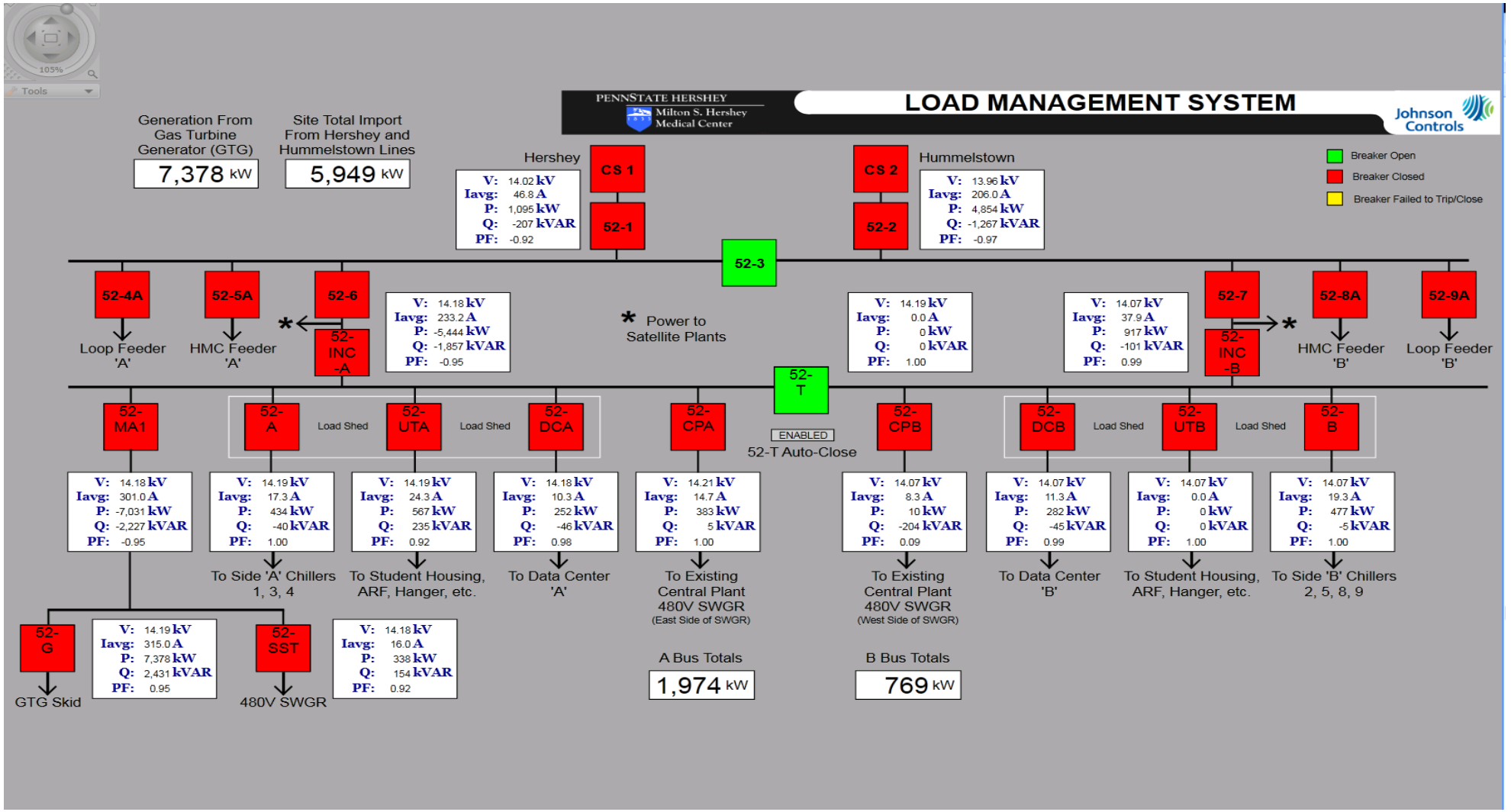
Hourly Steam Load Profile – 2015



Load Management System



Project Goals

- Reduce Annual Operating Costs
- Increase Resilience & Reliability
- Reduce Campus Carbon Footprint

Built CHP Plant

Project Overview

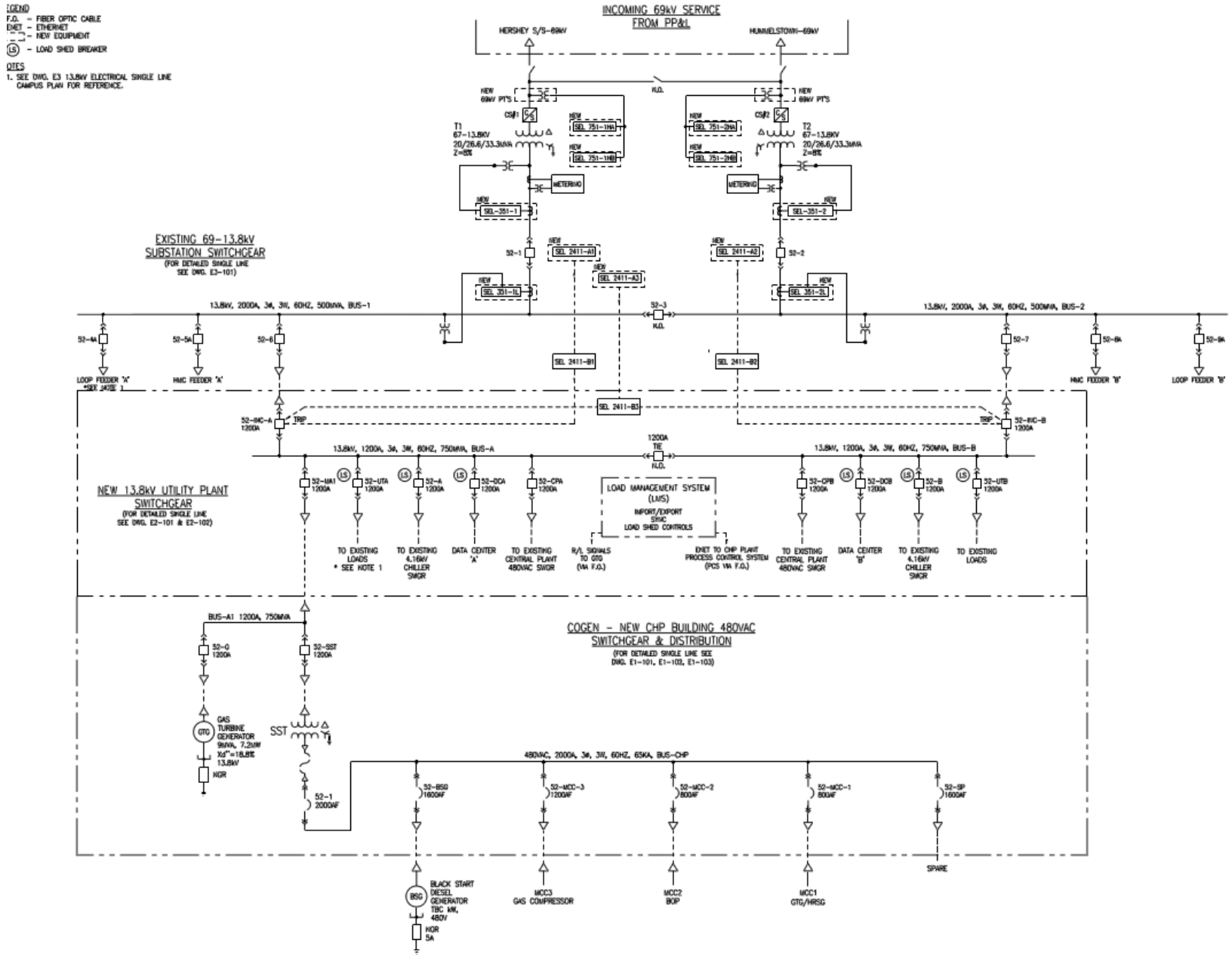
- 7.9 MW natural gas fired **Solar Turbine Taurus 70** combustion gas turbine
- **Heat Recovery Steam Generator** 80,000 lb/hr fired
- **10,500 SF Building**

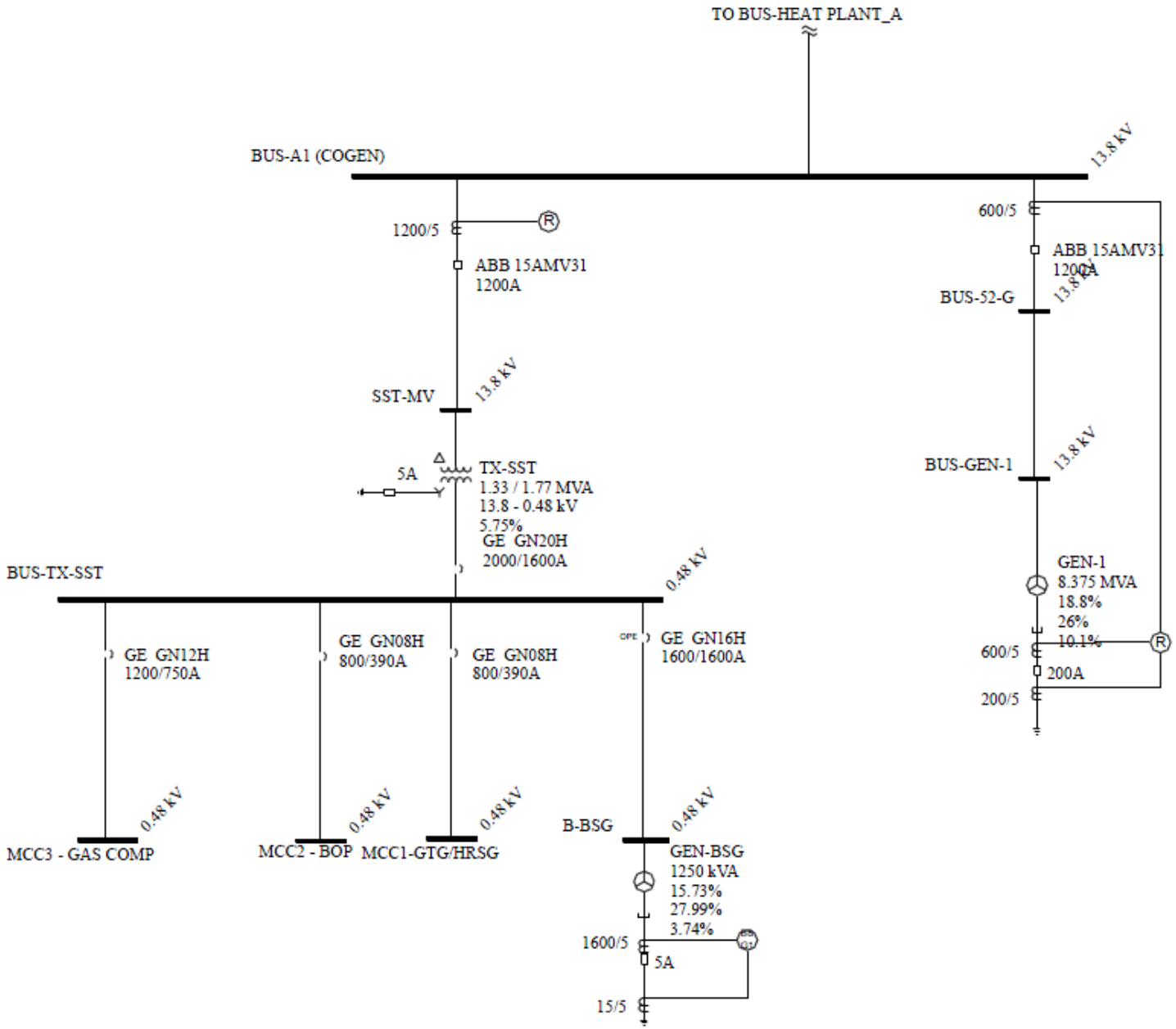
HMC Distribution System & CHP Interconnection Challenges

- Main 69kV substation feeding the central utility building, stepped down to 13.8kV to campus wide distribution system
- Central Plant existing switchgear, had no spare breaker to connect the CHP
- Existing protection in the 69kV switchgear and central plant 13.8kV switchgear protection not enough
- 69kV substation utility requirements to be implemented. 59N3V0 to be implemented thus requiring new PTs
- New protection panel incorporated to provide relays to implement IEEE 1547-2018 requirements
- Redundant CTs required by PPL in the 69kV switchgear

HMC Distribution System & CHP Interconnection Challenges

- Central Plant new switchgear clearance requirements
- Space constraints and clearances made the switchgear one high
- Switchgear replacement done in phases, by replacing half of the 13.8kV switchgear and making use of the tie breakers downstream at the 480V level
- The switchgear was commissioned once installation was complete
- Replacement of the switchgear helped achieve dynamic loadshedding using a Load Management System
- The relay programming logic was very complicated to cover all the protection, synching scenarios


LEGEND
F.O. - FIBER OPTIC CABLE
ENET - ETHERNET
- NEW EQUIPMENT
LS - LOAD SHED BREAKER
NOTES
1. SEE DWG. E3 13.8kV ELECTRICAL SINGLE LINE CAMPUS PLAN FOR REFERENCE.
INCOMING 69kV SERVICE FROM PP&L
HERSHEY S/S-69kV
HUMMELSTOWN-69kV
N.O.
T1 67-13.8kV 20/26.6/33.3MVA Z=8%
T2 67-13.8kV 20/26.6/33.3MVA Z=8%
METERING
EXISTING 69-13.8kV SUBSTATION SWITCHGEAR
(FOR DETAILED SINGLE LINE SEE DWG. E3-101)
13.8kV, 2000A, 3ø, 3W, 60HZ, 500MVA, BUS-1
13.8kV, 2000A, 3ø, 3W, 60HZ, 500MVA, BUS-2
52-4A
52-5A
52-6
52-7
52-8A
52-9A
LOOP FEEDER 'A' *SEE NOTE 1
HMC FEEDER 'A'
HMC FEEDER 'B'
LOOP FEEDER 'B'
SEL 2411-B1
SEL 2411-B2
SEL 2411-B3
52-MC-A 1200A
52-MC-B 1200A
TRIP
13.8kV, 1200A, 3ø, 3W, 60HZ, 750MVA, BUS-A
13.8kV, 1200A, 3ø, 3W, 60HZ, 750MVA, BUS-B
1200A TIE N.O.
NEW 13.8kV UTILITY PLANT SWITCHGEAR
(FOR DETAILED SINGLE LINE SEE DWG. E2-101 & E2-102)
52-UA1 1200A
52-UTA 1200A
52-A 1200A
52-DCA 1200A
52-CPA 1200A
52-CPB 1200A
52-DCB 1200A
52-B 1200A
52-UTB 1200A
LOAD MANAGEMENT SYSTEM (LMS)
IMPORT/EXPORT SYNC
LOAD SHED CONTROLS
TO EXISTING LOADS * SEE NOTE 1
TO EXISTING 4.16kV CHILLER SWGR
DATA CENTER 'A'
TO EXISTING CENTRAL PLANT 480VAC SWGR
R/L SIGNALS TO GTG (VIA F.O.)
ENET TO CHP PLANT PROCESS CONTROL SYSTEM (PCS VIA F.O.)
TO EXISTING CENTRAL PLANT 480VAC SWGR
DATA CENTER 'B'
TO EXISTING 4.16kV CHILLER SWGR
TO EXISTING LOADS
COGEN - NEW CHP BUILDING 480VAC SWITCHGEAR & DISTRIBUTION
(FOR DETAILED SINGLE LINE SEE DWG. E1-101, E1-102, E1-103)
BUS-A1 1200A, 750MVA
52-G 1200A
52-SST 1200A
GTG GAS TURBINE GENERATOR 9MVA, 7.2MW Xd"=18.8% 13.8kV
NGR
SST
52-1 2000AF
480VAC, 2000A, 3ø, 3W, 60HZ, 65KA, BUS-CHP
52-BSG 1600AF
52-MCC-3 1200AF
52-MCC-2 800AF
52-MCC-1 800AF
52-SP 1600AF
SPARE
BSG BLACK START DIESEL GENERATOR TBC kW, 480V
NGR 5A
MCC3 GAS COMPRESSOR
MCC2 BOP
MCC1 GTG/HRSG


TO BUS-HEAT PLANT_A
BUS-A1 (COGEN)
13.8 kV
1200/5
ABB 15AMV31
1200A
600/5
ABB 15AMV31
1200A
BUS-52-G
13.8 kV
SST-MV
13.8 kV
5A
TX-SST
1.33 / 1.77 MVA
13.8 - 0.48 kV
5.75%
GE GN20H
2000/1600A
BUS-GEN-1
13.8 kV
GEN-1
8.375 MVA
18.8%
26%
10.1%
600/5
200A
200/5
BUS-TX-SST
0.48 kV
GE GN12H
1200/750A
GE GN08H
800/390A
GE GN08H
800/390A
GE GN16H
1600/1600A
0.48 kV
MCC3 - GAS COMP
MCC2 - BOP
MCC1-GTG/HRSG
B-BSG
GEN-BSG
1250 kVA
15.73%
27.99%
3.74%
1600/5
5A
15/5

69kV Substation Existing Protection Upgrade

- Multiple paths to synchronize
- Inclusion of 59N3V0 using a Y Y Gnd transformer
- Utility substation using older and standard distribution protection technology requiring CHP interconnection to be set very sensitively
- New protection panel installed with appropriate protective relays to satisfy utility requirements
- Load shedding by the Load Management System (LMS)

System Modelling

- A power system model was created to study the HMC distribution system and CHP interconnection
- Load flow analyses were used to verify existing system voltage performance issues during CHP trips and then evaluate the effectiveness of potential remedies
- Key issues to address were
  - Arc flash levels and coordination at the new Central Plant switchgear
  - Ground Fault Protection
- Corrective measures to study
  - Made use of modern solid state protective relays
  - Made use of NGR (Neutral grounding Resistor) to mitigate ground faults


PHASE A
SYNCHROSCOPE
PHASE C
LOAD MANAGEMENT SYSTEM
SEL-2030A
SYNCHROSCOPE PT SIGNALS
OFF
ON
FT-1-1
FT-1-2
SEL-2411B1
SEL-2411B2
SEL-2411B3

CHP Design Takeaways

- Get the Utility involved in earlier stage of the project probably during design process
- Commissioning and testing to be carried out thoroughly prior synchronization of the generator and energization of switchgear
- CHP Interconnection Protection – Utilize direct transfer trips/directional/differential line protection to provide better selectivity

Thank you.

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