Case Study – Portsmouth Naval Shipyard Resiliency Project

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Implementing Micro Grids

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History of the Cogeneration Plant

- Phase 1
  - Energy Efficiency
  - Boiler upgrades
  - Distribution upgrades
  - First Turbine

- Phase 2
  - Second Turbine
  - Diesel generators

Phase 3

Water and sewer

Condensate upgrades

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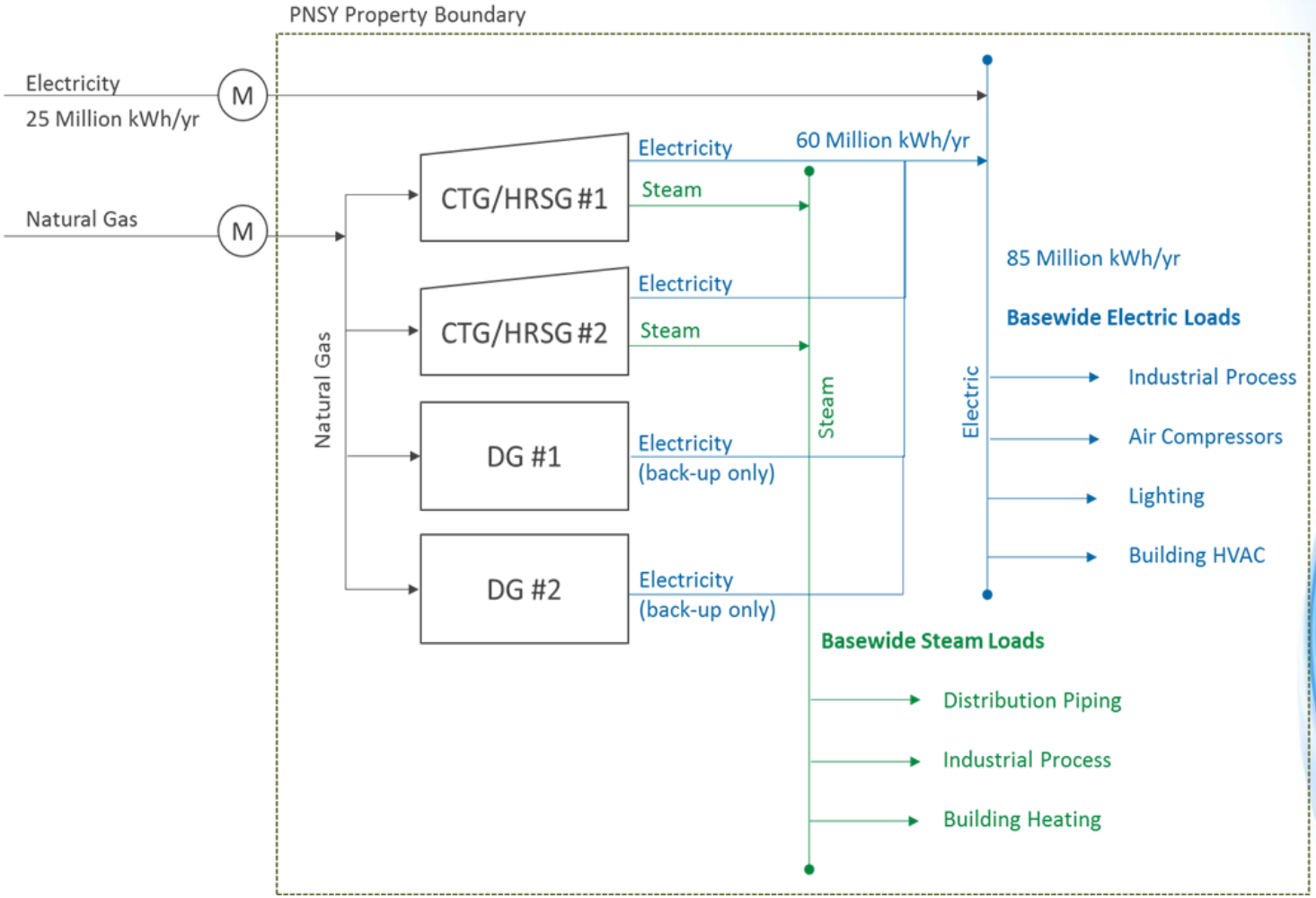
PNS Electric Supply



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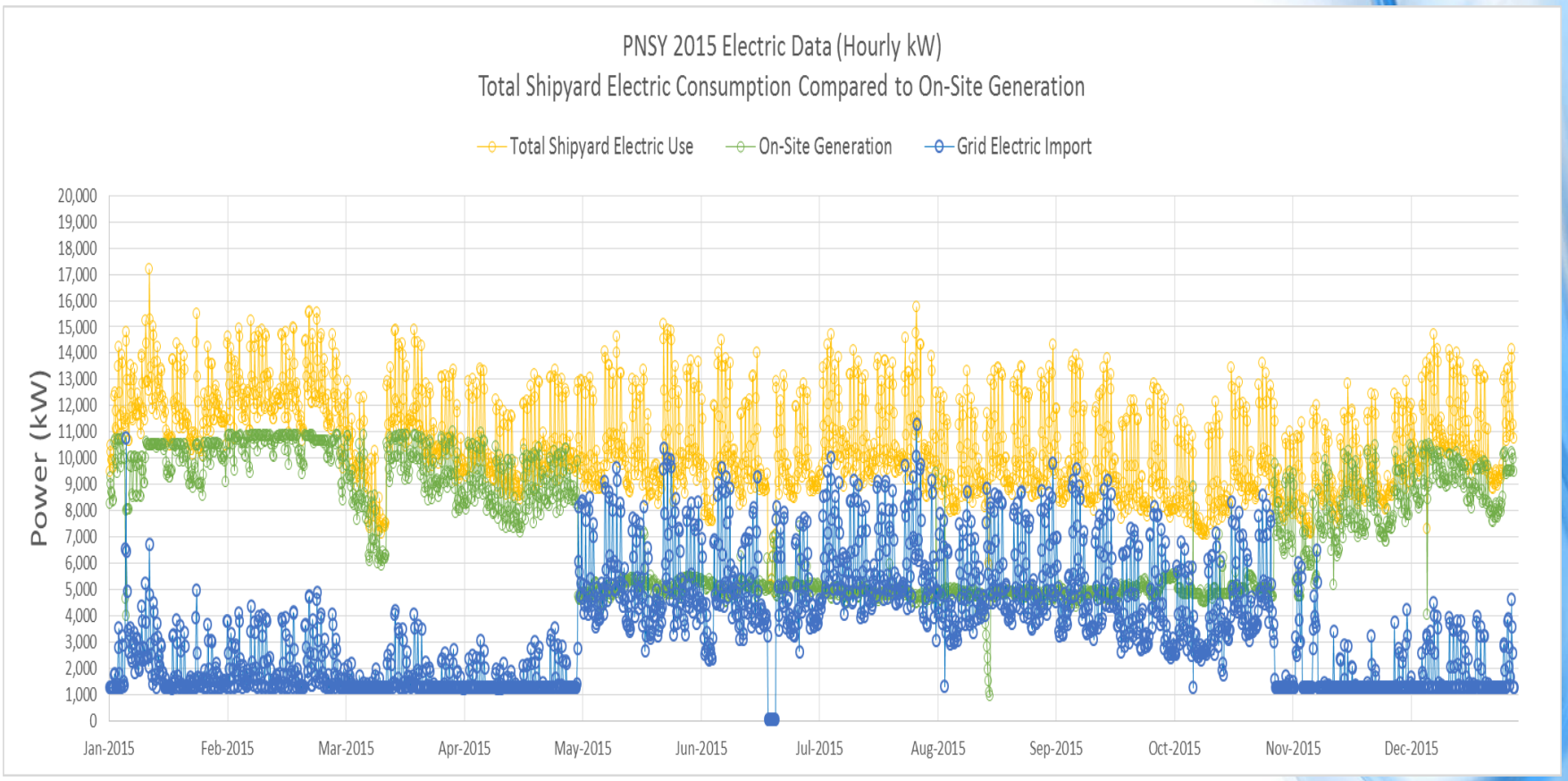
Shipyard Electric Demand (kW)



Problem and Microgrid Solution

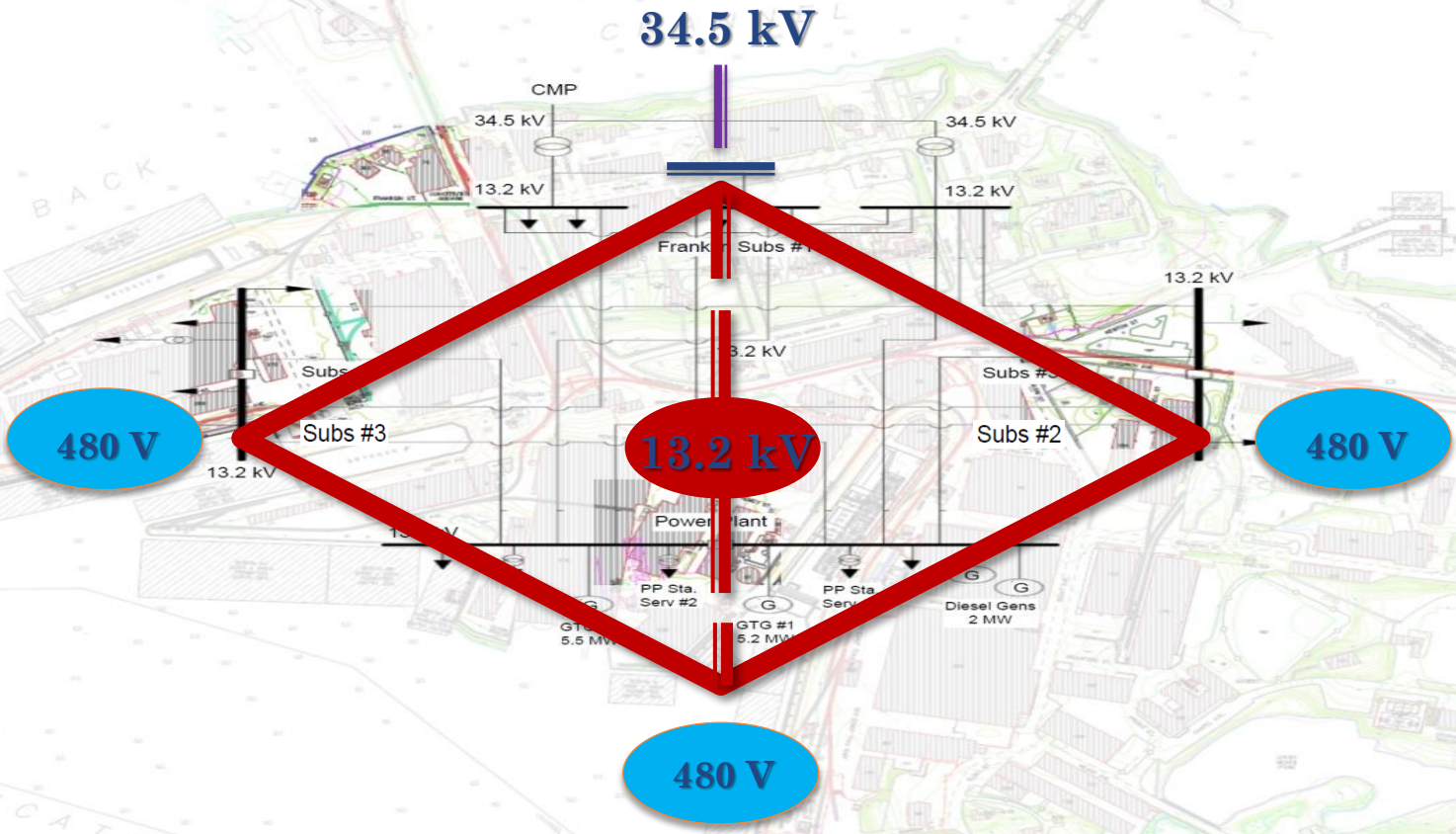
- **Problem:**
  - Shipyard CTG are overloaded when utility grid fails; trip off on internal safeties
  - Not taking full advantage of significant on-site generation capacity for critical loads
  - Traditional load shedding schemes operate too slowly to save on-site generation.

- **Solution:**
  - Very high speed load shedding is required to maintain gas turbine generation stability under fault conditions.
  - Microgrid Controls System (MCS) with intelligent fast load shedding

- **Major Benefits:**
  - Enhanced mission security at Shipyard
  - Reduce substantial cost associated with lost production during power outages
  - Reduces preemptive self-generation dispatching and associated emissions

Project supported by grant from DoD Environmental Security Technology Certification Program

TECHNOLOGY/METHODOLOGY DESCRIPTION



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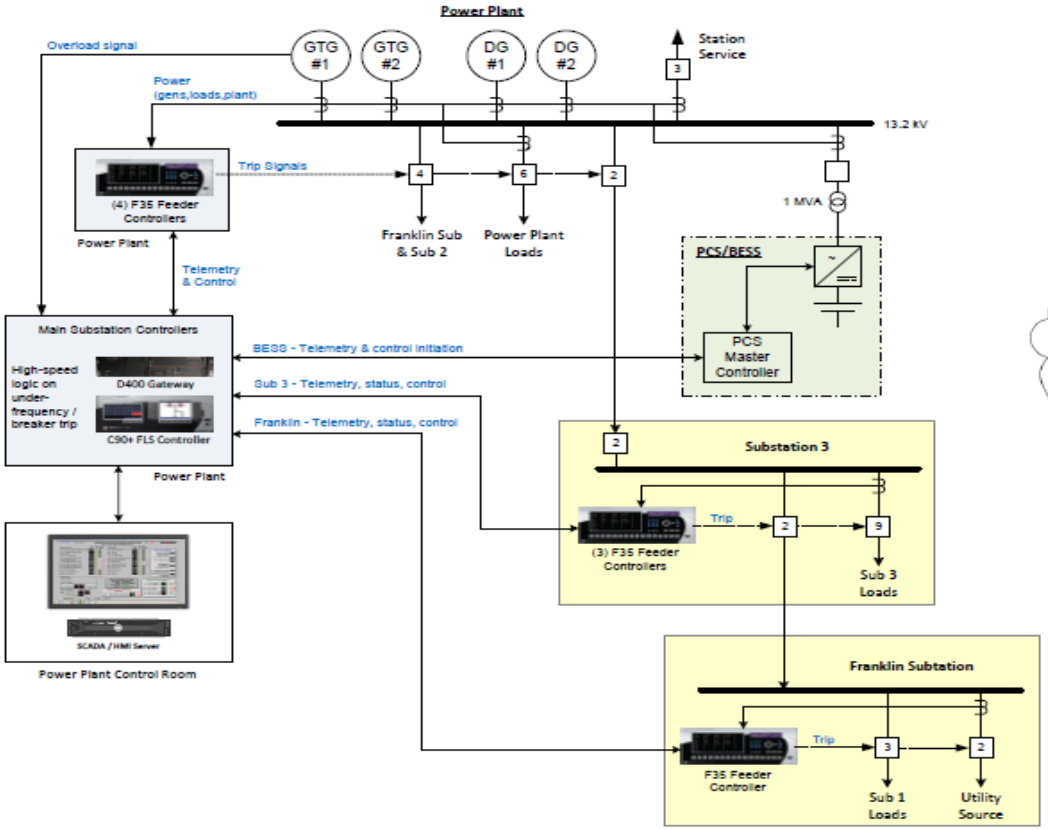
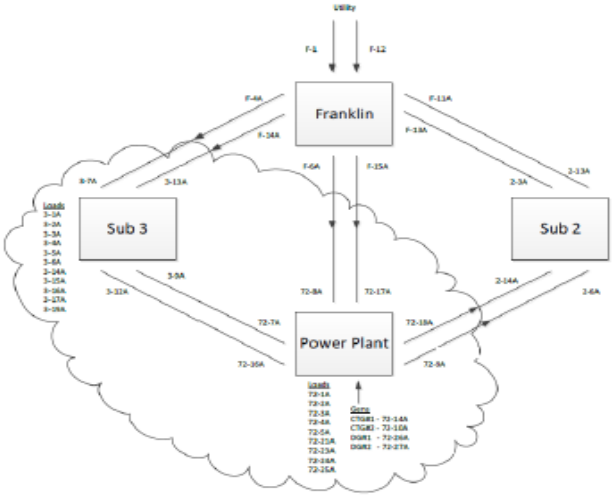
Portsmouth Naval Shipyard
Fast Load Shed System
Data and Control Scheme





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Fast Load Shed Approach -- Example

Priority No.	Load Served	kW
0	Never Shed (e.g. Power Plant Aux., Air Comp.)	3,000
1	Dry Dock #1	2,000
2	Dry Dock #2	1,200
3	Bldg.. 174	300
4	Weld Shop	500
5	Engineering Support Bldg..	700
. . . . .	. . . . .	. . . . .
24	Dry Dock #3 (Empty)	300
25	Substation 5	200
26	Bldg. 238	500
27	Substation 7	400
Total		**13,000**

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Fast Load Shed Response Time

#	Action	Response Time (mS)
1	Loss of Utility (LOU) detected by Relay F-35-1 at incoming utility breaker	Time "0"
2	F-35-1 sends LOU signal to C90	<1 ms
3	Calculations by C90 to determine which loads to shed; send System Island command to F-35 Relays controlling load breakers	<1 ms
4	System Island command received at farthest F-35 breakers through fiber optic switches	1.2 ms
5	Load Shed command issued by F-35 relays	2.0 ms
6	Breakers Open	32 ms
	Total Time from LOU detection to Load Shed	**36.4 ms**

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Performance Verification Testing

Simulation Testing

- Disable Tripping on Critical Feeders – Open Trip output on Test Switches
- Establish Summer and Winter Micro-grid Configurations
- Simulate a Loss of Power Initiation
- Outcome: Issues with load shed calculations. Corrections made and successfully retested.

Live Test

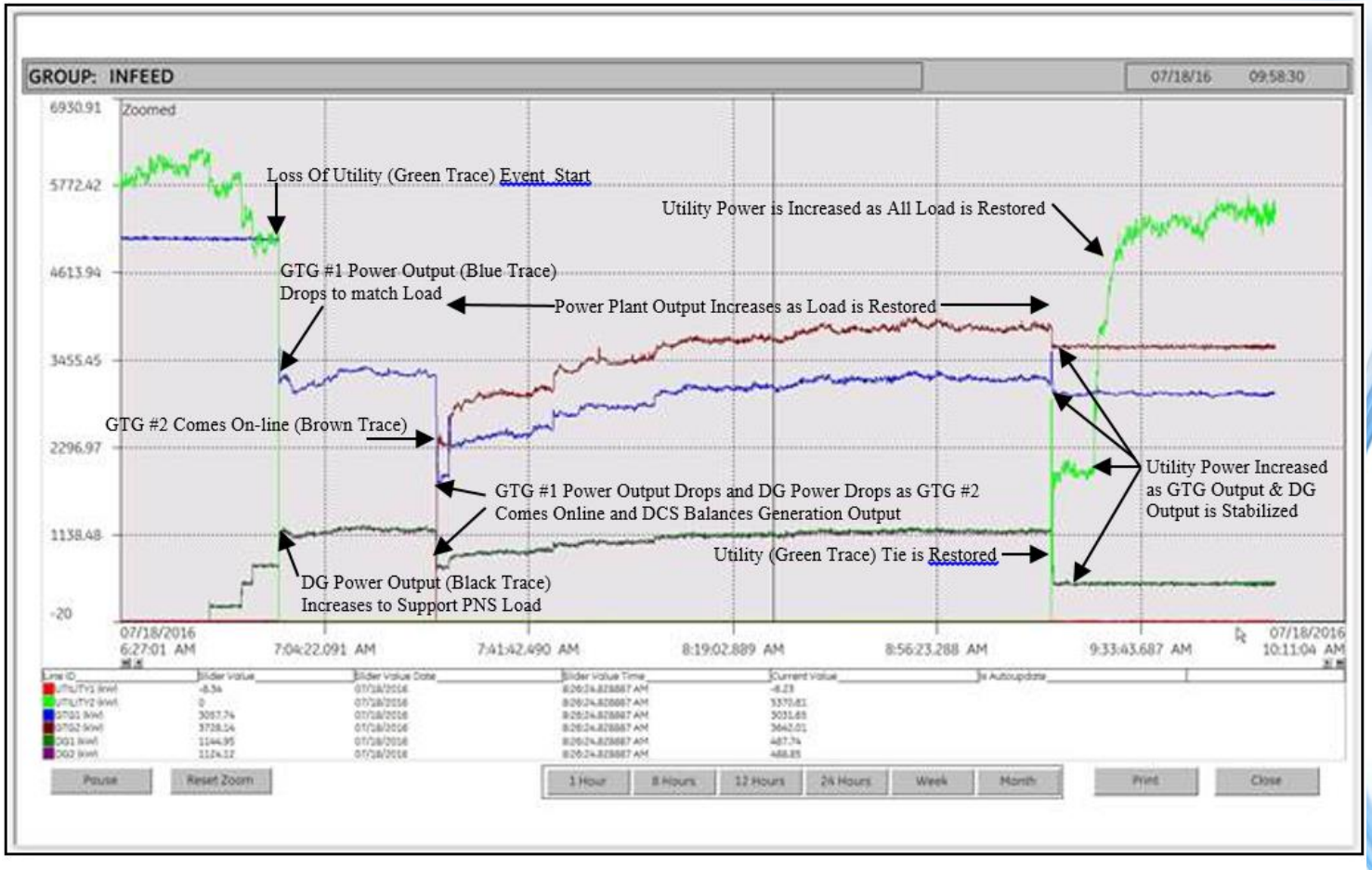
- Pull the plug on the utility. Observe Operation. Restore Distribution System
- Outcome: Performance as expected – Success !!
- New Question: What happens under actual fault conditions ??

Performance Data – LIVE Events

- **Event 1 – June 21, 2016**
  - Major failure of Air Gap Switch just outside Shipyard on Utility pole. Direct fault to ground on one phase.
  - Utility Breaker Opened initiating FLS per design.
  - CTG #2 Tripped on a ground fault protection . . .1 ms before Utility Breaker opened
  - Shipyard went black

- **Event 2 – July 18, 2016**
  - Loss of Utility, line to ground fault on utility side
  - Back-up Diesel Generators were operating on scheduled monthly run at time of LOU
  - FLS operated and CTG maintained generation – Successful Event

PERFORMANCE DATA – LIVE EVENTS



HMI Trend Display – July 18, 2016 LoU Event

Important Issues to Address

- Identify Better Means for Initiating FLS
  - Fast enough to protect generating assets
  - Not so fast to produce nuisance trips
- Ideas
  - Trigger based on Central Maine Power (CMP) Utility Recloser
  - Reverse power relay
  - Review / coordination of settings between utility breaker and CTG controls

Current and future Phases

- Address tripping scheme
- Expand number of breakers under shed control
- Add more on-site generation to serve more loads
- Add substantial BESS to bridge to back-up diesel generators
- Potential use of expanded BESS capacity for participation in ISO-NE ancillary services market

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Thank You

Questions

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