

DOE – LDES Workshop

Small Islanded Electrical Systems Use Cases

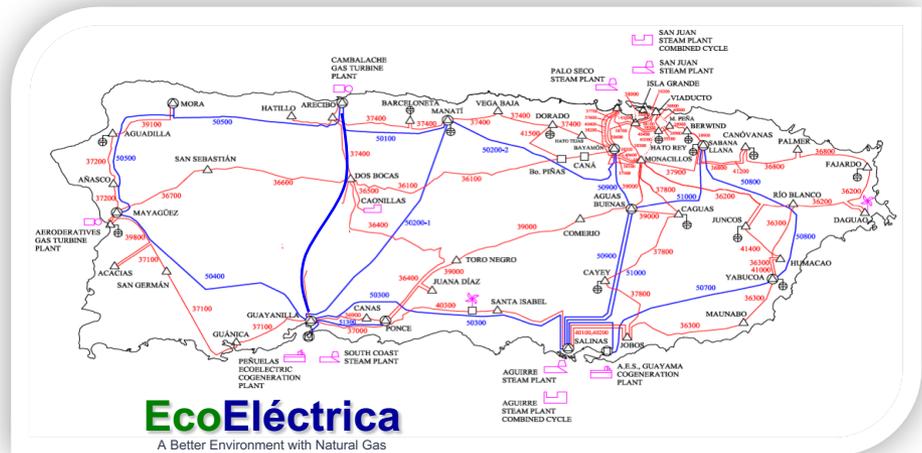
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March 9, 2021

Objectives

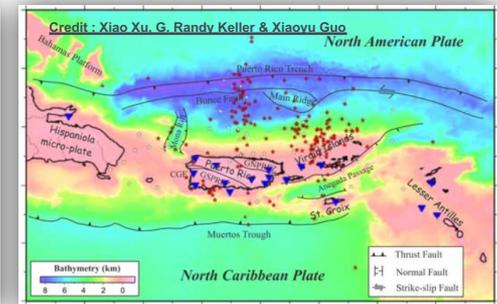
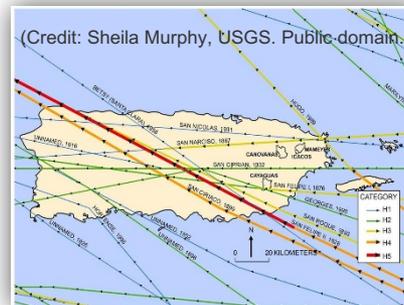
- ▶ Puerto Rico Electric System Overview
- ▶ Use cases
 - System Restoration after disasters
 - Critical Loads service during system restoration
 - Ancillary Services – Energy Transition
- ▶ Key Takeaways

System Overview

- ▶ Location – Puerto Rico, Caribbean
- ▶ System Peak Demand – 2,950MW
- ▶ Load factor – 79%
- ▶ T&D Grid – 230kV, 115kV & 38kV
- ▶ Production Mix (2019) –
 - Oil – 38.5%
 - Coal – 18.6%
 - LNG – 40.4%
 - Renewables – 2.4%

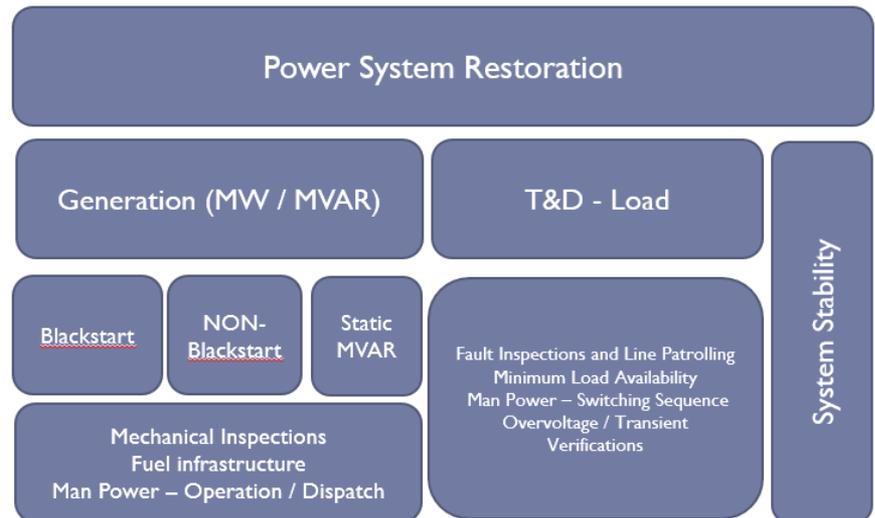


- ▶ EcoElectrica –
 - Combined Cycle – 530MW
 - LNG Terminal – 160k mt³ / 276MMSCFD
 - Water Production – 2MGD
 - % of system production – 18.5%
 - % of fuel imports to produce electricity – 32.6%
 - Ancillary services – supply more than 60% of system secondary regulation needs



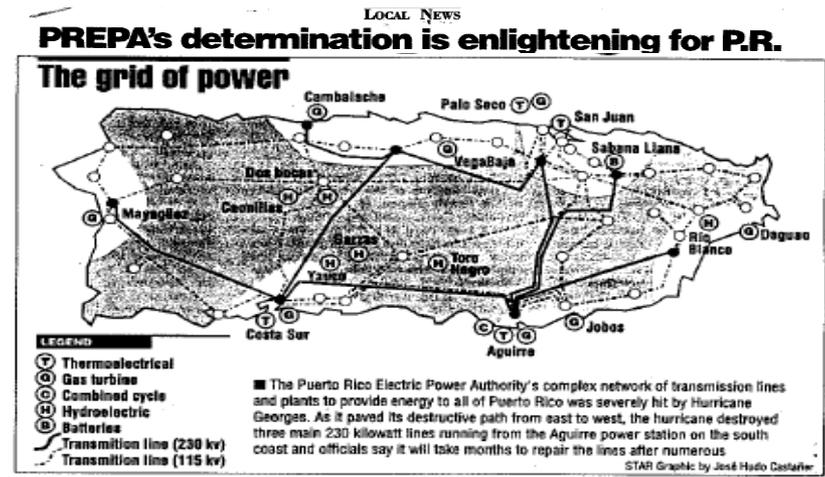
Restoration - Storms/Seismic Disasters

- ▶ Disaster periodicity.
- ▶ System re-collapses are common after major disasters due to undetected T&D faults and system stability problems.
- ▶ Truck delivered Diesel, LPG and LNG fuel supply chain will be disrupted for weeks and solar resource will not be fully available for several days after a tropical cyclone.
- ▶ Preparedness – most important phase.
- ▶ Restoration –
 - Blackstart capability and Energy Storage.
 - Communications.
 - Qualified Human Resources.
- ▶ Service restoration timeline.
- ▶ LDES will provide energy supply during initial stage of recovery for;
 - Communications.
 - First responders accommodations.
 - Initial energization for inspection of substations and transmission centers.



Critical Loads Service during Restoration

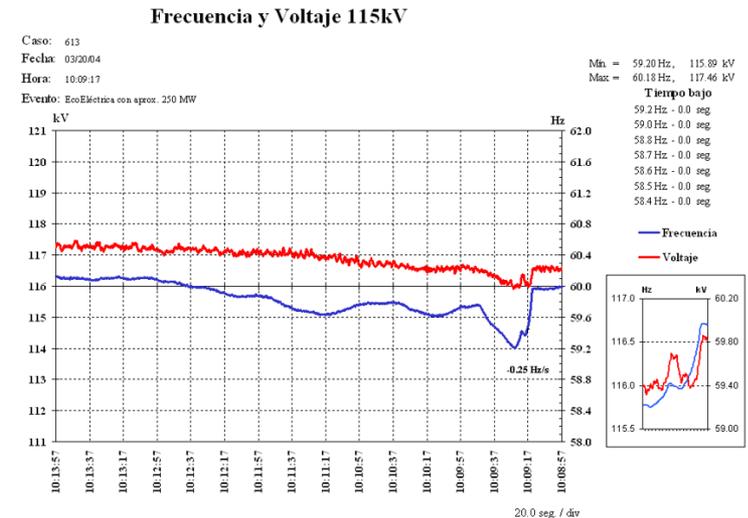
- ▶ Critical Loads.
- ▶ Feeders with critical loads - 33% of system peak demand geographically spread.
- ▶ System restoration strategy - small service areas operating disconnected from each other. As the inspections and repairs work is completed these areas are expanded and eventually synchronized one to the other until the system is fully integrated.
- ▶ LDES will provide to improve restoration time for critical loads located remote from initial small service areas.
- ▶ Combining LDES with DER's operating in micro grids will be a solution to maintain service in remote areas until system is integrated.
- ▶ Hurricanes GEORGES, 1998 and MARIA, 2017 experience.
- ▶ M6.4 earthquake, January 2020 experience.



Caribbean Business – Sunday September 27, 1998.

Ancillary Services – Frequency Control

- ▶ Puerto Rico RPS: 2025 – 40%, 2040 – 60% & 2050 – 100%.
- ▶ IRP Implementation plan encompass aggressive renewable capacity and storage installation over next five years, over the same period decommission of most of legacy conventional generation affecting system inertia. This plan, if not carefully implemented, will have a material impact on system quality of service.
- ▶ System BIAS:
 - 2000 – 20 to 25 MW/.1Hz
 - 2020 – 7 to 10 MW/.1Hz
- ▶ LDES – during normal system operations will provide frequency control services to the grid.
- ▶ Tropical cyclones impact (trajectory and intensity) is accurately forecasted days in advance to the disaster providing sufficient time for system preparedness. LDES will be removed from frequency control duty and SOC completed in preparation for the events.



Key Takeaways

- ▶ LDES applications for small islanded electric system;
 - System Restoration after disasters
 - Critical Loads service during system restoration
 - Ancillary Services – Energy Transition
- ▶ Value of LDES increase for electric systems exposed to frequent tropical cyclones and other natural disasters.
- ▶ LDES may have a combined functionality, frequency control during normal operations and system restoration support services after disasters.



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