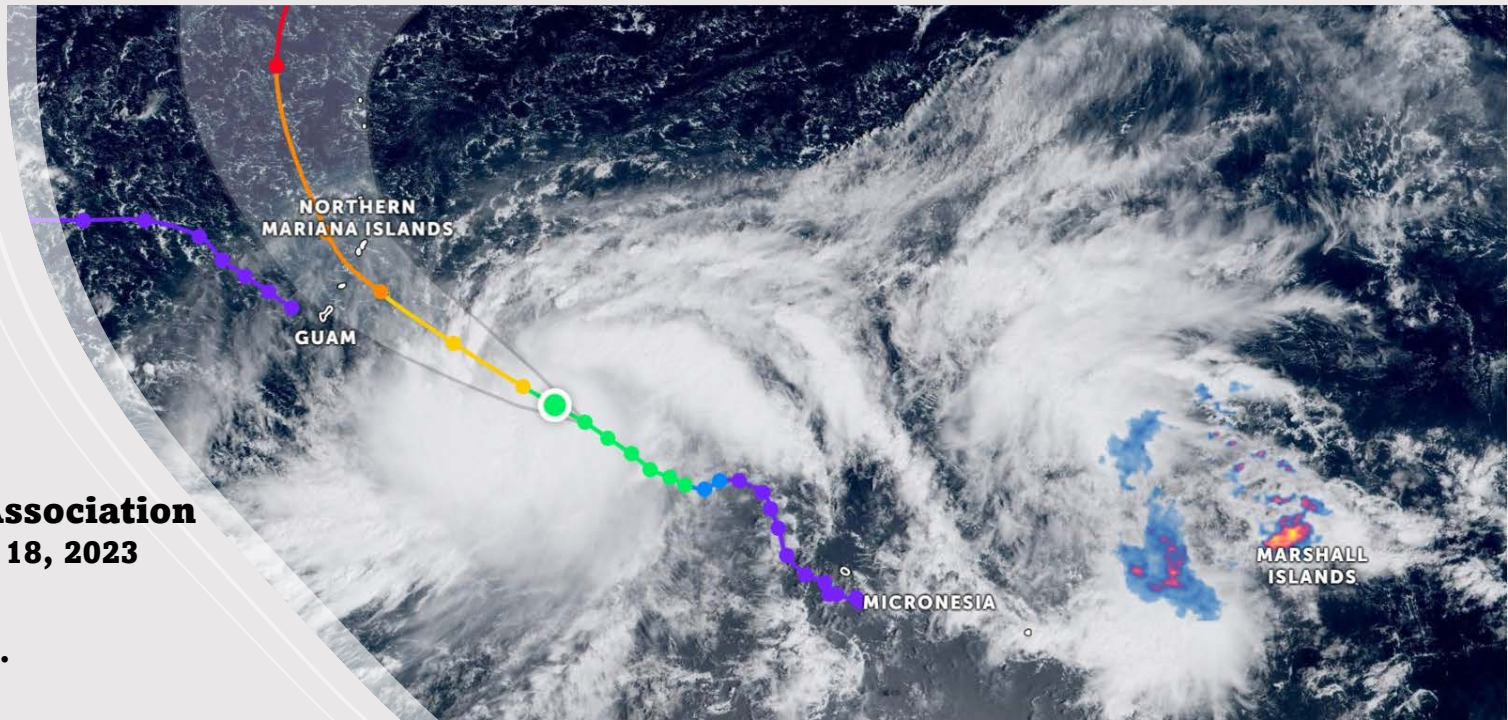
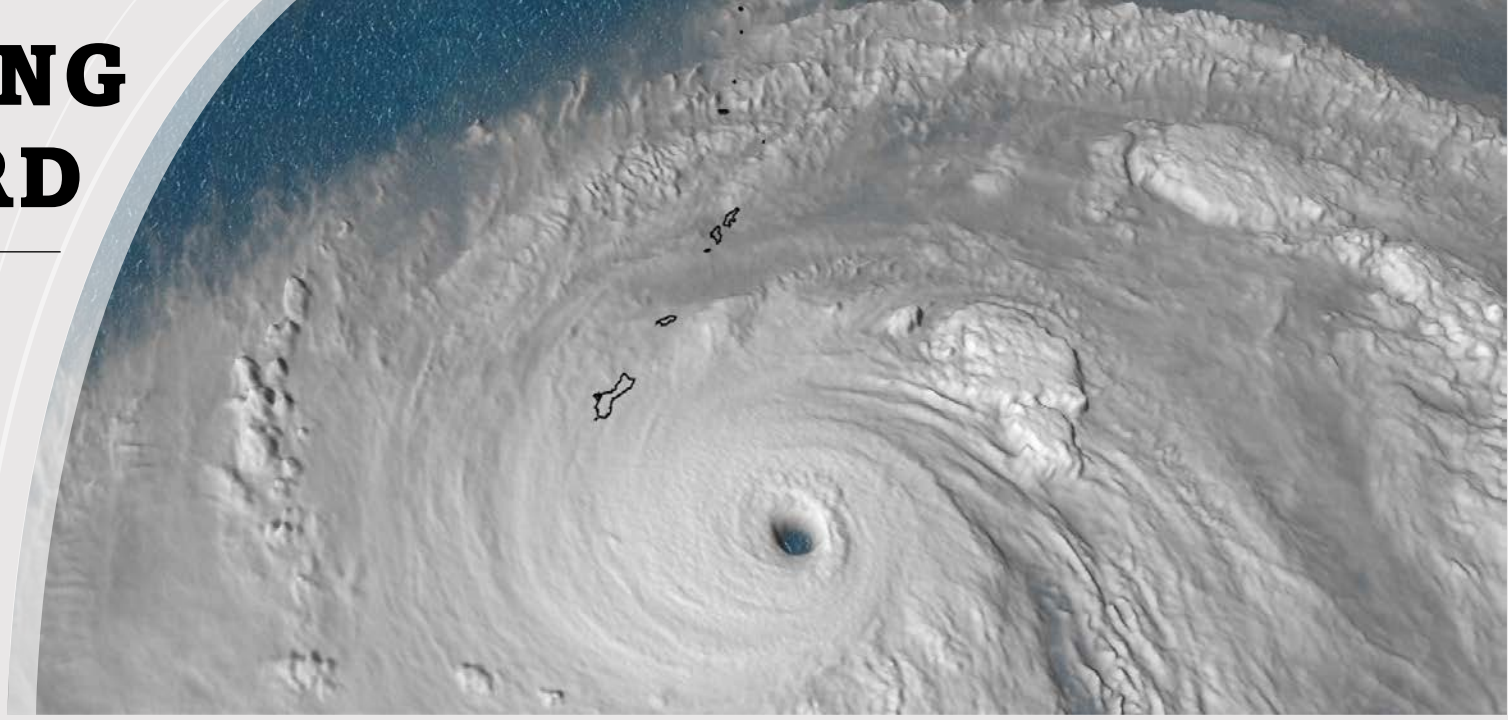


POWERING FORWARD

Ensuring Utility Resiliency

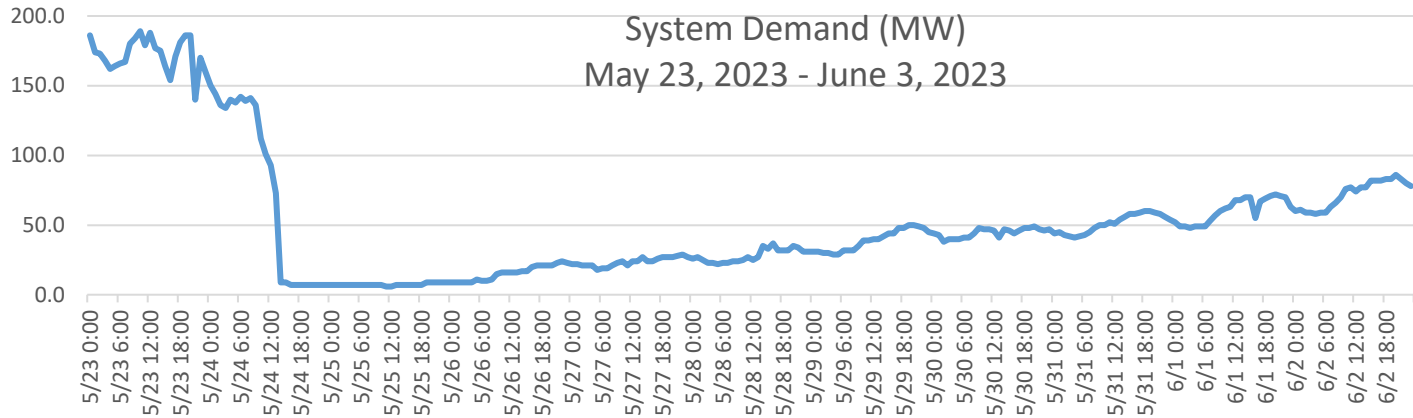


Guam Contractors Association
Westin Hotel | October 18, 2023

Guam Power Authority
John M. Benavente, P.E.
General Manager

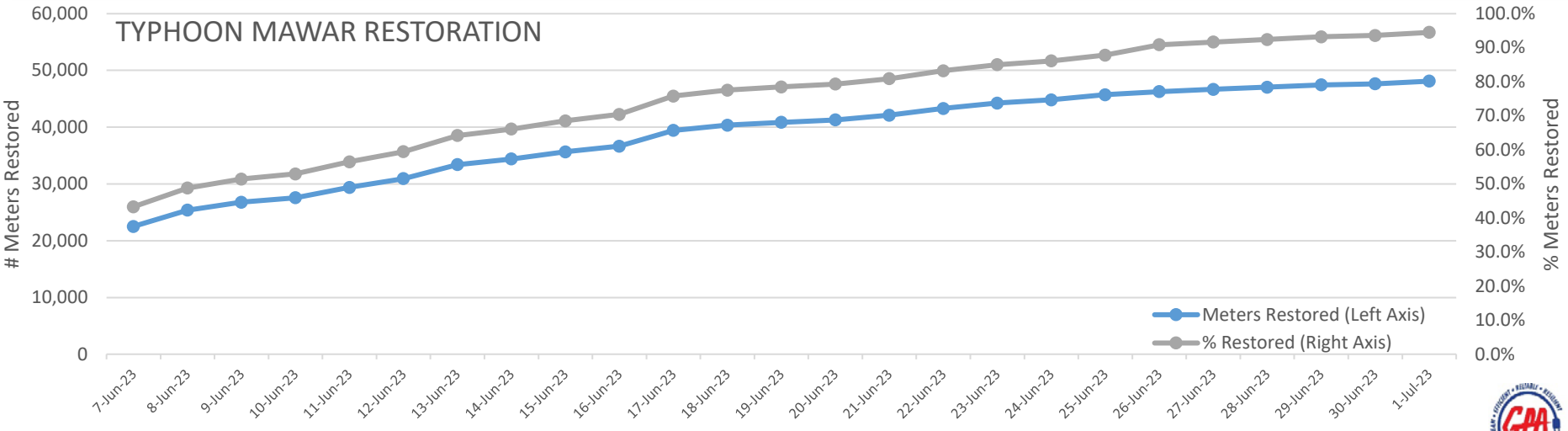
Typhoon Mawar: *Overview*

The islandwide power system did not experience a blackout during Typhoon Mawar, despite the significant damage to the T&D system during the prolonged and relentless wind (up to 150 mph) and torrential rain.



GPA continued to serve ~7 MW load throughout the typhoon, mainly to Andersen Air Force Base, through underground transmission lines and the hardened Dededo combustion turbine structure.

99% of pre-typhoon customers restored as of July 14, 2023, 50 days after COR 4 was declared.



Typhoon Mawar: *Transmission & Distribution System*

TRANSMISSION SYSTEM

- All 115kV transmission lines sustained serious damage
- Most 34.5kV overhead transmission lines sustained serious damage
- Transmission line repairs require special resources (high-reach bucket trucks, high-voltage line crew) and outages to ensure the safety of personnel.



Hardened Transmission Lines

The hardened, underground 34.5kV transmission line providing AAFB energy remained online through the typhoon. AAFB outages were due to damaged distribution systems, not the GPA transmission delivery system.

DISTRIBUTION SYSTEM

- Concrete power poles survived Typhoon Mawar's 150+ mph winds. Trees, flying debris, lightning, etc. damaged crossarms, transformers, hardware, and power lines.
- Emergency work clearances were issued for customer related damages such as weather-heads.

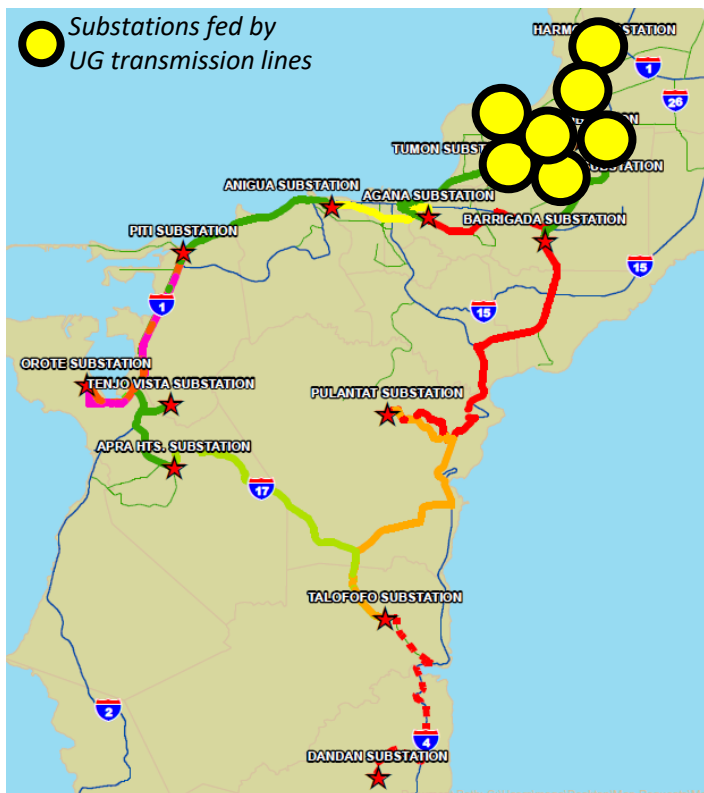


Typhoon Mawar: System Restoration

SUBSTATIONS

Harmon Sub energized	GRMC on island power	Tumon Sub energized	GMH on island power	Macheche Sub energized	& GIAA on island power	GIAA Sub energized	Tamuning Sub energized	San Vitores Sub energized	Mangilao Sub energized	Agana Sub energized	Barrigada Sub energized	Pulantat Sub energized	Anigua Sub energized	Piti Sub energized	Navy Drote Sub energized
1057	1626	1802	1825	1843	2005	2052	2145	0119	1544	2109	2324	1712	1910	1449	2023
25-May							26-May			27-May		28-May		30-May	

Underground Transmission Line Overhead Transmission Line



- Most substations had significant water and/or moisture accumulation from the wind-driven rain.
- Substations fed through underground transmission lines were able to be restored quicker than those fed through overhead transmission lines, as shown above.



STANDBY GENERATORS (Water Systems Diesel)

STATUS	Pre-Mawar	Post-Mawar	As of July-2023
<i>Generator Operational</i>	194	172	184
<i>Generator Out of Service</i>	26	48	36
Total Generators	220	220	220
<i>Availability:</i>	88%	78%	84%

**Sites include booster pumps, wells, reservoirs, water & wastewater treatment, and sewer pumps.*

GPA is focused on mitigating standby generator issues:

- ✓ Working with GWA on prioritizing sites to replace aged, damaged, or deteriorating units, install new units or upgrade units to meet site requirements
- ✓ Continuing repairs to down units (eligible for repair)
- ✓ Continuing required preventive maintenance on working units
- ✓ Ensuring adequate stock of spare parts
- ✓ Recruiting necessary manpower to support activities
- ✓ Assess site structures for improvements to minimize water intrusion
- ✓ Initiating contracts to enclose “open” sites
- ✓ Evaluating other support needs (e.g., purchase fuel tanker truck(s) to support refueling requirements)
- ✓ Pursuing FEMA mitigation funding

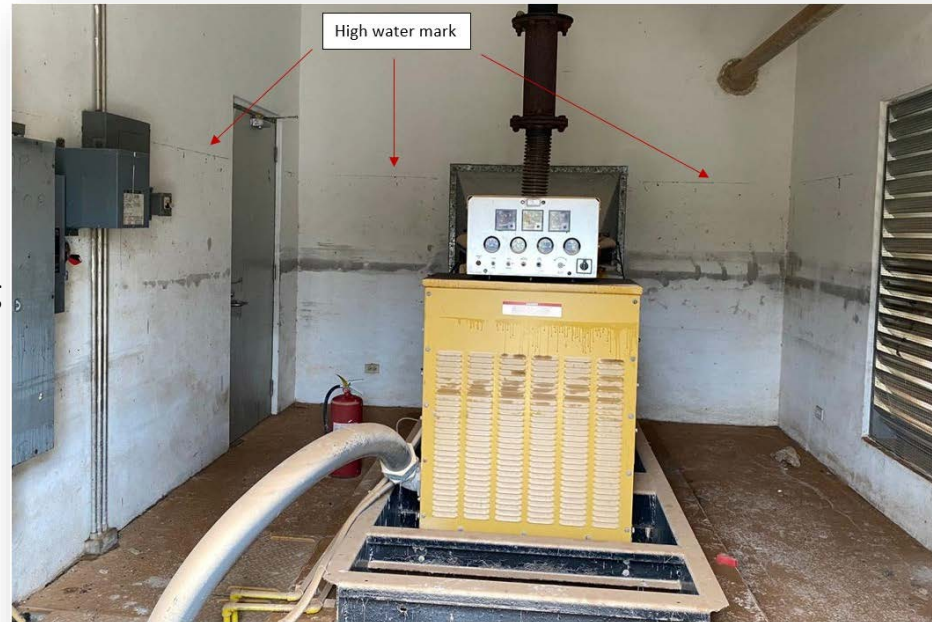


Photo (above) shows generator damage due to severe flooding during Typhoon Mawar.

Post-typhoon inspections revealed the flooding engulfed the generator, controls, and other components.

Typhoon Mawar - Generation

- **Yigo 20 MW Combustion Turbine** has not returned to service due to turbine and Mawar related generator issues. Off- and on-island repair work in progress but unit will now not be available until about February 2024 due to extensive rotor work required. The 20 MW capacity loss will impact our reliability when two base load units are out of service during the peak hours of 6pm to 10pm.
- **Cabras 1 (41 MW) and Cabras 2 (31 MW)** have returned to service with limited capacity but continue to be plagued with boiler tube leaks as it approaches 50 years of service. Plant will be retired after the new Ukudu 198MW plant is commissioned
- **Piti 8 & 9 units** have both returned to service at full capacity of 43 MW ea.
- The new **Ukudu Power Plant** sustained substantial damages to its fuel oil storage and treated water storage tanks. As a result of the damage, the commissioning date is delayed until January 2026

- ### UTILITY SCALE SOLAR POWER PURCHASE AGREEMENTS
- **KEPCO Mangilao Solar (KMS)** 60MW facility is up and generating close to its capacity. It suffered minor damages.
 - **Glidepath Dandan 25MW** solar facility is up generating at its capacity. It also suffered minor damage.



ULSD Tanks A&B, May 8, 2023



ULSD Tanks destroyed by Typhoon Mawar, May 25, 2023

Prior Mitigation Efforts Proved Successful

- This is the fastest recovery from super-typhoon winds the IWPS has ever experienced. This is the first time that the system did not experience a blackout from 150mph winds.
- The progressive hardening to the current concrete pole system prevented mass structural collapse compared to Typhoon Pongsona. Hardening projects were funded through GPA revenue funds, DoD (Air Force), and through prior FEMA mitigation funds received to place transmission systems underground.
- Investments made toward personnel training (SCADA and communication technicians, dispatchers, linemen, engineers, etc.), material inventory (over \$15M stock on hand), and equipment proved successful.

Post-Mawar Power Restoration

- The recovery from about 150mph Typhoon Mawar is the fastest it has been compared to other similar typhoons in the past. GPA has invested substantially in the electric grid infrastructure with over 98% of the system consisting of concrete and steel poles. Recoveries from similar typhoons has historically taken months in particular Typhoon Pongsona in 2002 took 3 months to recover from.

Key Resiliency Initiatives



Undergrounding
Transmission Lines



Undergrounding
Distribution Lines



Increasing Water &
Wastewater
Standby Generators



Hardening General
Communication
Core Sites



Hardening Critical
Communications
System (GPA)

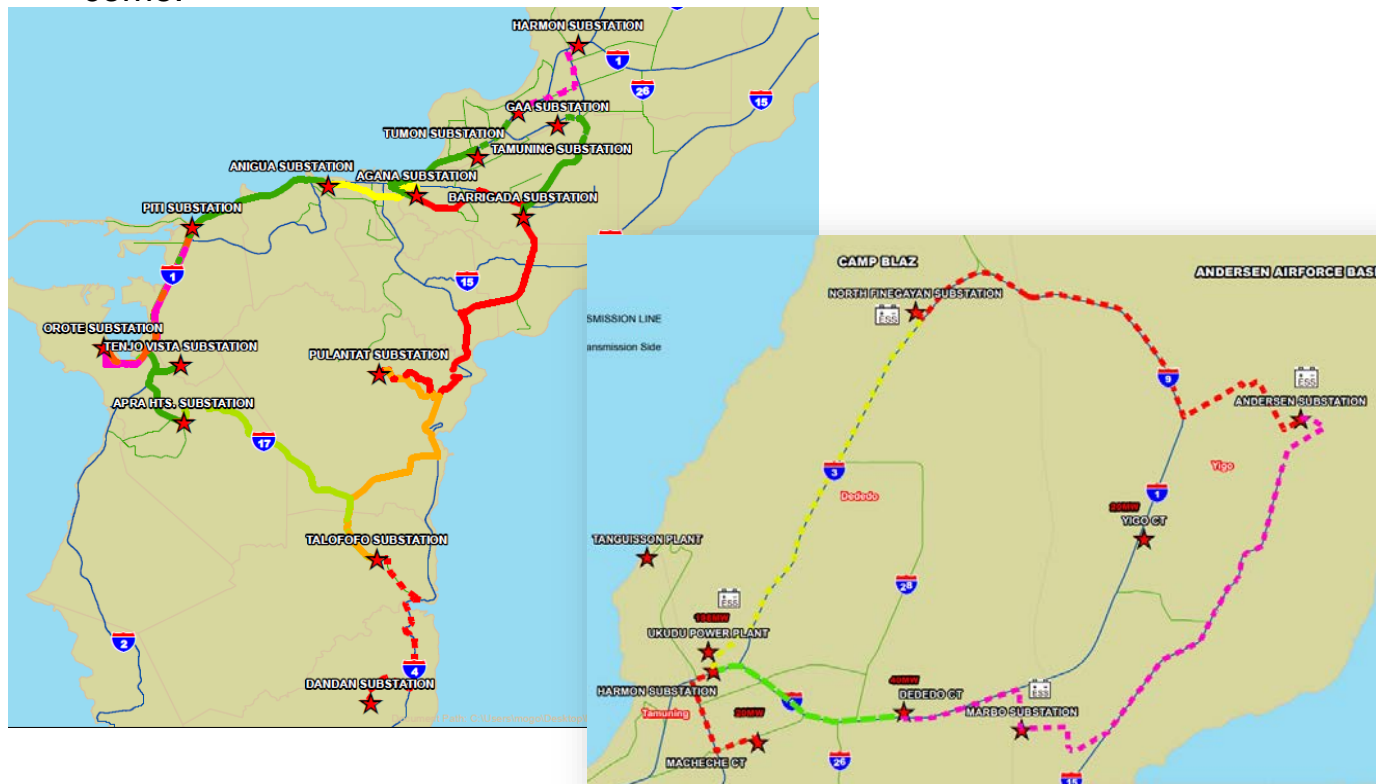


Addressing
Emergency &
Temporary Power

Infrastructure Resiliency Plan

One Guam Infrastructure Hardening Resiliency Plan

- It is imperative to upgrade utility infrastructure to provide resiliency from all the threats, natural or otherwise. These critical investments will bolster utility (power, water and wastewater) resiliency.
- A full underground system, excluding 115kV transmission, may cost about \$7B. GPA's ability to obtain funding for the billions in investments needed is doubtful. If GPA were able to secure funding, it will certainly double power rates, if not more, making island energy costs unaffordable.
- It is very important that the federal government and the local community work together to mitigate Guam's vulnerability to natural disasters and military conflicts.
- The investment of the federal government into Guam's infrastructure will provide returns over the decades to come.



Readiness Against Increased Natural & Bad Actor Threats

- The island power grid must be ready for the conflicts facing the nation and from national disasters, especially super typhoons.
- The community and national defense environment today has changed substantially over the past two decades and it is important to prepare the Guam electrical grid's infrastructure to survive and recover from super typhoons.
- The national threat from China and North Korea has substantially increased and Guam's strategic importance requires our infrastructure to be resilient for potential conflict with unfriendly nations.

Preliminary Cost Estimate: Infrastructure Resiliency Plan

<u>DESCRIPTION</u>	<u>EST. COST (\$M)</u>
ITEM 1: Underground Transmission Lines & Indoor Substations	\$ 833
<i>Islandwide Power System Incl Assets Serving Military Facilities</i>	
ITEM 2: Critical Distribution System Mitigation	\$ 813
<i>Underground distribution feeders for Y, D, F & M-Series water wells, treatment facilities/reservoirs, wastewater treatment plants, lift and pump stations</i>	\$ 502
<i>Underground of Naval Hospital feeder; communications core sites; industrial sector feeders; GDOE public schools, GCC, UOG</i>	\$ 78
<i>Standby generator systems including ATS/fuel storage for critical facilities such as public health, medical facilities, typhoon shelters, youth facilities, DOC, etc.</i>	\$ 95
<i>Hybrid underground of various villages secondary lines and to replace overhead transformers with pad mounted transformers</i>	\$ 138
ITEM 3: Other Critical Infrastructure Resiliency Projects	\$ 730
<i>Energy Storage Batteries (180MW/900MWh)</i>	\$ 500
<i>New 80MW Combustion Turbine Capacity</i>	\$ 100
<i>Standby generator upgrades placed in concrete housings with adequate fuel storage capacity for water and wastewater systems</i>	\$ 30
<i>T&D operations center. Backup SCADA. Fiber optic system. Physical facilities. GWA SCADA and motorized valves.</i>	\$ 80
<i>Bucket trucks, line equipment, underground systems training</i>	\$ 20
Subtotal - Immediate Critical Infrastructure Resiliency Projects (Items 1-3):	\$ 2,376
ITEM 4: Underground Remaining Distribution System	\$ 4,025
<i>Convert remaining distribution systems to fully underground system</i>	
Total - All Resiliency Projects:	\$ 6,401

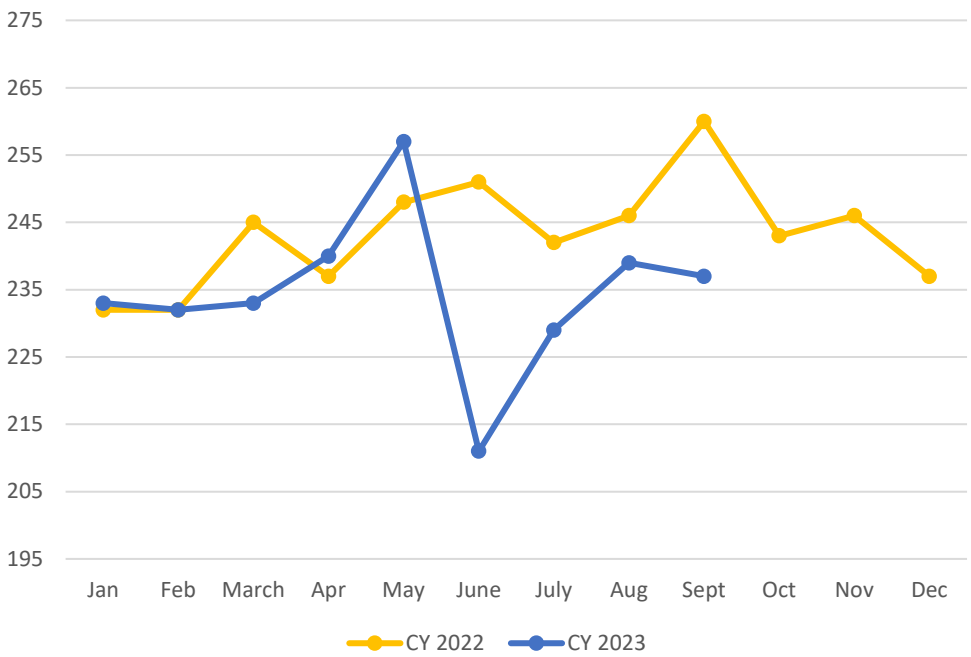
*Preliminary Estimate as of July 20, 2023



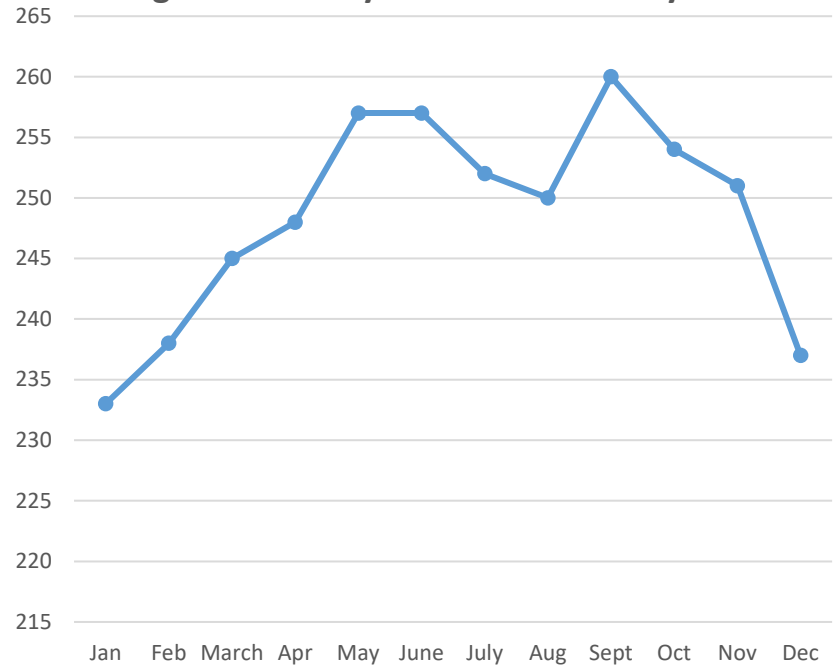
Generation Capacity Shortfall

PEAK DEMAND HIGHEST IN SEPTEMBER

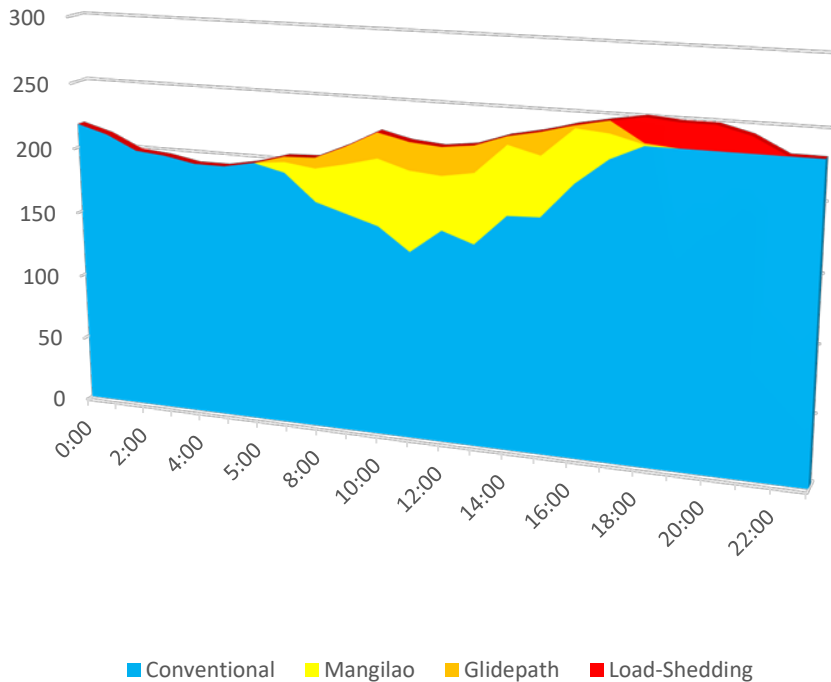
PEAK DEMAND Thru September 17, 2023



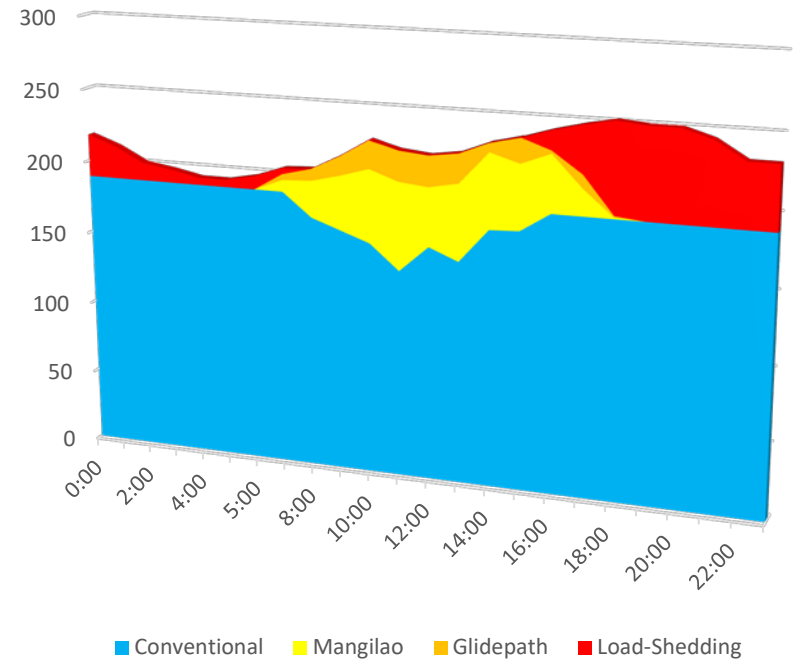
Highest Monthly Demand in Past 3 years



One Baseload Down
Load Shedding 18 MW
Capacity 232MW; Demand 250MW



Two Baseloads Down
Load Shedding 61 MW
Capacity 189 MW; Demand 250MW



Generation Capacity Shortfall: Demand

	Actual	Oct 20, 2023 Schedule
<i>Capacity Dates:</i>	18-Oct-23	One Baseload Under Maintenance
Cabras 1	41	41
Cabras 2	31	31
Piti 8	43	43
Piti 9	43	0
Piti 7	22	22
Dededo 1	18	18
Dededo 2	18	18
Macheche	16	16
Yigo CT	Down Hard	Down Hard
Yigo Diesels	9	9
Caterpillar Units	6	6
Manenggon #1	3	3
Manenggon #2	0	0
Total:	250	207
Interruptible Load	16	16
Total:	266	223
Anticipated Peak Demand	250	235
Reserve (Shortfall)	16	-8



Legacy Power Generation

GPA's aged generation capacity was being addressed by the planned commissioning of the new 198 MW Ukudu combined cycle power plant. The plant is currently under construction with commissioning originally scheduled for October 2022.

- **Delays:** The global COVID-19 pandemic impacted material, equipment, and personnel supply chain delaying the project nearly 2 years. Delayed government permits and legislative approvals extended months to critical milestones completion dates and the loss of reserve generation capacity, with revised commissioning in 2024. In May 2023, Typhoon Mawar caused substantial damage to fuel and water tanks, further delaying the commissioning to about January 2026.

Challenges to Current Generation Capacity

The delays to the Ukudu project challenges GPA to meet the demand over the next two years. GPA is focused on restoring down units and bringing in reasonably cost temporary power.

Typhoon Mawar damaged the Yigo 20 MW combustion turbine significantly impacting its ability to meet demand. The unit is now under repair but the return to service is not expected at best February 2024, limiting reserve capacity evident by the increased load shedding frequency.

Constraints in accomplishing these critical work consist mainly of a procurement processes which delays implementation most especially due to mundane legal requirements and a bid protest resolution process which is burdensome and takes many months and even years to resolve. Despite GPA's expressing its concern, there has not been adequate assistance to GPA to overcome these barriers.

GPA noted last month that effort to end the current load shedding situation may take about 6 to 9 months, with incremental improvements through the period. The following summarizes GPA's current action plan.

The work towards improving reliability, providing affordable energy (commissioning Ukudu 198 MW plant) and contracting for utility scale solar plants with energy shifting capability continues and barring any other substantial delays would be achieve in 2026.

GPA continues its focus on these projects to achieve its commitment to lower cost energy on a sustainable basis.

Plan of Action for Capacity Recovery

Power Generation

CABRAS BASELOAD UNITS

- Continue Cabras Unit 2 repair work to restore unit capacity to 40 MW in October 2023. Order boiler tube material and plan to replace problematic screen tube bank in January/February 2024
- Once Cabras 2 is operating and stable in October, shutdown Piti 7 for repair of plenum and increase capacity from 22 MW to 31 MW (5-day outage)

COMBUSTION TURBINES

- Expedite repair of Yigo 20 MW combustion Turbine Unit. Generator rotor was shipped to Texas and is close to arriving there for repair. The return to service targeted is now February 2024.

DIESEL UNITS

- Return to service Caterpillar units requiring significant repairs or rehabilitation and increase plant capacity by 10 MW
- Replace Manenggon Wartsila units control system and increase plant capacity by 5 MW
- Yigo Diesels Performance Management Contractor (PMC):
 - GPA resolved the original protest and was about to open the price proposal of three bidders when unfortunately, another protest was filed by the fourth and disqualified bidder. Work continues towards a solution.
 - Once an award on this bid can be made, GPA will need CCU and PUC Approvals
 - This plan could take six to nine months to accomplish if we could resolve protest issue
 - Repair and Replacement Plan could increase capacity by 25MW

Plant personnel assessing for safe entry into boiler to make necessary repairs to 48-year-old Cabras Unit 2 baseload plant.

Plan of Action for Capacity Recovery

REDUCE DEMAND

- Customers participating in the Interruptible Load Program are paid a set rate to assist in meeting peak demand during loss or scheduled maintenance of base load units. Current participants include GIAA, PAG, GRMC, PIC, Hilton, Micronesia Mall, KTWR and IT&E. Additionally, Navy and their DOD customers are supporting GPA with 5 MW of interrupted load or generator capacity. Some large customers are unable to participate due to down generators. Follow up calls are being made to other customers invited to participate.
- Upgrade emergency standby units for water and wastewater facilities. The majority of generators are over 30 years-old

DEMAND-SIDE MANAGEMENT

- Media campaign “BEAT THE PEAK” has been launched asking customers to help reduce load shedding while lowering their energy bill:
 - Shut off water heaters during peak times; lower their water heater temperature setting
 - Shut one or more air conditioners off during emergency load shedding periods
 - Government employees, schools and businesses to place their air conditioning thermostats at 75 degrees or higher after work; shut down air conditioners if possible
- Issue Load Shedding Schedule for a month:
 - Explain when one or several 1-hour outages could occur
 - Issue capacity alert scenario as early as possible which triggers extend of outage



BATTERY ENERGY STORAGE SYSTEMS & RENEWABLE ENERGY

- Pursue converting the Talofof Energy Storage System (ESS) to dual service which could allow the shifting of 16 MWH of solar PV to shave evening peak (in discussion)
- Pursue contracting the KEPCO Mangilao Solar Energy Storage System (ESS) to dual service which could allow the shifting of 25 MWH of solar PV to shave evening peak (In discussion)
- Pursue approval to bid for an Energy Storage Battery 45 MW / 225 MWh to shave peak demand and which could be charged by daytime solar PV or available conventional units. This is part of Integrated Resource Plan recommendation. GPA is requesting Federal Funding to implement

TEMPORARY POWER

- CCU approved for GPA to petition PUC for approval to bid for 40 MW of emergency temporary power for a three-year basic contract with two one-year renewal options. GPA hopes to get this approval in November 2023. GPA is working to determine which is best site for the temporary power and what may be permitted by Guam EPA and potentially USEPA.

Temporary Power: Cost-Benefit Analysis

Temporary Power Capacity (KW) required	40,000
Period (years)	4
Capacity Factor (Minor Source) Hours	2,500
Annual KWH	100,000,000
Annual MWH	100,000

ESTIMATED COST:	CY 2024	CY 2025	CY 2026	CY 2027
Capacity Charge:	\$ 8,500,000	\$ 8,925,000	\$ 9,371,250	\$ 9,839,813
Fixed O&M Charge:	\$ 2,500,000	\$ 2,625,000	\$ 2,756,250	\$ 2,894,063
Variable O&M (\$4.62/MWh):	\$ 462,000	\$ 485,100	\$ 509,355	\$ 534,823
Annual Cost Excluding Fuel:	\$ 11,462,000	\$ 12,035,100	\$ 12,636,855	\$ 13,268,698
Cost/kWh:	\$ 0.115	\$ 0.120	\$ 0.126	\$ 0.133
Annual Sales:	\$ 1,500,000,000	\$ 1,500,000,000	\$ 1,500,000,000	\$ 1,500,000,000
\$/kW Sales:	\$ 0.0076	\$ 0.0080	\$ 0.0084	\$ 0.0088
Average Residential Customer (1,000 kWh):	\$ 7.64	\$ 8.02	\$ 8.42	\$ 8.85

Potential Siting: Cabras Fuel Oil Storage Site, Tenjo Vista or Marbo Substation
 Subject to Air Permitting Constraints
 6 to 9 months Implementation period



Future with New 198 MW Ukudu Plant and Energy Shifting ESS

	CALENDAR YEAR	CY 2026	CY 2027	CY 2028	CY 2029	CY 2030
Current Operable Capacity:						
Ukudu Power Plant Commissioned (CY 2026)		198	198	198	198	198
Cabras Steam (Retired CY 2026)		-	-	-	-	-
Piti 8&9 (MEC)		86	86	86	86	86
BASELOAD TOTAL		284	284	284	284	284
NON-BASELOAD TOTAL		177	177	177	177	177
TOTAL CONVENTIONAL CAPACITY		461	461	461	461	461
Full Shifting Renewables (Firm Capacity):						
90 MW / 450 MWh Centralized ESS (Bid in CY 2024)		90	90	90	90	90
Phase IV CY 2023 180 MW Bid-COD CY 2026 (50% Firm ESS)		90	90	90	90	90
Phase V CY 2025 240 MW Bid-COD 2028 (50% Firm ESS)		-	-	90	90	90
FIRM ESS CAPACITY		180	180	270	270	270
TOTAL FIRM CAPACITY:		641	641	731	731	731
Peak Demand (2% Growth)		281	287	292	298	304
Reserve Capacity Margin (50% of Peak Demand)		141	143	146	149	152
CAPACITY BALANCE AVAILABLE FOR ADDITIONAL GROWTH		219	211	292	284	275



Si Yu'os Ma'ase'!

