



# Territorial Climate and Infrastructure Workshop

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# Guam Power Authority Update

## Overview

### Our Business

- An electric utility that provides monopoly electric services throughout Guam, including U.S. military bases
- A component unit of the Government of Guam

### Our Customers

- Serves a population of approximately 170,000 with a 2021 peak demand of 257 MW and FY 2021 energy sales of 1.6 million MWh
- Larger customers include U.S. Navy, various components of Government of Guam, shopping and hotel industry

### Our Assets

- Power supply comes from various fuel-oil based generating units with gross capacity of over 400 MW
- Electric system also includes 29 substations, 189 miles of transmission lines and over 1,608 miles of distribution lines

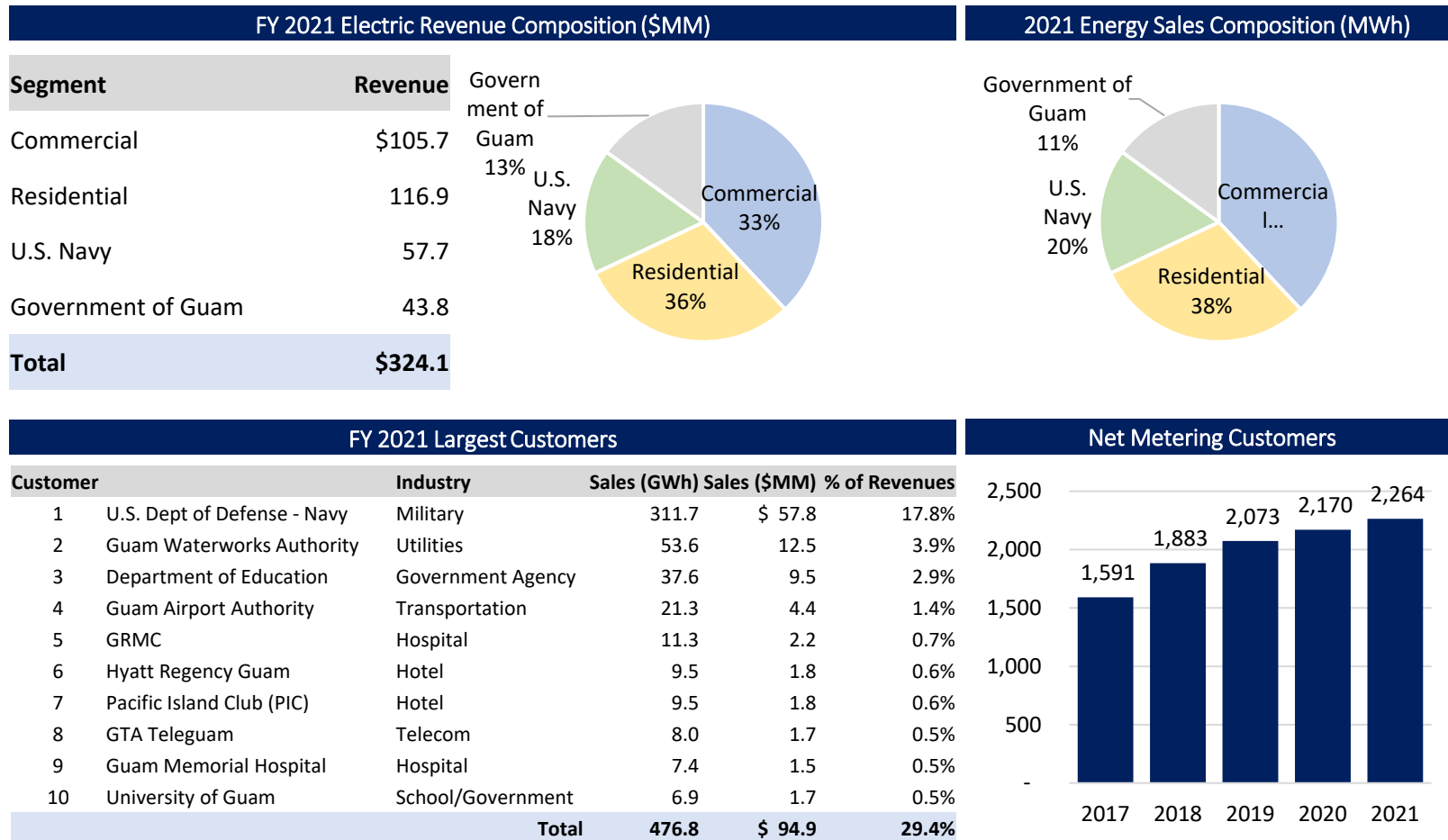
### Our Governance

- Governed by the Consolidated Commission on Utilities (CCU), an elected five-member board
- Rates subject to the regulations by the Guam Public Utilities Commission (GPUC)



# Guam Power Authority

*GPA has diverse a diverse and growing customer base and has been a long-term provider to the U.S. military*



# Guam Power Authority Update

## Power Supply Update

### Overview

- GPA has approximately 400 MW of generation capacity
- GPA's peak demand in 2021 was 257MW
- GPA's power resource are fueled primarily by fuel oil, except for 25.3 MW of renewables

### Ownership / Operation

- GPA provides power through:
  - GPA owned and operated units
  - GPA owned units managed by private companies
  - PPA for renewable resources

Primary Generating Units					
	Unit	Year Installed	Owner	Operator	Capacity Available (MW)
<b>Base Load</b>	Cabras Unit 1	1974	Authority	TEMES	66.0
	Cabras Unit 2	1975	Authority	TEMES	66.0
	Piti Unit 8	1999	Authority	MEC	44.2
	Piti Unit 9	1999	Authority	MEC	44.2
<b>Intermediate</b>	Macheche - CT	1993	Authority	TEMES	20.0
	Yigo – CT	1993	Authority	TEMES	20.0
	Piti 7	1997	Authority	Authority	40.0
	Dededo CT Plant	1993	Authority	TEMES	40.0
	Yigo Diesel Units	2016	Authority	Authority	40.0
<b>Peaking</b>	Diesel Units (10 units)	1993	Authority	Authority	44.0
<b>Subtotal:</b>					<b>424.4</b>
<b>Renewable</b>	Dandan Solar Project	2015	GlidePath	GlidePath	25.0
	Marbo Solar Project	2022	KEPCO	KEPCO	60.0
	Wind Turbine	2016	Authority	Authority	0.3
<b>Total:</b>					<b>509.4</b>

# Guam Power Authority

## Renewables Update

*GPA has made substantial progress in expanding its renewable resources and on track to achieve 25% renewables in 2025*

Existing Projects	Phase I	Wind Project
	<ul style="list-style-type: none"> <li>25 MW Dandan solar farm</li> <li>COD October 2015</li> <li>20 Year Power Purchase Agreement (PPA) Contract</li> <li>Take-and-pay contract with GlidePath</li> </ul>	<ul style="list-style-type: none"> <li>275 KW</li> <li>Funded by USDOJ grant</li> <li>COD March 2016</li> </ul>
In Progress	Phase II	Phase III
	<ul style="list-style-type: none"> <li>2 ea. 60 MW PPAs approved in 2018</li> <li>60 MW KEPCO operational in April 2022</li> <li>60 MW Hanwah Contract COD December 2023</li> <li>Contracted prices are well below current solar energy (\$0.085 / kWh) and below current LEAC rate (\$0.181 / kWh)</li> </ul>	<ul style="list-style-type: none"> <li>Bid to be awarded</li> <li>40 MW of solar PV to be constructed on Navy land</li> <li>All energy Stored in batteries and released at night to reduce peak</li> </ul>

# Guam Power Authority

## GPA's Transmission and Distribution System

*GPA manages an island-wide and resilient power delivery system*

### Overview

- GPA's power delivery system includes
  - 29 substations connected through 189 miles of transmission lines
  - Substations supply 67 distribution feeders with 1,600 miles of distribution lines
- GPA's delivery system is managed through the Power System Control Center and, beginning mid-2018, SCADA at its state-of-the-art GBN Facility

### System Resilience and Efficiency

- For the past 10-15 years, GPA has strengthened its delivery system
- Installing hardened poles
  - Over 30,000 of Guam's 34,340 power line poles are steel or concrete
  - Replacement of wood poles is an ongoing program; over 280 poles have been replaced since 2019
- Installing smart grid technology
  - GPA has installed new meters for all customers in its system
  - The technology includes substation automation and broadband communication
- Placing vital power lines underground
  - Over 60% of system (key business areas and high-density residential regions) are served by underground systems
  - Covering nearly one-fourth of GPA's customers
  - This process continues in key areas throughout GUAM
- Maintaining a significant inventory of essential equipment on island

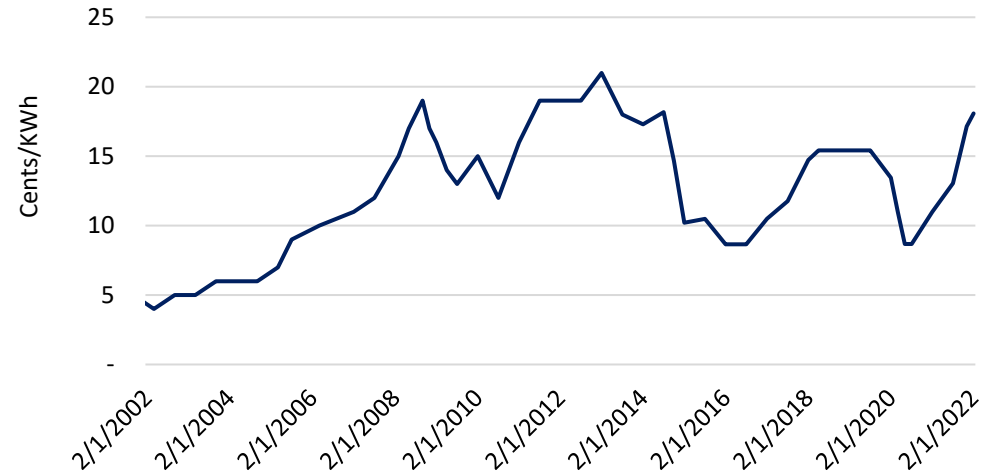


# Rates

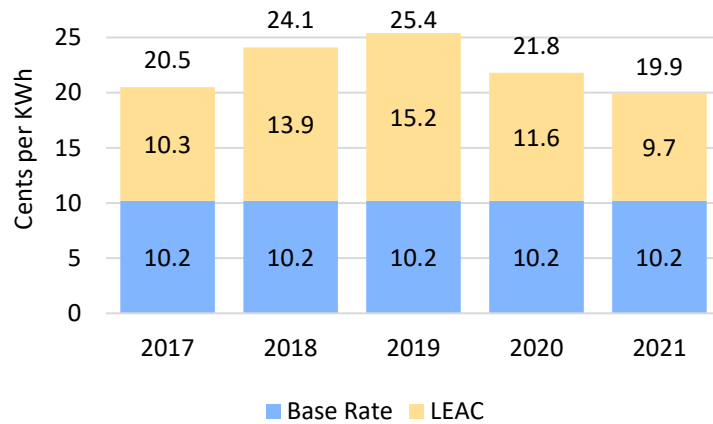
## GPA Rate Structure

- Base rates include fixed costs and non-fuel O&M
- GPA's rate structure consists of a base rate and a Levelized Energy Adjustment Clause rate
- LEAC rates include fuel expense and carrying cost; renewables
- LEAC rates are adjusted semiannually

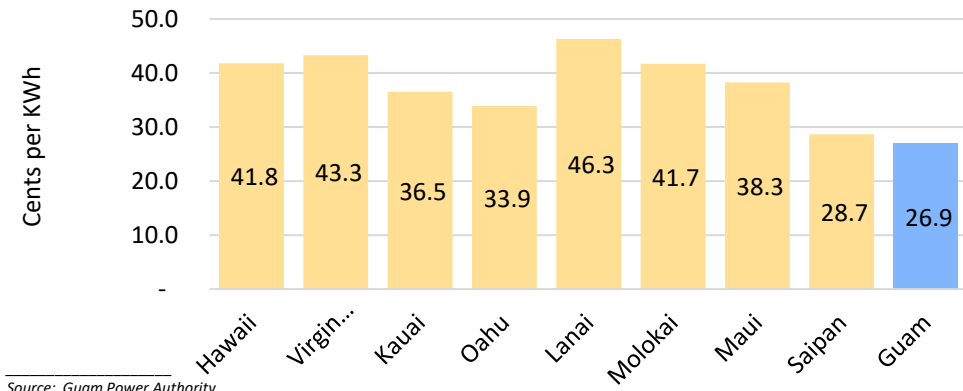
## LEAC Semi-Annual Adjustments



## GPA System Average Rates



## Residential Rate Comparison\*\*



Source: Guam Power Authority.

\* Effective for 1 year reflecting some of the refunding savings from 2012 financing.

\*\* Rates for Guam as of December 1, 2021; Rates for Oahu, Molokai, Lanai, Hawaii and Maui as of January 1, 2022; Rates for Saipan as of January 1, 2022; Rates for Kauai as of January 1, 2022; Rates for Virgin Islands as of July 1, 2021.

# Agenda

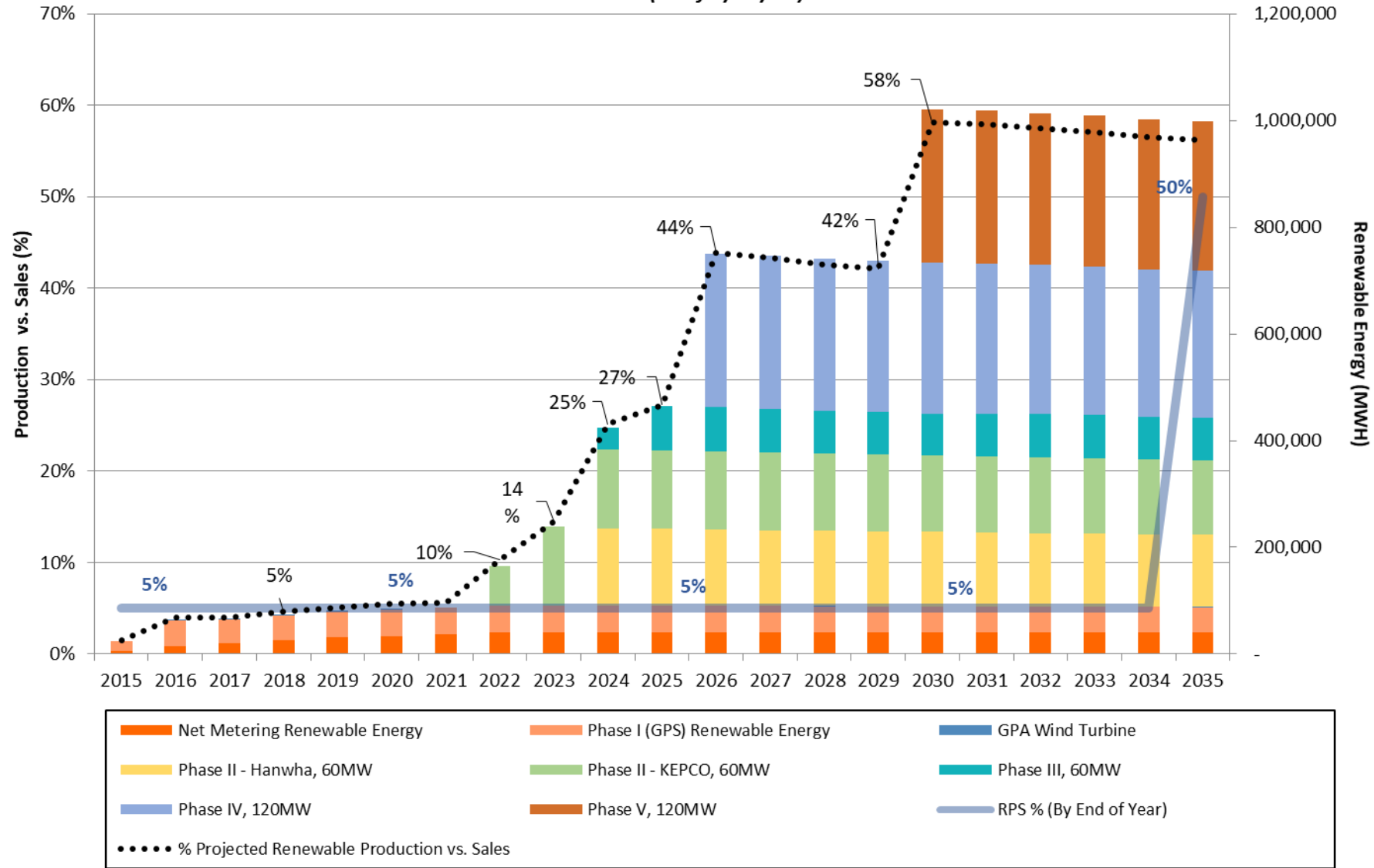
- Hafa Adai!
- Utility Profile
- Begin with the end in mind
- Put First Things First
- GPA Utility Scale BESS
- More BESS, Please
- Next Steps



Begin with the end in mind

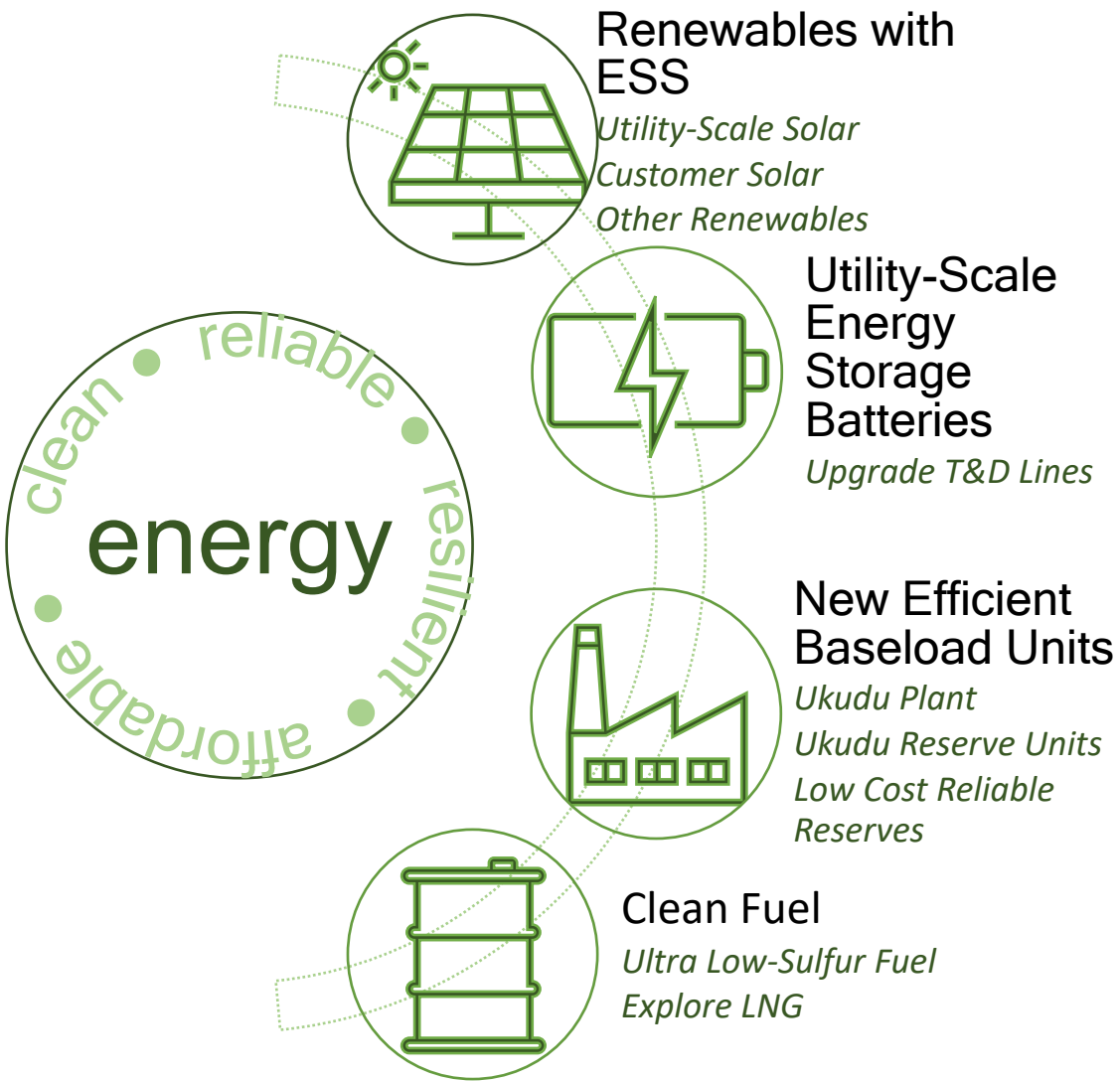
# Renewable Portfolio Standards (RPS) Tracking Projection thru 2035

(as of 3/17/22)

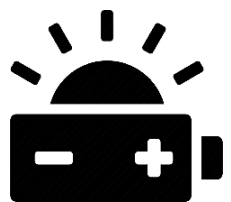



# Define clear measures of success and a plan to achieve them.

- GPA will:
  - Achieve 25% Renewables by 2025; 50% Renewable energy by 2030; and 100% by 2040 while significantly improving energy reliability, affordability, and resiliency for Guam and its customers
  - Delight its Customers
  - Electrify Guam Transportation




## 2025 PROJECTED ACHIEVEMENTS

 **25.30%**  
 Renewable Energy Generation

**(49,152,752)** million gallons reduced oil imports  
 (about \$120M cost reduction) 

 **COMPLIANCE**  
 Consent Decree  
 USEPA Air Quality Standards

**99% IMPROVEMENT**  
 SO2 emissions  
 ↓ **1 million** gallons reduced wastewater outfall 

 **LOWER BILLS**  
 Est. \$0.1162 LEAC gives ratepayers sustainable, affordable rates

# GPA Strategic Goals






- Grid Transformation
- Digital Transformation
- Affordability Transformation
- Customer Experience Transformation
- Foundational Infrastructure

## GPA FOUNDATIONAL INFRASTRUCTURE SOLUTIONS







	<p><b>Human Resource Rebalancing</b> - GPA will soon retire several power plants beginning with Cabras 1&amp;2. GPA must plan to rebalance its workforce considering the displacement of these employees. This must be well in advance of the actual plant retirements.</p>		<p><b>Succession Planning</b> - With over 50% of its workforce eligible to retire within five years, GPA must hire and train new employees to take over. GPA must update its job descriptions and eligibility requirements moving these jobs into the 21st century. Many jobs will have changed because of digital transformation and technology.</p>
	<p><b>Grid Transformation Solutions</b> - Without completion of Grid Transformation Projects, the grid will not be stable, reliable, resilient, and affordable.</p>		<p><b>Smart Grid (SG)</b> - Smart Grid is the grid's information superhighway driving operational improvements and efficiencies.</p>
	<p><b>GPWA Information/Operations Technology (IT/OT) Consolidation</b> - A secure, reliable, and responsive IT/OT organization and infrastructure is critical for supporting GPA's Strategic Transformation.</p>		<p><b>Aging T&amp;D Infrastructure Replacement</b> - Like all other U.S. power utilities, GPA must plan for replacing its aging infrastructure. GPA should invest in an Asset Management ERP capability to guide and manage the replacement process.</p>
	<p><b>Creating Organizational Alignment &amp; Fit</b> - Creating a more resilient, streamlined, and effective organization through process mapping &amp; re-engineering. Incorporating and leveraging information technology into business processes creates the digital transformation shift.</p>		<p><b>Improving Generator Reliability</b> - Achieving 95% GPA generator availability is a cornerstone for grid resiliency, reliability, and affordability.</p>
	<p><b>Cyber and Physical Security (CAPS)</b> - Secure GPA's cyber resources. Secure GPA substations, power plants, and other critical infrastructure facilities.</p>		

- GPA Roadmap to a Clean, Reliable, Affordable, and Resilient Energy Future

## GPA GRID TRANSFORMATION SOLUTIONS TOWARD A HIGHLY RESILIENT, RELIABLE, AFFORDABLE AND HIGH RENEWABLE ENERGY PRODUCTION GRID

	<b>Charge/Discharge-Anytime Battery Energy Storage Systems (BESS)</b> - Provides spinning reserve and frequency regulation. Greatly improves grid response to FIDVR, duck curve ramp ups, and excess solar PV production events. Provides other grid services.		<b>Time-of-Use (TOU) Rates</b> - Provides incentives for customers to change their electricity-use behavior to match the needs of the grid.
	<b>Flexible Efficient Generation</b> - Better follows the changes in demand and available generation online especially when large intermittent sources of power are on the grid. Reduces power rates.		<b>Daytime Charging Electric Vehicles (EV)</b> - Prevents curtailment of synchronous generation and solar PV during excessive solar PV production events when solar PV production is high and daytime loads are low. Slows growth of system peak deferring expensive investments for new capacity.
	<b>Energy Shifting Battery Energy Storage Systems (ES BESS)</b> - Decreases Excess Solar PV Production Events by storing 100% of energy for nighttime use; Replaces expensive production from peaking generation.		<b>Microgrids</b> - Using synchronous generators and Solar PV + energy-shifting battery energy storage systems with grid forming capability to provide power after natural disasters such as typhoons especially in southern Guam.
	<b>Demand Response (DR)</b> - Adjusts customer demand up or down however needed by the grid.		<b>Grid Controller</b> - Optimizes all resources to provide the most benefit at the least cost. Improves system stability and system economics.
	<b>Synchronous Condensers (SC)</b> - Provides Short-Circuit MVA to power system to keep the grid stable, prevents grid-tied inverter cessation, improves fault response and voltage, and allows GPA grid to operate with 100% renewable energy.		<b>Solar Irradiance Sensor Network</b> - Provide real-time estimates of solar PV power production. Forecast solar PV power production. Track cloud cover.
	<b>Smart Grid (SG)</b> - Advanced technology for getting the right information to the right people or systems at the right time to make the right strategic and operational decisions.		<b>System Protection</b> - Improve System Protection to operate in an environment with less synchronous generation and more inverter based resources.
	<b>Energy Efficiency</b> - Energy efficiency has a much higher rate of return than just simply installing solar PV. Putting energy efficiency first lowers energy costs for everyone.		<b>Improving Generator Reliability</b> - Improving GPA generator availability results in serving more load using less generation. It also significantly lowers energy costs.










## GPA DIGITAL TRANSFORMATION SOLUTIONS

	<b>GPWA Information/Operations Technology (IT/OT) Consolidation</b> - A secure, reliable, and responsive IT/OT infrastructure supported by a skilled and capable staff is critical for supporting GPA's Strategic Transformation.		<b>Smart Grid (SG)</b> - The technology enabler for driving operational improvements and efficiencies. The Smart Grid makes possible the transition of GPA manual processes into information-based, digitally enhanced automated processes. Use of smart controls and sensors improves reliability, resiliency, and affordability.
	<b>Creating Organizational Alignment &amp; Fit</b> - Creating a more skilled, resilient, streamlined, and effective organization through process mapping & re-engineering leveraging information and operational technology is the end goal for digital transformation.		<b>Energy Sense Program Outreach</b> - Customer expectations are driven by the customer connection capabilities of the telecom, streaming entertainment, and virtual shopping industries. Building this outreach through relevant content improves GPA's relationships with its customers. The conversion of the manual Energy Sense Rebate Application process to a digital platform supports the objective of digital transformation.
	<b>Business Analytics</b> - The Smart Grid, Energy Sense Web-sites, Internet of Things (IoT) and Third-party content providers are creating more data and information that any individual(s) can analyze the business value for GPA. The use of artificial intelligence engines with defined logic provides GPA the ability to respond in a proactive manner to grid conditions to determine the best resolution for customers.		<b>Simulation and the Digital Twin</b> - In response to extreme natural events, the ability to work remotely along with utilize real-time simulation through a Digital Twin of an energy system allows for continuous learning to GPA engineers and operators.

## GPA AFFORDABILITY TRANSFORMATION SOLUTIONS

	<b>Guam Transportation Electrification</b> - Electric vehicles charging from the grid will increase GPA revenues allowing GPA to reduce rates for everyone. Reduces GPA fleet expenses for fuel and maintenance.		<b>Energy Efficiency</b> - Energy efficiency has a much higher rate of return than just simply installing solar PV. Putting energy efficiency first lowers energy costs for everyone.
	<b>Improving Generator Reliability</b> - Improving GPA generator availability results in serving more load using less generation. It also significantly lowers energy costs.		<b>Flexible Efficient Generation</b> - Better follows the changes in demand especially when large intermittent sources of power are on the grid. Reduces LEAC rates especially when using natural gas.
	<b>Daytime Charging Electric Vehicles (EV)</b> - Slows growth of system peak deferring expensive investments for new capacity resulting in lower future energy costs.		<b>Smart Grid (SG)</b> - Smart Grid systems such as Mobile Workforce Management, Advanced Grid Analytics, Distribution Automation increase work productivity reducing energy costs passed onto customers.
	<b>Energy Shifting Battery Energy Storage Systems (ES BESS)</b> - Decreases Excess Solar PV Production Events by storing 100% of energy for nighttime use; Replaces expensive production from peaking generation. Lowers and stabilizes LEAC rates.		<b>GPWA Information/Operations Technology (IT/OT) Consolidation</b> - Reduces IT/OT capital and operating costs for GPA and GWA. Reduces costs passed onto customers.
	<b>Conservation Voltage Reduction (CVR)</b> - Reduces distribution system line losses lowering LEAC rates. Reduces customer energy consumption.		<b>LNG Infrastructure and Supply</b> - Greatly reduces fuel costs. Significantly lower greenhouse gas emissions. Enables Guam to bunker large gas-fueled ships. Enables Guam to be a regional natural gas hub. Increases GPA revenue streams that can be used to reduce base rates.

## GPA CUSTOMER EXPERIENCE TRANSFORMATION SOLUTIONS

	<b>Guam Transportation Electrification</b> - As customers switch to electric vehicles, their relationship with GPA becomes more critical. Designing the charging experience to delight customers will improve GPA customer experience.		<b>Energy Efficiency</b> - Energy efficiency has a much higher rate of return than just simply installing solar PV. Customers who get rebates or who have better knowledge of the Energy Sense Appliance Rebate Program do not rate GPA as a company unsatisfactory. Getting rebates is a highly positive customer experience.
	<b>Energy Shifting Battery Energy Storage Systems (ES BESS)</b> - Using BESS to provide spinning reserve and frequency regulation improves power quality and reduces customer outages improving the GPA customer experience. GPA addition of renewable energy improves customer satisfaction with GPA as a company.		<b>Smart Grid (SG)</b> - Smart Grid systems can reduce the number of customer outages improving the GPA customer experience.
	<b>Conservation Voltage Reduction (CVR)</b> - Reduces distribution system line losses lowering LEAC rates. Reduces customer energy consumption.		<b>Conversion of Manual Customer-Facing Processes to Digital Ones</b> - Customer expectations for service are being driven by the telecom, virtual commerce, and entertainment industries. Going digital improves the GPA customer experience. Going digital includes online payment portals, mobile apps, and Energy Sense online rebate application processing, and more.
	<b>Customer Outreach</b> - Customers want to be informed about GPA outages, rates, and other GPA matters. Building this outreach improves GPA's relationships with its customers. It also defuses disinformation.		<b>Energy Sense Program Outreach</b> - Customers want to be informed about energy efficiency, renewable energy, and ways to lower their power bills. Building this outreach improves GPA's relationships with its customers.
	<b>GPWA Information/Operations Technology (IT/OT) Consolidation</b> - Reduces IT/OT capital and operating costs for GPA and GWA. Reduces costs passed onto customers.		



Put First Things First

# Top Three Projects Plus One

- Without the top three priority Projects, the Guam grid will not be stable nor resilient
  1. Relay Upgrade
    - a. Reduce critical clearing times on the 115 KV system to 5 cycles or less
    - b. Reduce critical clearing times on the 34.5 KV system to 6 cycles or less
  2. Synchronous Condenser Conversions
    - a. Convert Existing CTs for Synchronous Condenser Operation
    - b. Build a standalone Synchronous condenser by 2025 (Prior to Phase IV COD)
  3. Grid Controller
    - a. AI Based Power System Control – Fly-by-Wire Grid
    - b. Automatic Generation Control
    - c. Unit Commitment
    - d. Utility Scale BESS charge and Discharge Management
    - e. EV Charging Control Management
    - f. Synchronous Condenser Commitment
    - g. Solar PV Curtailment Management

# Plus One: Standalone Energy-Shifting BESS

- Prevents Excess Solar PV Production Events
  - GPA has no interconnecting Tie lines with other Utilities to offload overproduction of energy from renewables when day loads are low
  - Gives GPA flexibility of dispatching Flexible Generation on natural gas for economics
  - Provides grid services such as spinning reserve and frequency regulation
- Provides GPA the Option of securing Solar PV with energy-shifting BESS or without energy-shifting BESS
  - Reduce Solar PV Contract Price
- 75 MW/300 MWH BESS

# Estimated Budget

Priority	Project	Description	Estimated cost (\$)
1	Relay Upgrade	Implement RIS recommendation for reduced fault clearing time.	\$ 5,000,000
2	Synchronous Condenser Conversions (Based on Leidos Report, 11/12/2021)	Macheche CT - Add clutch	\$ 7,732,336
		Yigo CT - Add clutch	\$ 7,732,336
		Dededo CT - Add clutch	\$ 7,732,336
		Piti 7 CT - Add clutch	\$ 9,747,651
	Stand-alone Synchronous Condenser	Study in Progress to Size Synchronous Condenser	TBD
3	Grid Controller	Implementation of RIS Recommendation	\$ 1,500,000
Plus One	Standalone BESS	75 MW/300 MWH Standalone BESS	\$ 131,250,000
<b>Total</b>			<b>\$ 170,694,659</b>

GPA Utility Scale BESS

# BESS Now

- 2014 Energy Storage Feasibility Study recommended 70 MW BESS to reduce UFLS by 75%.
- Hagatna (Agana) Spinning Reserve BESS is nominally a 24 MW/6 MWh BESS but this is guaranteed capacity after 20 years. It is actually a 40 MW BESS
- Talofofo BESS is a firming and Shaping BESS for 26 MW DanDan Solar PV Plant
- All future GPA Utility Scale Solar PV PPAs are to include energy shifting BESS. Solar PV is DC-Coupled to BESS to reduce SC-MVA requirements. These BESS will share in frequency regulation and spinning reserve.
- Phase III is an aggregate of 60 MW and 300 MWH BESS across Naval Base Guam and South Finegayan. First GPA Dispatchable Solar PV Power Plant. Engie price is 11 cents/kWH.

# O&M Contract

- 25-year O&M contract with LG CNS
- 20-year warranty
  - 95% minimum availability
  - 85% minimum AC-AC round-trip efficiency
  - Agana ESS: Frequency regulation within  $60 \pm 0.15$  Hz with 95% success rate
  - Talofofa ESS: Solar farm ramp-rate control within 250 kW/min with 97% success rate
  - 0.25% annual degradation allowed

# Agana ESS

- Lithium-ion Battery Energy Storage System
- BESS Size
  - 24 MW / 6 MWh
  - Discharge or charge at constant 24 MW full capacity for 15 minutes at full state of charge
- Control Functions
  - Frequency Regulation
  - Spinning Reserve



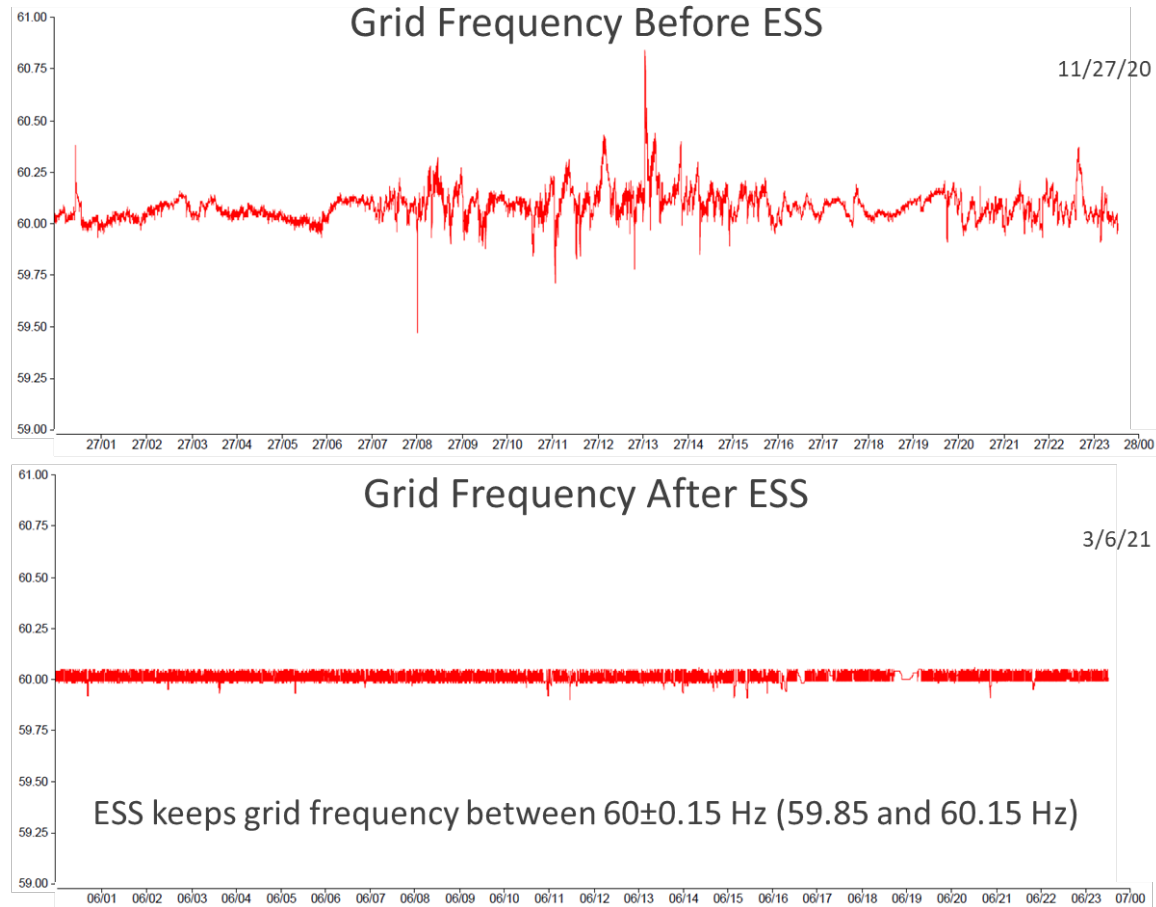
# Agana ESS Site Location



# Agana ESS Site Layout



# Agana ESS Frequency Regulation



# Agana ESS Spinning Reserve

ESS provides significant reduction in customer outages for Piti 8&9 trips

Date	Unit(s) Tripped	Agana ESS Status	Feeders Tripped
→ 2021 Mar 01	Piti 8&9	Online	5
2021 Jan 16	Piti 8	Offline	14
2021 Jan 15	Piti 8&9	Offline	11
2020 Jan 11	Piti 8	Offline	21
2020 Nov 09	Piti 8	Offline	14
2020 Oct 24	Piti 8	Offline	20

# Talofofu ESS

- Lithium-ion Battery Energy Storage System
- BESS Size
  - 16 MW / 16 MWh
  - Discharge or charge at constant 16 MW full capacity for 1 hour at full state of charge
- Control Function
  - Ramp-Rate Control for Dandan Solar Farm
  - Firming and Shaping BESS

# Talofofo ESS Site Location



# Talofofu ESS Site Layout



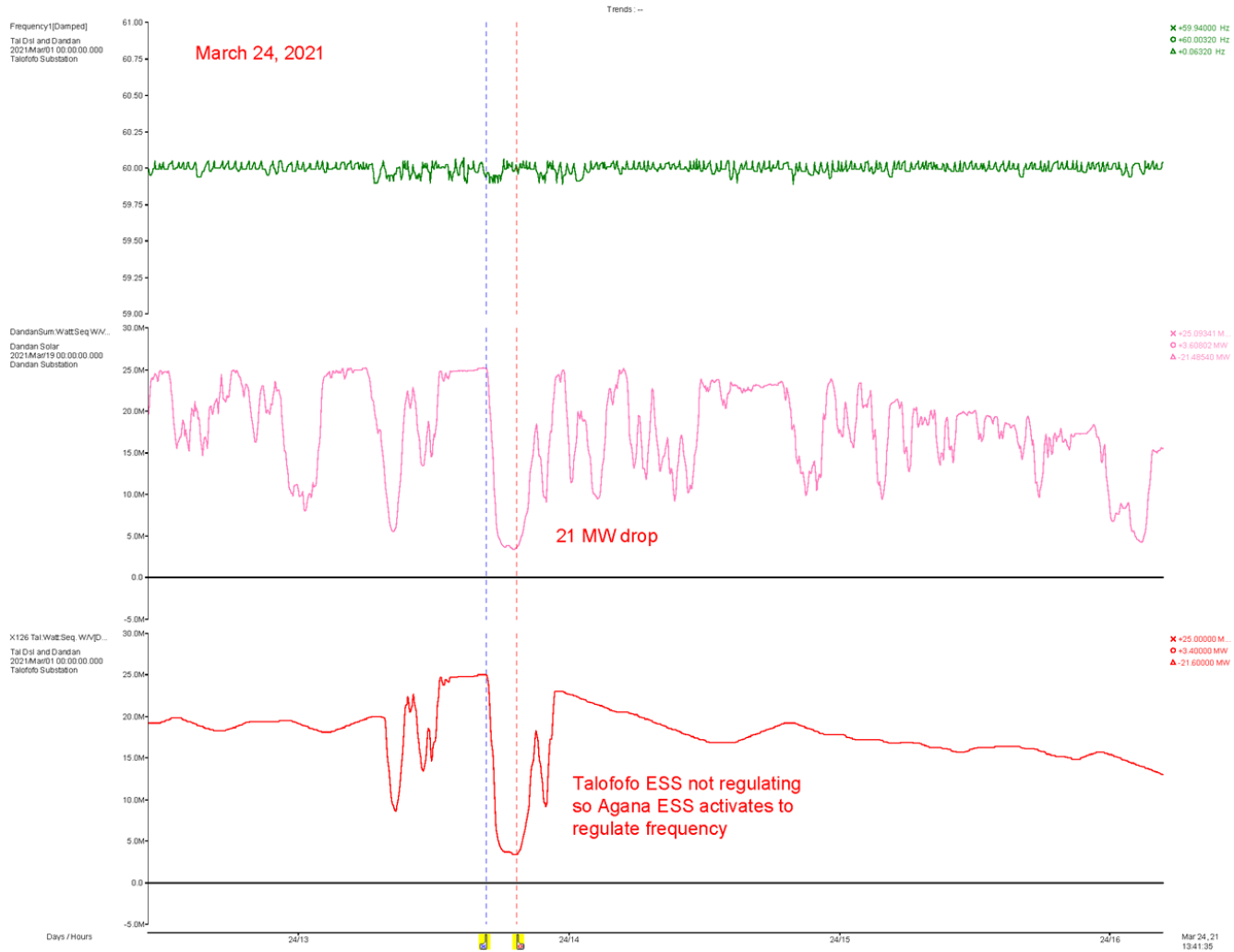


Figure 14-3. Talofoto BESS not Operating. Agana BESS activates to Smooth Frequency



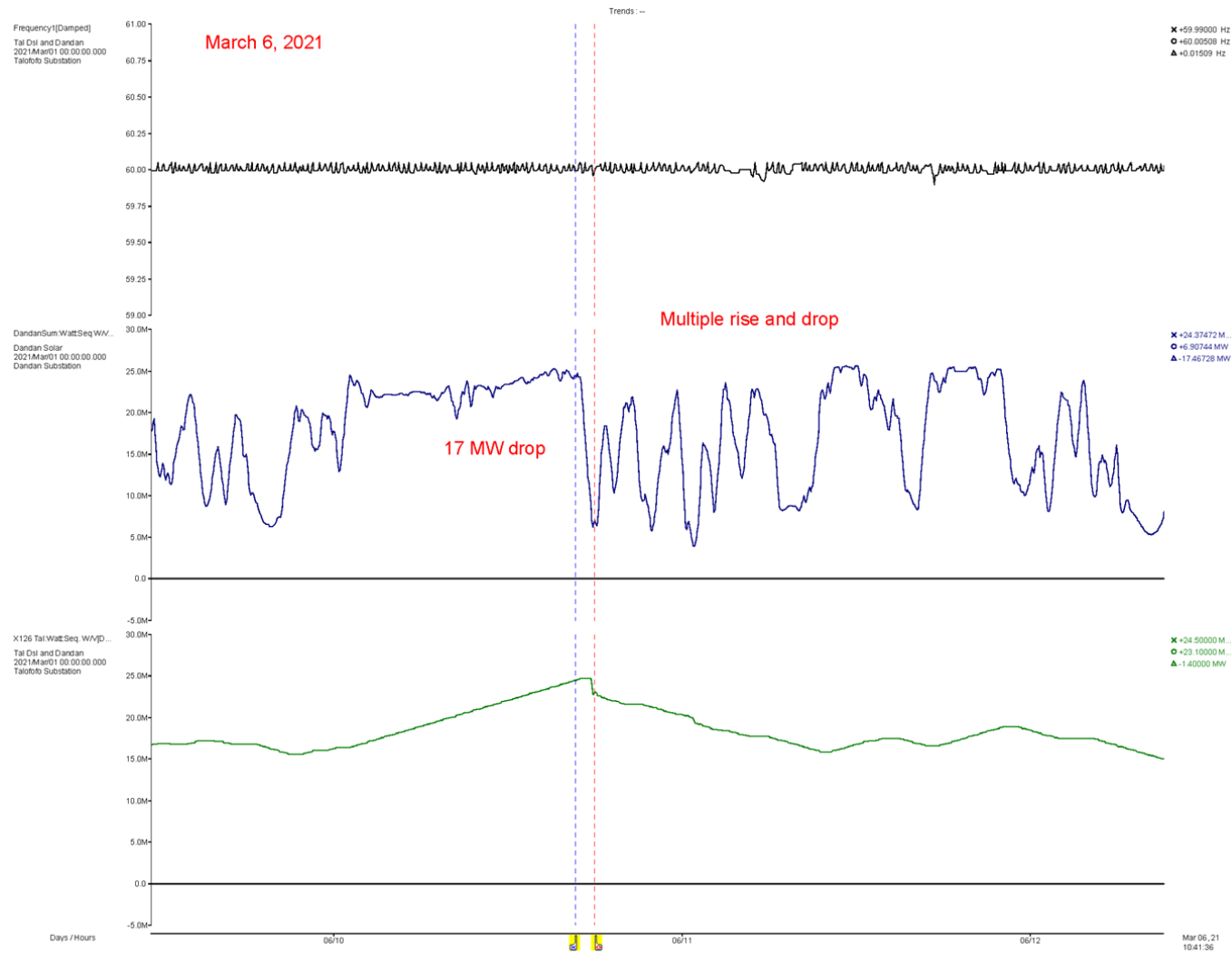


Figure 14-2. Talofoto BESS Smoothing Solar PV Plant Intermittency and Dropouts

# More BESS, Please



# Next Steps

- **GPA needs funding and Technical Support**

- Guam is a city-sized, Island grid
- The Guam Grid is a weak grid and the technical innovations highlighted in this presentation and in the 2022 Clean Power Master Plan can make immediate, huge performance improvements to energy reliability, resiliency, and affordability.
- Our LEAC (Fuel Charge) is headed for \$0.20/KWH . Our Phase II contracts are 8.5 cents/kWh or less.
- Increasing the penetration of fixed price renewable energy contracts will eliminate oil price volatility experienced by GPA customers stabilizing the economy and ensuring energy affordability and peace of mind to DoD and civilian customers

Thank you. Si Yu'us Maase