D GRAHAM BOTHA, ESQ.
General Counsel
Guam Power Authority
688 Route 15, Suite 302
Mangilao, Guam 96913
Ph: (671) 648-3203/3002
Fax: (671) 648-3290

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Public Utilities Commission
GUAM

BEFORE THE GUAM PUBLIC UTILITIES COMMISSION

IN THE MATTER OF: The Guam Power Authority 2022 Integrated Resource Plan (IRP)	**GPA DOCKET NO. 22-08** **FILING OF GUAM POWER AUTHORITY 2022 INTEGRATED RESOURCE PLAN (IRP)**

COMES NOW, the GUAM POWER AUTHORITY (GPA), by and through its counsel of record, D. GRAHAM BOTHA, ESQ., and hereby files the Guam Power Authority (GPA) 2022 Integrated Resource Plan (IRP). The 2022 GPA IRP focuses on how to achieve additional operational savings through efficiencies and to implement projects and programs to support achieving the 50% Renewable Portfolio Standard, grid security, stability and reliability while also achieving reduction in greenhouse gas emissions. The primary recommendations of the 2022 IRP include no additional synchronous generation resources required in the next 10 years with the addition of the new Ukudu Power Plant (198MW) and the Cabras Reserve Facility (41MW); procurement of renewable energy contracts with an annual 300,000 MWH by 2025 and another 300,000 MWH by 2029; execute portfolio of about $233M in projects necessary to additional renewables integration with the grid; optimization of infrastructure to improve operations and reduce costs; implement demand side management programs; and implement charging facilities for growth in electric vehicles. In support of this Petition, GPA hereby provides the PUC with Consolidated Commission on Utilities (CCU) Resolution No. FY2022-08, which authorizes the General Manager to submit the 2022 IRP to the PUC for review and

approval. Said resolution and its exhibits are attached herein as Exhibit A, and incorporated by reference herein as if fully set forth.

RESPECTFULLY SUBMITTED this 28th day of January, 2022.

D. GRAHAM BOTHA, Esq.
GPA General Counsel

CONSOLIDATED COMMISSION ON UTILITIES
Guam Power Authority | Guam Waterworks Authority
P.O. Box 2977 Hagatna, Guam 96932 | (671) 648-3002 | guamccu.org

GPA RESOLUTION NO. FY2022-08

APPROVAL OF THE 2022 INTEGRATED RESOURCE PLAN

WHEREAS, the Integrated Resource Plan (IRP) is a process that evaluates the need for new generation resources to meet future load growth at reduced and lower rates on a sustainable basis, address environmental requirements and optimize costs and sets the stage for projects and activities over the next 10 years; and

WHEREAS, since 2008, the common strategic initiatives through the past IRP's have been:

- Fuel Diversity, fuel supply risk, and renewable energy;
- Supporting the electric power service requirements for the impending Department of Defense (DOD) build-up and its economic consequences;
- Acquisition of new electric energy supply and its implication on human resource requirements and the Authority business model; and

WHEREAS, through the 2008 IRP recommendations for renewable energy, GPA was able to contract its first renewable energy contract and initiate evaluation of fuel diversification to reduce costs; and

WHEREAS, from the 2012 IRP and its update in 2016, the IRP also considered and addressed environmental compliance requirements which have resulted in the contracting of additional renewable energy contracts and the new Ukudu Power Plant as well as the fuel conversion and retirement plans for Cabras and Piti units; and

WHEREAS, with the Ukudu Power Plant set for commissioning in 2024 and GPA commitment to a 50% Renewable Portfolio Standard by 2030, the 2022 IRP focuses on to how to achieve additional operational savings through efficiencies and to implement projects and programs to support these as well as to support grid security, stability and reliability while also achieving reduction in greenhouse gas emissions; and

WHEREAS, the 2022 IRP recommends the following:

- No additional synchronous generation resources are required in the next 10-20 year with New Ukudu Power Plant (CCCP & Reserve Facility) contingent on the amount of synchronous generation retired;
- Initiate procurement for renewable energy contracts for additional annual 300,000 MWH by 2025 and another 300,000MWH by 2029 to achieve 50% Renewables by 2030;

- Execute portfolio of about $233M in projects and initiatives for integration of renewables;
- Continued analysis of distributing circuits to determine projects necessary to mitigate negative impacts attributed to uncontrolled solar roof top generation;
- Increase optimization of infrastructure to enhance and improve operations and reduce costs;
- Continue to evaluate and implement demand side management programs and programs to address EV charging to reduce impacts on peak system, harmonics, 3-phase power unbalance, and power quality;
- Evaluate and implement charging facilities as necessary to support growth in electric vehicle utilization;
- Implement IT/OT Shared Services Transformation between GPA and GWA to support GPA increased IT operation; and

WHEREAS, the review and approval of the IRP allows dialogue between GPA, CCU and the Public Utilities Commission and an understanding and reasoning of the GPA project planning and activities over the next 10 years;

WHEREAS, the approval of the IRP does not waive necessary procurement or contract protocols that may require CCU and PUC approvals and GPA will continue to follow these processes as required.

NOW THEREFORE, BE IT RESOLVED, by the CONSOLIDATED COMMISSION ON UTILITIES as the governing body of GPA, and subject to the review and approval of the Public Utilities Commission as follows:

1. The General Manager of the Guam Power Authority is hereby authorized to submit the IRP to the PUC for review and approval.

RESOLVED, that the Chairman of the Commission certifies and the Board Secretary attests the adoption of this Resolution.

DULY and REGULARY ADOPTED AND APPROVED THIS 25TH DAY of JANUARY, 2022

Certified by:

JOSEPH T. DUENAS
Chairperson
Consolidated Commission on Utilities

Attested by:

MICHAEL LIMTIACO
Secretary
Consolidated Commission on Utilities

I, Michael Limtiaco, Secretary for the Consolidated Commission on Utilities (CCU), as evidenced by my signature above do certify as follows:

The foregoing is a full, true, and correct copy of the resolution duly adopted at a regular meeting of the members of Guam Consolidated Commission on Utilities, duly and legally held at the meeting place properly noticed and advertised at which meeting a quorum was present and the members who were present voted as follows:

Ayes: 5

Nays: ϕ

Absent: ϕ

Abstain: ϕ

2021 INTEGRATED RESOURCE PLAN

January 2022

Overview

The **Integrated Resource Plan** (IRP) historically focused on the evaluating the need for new generation resources to meet future load growth, address environmental requirements and optimize costs. With the Ukudu Power Plant set for commissioning in 2024 and GPA commitment to a 50% Renewable Portfolio Standard by 2030 the focus has shifted to how to achieve additional operational savings through efficiencies and to implement projects and programs to support these as well as to support grid security, stability and reliability while achieving meaningful GHG emissions reductions.

GPA's balanced approach to reducing GHG emissions includes: ***Energy Efficiency, Renewable Energy, Grid Transformation, and Transportation Electrification.***

The American Council for an Energy Efficient Economy as well as studies performed for the US EPA maintain that the United States can achieve up to 50% of its targeted GHG emissions reductions through energy efficiency.

Summary

- No additional generation resources are required in the next 10-20 year with New Ukudu Power Plant (CCCP & Reserve Facility)
- **To achieve 50% Renewables by 2030 would require:**
  - 300,000 MWh (188 MW Capacity) by December 31, 2025
  - 300,000 MWh (188 MW Capacity) by December 31, 2029 for **LOW** load forecast scenario or 350,000 MWh (220 MW Capacity) by December 31, 2029 for **HIGH** load forecast scenario
  - Once CCU and PUC approvals are received, GPA would issue procurements packages
  - IRP adjusted load forecast to project about 30.8 MW of solar roof top renewables thru the next 10 years
- The IRP provides a portfolio of about **$233M** in projects and initiatives for integration of renewables.
- Synchronous Condensers are required to support increased solar penetration on the grid for grid stability. Renewable Integration Study recommendations must be completed soonest. Some existing older generators should be converted to Synchronous Condensers
- Increased optimization of infrastructure will enhance and improve operations and reduce costs
- Continued evaluation and implementation of demand side management programs and programs to address EV charging to reduce impacts on peak system, harmonics, 3-phase power unbalance, and power quality.
- CIP Budget for IT/OT Shared Services Transformation is $2,710,280
- **The IRP provides a portfolio of projects and initiatives for:**
  - *Grid Transformation*
  - *Customer Experience Transformation*
  - *Energy Affordability Transformation*
  - *Digital Transformation*
  - *Foundational Infrastructure*

Project Priority	Project Name	Project Description	Total Project Budget ($)	Priority Total - No CT Capacity Retired	FY Start	FY End
1	Relay Upgrade	Implement RIS recommendation for reduced fault clearing time.	$ 5,000,000.00	$ 5,700,000.00	2022	2025
	Adaptive Underfrequency Load Shedding (UFLS)	AUFLS study	$ 50,000.00			
		AUFLS imlementation	$ 300,000.00			
	Adaptive Under Voltage Load Shedding (UVLS)	AUVLS study	$ 50,000.00			
		AVULS imlementation	$ 300,000.00			
2	Synchronous Condenser Conversions (Based on Leidos Report, 11/12/2021)	Macheche CT - Add clutch	$ 7,732,335.96	$ 32,944,658.59	2023	2025
		Macheche CT - Demo CT and add motor/static start ** Only if retiring capacity	$ 5,485,680.22			
		Yigo CT - Add clutch (assumed same costs as Macheche)	$ 7,732,335.96			
		Yigo CT - Demo CT and add motor/static start (assumed same cost as Macheche) ** Only if retiring capacity	$ 5,485,680.22			
		Dededo CT - Add clutch	$ 7,732,335.96			
		Dededo CT - Demo CT and add motor/static start ** Only if retiring capacity	$ 5,485,680.22			
		Piti 7 CT - Add clutch	$ 9,747,650.70			
		Piti 7 CT Demo CT and add motor/static start ** Only if retiring capacity	$ 6,598,280.25			
	Stand-alone Synchronous Condenser	Study in Progress to Size Synchronous Condenser	TBD			
	Standalone BESS	75 MW/300 MWH Standalone BESS	$ 131,250,000.00	$ 131,250,000.00	2022	2024
3	Grid Controller	Implementation of RIS Recommendation	$ 1,500,000.00	$ 3,300,000.00	2022	2023
	Synchrophasor Network	Provide Information for Grid Controller to detect impending system instabilities	$ 1,800,000.00			
4	Malojloj - Hagatna 115 KV Line	Implementation of RIS Recommendation	$ 46,000,000.00	$ 46,000,000.00	2023	2026
5	Demand Response Programs	Customer ESS Pilot Project: Use BESS to reduce demand charges for large customers. (Energy Sense Funds)	$ 500,000.00	$ 6,124,588.50	2022	2025
		Water Heater DLC Programs	$ 3,124,588.50			
		Streetlight Dimming Control	$ 2,500,000.00			
	Demand Response with GWA	Use of GPA backup generation as demand response resource.	TBD			
6	Remote Start/Stop/Autostart	Tenjo Vista Power Plant	$ 430,000.00	$ 3,280,000.00	2023	2025
		Yigo CT	$ 950,000.00			
		Macheche CT	$ 950,000.00			
		Dededo CT				
		Piti 7 CT	$ 950,000.00			
7	Umatac Microgrid	Relocation and resiting 15-MW from Yigo to Umatac	$ 4,145,200.00	$ 4,220,200.00	2023	2025
		Self-forming Microgrid bid specifications	$ 75,000.00			
8	Solar Irradiance Sensor Network	Procure Razon Solar Irradiation Sensors	$ 61,425.00	$ 151,425.00	2023	2023
		Build out Sensor network. Configure data communications from sensors to SCADA. Configure SCADA displays and database.	$ 10,000.00			
		Configure data communications from irradiance sensors to L+G AGA to compute real-time NEM PV output.	$ 80,000.00			
	TOTAL			**$ 232,970,872.09**		

Contents

Volume 1

GENERATION SYSTEM RELIABILITY, ADEQUACY AND RESILIENCY

An in-depth examination of GPA Generation System Reliability, Adequacy & Resiliency to determine baseline conditions is necessary to support future growth and considerations in retirement of existing units.

The activities in evaluating these requirements include:

- Creation of mathematical models to analyze GPA System Reliability
- Evaluation of how the following affect overall Generation System Reliability (Peak Load Carrying Capability (PLCC)
  - GPA Legacy Generation Reliability
  - Solar PV + Energy-Shifting BESS additions
  - Retirements of Legacy Generation
- Examination of how increasing renewable energy without energy-shifting Battery Energy Storage System (BESS) affects GPA Costs and Operations.
- Evaluation of how increase additions of inverter-based systems affect the grid requirements and inverter capability requirements

Volume 1 *(continued)*

GENERATION SYSTEM RELIABILITY, ADEQUACY AND RESILIENCY

- Summary and consideration of the FRONTIER Project which evaluates several threat Scenarios to make recommendations to improve Guam Energy Resiliency.
- Evaluation of the need for GPA to implement a state-of-the-art AI-based Grid Controller to manage Solar PV Curtailment, Security Constrained Economic Dispatch, Automatic Generation Control, EV Charging Management, BESS charging Management, Fast Frequency Regulation/Response, Demand Response, Volt/Var Management, System Instability Detection & Proactive Response
- Other evaluations such as System Protection Needs, Demand Response Programs and EV Charging on GPA grid.

The following are the recommendation and conclusions of this study:

- Maintain a Legacy Generation Availability of 95%
- Schedule Major Maintenance during March (lowest daily System Peak & highest daily Solar PV production)
- Recommend a minimum installed reserve policy of 200 MW for Ukudu Steam Turbine Outages.
- Evaluation of Optimum Generation Outage Scheduling for Ukudu Steam Turbine Outages
- Complete the Renewable Integration Study Recommended Projects
- Implement Adaptive Under-Frequency Load Shedding (AUFLS) and Adaptive Under Voltage Load Shedding (AUVLS)
- Procure and Implement Grid Transformation Solution Projects

Volume 2

GENERATION EXPANSION PLAN

This plan evaluates new resource options to meet energy requirements for the next 20 years.

Summary of analysis is presented that considers various scenarios based on:

- Forecasted fuel prices
- Forecasted load requirements (MW)
- Reliability study recommendations
- Environmental strategic plan recommendations
- Consent Decree and State Implementation Plan requirements
- Renewable Portfolio Standards (RPS)
- Estimated current generating units' availability

Volume 2 *(continued)*

GENERATION EXPANSION PLAN

+ Phase III RRA
+ Phase IV RRA
+ Phase V RRA

Scenario		NPV Cost (MM)	Savings from BASE (MM)	Lowest RM after 2024 (%)	2024	2025	Units Built: 2026	2027	2028	2029	2030	2031
Fuel Price Forecast for ULSD set to 2030 price for the rest of study period; no escalation.												
RA2-A	Base	$ 4,260.45		94.45								
RA2-B	Base+345	$ 4,054.09	$ 206.37	133.28								
RA2-D	Base+345-Piti89	$ 4,010.03	$ 250.42	106.28								
RA2-E	DC	$ 4,480.55	$ (220.09)	83.01								
RA2-F	DC+345	$ 4,284.68	$ (24.22)	119.56								

Cases assume Phase 1 and 2 renewable resources online:

- **No additional renewable contracts and no existing units retiring** => No new units built for the Base Case with Base Load Forecast (A) and the Base Case with Data Center (High) Load Forecast (RA2-E)
- **Addition of Phases 3,4, and 5 renewable contracts and no existing units retiring** => No new units built (RA2-B and RA2-F)
- **Base Case with Base Load Forecast and Piti 8&9 retired** => No new units built (RA2-D)

Volume 2 *(continued)*

GENERATION EXPANSION PLAN

+ Phase III RRA
+ Phase IV RRA
+ Phase V RRA

Scenario		NPV Cost (MM)	Savings from BASE (MM)	Lowest RM after 2024 (%)	2024	2025	Units Built: 2026	2027	2028	2029	2030	2031
Fuel Price Forecast for ULSD set to 2030 price for the rest of study period; no escalation. Piti 8&9 retire on 1/1/2029, all others retire on 1/1/2024.												
RA2-H	DC+345-Piti89	$ 4,279.99	$ (19.54)	119.56								
RA2-H_R1	DC+345-Piti89Piti7	$ 4,266.35	$ (5.89)	108.00								
RA2-H_R2	DC+345-Piti89Tenjo	$ 4,257.24	$ 3.22	111.79								
RA2-H_R3	DC+345-Piti89TenjoMDI	$ 4,253.37	$ 7.09	108.73								
RA2-H_R4	DC+345-Piti89TenjoYCT	$ 4,235.43	$ 25.02	106.20								
RA2-H_R5	DC+345-Piti89TenjoMDIYCT	$ 4,231.56	$ 28.89	103.14								
RA2-H_R6	DC+345-Piti89Piti7Tenjo	$ 4,243.59	$ 16.86	100.23								
RA2-H_R7	DC+345-Piti89Piti7TenjoMDI	$ 4,239.72	$ 20.73	97.17								

- **High Load Forecast with retirement of Piti 8&9 and combination of other units (Piti 7, Tenjo, MDI, Yigo CT)** => No new units built

Volume 2

GENERATION EXPANSION PLAN

Recommendations

GPA must commit to:

- Acquisition of energy from renewable resources to meet the RPS (Phase 4 RRA onwards): Renewable Energy + Energy-Shifting BESS or firm power renewable technologies
- Continuous investigation of possible unit retirements and capital improvements needed for the existing generating units
- An update of the LNG study with impact of increasing renewable energy in the system
- Complete projects recommended in the Renewable Integration Study including, but not limited to:
  - System impact studies
  - Analysis of short-circuit MVA requirements
  - Conversion of GPA's CT units into synchronous condensers
  - System protection upgrades

Volume 3

2018 Environmental Strategic Plan & Addendum

The Environmental Strategic Plan (ESP) addresses the environmental regulations applicable to GPA power generating plants.

As an addendum to the 2018 ESP, GPA summarizes the most recent requirements from the April 2020 Consent Decree and the 2020 State Implementation Plan (both of which are still in progress).

This includes the following projects:

- Conversion of Cabras 1&2 fuel to 0.2%S RFO, and retirement after the Ukudu Power Plant is placed online
- Conversion of Piti 8&9 fuel to ULSD

Continuous monitoring and managing of USEPA regulations are required to prepare for compliance deadlines. GPA continues to research on and pursue recommendations from the 2018 Environmental Strategic Plan.

Volume 3 *(continued)*

2018 Environmental Strategic Plan & Addendum

2018 ESP Key Initiatives and Recommendations:

- Expanded, aggressive compliance program
- Inclusion of Fuel Supply System in GPA Continuing Obligations
- Compliance Review for Temporary Power Generation
- Asset Retirement or De-activation
- Continue work on decreasing hazardous air emissions – DSM programs, electric vehicles, renewable energy contracts, execution of compliance options for current/older power plants
- Investigation of Utility-scale and Island-wide use of Electric Vehicles
- Investigation on proper disposal of Solar PV Panels and Lithium Ion Batteries
- Regulatory Compliance and Solicitation for New Generation
- Continue tracking, monitoring of compliance requirements, Clean Power Plan (CPP), Affordable Clean Energy (ACE) Rule

Volume 4

Demand Side Management Plan

This Volume discusses the Demand Side Management (DSM) Program. DSM is much more that just the appliance rebate program.

It consists of these major activities:

- Energy Sense Appliance Rebate Program
- Energy Sense Appliance Residential and Small Non-Residential Energy Audit Program
- Marketing
- Metering & Verification
- Utility Energy Services Contracting (UESC)
- Grant Funded Projects
- Organizational Infrastructure
- Pilot Project Programs
- Demand-Response Programs (Future)

Volume 4 *(continued)*

Demand Side Management Plan

- Expanding the appliance rebate program to include commercial customers to fulfill part of PUC Order Docket 13-14.
- Reset of the current residential rebate program incentive levels to ensure that GPA is not over funding the cost of the appliances.
- Adding an online service (DSM (Online) Digitization) will allow GPA to improve the program by increasing efficiency, reduce errors, consolidate business tools, and record and extract data for analysis and reporting.
- Partnering with Siemens under UESC contract allows to provide Navy, UOG, GDOE, private schools (Guam Energy Office) with energy efficient projects and accomplishes the grant funded projects.
- Marketing allows to conduct surveys and promote the commercial rebate program and DSM Digitization
- LEAC funding enable GPA to meet the PUC's DSM mandates.

Volume 4 *(continued)*

Demand Side Management Plan - Commercial Rebate Levels

Commercial Program Description	Rebate ($ Per Ton)
Ductless Split Air Conditioning Units	
≥ 18 SEER and < 21 SEER	105
≥ 21 SEER and < 25 SEER	135
≥ 25 SEER	155
Ducted Central Air Conditioning Units	
< 5 Ton	
≥ 17 SEER and < 21 SEER	230
≥ 21 SEER and < 25 SEER	300
≥ 25 SEER	350
≥ 5 Ton	
≥ 16 IEER and < 18 IEER or (≥ 11 EER and < 12 EER Expire in 2024)	175
≥ 18 IEER and < 20 IEER or (≥ 12 EER and < 13 EER Expire in 2024)	230
≥ 20 IEER or (≥ 13 EER Expire in 2024)	320

Commercial Program Description	Rebate ($ Per Ton)
Variable Refrigerant Flow Units	
< 5 Ton	
≥ 17 SEER and < 21 SEER	230
≥ 21 SEER and < 25 SEER	300
≥ 25 SEER	350
≥ 5 Ton	
≥ 16 IEER and < 18 IEER or (≥ 11 EER and < 12 EER Expire in 2024)	175
≥ 18 IEER and < 20 IEER or (≥ 12 EER and < 13 EER Expire in 2024)	230
≥ 20 IEER or (≥ 13 EER Expire in 2024)	320
Package Rooftop Units	
< 5 Ton	
≥ 17 SEER and < 21 SEER	230
≥ 21 SEER and < 25 SEER	300
≥ 25 SEER	350
≥ 5 Ton	
≥ 16 IEER and < 18 IEER or (≥ 11 EER and < 12 EER Expire in 2024)	175
≥ 18 IEER and < 20 IEER or (≥ 12 EER and < 13 EER Expire in 2024)	230
≥ 20 IEER or (≥ 13 EER Expire in 2024)	320

Volume 4 *(continued)*

Demand Side Management Plan - Residential Rebate Levels (Current vs. Reset)

Programs	Current Rebate ($)	Reset Rebate ($ Per Ton)
Ductless Split Air Conditioning Units		
< 1 Ton		
≥ 18 SEER and < 21 SEER	100	79
≥ 21 SEER and < 23 SEER	200	131
≥ 23 SEER	250	131
≥ 25 SEER		158
≥ 1 Ton		
≥ 16 SEER and < 21 SEER	200	105
≥ 21 SEER and < 22 SEER	300	175
≥ 22 SEER and < 25 SEER	325	175
≥ 25 SEER and < 28 SEER	350	210
≥ 28 SEER	600	210
Ducted Central Air Conditioning Units		
≥ 3 Ton and < 4 Ton		
≥ 16 SEER and < 21 SEER	500	140
≥ 4 Ton		
≥ 18 SEER	800	140

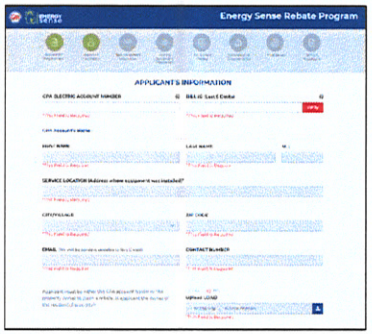
Programs	Current Rebate	Reset Rebate
Washer Units	$ 200 per Unit	$ 20 per Unit
Dryer Units	$ 200 per Unit	$ 40 per Unit

Volume 4 *(continued)*

Demand Side Management Plan

- DSM Digitization
  - Customer fill-out, submit rebate application form and tract rebate status online
  - GPA process and approve rebate online

- UESC Contract
  - UOG Investment Grade Audit and Energy Efficient Projects
  - AAFB Energy Efficient Project
  - Navy Base Guam Preliminary Audit
  - UOG Energy Efficient Model House Pilot Project
  - B.P Carbullido Elementary School Energy Efficient Retrofit Pilot Project
  - Guam BEST School Program – GDOE and Private Schools (partnered w/ GEO)



Volume 4 *(continued)*

Demand Side Management Plan - On-going Projects Timeline

- Commercial Rebate Program Roll-out
- Soft Roll-out: Ductless Split and Central Ducted (under 5 ton) – June 2021
  - Central Ducted (over 5 ton), Variable Refrigerant Flow (VRF) and Package Rooftop - January 2022
- DSM (Online) Digitization Go Live - February 2022
- UOG Energy Efficient Project - June 2022
- AAFB Energy Efficient Project - January 2022
- NBG Preliminary Audit - January 2022

Volume 5

Medium-Range Distribution Plan

Distribution System Analysis and Planning is required to determine the impacts of distributed generation and the locational value of solar.

GPA and its Consultant, Landis + Gyr (L+G), are **Finalizing the Medium Range Distribution Plan for 6 substations on GPA's system**.

GPA and L+G will complete all 66 feeders over several fiscal years depending upon funding. As GPA gains more familiarity with using the Advanced Grid Analytics (AGA) tools, GPA will perform more of the work.

Several of the scope items in the study investigate existing and future distribution feeder issues due to distributed generation. They also provide instances of locational value of solar. In the Conservation Voltage Reduction (CVR) case, specific customer inverters can be identified for control to improve feeder voltage. These customers may be compensated for their participation.

Volume 5 *(continued)*

Medium-Range Distribution Plan

GPA has already put the outputs of some of the analysis to immediate use. GPA has taken the results of distribution transformer overloads analysis and begun to correct the GIS model for overloads that are obvious incorrect transformer parameters as well as fix real overloads. This process ensures that GPA has an increasingly more accurate GIS model of its distribution system. It also means that GPA can prevent customer power quality and safety issues before they cause outages or damage

AGA's voltage platform was used to identify voltage issues. Engineering has used this to change-out faulty transformers, adjust transformer taps, upgrade secondaries, and re-distribute load to regulate voltages.

Volume 5 *(continued)*
Medium-Range Distribution Plan

- Results for Scope Item #4 regarding Rooftop PV System impacts on the distribution system
  - Some clusters of net metering systems are causing power quality issues for neighboring non-net metering accounts including but not limited to flicker, high or low voltage, and reverse power flows.
  - As additional penetration of net metering systems are allowed on feeders, these problems become worse without mitigation.
  - Some solutions to these issues include localized energy storage, GPA control of customer inverters, and intelligent charging to support PV (EV's and distributed storage).
  - Leverage intelligent charging EV's to accommodate base load variability related to PV and reduce generation curtailment.

Volume 5 *(continued)*
Medium-Range Distribution Plan

- Scope Items 6 & 7
  - Volt-Var Optimization/Conservation Voltage Reduction optimization typically result in savings on both the customer side of the meter as well as on the distribution system (system losses/fuel savings)
  - Savings typically are concentrated on the customer side of the meter.
  - Deferred cost of infrastructure (medium voltage equipment), by leveraging the voltage profiles and consumer inverters, additional net benefit of VVO can be gained by using existing customer assets

Medium Range Distribution Plan Scope

Scope Item	Scope Description	New Schedule
1	A System Assessment for the Advanced Grid Analytics (AGA) software application that uses Smart Meter data and GPA's GIS model to perform various distribution system analysis (GPA has several modules of ADA installed)	11/12/21
2	Using Landis+Gyr AGA Network Model Validator to analyze GPA feeder GIS data input to the AGA models and recommend corrections as required.	11/12/21
3	Using AGA Asset Loading to perform load flow studies and find system issues such as transformer overloads.	2/24/22
4	Using AGA Planning Case Studies to analyze Distributed Renewable Energy Intermittency and Voltage Issue Elimination or Management.	2/24/22
5	Using AGA Voltage Visualization to perform a System Wide Voltage Analysis Study.	2/24/22
6	Using AGA Planning Case Studies to perform a Volt/VAR Optimization Study	2/24/22
7	Using AGA Capacity Contribution, Voltage Visualization, and Planning Case Studies to perform a Conservation Voltage Reduction (CVR) Study	2/24/22
8	Using AGA Capacity Contribution and Planning Case Studies to perform a Demand Response Study	2/24/22
9	Perform an Automated Switching and Communicating Fault Circuit Indicator Study	11/12/21
10	Consolidate the different Scope Reports into a consolidated report	3/9/22 *Pending feedback after delivery of the individual reports above

- **Schedule for the 6 substations (22 feeders) in scope: Apra (4 feeders), Dededo (3 feeders), Harmon (4 feeders), Pagat (4 feeders), San Vitores (4 feeders), Yigo (3 feeders)**

Volume 6

Information/Operation Technology Plan

The IT/OT Technology Plan is a joint effort between GPA and GWA supporting digital transformation through consolidation of Information and Operations Technology (IT/OT) services and responsibilities across GPWA. GPA and GWA hired Sheffield Scientific to assist GPA and GWA develop the IT/OT Technology Plan.

The principal thrust of Volume VI is developing a GPA/GWA Information Technology (IT) Shared Services Model to increase the operational efficiency and effectiveness of the IT organization for creating a governance, people, process, and technology infrastructure that delivers core IT services across both power and water divisions.

This report advances digital transformation for GPWA. To date, GPA and GWA have taken the initial steps to digitalize their business front ends to provide a deeper level of seamless customer service. By taking the next step of digitalizing backend operations through digital shared services, they can expand efficiently, achieve significant time savings, and avoid outsourcing.

Volume 6 *(continued)*

Information/Operation Technology Plan

Volume VI provides GPWA IT with roadmap to a future state with a connected and integrated efficient **IT Shared Service Model** providing consistent services, standards, and technology through a common IT roadmap. **A concise set of 38 recommendations exist for the following areas:**

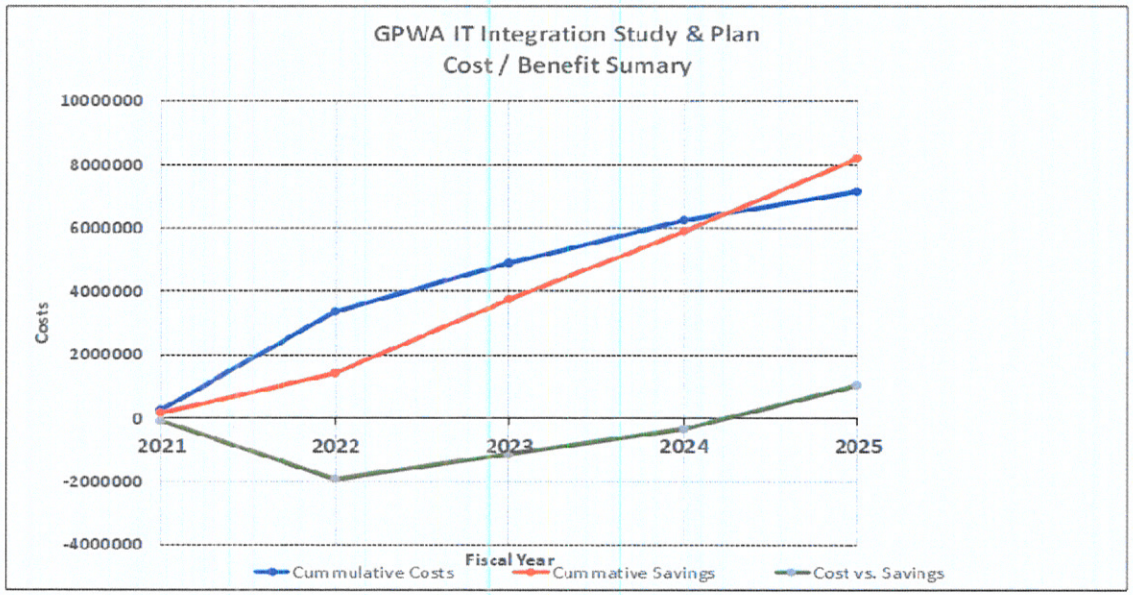
- Network Infrastructure
- Security Policies and Procedures
- Applications and Software
- Operational Analysis and Network Future Design

IT Integration Study & Plan

Business Case Data Summary

	2021	2022	2023	2024	2025
Total Costs	**$262,500**	**$3,092,080**	**$1,535,380**	**$1,350,700**	**$914,700**
Capital Costs:	$262,500	$1,391,100	$620,680	$436,000	$0
O&M Costs:	$0	$1,700,980	$914,700	$914,700	$914,700
Total Savings	**$164,580**	**$1,259,444**	**$2,346,584**	**$2,126,444**	**$2,311,304**
Capital Savings:	$164,580	$780,000	$1,460,060	$1,340,040	$1,520,000
O&M Savings:	$0	$479,444	$877,524	$786,404	$781,404
Cummulative Costs:	$262,500	$3,354,580	$4,889,960	$6,240,660	$7,155,360
Cummulative Savings:	$164,580	$1,424,024	$3,770,608	$5,897,052	$8,208,356
Costs vs. Savings:	**-$97,920**	**-$1,930,556**	**-$1,119,352**	**-$343,608**	**$1,052,996**

* Savings are currently based on an average between conservative and aggressive savings for a GPWA IT organization



Cost versus Savings for IT Integration Projects and Organization Restructure

Volume 7

Strategic Plan

The Strategic Plan is a based on the common results of discussions over time which address GPA's mission and vision. The Mission, Vision, and Critical Success Factors /CCU Key Performance Indicators (KPIs) have not changed.

Over the next 10 years, GPA should strive to achieve goals that will improve service to our customers. These include eliminating underfrequency load shedding, reducing greenhouse gas emissions, obtaining better bond ratings, and achieving operational effectiveness across all GPA activities. **These goals can be categorized into 5 general strategic objectives:**

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

GPA GRID TRANSFORMATION

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

Charge/Discharge-Anytime Battery Energy Storage Systems (BESS) - 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.

Flexible Efficient Generation - Better follows the changes in demand and available generation online especially when large intermittent sources of power are on the grid. Reduces power rates.

Energy Shifting Battery Energy Storage Systems (ES BESS) - Decreases Excess Solar PV Production Events by storing 100% of energy for nighttime use; Replaces expensive production from peaking generation.

Demand Response (DR) - Adjusts customer demand up or down however needed by the grid.

Synchronous Condensers (SC) - 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.

Smart Grid (SG) - 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.

Energy Efficiency - Energy efficiency has a much higher rate of return than just simply installing solar PV. Putting energy efficiency first lowers energy costs for everyone.

Time-of-Use (TOU) Rates - Provides incentives for customers to change their electricity-use behavior to match the needs of the grid.

Daytime Charging Electric Vehicles (EV) - 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.

Microgrids - 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.

Grid Controller - Optimizes all resources to provide the most benefit at the least cost. Improves system stability and system economics.

Solar Irradiance Sensor Network - Provide real-time estimates of solar PV power production. Forecast solar PV power production. Track cloud cover.

System Protection - Improve System Protection to operate in an environment with less synchronous generation and more inverter based resources.

Improving Generator Reliability - Improving GPA generator availability results in serving more load using less generation. It also significantly lowers energy costs.

GPA CUSTOMER EXPERIENCE TRANSFORMATION SOLUTIONS

Guam Transportation Electrification - 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.

Energy Shifting Battery Energy Storage Systems (ES BESS) - 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.

Conservation Voltage Reduction (CVR) - Reduces distribution system line losses lowering LEAC rates. Reduces customer energy consumption.

Customer Outreach - 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.

GPWA Information/Operations Technology (IT/OT) Consolidation - Reduces IT/OT capital and operating costs for GPA and GWA. Reduces costs passed onto customers.

Energy Efficiency - 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.

Smart Grid (SG) - Smart Grid systems can reduce the number of customer outages improving the GPA customer experience.

Conversion of Manual Customer-Facing Processes to Digital Ones - 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.

Energy Sense Program Outreach - 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.

GPA AFFORDABILITY TRANSFORMATION SOLUTIONS

Guam Transportation Electrification - 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.

Improving Generator Reliability - Improving GPA generator availability results in serving more load using less generation. It also significantly lowers energy costs.

Daytime Charging Electric Vehicles (EV) - Slows growth of system peak deferring expensive investments for new capacity resulting in lower future energy costs.

Energy Shifting Battery Energy Storage Systems (ES BESS) - 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.

Conservation Voltage Reduction (CVR) - Reduces distribution system line losses lowering LEAC rates. Reduces customer energy consumption.

Energy Efficiency - Energy efficiency has a much higher rate of return than just simply installing solar PV. Putting energy efficiency first lowers energy costs for everyone.

Flexible Efficient Generation - 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.

Smart Grid (SG) - Smart Grid systems such as Mobile Workforce Management, Advanced Grid Analytics, Distribution Automation increase work productivity reducing energy costs passed onto customers.

GPWA Information/Operations Technology (IT/OT) Consolidation - Reduces IT/OT capital and operating costs for GPA and GWA. Reduces costs passed onto customers.

LNG Infrastructure and Supply - 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 DIGITAL TRANSFORMATION SOLUTIONS

GPWA Information/Operations Technology (IT/OT) Consolidation - A secure, reliable, and responsive IT/OT infrastructure supported by a skilled and capable staff is critical for supporting GPA's Strategic Transformation.

Business Analytics - 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.

Energy Sense Program Outreach - 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.

Creating Organizational Alignment & Fit - 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.

Smart Grid (SG) - 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.

Simulation and the Digital Twin - 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 FOUNDATIONAL INFRASTRUCTURE SOLUTIONS

Human Resource Rebalancing - GPA will soon retire several power plants beginning with Cabras 1&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.

Creating Organizational Alignment & Fit - Creating a more resilient, streamlined, and effective organization through process mapping & re-engineering. Incorporating and leveraging information technology into business processes creates the digital transformation shift.

Smart Grid (SG) - Smart Grid is the grid's information superhighway driving operational improvements and efficiencies.

Grid Transformation Solutions - Without completion of Grid Transformation Projects, the grid will not be stable, reliable, resilient, and affordable.

Cyber and Physical Security (CAPS) - Secure GPA's cyber resources. Secure GPA substations, power plants, and other critical infrastructure facilities.

Aging T&D Infrastructure Replacement - 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.

GPWA Information/Operations Technology (IT/OT) Consolidation - A secure, reliable, and responsive IT/OT organization and infrastructure is critical for supporting GPA's Strategic Transformation.

Succession Planning - 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.

Improving Generator Reliability - Achieving 95% GPA generator availability is a cornerstone for grid resiliency, reliability, and affordability.

Volume 8

Electric Vehicle (EV) Roadmap

- This Volume discusses the electrification of vehicles on Guam and the role GPA should play in order to plan and manage energy use to minimize its impact on the grid.
- With automakers releasing new electric vehicles, an Electric Vehicle Roadmap addresses the potential take off on electric vehicle sales locally by evaluating forecasted local sales, requirements for charging stations, new policies and rate incentives, as well as planning activities for execution and marketing.
- EV charging loads can have a great impact on system peaks. Incentivizing or controlling charging at more appropriate times during the day will avoid need for additional generation and could improve grid efficiency. GPA agrees with the Smart Electric Power Alliance (SEPA) recommendation that utilities avail themselves of EV Managed Charging Services.

Survey of Local Car Dealerships Shows New Electric Vehicles Options

Dealerships	AK	CarsPlus	Nissan	Triple J	Prestige
EV sold to date		25	32		
EV Brands/Models Currently for Sale		Hyundai Kona EV	Nissan Leaf Hatch back with 220 mile range		
Start Date of new EV Brands/Models on Sale	Chevrolet Bolt EV & EUV, January 2022 BMW i4 & iX, January 2023	Hyundai Kona EV, Now	Nissan Leaf Hatch back with 220 mile range, Now Ariya SUV with greater than 300 miles range, Q1 2022	Ford, Kia, Volvo, Honda, & Commercial Vehicles, Q1 2022	Subaru Solterra SUV, 2023
Type of charging infrastructure do you anticipate may be needed to accelerate EV adoption?	Public charging stations at high traffic areas e.g., shopping malls, banks, and hotels	Covered parking area for fast charge Level 3 systems	... definitely access points around the island would be needed to accommodate the growing penetration of electric vehicles.	High traffic areas such as restaurants, Malls, Government Agencies, Schools & Universities	Adequate locations of charge stations that either private entities or the government operate.

Recommendations

- Electric Vehicle Roadmap
- Procure EV Managed Charging as a service to control EV Charging and mitigate impacts on distribution system.
- Explore behavioral incentives to shift EV charging load such as Time of Use (TOU) rates
- Execute Customer Outreach on EV including strategies on reducing charging costs and preserving battery life.
- Work with Guam Dealerships on rolling out public and Dealership charging infrastructure. GPA is already engaging dealerships and candidate providers of EV charging systems.
- Using AGA, investigate EV impacts and fixes as a guide to infrastructure placement.

Volume 9
Net Metering Plan

This volume provides a review and recommendation on appropriate penetration levels of customer installed solar, revisions to the current rate methodology, and to address PUC Docket **TBD**

The increase in customer installed solar has created system reliability concerns and financial impacts for **non-NEM** customers.

The study recommends the following:

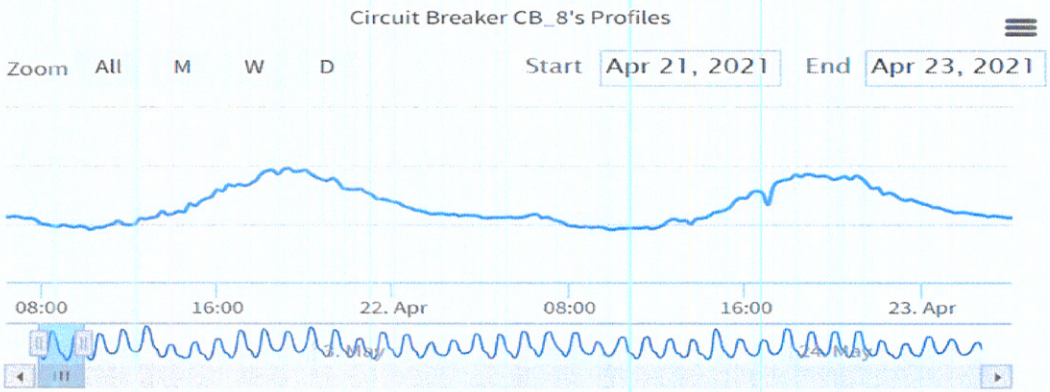
- Solar penetrations on each feeder should not exceed 30% of the minimum respective feeder daytime load
- Above 30%, new solar installations should require "smart" inverters and adequate battery storage capacity
- A value of solar rate methodology should be used to reimburse customers for solar generation
- Modify the current NEM rate methodology to either a Net Billing or Buy All/Sell ALL methodology that more accurately reflects the benefits of solar generation to GPA
- Grandfather current NEM customers for a period of 10 years

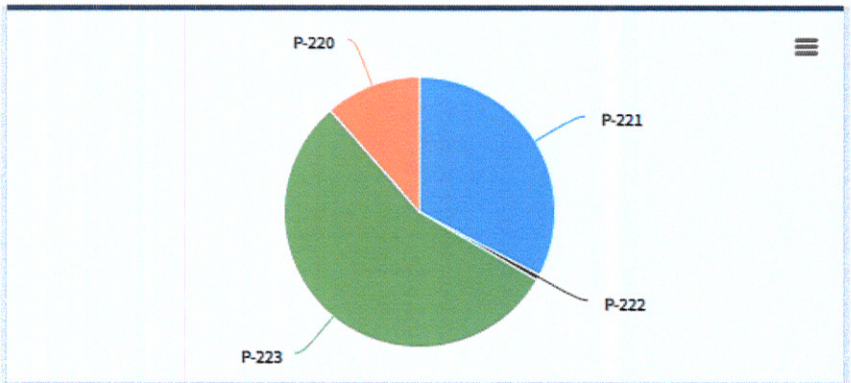
Distributed Energy Resource (DER) Impact Study

Agenda

- Existing State APRA Substation
- Reserve Flow Impact
- Power Quality Impact
- Consumer Stress Impact
- Corrective Solutions

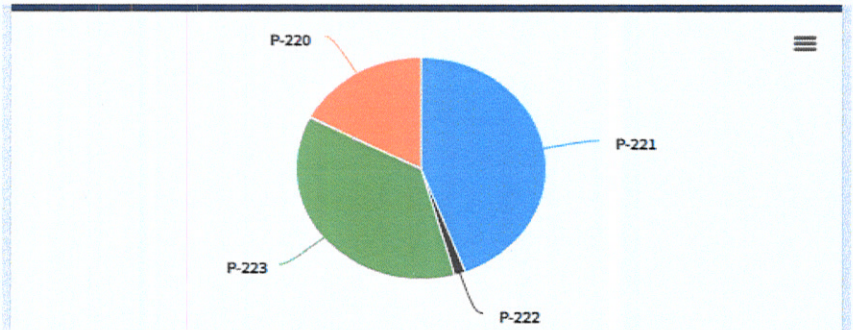
Existing State





All Customers

Substation	Count
P-223	1,329
P-221	787
P-220	276
P-222	16



Known PV Customers

Substation	Count
P-221	61
P-223	51
P-220	24
P-222	2

Peak Loading on this substation occurred at 21:00 04/08/2021

PV Customers Account for Approximately 1.33 MW

(hidden or masked load)

Existing Customer Example

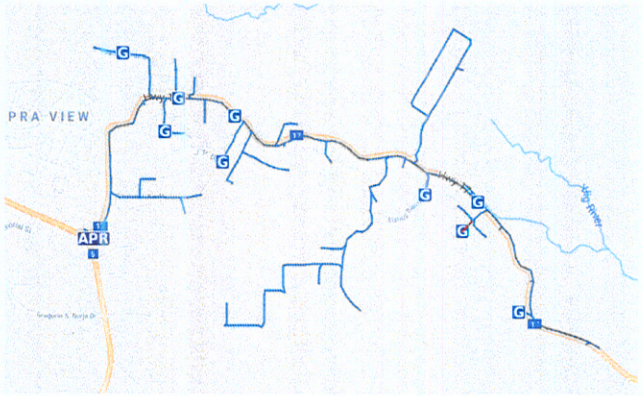
System Example P-222

Reverse Flow

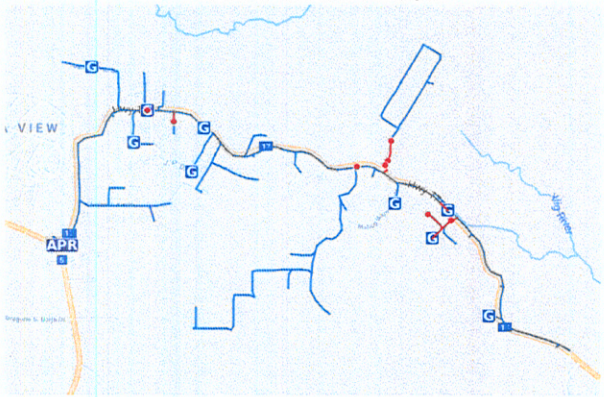
As part of the assumptions of this study we used an assumption of 1KW for the unknown values per connected generation site. This is likely significantly higher and will drive the need to moving forward with recommendations earlier.

Reverse Flow Impact – Host Capacity

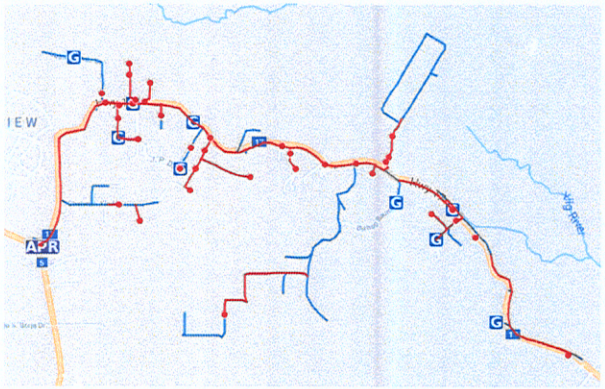
Base Case



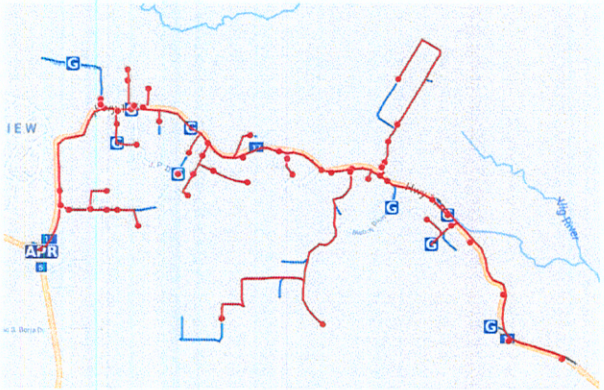
Base Case+30%



Base Case+60%



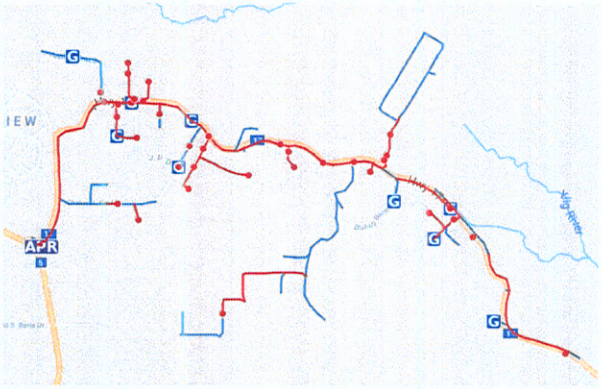
Base Case+90%



Detailed is the progression from the BC system host capacity through 30, 60, and 90. Note that on this circuit as low as 30% PV host capacity begins to cause reverse flow challenges.

Reverse Flow Impact

P 220 Base +60

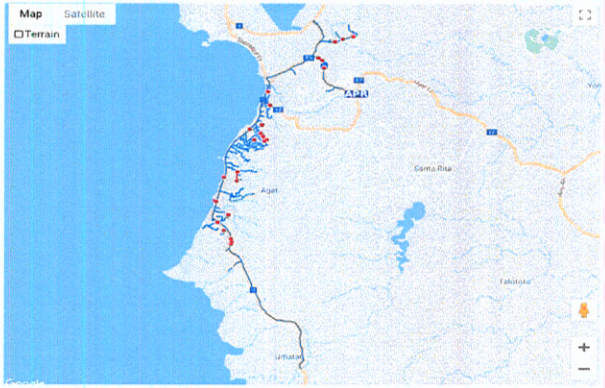


P 221 Base +60

P 222 Base +60

All circuits need to be examined individually, however for APRA at 60% PV host capacity reverse flow will overtake some portions of the respective circuits. The impact varies between circuits, but all would require hardening to prevent risk to protection devices or power quality issues associated with PV fluctuations.

P 223 Base +60



256 core distribution assets will see some level of reverse flow at 60% normalized host capacity. This includes secondary/primary conductor, transformers and protection equipment. By focusing management on the transformer a reduction of reverse power flow occur.

Power Quality

Risks of swell voltage and voltage flickers

PV Impact Contribution to Over Voltage

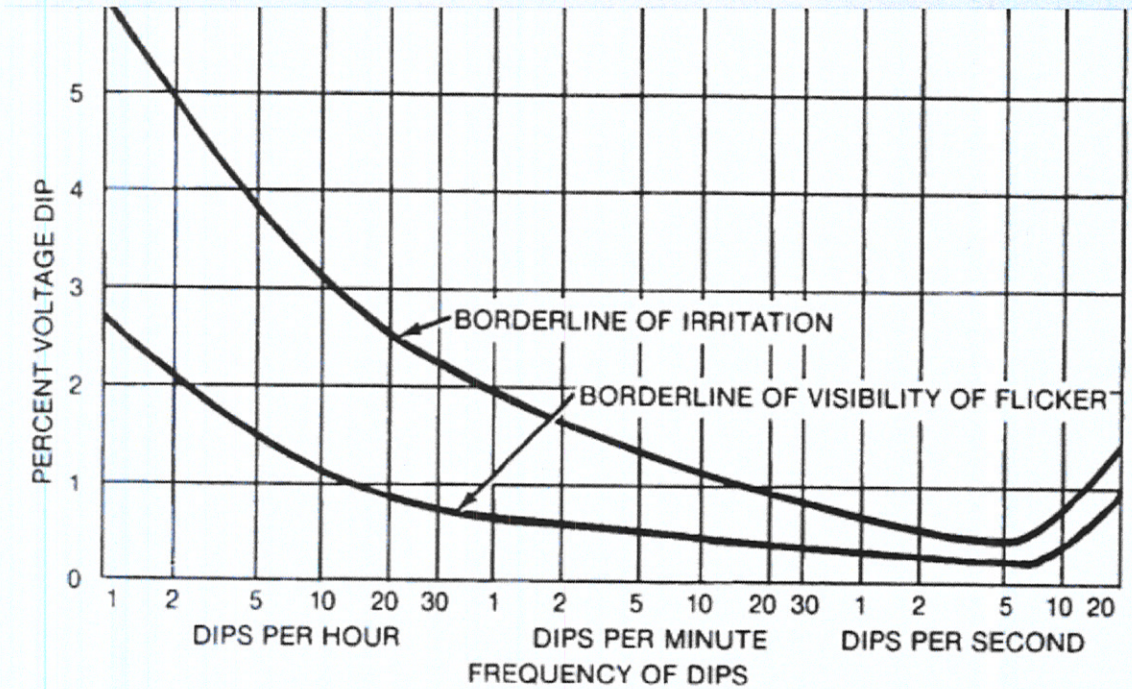
There is a minimum of 36 transformer banks where power quality issues associated to overvoltage from PV is causing challenges for multiple customers

PV Sites Causing Voltage Swell on Neighboring Customers

Meter	Service Location	Transformer	Feeder	Substation	Highest Voltage%	Day Count
2364694	79361	26814	P-223	APRA	123.26	85
2364383	123862	31125	P-221	APRA	123.11	86
2335232	80314	26634	P-221	APRA	122.99	84
2361814	110564	29227	P-223	APRA	122.9	86
2338264	80234	26233	P-221	APRA	122.58	77
2009819	79359	29223	P-223	APRA	122.43	63
2016613	80216	19136	P-221	APRA	122.07	83
2801563	79400	29223	P-223	APRA	121.81	84
2016612	80221	19136	P-221	APRA	121.75	85

Complete list in the DER and Voltage Visualization reports. Note that the list is based on a min of 15 occurrences and 2+ customers.

Flicker Consumer Irritation



8 The Modified GE Flicker Curve Published in IEEE Standard 141[4].

Voltage Flicker

Feeder	Percentage Change	Number of Nodes
P 220	VISIBLE RANGE / ELEVATED STRESS LEVEL	308
P 221	VISIBLE RANGE	6
P 222	NEARING VISIBLE RANGE	44
P 223	VISIBLE RANGE / ELEVATED & BEYOND PEAK STRESS	4442

Options for Corrective Action

Distributed Storage Support for PV and DR

Feeder	Average Size Per Distribution Transformer Storage Size	Number of Customers
P 220	32 KW	29
P 221	34 KW	1
P 222	22 KW	2
P 223	13 KW	25
APRA	23 KW	57

Net: 1.3 MW Support

Batteries will smooth the system variability and reduce the voltage fluctuations and provide some stability to PV production dependencies on the weather. Implementing storage on the load side of the distribution transformer reduces the increase burden on protection equipment. A typical 7KW battery bank for GPA consumers coupled with incentive programs that allow GPA to program voltage profiles and PF curves as well as control to charge and discharge to support optimizing management of renewables.

Options for Corrective Action

EV Charging station and support of DR

Feeder	Assuming Automated Control of L2 Chargers	Number of Customers
P 220	8 KW	464
P 221	8 KW	20
P 222	8 KW	12
P 223	8 KW	164
APRA	8 KW	660

Net: 1.3 MW Support (assumes 25% availability)

Implementing a centralized and automated EV charging control solution can also provide the virtual power plant (VPP), and controllable load capacity needed to manage variability associated with the high PV penetration in the GPA service territory. Level 2 charge programs can support from 8-11.5KW support depending on the service voltage.

APRA

Solution Summary:

- Focus on deploying inverter control for PV production and storage at the identified locations in the study.
- If target Inverter or storage control is not adopted see which customer sites are open for load control, specifically EV charging solutions that can supplement load curve flattening, and shifting load volatility.