System Operation Principles

Version 1.1 (updated June 21, 2021)

Executive Summary

This System Operation Principles (SOP) document, which LUMA is submitting to the Puerto Rico Energy Bureau (PREB), defines how the Bulk Power System in Puerto Rico will be managed upon LUMA's commencement of operations as per the terms of the Transmission and Distribution System Operation and Maintenance Agreement (OMA). The implementation of the SOP is an integral part of LUMA's plan to provide the operation and maintenance (O&M) services detailed in the OMA and to operate the transmission and distirbution (T&D) system. Key elements of the SOP are linked to activities proposed in LUMA's Initial Budgets and System Remediation Plan, and will support the improved service results targeted in the Performance Metrics.

The LUMA team reviewed publicly available manuals and procedures from several North American control areas and operators and spoke with their key personnel to develop best practices applicable to Puerto Rico, given the size of the Bulk Power System, generation portfolio and other characteristics. LUMA also visited all major operating plants and transmission centers and spoke with operators to develop an understanding of the existing system.

This SOP establishes rules and protocols to operate the system in accordance with Prudent Utility Practice and as economically as possible in consideration of available electricity supply, other system constraints and Power Purchase and Operations Agreement (PPOA) obligations. LUMA's role as the System Operator and the SOP are consistent with the legal structure and applicable regulatory requirements for the interaction between generation and the rest of the electrical system. LUMA's independence from ownership and operation of generation, and the System Operator's non-discriminatory dispatch of generation to satisfy reliability and economic objectives, will result in tangible customer benefits in the short and long terms.

LUMA will emphasize four key success factors for the operation and management of the Bulk Power System: safety, data-driven decision making, transparency and performance.

The SOP is organized to address the following functions.

SYSTEM & RESOURCE PLANNING

LUMA, the System Operator, will coordinate planning across the following areas: load forecasting, integrated resource planning, transmission planning, resource adequacy and other planning activities, including additions of renewable energy and storage to comply with Puerto Rico's Renewable Portfolio Standards (RPS) and Integrated Resource Plan (IRP) Modified Action Plan.

All new Generators will be required to comply with the SOP to enable the coordinated addition of new resources and reliable operations.

DATA MANAGEMENT

LUMA will develop procedures that stress the importance of data accuracy and data security so that the decisions made are informed, accurate and timely. LUMA will also define and stress adherence to strict protocols related to security and data management.

In response to the immediate and growing threats to computer systems and internet-connected devices, LUMA will develop a comprehensive strategy on cybersecurity for operations that conform with LUMA's overall cybersecurity program requirements.

System Operation Principles

ENERGY DISPATCH

LUMA will operate within security-constrained economic dispatch principles to dispatch sufficient resources. These resources could include generation, storage or other non-wire alternatives to control constraints and system impacts within clearly defined system limits while meeting system demand.

LUMA will define appropriate communication protocols for each situational need. Automation and control procedures will be used to increase each legacy generation plant's reliability and resilience, as well as the overall transmission system. The System Operator will implement defined rules for load-shed events.

OPERATING PARAMETERS

LUMA will define detailed rules and procedures for operating reserves with the goal of being able to operate even while losing the largest block of power being generated by any one facility at any point in time or losing a key transmission line without impairing system safety, stability and reliability.

Based on an understanding of the factors that could threaten or disrupt service, LUMA will define procedures for controlling steady-state power system stability, minimize disruptions caused by contingencies and establish transmission operating limits.

ENERGY MANAGEMENT SYSTEM

LUMA will implement a new energy management system to provide comprehensive, integrated visibility for the entire generation, transmission and distribution system so that the on-shift Operator can be prepared to react to an adverse event using real-time data.

OUTAGE SCHEDULING & REPORTING

All planned generation and transmission outages will be coordinated and approved through LUMA as System Operator. To ensure that outages are conducted in a controlled and orderly manner, LUMA will define a procedure for requesting and approving all scheduled generation and transmission outages on a rolling two-year basis.

EMERGENCY RESPONSE

Every power system experiences emergencies, and the Puerto Rico system has proven to be extremely vulnerable to weather– and infrastructure-related events. LUMA will implement and maintain a high level of emergency preparedness in accordance with Prudent Utility Practice, which includes defined plans and procedures and regular practice drills for all reasonably expected potential emergency scenarios.

Responsive System Operations are among the most critical elements of effective emergency response to natural disasters and other major events that threaten overall system stability and lives. As part of its Front-End Transition Services, LUMA is developing an Emergency Response Plan (ERP) that includes system operation activities during emergency events. LUMA will also establish a program to drill emergency procedures, including coordination with government agencies, other utilities and key stakeholders as defined in the LUMA Emergency Response Plan.

BALANCING FREQUENCY & SYSTEM IMPACTS

LUMA will develop procedures and schedules to enable the collection of secure, accurate and timely data so that responses to sub-optimal voltage and/or frequency situations are coordinated and timely. This enables the maintenance of system level voltages within established limits, thus preventing voltage collapse and system instability.

Contents

1.0 Defined Terms ... 5

2.0 Introduction & Purpose ... 7
2.1 Overall Framework for the System Operation Principles ... 7
2.2 Objectives of the System Operation Principles ... 8
2.3 How the System Operation Principles Were Prepared ... 8
2.4 Assessment of Current System Operations ... 9
2.5 System Operation Principles Will Support the Later Development of Procedures ... 10
2.6 Building a Foundation for the Future ... 11

3.0 System & Resource Planning ... 12
3.1 Components of System & Resource Planning ... 12
3.2 Requirements for Interconnected Generation Resources ... 13
3.3 System Operator Will Coordinate All Generation Retirement Requests ... 14
3.4 System Operator Will Coordinate Requests for New Generation & Transmission Interconnecting to the Transmission System ... 15

4.0 Data Management ... 16
4.1 System Procedures Will Reflect a Structured Mechanism to Coordinate Data-Related Issues ... 16
4.2 System Operator Will Maintain Programs & Rules for Cybersecurity ... 16

5.0 Energy Dispatch ... 17
5.1 System Operator Will Dispatch Resources to Maximize System Reliability ... 17
5.2 System Operator Will Define Dispatch Order ... 18
5.3 System Operator Will Operate the System in a Non-Discriminatory Manner to Achieve System Objectives Consistent with Individual PPOAs ... 19
5.4 System Operator Will Define Actions to Address Insufficient Generation Supply & Transmission Resources 19

6.0 Operating Parameters ... 20
6.1 System Operator Will Establish Policies on Reserves & Line Loading ... 20
6.2 System Operator Will Define Procedures to Control Steady-State Power System Stability to Avoid a Puerto Rico-Wide Blackout Condition ... 20
6.3 System Operator Will Develop Action Plans to Reduce Risk Exposure to Contingencies ... 21
6.4 System Operator Will Develop a Set of Transmission Operating Limits ... 21

7.0 Energy Management System ... 22

8.0 Outage Scheduling & Reporting ... 22
8.1 System Operator Will Manage All Generation & Transmission Planned Outages ... 22
8.2 System Operator Will Develop Planned Outage Requirements ... 22
8.3 System Operator Will Develop Unplanned & Forced Outage Management Procedures ... 23
8.4 Prudent Utility Practice Requires Processes & Procedures to Address Analyzing & Learning from System Events ... 23

9.0 Emergency Response ... 23

9.1 System Operator Will Implement an Emergency Response Plan 24
9.2 System Operator Will Develop a Prioritized List of Actions to Take in Emergency Situations 24
9.3 System Operator Will Develop & Implement Black Start & System Restoration Procedures 25
9.4 LUMA Will Determine How to Respond to Short-Term Resource Adequacy Issues 25
9.5 System Operator Will Administer the LUMA Procedure for Critical Loads 26

10.0 Balancing Frequency & System Impacts 26
10.1 Systems Operations Will Implement Prudent Utility Practice to Maintain Proper Frequency & Voltage 26
10.2 Controlling Actions for Proper Voltage & Frequency 26

Appendix A: Appendices 28
A.1 List and Description of Procedures for System Operator 28
A.2 Generating capacity data operating characteristics to be compiled for all units 33

Appendix B: Glossary of Technical Terms 34

Tables & Figures

Table 2-1. Elements of SOP Framework 7
Table 2-2. Key Success Factors 8
Figure 2-1. Procedure Development Plan 11
Figure 10-1. Typical hierarchy of control to maintain frequency and voltage 27
Table A-1. Generation Data 33

1.0 Defined Terms

Black Start: Black Start service enables the System Operator to designate specific generators, called Black Start Units, whose location and capabilities are required to re-energize the transmission system following a system-wide blackout.

Bulk Power System: The collection of interconnected transmission, generation and control systems necessary to operate an integrated transmission system while maintaining reliability, which includes 230 kV, 115 kV and 38 kV voltages.

Emergency Response Plan: LUMA's plan to respond to emergency events, including the definition of different levels of emergency, structure of command organization and other requirements.

Generator: For purposes of this SOP when used as a defined term, the entity that operates generating facilities and performs the functions of supplying energy to the Bulk Power System.

Incident Commander: The individual designated to have overall responsibility for LUMA's response during an Emergency Event.

Load Relief Warning: A tool used to warn the System Operator in advance of a contingency to coordinate future load shedding.

Load Shed Event: A system condition where end-use electrical consumption must be switched off to certain customer loads in order to bring the electrical system into balance.

Non-Discriminatory Treatment: The standard of care the System Operator must follow to make decisions that are not preferential or to the detriment of an asset because of the ownership of that asset and in accordance with the public policy pursued by Act No. 83 of May 2, 1941, as amended. While some decisions and scenarios may favor one asset to the detriment of another, if the decision was based upon the operational conditions and benefits to the system, it is considered non-discriminatory.

Operation and Maintenance Agreement (OMA): The Transmission and Distribution System Operation and Maintenance Agreement executed by the Puerto Rico Electric and Power Authority, the Puerto Rico Public-Private Partnerships Authority, LUMA Energy LLC and its subsidiary LUMA Energy ServCo, LLC, with an effective date of June 22, 2020.

Participant: For purposes of this SOP, an entity that is involved in either the transmission, generation or consumption of electricity, or otherwise has a commercial or business interest in some aspect of System Operation.

Planned Outage: The scheduled removal from service, in whole or in part, of a generating unit for inspection, maintenance or repair with approval of the System Operator.

Plant-Level Agreement (PLA): An agreement entered into between each Generator and System Operations that defines the technical and communication protocols that will exist between that plant and System Operations. A generic Plant-Level Agreement template is used as the starting basis, and then adjusted for any unique plant attribute or exception. The document is signed by both parties.

Power Purchase and Operations Agreement (PPOA): A contract executed between two parties, one who generates electricity (the seller) and one who purchases electricity (the buyer).

System Operation Principles

Prudent Utility Practice: At any particular time, the practices, methods, techniques, conduct and acts that, at the time they are employed, are generally recognized and accepted by companies operating in the United States electric transmission and distribution business as such practices, methods, techniques, conduct and acts appropriate to the operation, maintenance, repair and replacement of utility assets, facilities and properties. The full definition of Prudent Utility Practice is in the OMA.

Reliability Must Run (RMR): A generating unit that is slated to be retired by its owners but is needed to be available for reasons of reliability. Typically, it is requested to remain operational beyond its proposed retirement date until additional resources or other system upgrades are completed.

Resource Adequacy: The regulatory construct that is used to ensure that there are sufficient resources available to satisfy electrical demand under all but the most severe conditions.

System Operations: Refers to the LUMA organizational department responsible for the interaction and management of all aspects of the Bulk Power System to ensure safe and reliable electricity to supply the end-user customers.

System Operator: The entity that is responsible for the safe and reliable operations of the Bulk Power System and the decision making associated with use of existing equipment to generate, transmit and deliver energy. The OMA designates LUMA as the System Operator for Puerto Rico.

2.0 Introduction & Purpose

LUMA is submitting the System Operation Principles (SOP) to the Puerto Rico Energy Bureau (PREB) in accordance with the Transmission and Distribution System Operation and Maintenance Agreement (OMA) executed by the Puerto Rico Electric and Power Authority (PREPA), the Puerto Rico Public-Private Partnerships Authority (P3A), LUMA Energy and its subsidiary LUMA Energy ServCo, LLC (LUMA ServCo) (LUMA Energy and LUMA Servco, together LUMA).

This SOP document defines how the Bulk Power System in Puerto Rico will be managed upon LUMA's commencement of operations as per the terms of the OMA, and in the future to enable the System Operator to safely, reliably and efficiently operate the electrical system. The System Operator plays a critical role in the reliable and cost-effective operation of the electric grid. As the System Operator, LUMA will manage the real-time operation of the Bulk Power System including dispatch of power plants and flow of power over the electric system to maintain supply and demand in balance. LUMA will also carry out short– and long-term system planning and will manage the system under emergency conditions.

This SOP establishes rules and protocols to operate the system in accordance with Prudent Utility Practice and as economically as possible in consideration of available electricity supply, other system constraints and PPOA obligations.

2.1 Overall Framework for the System Operation Principles

The System Operations Principles describe how the Bulk Power System will operate. These Principles must also be consistent with a broader framework that includes contracts, procedures and agreements. The SOP must also conform with the laws of Puerto Rico, regulatory orders from PREB and permit requirements issued by various government agencies.

The key elements of the overall framework to implement the SOP are illustrated in table below.

Table 2-1. Elements of SOP Framework

Elements of Framework	Objectives

System Operation Principles	▪ Document that reflects Policy and Objectives including:
	  ▪ Safety and Reliability
	  ▪ Cost Effective Operations
	  ▪ Non-Discriminatory Behavior

Operating Procedures	▪ Define how SOP are implemented to ensure consistency across System ▪ Provide basis for to assess potential process improvements, and after-event lessons learned
Plant Level Agreements	▪ Document technical and communications requirements between each plant and Dispatch Center and notes any exceptions ▪ Ensures consistent operations by defining exactly what each plant is required to do

The SOP itself is reviewed and approved by PREB. P3A, as Administrator, and LUMA may from time to time propose changes to the SOP. LUMA shall submit these proposed changes to PREB for their review and approval. PREB has the right to approve, deny or propose modifications to the revised SOP.

2.2 Objectives of the System Operation Principles

The OMA designates LUMA as the System Operator and tasks LUMA with preparing the SOP related to the dispatch of power and electricity (OMA, Section 4.1 (d)) during the Front-End Transition Period. LUMA did so with input from PREPA and P3A. The SOP defines how the System Operator will operate the Bulk Power System in a safe and reliable manner. The System Operator will use Prudent Utility Practice to operate the electricity delivery system as economically as possible in consideration of the electricity supply system and PPOA obligations. (OMA, Annex I, Schedule 1, Introduction). This operational principle is also known as security-constrained economic dispatch.

As required in the OMA, the SOP are subject to the review and approval of first P3A and subsequently PREB. (OMA, Section 4.1 (h)). After LUMA commences operations, and from time to time, the SOP shall be subject to further review and update by LUMA and P3A based on “Applicable Law, load and energy forecasts, long and short-term system plans, proposed annual operating and maintenance plan[s], any limitation criteria, and the condition of the entire electric system.” These proposed updates shall be submitted to PREB, which has the right to approve, deny or propose modifications to such revisions (OMA, Section 5.13(c)).

To achieve the defined objectives of the SOP, LUMA will emphasize four key success factors: safety, data driven decision making, transparency and performance. These are described in Table 2-2.

Table 2-2. Key Success Factors

Safety First	The health and safety of our employees and members of the public are our top priority
Data-Driven Decision Making	LUMA will use best practices to collect, validate and review data. System Operations decisions will use data to drive decisions, assess risk and report results In accordance with public policy mandates, LUMA will employ non-discriminatory treatment of all Generators and operate the Bulk Power System based on data available, Prudent Utility Practice, seeking the combined system objectives of reliability, resiliency and cost to customers
Transparency	LUMA will consider customer impacts and engage with stakeholders to ensure accountability LUMA will provide information to Bulk Power System Participants, stakeholders and the public to enable them to better understand the operation of the system
Performance	LUMA will apply technical and managerial expertise to develop solutions LUMA’s Performance Metrics and System Remediation Plan have defined milestones to track performance and report on progress toward achievement of reliable and efficient System Operations

2.3 How the System Operation Principles Were Prepared

As required in the OMA, during the Front-End Transition Period LUMA reviewed relevant information and worked collaboratively to develop the SOP. Subject-matter experts (SMEs) brought to bear relevant professional experience in and technical knowledge of the following control areas and/or System Operators: AESO, ATCO, Hydro-Quebec, PJM, MAIN, PECO, Commonwealth Edison and NIPSCo. This information was combined with specific data and operating knowledge from PREPA's dispatch control center, System Operations and generation operations.

The LUMA team reviewed publicly available manuals and procedures from several North American control areas and System Operators to develop best practices applicable to Puerto Rico, given the size of the Bulk Power System, generation portfolio and other characteristics. LUMA also visited all major operating plants and transmission centers, reviewed generation and operations information and spoke with operators to develop an understanding of how the existing system is being operated and maintained, as well as reviewing current operational and other constraints. Several calls were held with personnel in operating North American transmission systems, who generously provided feedback to discuss interpretation of specific sections and rules, how these might be applied in Puerto Rico and the relative importance of those rules in their particular systems and applicability to Puerto Rico.

In preparing the SOP, LUMA SMEs followed the outline in Schedule 1 to Annex 1 of the OMA, which describes major areas of the SOP. LUMA based its work on information from PREPA (in particular the System Operations function and its dispatch of generation) and industry practice and principles employed in Bulk Power Systems in North America, including NERC guidelines such as NERC Standard TPL-001-4. LUMA carried out other diligence activities, including interviews and workshops with PREPA's generation and System Operations personnel, site visits to PREPA's major generation stations, review of historical and current data on generation and transmission dispatch, availability, outages and other information relevant to the Bulk Power System.

2.4 Assessment of Current System Operations

Management challenges, natural disasters and a lack of financial resources have contributed to an unreliable PREPA generation fleet and T&D system that have resulted in PREPA's inability to operate its generation and System Operations in accordance with Prudent Utility Practice. Key observations include:

- Inadequate safety practices resulting in operations that are often unsafe for employees and the public
- Inadequate operating reserves
- Poor situational awareness and integrated communications capability (e.g., AGC, telemetry, RTUs)
- An inflexible PREPA generation fleet with low availability and high forced outage rates and
- Generation units often operating outside of efficient output rates, consuming more fuel than would be the case for operations within the recommended range of output.

The main priority facing the System Operator is to bring the existing system to minimum industry standards as quickly as possible while supporting compliance with the Integrated Resource Plan (IRP) Modified Action Plan, which includes shifting from a fossil-based generation fleet to one made up predominantly (and eventually exclusively) of renewables and storage. Achieving this transformation while maintaining reliability, resiliency and reasonable costs requires:

- Significant upgrades to transmission and distribution equipment to bring the system up to an acceptable industry standard
- Implementation of new written policies and procedures along with training programs to prepare the System Operations group for a more robust system with a more diverse power generation portfolio and
- An assessment of how the more robust system will allow for the addition of renewable resources and how to effectively operate these new sources initially alongside the current fossil fleet and eventually without it, after the retirement of the legacy generation units.

The implementation of the SOP is an integral part of LUMA's plan to operate the System. Key elements of the SOP are linked to activities proposed in LUMA's Initial Budgets and the System Remediation Plan. Implementation of the SOP will support the improved service results targeted in the Performance Metrics. Some the programs aimed at the most effective improvements in System Operations include:

- Construction or refurbishment of buildings to house the main and back-up control centers and all ancillary support services
- Critical energy management system upgrades and the addition of relevant technology to operate the electric system safely and reliably
- Development of new strategies and mechanisms for energy balancing and operating reserves as well as new technology to efficiently integrate renewable energy, battery storage and demand response into the system and
- Other new procedures and strategies to operate the system reliably and efficiently.

These programs that address higher-impact deficiencies identified during LUMA's gap assessment are included in the System Remediation Plan. All costs for LUMA's System Operations described in this SOP, including improvement initiatives aimed at physical and IT upgrades for the first three years, are included in LUMA's Initial Budgets. As LUMA executes new investments and other programs focused on System Operations we will improve safety for employees and the public, increase reliability and resiliency, while providing stakeholders with greater transparency. These actions directly enable the modernization of the electric grid targeted in the IRP. In particular, implementation of a modern EMS is required in order to effectively integrate new renewable utility-scale energy sources and energy storage systems as required under the Modified Action Plan of the approved IRP and the RPS requiring 100% renewable energy supply. Overall, the implementation of this SOP will result in better service to customers and an electric grid that supports economic growth and improved quality of life in Puerto Rico.

2.5 System Operation Principles Will Support the Later Development of Procedures

There currently are no written procedures at PREPA that operators use to manage the Bulk Power System. What few documents exist are many years old and rarely, if ever, used. This lack of principles and procedures creates daily operational challenges and limits the ability to improve System Operations. This absence of documentation also damages the utility's credibility with the public and all Participants. Lacking a consistent understanding of what is supposed to happen, the public, customers and Participants in the Bulk Power System form the opinion that operations are generally arbitrary and often unfair.

These System Operation Principles provide a comprehensive guide for operations in Puerto Rico. In addition to these System Operation Principles, LUMA will develop as-is documentation of existing control center practices prior to the start of operations. LUMA has identified 12 critical operating procedures, which will be revised and re-written prior to commencement, and another 13 non-critical operating procedures that will be revised and re-written within 6 months of commencement. The remaining four operating procedures will be completed within 12 months after commencement. Operating procedures will be available in both English and Spanish.

The entire list of expected procedures is identified in Appendix A. LUMA has divided the development of specific procedures into three phases, which are illustrated below.

Figure 2-1. Procedure Development Plan

2.6 Building a Foundation for the Future

Puerto Rico has enacted legislation to move the electrical production currently derived from fossil fuels toward greener resources, and primarily to solar. As the production of electricity shifts from primarily using fossil-fired units to using primarily renewable resources, LUMA will develop processes to integrate additional variable and intermittent generation resources like solar and wind into the integrated system. Given these fundamental changes, the electrical power system in Puerto Rico will require specific strategies for adding generation and storage resources, retiring older generation units and managing a changing electrical system while maintaining reliability and resiliency at a reasonable cost. LUMA, as System Operator, will maintain and update procedures as several significant changes are expected over coming years. Any new PPOAs will need to be reviewed for consistency with these SOP.

Operating conditions on the Bulk Power System will evolve as LUMA implements the investment plan. Changes to the system will result from T&D line and substation improvements, new generation and storage resources being added from new competitive solicitations, and as regulatory policy drivers evolve. When these circumstances change, it is expected that the SOP will be reviewed and potentially revised in order to address a new context. LUMA will work with P3A and submit any revised SOP to PREB for its review and approval. (OMA Section 5.13 (c)). LUMA will communicate any revised SOP to Generators and stakeholders. LUMA will also update all related procedures and implement any new required training.

1 As-Is documentation of existing approach for daily management of grid
2 Critical operating procedures ready at start of LUMA operations; cover responses for key events and key decision-making processes
3 Non-critical operating procedures ready six months after operations start involves other departments or processes that will be changing from PREPA's current practices
4 Process/support procedures ready 12 months after operations start support process definition or documentation requirements, but do not deal with real-time decision-making and require extensive involvement of other departments
5 QA/configuration management coordinates updates to procedure and reviews other related procedures

3.0 System & Resource Planning

The planning function will cover both short-term and long-term planning horizons. Short-term planning functions will include load forecasting and other tools as may be developed from time to time. Long-term planning will include Resource Adequacy and Integrated Resource Planning.

3.1 Components of System & Resource Planning

LUMA will coordinate planning across the following areas.

LOAD FORECASTING

A single load forecast will be prepared for Puerto Rico, which will be carried out and coordinated by LUMA. The load forecast will be updated at least annually and shall form the basis of all related planning studies and financial projections. Additional econometric scenario analysis may be performed and will be coordinated internally and/or with other stakeholders by LUMA, as applicable. LUMA will also develop near-term load forecasts on a rolling weekly or monthly basis.

INTEGRATED RESOURCE PLANNING

The IRP is the reference for all long-term planning and resource projections. The IRP will be prepared by LUMA and is reviewed and approved by the PREB. LUMA will use operational data and assumptions derived from System Operations for forecasts, scenarios and analysis related to the IRP. A long-term capacity expansion plan will be a key output of the IRP process and will describe the long-term vision of how supply– and demand-side plans are to be integrated.

RESOURCE ADEQUACY

Resource Adequacy refers to maintaining adequate generating capacity (i.e., the capability to produce electric energy) to serve all system load. LUMA will coordinate a Resource Adequacy assessment at least annually. The assessment will focus on the Resource Adequacy of the system, considering Puerto Rico's environment and other specific constraints, including potential investments in PREPA's legacy generation fleet and prospective timing for retirement of some of these units. The assessment will analyze the current situation and a near-term planning horizon of approximately three to five years. This assessment will define gaps in Resource Adequacy levels compared to Prudent Utility Practice and applicable industry guidelines as appropriate for Puerto Rico. LUMA may also analyze near-term alternatives to address existing Resource Adequacy deficiencies and present options to PREB for review. As part of its work during the Front-End Transition, LUMA evaluated the effective availability of generation to meet demand. Overall, the system currently often has inadequate resources available to meet peak demand. This can be addressed by improvements to existing units and by adding additional resources, or a combination of both. LUMA's evaluation on this matter is further discussed in Figure 5-1 of the Initial Budgets report.

OTHER PLANNING TASKS

Additional planning activities may be identified to support the provision of O&M Services or address needs identified for the Bulk Power System. Such activities may include transmission planning and the consideration of storage and non-wire alternatives.

3.2 Requirements for Interconnected Generation Resources

The System Operator will require all newly connected Generators to comply with the SOP and applicable procedures to maintain generator capability and controls related to generator frequency and voltage-support devices that are used for transmission support. The intent of this requirement is to standardize the rules by which interconnected facilities interact with the grid to ensure safe and reliable operations. This includes the ability to provide primary frequency response. For generators installed in a generator-plus-storage configuration (e.g., solar + storage), the ability to provide primary frequency response may be satisfied through the storage portion of the facility. In the case of Generators with existing PPOAs, these capabilities generally already exist. In the case of existing legacy PREPA generating plants, these capabilities will have to be installed on a timeline still to be discussed and resolved by PREB in order to support the requirements to unbundle generation. It is contemplated that discussions with these existing thermal assets may be required to agree on a reasonable accommodation. Key requirements which will need to be discussed with the operator of PREPA's generation units are listed below.

- Generators will need to maintain and calibrate all generator control systems to ensure that data used to control the electrical system and support short-term and long-term resource planning is accurate, secure and timely.
- Generators will need to agree to rules governing interconnected generation resources frequency and voltage system maintenance, specifically Automatic Voltage Regulators (AVR), governor controls, Automatic Generator Control (AGC) and other legacy controls and telemetry devices that support electrical system stability and/or provide valid data to the System Operator.
- Annual testing and verification of all interconnected generator control systems shall be carried out and evidenced.
- While PREPA's generation units do not currently meet the above requirements, PREPA, or the new operator of PREPA's generation assets, will have to work with LUMA to implement these measures or agree to other solutions that meet the defined objectives. Installation or implementation of solutions such as AGC for legacy plants will be subject to cost-benefit analysis that considers anticipated costs of investment and benefits to reliability, stability and other system impacts.

Each Generator will be required to provide regular reporting to the System Operator to comply with the SOP. Each Generator will be required to execute a Plant Level Agreement (PLA) with the System Operator which will itemize requirements and exceptions to the PLA template for their specific plant. The signed PLA will provide each plant with a clear identification of relevant technical and communication requirements of that plant. The PLA will not contain commercial or pricing information and will not be relied upon for any dispute resolution purposes. All commercial terms and conditions will be based upon the signed PPOA. The System Operator will execute all System Operations and control actions in accordance with signed PPOAs and the PLA. Existing PPOAs, or new agreements with a new generation operator for the legacy PREPA thermal plants, may need to be reviewed for consistency with the SOP, and will be handled on a case-by-case basis.

3.3 System Operator Will Coordinate All Generation Retirement Requests

When a generation owner or operator has determined it plans to retire a generation unit, a request will be sent to the System Operator. To ensure that this process conforms with a uniform procedure, the System Operator will define rules related to how that retirement request must be presented. Any such retirement decision shall be evaluated by the System operator and presented to the PREB for regulatory approval. In accordance with IRP reporting requirements to the Bureau, LUMA would provide quarterly updates and compliance reports associated with the plans for retirement of steam units, with specific reporting and compliance information requirements and dates as described in the Modified Action Plan. These regular updates and compliance reports would include all information on the status of conversion to synchronous condensing where applicable.

All retirement evaluations shall be carried out consistent with the approved IRP and The Modified Action Plan, and in accordance with required approvals. Topics in retirement evaluation include:

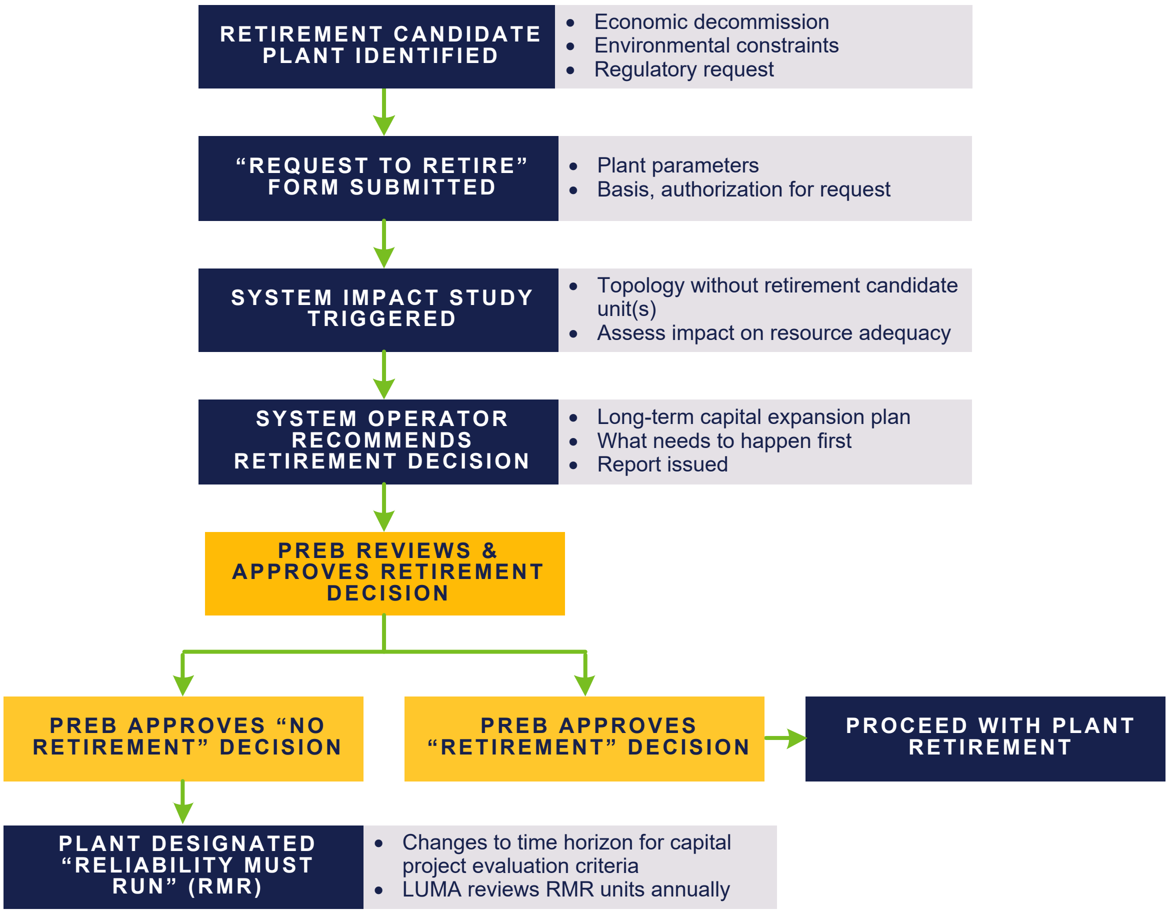
- Established schedule for retirement.
- Whether it should be aligned with conversion of some units to synchronous condensing operation.
- Whether applicable reliability milestones have been reached.
- Load reduction, new capacity and existing capacity reliability.
- Threshold capacity at which retirement of unit was slated to commence.

LUMA will consider the following associated issues in its analysis of retirement scenarios:

- Completed information and forms required to both carry out analysis of the requested retirement and to process the request,
- Date of requested retirement and findings from required system impact studies to determine overall system impact and any recommendation or requests regarding timing of retirement, and
- Whether the unit should be designated to be Reliability Must Run (RMR), as described below.

Figure 3-1 below describes the general process to retire a generating unit.

Figure 3-1. General Process to Retire a Unit



Note: "Reliability Must Run" can also be used at times to designate facilities that are necessary during certain operating conditions to maintain the security of the power system.

3.4 System Operator Will Coordinate Requests for New Generation & Transmission Interconnecting to the Transmission System

Any new Generator must submit a request to LUMA to connect a new generation unit to the integrated system. The new Generator will be required to follow the System Operator's new interconnection procedure. To ensure that this process conforms with a uniform procedure, the System Operator will define the procedures for how all new interconnection requests must be presented, studied and approved by LUMA. LUMA will follow the same process for interconnection of new transmission to the Bulk Power System. The System Operator will consider the following topics for new interconnection requests:

- Completed documentation and forms required for the interconnection request with all necessary signatures and approvals
- Results from system impact studies including any necessary upgrades or modifications to support the new generation or transmission asset
- Identification of which parties are responsible for all payments and the timing of such payments, including for system upgrade costs

- Timeline of expected milestones including requested in-service dates and possible coordination with any other known projects occurring in the same timeframe
- Electrical, controls, AGC, telemetry, performance and metering requirements

Interconnection procedures will be consistent with the IRP and other applicable energy policy — including the transition from fossil generation to renewables and utility-scale battery storage — while promoting the safe, reliable and cost-effective operation of the system.

4.0 Data Management

Data management and data security are critical to making informed decisions. The System Operator will develop procedures that stress the importance of data accuracy and data security so that decisions made are informed, accurate and timely. The System Operator will also define and stress adherence to strict protocols related to data security and data management.

4.1 System Procedures Will Reflect a Structured Mechanism to Coordinate Data-Related Issues

Data management is a vital component of stable and efficient operations. To proactively coordinate and manage data-related factors, system procedures will define roles and responsibilities, governance and reporting requirements.

Data management coordination will ensure that all personnel are trained on data management protocols. To adhere with industry practices, LUMA will prioritize accurate, complete and credible data, as well as comprehensive data validation. It will also establish data retention policies that allow critical data to be readily accessed to facilitate the timely investigation of incidents.

LUMA will develop a data redundancy standard and set requirements for proper data storage in multiple secure locations, as well as redundancy of the software operating system to maximize uptime and minimize disruptions to operation of the Bulk Power System.

Data and communication protocols and requirements of all parties will be managed for both secured and unsecured data transfer.

Administrative controls will be implemented related to future changes or industry standards:

- Information requirements for each Generator
- Telemetry specifically related to generation, transmission and distribution interconnected devices used in the management of the electrical system and other data capture requirements (SCADA)
- Infrastructure requirements to capture and communicate the data (RTUs)
- Maintaining alignment with evolving industry standards

4.2 System Operator Will Maintain Programs & Rules for Cybersecurity

In response to the immediate and growing threat of cyberterrorism and external hacking of systems and internet connected devices, the System Operator will develop a comprehensive strategy on cybersecurity.

System Operations will conform with LUMA's overall cybersecurity program requirements. The System Operator will define cyber-related requirements for assets and Participants on the system, which will reflect the type of Participant, the information system it has access to and the impact on LUMA's cybersecurity program.

The System Operator's cybersecurity program and rules will form part of LUMA's overall Cybersecurity Plan whose implementation will be managed by LUMA's IT department to ensure compliance with any Puerto Rico-specific standards as well as other applicable standards, including federal government agencies such as the Department of Homeland Security, the Department of Energy, the FBI and the Department of Defense.

To ensure that the cybersecurity programs and rules are properly developed and implemented, the System Operator will establish a cybersecurity management team. The cybersecurity management team will work closely with LUMA's IT department and will identify threats and develop the organization's strategy to manage cybersecurity risk with the goal of protecting and fortifying LUMA's systems by detecting events through 24/7 monitoring and responding quickly using well-defined plans.

In addition to preventing cybersecurity breaches, the LUMA team will establish processes than enable systems to recover quickly from such events, using multiple contingency plans to minimize impact and bring critical systems back online rapidly and safely.

5.0 Energy Dispatch

One core function of operating the system is energy dispatch, the process of balancing and allocating system resources based on customer load, economic operation, system reliability and stability and safety.

5.1 System Operator Will Dispatch Resources to Maximize System Reliability

System reliability depends on the collection of secure, accurate and timely data to allow the System Operator to efficiently and effectively allocate resources. The System Operator will operate within security-constrained economic dispatch principles to dispatch sufficient resources to control constraints and system impacts within defined system limits while meeting system demand. Available resources will consist of both supply and demand-side resources including generation, storage, or other non-wire alternatives.

The System Operator will develop the basic building blocks of system dispatch This will enable the System Operator to develop, over time, the capability to implement security constrained economic dispatch and to adequately incorporate technologies such as Distributed Energy Resources (DERs), storage, and non-wires alternatives when those technologies are deployed in Puerto Rico. The capabilities that are currently lacking, but that System Operator will develop include:

- Sufficient generation to meet customer demand with adequate planning reserve margins to avoid load shed events
- Adequate communication capabilities such as Automatic Generation Control (AGC), and Automatic Voltage Regulators (AVR) at all applicable operating units. This will enable the System Operator to make, for the first time, real-time dispatch decisions to maintain frequency and voltage
- Identification and capture of critical operating data to provide adequate situational awareness on a real-time basis of items such as unit availability, reliable ramp rates, and contingency analysis.

After these building blocks have been established, the System Operator will be able to effectively incorporate new technologies such as DERs, battery storage, and non-wires alternatives. These new technologies provide other bulk power systems in the mainland with valuable tools to address peak demands more efficiently than relying in the less efficient peaking generation capacity in the system.

5.2 System Operator Will Define Dispatch Order

LUMA will require multiple dispatch scenarios for economic and reliability reasons. Generation dispatch will be prioritized in a sequence that considers both economics and reliability, in order to provide for the lowest feasible cost, taking into consideration system security. To dispatch generation efficiently, the System Operator must have accurate and timely data on marginal costs and forecast marginal costs by generating unit.

The primary objective is to reliably operate the system, although economics and reliability must each be weighed together by the System Operator when managing contingencies throughout the system. Based on its determination for the sequence of dispatch and stability requirements, the System Operator will define criteria to guide how dispatch is sequenced.

Generator units will be committed and dispatched in economic merit order taking into account the security constraints of the system. However, while economic dispatch represents the goal, it may not always be feasible. System stability and reliability will drive real time daily dispatch decisions and may require changes to the initial dispatch sequence as the Operators manage dynamic changes to their loads and resources.

After the System Operator has established the basic building blocks described in section 5.1, it will then develop the capability to implement economic dispatching of existing units. It will compile validated and timely data from existing generators such as performance curve and marginal costs data in order to support the development of a meaningful economic supply stack merit order. The merit order will support decision-making and monitoring of performance trends.

The System Operator will also incorporate economic parameters of new DERs, storage, and non-wires alternatives after ongoing PREB proceedings (including rulemaking) and future contracts which will contain pricing and dispatching requirements define how these resources will be used. For example, the results of the Tranche 1 solicitation for new renewable capacity is expected to provide several Virtual Power Plant (VPP) proposals which will provide valuable insight. In addition, the Demand Response (DR) pilot proposed in NEPR-MI-2021-0006 which is expected to launch at the end of 2021 will be designed to allows LUMA to obtain information necessary to incorporate DR into dispatching decisions.

Any changes to the initial dispatch sequence shall be done in a way to minimize total cost where possible. Emergency situations can also justify other non-economic decisions on an as-needed basis.

Procedure compliance, improved system visibility and increased data availability will allow the on-shift Operator to dispatch system resources and assets in a way that trends towards lower costs as Resource Adequacy improves.

5.3 System Operator Will Operate the System in a Non-Discriminatory Manner to Achieve System Objectives Consistent with Individual PPOAs

In accordance with public policy mandates of protecting the trust of customers and stakeholders in the management and handling of the grid, to avoid arbitrary discrimination in the dispatch of energy and to pursue independence in the dispatch decision process, all system resources will be treated in a non-discriminatory manner that does not consider asset ownership in the decision-making process. The primary decision criteria will be to produce a more reliable system and lower costs to consumers, subject to security constraints on the system. Dispatch sequences will be defined to optimize overall production and PREPA's legacy plants will not receive preferential status over other independent power projects on the system.

When some operating dispatch decisions could achieve the same system benefit, the System Operator will select the option that is least costly to consumers when possible, considering both reliability and system security.

The System Operator will dispatch all plants consistent with the terms of their PPOAs and shall record and tabulate all production data required to support monthly costs invoiced by the Generator under its PPOA. LUMA will use production data to validate the invoice and payment requirements under the commercial terms of PPOAs.

LUMA plans to increase the level of involvement and dialogue with Generators and other Participants in the system compared with current practice to promote industry best practices:

- LUMA will prepare a written report on the progress of transformation of the systems operation function and will communicate this progress to Generators interconnected to the system
- LUMA will provide increased information to the public to enable energy developers to better understand the operation and constraints of the existing system and to encourage greater deployment of renewables, non-wire alternatives and emerging technology solutions
- LUMA will place information on its website to better communicate various aspects of System Operations that could provide developers with additional information, which could inform their development projects.

5.4 System Operator Will Define Actions to Address Insufficient Generation Supply & Transmission Resources

The System Operator will analyze and evaluate the overall resource inventory of the system and determine a course of action that will maintain system integrity. Specific areas to be considered include limiting thermal overloads and ensuring network operating frequency and voltage levels.

If there are insufficient generation and/or transmission resources available to control constraints within established procedures, the System Operator will implement a defined response plan to impacted areas across the system and issue a Load Relief Warning, which will be communicated to all Generators and demand-side resources.

The System Operator will implement defined rules for Load-Shed Events to minimize threats to employee and public safety, equipment damage and customer impact. LUMA will identify which critical loads will remain online when possible in coordination with the LUMA critical loads policy and LUMA's Emergency Response Plan (ERP).

The System Operator can manually dispatch generation to minimize or mitigate resource shortfalls during Emergency Conditions if there are insufficient resources as defined in established procedures. Voltage reduction and other strategies may be used in accordance with procedures and current operating conditions.

6.0 Operating Parameters

The following section outlines high-level policies related to the operation of the system. The objective of these policies is to ensure stable, safe operations and actions to be taken including defining resources to be used when operations fall outside of these ranges.

6.1 System Operator Will Establish Policies on Reserves & Line Loading

The System Operator will define detailed rules and procedures on reserves. Operating reserves are electricity supplies that are not currently being used but that can be made available in a timely manner in the event of an unexpected loss of generation or a transmission event. The goal of having adequate reserves is to be able to operate the system during a G-1 or a T-1 event, meaning that losing the largest generating unit or losing a key transmission line does not impair system safety, stability and reliability.

These policies will include specifications to be applied to existing generators, storage and other non-wire alternatives and the mechanism to calculate reserves.

The System Operator will manage all contingencies on the system to mitigate or reduce system interruptions. A contingency is defined as an event, usually involving the loss of one or more elements in generation or transmission, that affects the power system's ability to serve load. The System Operator will define appropriate contingency reserve requirements to address smaller load and generation imbalances by using regulation connected devices such as reactors and capacitors.

The System Operator will define appropriate operating reserves requirements to address larger load and generation imbalances. Spinning reserves should be used to stabilize the system immediately following a disturbance and to provide coverage of the largest unit on the system. Non-spinning, fast start reserves should be used to return the frequency and voltage to prescribed limits after spinning reserves are used.

The reserve policies will also consider the timeliness of receiving reserves. The System Operator will define appropriate reserve requirements to restore the spinning reserves after the disturbance, once the system has been restored to pre-contingency levels.

6.2 System Operator Will Define Procedures to Control Steady-State Power System Stability to Avoid a Puerto Rico-Wide Blackout Condition

The System Operator will define procedures for controlling and preserving steady state power system stability based on an understanding of the factors that could threaten or disrupt service. Power system stability is the ability of an electric power system to regain a state of operating equilibrium after being subjected to a physical disturbance for a given initial operating condition. Steady-state power system stability entails most of the system variables being bounded within certain bandwidths such that the system remains intact after a disturbance. Factors that can affect steady-state stability include:

- Unbalanced loads
- System disturbances including loss of a transmission line or lines
- Loss of one or more generation units
- Loss of major equipment
- System faults
- Low voltage operation
- Frequency regulations malfunction
- Automatic Load-Shed Event recovery

6.3 System Operator Will Develop Action Plans to Reduce Risk Exposure to Contingencies

To minimize disruptions to the system caused by contingencies, the System Operator will establish a baseline of consistent service based on dispatch instructions and provide guidance when generating units have deviated from those instructions. Many of these parameters already exist for plants under existing PPOAs but may need to be developed for legacy thermal units. Development of these Plant-Level Agreements for legacy plants will need to balance the need to mitigate risks against the cost required for such risk mitigation.

The System Operator will develop local load-relief procedures that minimize the impact of Load-Shed Events. These procedures will require operators to maintain accurate reporting of generation and transmission capabilities and set system operating limits (SOL) including generating and thermal transmission limits.

The procedures will also establish a requirement for contingency planning to assist the on-shift Operator in switching transmission lines, dispatching generation units or a combination of actions to mitigate or minimize overall system impact.

6.4 System Operator Will Develop a Set of Transmission Operating Limits

In order to keep the power system operating within safe, stable and reliable levels of energy flow, the System Operator will define transmission operating limits that reflect the appropriate facility rating, voltage stability and transient stability.

The System Operator must be aware when line flows approach a limit on both an actual and a contingency basis, and perform the following:

- Analyze the situation or contingency
- Develop a plan to mitigate or minimize the impact of the situation/contingency
- Implement the plan
- Check to see desired effects have been achieved

To avoid a cascading series of events, the System Operator must evaluate and prioritize multiple simultaneous problems and contingencies and prioritize the order in which to address them. The System Operator will implement controlling actions in the order necessary to avoid other violations.

7.0 Energy Management System

A robust energy management system is critical to optimizing the efficient, safe and reliable operation of the Bulk Power System. One of the fundamental elements of Prudent Utility Practice is a fully functioning energy management system (EMS). PREPA's EMS is no longer supported by the vendor and does not have the functionality to adequately manage and control a modern grid with a large portion of renewable resources. The System Operator will implement a new EMS to provide comprehensive, integrated visibility into the entire generation, transmission and distribution system so that the on-shift Operator can be better prepared to react to an adverse event using real-time data. Implementation of the new EMS is described as part of LUMA's System Remediation Plan.

The EMS will provide operators with situational awareness to enable appropriate decisions in response to system events. The EMS also allows development of prescribed actions to assist in mitigating outages or minimizing outage durations.

The EMS will enable the System Operator to verify that system operation contingency definitions are correct. Telemetry errors from generation and transmission will be identified and logged, and a resolution will be coordinated. The System Operator will also investigate situational issues to resolve potential contingencies.

By coordinating generation and transmission data, the System Operator can model and determine the most conservative solution to emergent issues and minimize impact on both generation and transmission. On-shift Operators can then implement these action plans to resolve discrepancies. LUMA will implement processes to confirm that the on-shift Operator resolves discrepancies within prescribed operational and time limits.

8.0 Outage Scheduling & Reporting

System outages occur for a variety of reasons, both planned and unplanned. The System Operator will prepare for each possible outage and perform an analysis of each event after it occurs.

8.1 System Operator Will Manage All Generation & Transmission Planned Outages

All planned generation and transmission outages must be coordinated and approved through the System Operator. To ensure that outages are conducted in a controlled and orderly manner, the System Operator will define a procedure for requesting and approving all scheduled generation and transmission outages on a rolling two-year basis.

8.2 System Operator Will Develop Planned Outage Requirements

The procedure will include:

- Request forms
- Requirements regarding timing for submittal
- System impact study
- Outage duration
- Restoration plans
- Communication and coordination plan between generation and transmission

Outage scheduling will be done with a minimum of two years for all Planned Outages of all major generation units.

The System Operator will review all requests for transmission or equipment outages to determine system impact on other Generators, transmission lines and/or equipment. The System Operator will manage generation and equipment outages to maintain proper system configuration, maximize system resilience and resolve all out-of-service conditions in a timely manner. LUMA processes will prescribe coordination between field activities and System Operations to plan for outages required for capital projects and maintenance activities.

8.3 System Operator Will Develop Unplanned & Forced Outage Management Procedures

The System Operator will have command and control authority over forced outage responses consistent with existing PPOAs and will lead the implementation of immediate response and corrective actions regarding critical loads. In addition, the System Operator will define rules for reporting and updating dispatch sequence during forced outages, determine estimated outage duration and implement restoration plans.

To minimize the impact and disruption of forced outages, the System Operator will develop procedures that define the appropriate course of action in each area of operation. These procedures will provide guidance to generation and transmission operators on their responses to forced outages.

8.4 Prudent Utility Practice Requires Processes & Procedures to Address Analyzing & Learning from System Events

The System Operator will develop a process to investigate and analyze system events in generation and transmission and subsequently perform a root-cause analysis (RCA) of significant system events to identify causal and contributing factors.

By performing a thorough analysis of systems, human performance, work processes, materials, procedural compliance, environmental conditions and physical plant and management systems, the System Operator can identify the factors, both individually and collectively, that contributed to the event. The RCA will focus on the lessons learned from the event and on improving the reliability of the system and should not be viewed as a punitive exercise. Generators (and/or customers as appropriate) will be required to share their data and analysis on system events as requested by the System Operator.

The System Operator will share all lessons learned across the organization and create communication standards to ensure that the learning messages are well understood and that corrective actions are taken. Subject to system conditions and constraints, the System Operator will implement the corrective actions in a timely fashion to improve overall system reliability.

9.0 Emergency Response

Every power system experiences emergencies and the Puerto Rico system has proven extremely vulnerable to weather and other emergency events. The System Operator will implement and maintain a high level of emergency preparedness in accordance with Prudent Utility Practices.

9.1 System Operator Will Implement an Emergency Response Plan

Responsive System Operations are among the most critical elements of effective emergency response to natural disasters and other major events that threaten overall system stability and could potentially result in prolonged outages leading to possible life-threatening events in communities. As part of its Front-End Transition Services, LUMA is developing an Emergency Response Plan (ERP) that includes system operation activities during emergency events. (OMA, Section 4.2 (g)). The ERP will include:

- Classification of events and emergencies
- Appropriate response based on classification
- Emergency command center (ECC) to be manned during an event
- Incident commander and roles and responsibilities for an emergency response organization consistent with FEMA guidelines
- Procedures that define proper responses to events and emergencies and after-action reviews

LUMA will establish a program to drill emergency procedures, including coordination with government agencies, other utilities and key stakeholders. LUMA's Performance Metrics include metrics that will be used during major outage events to track LUMA's performance during emergencies, provide key data and allow for continuous improvement of emergency procedures and activities.

9.2 System Operator Will Develop a Prioritized List of Actions to Take in Emergency Situations

The System Operator will prepare a list of actions to be followed during significant system events and disturbances to the electric system. The list will include preventive and corrective actions that can be taken to mitigate outages and/or restore the system in situations such as:

- Storms and hurricanes
- Earthquakes
- Tsunamis
- Equipment malfunctions
- Operating errors

The list will include other major system disturbances which could result in cascading events, such as:

- Electrical islanding
- Load shedding
- Trip of generation
- Full or partial blackout

The risk mitigation plan should reflect the degree of advance warning or expected severity of the approaching event. LUMA will use industry best practices including the development of a damage prediction model and timely post-event damage assessment to support restoration activities. The list of events above is illustrative and not intended to be exhaustive.

9.3 System Operator Will Develop & Implement Black Start & System Restoration Procedures

When part or all of the system has experienced a loss of power and a blackout condition has been declared by the System Operator, the System Operator will be required to follow Black Start procedures to restore service. The System Operator will create and maintain a defined set of procedures that dictate actions to restore the system from blackout condition.

These procedures will identify generation equipment that is able to start without an outside electrical supply, as well as the proper steps to energize defined portions of the transmission system. The System Operator will create a desktop procedure for on-shift Operators to select which units to restore first in order to restore the system safely.

At all times, the System Operator should be in control of start and dispatch of all generation units connected to the system. Emergency operating conditions shall be at the sole discretion of the on-shift Operator.

During a blackout, the System Operator will follow its Black Start procedures to get the first generation unit restored. Upon restoring that first generation unit, the System Operator will commence actions to safely energize portions of the transmission system in coordination with the restart of other generation resources.

System restoration will be drilled annually. As part of its regular planning, the System Operator will give special attention to the fragility of the system during a system restoration. The process should carefully manage frequency control, voltage control and ramping time, along with avoiding overcurrent conditions and cold load pickup situations.

9.4 LUMA Will Determine How to Respond to Short-Term Resource Adequacy Issues

The System Operator will need to address any shortfalls in Resource Adequacy. In response to this, LUMA will develop a plan for alternatives to serve as a near-term bridge (less than three years) to achieve Resource Adequacy. This plan could include, but not be limited to:

- Non-wire alternatives
- Demand-side management
- Distributed generation
- Storage
- Demand response
- Temporary or mobile generation
- Temporary or mobile substations

LUMA will meet with PREB on an annual basis as defined in OMA section 5.13(d)(iii) to review and assess prepared analyses, demand projections and existing generation supply to discuss the current and projected Resource Adequacy in the system. LUMA will indicate whether additional resources are needed, along with other potential responses to a projected shortfall in resources compared to demand. At that time, LUMA will identify potential solutions, trade-offs and technical considerations in selecting a path to restore Resource Adequacy.

9.5 System Operator Will Administer the LUMA Procedure for Critical Loads

The System Operator will implement LUMA's policy regarding consideration of critical loads during emergencies. Procedures for prioritizing critical loads for restoration of service to sustain essential services and maintain community functionality are included in the ERP. Critical loads may include but are not limited to the following critical facilities:

- Hospitals
- Police, fire and other first responder facilities
- Utilities, including water and telecommunications
- Government facilities providing lifeline services to communities.

LUMA will also review policy regarding consideration of critical-care customers, which may include residential facilities and individual residences that have life-support equipment. Factors to consider include the process for identifying critical-care customers, validation of the list for accuracy and updates of datasets for use by on-shift Operators.

10.0 Balancing Frequency & System Impacts

Using a hierarchy of methods and measures, the System Operator will maintain a balanced system and minimize impacts wherever possible.

10.1 Systems Operations Will Implement Prudent Utility Practice to Maintain Proper Frequency & Voltage

The System Operator will develop procedures and schedules to test generators, reactors and capacitors connected to the system to provide current performance data. These procedures will enable the collection of secure, accurate and timely data, so that the on-shift Operator will be able to optimize responses to sub-optimal voltage and/or frequency situations.

Critical frequency support elements include voltage and frequency support. Voltage support is required to maintain system level voltages within established limits, thus preventing voltage collapse and system instability. Frequency support is required to support stable frequency on the synchronized system and to maintain continuous load and resource balance by employing automatic response functions in response to deviations from normal operating frequency.

The on-shift Operators must have the capability to raise or lower generation or load, either automatically or manually, under normal and post-contingency conditions.

10.2 Controlling Actions for Proper Voltage & Frequency

Figure 10-1 illustrates an operator's typical hierarchy of control to maintain frequency and voltage.

Figure 10-1. Typical hierarchy of control to maintain frequency and voltage

PRIMARY RESPONSE:	The governor in each operating generator will respond to subtle frequency variations
SECONDARY RESPONSE:	Automatic generation control is required to allow the System Operator to control the system during a G-1 event
TERTIARY RESPONSE:	When the primary and secondary responses are not capable of rectifying the system disturbances, the System Operator could add additional generation, typically quick start
BALANCING METHODS:	**Voltage Reduction:** System Operator will develop a voltage reduction plan to avoid or limit load shed **Load Shed:** As a last resort, System Operator could take actions that safely unload the transmission system

Appendix A: Appendices

A.1 List and Description of Procedures for System Operator

As part of LUMA's Front-End Transition deliverables and as a Condition Precedent to Service Commencement, LUMA was required to 'prepare principles related to the dispatch of Power and Electricity' *OMA, Section 4.1(h)* (called the System Operation Principles) that are 'generally consistent with those set forth in Schedule 1 to Annex I'.

During O&M Services, LUMA will provide generation related power supply dispatch and management services in accordance with Section 5.13 of the OMA and the System Operation Principles, including:

- Dispatch, schedule and coordinate Power and Electricity from available generation assets and power related services
- Coordinate the scheduling of load requirements and Power and Electricity with IPPs pursuant to their respective contracts
- Implement and apply on a continuous basis on the relevant time basis applicable the System Operation Principles in order to ensure and coordinate the delivery of Power and Electricity
- Develop load and energy forecasts, scheduling requirements and capacity requirements taking into consideration unit outages
- Request and consider information with respect to operational constrains
- Perform other services related to dispatch, scheduling or coordination of Power and Electricity from existing and future available generation assets

This includes periodic review of System Operation Principles and submit revised System Operation Principles to this Bureau.

Implementing the System Operation Principles will consist of:

- Implementation of procedures over time
- Operator training
- Recording of data and findings as required by procedures
- Development of additional procedures, as necessary
- Review procedures for improvements and updates

LUMA discovered through the Gap Assessment that PREPA currently operates the system without written procedures and with minimal documentation, below industry standards. The development of procedures was not contemplated during the Front-End Transition. Rather than verifying, modifying and adding to an existing set of procedures, LUMA has undertaken the challenge of developing a large number of procedures from scratch for the Puerto Rico bulk electric system. LUMA recognized the benefit of accelerating the development of the higher priority procedures and began developing the procedures after submitting the System Operation Principles to the Energy Bureau.

In support of the operationalization of the System Operation Principles, Phase I procedures, listed and described below, will be completed in advance of June 1st, 2021 and will begin implementation soon after commencement. Phase II procedures will be completed in advance of December 31, 2021 and will begin implementation soon after January 1, 2022. Draft Phase I procedures are presented to the Bureau within RFI-LUMA-MI-21-0001-210511-PREB-009.

The following table lists each major principle and the corresponding procedures LUMA intends to utilize to implement that principle.

System Operation Principles

Principle	Procedure	Procedure Description
Planning	Load Forecasting - Phase II	Describes data input requirements, processing and data reporting to enable load forecast data reporting requirements.
	New Generation Interconnections - Phase I	Provides guidance to a new Generator through the application and agreement process including specific requirements and rights
	Resource Adequacy Assessments - Phase I	Describes the process and procedure for establishing the amount of generating capacity required to supply load with sufficient reserve for reliable service
	Retirements - Phase II	Describes the process for submitting a notification/requests for retirement of a unit to System Operator. The process will include reason for retirement, timing of the retirement and system impact study
Standards	G&T Demarcation & Metering - Phase I	Describes the demarcation point between generation and transmission and the process and requirements necessary to properly provide for the demarcation point
	Generator Capabilities - Phase I	Provides specific requirements and rules to Generators who operate on the Puerto Rico bulk system
	Black Start - Phase I	Describes all the requirements for each unit's capability for a Black Start, including items such as ramp rate, time to be online, fuel capacity, available run time and other critical items for a successful Black Start
	Telemetry - Phase II	Describes all the telemetry needed for generation, substations and transmission; also addresses needed fiber, back-up capabilities, testing requirements

System Operation Principles

Principle	Procedure	Procedure Description
	Data / Cybersecurity - Phase II	Describes data submittal and maintenance rules and requirements for all interconnected Generators and commercial and industrial loads to maintain safe, secured and accurate data, which allow the Participant to continue in good standing with the System Operator and in accordance with all data requirements. Cybersecurity standards establish best practices that comply with LUMA requirements. These cybersecurity standards with also comply with all governmental and regulatory requirements.
	Root Cause & Lessons Learned - Phase II	Describes how to properly perform a root-cause analysis when an event occurs on equipment or personnel. Provides a detailed and thorough investigation into and event. Also describes how to properly communicate all lessons learned throughout the organization.
	Public Reporting - Phase I	Provides guidance regarding communication requirements to the regulatory and public stakeholders. Also provides recommended metrics such as Estimated Time of Restoration to be reported and a frequency for reporting
	Performance Reporting - Phase II	Provides guidance regarding appropriate metrics including but not limited to safety, reliability, status of equipment, corrective and preventative maintenance and budgetary reporting.
	Stakeholder Management - Phase II	Provides guidance on the stakeholder process including an issues resolution process and process to develop and evaluate enhancements and other changes that impact multiple stakeholders.
Management of Reserves	Policy on Reserves - Phase I	Describes the rules, procedures and requirements for adequate availability of necessary resources that can be called upon to support reliability.

System Operation Principles

Principle	Procedure	Procedure Description
	Reducing Risk Exposure to Contingencies - Phase II	Provides guidance, rules and procedures that establish how to proactively monitor and react to contingencies and be able to analyze and react to system issues to prevent contingencies.
Contingency Planning	Critical Loads - Phase I	Identifies steps to maintain critical loads online, prevent load shedding and other switching steps to mitigate interruption of service to critical loads and critical-care customers. Overall policy to be developed by other groups outside System Operations, including Utility Transformation and Customer Service.
	Load Shedding - Phase II	Provides guidance regarding under-frequency conditions and sets limits and timeframes for deviation from these limits; defines procedures for load shedding or bus isolation, frequency limits and the steps to shed load in a safe and controlled manner.
	Contingency & System Operating Limits - Phase I	Describes contingencies and establishes operating limits with corrective actions and timeline for proper response.
Dispatch Operations	Energy Dispatch, Scheduling & Merit Order - Phase I	Procedure for the On Shift Operators to maintain adequate regulation, and system frequency and voltage within tolerances. Also describes responsibilities for switching and blocking and other daily shift responsibilities.
	Transmission Operations - Phase II	Transmission operations, including switching, communications and reporting describes all activities involved with the transmission system, including operations, maintenance, and planning.
	Plant-Level Agreements - Phase I	Template for all plant-specific technical and communication protocols for Generator interfaces with System Operator.
	Balancing Frequency & Voltage - Phase I	Describes how to manage capacity resources, monitor transmission and provide services within the Puerto Rico service territory.

System Operation Principles

Principle	Procedure	Procedure Description
	Demand-Side Resources (NWAs) - Phase II	Outlines the demand-side response rules, including non-wire alternatives, that could support reliability during high demand or unstable periods.
	Shift System Operator Training Requirements - Phase II	Addresses initial and ongoing training programs for On Shift Operators.
Outage Management	Scheduling Planned T&G Outages - Phase II	Provides operating philosophies and operating parameters with respect to outage planning and scheduling. Also addresses the reporting, analyzing and approval of scheduled generation and transmission outages.
	Forced Outage Response - Phase I	Describes actions to be taken in response to a forced outage to either generation or transmission. Includes communications responsibilities regarding cause of outage, outage duration and other steps to recover in a timely manner.
	Outage Execution & Closeout - Phase II	Describes process for executing work during outages, reporting t and steps for recovery and closeout of an outage.
Emergency Response	Emergency Response Execution - Phase I	Provides guidance for emergency response, including roles and responsibilities, system operating conditions, system restoration and blackout restoration.
	Emergency Drills - Phase II	Provides guidance on periodic drills of emergency response procedure.

A.2 Generating capacity data operating characteristics to be compiled for all units

Table A-1. Generation Data

Data Element	Unit
Plant / unit name	—
Location	—
Company	—
Contact information	—
Phone and email	—
Commercial operation date	—
Name plate rating	MW
Max output	MW
Total gross energy	MW
Aux load (how connected)	MW/MVAR
Station service load (how connected)	MW/MVAR
Leading under-excited	MVAR
Lagging over-excited	MVAR
Single line diagrams	Attachment

Intermediate Units		Major Generation Units		Independent Power Plants
Cambalache 1	Aguirre CC1-3	Palo Seco 1	San Juan 9	EcoEléctrica
Cambalache 2	Aguirre CC1-4	Palo Seco 3	San Juan 10	AES
Cambalache 3	Aguirre ST-1	Palo Seco 4	Aguirre 1	Solar
Mayaguez 1	Aguirre CC2-1	San Juan 5	Aguirre 2	Wind
Mayaguez 2	Aguirre CC2-2	San Juan 6	Costa Sur 5	Landfill Gas
Mayaguez 3	Aguirre CC2-3	San Juan 7	Costa Sur 6	**PREPA Hydro**
Mayaguez 4	Aguirre CC2-4	San Juan 8		—
Aguirre CC1-1	Aguirre ST-2			
Aguirre CC1-2				

Appendix B: Glossary of Technical Terms

The following general technical terms are used in this report. They are provided below for convenience.

Automatic Generation Control (AGC): AGC is a system for adjusting the power output of multiple generators at different power plants, in response to changes in the overall system load. AGC is used in real-time control to match the area generation changes to area load changes to keep frequency at nominal value. For successful operation of the power system, the load must be fed with constant voltage and frequency.

Automatic Voltage Regulator (AVR): A generator control device that adjusts voltage output from a generator to support system voltage.

Blackout: A total failure of the Bulk Power System or a large portion thereof. While the criteria for "large" can vary by country and power system, this SOP has designated a threshold of 50,000 customers and 300 MW as "large."

Bus: A point of interconnection to the system where power produced becomes available for transmission. Also, an electrical conductor that serves as a common connection for two or more electrical circuits.

Capacitor: An electronic component that stores an electric charge and releases it when required. When connected to the power system, capacitors will provide reactive power and thereby increase the voltage on the system.

Capacity Resource: A generating unit, demand resource, energy efficiency resource or aggregate resource that has obligated itself to deliver electricity or reduce load whenever the System Operator determines it is needed to meet power system emergencies.

Cascading Event: An occurrence when one element fails (completely or partially) and shifts its load to nearby elements in the Bulk Power System. Those nearby elements are then pushed beyond their capacity, so they become overloaded and shift their load onto other elements. Cascading failure can occur in high-voltage systems, when a single point of failure (SPF) on a fully loaded or slightly overloaded system results in a sudden spike across all nodes of the system. This surge current can induce the already overloaded nodes into failure, setting off more overloads and thereby taking down the entire system in a very short time.

Cold Load Pickup: An occurrence of increased current that takes place when a distribution circuit is reenergized following an extended outage.

Constraint: A limitation on one or more transmission elements, which may be reached during normal or contingency System Operations, that restricts and prevents the dispatch of electrical energy on a specific transmission line.

Contingency: An event, usually involving the loss of one or more elements such as a generator or transmission equipment, that affects the power system at least momentarily.

Contingency Reserve: The synchronized and non-synchronized generation, available in a short period of time (30 minutes or less), to allow for the system to recover from either a unit trip, voltage event or frequency event. Some System Operators require contingency reserves equal to one-times the largest operating generator.

Controlling Actions: Operator actions taken to mitigate or minimize a contingency/system event.

Critical Load: A prioritized collection of load or customers that are defined as critical for the purposes of avoiding load shed and/or prioritizing restoration. These customers may include hospitals, telecom facilities, wastewater treatment facilities, emergency response facilities and other critical infrastructure.

Demand Side Resource: A resource with a demonstrated capability to provide a reduction in demand or otherwise control load.

Demand Side Response: A change in electricity usage by a customer in response to price or an emergency event affecting system reliability.

Distribution: Distribution is the final stage of delivering electricity to an end user. A distribution system steps down electricity from the higher voltage levels on the transmission system to deliver it directly to homes or businesses. In Puerto Rico distribution includes equipment with voltage levels of less than 38 kV.

Distributed Generation: Electrical generation and energy storage performed by small grid-connected or distribution-connected devices.

Economic Dispatch: The short-term determination of the optimal output of generation facilities, to meet the system load, at the lowest possible cost, subject to transmission and operational constraints.

Electrical Islanding: Islanding is a condition in which a distributed generator continues to feed nearby load even when the supply is disconnected from the Bulk Power System.

Energy Management System: A combined system of information technology hardware and software tools that provide real-time monitoring of operational information for critical electrical equipment in the Bulk Power System.

Emergency Command Center: The physical location(s) where coordination of information and resources to support incident management activities during an emergency.

Emergency Operating Conditions: Abnormal conditions that require manual or automatic response to maintain system frequency and prevent loss of load, equipment damage and tripping of system elements that would affect the reliability or safety of the system. Emergency operating conditions may also relate to loss of fuel situations and/or implementation of emergency procedures.

Emergency Response Organization: The organization responsible for managing all emergency situations on the system, restoring the electrical system to best configuration and restoring power to customers. The emergency response organization has complete command and control of all emergency response personnel and actions to restore the system consistent with Incident Command Structure protocols.

Federal Energy Management Agency: The Federal Emergency Management Agency (FEMA) is an agency of the United States Department of Homeland Security. It was initially created by President Jimmy Carter under Presidential Reorganization Plan No. 3 of 1978 and implemented by two executive orders on April 1, 1979.

Forced Outage: A term describing the immediate unplanned removal of either a transmission line or generator due to circumstances not foreseen.

Frequency: Frequency is the rate at which current changes direction per second.

Frequency Control: The process of controlling frequency within predefined limits to avoid unexpected disturbances that can create problems to the connected loads or even cause equipment and/or system failure.

G-1 Standard: A planning standard describing an operating requirement whereby a generator can be lost from service for any reason without immediately causing a contingency requiring a Load-Shed Event or other action that has significant impact on service.

Generation: Generation describes both the process of producing electrical energy from other forms of energy (e.g., a power plant producing energy from a fuel or a wind turbine turning moving air into energy) as well as the amount of electrical energy produced.

Generator Control System: Controls that perform multiple functions such as overspeed control, regulating, protection and other functions to respond to demand and protect the generator.

Governor: A device used to measure and regulate the speed of a machine, such as a generator. Also called a speed limiter or controller.

Grid: An electrical grid is an interconnected network of generation, transmission and distribution elements that delivers electricity from suppliers to consumers.

Incident Command Structure (ICS): A standardized, on-scene and integrated emergency management organizational structure that reflects the complexity and demands of single or multiple incidents without being hindered by jurisdiction boundaries

Lagging Over-Excited: The term ‘lagging power factor’ is used when the load current lags behind the supply voltage. It is a property of an electrical circuit that signifies that the load current is inductive, meaning inductive loads will cause a lagging power factor.

Leading Under-Excited: For capacitive circuits, when the load current leads the supply voltage.

Load (Demand): Load is the overall usage or consumption of electricity on a power supply. Load is generally expressed in kilowatts or megawatts.

Load Relief: A controlled system response to relieve stress on a primary energy source when demand for electricity is greater than what the primary power source can supply.

Nameplate Rating: The generation capacity of a completed generation facility, expressed in megawatts, consistent with the recommended power factor and operating parameters provided by the manufacturer.

North American Electric Reliability Corporation (NERC): NERC operates as an electric reliability organization to improve the reliability and security of the Bulk Power System in North America. While NERC guidelines are an indicator of current industry best practice, use of NERC rules, definitions and procedures in Puerto Rico are not obligatory.

Non-Wire Alternative(s): Electric utility system investments and operating practices that can defer or replace the need for specific transmission and/or distribution projects.

Operating Procedures: The collection of procedures that define how LUMA and the System Operations Group will implement the principles defined in the SOP.

On-Shift Operator: The personnel at the control center responsible for operating the system.

Outage: Planned or unplanned intervals of time (short term or long term) when either transmission lines or power plants are temporarily removed from service.

Power: Power is the rate at which energy is transferred, used or transformed. It is measured in watts.

Ramp Rate: The rate, expressed in megawatts per minute, at which a generating unit can change output level.

Reactor: Equipment installed at transmission and distribution substations to help stabilize the power system.

Regulation: The capability of a specific resource with appropriate telecommunications, control and response capability to increase or decrease its output in response to a regulating control signal to control for frequency deviations.

Operating Reserves: Capacity that currently is not being used but that can be quickly available for the unexpected loss of generation.

Resource: All supply and demand side assets and programs that a System Operator can use to maintain system stability. This includes generators, reactors, capacitors, storage and non-wire alternatives.

Root-Cause Analysis: Use of a systematic approach to analyze an event that had negative consequences, with the goal of finding the causal and contributing factors of the event and developing recommendations to prevent a recurrence of the event.

Remote Terminal Unit (RTU): An electronic device that is controlled by a microprocessor and interfaces with physical objects to a Supervisory Control and Data Acquisition (SCADA) system by transmitting telemetry data to the master system.

Supervisory Control and Data Acquisition (SCADA): A system of remote control and telemetry used to monitor and control the electric system components.

Security Constrained Economic Dispatch: A system operation method that co-optimizes energy costs and system security. The goal is to minimize production costs while enforcing all security constraints on the system.

Steady State Stability: The condition of a power system operating equilibrium.

System Operating Limit (SOL): The value (such as MW, MVAR, amperes, frequency or volts) that satisfies the most limiting of the prescribed operating criteria for a specified system configuration to ensure operation within acceptable reliability criteria.

System Restoration: The process of sequentially restoring generation and transmission elements to a system following a system blackout event. The process would involve coordinating and executing Black Start procedures in place at one or more locations.

T-1 Standard: A planning standard describing an operating requirement whereby a transmission asset can be lost from service for any reason without immediately causing a contingency situation.

Telemetry: The automatic collection of measurements or other data at remote points and subsequent automatic wireless transmission of data to receiving equipment (telecommunications) for monitoring. See SCADA definition.

Thermal Overload: A state when the amount of power carried by an element exceeds its rated thermal limits and the heating effect can potentially damage the device.

Transient Stability: The ability of the power system to return to its normal conditions after a large disturbance.

Transmission: Transmission is the bulk movement of electrical energy from a generating site to an electrical substation closer to areas of demand for electricity. The interconnected lines which facilitate this movement are known as a transmission network that deliver power to distribution equipment and then to customers. Transmission in Puerto Rico is all equipment with voltages 38 KV or above.

Voltage: The potential difference in electrical charge between two points in an electrical field. It is measured in volts.

Voltage Reduction: A means to reduce customer demand by lowering voltage.

Watt: A watt is a unit of power that measures the rate at which energy is transferred or converted.