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GOVERNMENT OF PUERTO RICO
PUERTO RICO PUBLIC SERVICE REGULATORY BOARD
PUERTO RICO ENERGY BUREAU

IN RE: OPTIMIZATION PROCEEDING OF MINIGRID TRANSMISSION AND DISTRIBUTION INVESTMENTS	**CASE NO.:** NEPR-MI-2020-0016 **SUBJECT:** LUMA's Motion Submitting Comments and Presentation for the Minigrid Optimization Technical Workshop of March 23, 2021.

MOTION SUBMITTING LUMA'S COMMENTS AND PRESENTATION FOR THE SECOND MINIGRID OPTIMIZATION TECHNICAL WORKSHOP OF MARCH 23, 2021 AND REQUEST FOR LEAVE TO OFFER POWER POINT PRESENTATION IN THE MARCH 23rd TECHNICAL WORKSHOP

TO THE PUERTO RICO ENERGY BUREAU:

COME NOW, LUMA ENERGY SERVCO, LLC and **LUMA ENERGY, LLC** (collectively, LUMA), through the undersigned legal counsel and respectfully submit the following:

1. In a Resolution and Order dated December 22, 2020, this honorable Energy Bureau initiated this Optimization Proceeding in accordance with the Resolution and Order approving the Integrated Resource Plan, Case No. CEPR-AP-2018, to first "develop[] a set of guiding principles and concepts which will be used to analyze various options for either the entire island (e.g., DER solutions), or for each Minigrid region (e.g., for specific transmission solutions)." *See* December 22nd Resolution and Order at page 4. The Bureau further explained that it would "develop[] . . . parameters . . . to measure and quantify the benefits and costs when comparing transmission and substation (new or existing) hardening options with distributed resiliency options." *Id.*

2. In the December 22nd Resolution and Order, the Bureau announced that it would hold two initial technical workshops. The two initial technical workshops were held on January

21st and 22nd, 2021, to develop optimization plans for all of the minigrid regions. *See* February 11, 2021 Resolution and Order at page 1, Case No. NEPR-MI-2020-0016.

3. On February 11, 2021 the Bureau issued a Resolution and Order to, among others, schedule a Technical Workshop "to focus on the examination of the San Juan-Bayamón region transmission options". *Id.* at page 2. The Bureau also indicated that it "will continue further examination of how the economics of Distributed Energy Resources alternatives for resiliency influence the overall consideration of transmission options." *Id.* The Technical Workshop was held on February 23, 2021.

4. On February 23, 2021, LUMA representatives appeared before the Energy Bureau for the Technical Workshop that was held via videoconference.

5. With leave from the Energy Bureau, Lee Wood and Shay Bahramirad, PhD offered a Power Point™ presentation in the February 23rd technical workshop. On March 3, 2021, LUMA filed for the record a copy of said Power Point™ presentation.

6. In its presentation of the February 23rd technical workshop, the Energy Bureau stated that the technical workshop scheduled for March 23rd would focus on Distributed Energy Resources ("DER") solutions and how to create or expand metrics to determine and compare costs for DER options. *See Resilience Optimization Proceeding*, February 23, 2021 at slide 38. The Bureau also published questions on how to provide and rapidly deploy DER and directed that comments and responses to questions are to be filed prior to the March 23rd workshop. *Id.*

7. With this motion, LUMA respectfully submits its comments and responses to questions posed by the Bureau throughout the proceedings and in preparation for the March 23rd Technical Workshop. *See* Exhibit 1. The comments also outline LUMA's perspective on the MiniGrid optimization roadmap and the near-term transmission and distribution investment

criteria. Ashley Engbloom, Lee Wood, and Shay Bahramirad, PhD, are available to present LUMA's comments and answer questions from the Bureau and its consultants. It is respectfully requested that this Honorable Bureau accept and consider LUMA's comments and responses to questions that the Bureau has posed in this proceeding. Exhibit 1.

8. With this motion LUMA is also submitting the Power Point™ presentation that LUMA personnel, Ashley Engbloom, Lee Wood, and Shay Bahramirad, PhD, propose to offer during the March 23rd Technical Workshop. *See* Exhibit 2. LUMA requests leave to give the presentation on March 23, 2021.

WHEREFORE, it is respectfully requested that the Energy Bureau **accept and consider** the filing of LUMA's comments and responses to questions, Exhibit 1, and **grant** LUMA leave to give the Power Point™ presentation, Exhibit 2, during the March 23rd technical workshop.

RESPECTFULLY SUBMITTED.

In San Juan, Puerto Rico, this 23rd day of March 2021.

I hereby certify that I filed this motion using the electronic filing system of the Puerto Rico Energy Bureau and that on this date, I will send an electronic copy of this motion to counsel of record for the Puerto Rico Electric Power Authority, Joannely Marrero-Cruz, jmarrero@diazvaz.law; and Katiuska Bolaños-Lugo, kbolanos@diazvaz.law.

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Exhibit 1

Resilience Optimization Technical Workshop LUMA's Response

NEPR-MI-2020-0016

Table of Contents

1. Introduction

LUMA is pleased to have the opportunity to join the collaborative Resilience Optimization conversations held by the Puerto Rico Energy Bureau (PREB). Hearing different stakeholders' perspectives allowed us to gain important insights and share ideas related to existing transmission and distribution planning principles, criteria, processes, and procedures. Discussions at previous workshops were productive, and we look forward to more discussions at upcoming workshops.

This document outlines LUMA's perspective on the grid optimization roadmap and the near-term transmission and distribution investment criteria.

1.1 Objectives

In the December 22, 2020 Resolution and Order[1], opening this Resilience Optimization Proceeding, PREB stated that the objective of the proceeding was to begin a sequential process of comparing two approaches for increased resiliency in Puerto Rico:

"*(i)* One based on transmission system hardening, coupled with distribution system reinforcements, to reliably deliver broadly localized power to loads even after extreme weather events have severed the transmission system links between regions; and *(ii)* another one based on providing many points (potentially, thousands) of site-specific or MicroGrid provided distributed generation and storage to serve critical and potentially other loads, also after an extreme weather event has severed the transmission system."

PREB defined broadly localized power as the energy and capacity presumed available by PREPA in the MiniGrid approach. LUMA agrees with PREB that the resiliency solutions are not mutually exclusive, and alternative distributed resiliency solutions such as MicroGrids and DERs complement transmission and distribution investments. Overall LUMA views resiliency planning as part of overall grid planning, which must take into account practical, technically sound and reasonable options that best achieve the multiple policy objectives for the grid and accomplish improved customer benefits. LUMA believes that the path to a more resilient, reliable grid with upgraded customer service should be viewed based on established criteria which should be part of the results of the current process.

LUMA's proposed roadmap in Section 2.0 aims to establish the grid analysis framework in the long-term. The proposed roadmap aims to address PREB's response to the IRP regarding the lack of optimization of MiniGrid investments against alternative distributed resiliency approaches, as stated in the IRP order[2]. LUMA agrees with PREB in moving forward with near-term transmission and distribution resiliency solutions that are clearly beneficial and support resiliency and other goals. To that end, LUMA is focusing on a framework for identifying near-term transmission and distribution projects for federally funded recovery projects. LUMA's near-term goals also include supporting the establishment of a conceptual approach to transmission and distribution optimization process with MiniGrid, MicroGrid, and DER options, agreeing on a long-term roadmap, and focusing MiniGrid design and scoping efforts on a single R&D pilot region. It is important to note that the concept of Minigrids as a resiliency measure is a relatively new concept in the utility industry with no history of deployment. The widespread use of MicroGrids and DER as the primary resiliency measure for a grid likewise has a limited operating history in electric utilities. The purpose of the proposed approach along with proposed distributed resiliency solution pilots is to further refine the analytical framework and conceptual approach prior to determining if MiniGrids and/or distributed energy solutions should be scaled to other regions and how to carry out such a deployment.

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[1] Puerto Rico Energy Bureau, NEPR-MI-2020-0016 "In RE: Optimization Proceeding of MiniGrid Transmission and Distribution Investments", 2020.

[2] Puerto Rico Energy Bureau, CEPR-AP-2018-0001 "In RE: Review of the Puerto Rico Electric Power Authority Integrated Resource Plan".

In the long-term, the objective is to evolve from near-term transmission and distribution project criteria, based on data currently available, into a more rigorous investment and planning process employing analytical, data-driven approaches that use enhanced data (GIS, PI historian, loading, hosting capacity, asset health assessment index, etc.). This long-term target will be shaped by outcomes from current interrelated proceedings, research projects including DOE analyses and planning efforts, and optimization-based resource planning models that have been the focus of national laboratories. In one study, for instance, Sandia National Laboratory determined optimal PV and battery storage sizing & siting for the five-municipality consortium (CEM) in Puerto Rico as distributed resiliency solutions to meet the power demands of the consortium[3].
LUMA believes that a planning effort described above should begin with a set of goals that reflect Puerto Rico public energy policy and the short-term and long-term goals already set out for the grid. To that end, LUMA proposes to use a Recovery and Transformation Framework (RTF) to remain focused on achieving tangible customer benefits. LUMA's mission within this framework is to deliver customer-centric, reliable, resilient, safe, sustainable electricity at reasonable prices, The Recovery and Transformation goals that reflect Puerto Rico energy public policy (see Section 3.0**Error! Reference source not found.**) provide opportunities for deploying distributed energy resources as non-wires alternatives (NWA) to the extent feasible, reliable, and cost-effective from a holistic system perspective.

Distributed resiliency solutions can be put to dual-use and provide energy and capacity-related grid services during blue sky days (days without major events) as well as making the system resilient during catastrophic events. At the end of this document, we provide our responses to technical questions that touch upon the various mechanisms regarding deployment of distributed energy resources (scale, procurement mechanisms, valuing avoided transmission, and investments).

Prudent Utility Practice, the current state of the Puerto Rico grid and LUMA's technical judgement dictate that the detailed technical considerations and analysis required for MiniGrid, MicroGrids, and distributed resiliency solutions in general must be studied and understood in order to responsibly move forward. Consequently, LUMA proposes focusing efforts on an individual pilot region and initiating scoping of the pilot in the near-term, with deployment in the medium-term. Near-term pilot MiniGrid scoping efforts include a detailed list of technical considerations and procedures listed in Section **Error! Reference source not found.**. Pilot learnings will drive the analytical framework required for cost and benefit analysis, optimize investment decisions between MiniGrids, transmission and distribution projects and distributed resiliency solutions, and eventually a holistic planning function.

2. Grid Optimization Roadmap

Error! Reference source not found. In order to assure that LUMA's operations and investment implementation reflect Puerto Rico energy public policy and achieve customer benefits, LUMA developed the following goals to plan, design, and operate the grid:

[3] Cody J. Newlun, Daniel R. Borneo, Susan Schoenung, Tu Nguyen, "Regional resource planning for Puerto Rico Mountain Consortium". Sandia National Laboratories, 2020.

Figure 2-1 Recovery and Transformation Goals

PRIORITIZE SAFETY
Reform utility activities to support a strong safety culture focused on employee safety and the safety of the people of Puerto Rico

IMPROVE CUSTOMER SATISFACTION
Transform operations to deliver a positive customer experience and deliver reliable electricity at reasonable prices

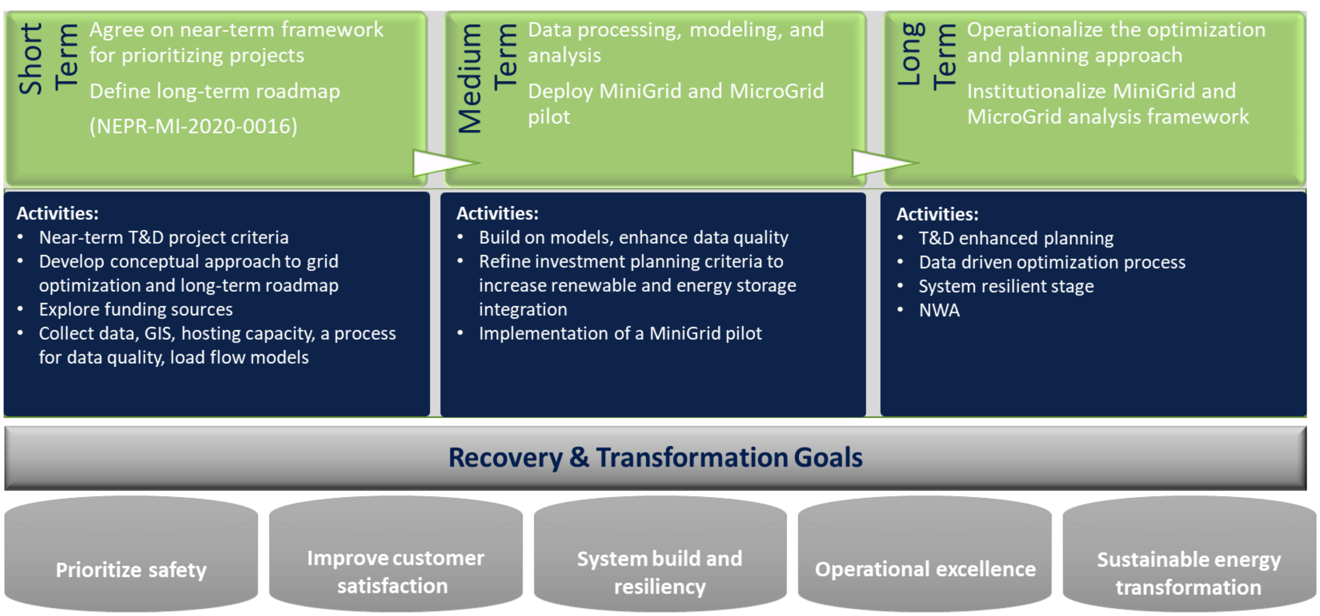
SYSTEM REBUILD AND RESILIENCY
Effectively deploy federal funding to restore the grid and improve the resilience of vulnerable infrastructure

OPERATIONAL EXCELLENCE
Enable employees to pursue operational excellence through new systems, processes and training

SUSTAINABLE ENERGY TRANSFORMATION
Modernize the grid and the utility to enable the sustainable energy transformation

The mission and goals are the outcome of the planning framework that is meant to establish a solid link from Puerto Rico's key policy drivers to LUMA's strategy and plans.
To support and in alignment of the five goals listed in **Error! Reference source not found.**, LUMA has outlined a grid optimization roadmap (**Error! Reference source not found.**). This roadmap is a collection of short-, medium-, and long-term objectives focusing on the operationalization of a full investment optimization and integrated planning approach.

Figure 2-2 Grid Optimization Roadmap



2.1 Near-Term Recommendations

Near-term recommendations consist of two main objectives:

1. Agreeing on a framework for near-term transmission and distribution project criteria to address the most vulnerable assets.
2. Exploring the development of a more comprehensive framework for long-term optimization planning by scoping a MiniGrid R&D pilot. Pilots will also include distributed resiliency solutions such as MicroGrids, different types of DERs; energy efficiency, demand response, and energy storage, either in the same region as the MiniGrid or somewhere else.

Establishing a framework for the near-term transmission and distribution projects aims to move forward with improving the resiliency of Puerto Rico's electric grid during major events. The near-term framework and subsequent selected projects will also focus on reducing restoration response times. The framework's details and criteria are discussed in Section **Error! Reference source not found.**.
Before institutionalizing any long-term framework, LUMA recommends focusing efforts on a single MiniGrid pilot area, capturing learnings before the consideration of a full-scale deployment of MiniGrids or alternative distributed energy-focused plan. As part of the near-term MiniGrid R&D pilot scoping, the following should be established:

- The MiniGrid pilot objectives
- Electrical area selection and boundary determination
- A detailed list of technical considerations
- Success criteria

More information about these considerations is in Section **Error! Reference source not found.**.

To better understand and evaluate alternative distributed resiliency projects, we also suggest piloting MicroGrid and different types of DERs such as energy storage, energy efficiency, demand response, and distributed generation. An area for the MicroGrid/DERs pilot can be identified based on a screening procedure. Through the screening procedure, the most vulnerable areas of the system (from a criticality, reliability and resiliency perspective) can be identified to determine potential pilot locations. The pilot's potential locations can then be ranked and prioritized to identify the most appropriate and beneficial (financially and technically) area.
The US Department of Energy's focus on climate change and resilience is an opportunity to attract additional funding for the MiniGrid pilot and alternative distributed resiliency pilots. In collaboration with Puerto Rico universities and several national laboratories, these efforts will emphasize local workforce development and attract financial funding for forward-looking projects.

As part of the framework refinement for near-term transmission and distribution projects and MiniGrid pilot scoping, the near-term goal for LUMA includes a detailed field inventory program. The detailed field inventory program will serve to:

- Update GIS data,
- Identify the T&D system element's condition,
- Improve the quality of data monitoring, collection and analysis (e.g., circuit active and reactive load profiles, system voltage performance, DG profiles, etc.),
- Enhance outage data recording and processing (e.g., historical reliability data, outages, restoration times, critical loads, etc.),
- Integrate and adopt advanced analytical/planning tools and increase the collaboration with the Department of Energy and national labs utilizing several analyses performed or piloted.

Puerto Rico in many ways is on the forefront of tackling some of the thorniest questions about the best measures for grid resiliency given the expansion of potential tools like MiniGrids, MicroGrids, distributed energy resources and thoughtful hardening of the existing grid. The use of field-collected data based on actual grid conditions (rather than assumed or approximate values) is critical for the responsible deployment of appropriate grid solutions in Puerto Rico.

2.2 Medium-Term Recommendations

Medium-term recommendations from LUMA include:

1. Refining the near-term transmission and distribution framework and moving toward a more detailed investment planning approach by incorporating enhanced data that will become available and focusing on increasing renewable and storage integration in addition to resiliency
2. Collecting and analyzing data to support long-term planning methods for investment
3. Implementing and evaluating the MiniGrid pilot and alternative distributed resiliency solution pilots

To evolve from near-term transmission and distribution investment criteria into a rigorous, long-term planning function, medium-term activities include:

1. Collecting enhanced system data (e.g., GIS, hosting capacity)
2. Establishing and collecting enhanced resiliency performance indicators and data to support major event impact analysis
3. Initiate hurricane modeling to support the long-term planning method

MiniGrid, MicroGrid, and DER pilots will be implemented in the medium-term based on the area selected in the near-term and based on the evaluation of technical considerations included in Section **Error! Reference source not found.**. The pilots will be evaluated based on established and transparent success criteria.
DER pilots can be used to evaluate various types of value of different DER technologies at different scales to the grid, such as avoided transmission & distribution capacity upgrades, increase in renewable hosting capacity, cost reduction at a bulk-level across generation capacity, energy cost, and ancillary services.

2.3 Long-Term Recommendations

Long-term recommendations include:

1. Operationalize and institutionalize integrated planning methods and systems
2. Implement lessons learned from MiniGrid, MicroGrid, and DER pilots to assess the best approach to improve resiliency

LUMA's long-term recommendation is to develop a comprehensive planning and optimization function by adopting data-driven procedures, enhancing analytical tools, and incorporating learnings from the pilots. The goal of the integrated investment planning function is to holistically consider and evaluate all type of resources, investments, assets (including DERs, energy efficiency, demand response, and energy storage) according to established planning objectives and metrics. Given the ambitious policy objectives in Puerto Rico, coupled with the state of the grid post-Hurricane Maria, any long-term planning exercises need to account for the potential value of all investments across generation, transmission, and distribution planning processes.
For instance, transmission line capacity issues have traditionally been resolved by upgrading the line or installing additional lines. With energy storage as a Non-Wires Alternative (NWA), capacity issues can be mitigated through the strategic placement, charging, and discharging of coordinated energy storage facilities. Another example is that resilience issues have traditionally been addressed by preventing outages with the construction of stouter towers, stronger and insulated conductors, or undergrounding of at-risk facilities. MicroGrids can also improve the resilience of the grid through islanded operation even if an outage occurs. The type of investments described above have overlapping benefits and need to be evaluated in a coordinated manner to ensure that each is valued appropriately and looked at in conjunction with funding requirements. The integrated planning function in the long-term aims to address the evaluation of such traditional versus alternative investments.

In the long-term, lessons learned and data collected from the MiniGrid, MicroGrid and other DER pilots will inform the required analytical framework for institutionalizing any solutions to other regions in Puerto Rico and to determine which approach is best for which loads and area as part of integrated planning function.[4]

3. LUMA Recommendations

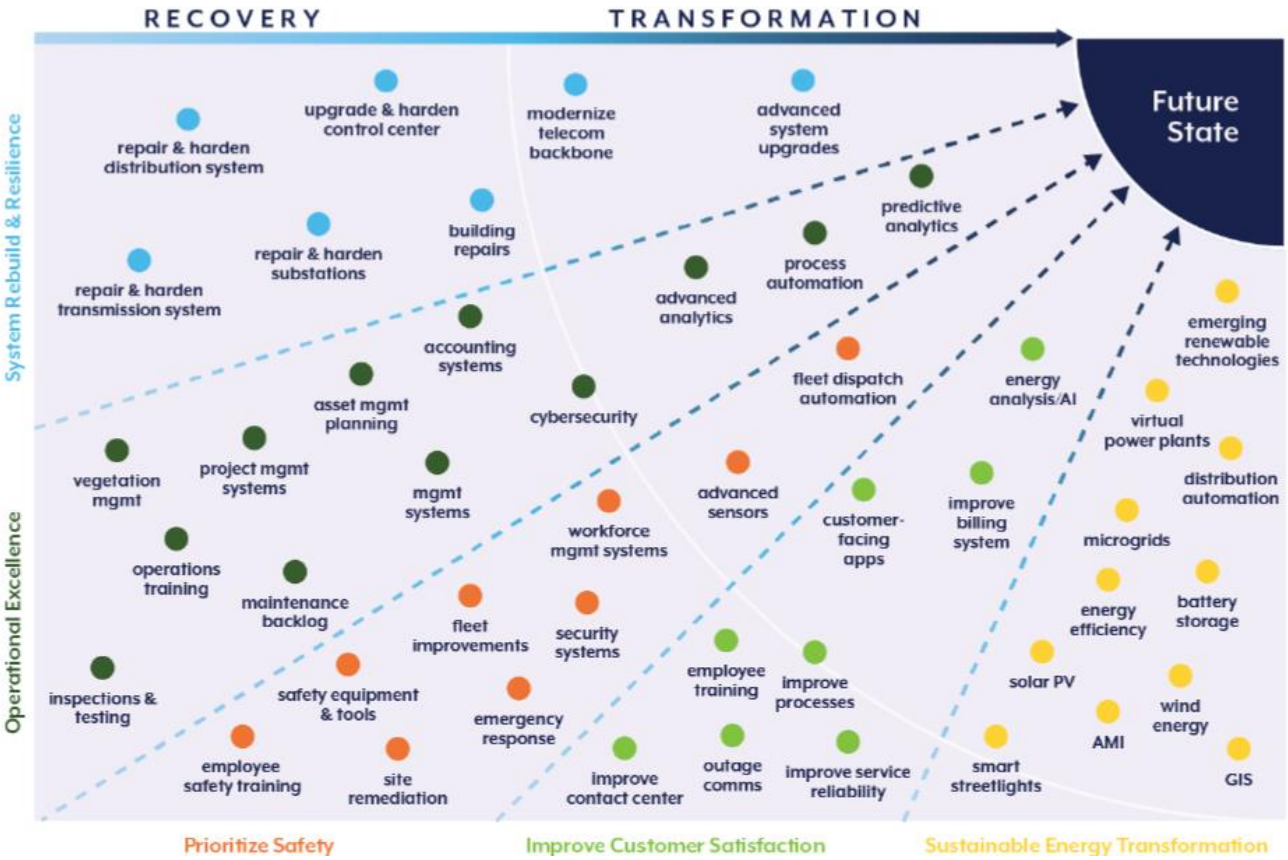
3.1 Near-Term Criteria

LUMA's investment plan is characterized by a near-term emphasis on foundational recovery programs to improve the system infrastructure while paving the way for an increased focus on transformation programs. Recovery phase involves restoring the utility's infrastructure and processes to a well-functioning state and repairing the highest risk assets within the grid in the near-term. The importance of establishing minimum levels of performance and compliance cannot be overemphasized or glossed over. LUMA's utility wide, risk-based screening process and assessment carried during the Front-End Transition Period reflected extremely low maturity levels and consistently poor health of the most critical assets, implying a consistently high likelihood of a risk event occurring. LUMA's implementation activities must have a strong initial focus on remediating these conditions to improve basic resiliency and reliability of the grid. Overlaying complicated, MiniGrid, MicroGrid and/or DER measures on top of a fundamentally fragile grid is unlikely to achieve broad, equitable benefits to electric utility customers. The pilot activities LUMA is proposing will provide the technical basis for the transformation phase, which includes redesigning the utility to meet Puerto Rico's energy needs for the upcoming decades focusing on renewable generation and DERs [see **Error! Reference source not found.**]. Many of the transformation programs will begin alongside recovery programs. The high-level recovery and transformation roadmap is organized by the goals (most programs have multiple benefits, [see **Error! Reference source not found.**]). LUMA created the Recovery and Transformation Framework (RTF) to align activities and spending with Puerto Rico's public energy policy.

Figure 3-1 Recovery and Transformation Phases

[4] As stated earlier, LUMA agrees with PREB that these approaches are not mutually exclusive.

Figure 3-2 Recovery and Transformation Roadmap



The Initial Budgets and System Remediation Plan filed by LUMA[5] identified programs to be executed during the first three years after commencement. LUMA envisions a staged-based process to select near-term transmission and distribution projects and improve the transmission and distribution asset health assessment index, enhance the data gathering process to improve the analysis and project selection means progressively. The approach evolves from using readily available data and foundational engineering analysis toward a comprehensive planning approach that considers advanced analytics.

Figure 3-3 Near-term Transmission and Distribution (T&D) Project Selection Criteria and Goal Alignment

[5] LUMA's Initial Budget: First 3 Years of Recovery & Transformation, February 23, 2021.

Criteria	Key Goal Alignment
Resiliency / Reliability Index (T&D)	
Historical Performance	Operational Excellence, System Rebuild & Resiliency, Prioritize Safety
Loading	System Rebuild & Resiliency
Circuit configuration	System Rebuild & Resiliency, Operational Excellence
N-1	Improve Customer Satisfaction, System Rebuild & Resiliency
System condition	Prioritize Safety, Sustainable Energy Transformation, System Rebuild & Resiliency
Critical facility (D)	Prioritize Safety, Improve Customer Satisfaction
Restoration time (T&D)	Prioritize Safety, Improve Customer Satisfaction, System Rebuild & Resiliency

3.1.1 Near-term criteria

LUMA's proposed near-term criteria [see **Error! Reference source not found.**] to prioritize transmission and distribution projects are in alignment with Recovery and Transformation goals listed in **Error! Reference source not found.**.

In the near-term, the high-risk transmission and distribution and substation assets damaged by Hurricanes Irma and Maria will receive permanent repairs.

Capital investment initiatives, aiming to increase the system hardening, are prioritized based on resiliency and reliability objectives, and in general to support the main goals of the Recovery and Transformation Framework. The near-term prioritization criteria include the analysis of circuits with critical loads/facilities, restoration times (i.e., customer minute interruption), historical reliability index, circuit configuration (e.g., overhead vs. underground), and renewable integration.
In the following, we describe the near-term criteria in more detail:

System Condition: Field inspection reports produced after hurricane Maria, which marks out the system conditions and identify temporary solutions are the primary source of data considered for prioritizing investment in the transmission and distribution system. Assets, such as towers, poles, lines, anchors, and guys, will be restored to current standards and, when possible, hardened to increase resiliency.
Resiliency/reliability index: Historical reliability data (reliability indices such as SAIFI, CAIDI), particularly CEMI (customer experiencing multiple interruptions), loading, and N-1 contingencies are assessed to identify vulnerable and critical areas of the system. Circuit configuration and automatic restoration is also taken into account.
Critical loads: Critical loads (e.g. medical facilities, airports, water treatment facilities, fire station, police and first responders departments, etc.) is an essential criterion in near-term project prioritization so that these loads are either not affected or restored in a short period of time following a major event or outages. Critical loads can be prioritized/weighted within themselves, and a total weighted number of critical loads can be used as a criterion in prioritizing projects. Prioritizing critical facilities in the distribution system supports prioritizing safety and improving customer satisfaction.
Restoration time: Historical restoration time data, for instance customer-minute interruption (CMI) for distribution, can be used to assess areas of the system that might take longer to restore following an event or outage. These areas need to be prioritized to restore power faster.
In the near-term, field inspection programs will be initiated to:

- Improve the understanding of system and equipment conditions (e.g., transmission and distribution line inspection programs, Lidar program to survey existing transmission lines, pole inspection test and treat, infrared inspection to identify current leakage, etc.)
- Yield improved and reliable transmission and distribution power system data (e.g., GIS information, equipment settings, physical security, etc.)

3.1.2 Medium-term criteria

In the medium-term, remaining transmission and distribution and substation assets damaged by Hurricanes Irma and Maria will continue to receive permanent repairs, designs will be improved, and standards will be established to improve resiliency and integrate renewable energy.

In the medium-term, capital investment initiatives will be prioritized based on enhanced data availability. In addition to the near-term criteria, the prioritization will include load shed analysis and system vulnerability assessment to analyze avoided outages and better data to estimate restoration time. The circuit and equipment health assessment index will be included with the constant and increased renewable generation integration. Field inspection programs will be ongoing. However, some districts will already have completed field inspections and inventory counts. GIS system, power system data, and system conditions assessment will be ready for those areas/districts.

Implementing Advanced Metering Infrastructure (AMI) systems and others form of automation devices and processes will allow for better and faster data collection.

3.1.3 Long-term criteria

Long-term investment planning will evolve to an integrated resource planning function. This will be enabled by collected data and will consider system condition, load and generation forecast, renewable energy integration targets, hurricane models, set up processes, enhanced designs and established standards. These considerations are in alignment with Recovery and Transformation goals; data driven methods such as hurricane modeling support advance and predictive analysis objectives as part of operational excellence goal, and renewable energy integration targets the sustainable energy transformation goal.

3.2 R&D Pilot Technical Considerations

Since MiniGrids is a new concept in the utility industry and one that has not yet been deployed, the quickest way to achieve learning, refine the approach in a cost-effective way and compare with other types of investments is to focus efforts on a single pilot region, before reviewing the results and contemplating the scaling of the MiniGrid approach to other regions. To that end, LUMA proposes to do a pilot in a region which is determined by technical considerations for electrical boundary determination. LUMA summarizes the objectives of doing a MiniGrid R&D pilot as the following:

- Test and refine the conceptual approach to optimize transmission and distribution investments with MiniGrids and other alternatives (MicroGrids, DERs), while maintaining reliability, resiliency, and energy security,
- Evaluate and incorporate learnings from the pilot into a planning approach as part of the long-term optimization roadmap recommendations,
- Pursue diverse partnerships with national laboratories, universities, vendors, and environmental non-for-profits.

A scalable and successful MiniGrid R&D pilot requires an extensive list of technical considerations, which are outlined in the remainder of this section.

Few technical considerations for MiniGrid sizing and boundary selection are listed below:

- **Electrical Boundary determination:** Recognize the current grid condition, geographical location, and expected time to repair the transmission and sub-transmission system after a major event impacts Puerto Rico, which are evaluations to start the demarcation of a MiniGrid[6].
- **Large-sized MiniGrids or regional control area** supplied by 230/115 kV lines designed to an N-1-1 (contingency) of the system to make sure transmission line and central generator outages are covered. This evaluation considers hardened sub-transmission (38kV, Medium voltage - MV) and distribution system under the N-1-1 (appropriate contingency planning) criterion to ensure power supply reaches critical load.
- **Medium-sized MiniGrids** supplied by 38kV and are designed to N-1-1 but the second one can be DERs or MicroGrid(s). In sizing medium sized MiniGrids, local generation or mix of renewable generation with controllable energy sources able to actively balance the load requirement is necessary to consider. The evaluation balances between hardening distribution system and certain medium voltage systems and DERs and MicroGrid(s), thus power can flow to critical loads under the N-1-1 criterion.
- Small-sized MiniGrids/MicroGrids are designed to N-1 with a reliance on DER deployment for post-contingency. This design is closer to the critical load, and a detailed assessment of the distribution system will be required. Critical load assessment is detailed below.

Additional technical considerations necessary in designing and evaluating the MiniGrid R&D pilot and investments include:

- **Vulnerability assessment** encompasses simulation of major events and assessment of potentially impacted grid assets, and assessment of loads at risk and identification of single and common point of failure of the overall system and MiniGrids after established. Hurricane simulations and resulting impact on grid assets for project prioritization in Puerto Rico is studied by Pacific Northwest National Laboratory, where total load lost, and total voltage violations of each scenario are calculated7. In addition, system restoration and blackstart capability, either at the MiniGrid level or the entire grid should be evaluated. Assessment of impacted grid assets can be based on post storm field inspection, system health assessment index, historical information regarding expected restoration time due to geographical location.
- **Critical load assessment** within the grid is essential in ensuring resilient power delivery to these loads after a major event. Location of critical loads is a major factor in determining whether these loads should be served by transmission and distribution projects or distributed resiliency solutions. Critical loads that provide essential service to community welfare include emergency response, trouble restoration management, water supply, safety and protection, critical water treatment facilities, telecommunication facilities, and community shelter. These loads may ride through or be restored after a major natural disaster. Another load classification may be considered as suggested in the IRP8.
- **Scenario based planning** includes system wide and areas of control power flow for current and future load/DER forecast. Definition of scenarios may include generation portfolios (e.g., existence of local combine cycle units, capacity of synchronous condenser, energy storage, renewable sources, generation patterns, etc), load profiles (e.g., mainly industrial, commercial, or residential, etc.), operating reserve of MiniGrid after configuration, major event simulation and location, assessment of load lost, export and

[6] The initial demarcation process used by PREPA and Siemens during the elaboration of the IRP can be a good starting point in the MiniGrid optimization process.

[7] Marcelo Elizondo, Sarah Davis, Xiaoyuan Fan, Bharat Vyakaranam, Sarah Newman, Patrick Royer, Xinda Ke, Emily Barrett, Pavel Etingov, Jeff Dagle, “Dynamic Contingency Analysis Tool (DCAT) Applied to Puerto Rico – Risk Based Approach”. PNNL, March 2021.

[8] IRP’s Load classification: priority load, loads to be restored after critical loads are back to normal, and balancing load which services are identified to be restore after critical and priority loads

import capability, evaluation of existing generation firm capacity compared to nameplate installed capacity.

- **Reliability based planning** is probabilistic approach and review of historical reliability data and indexes per transmission and subtransmission line segment. At medium voltage level, proper reporting of outage data and use of AMI feeding outage management system may provide reliability information at circuit segment level. Assessment of reliability and time to restoration is an integral part of the MiniGrid configuration.

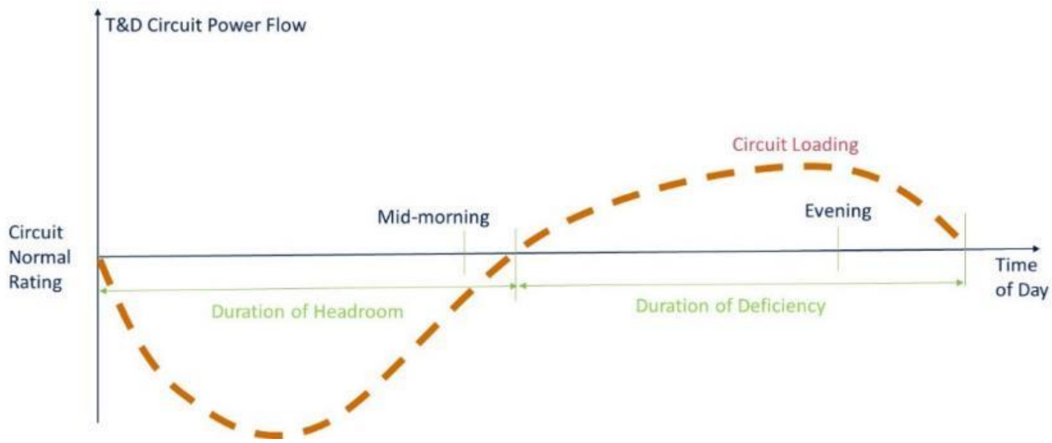
- **Topology assessment** includes identifying weak points of the network, identification of radial circuits, circuits with weak links to perform load transferring or switching. Topology assessment also includes vegetation assessment.

- **Control/Communication infrastructure** includes sending operation signal to devices and generation units.

Success metrics to evaluate the MiniGrid pilot can be defined as the following:

- Bulk transmission system reliability benefit (e.g., unbottling renewable generation)
- Resiliency benefit (e.g., adding redundancy by building new/upgrading or hardening with bump-up existing transmission lines into constrained MiniGrids, critical load restoration time)
- Energy and capacity benefits due to increased import capability (e.g., reduced energy cost, capacity procurement cost, system operating reserve, frequency, voltage regulation costs, etc.)
- Beyond addressing local system reliability needs, enable reductions in polluting emissions (e.g., reduced fossil generation running hours)
- Creating overall transmission and distribution system efficiency in renewable energy delivery (e.g., the loading factor of the transmission and sub-transmission circuits, etc. [see **Error! Reference source not found.**]).
- Servicing load growth through electrification (e.g., providing increased hosting capacity for future renewable integration, system operational flexibility, etc. to accommodate the load growth expected from electrification in the transportation sector)

Figure 3-4 Transmission and Distribution Facility Utilization Performance Tracking



4. Responses to Technical Questions

This section includes our responses to technical questions posed by PREB throughout the proceedings, categorized by common topics.

T&D system hardening and MicroGrids/DERs:

- What approach works (T&D system hardening and MicroGrid and stand-alone DERs) quickly? But what is best for the long term?

  When planning for system resilience, T&D system hardening, MicroGrids, and stand-alone DERs should not be considered mutually exclusive options. These solutions are complementary solutions that address different aspects of resilience and need to be looked at holistically. Per the 2nd edition of FEMA National Disaster Recovery Framework, resilience is defined as the ability of systems and communities to:

  - Prepare for changing conditions
  - Adapt to changing conditions
  - Withstand disruptions due to deliberate attacks, accidents, or naturally occurring threats or incidents
  - Recover rapidly from disruptions due to deliberate attacks, accidents, or naturally occurring threats or incidents.

  An important point covered by the report is that critical infrastructure owners and operators can improve resilience by identifying risks and incorporating mitigation measures into facility design and construction. That would translate into looking at the system holistically to avoid large-scale electricity outages to the extent possible and improving recovery time. In addition to resilience, other planning objectives such as integrating renewable energy can be supported by looking at the system holistically. For example, bulk generation and large renewable resources depend on the transmission and sub-transmission systems to bring power to load centers. Ambitious clean energy targets, which can mainly be achieved with a combination of utility-scale and distributed and localized resources, are dependent on a resilient transmission system to deliver the power generated by those resources where and when it is needed most. The current literature on high levels of renewables penetration supports the need for a strong transmission network to allow different regions to share resources, provide greater efficiency, and lower overall system costs to customers.

  There also needs to be a focus on the distribution system which feeds most critical facilities. Hardening the distribution feeders serving critical loads will improve resilience and services during an event, even if it will not address 100% of the load.

  A holistic, integrated planning function is required to take into account the impacts of transmission and distribution system hardening, other solutions such as MiniGrid, MicroGrids, distributed control, and different types of distributed energy resources, including but not limited to solar, energy storage, energy efficiency, and demand response coupled with the multi-layered policy and strategic objectives that must be met both in blue sky, and gray sky days, and targeted penetration of renewable energy resources.

- How to estimate the value of avoiding MiniGrid transmission costs of DER resources as distributed resiliency solutions?

  As proposed in the previous section, a demonstration project would provide the opportunity to understand the benefit of alternative solutions such as MiniGrid, MicroGrid and different types of DER compared to traditional solutions. An Avoided Cost Calculator can be established for DERs and alternative localized solutions. The avoided costs can be evaluated based on the operational profile and characteristics and benefits of the solutions.

Stand-Alone DERs:

- How do we evaluate the value of DER to the grid?

  Different categories of value:

  - Avoided T&D cost by increasing the capacity on the T&D system – this can be evaluated in terms of deferred or avoided investment
  - An increase in renewable hosting capacity can be evaluated by quantifying the value of hosting capacity (can be involved) and avoided T&D upgrade cost to accommodate more renewable
  - Cost reduction at a bulk level across generation capacity, energy cost, and ancillary services – depending on the bulk system structure, these values can be monetized. If there is a wholesale market, these services are usually market products that can be evaluated using market prices. Otherwise, their impact can be calculated using the marginal cost from cost production models. It should also be noted that depending on the penetration of DER, these resources can, in aggregate, impact the bulk level price/cost. These impacts can be simulated using production cost models and/or market clearing price simulations.

  An important point is that DER can also increase transmission and distribution system costs. PV can add to voltage fluctuations or cause backflow that requires protection upgrades. Intermittent resources can increase the need for ancillary services and drive up the cost there. To have a fair evaluation, these costs should also be quantified along with the benefits described above.

- Capacity only, or capacity + energy?
  Both can be used depending on how DER is being operated and controlled. Both methods require some extent of performance verification if providing grid services. Settlements for capacity + energy payment construct will be more complicated and might require more frequent billing and dispute resolution processes. A firm, verifiable obligation to provide capacity or capacity and energy under certain scenarios must be established for the system to consider DER to be an effective resiliency solution.

- Battery storage:
  - Does PREPA control via VPP or Demand Response (DR) aggregator?
    Control via DR aggregator is more cost-effective for smaller-scale storage, but measurement and validation of operations can become an issue.
  - How is control instituted?
    Via Distributed Energy Resources Management System (DERMS) or autonomous controls for some applications (flicker control, frequency control)
  - How to measure value?
    PREPA/ LUMA will develop a DER BCA handbook, as has been the case for several US utilities, where the framework for valuing DER of different technologies, including storage, is addressed. Values may include capacity deferral, renewables integration, emissions reduction, energy savings, ancillaries provision, resiliency.

- Data source for cost and coverage for DER solutions (Sandia, NREL, actual installations?)
  In the Sandia resource planning study for the CEM region[9], solar profiles were created using NREL's PVWatts database. Unit costs for PV and storage were estimated using current investment costs derived from the NREL Annual Technology Baseline (ATB) database. These databases can be utilized in the optimization process.

- How is resilience value considered? Is the resiliency value for DERs as simple as measuring the avoided transmission investments?
  Resiliency metrics will be developed (e.g., 2020 IEEE resiliency report requested by US Department of Energy[10]), and these will be used to compute the impact of DER on resilience. These typically include reduced outage frequency and duration; able to withstand severe disruption, and so on. Metrics should

[9] Cody J. Newlun, Daniel R. Borneo, Susan Schoenung, Tu Nguyen, "Regional resource planning for Puerto Rico Mountain Consortium". Sandia National Laboratories, 2020.

[10] IEEE Power and Energy Society Industry Technical Support Leadership Committee Task Force, "Resilience Framework, Methods, and Metrics for the Electricity Sector". IEEE, October 2020.

take into account the benefits and limitations of DER, such as: *(i)* DER is after all not as reliable and energy limited as the grid level resources. For an event only, it tends to have better performance, but may not be in duration, *(ii)* Particularly remote DERs may take longer to repair and restore.

- The type of resources that should be used as distributed resiliency solutions? Should resources include existing or new fossil resources or only PV (or other renewable) plus storage?
  Optimal mix of resources will be evaluated as part of the planning function and full investment optimization approach, considering all viable generation resources. Resource planning decisions can be modeled to include existing generation.

- DERs – small scale:

  - How are 1) via VPP procurements, 2) DR tariff, 3) alternative resiliency programs best deployed, rapidly, in best locations?
    NWA procurement by the utility provides the ability to manage DER deployment for NWA safely and monetize the value they provide as well as resiliency purposes and can be done in bulk with presumably lower costs. Customer tariff or incentive, or an RFP process, offers customer choice and more room for innovation. A combination of procurements, incentives, tariffs is a forward-looking mixture. Third party GenCos can also be considered through RFPs to provide different types of generation; synchronous generators and inverter based DERs.
  - DR/DER tariff – proportional to costs from VPP competitive procurement?
    A tariff based on NWA value to the grid can be developed conceptually. If this is not sufficient then an additional incentive can be formulated to drive deployment for societal purpose or policy driven, however, the approach will not necessarily be least cost option.

  - The nature, type and cost of distributed generation and storage resources likely available to provide distributed resiliency solutions?

    - PV plus storage – customer or grid scale; Large scale provides more value to the grid

    - Wind plus storage
    - The storage resources most attractive will be those requiring the least site preparation and maintenance. Interconnection cost should be considered. This today means some variation of lithium battery. (Li-FePO, etc). Flow batteries which require pumps, or sodium sulfur that require pumps and which operate at highly elevated temperatures, are less attractive other than in facilities where safety measures are carefully considered and are in place.

Microgrid resources:

- Networked MicroGrids when practical?
  Deploying Networked MicroGrids (NMG) has its own limitations and complexities but potentially can add additional value. There hasn't been any network microgrids installed in the country. The concept has been evaluated in research domain. In addition, a coordinated control is required to manage the operation of several MicroGrids in accordance with utility operations, which requires design considerations (such as coordinating sequence of operation) and significant infrastructure upgrades. Network microgrids add to resiliency of the system locally. In Puerto Rico, coordinated control technology required for networked MicroGrids will only be possible to deploy after remediation measures from the SRP are implemented. The system is assumed to be functioning at the distribution level and resilient communication infrastructure is required to implement such distributed control and essential situation awareness.
  In the MicroGrid study for Puerto Rico, Sandia National Laboratories stated that in the long-term, other considerations such as networked MicroGrids would be incorporated to support inclusion of MicroGrids into the overall grid modernization portfolio for Puerto Rico. Sandia also stated that networked MicroGrids could further improve service provisions, where the starting point could be linking two MicroGrids together via a hardened feeder that picks up additional infrastructures[Error! Bookmark not defined.]. All above assumptions are valid.
- Generation resources for microgrids: Need for any small fossil generation given PV/storage economics?

- Generation mix selection and sizing is a key step in design of a microgrid that would reflect upon design criteria and customer needs. Normally dispatchable generation; synchronous generation needs to be deployed when supply of load is expected for longer durations (e.g. days) beyond the economic size of an energy storage system (4 to 8 hours optimal). This is determined during conceptual design stage and based on the historical outage data, electrical boundary, system configuration and load profiles. The energy requirements (kWh consumption) for the longest outage duration is used to estimate the required energy and size of generation and the mix.

- Beyond economic reasons, fossil-based generation sources might be needed for operation aspects or other technical reasons such as fault current levels, at least until non-fossil sources are shown to be able to provide such services at an acceptable cost.

Exhibit 2

Resilience Optimization Technical Workshop LUMA Recommendations

NEPR-MI-2020-0016

Resilience Optimization

1. Context
2. Confirming Proceeding Objectives
3. Recommendations and Roadmap
4. Resilience Definition
5. Near-term T&D Project Criteria
6. MiniGrid R&D Pilot

Context

- **Improved resiliency is the result of multiple activities** – investments in physical assets (hardening, minigrids, distributed resiliency options, etc.) and foundational activities including - improved systems, procedures, processes and mitigation of high risk assets
- As part of LUMA's Front-End Transition Deliverables, LUMA has proposed improvement programs to address **many foundational activities that will form the groundwork to support analyses of resiliency investment options**
- These activities are proposed as part of a **continuum of recovery and transformation**

Context

- As part of LUMA's planning for recovery and transformation - LUMA created a link from Puerto Rico's key policy drivers to LUMA's strategy and plans
- These key goals are aligned with the evaluation of resiliency solutions

Our mission

Recover and transform the utility to deliver customer-centric, reliable, resilient, safe, sustainable electricity at reasonable prices.

KEY GOALS

PRIORITIZE SAFETY
Reform utility activities to support a strong safety culture focused on employee safety and the safety of the people of Puerto Rico

IMPROVE CUSTOMER SATISFACTION
Transform operations to deliver a positive customer experience and deliver reliable electricity at reasonable prices

SYSTEM REBUILD AND RESILIENCY
Effectively deploy federal funding to restore the grid and improve the resilience of vulnerable infrastructure

OPERATIONAL EXCELLENCE
Enable employees to pursue operational excellence through new systems, processes and training

SUSTAINABLE ENERGY TRANSFORMATION
Modernize the grid and the utility to enable the sustainable energy transformation

Confirming Proceeding Objectives

As part of the IRP Resolution and Order, the Energy Bureau commenced an Optimization proceeding

- In the December 2020 order[1], purpose was defined as to

  "Begin a sequential process of comparing two approaches to attain increased electric power system resiliency:

  1. One based on **transmission system hardening, coupled with distribution system reinforcements**, to reliably deliver **broadly localized power[2]** to loads even after extreme weather events have severed the transmission system links between regions;
  2. Another based on **providing many points** (potentially, thousands) of **site-specific or MicroGrid-provided** distributed generation and storage to serve critical load and potentially other loads, also after an extreme weather event has severed the transmission system."

- The two resiliency solutions are not mutually exclusive

[1] Puerto Rico Energy Bureau, "In RE: Optimization Proceeding of MiniGrid Transmission and Distribution Investments", NEPR-MI-2020-0016, December 2020.
[2] Broadly localized power in this context is the capacity and energy presumed available by PREPA in its MiniGrid Approach

Resilience

In the National Disaster Recovery Framework[3], FEMA defines resilience as the ability of systems and communities to

- Prepare for changing conditions
- Adapt to changing conditions
- Withstand disruptions due to deliberate attacks, accidents, or naturally occurring threats or incidents
- Recover rapidly from disruptions due to deliberate attacks, accidents, or naturally occurring threats or incidents.

Critical infrastructure owners and operators can improve resilience by **identifying risks** and incorporating mitigation measures into facility design and construction. This translates into **looking at the system holistically** to avoid large-scale electricity outages to the extent possible and **improving recovery time.**

DOE defines resilience as[4]

- The ability of a power system and its components to withstand and adapt to disruptions and rapidly recover from them

IEEE Technical Report PES-TR65 and FERC Docket No. AD18-7-000 defines resilience as[4]

- The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event

IEEE Technical Report PES-TR83 (Resilience Framework, Methods, and Metrics for the Electricity Sector) defines resiliency as[4]

- The ability to protect against and recover from any event that would significantly impact the grid

[3] US Department of Homeland Security, "National Disaster Recovery Framework". Second Edition. June 2016.

[4] IEEE Power and Energy Society Industry Technical Support Leadership Committee Task Force, "Resilience Framework, Methods, and Metrics for the Electricity Sector". IEEE, October 2020.

Recommendations to Achieve Objectives

LUMA proposes to:

- Develop near-term T&D criteria to improve resiliency of the system
- Develop a conceptual approach to grid optimization and initiate the roadmap
- Focus efforts on a single MiniGrid R&D pilot region
- Initiate scoping of distributed resiliency solution pilots (MicroGrid, DERs within the same region or elsewhere)
- Look for grants/source of funding in partnership with national laboratories/universities (DOE, DOA, DOT)

with a long-term goal of

- Incorporating pilot learnings and enhanced system data into planning, design and operation functions

Grid Optimization Roadmap

Short Term

- Agree on near-term framework for prioritizing T&D projects
- Define long-term roadmap, Scope pilots' objectives

Medium Term

- Collect system data, Improve data quality, modeling capabilities
- Deploy MiniGrid and MicroGrid pilot

Long Term

- Operationalize the optimization and planning approach
- Institutionalize alternative resiliency solutions such as MiniGrid, MicroGrid, etc.

Near-Term Criteria for Prioritizing T&D Projects

Criteria	Key Goal Alignment
Resiliency / Reliability Index (T&D)	
Historical Performance	Operational Excellence, System Rebuild & Resiliency, Prioritize Safety
Loading	System Rebuild & Resiliency
Circuit configuration	System Rebuild & Resiliency, Operational Excellence
N-1	Improve Customer Satisfaction, System Rebuild & Resiliency
System condition	Prioritize Safety, Sustainable Energy Transformation, System Rebuild & Resiliency
Critical facility (D)	Prioritize Safety, Improve Customer Satisfaction
Restoration time (T&D)	Prioritize Safety, Improve Customer Satisfaction, System Rebuild & Resiliency

- Near-term criteria to improve resiliency of the system aligned with FEMA's, DOE's, and IEEE's definition of resiliency
- Long-term investment plan will evolve into planning functions to take into consideration system condition, load and generation forecast, renewable energy integration targets, hurricane models enabled by collected data, set up processes, enhanced designs and established standards.

MiniGrid R&D Pilot

- Since MiniGrids are a new concept and have not been deployed yet in the industry, quickest way to achieve learning and refine the approach in a cost-effective way and compare with other types of investments is focusing efforts on a single pilot region
- LUMA proposes to focus efforts on a single MiniGrid region with the purpose of:
  - Test and refine the conceptual approach to optimize investments between MiniGrid transmission and distribution projects and other distributed alternatives (MicroGrids, DERs), while maintaining reliability, resiliency, and energy security of the system,
  - Evaluate and incorporate learnings from the pilot into planning functions,
  - Pursue diverse partnership and alternative R&D funding
    - National laboratories, universities, vendors, environmental non-for-profits.

MiniGrid R&D Pilot - Technical Considerations

- A scalable and successful MiniGrid pilot requires an extensive list of technical considerations that initiate from:
  - **Electrical boundary and size determination:** Current grid condition, expected transmission and sub-transmission repair times
- Additional technical considerations for MiniGrid pilot design and evaluations include but are not limited to:
  - **Generation and load balance:** Assessment of existing generation and loading, resource planning
  - **Critical load assessment:** Load classification and location of critical load
  - **Vulnerability assessment:** Load at risk
  - **Topology assessment:** Weak points of the network, switching positions and conditions
  - **Distributed control/Communication infrastructure:** Sending operation signal to devices, generation units, etc.
- Success criteria for the pilot:
  - Reliability and resiliency benefit
  - Operational flexibility benefit
  - Energy and capacity benefit
  - Overall transmission and distribution system efficiency
  - Benefit vs. cost