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

IN RE: IMPLEMENTATION OF THE PUERTO RICO ELECTRIC POWER AUTHORITY INTEGRATED RESOURCE PLAN AND MODIFIED ACTION PLAN	**CASE NO.:** NEPR-MI-2020-0012 **SUBJECT:** Plan to Address and Solve Potential Long-Term Renewable Energy Penetration Issues

MOTION SUBMITTING DETAILED PLAN TO ADDRESS AND SOLVE ANY POTENTIAL LONG-TERM RENEWABLE ENERGY PENETRATION ISSUES

TO THE HONORABLE PUERTO RICO ENERGY BUREAU:

COMES NOW the Puerto Rico Electric Power Authority ("PREPA") through the undersigned legal representation and respectfully submits and requests as follows:

1. On March 30, 2021 PREPA submitted with the Puerto Rico Energy Bureau for the Public Service Regulatory Board ("Energy Bureau") *Motion Requesting Extension of Time to Submit Detailed Plan to Address and Solve any Potential Long-Term Renewable Energy Penetration Issues* ("Motion for Extension").
2. The Motion for Extension was in response to the January 26, 2021 Resolution and Order entered by the Energy Bureau ("January 26 Resolution") regarding the *Issuance of RFP and Timeline for Filing of Responses to Questions Received from Stakeholders* and the fact that, at the time, PREPA was unable to comply with the April 1, 2021 deadline given that PREPA's main consultant for these matters, Sargent & Lundy, LLC, had reached its contract budget limit affecting many workstreams at PREPA. Among the workstreams affected was the draft of the plan for potential long-term renewable energy penetration issues.
3. As stated in the Motion for Extension, before PREPA amends a contract or increases the

budget of any contractor, it must comply with the requirements and seek authorization from various governmental stakeholders including the Federal Oversight and Management Board for Puerto Rico and the Puerto Rico Public Private Partnership Authority which results in a longer than expected contract execution process.

4. As a result, PREPA respectfully requested that the Energy Bureau grant it a 45-day extension, or until May 16, 2021, to submit the detailed plan to address and solve any potential long-term renewable energy penetration issues as required by the Energy Bureau.

5. In compliance with the above, PREPA hereby submits *Plan to Address Longer Term Renewable Integration Issues* prepared by Sargent & Lundy, LLC, and included as Exhibit A.

WHEREFORE, PREPA respectfully requests that the Energy Bureau **ACCEPT** the submittal of the *Plan to Address Longer Term Renewable Integration Issues* and **FIND** PREPA in compliance with order.

RESPECTFULLY SUBMITTED.

In San Juan, Puerto Rico, this 17th day of May 2021.

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Exhibit A

Plan to Address Longer Term Renewable Integration Issues

Plan to Address Longer-Term Renewable Integration Issues

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Introduction

This report provides recommendations resulting from an integration impact assessment performed by Sargent & Lundy to determine the necessary improvements needed of the Puerto Rico Electric Power Authority's (PREPA) infrastructure to accommodate a substantial increase of renewable generation, energy storage, and distributed generation resources.

It is important to note that as LUMA assumes the responsibility of the operations of PREPA's Transmission and Distribution systems, LUMA will also assume the responsibility for addressing these long-term integration issues including implementation of PREPA's Procurement Plan. Therefore, LUMA will be responsible for undertaking some of the recommended actions discussed in the following section.

PREPA will provide inputs and guidance as needed, but the timeline of these projects will be controlled by LUMA. Also, given the magnitude of the planned integration of renewables, there may be some additional issues that arise as the transformation takes place. For that reason, it is critical that the progress of renewable integration be regularly analyzed and that the plan to address potential issues be periodically revised as necessary.

Recommended Actions for Renewable Integration

1. Energy Management System (EMS)

   The Energy Management System (EMS) monitors and controls the distribution of power across the transmission system and support infrastructure: transmission centers, substations, transmission lines, circuit breakers, and Remote Terminal Units. The EMS provides visibility of the power grid operational status to the system operators at the Energy Control Center (ECC) and at remote monitoring stations. PREPA does not currently have infrastructure to effectively utilize and control the large number of planned renewable energy projects, distributed energy resources, and energy storage systems that are planned because the current EMS is an outdated Siemens Spectrum system that has several limitations.

   The EMS is one of the most crucial elements in the renewable integration process and provides the ability to monitor and control renewable power production and the coordination between the charge/discharge process of the large amount of Battery Energy Storage Systems (BESS) and renewable generation. PREPA shall select, procure, and install a modern, electric grid EMS to enable the automatic control of renewable energy projects, conventional power plants, distributed energy resources, and energy storage systems. This EMS will allow for the complete elimination of manual dispatch during

normal operations. Without proper monitoring and control, the benefits of the renewable energy projects and energy storage systems cannot be fully realized.

The "Energy Management System (EMS) (OT/Backoffice)" project is included in the March version of PREPA's 10-Year Infrastructure Plan ("10-Year Plan"). A brief description of this project and cost estimate can be found on page 90, with estimated project timing information included in section VI of the 10-Year Plan.

2. Transmission Planning and Analysis Model (High Voltage)

The importance for high quality and accurate electrical system modeling cannot be overstated, especially as PREPA implements massive improvements to the transmission and distribution system and as Puerto Rico embarks on a rapid transition away from existing thermal generation to renewable energy. As improvements to the Puerto Rican electrical grid are made, it will be important for existing electric grid models (i.e., Power System Simulator for Engineering [PSS/E] transmission planning models) to be updated to capture all changes to the electrical system. The existing Siemens PSS/E model does not accurately capture the entirety of the dynamic behavior of PREPA transmission system and generating facilities. One of the critical factors is the deficient performance of the PSS/E model when simulating dynamic events in the system, such as the loss of a large portion of generation or a high voltage transmission line. The simulation of dynamic events is essential to identify the potential impact of renewable generation and it largely depends on the generating units' responses.

PREPA shall develop a recommended path to improve the analytical tools used with the growing integration of inverter-based projects. From previous work, it is known that the response of PSS/E dynamic models for generating units, turbine-governors, and excitation systems responses to grid events may be more optimistic (i.e., much better) than the actual generator and controls that are in service, thus resulting in a mismatch between the PSS/E simulation and the SCADA measured response. Stakeholders often fail to fully understand or appreciate the enormous challenge a utility faces without an accurate analytical model of the electric distribution system. This makes the planning and deployment of distributed energy resources slow, risky, and expensive. Without an accurate model, it is difficult to study and predict how new generation, including inverter-based renewable generation and, energy storage, will impact the electric system.

The PSS/E model upgrade is not included in the March version of PREPA's 10-Year Infrastructure Plan ("10-Year Plan"). Recommend adding to next 90-day update.

3. Distribution System Model (38KV Systems and Below)

   The first step to safely integrating distributed generation into the PREPA system is to develop accurate analytical models of PREPA's electric distribution system and feeders (the 13.2 kV system and below). This is needed to study, plan, and prepare for the safe, orderly, and cost-effective deployment of distributed energy resources, customer-sited energy storage systems, and virtual power plants. Currently PREPA has approximately 10% of its distribution feeders modeled in Synergee (analytical software used by PREPA), with unknown accuracy. Gathering the data to model the distribution is a significant undertaking, since it includes more than 16,000 miles of distribution circuits, loads, distributed generation, as well as substations. PREPA and LUMA have estimated that the complete modeling (including verification of the model) will take more than four years to complete[1], which is understandable given the work required. Without a model, it is difficult to study and predict how new distributed energy resources will impact the electric system. Also, without distribution electrical models, the analysis of the interconnection and integration of future resources at the distribution level (distributed generation, energy storage systems, demand response, Virtual Power Plant [VPP]) is not possible. By implementing distributed energy resources without performing the appropriate prudent utility practice studies, there could be equipment overloads, failures, and damage, both to the electric system as well as to behind the meter electric systems.

   The Distribution System Model is supported by the "Advanced Distribution Monitoring System (ADMS) (OT/Backoffice)" and "GIS System" projects. Details on these two projects can be found on pages 88 and 89 with estimated project timing information included in section VI of the March version of the 10-Year Plan.

4. Grid Control Center Communication System

   The PREPA telecommunications transport network requires upgrade and migration to IP/Multiprotocol Label Switching (MPLS) and introduction of Field Area Network (FAN) infrastructure to support Distribution Automation (DA), Advanced Metering (AMI), and

[1] Plan for Distribution System Interconnection Capacity Map & Power System Inventory – Compliance Hearing (NEPR-MI-2016-0011), April 13, 2021.

Renewable Energy Resources. Effective control algorithms require robust performance, including high reliability and low latency communications. With MPLS Quality-of-Service (QoS) prioritization techniques and ample transport bandwidth, the necessary predictable, or deterministic, communications performance can be achieved reliably to ensure latency is maintained within acceptable limits. Depending on the capacity and flexibility of the AMI technology solution selected by PREPA, it may well be possible to leverage the AMI as a FAN to also serve DA and reliable, secure communications connectivity to Renewable Energy Resources for monitoring and control.

Data communications for Renewable Energy Resources require the support of a robust, reliable, and secure telecommunications infrastructure to operate effectively and reliably. The communications architecture will leverage PREPA's multiprotocol label switching (MPLS) telecommunications transport network and future Field Area Network (FAN). Connectivity is necessary for both monitoring and control, and for system protection. Besides the data communications path to provide visibility and control signals to and from the EMS / SCADA master station(s), an adjacent communications path is required from Renewable Energy Resource site locations to their serving substations to support the requirement for protective relaying. Fiber optics is strongly preferred to serve for both the data communications and protection paths.

Numerous projects in the 10-Year Plan support the Grid Control Center Communication System recommendation. Brief descriptions and cost estimates for the "MPLS Network Deployment" and "FAN" projects can be found on pages 87 and 88 of the March version of the 10-Year Plan; details on the "Advanced Metering Infrastructure (AMI)" project can be found on page 93. Note that Distribution Automation scope is included in each distribution feeder project in the 10-Year Plan. Estimated project timing information for each of these projects can be found in section VI of the 10-Year Plan.

5. Transmission Interconnection Application Process for New Electric Generation and Energy Storage Projects

   An interconnection application process should be established for new electric generation and energy storage projects in Puerto Rico. Nearly all other parts of the United States have an established, formal interconnection application process for new electric generation resources and energy storage systems. These interconnection processes

cover all types of generation, including renewable energy projects, conventional generation projects, battery energy storage systems, and distributed energy resources. With the projected large volume of new projects expected to be constructed in Puerto Rico to support the RPS goals, an organized and controlled method of integration is necessary to ensure new projects do not negatively impact the reliability of the grid.

A typical interconnection application process consists of the three phases with each phase building on the previous. The first phase of the interconnection application process is a feasibility study to determine if the project meets key threshold criteria for integration into the grid. The second phase of the interconnection application process is a system impact study to determine what the impact of integrating the new project into the overall grid is. The third and final phase of the interconnection application process is a facilities study which provides a reasonable estimate of the equipment and associated costs required to integrate the new project in the grid. At each phase a fee is collected from the interconnection applicant to support the costs associated with performing the necessary studies. For projects that complete all three phases and decide to proceed, the end result is typically an interconnection service agreement that defines the terms and conditions for interconnection of the project in question, as well as the cost and timing for grid upgrades that are required and assignment of responsibility for which party (or parties) are responsible for completing the upgrades. Initial application submission to a signed interconnection agreement typically takes 18 – 24 months. Planned new projects that have not yet begun the application process have tremendous uncertainty about the cost and complexity of interconnection. As projects move through the process, the level of uncertainty continues to go down. The lack of an established interconnection application process in Puerto Rico jeopardizes the timely and successful completion of the six rounds of renewable energy and energy storage RFPs (the first round is already underway).

Near Term Action is required to:

a. Design the Interconnection Application Process

b. Design the Interconnection Application forms and data fields for completion

c. Develop online submittal and communication system for the Interconnection Application Process

6. Controls and Processes to Minimize Renewable Curtailment

The effective dispatch of renewable energy in the future will be important so that Puerto Rico can achieve RPS targets in a cost-effective manner. Curtailment is a common tool a utility employ to help manage renewable generation and manage electrical system stability. Puerto Rico is set to install thousands of MWs of renewable generation in the near term, and as a result, how best it should manage and minimize future renewable curtailment should be addressed. In the worst case, not having a plan for how best to manage renewable curtailment could result in periods of system instability due to system overloads.

There are a number of potential solutions that can be employed to help minimize potential renewable curtailment (and any associated negative financial consequences), including the development of energy storage systems and other dispatchable generation, a diverse mix of different renewable energy technology types, transmission upgrades / expansion (to alleviate potential congestion-induced curtailment risks), and innovative contracting structures for renewable energy projects (that might reduce potential curtailment and/or minimize potential negative financial impacts).

Near Term Action is required to:

a. Assess and evaluate the potential benefits of developing a diverse mix of traditional renewable generation (i.e., solar PV, wind, hydroelectric, etc.) from a system dispatch, cost / economic, and system reliability perspective. A diverse mix of renewable generation (with different hourly generation profiles) would help reduce the risk of renewable curtailment. Given the fact that the hydroelectric units are dispatchable, synchronous, and renewable, an investigation into the revitalization of these units is important, provided that the cost to do so is not prohibitive. The dispatchability of the hydroelectric units makes them a unique renewable tool for managing (and potentially reducing) the risk of curtailment to other, non-dispatchable, renewable resources.

b. Energy storage systems will be an important tool to help manage and reduce the risk of renewable curtailment. As new renewable generation is added into Puerto Rico, the optimal locations for energy storage, in addition to how best to utilize the different energy storage systems (i.e., load shifting, ancillary services, etc.) should be assessed. The electrical system operation and its associated needs will

continually evolve as more renewable generation is added; thus, how best to implement and utilize energy storage will need to be re-assessed on an ongoing basis. The 10-Year Plan contains the "Battery Energy Storage" project, which is described on page 51 of the March version of the 10-Year Plan, with timing details included in section VI. RFPs for the Battery Energy Storage project were included in the first tranche of RPPs released in February of this year.

c. Evaluate existing thermal generation units that may utilize or be reconfigured to be dual fuel units to burn biofuels for periods of generation. Part of this work would also be to assess bio-fuel sources that may provide bulk deliveries from the originating country to ports in Puerto Rico, in compliance with maritime and regulatory restrictions. Like the hydroelectric units, the dispatchability of the thermal units makes them a tool that can be used to help manage the risk of curtailment to non-dispatchable renewable resources.

d. Given that transmission line congestion can result in renewable generation curtailment, congestion potential and risk should be continually assessed as new renewable generation is developed.

e. The potential to employ innovative renewable energy contracting structures (i.e., fixed capacity payments vs. per MWh payments, etc.) in the future should be assessed as a possible tool to both manage / minimize renewable curtailment and address the financial consequences of curtailment.

7. Transmission Grid Stability

Preliminary studies of the PREPA transmission grid system indicate that, at some point, with the projected increase of instantaneous inverter-based generation levels, there would not be sufficient electrical system inertia to maintain system frequency and stability following a large disturbance sudden loss of generation event. If large levels of inverter-based generation and energy storage resources are allowed to interconnect to PREPA's transmission system without the proper studies to understand the limitations of the system, the grid is at risk of instability and increased incidences of load shedding. In the worst-case scenario, the lack of a plan and additional equipment to support the system could result in system instability leading to loss of loads and system collapse (blackout). The RPS goal requirements, which include large amounts of renewable generation and energy

storage systems, in combination with the significant retirement of many of the existing gas and thermal generation requires extensive analysis and planning.

Near Term Action is required to:

a. Develop and implement studies that may assess the integration of inverted-based and energy storage systems for the different stages of the implementation of the RPS

b. The progressive studies and analyses shall consider the timeline of the implementation of the RPS to identify the necessary upgrades that will help to mitigate the risk of system instability as the island incorporates inverted-based generation. The action plan will determine the necessary additional equipment to maintain stability, such as synchronous condensers and energy storage systems, as well as operational guidelines that may include the limitation of inverted-based instant generation under specific circumstances.

8. Synchronous Condensing

PREPA's Integrated Resource Plan (IRP) suggests repurposing existing generation units from the 1960s and 1970s as synchronous condensers. On-going system studies and site visits are being carried out to evaluate the feasibility of this plan. The preliminary results have concluded that repurposing is not a practical solution due to the age and condition of these units. The ongoing system studies will also determine the locations where the system requires support, which may not be at the locations of the existing generators. If the required synchronous condenser projects are not defined and implemented soon, this could delay the penetration of renewable generation in the system. These synchronous condenser projects need to be already in place in advance of the new renewable generation so that the transmission system is ready to accommodate the new projects and can operate reliably.

Near Term Action is required to:

a. Complete the transmission and generation system dynamic modeling to determine the locations and characteristics of the required synchronous condensers.

b. Design, procure, construct, and install the necessary synchronous condensing projects.

The 10-Year Plan contains the “Synchronous Condensers” project, which is described on pages 51 and 52 of the March version of the 10-Year Plan, with estimated timing information contained in section VI. Near Term Action is required to define the source for funding these projects.