NEPR

Received:

Oct 12, 2022

10:44 PM

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

IN RE: REVIEW OF LUMA'S INITIAL BUDGETS	**CASE NO. NEPR-MI-2021-0004** **SUBJECT: Second Set of Responses to Requests for Information**

SUBMISSION OF SECOND SET OF RESPONSES TO REQUESTS FOR INFORMATION IN COMPLIANCE WITH BENCH ORDER ISSUED DURING TECHNICAL CONFERENCE OF SEPTEMBER 13, 2022

TO THE HONORABLE PUERTO RICO ENERGY BUREAU:

COME NOW LUMA Energy, LLC ("ManagementCo"), and **LUMA Energy ServCo, LLC** ("ServCo"), (jointly referred to as "LUMA"), and respectfully state and request the following:

1. On April 2, 2022, LUMA submitted to this Energy Bureau its Annual Budgets for Fiscal Years 2023 through 2025 ("Annual Budgets"). LUMA also submitted supporting workpapers on April 8, 2022.

2. On May 19, 2022, this Energy Bureau issued a Resolution and Order with the subject "Fiscal Year 2023 Annual Budget Review: Requirement of Information and Establishing a Procedural Calendar" ("May 19th Order"). This Energy Bureau issued one hundred and sixteen (116) requests for information, stated in Attachments A through F of the May 19th Order. Additionally, in the May 19th Order, this Energy Bureau scheduled a Technical Conference for June 10, 2022, which conference convened and was canceled minutes after the record opened and witnesses were administered the oath or affirmation.

3. In compliance with the May 19th Order, through separate filings dated May 26, June 3 and June 7, 2022, LUMA and the Puerto Rico Electric Power Authority ("PREPA") submitted their responses to the Energy Bureau's Requirements for Information.[1]

4. On July 13, 2022, LUMA filed a *Motion Submitting Fiscal Year 2023 Annual Budget as Approved by the Financial Oversight and Management Board for Puerto Rico* (the "Informative Motion") whereby it submitted to this Energy Bureau the Fiscal Year 2023 Budget as certified by the Financial Oversight Management Board for Puerto Rico ("FOMB"). LUMA included the FY2023 Budget as certified by the FOMB ("Certified Budget"), an updated LUMA Annual Budgets report for FY2023 to FY2025, and its accompanying updated schedules with its Informative Motion.

5. On July 16, 2022, the Energy Bureau entered a Resolution and Order (the "July 16th Order") whereby it took notice of the Certified Budget. The Energy Bureau further determined to open a review of the Certified Budget. As part of such process, the Energy Bureau ordered LUMA to submit further responses to 9 requests included in the July 16th Order before July 29, 2022 at noon.

6. In compliance with the July 16th Order, on July 29, 2022, LUMA submitted the information requested. On the same date, this Energy Bureau entered a Resolution and Order whereby it established a second procedural calendar in this proceeding. As per the second procedural calendar a virtual technical conference was scheduled for August 17, 2022.

7. On August 12, 2022, this Energy Bureau entered a Resolution and Order through which, in its pertinent part, it issued a third revision to the procedural calendar as per which the virtual technical conference was postponed for September 9, 2022, the filing of revised or

[1] LUMA responded to all of the Energy Bureau's requirements, except for Requirements nos. A7, A8, A9, F1, F2, F3(A)-(C), F4, F5(A)-(E), F6(A)-(E), F7, F8, F9(A), F10(A)-(D) which were responded by PREPA.

additional information required by the Energy Bureau during the conference was scheduled for September 23, 2022 and the virtual public hearing and filing of comments by the public was set for October 7, 2022 ("August 12th Order"). LUMA's filing of its presentation for the virtual technical conference was consequently set for September 6, 2022. In the August 12th Order, this Energy Bureau also issued seven (7) additional requests for information due on August 29, 2022.

8. On August 18, 2022, PREPA filed a *Request for Continuance of Technical Conference* which was granted through Resolution and Order entered on August 19, 2022. Therefore, the virtual technical conference was postponed to September 13, 2022.

9. On August 29, 2022, LUMA submitted its Responses in Compliance with the August 12th Order.

10. On September 7, 2022, LUMA was notified of a Resolution and Order whereby this Energy Bureau set September 14, 2022, as a second day for the Technical Conference to consider the Certified Budget ("September 7th Order"). On September 9, 2021, LUMA filed a motion styled "Urgent Request to Re-Schedule Second Day of Technical Conference and for Issuance of Agenda," where it informed that several of its witnesses and management personnel as well as PREPA's witnesses, were not available to appear before this honorable Energy Bureau on September 14, 2022 and requested that the Energy Bureau re-schedule the second day of the Technical Conference on the Certified Budget.

11. The first day of the Technical Conference on the Certified Budget was held on September 13, 2022 from 10:00 a.m. until past 5:00 p.m. ("September 13th Technical Conference"). Twenty-nine (29) members of LUMA's work force in charge of different aspects of LUMA's operations and organization, appeared and were sworn in to answer questions from

this Energy Bureau. Representatives of PREPA also appeared but were excused given that the Energy Bureau and its consultants first addressed questions to LUMA.

12. Regarding the second day for the Technical Conference, this Energy Bureau informed that at the close of the September 13th Technical Conference it would make a determination on the need to convene LUMA and PREPA for a second day and, if needed, the second day of the Technical Conference would be held on September 27, 2022.

13. Throughout the Technical Conference, this Energy Bureau and its consultants issued several requests for information to LUMA ("RFIs"). In total, the Energy Bureau issued eighteen (18) RFIs, some of which include several requests.

14. Close to 5:00 pm during the September 13th Technical Conference, this Energy Bureau determined that it was necessary to extend the Technical Conference for a second day and set the same for September 27, 2022.

15. Regarding the RFIs, at the close of the September 13th Technical Conference, this Energy Bureau indicated that it would issue a written order with the RFIs and granted LUMA until 5:00 pm on September 23, 2022 to submit its responses. The Energy Bureau explained that the responses were needed on September 23rd to allow Commissioners and Energy Bureau consultants to review the responses ahead of the September 27th Technical Conference. At the time of the filing of this Motion, this Energy Bureau has not issued a written order with the RFIs.

16. On September 16, 2022, PREPA submitted a motion styled "Request for Continuance of Technical Conference Scheduled for September 27, 2022," ("PREPA's Motion to Continue Second Day of Technical Conference") whereby it informed that one of its main witnesses, its chief financial advisor, was not available to appear before this Energy Bureau on

September 27th. Thus, PREPA requested to continue the second day of the Technical Conference for a later date on or after October 7, 2022.

17. On September 20, 2022, this Energy Bureau issued a Resolution and Order whereby it issued an amended procedural calendar in this proceeding ("September 20th Order"). In what is relevant to this Motion, this Energy Bureau set the date for LUMA to file its responses to the RFIs for October 7, 2022. Further, the Energy Bureau scheduled the continuation of the Technical Conference for October 18, 2022.

18. On October 5, 2022, LUMA submitted a Motion styled *Urgent Request for Extension of Time to Submit Responses to Requests for Information and Request for an Agenda for the October 18th Technical Conference* ("October 5th Request for Extension"). In the October 5th Request for Extension, LUMA explained that although after the September 13th Technical Conference ended, LUMA's witnesses and supporting personnel adopted a workplan to answer the RFIs and immediately begun work to prepare the responses, the unforeseen event beyond LUMA's control of the passage through Puerto Rico of Hurricane Fiona on September 18, 2022, required the deployment of LUMA's workforce to prepare for and address an island-wide emergency and forced LUMA and its personnel to stay work on the responses to the RFIs.

19. LUMA explained that several of its witnesses regarding the Certified Budget and supporting personnel involved in preparing the responses to the RFIs, were activated in LUMA's Emergency Operations Center ("LEOC") and remain activated in the recuperation and restoration efforts in the aftermath of Hurricane Fiona. Consequently, LUMA informed this Energy Bureau that it was not possible at this time to complete the full set of responses to the RFIs by October 7, 2022.

20. In the October 5th Request for Extension, LUMA proposed to submit a first set of RFI responses by October 7th and requested that additional time beyond October 7th , until October 12, 2022, be granted to submit a second set of responses.

21. In compliance with the bench orders issued on September 13th and the September 20th Order, on October 7, 2022, LUMA submitted a first set of responses to the RFIs.

22. In further compliance with the bench orders issued on September 13th and the September 20th Order, LUMA hereby submits the second set of responses to the RFIs as *Exhibit 1* to this motion. LUMA respectfully requests that the redacted portions of responses to RFI number 13of *Exhibit 1* herein be kept confidential by this honorable Energy Bureau pursuant to the Energy Bureau's Policy on Management of Confidential Information, CEPR-MI-2016-0009, issued on August 31, 2016, and partially amended on September 16, 2016. In accordance with this policy, LUMA will submit a Memorandum of Law in support of this request in within the next ten (10) days.

23. LUMA respectfully restates the petition included in the October 5th Request for Extension, that the Energy Bureau maintain the second day of the Technical Conference as scheduled for October 18, 2022 and issue an Agenda.

WHEREFORE, LUMA respectfully requests that the honorable Bureau **take notice** of the aforementioned for all purposes; **deem** that LUMA complied with the bench orders with requests for information issued on September 13, 2022; **hold** the second day for the Technical Conference for LUMA and PREPA on October 18, 2022; and **issue** an agenda for the second day of the Technical Conference.

RESPECTFULLY SUBMITTED.

In San Juan, Puerto Rico, this 12th day of October, 2022.

We hereby certify that this motion was filed using the electronic filing system of this Energy Bureau. We also certify that copy of this motion will be notified to the Puerto Rico Electric Power Authority, through its attorneys of record: jmarrero@diazvaz.law and kbolanos@diazvaz.law.

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Exhibit 1

Second Set of Responses to Requests for Information
Issued on September 13, 2022

Exhibit 1: Second Set of Responses for Requests for Information

NEPR-MI-2021-0004

October 12, 2022

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-005

SUBJECT

Distribution Hosting Capacity

REQUEST

What percent of the inspection progress has been done at the Distribution level for hosting capacity.

RESPONSE

As of September 2022, LUMA and its contractors have performed inspections of 68 feeders out of a total of 1,128 feeders, or 6% of those in use today.

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-006

SUBJECT

Finance

REQUEST

How much IEM was paid for their services in FY22? And Budget projections for FY23?

RESPONSE

IEM was paid $7.6 million for federal funding advisory services performed in Fiscal Year 2022. The forecast for Fiscal Year 2023 for IEM is $8 million.

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-007

SUBJECT

System Remediation Plan

REQUEST

Summary of the System Remediation Plan (SRP) Programs where the milestones were updated and a summary of milestones that were delayed.

RESPONSE

LUMA filed revisions to the System Remediation Plan Improvement Programs on April 14, 2022 within Case No. NEPR-MI-2022-0019. This included programs for which milestones were updated, including delays. Please see TC-RFI-LUMA-MI-21-0004-220913-PREB007_Attachment 1 for a summary of the updated milestones.

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-008

SUBJECT

Federal Funding

REQUEST

What will happen if the Government of Puerto Rico does not obtain the cost share portion for the projects for the FY 22 and FY 23?

RESPONSE

LUMA shares PREB's concern around matching funds and has been actively encouraging the government to secure matching funds for the FEMA amounts. It is the responsibility of the Government of Puerto Rico to identify and fund the cost share portion of the FEMA grants. The Government of Puerto Rico, COR3 and PREPA as recipient and sub-recipients are the ones responsible for identifying the necessary funding sources for LUMA to execute the work.

However, it is LUMA's understanding that $500 million of CBDG-DR funds are allocated to the cost share portion of the FEMA grant utilizing the ER-1 Cost Share program developed by HUD/Vivienda as part of the Puerto Rico Action Plan.While this is not the full amount required to deploy the full amount of obligated funds, this will allow LUMA to deploy $5 billion in federal funds which are more than required for the current budgeted and forecasted years (fiscal years 2023, 2024 and 2025). Nonetheless, LUMA has been in constant communications with HUD to understand the pursuit of CBDG-DR funding sources for both the FEMA Grant cost share applications with the ER-1 Program and also the CDBG-DR Non-Federal Match Program. This is available for Cost Share components of other Federal Grants issued for the T&D System by agencies such as HUD, DOE and others.

LUMA continues to urge the Government of Puerto Rico to actively pursue the cost share portion of the funding and provide direction to LUMA so that LUMA can actively engage in any application or reporting requirements associated with the cost share funds.

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-009

SUBJECT

Federal Funding

REQUEST

Projections for the capital account for Federally Funded Projects. How does it work and how is it replenished?

RESPONSE

Federally Funded Capital Improvements are funded from the Capital Account – Federally Funded Service Account established pursuant to the Puerto Rico Transmission and Distribution System Operation and Maintenance Agreement ("T&D OMA") executed on June 22, 2020, among the Puerto Rico Electric Power Authority ("PREPA"), Puerto Rico Public-Private Partnerships Authority ("P3A") and LUMA Energy, LLC and LUMA Energy ServCo, LLC (collectively, "LUMA").

As per section 7.5(b) of the T&D OMA, PREPA is required to fund the Capital Account – Federally Funded with 4.5 months of the anticipated Capital Costs – Federally Funded for Federally Funded Capital Improvements that have been Obligated and scheduled. PREPA is also required to replenish the account monthly to maintain this funding level.

In May 2021, in advance of commencement, the Federal Oversight and Management Board ("FOMB") certified a $750 million Commonwealth transfer to PREPA in order to provide for $1 billion of OMA-related PREPA reserves. This transfer funded reserves so that PREPA could continue to fund the Service Accounts, including the Capital Account – Federally Funded, while reimbursement was being sought.

As part of LUMA's grant management strategy, LUMA is coordinating with the Central Office of Recovery, Reconstruction, and Resiliency ("COR3") to appropriately manage and administer in the Request for Reimbursement ("RFR") process. These efforts aim to meet Federal requirements set forth for Federal recovery funds from the Federal Emergency Management Agency ("FEMA") under the Public Assistance Program, maximizing and expediting the availability of funds to restore the Puerto Rico Electrical Grid. As such, LUMA complies with and submits requests for reimbursement as per COR3's established Disaster Recovery Federal Funds Management Guide for payment and cash management. As per the established Recipient's guidelines, LUMA has been submitting requests for reimbursements for Large Projects, providing all necessary supporting documentation to receive an advance or a reimbursement.

Regarding reimbursement, LUMA has identified alternate payment processes, such as the Working Capital Advance Pilot Program (RFCA) and the Sample Review Process (SRP). Further, LUMA is working hand in hand with COR3 to identify alternate payment methods to streamline and accelerate the reimbursement process.

As of September 15, 2022, the Capital Account – Federally Funded balance is $218 million.

Projected Fiscal Year 2023 cash outflows for Federally Funded Capital Improvements are estimated around $270 million.

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-010

SUBJECT

Federal Funding

REQUEST

Certification of the mechanisms that LUMA is using for the reimbursement of the federally funded capital projects. There are 4 different mechanisms: 1- The traditional 2-The COR3 pays directly to the contractor 3- Access to working capital to COR3 for an advance payment without a cap. 4- 25% COR3 advance payment. In the absence of one of these mechanisms, state why and the grounds for not having access to one. This response must be certified.

RESPONSE

LUMA confirms access to three of the four federal funding mechanisms outlined by the Energy Bureau. The mechanisms that LUMA has access to include 1, 3 and 4 listed below, with a brief summary of each and comments on LUMA's use of the method. The list is numbered according to the list of 1-4 outlined in the request.

PREB Method	Brief Summary	LUMA's Comments
Method 1: Traditional	Work is completed, LUMA pays the contractors and submits an RFR (Request for Reimbursement) to COR3.	LUMA currently utilizes this method.
Method 2: COR3 Payment to Contractor	COR3 directly pays contractors for work performed.	Upon further discussions with COR3, COR3 stated that a funding mechanism where COR3 directly pays a contractor does not exist. Contractors are paid through the RFR process based off of submitted invoices for which, once approved, COR3 issues the payment to the award recipient for payment to the contractor for services. LUMA respectfully requests clarification on Method 2.

Method 3: COR3 Working Capital Advance *(without cap)*	A working capital advance is available and can be obtained as an advance against the FEMA FAASt Grant funds currently obligated.	This method is available to LUMA. Method 3 can be used to procure materials and equipment to get a jumpstart on the procurement process. LUMA has worked with federal agencies and prepared for its use, if required, when procurement needs arise.
Method 4: COR3 25% Advance Payment	Request For Advance (RFA) method can be utilized to ask for an advance of 25% of the cost of an identified and obligated project. (once per Project Worksheet).	This method is available and is being explored by LUMA.

I hereby certify that the information provided above is complete and accurate to the best of my knowledge, information and belief.

Juan Rodriguez, PE, MBA, PMP
Vice President Projects, Capital Programs

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-011

SUBJECT

AMI

REQUEST

Submit all documents filed to Vivienda, COR3 regarding the request for funds for the AMI Projects. When is LUMA going to make a formal request for funding AMI, including streetlighting?

RESPONSE

LUMA has conducted a series of discussions with Vivienda and COR3 regarding funding for AMI Projects. Throughout the discussions, LUMA has provided detailed documentation of the AMI projects including an overview of existing conditions, the goals and approach for the project, potential impact, risks, issues, project budget, timeline and benefit cost analysis. A summary of LUMA's discussions with the agencies and the documentation submitted is outlined below and included in TC-RFI-LUMA-MI-2021-0004-220913-PREB-011 Attachment 1 and 2.

Through ongoing discussions with COR3, LUMA provided the AMI project description, scope and costs in a document included as TC-RFI-LUMA-MI-2021-0004-220913-PREB-011 Attachment 1. Upon review of the project documentation, COR3 confirmed that there is currently no mechanism to fund the AMI project, resulting in the project being placed in "hold" status until a funding source can be identified. COR3 is actively evaluating funding sources available.

During the fall of 2021, LUMA initiated discussions with Vivienda regarding the installation of AMI as an unmet need associated with electrical system resilience. An overview of the AMI project is included in the publicly available document published by Vivienda titled, *Puerto Rico Disaster Recovery Action Plan for the Use of CDBG-DR Funds for Electrical Power System Enhancements and Improvements*, accessible at this link, with a reference to the AMI project submitted by LUMA on page 58. LUMA has also prepared a detailed Unfunded Needs Summary, shared with various agencies. This summary is included as TC-RFI-LUMA-MI-2021-0004-220913-PREB-011 Attachment 2. LUMA is currently waiting for the results of the CDBG DR evaluation of funding sources. Once identified, LUMA will continue to develop the business proposal for the implementation of AMI.

LUMA FEMA 404 Hazard Mitigation Grant Program Projects

TC-RFI-LUMA-MI-2021-0004-220913-PREB-011 - Attachment 1

1.0 Introduction

Puerto Rico, including offshore islands of Vieques and Culebra, were severely impacted by hurricanes in 2017, with many of the T&D assets damaged, some of which were only repaired long after the initial recovery.

Modernizing and repairing the grid with state-of-the-art technologies is crucial to mitigate the impact from future storm and hurricane events and enable the sustainable transformation of the grid.

This package consists of three projects:

- Advanced Metering Infrastructure (AMI)
- Vieques and Culebra Interconnected Microgrids
- Submarine Cable Replacement

2.0 Advanced Metering Infrastructure

The status of the aging and vulnerable grid infrastructure and lack of modern technologies that provide visibility over and monitoring of the system has exacerbated the damages and impacted the pace of repair and recovery efforts during the hurricanes of 2017. Grid modernization and intelligence technologies such as Advanced Metering Infrastructure (AMI) and Energy Management System (EMS) are vital to enhancing the reliability and resilience of Puerto Rico's grid. This project proposes to install Advanced Metering Infrastructure (AMI) throughout Puerto Rico, with the purpose of improving reliability and resilience, as well as customer experience. AMI system can provide detailed information on the performance of the distribution grid at the customer premise, by monitoring key parameters such as power and voltage. Through granular visibility over the system at the customer level such as voltage, AMI system will support enhanced resilience during stressed conditions such as a storm and hurricane. AMI allows for faster outage detection, restoration, and notification through the wireless network. This will allow faster crew dispatch to an accurate area in the distribution grid, improving the repair and recovery process. Visibility and monitoring capabilities over distribution grid parameters that AMI provides will also facilitate integration of renewable generation at the distribution grid level. The monitoring information will allow LUMA to enact solutions to mitigate and eliminate potential harmful voltage profile impacts that could occur with a large penetration of renewables on a distribution circuit.

The benefits of AMI are summarized below:

- **Improve reliability:** Faster notification of service interruptions via last gasp messages (instead of customer trouble calls). Reliability is improved by providing detailed information on the performance of the distribution grid all the way to the customer premise.

- **Improve resilience:** More accurate crew dispatch and faster remote restoration during outages by identifying precise location of the fault. AMI provides the state of load at the customer level, particularly voltage, allowing the grid operator to make smarter control decisions and maintaining the performance of the distribution grid.

- **Improve customer experience:** Greater and more frequent consumption and bill information to allow the customer to have a no surprise bill. Consumption information on a daily basis will provide the customer with the ability to further control his energy use. Greater number of payment options such as pre-pay, bi-weekly, twice a month, etc. Greater consumption information to promote energy efficiency and measure energy efficiency improvements. Customers with distributed generation (IE. Solar panels) will be able to monitor on a daily basis not only the consumption but the amount of energy exported into the utility grid. Immediate automated power outage notification by the meter to the customer and to LUMA enables a faster LUMA response, especially when the customer is not home to report the outage. Knowing the voltage at the meter will allow an automated method to control devices on the grid to allow for an improved voltage level to the customer, especially with distributed generation on distribution circuits.

- **Improve LUMA efficiency:** Reduces Fraud by alerting LUMA that someone is tampering with the meter or removing the meter. Enables an improved method for identifying non-technical losses by providing granular energy consumption information that can be totalized at the transformer level for energy comparisons. Eliminates wasted LUMA field trips to repair outages that have already been energized (common utility problem with no AMI).

- **Enables energy resource optimization:** Provides an enabling platform to allow active prosumers on the grid. Prosumers could be offered time of use rates or other innovative rate structures that require greater energy consumption information (i.e., 15-minute energy consumption information).

2.1 Estimated Project Budget

The following shows the estimated project budget. Costs estimates were gathered as part of budgeting for System Remediation Plan during the Front-End Transition (FET) period. Estimates are for a managed service offering where servers would be off island. Associated O&M is estimated @ $19M/year.

Table 1 – Estimated Project Budget

	Total ($k)
Meters	292,000
Network Communications Equipment	8,400
Installation	
• Meters	99,000
• Network Equipment	3,600
Software Licenses	8,400
Integration and Delivery Services	152,000
AMI Project Management / Support (over 5-year project)	6,000
Total	569,400

3.0 Vieques and Culebra Microgrids

Following Hurricanes Irma and Maria, several third-party developers installed behind-the-meter (BTM) batteries and solar panels as a means of quickly restoring power to critical loads. While this helped each individual facility in the short-term, the resources were not integrated as part of a holistic, resilient design for the system.

In the emergency aftermath, the Vieques backup generators operated in the diesel plant were not able to sustain the island's load. Only one of the two units was operational at that time, and it ended up failing during the first few weeks it was operated. In fact, emergency generators had to be brought into the island and operated for nearly 3 months, until the diesel plant generators could be repaired. This resulted in a recorded outage that exceeded 80 days for all inhabitants of the island of Vieques.

This project proposes to develop interconnected microgrids on Vieques and Culebra, in a phased approach, focused initially on developing robust hybrid microgrids by diesel retrofits to deliver quick resilience gains. Years 2 and 3 will involve integration of renewables and energy storage to reduce the diesel footprint and enhance resilience through a layered microgrid concept that enables islanding of multiple electrical islands according to the state of the system following a major event. Developing hybrid microgrids that fold in legacy systems represent an important opportunity to rebuild the communities' trust and illustrate how to leverage existing assets. The project will serve as a reproducible model for other communities in Puerto Rico and demonstrate how microgrids can be built out incrementally and maintained over time.

3.1 Estimated Project Budget

The following table shows the breakdown of the total project budget:

Table 2 - Estimated Project Budget

Task	Total ($k)
Task 1 – Feasibility Analysis	150
Task 2 – Development of multi-layered microgrid cluster controller	250
Task 3 – Detailed design and analysis	400
Task 3 – Controller HIL Testing	400
Task 4 – Community Engagement and System Maintenance Plan	150
Task 5 – System Development and Commissioning	
Labor	1,100
Equipment	
Culebra Diesel retrofit & controls[1]	200
PV (12 MW) - Vieques	25,880
PV (3 MW) - Culebra	6,470
BESS (7MW/1hr) – Vieques	5,180
BESS (3MW/1hr) – Culebra	2,220
Microgrid controller	2,000
Distribution automation	1,000
Communications infrastructure	500
Distribution state estimator	500
EPC	1,200
Task 6 – System Demonstration and M&V	400
Total	48,000

[1] The retrofit in Vieques is presented by PREPA.

4.0 Culebra Submarine Cable and Microgrid

In addition to the microgrid, this project also proposes to replace and reroute the submarine cable between Punta Lima in the main island and Vieques. The submarine cable is beyond its useful life. Punta Lima 38 kV Submarine Transition Station (STS) structure was destroyed in the 2017 hurricanes. Due to the following issues with regards to the Punta Lima structure, a rerouting has been proposed:

- Difficulty of access
- Archaeological site
- Significantly high repair costs of the damages from Hurricane Maria
- Environmental and Historic Preservation issues

The new proposed area for the transition station in Vieques, Matineau Industrial Zone, is outside of the flood zone, hence will reduce the risk of flooding damages in a future storm or hurricane event. In addition, the existing submarine cable that connect Culebra to Vieques will also be replaced and rerouted, and a new Culebra STS will be built. The existing submarine cable is also beyond its useful life. Reliable and resilient connection to the main island's grid is crucial to achieve resilience in Culebra and to achieve redundancy in its islanded electric system. New submarine transition station in Culebra will consider the proposed integrated microgrid system.

4.1 Estimated Project Budget

Table 3 - Estimated Project Budget

Task	Total ($k)
Submarine cables (Playa Los Machos to Vieques, Vieques to Culebra)	197,620
Los Machos transition station	4,000
Vieques transition station	8,070
Culebra transition station	3,180
Total	**212,870**

LUMA Energy's Unfunded Needs

TC-RFI-LUMA-MI-2021-0004-220913-PREB-011 - Attachment 2

Contents

1.0 Introduction

Puerto Rico, including offshore islands of Vieques and Culebra, were severely impacted by hurricanes in 2017, with many of the T&D assets damaged, some of which were only repaired long after the initial recovery, thus leaving a significant portion of activities necessary for Puerto Rico's Long Term Recovery efforts.

Modernizing the grid with state-of-the-art technologies is crucial to the restoration of critical infrastructure, will mitigate the impact from future events and enable the sustainable transformation of the grid. Projects designed to restore and/or rebuild more resilient methods of providing, delivering and sustaining power are essential to and beneficial for the residents of Puerto Rico and Vieques and Culebra.

This package consists of four projects:

- Advanced Metering Infrastructure (AMI)
- Energy Control Center Replacement
- Vieques and Culebra Microgrids
- Submarine Cable Replacement

2.0 Advanced Metering Infrastructure

Grid modernization and intelligence technologies such as Advanced Metering Infrastructure (AMI) are vital to enhancing the reliability and resilience of Puerto Rico's grid due to increased severe weather resulting from climate change. An AMI system includes smart electric meters, two-way wireless communications from the meter to the head end, and interfaces to the headend for various applications. As electric smart meters are placed at each point of customer connection, smart meters can provide a vast amount of information on the distribution grid. The status of the aging grid infrastructure and lack of modern technologies such as AMI that provide visibility and monitoring of the system has contributed to the pace of recovery efforts during the hurricanes of 2017 and limited the identification of proactive measures to mitigate system issues prior to storms.

Grid modernization and intelligence technologies such as Advanced Metering Infrastructure (AMI) are vital to enhancing the reliability and resilience of Puerto Rico's grid due to increased severe weather resulting from climate change. An AMI system includes smart electric meters, two-way wireless communications from the meter to the head end, and interfaces to the headend for various applications. As electric smart meters are placed at each point of customer connection, smart meters can provide a vast amount of information on the distribution grid. The status of the aging grid infrastructure and lack of modern technologies such as AMI that provide visibility and monitoring of the system has contributed to the pace of recovery efforts during the hurricanes of 2017 and limited the identification of proactive measures to mitigate system issues prior to storms. An AMI system is usually seen as a top priority foundational program for grid modernization due to its functionality and ability to enable dependent programs on the power grid as well as the customer benefits that are immediately available.

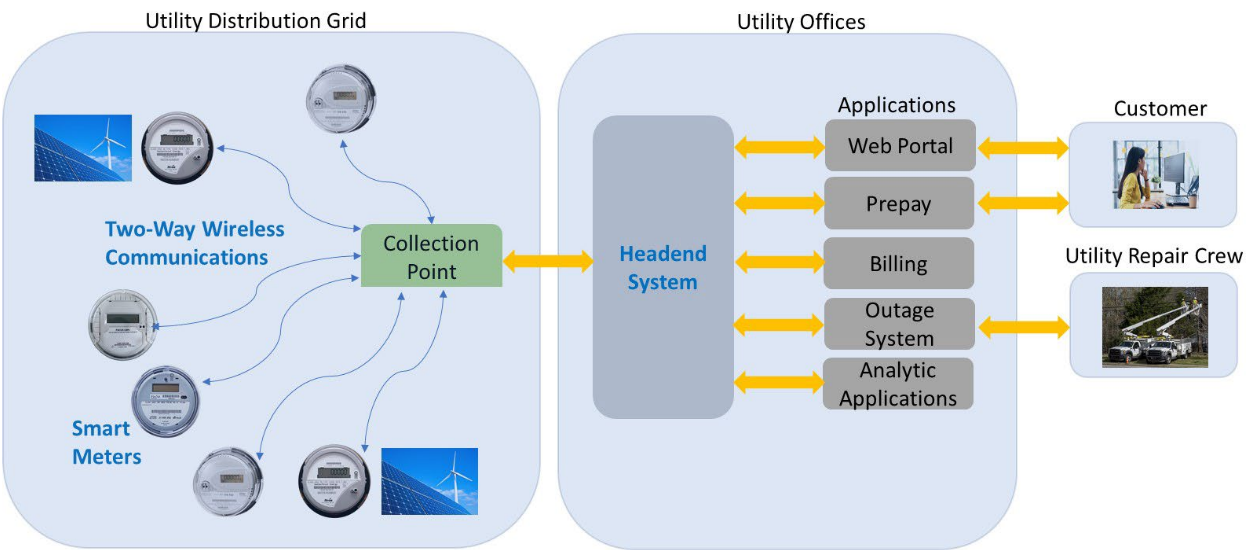

Figure 1 – AMI System Components: Smart Meters, Two Way Communications and Headend System

2.1 Existing Conditions

PREPA has deployed two earlier generation metering systems that utilize power line carrier (PLC) technology for communications to the electric meters. PLC technology has limited bandwidth since it uses the utility distribution lines as the communication medium. Unlike an AMI system, the PLC technology does not possess the bandwidth needed for detailed data collection, alerts and alarms, e.g. it cannot be used for outage detection to facilitate restoration.

2.2 Project Goals

This project proposes to install Advanced Metering Infrastructure (AMI) throughout Puerto Rico, with the purpose of improving reliability and resilience, as well as customer experience. LUMA recognizes that customers of low and medium income (LI and MI) levels need to have a "no surprise" electric bill. An AMI system will provide the information needed for customers to control their usage and consequently their electric bill. It will also provide flexible bill due dates to accommodate LI and MI pay days. Another important benefit from an AMI system is the detailed energy usage that can be used to apply for energy efficiency programs.

2.3 Proposed Approach

The project consists of the following tasks:

- Task 1: Requirements definition
- Task 2: RFI/RFP
- Task 3: Bid Qualification and Vendor Selection/Award
- Task 4: Contract Negotiations/Contract Signature
- Task 5: Pilot
- Task 6: Meter Installations
- Task 7: Program Finalization

2.4 Current State-of-the-Art Technology

Historically meters were induction disk electromechanical devices installed at the customer premise to measure only energy usage. As high-speed wireless communications systems evolved, AMI systems have become the norm for utilities. AMI systems include smart meters which have much more functionality than an electromechanical meter. The smart meters utilize high bandwidth two-way wireless communications to communicate to a central collection point or communicate directly to a central location. At the central location, the AMI headend interfaces to other systems such as the billing system, grid monitoring applications, load control applications, or outage management system (OMS).

Smart meters are microprocessor based and include many functions in addition to energy usage measurement not previously available for most customers such as measurement of bi-directional energy usage to enable local generation for renewables, power outage and restoration indication to facilitate restoration efforts following storms, load reduction programs to decrease energy usage at critical times, voltage/current/energy usage recording over time typically in 15 minute or 1-hour intervals to monitor the grid impacts of renewables or microgrids, and a variety of other functions of benefit to the customers.

AMI system can provide granular visibility over the distribution grid at the customer level such as voltage, AMI system will support enhanced resilience during stressed conditions. AMI also allows for faster outage detection, restoration, and notification through the wireless network. This will allow faster crew dispatch to an accurate area in the distribution grid. The monitoring information will allow LUMA to enact solutions to mitigate and eliminate potential harmful voltage profile impacts that could occur with a large penetration of renewables on a distribution circuit.

Potential Impact

A modern AMI system can provide details such as voltage, energy consumption/generation, outage detection, etc. at each of LUMA's 1.5 million customer locations. This visibility is beneficial to the grid operation and to people of Puerto Rico. For this reason, AMI is considered a key foundational building block for grid modernization. The benefits of AMI are summarized below:

- **Improve reliability and resilience:**
    - High penetration of renewables and microgrids help to improve the system reliability and resilience.
        - High penetration of renewables and microgrids requires bi-directional metering capability provided by a smart meter in an AMI system
        - High penetration of renewables and microgrids can impact the power system voltage levels. Smart meters and an AMI system enable LUMA to monitor the impact at the customer location to minimize adverse impacts.
    - Automated notification of power outages from smart meters instead of customer reports insures fast and accurate indication of the scope of system outages.

- The power network reliability is defined in terms of frequency and the duration of outages. Indices such as System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI). An AMI system can be used to accurately calculate SAIDI and SAIFI indices which can be used to proactively identify areas prone to outages. Once identified, options such as feeder automation, automated restoration schemes, or improved vegetation management can be implemented to reduce the impact of storms on customer outages.

- This enables deployment of LUMA repair crews more quickly especially when the customer is not home and with more precision. Once the repair is completed, smart meter restoration indication illustrates that the customers power has been restored. Reliability is improved by more accurate outage indication and faster repair times.

- AMI based load control devices allow control of loads such as pool pumps and HVAC units to be remotely controlled by the utility. AMI systems enable load reduction programs on an on-going basis to limit peak load but can also provide load reductions on request to minimize system impacts during severe events where generation production or transmission capability is limited. This can contribute to the grid resiliency during critical events.

- Since AMI system communications cover most of the distribution grid, AMI can enable communications to medium voltage equipment on the distribution grid such as automated feeder switches and feeder reclosers. Remote control of these devices can be used during outages to retore power to customers using fault location, isolation, and restoration schemes.

A modern AMI system supports resiliency of the grid by knowing the actual state of loads at the customer level, especially voltage; using this data to guide control actions to maintain the performance of the distribution system during stressed conditions; taking smarter control actions by integrating AMI and distribution automation together; and understanding at the customer level how the penetration of DERs impacts or improves system performance. AMI systems also help with security of the system through monitoring of customer loads and energy profiles to detect problems and guide solutions, as well as driving faster outage detection, restoration, and notification. An AMI system is a critical piece in integrating DERs at the distribution level, with the ability to provide bidirectional metering of consumption and generation, know the availability and impact of DERs on the system, and integrate DERs and DER data into voltage regulation and other control schemes.

In addition to reliability and resilience improvements, AMI systems offer additional advantages as outlined below.

- **Improve customer experience:**
  - AMI systems enable web portals for usage and bill presentment. Customers can view detailed consumption date to visually see where their consumption is occurring. This allows customer to consider making changes that can reduce their bills.
  - Using a web portal, a customer can monitor energy usage information on a daily basis with the ability to further control his energy use. Greater consumption information promotes energy efficiency and allows the customer to measure energy efficiency improvements.
  - Enable various rate options. Customers can conduct "what if" analysis between rates to see how switching from one rate to another could benefit them from a cost perspective putting them in more control of how and when they use energy
  - AMI enables a greater number of payment options such as pre-pay, bi-weekly payments, etc. giving customers greater flexibility. Customers benefit by not having to pay a deposit fee, significantly lowering the barrier to electrification. This puts the customer in direct control of the energy they use and helps them control their bill and spend level.
  - Customers with solar panels will be able to monitor bi-directional usage on a daily basis to review their consumption as well as the amount of energy exported into the utility grid.
- **Improve LUMA efficiency:**
  - Provide improved metrics such as SAIDI and SAIFI to highlight areas for improvement.
  - Improved outage indication and restoration as outlined above to reduce outage times. Automated restoration eliminates unnecessary LUMA field visits to repair outages that have already been energized (common utility problem with no AMI).
  - Enable load control and demand response programs
  - Reduces fraud by automatically alerting LUMA when someone has tampered with the meter.
-

2.5 Key Technical Risks/Issues

Modern AMI systems are based on unlicensed and licensed two-way wireless frequencies and cellular frequencies. Given the terrain and remote nature of a small percentage of customers, this could present a technical frequency propagation challenge for these areas. Also, it is important to clearly specify requirements for advanced applications such as SAIDI/SAIFI calculation, voltage monitoring, prepayment, and interval data for the AMI system and develop an acceptance criterion related to the numerous applications.

Project Budget

The table below outlines the estimated project budget. Costs estimates were gathered as part of the budgeting for System Remediation Plan during the Front-End Transition (FET) period. Estimates are for a managed service offering where servers would be off island. The associated O&M costs are estimated to be $19M/year.

Table 1 - Project Budget

Project Estimates	Total ($k)
Meters	292,000
Network Communications Equipment	8,400
Installation	99,000
· **Meters**	3,600
· **Network Equipment**	
Software Licenses	8,400
Integration and Delivery Services	152,000
AMI Project Management / Support (over 5 year project)	6,000
Total	569,400

2.6 Project Timeline

Upon approval of the funding, the project phases and timeline is as the following:

Figure 2 - Timeline for AMI project

2.7 Benefit Cost Analysis

AMI systems mitigate outage durations through reducing the restoration times:

- Faster notification of service interruptions
- Providing detailed information on the performance of the distribution grid (state of voltage at the customer level allows the operator to make control decisions)
- Allowing for more accurate crew dispatch and faster remote restoration during outages by identifying precise location of the fault
- More efficient restoration verification by communicating with the meters
- Integration with Outage Management Systems for enhanced outage management capabilities

AMI can also provide crucial input to maintenance decisions, by exposing the vulnerable areas in the network in terms of frequent outages. Using such data in predictive maintenance can mitigate future events.

Utilities have reported reduction in major outage durations with integration of AMI with Outage Management System[1]. Another utility, PEPCO, has reported in 2013 that its AMI system has helped around 6,000 customer outages in 2013[2], where a total of 277,222 meters were installed. Florida Power and Light reported faster restoration by around 5 million minutes as a result of AMI[3].

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[1] https://www.coned.com/-/media/files/coned/documents/accountandbilling/about-your-bill-rates/09-ami-panel-exhibits-ami-001-ami-005.pdf

[2] Survey of International Experience in Advanced Metering Infrastructure and its Implementation, World Bank Group, November 2018.

[3] http://mydocs.epri.com/docs/PublicMeetingMaterials/1028/Session_5_AMI_Beyond_Meter_Reading.pdf

The island wide adoption of AMI will have reliability and resilience impacts throughout Puerto Rico. Data shows that Hurricane Maria in 2017 caused an average outage duration of 2931 hours (122 days). Using FEMA standard value for loss of electricity4 ($174 per person per day), a half of the island wide outage per day would translate into approximately $278 million US dollars per day. Assuming an 8% reduction in outage duration due to AMI, a total of 30-day outage would translate into an avoided cost of lost load of approximately 667.2 million, noting that total of 30 days assumption is conservative compared to the outage durations sustained during Hurricane Maria alone.

[4] https://www.fema.gov/sites/default/files/2020-08/fema_bca_toolkit_release-notes-july-2020.pdf

3.0 Vieques and Culebra Microgrid

Following Hurricanes Irma and Maria, several third-party developers installed behind-the-meter (BTM) batteries and solar panels as a means of quickly restoring power to critical loads. While this helped each individual facility in the short-term, the resources were not integrated as part of a holistic, resilient design for the system.

In the emergency aftermath, the Vieques backup generators operated in the diesel plant were not able to sustain the island's load. Only one of the two units was operational at that time, and it ended up failing during the first few weeks it was operated. In fact, emergency generators had to be brought into the island and operated for nearly 3 months, until the diesel plant generators could be repaired. This resulted in a recorded outage that exceeded 80 days for all inhabitants of the island of Vieques. Culebra's diesel generators fared better, as the plant's resources were capable of supplying electricity to all its residents until the subtransmission line was repaired, several months later.

As part of resilience work funded by the Department of Energy (DOE), Sandia National Laboratories studied the Isabel Segunda microgrid on Vieques as one of 159 potential systems analyzed[5], while the neighboring island of Culebra was assessed by National Renewable Energy Laboratory[6] (NREL). The Isabel Segunda microgrid represents a total peak load of roughly 1.7 MW with 108 kW of critical load, while the island of Vieques has a recorded peak load of 5.6 MVA in 2019. By comparison, the neighboring island of Culebra had a peak load of 2.89 MVA in 2019. Historical peak for Vieques and Culebra is 7.4 MVA and 3.3 MVA, respectively. Prior to the hurricanes, the coincident peak demand of both islands was 9.9 MW as reported by PREPA.

3.1 Existing Conditions

According to the information obtained by PREPA, there is a diesel generation system with two units in Vieques, each rated at 3.3 MW and only one of the units is operational due to control system issues as well as faulted protective relays. The automatic synchronization capability is also out of service, requiring outages before and after any loss of subtransmission supply. PREPA plans on replacing the controllers of both generating units as well as all defective relays. Hence, in the case of an outage, the single diesel unit is not able to cover the peak demand in the island of Vieques. In addition to diesel units, there is a 260 kW of distributed generation in Vieques.

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[5] Jeffers, Robert F., Michael J. Baca, Amanda M. Wachtel, Sean DeRosa, Andrea Staid, William Fogleman, Alexander Outkin, and Frank Currie. 2018. Analysis of Microgrid Locations Benefitting Community Resilience for Puerto Rico. Sandia National Laboratories. SAND2018-11145.

[6] Salasovich, James and Gail Mosey. 2019. Energy Resilience Assessment for Culebra, Puerto Rico. Golden, CO: National Renewable Energy Laboratory. NREL/TP-7A40-73885. https://www.nrel.gov/docs/fy19osti/73885.pdf.

The existing submarine cables are operational. The submarine cable (line 5400) is a redundant 38kV line between Punta Lima and Vieques, as well as from Vieques and Culebra. One of the redundant cables' termination was damaged during an attempted copper theft. The second cable is also damaged but operational. It is possible to repair these cables. However, Punta Lima requires extensive upgrades, including the addition of breakers. There are serious issues related to soil integrity where Punta Lima was constructed, and these necessary upgrades are not doable considering the soil condition. For this reason, the transition station will be relocated to Ceiba and the existing Punta Lima station will be decommissioned.

The Culebra generation station is currently in working condition, with both 2MW generators in working condition.

3.2 Project Goals

Recently, a Puerto Rico Energy TCT Vieques & Culebra Working Group was established to guide developments targeting improving resilience of the power supply to the two islands. The group created a white paper[7] that outlines, among other things, a Master Plan for the area, which includes the integration of renewables, development of hybrid microgrids, and plans for eventual reinforcement of the undersea cable infrastructure.

This project proposes to develop microgrids on Vieques and Culebra in a phased approach, focused initially on developing robust diesel-based microgrids to deliver quick resilience gains. Years 2 and 3 will involve integration of renewables and energy storage to reduce the diesel footprint, and enhance resilience through a layered microgrid concept that enables islanding of multiple electrical islands according to the state of the system following a major event (see Figure 2). The two islands represent excellent candidates for developing practical, sustainable microgrids. There is a clear need to improve system resilience, as made clear by the prolonged outages during Hurricane Maria, potential to serve as a non-wires alternative (NWA) to reduce historic diesel consumption and contribute to the renewable portfolio of Puerto Rico, , and an engaged community seeking to deliver a larger share of their energy needs from local renewable resources. This is especially important in the face of climate change, as a microgrid powered by renewable resources addresses both climate change mitigation through decarbonization, and adaptation through providing sustained power during emergencies.

Developing hybrid microgrids that fold in legacy systems represent an important opportunity to rebuild the communities' trust and illustrate how to leverage existing assets. The project will serve as a reproducible model for other communities in Puerto Rico and demonstrate how microgrids can be built out incrementally and maintained over time.

The project aims to deliver on the following high-level objectives:

[7] DeCesaro, Jennifer. 2020. Resilient Power for the Island Municipalities of Vieques & Culebra. US DOE White Paper.

- Develop a multi-layered microgrid architecture that delivers resilience through combination of new and legacy customer-owned assets and utility developed infrastructure. Develop a modular design that fits in a layered control architecture supporting the tenets of interoperability, scalability, extensibility, and resilience. The concept should allow incrementally building up layers or starting from a diesel-based system and adding resilient sublayers.
- Develop feasibility analysis and conceptual design for Vieques and Culebra microgrids, including auditing of existing systems, capturing community objectives, and considering social burden.
- Carry out necessary studies (load flow, protection and electromagnetic transients EMT studies) to ensure the desired performance of the proposed topology is achieved for each of the three phases of the project
- Perform proof-of-concept testing of the approach using controller hardware-in-the-loop
- Engineering, procurement and construction, and commissioning of the Vieques and Culebra Distributed microgrids and perform detailed testing and performance auditing
- Develop a Community Engagement and Operation and Maintenance plans that ensures long-term viability of the approach. LUMA will work with the local community to foster a collaborative environment that supports retraining of local resources, accrual of benefits to the community, and ensures knowledge transfer to support long-term operation of the project and its support of economic development.

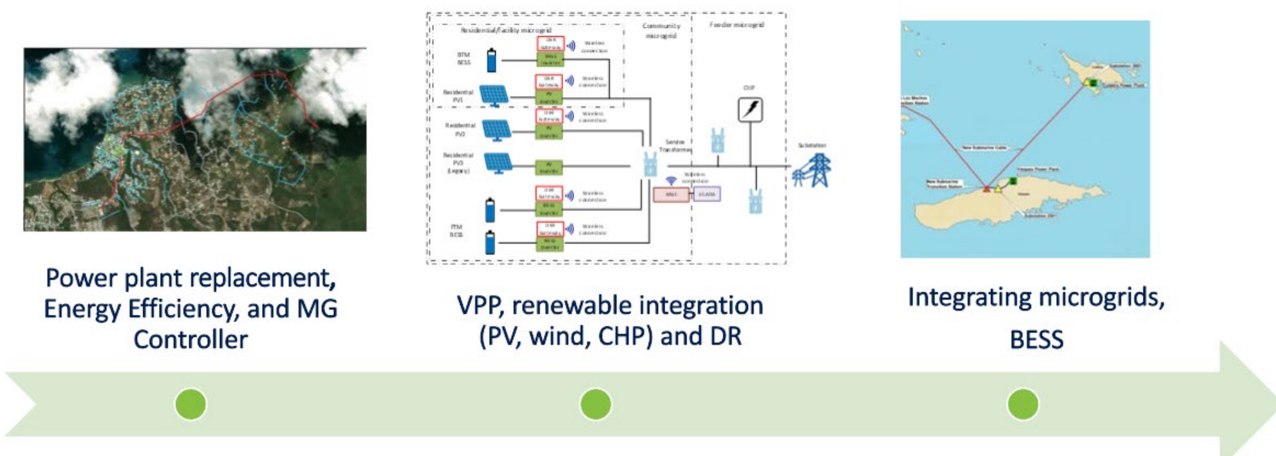

Figure 3. Phased approach for development of the integrated microgrids concept for Vieques and Culebra

3.3 Proposed Approach

Approaching resilience from a grid architecture perspective represents a novel way to think about the power system and its design, where power system infrastructure and control and communication architecture are designed concurrently to integrate distributed energy resources (DER) and microgrids and ensure delivery of power to critical loads, even under extreme events[8]. From a theoretical perspective, there is a compelling argument for this approach, but legacy issues have slowed real adoption in the industry. The proposed project represents a unique opportunity to develop a system according to these tenets as many of these characteristics also make it a superior design, but doing so in a phased approach that will deliver resiliency benefits in the short term.

Figure 2 presents the overall approach to achieve the integrated microgrids vision. The first phase will focus on delivering resilience benefits by replacing existing assets and augmenting generation at the Vieques diesel plant, and retrofit for controls and protections in Culebra, that will be along with the integration of a microgrid controller to enable island-wide microgrids to provide autonomy to each of the two islands in the event of power outage. The system will be planned and studied with Phases 2 and 3 in mind, that is, considering how the microgrid controller, protection scheme, communication requirements, and distributed controls will evolve under each of the phases. This includes sizing of battery energy storage facilities for different scenarios of renewable adoption and energy efficiency measures, placement of automated switches and sensors, and development of an evolving concept of operations document. Phase 2 will then integrate renewables into the control architecture, with goals of reducing the diesel consumption and developing resilient layers within each of the two hybrid microgrids. Finally, phase 3 will endeavor to operate the two microgrids in parallel, maximizing benefits under both *blue sky* and *dark sky* days[9]. Similar to the technical planning considerations, community engagement will initiate in Phase 1 but with a strategy that underpins successful implementation of Phases 2 and 3 as well.

Phases 2 and 3 will enlarge the scope of the microgrids by incorporating a layered community microgrid concept, that considers the behind-the-meter (BTM) microgrid – residential or commercial/facility level – as the fundamental building block of a resilient grid architecture, shown conceptually in Figure 3. Each BTM microgrid is then added to form community microgrids at the level of the service transformer, and extended further to the feeder and substation level as part of the substation microgrid commissioned in Phase 1. This system of systems (SoS) architecture breaks down the complexity of the problem and can be dynamically managed to scale to hundreds of DER assets, including BTM and front-of-the-meter (FTM), utility-owned or third party owned assets. These DERs can even include mobile assets such as existing mobile diesel generators or mobile energy storage systems (MBESS) to quickly optimize the system following a major event, depending on the extent of the damage. All systems are integrated to microgrid controllers by implementing monitoring and controls over a field message bus, with automated discovery and standard data models to favor interoperability and rapid reconfiguration of the system, see Figure 4. Phase 1 will

[8] Taft, J., "Electric grid resilience and reliability for grid architecture," PNNL technical report PNNL-26623, Nov. 2017.

[9] *Blue sky* and *dark sky* days refers to the language coined by DOE National Labs that refer to normal grid-tied operation and operation following system-wide outages or planned islanding scenarios, respectively.

establish the foundational elements for this system, while Phase 2 builds up complexity and resilience from the bottom-up.

The project approach focuses on delivering a system that is functional and delivers the benefits of improved renewable energy contribution and resilience, but the project team will also deliver important innovations that will benefit underrepresented communities and the industry at large. The scalable layered architecture allows the system to scale to larger systems, or as in the case of the proposed approach, build out resilient sublayers of diesel microgrid as renewables are integrated through VPP or other energy procurement exercises. The island microgrid controller will also provide integration to the SCADA system and can coordinate with back-office applications LUMA plans to deploy, such as an energy management system (EMS).

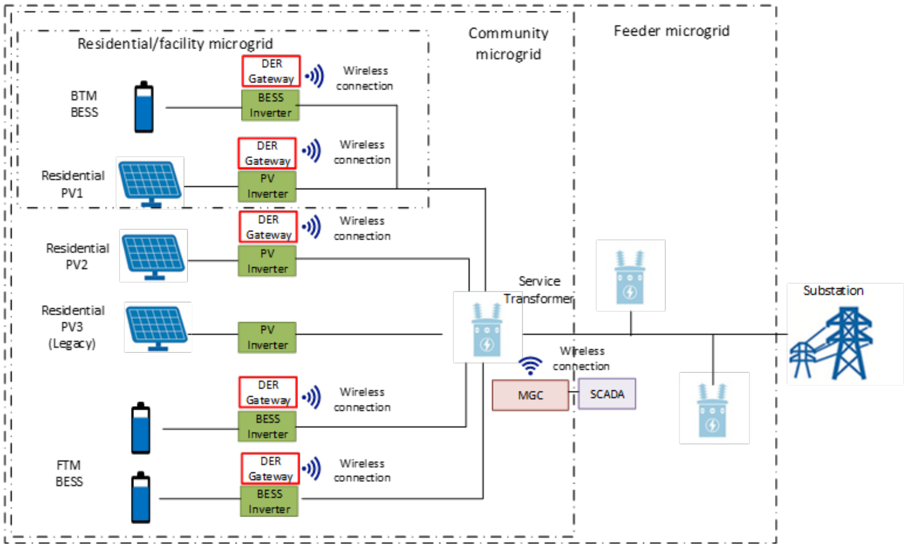

Figure 4. Resilient community microgrid layered approach using BTM and FTM DER assets as sublayer of diesel microgrid

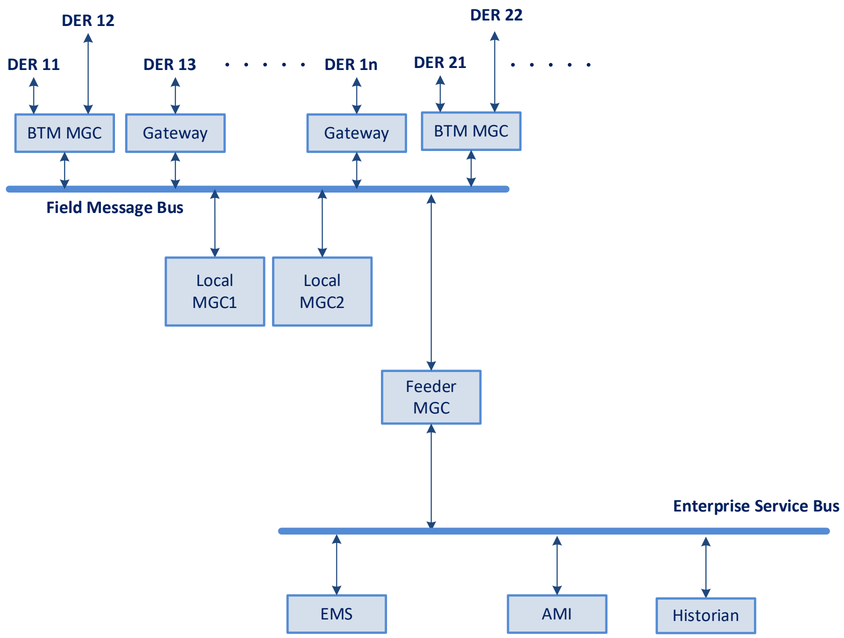

Figure 5. Resilient architecture for monitoring and control for the Vieques and Culebra microgrids

The project endeavors to deliver the following performance targets related to interoperability, scalability and reliability, that are deemed achievable, based on previous work[10,11].

- Improve the resilience of the two islands through the initial implementation of a hybrid microgrid, eventually reducing the overall diesel consumption, should the islands experience another extended outage such as that resulting from hurricane Maria, by more than 45% -. There are potentially higher savings to be achieved by the time the project moves forward, due to declining cost trends for PV generation and BESS, through Phases 2 and 3.
- Reliably operate each of the community microgrid layers (BTM, service transformer, and feeder) at 75% of its total peak load in islanded operation, respecting industry standards such as IEEE 1547-2018 limits.
- Connect and integrate a mobile DER or new DER to the community microgrid within two hours.
- Demonstrate through nesting of community microgrids, the technology can achieve scalability of more than 500 DER assets, through real-time simulation testing and field validation at the demonstration project.

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[10] K. P. Schneider et al., “A Distributed Power System Control Architecture for Improved Distribution System Resiliency,” in IEEE Access, vol. 7, pp. 9957-9970, 2019.

[11] W. Du et al., "Modeling of Grid-Forming Inverters for Transient Stability Simulations of an all Inverter-based Distribution System," 2019 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT), Washington, DC, USA, 2019, pp. 1-5.

Microgrid design and operation will comply with industry standards such IEEE 1547 and IEEE 2030 (specifically IEEE 2030.7 for microgrid requirements and IEEE 2030.8 for the microgrid testing and commissioning).

The project team proposes to implement the concept across seven tasks over a three-year period:

- Task 1. Feasibility Analysis and Planning of Vieques and Culebra Microgrids (Lead: Sandia, Argonne, LUMA, Columbia University)
- Task 2. Development of Multi-Level Layered Microgrid Controller (Lead: University of Puerto Rico, LUMA, IIT, Plug)
- Task 3. Detailed planning using information from distribution planning and analysis computational models (e.g., Synergi), available data from utility operations and information systems (e.g., SCADA, AMI, EMS) and advanced sensor data, for analysis of the microgrids for each of the three phases. This includes load flow, short-circuit, performance grounding, and electromagnetic transient for islanding, black start and fault behavior. The team will also investigate the use of microgrid design toolkit (MDT) as part of this step (Lead: LUMA, IIT, Sandia)
- Task 4. Controller HIL testing (Lead: IIT, LUMA)
- Task 5. Community Engagement and System Maintenance Plan (Lead: LUMA, University of Puerto Rico, Columbia University, Federación Canófila de Puerto Rico)
- Task 6. Final System Design, EPC and Commissioning (Lead: LUMA, University of Puerto Rico, IIT)
- Task 7. System Demonstration, Performance Auditing, and Dissemination (Lead: LUMA, University of Puerto Rico, IIT)

3.3.1 Proposed Microgrid Size

Different objectives were considered when deciding on the sizes of the PV generation and energy storage to be installed in both Vieques and Culebra. The microgrid optimization tool HOMER was used to size the DERs. The analysis took two objectives in consideration:

Objective 1: Reduction in diesel consumption when Vieques and/or Culebra are separated from the main grid:

1a. Reduction in diesel consumption when Vieques is operated in isolation;

1b. Reduction in diesel consumption when Culebra is operated in isolation;

1c. Reduction in diesel consumption when Vieques and Culebra are separated from the main grid, but connected to one another;

Objective 2: Reduction in excess energy when Vieques and/or Culebra are separated from the main grid:

2a. Reduction in excess energy when Vieques is operated in isolation;

2b. Reduction in excess energy when Culebra is operated in isolation;

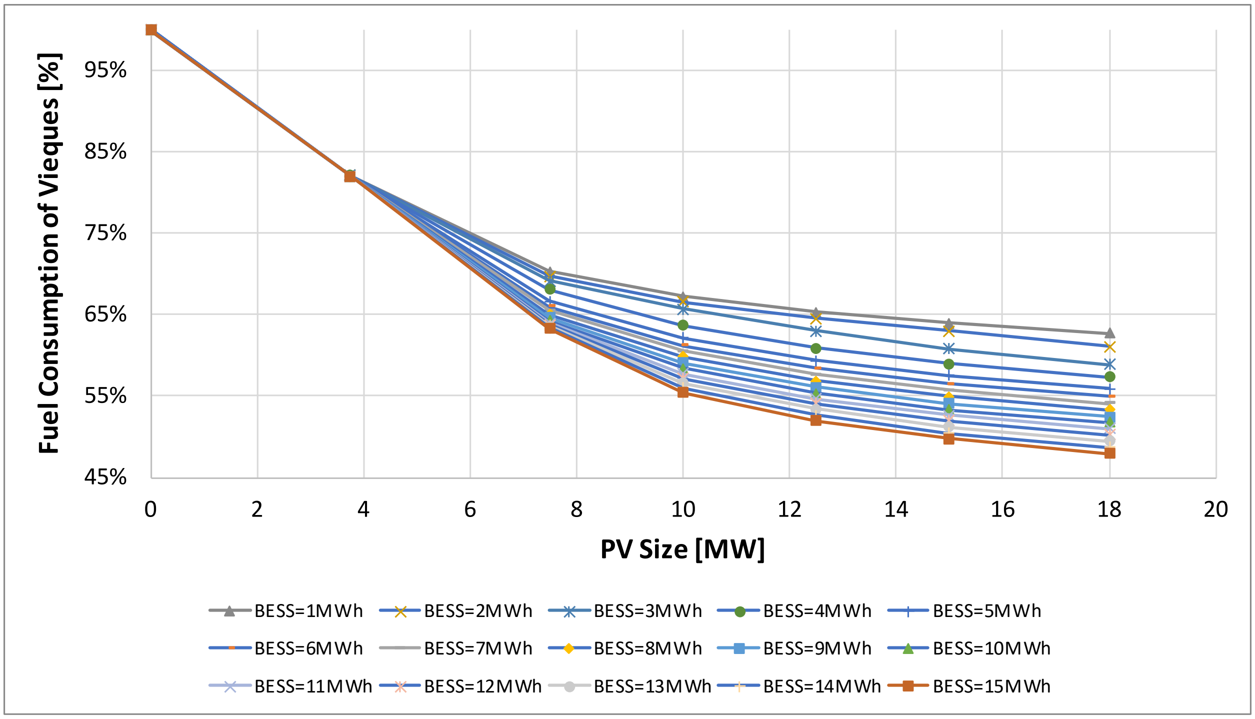
2c. Reduction in excess energy when Vieques and Culebra are separated from the main grid, but connected to one another;

To achieve this recommendation, an exhaustive search containing various microgrid scenarios was conducted. The loading for both Vieques and Culebra for one year, using a one-hour resolution, was used. The results of the sizes, as well as of each of these parameters, are shown in Table 2. These results demonstrate that renewable energy curtailment is unavoidable under practical DER sizes, but scenarios can be optimized to reduce both objectives.

Table 2 - Suggested sizes and their impact on diesel consumption and energy production

	BESS	PV	Reduction in Diesel consumption	Excess Energy	Energy offset
Vieques (isolated)	7 MWh	12 MW	41%	13%	41%
Culebra (isolated)	3 MWh	3 MW	35%	5%	35%
Vieques + Culebra (isolated)	10 MWh	15 MW	42%	14%	42%
Combined (grid-connected)	10 MWh	15 MW	N/A	0%	56%

The exhaustive search conducted to reach these results also serves as a sensitivity exercise, as it displays the impact of changing the configuration on the diesel consumption. This is shown Figure 5.


Fuel Consumption of Vieques [%]
95%
85%
75%
65%
55%
45%
0
2
4
6
8
10
12
14
16
18
20
PV Size [MW]
BESS=1MWh
BESS=2MWh
BESS=3MWh
BESS=4MWh
BESS=5MWh
BESS=6MWh
BESS=7MWh
BESS=8MWh
BESS=9MWh
BESS=10MWh
BESS=11MWh
BESS=12MWh
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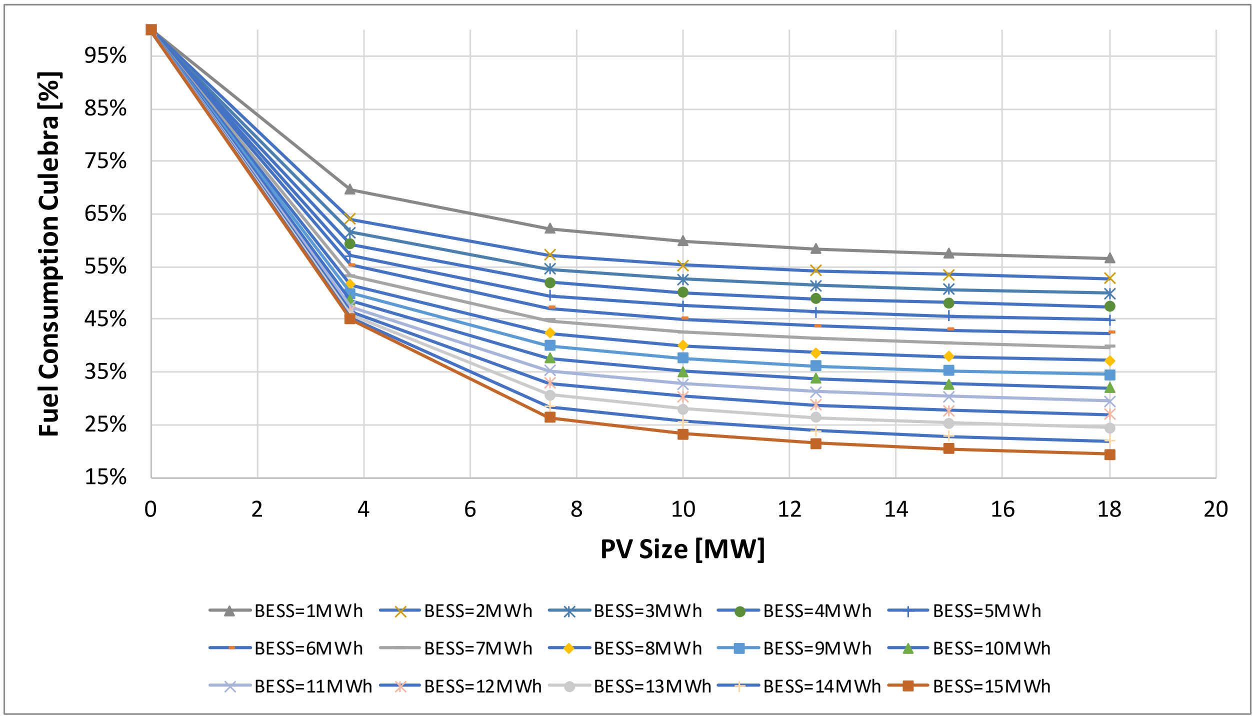
BESS=14MWh
BESS=15MWh

a.


Fuel Consumption Culebra [%]
95%
85%
75%
65%
55%
45%
35%
25%
15%
0
2
4
6
8
10
12
14
16
18
20
PV Size [MW]
BESS=1MWh
BESS=2MWh
BESS=3MWh
BESS=4MWh
BESS=5MWh
BESS=6MWh
BESS=7MWh
BESS=8MWh
BESS=9MWh
BESS=10MWh
BESS=11MWh
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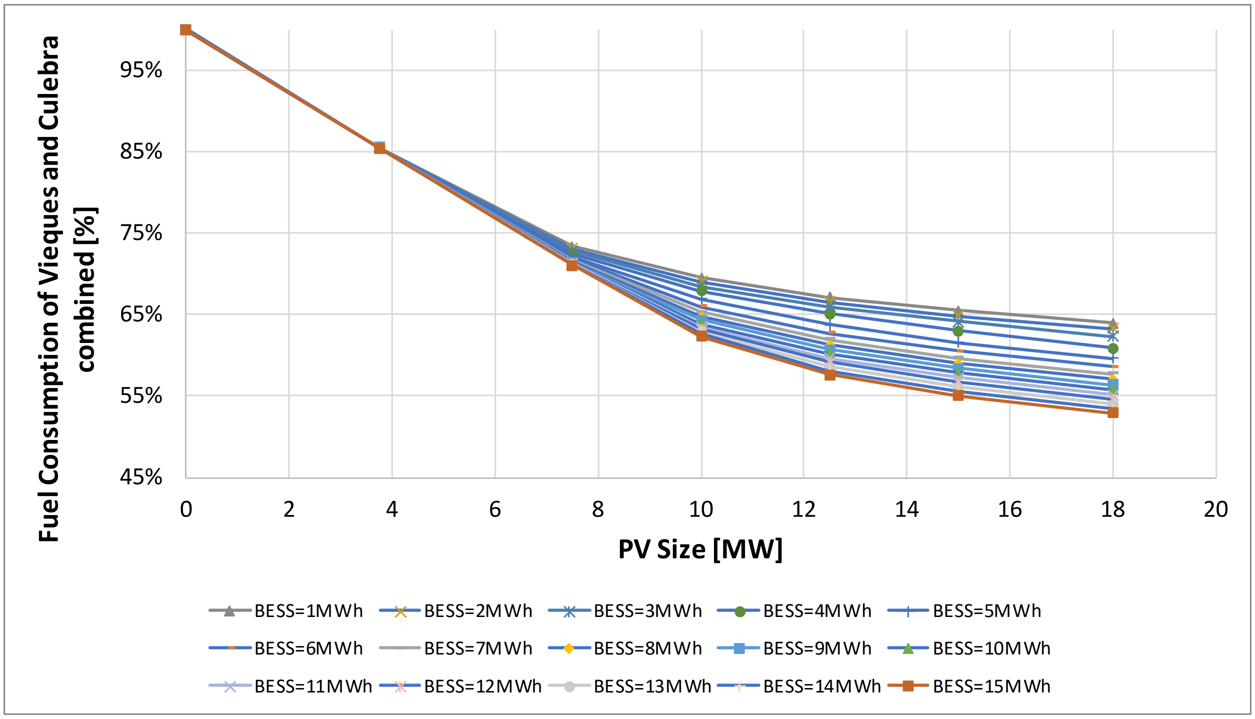
BESS=14MWh
BESS=15MWh

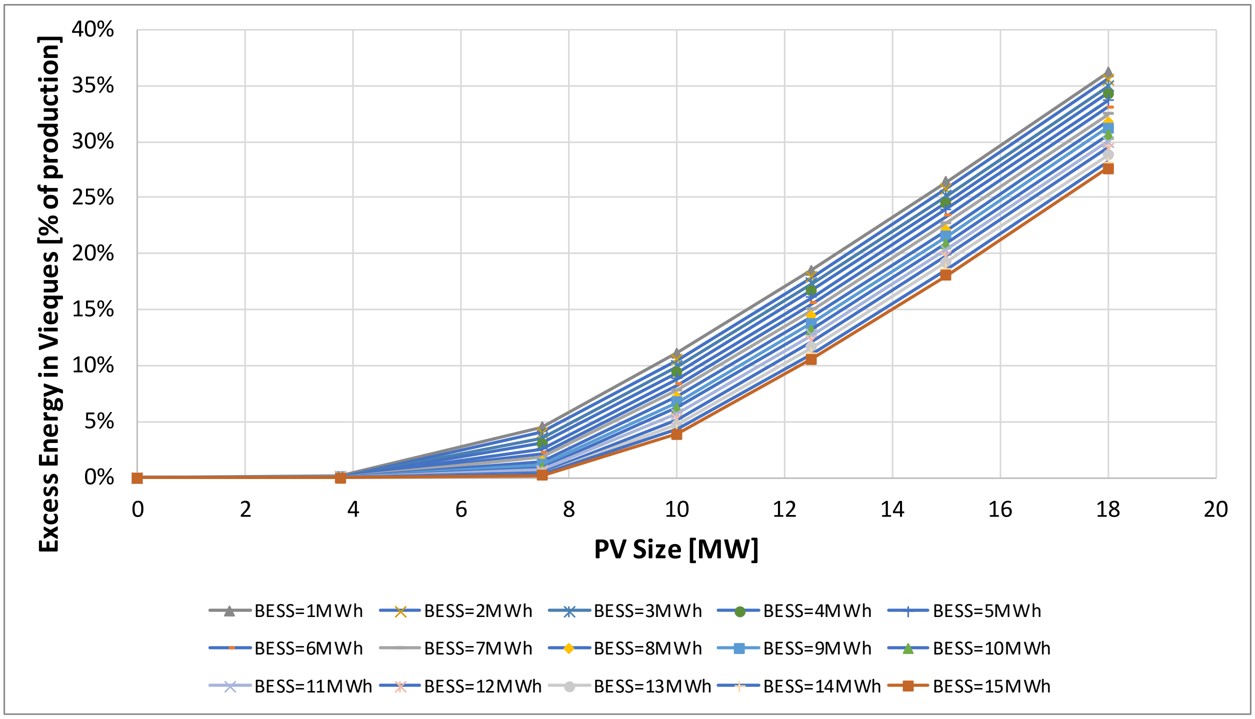
b.



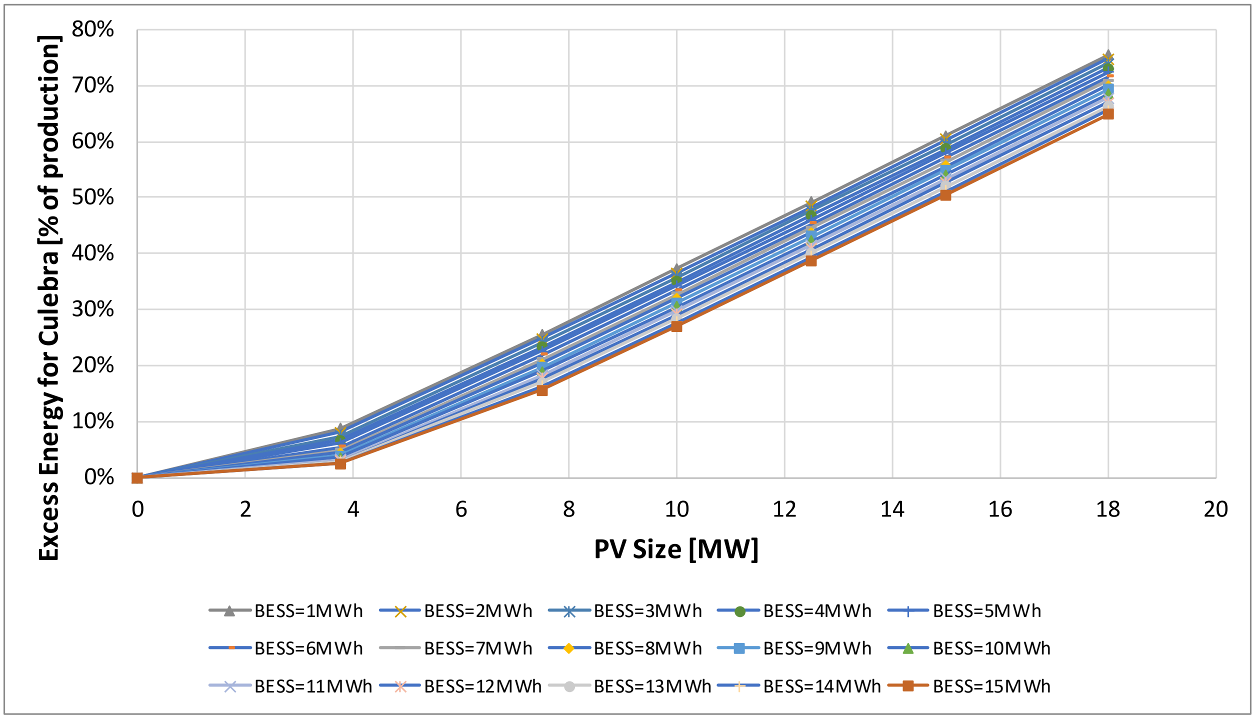
c.

Figure 6 - Sensitivity analysis results for diesel consumption reduction of different scenarios, (a) Vieques microgrid, (b) Culebra microgrid, and (c) combined Vieques-Culebra integrated microgrids.

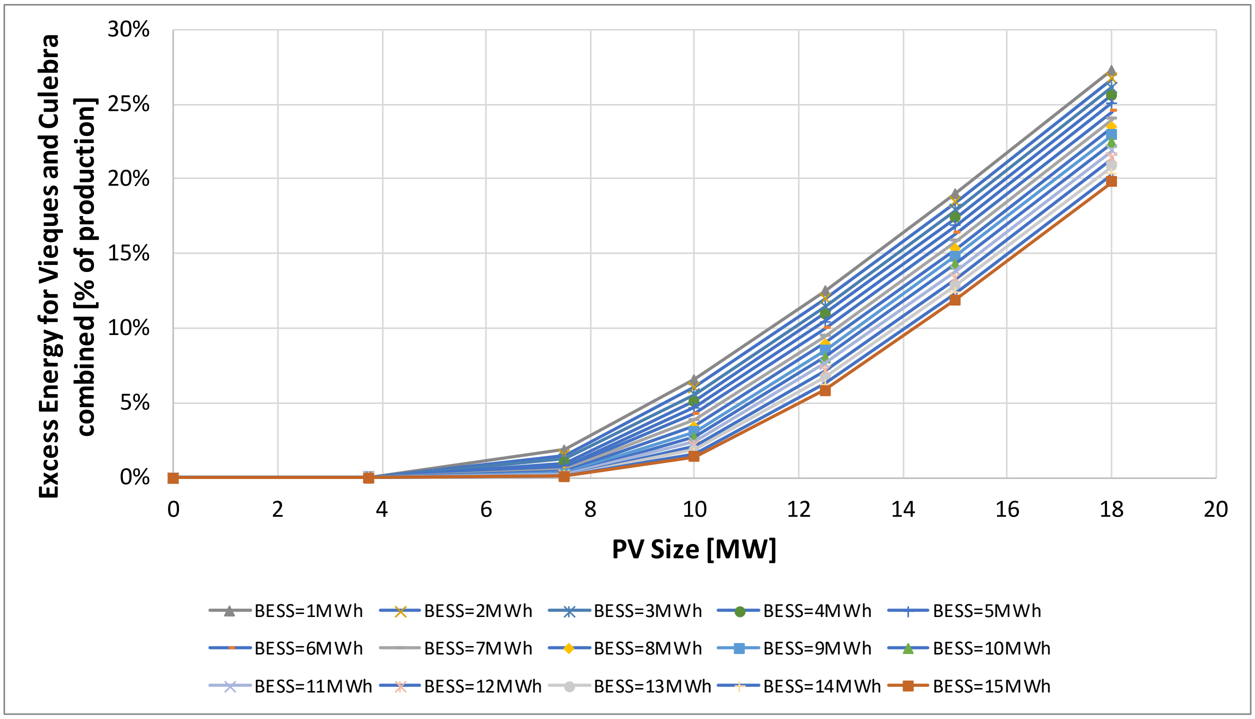
These simulations above were conducted assuming total loss of subtransmission (line 5400) supply (black sky event), and the configuration results in major PV generation curtailment, as suggested by Figure 6. These figures indicate this large amount of curtailed PV energy could be used under blue sky operation to further offset the total energy consumption of Vieques and Culebra, when the subtransmission supply is available.


40%
35%
30%
25%
20%
15%
10%
5%
0%
Excess Energy in Vieques [% of production]
0
2
4
6
8
10
12
14
16
18
20
PV Size [MW]
BESS=1MWh
BESS=2MWh
BESS=3MWh
BESS=4MWh
BESS=5MWh
BESS=6MWh
BESS=7MWh
BESS=8MWh
BESS=9MWh
BESS=10MWh
BESS=11MWh
BESS=12MWh
BESS=13MWh
BESS=14MWh
BESS=15MWh

a.


80%
70%
60%
50%
40%
30%
20%
10%
0%
Excess Energy for Culebra [% of production]
0
2
4
6
8
10
12
14
16
18
20
PV Size [MW]
BESS=1MWh
BESS=2MWh
BESS=3MWh
BESS=4MWh
BESS=5MWh
BESS=6MWh
BESS=7MWh
BESS=8MWh
BESS=9MWh
BESS=10MWh
BESS=11MWh
BESS=12MWh
BESS=13MWh
BESS=14MWh
BESS=15MWh

b.



c.

Figure 7. Initial feasibility analysis results showing excess energy of different islanded scenarios, (a) Vieques microgrid, (b) Culebra microgrid, and (c) combined Vieques-Culebra integrated microgrids.

In summary, the 10MWh BESS and 15 MW PV generation will provide:

- 41% reduction of the overall diesel consumption in Vieques, assuming Vieques and Culebra are operating independently from one another, should there be total loss of subtransmission supply.
- 35% reduction of the overall diesel consumption in Culebra, assuming Vieques and Culebra are operating independently from one another, should there be total loss of subtransmission supply.
- 42% of overall diesel consumption in the minigrid containing Vieques and Culebra, assuming Vieques and Culebra are still connected to one another, should there be total loss of subtransmission supply between the main island of Puerto Rico and Vieques.
- 54% reduction of the overall energy consumption in Vieques, should there be no loss of subtransmission supply (blue sky operation).
- 40% reduction of the overall energy consumption in Culebra, should there be no loss of subtransmission supply (blue sky operation).
- 56% reduction of the overall energy consumption in Vieques and Culebra, should there be no loss of subtransmission supply (blue sky operation).

3.4 Community Engagement

LUMA will also engage in a community engagement strategy to ensure that community priorities and social infrastructure are part of planning considerations for critical infrastructure restoration and long term recovery. Additionally, the benefits of the microgrid will be optimal if there is broad awareness of the BTM footprint and capabilities, and integration into community disaster resilience and recovery plans. With community engagement, the benefits will also extend beyond the boundaries of the microgrid to benefit surrounding communities that can access critical resources during a grid outage.

As part of Vieques and Culebra microgrid efforts, Sandia national laboratories will be holding microgrid conceptual design workshops. A parallel process can be adopted for deployment in Vieques and Culebra leveraging existing partnerships of LUMA and those of the National Center for Disaster Preparedness (NCDP) at Columbia University's Earth Institute.

NCDP has been working in Puerto Rico for several years now and has established community resilience coalitions under a separate initiative focused on building child-focused community resilience. These coalitions include representatives from community-based organizations, emergency management and other stakeholders. As part of coalition efforts in Humacao liaisons with the islands of Vieques and Culebra were also included, and initial efforts have been undertaken to establish similar coalitions in these islands. NCDP has also developed and delivered a community tabletop exercise to communities within or adjacent to microgrids in the Chicago area to identify key benefits of the microgrid, develop lessons learned for ongoing development, and educated community stakeholders on the capabilities of the microgrid for integration into local planning.

NCDP will provide support for the development of community stakeholder groups for outreach efforts. In addition to these outreach efforts, NCDP may also develop community discussion-based tabletop exercises to provide an opportunity to gain feedback on the proposed microgrid in the context of a simulated disaster. This provides an opportunity for richer input into the community value of the microgrid and surrounding communities during a disruptive event. Further, NCDP will also develop guidance for community-based organizations to integrate the microgrid footprint and capabilities into local and regional disaster management plans in order to ensure that the value is fully realized in a disaster situation.

3.5 Current State-of-the-Art Technology

Operational microgrids have been implemented nationwide, demonstrating the feasibility of the concept. Several notable ones[12],[13] have successfully demonstrated islanding and include initial concepts around

[12] H. Katmale, S. Clark, T. Bialek, L. Abcede, "Borrego Springs: California's First Renewable Energy Based Community Microgrids," Final report for EPIC project EPC-14-060, Feb. 2019.

[13] X. Lu, S. Bahramirad, J. Wang, C. Chen, "Bronzeville community microgrids: A reliable resilient and sustainable solution for integrated energy management with distribution systems," Electr. J., vol. 28, no. 10, pp. 29-42, 2015

microgrid clustering or layering – concept of having electrically close microgrids that can operate independently or as a single, larger microgrid. Many of these systems continue to employ combustion turbines and synchronous generators as the isochronous generators, while some work has begun using grid-forming capabilities of smart inverters, particularly as part of BESS. The limitations of this background innovative work include: microgrids planning was disconnected from grid modernization, relatively limited number of fully inverter-based microgrids, and the microgrids is viewed as a mostly static concept, with defined boundaries. The challenge going forward is to develop a general microgrid control philosophy that integrates seamlessly into any architecture and leverages all DER considering their capabilities and availability.

3.6 Potential Impact

This project addresses several community lifelines identified by FEMA. By providing sustained power during outages the microgrid brings enhanced resilience to both islands, directly addressing energy lifeline. In the face of an emergency, by providing power to the islands including critical facilities, food, water, shelter, and safety & security lifelines are addressed as well. The project is also well aligned with Puerto Rico's Hazard Mitigation Plan and addresses the following objectives and actions:

- *Objective 2.3. Reduce the degree of vulnerability of critical and essential buildings and vital and critical state infrastructure.*
- *Objective 4.3. Encourage the use of renewable energy in new infrastructure developments.*
- *Action 4.3.1. Establish assistance programs to support the implementation of renewable energy/ alternative energy microgrids.*

The potential impact of this demonstration project and associated research is significant as it proposes to demonstrate resilient architecture techniques that have yet to be adopted by utilities. The project will develop a robust concept for deploying resilient distributed community microgrids that can be grown incrementally and quickly rebuild/reconfigure following major natural disaster events. This will build a sustainable approach to microgrids that will cultivate community trust and, if successful, can be used as a model to reproduce this concept at other locations within Puerto Rico and in the continental US. The expected innovations could deliver significant improvements in resiliency and energy security, particularly in underprivileged communities in areas threatened by natural disasters.

Community engagement in addition to cutting-edge engineering solutions will also greatly extend the benefit of the microgrid by ensuring integration into social infrastructure and community disaster plans. While community engagement is often assumed as part of regulatory requirements, this proposal goes beyond that to meaningfully integrate a diverse set of community stakeholders in the planning and implementation processes based on proven community coalition development strategies utilized in Puerto Rico, and elsewhere for efforts related to community disaster resilience.

3.7 Key Technical Risks/Issues

The key technical risks relate to implementation, integration, availability of adequate measurements, building community trust, and dealing with legacy issues around compatibility of the concept with other technologies current deployed on the island. Implementation risks relate to the ability to translate theoretical development into practice by ensuring the control algorithms can be developed, tested, and commissioned on commodity hardware. Integration challenges often generally lead to project delays but, where possible, the project team will leverage industry standards to mitigate those issues. Legacy issues relate to proper mapping of the developed concepts to the legacy systems and what degree of retrofits are required in terms of additional hardware or firmware updates. Developing healthy collaboration with the community is an on-going challenge across Puerto Rico and the project will hopefully serve as a positive example of LUMA working together with National Labs, local university partners and the communities to develop sustainable, long-term solutions that support the health and prosperity of the communities it serves.

3.8 Project Budget

The following table shows the breakdown of the total project budget:

Table 3 - Project Budget

Task	Total ($k)
Task 1 – Feasibility Analysis	150
Task 2 – Development of multi-layered microgrid cluster controller	250
Task 3 – Detailed design and analysis	400
Task 3 – Controller HIL Testing	400
Task 4 – Community Engagement and System Maintenance Plan	150
Task 5 – System Development and Commissioning	
Labor	1,100
Equipment	
Culebra Diesel retrofit & controls	200
PV (12 MW) - Vieques	25,880
PV (3 MW) - Culebra	6,470
BESS (7MW/1hr) – Vieques	5,180
BESS (3MW/1hr) – Culebra	2,220
Microgrid controller	2,000
Distribution automation	1,000
Communications infrastructure	500
Distribution state estimator	500
EPC	1,200
Task 6 – System Demonstration and M&V	400
Total	48,000

3.9 Project Timeline

Figure 7 presents the project implementation timeline by tasks as defined in Section 3.3. The team plans to complete the overall project on over a three-year time frame, depending on lead times associated with microgrid equipment and coordination with other activities.

The feasibility analysis for the microgrid has already been initiated and will be completed in the first quarter of the first year of the plan. This will provide the basis for a strong conceptual design and will serve as input to the many of the subsequent tasks, including Task 2, 3, and 5. Task 2 will entail development of the concepts for the layered microgrids and validation of those concepts in more of a research setting. The results of that research will be incorporated in some capacity in the design and planning associated with integration of DERs in year 2. Task 3 represents the detailed plan to be led by LUMA. This will entail the detailed studies and analysis to ensure compatibility of the microgrid development with the distribution infrastructure and established LUMA system performance criteria.

Hardware in the loop (HIL) testing will be conducted in Task 4 at the partner facilities to validate the concepts and specific vendor solutions prior to field implementation. This will be essential to de-risk each of the implementation phases and link the research activities to the implementation tasks.

Task 5 will start immediately and run throughout the project to ensure alignment with the community objectives and other existing initiatives such as the virtual power plant (VPP) RFPs and energy efficiency initiatives. New development is expected throughout each of the three years, and hence the importance of coordinating and adjusting the implementation throughout the project timeline.

Task 6 represents the detailed engineering, procurement and construction (EPC) of the microgrids. This is broken down further in the following section for those interested in more details. Finally, Task 7 will document, analyze, and disseminate the results as each of the three phases and associated functionality is put into operation. This will be crucial in capturing learnings and translation of the concept to other locations in Puerto Rico and the continental US.

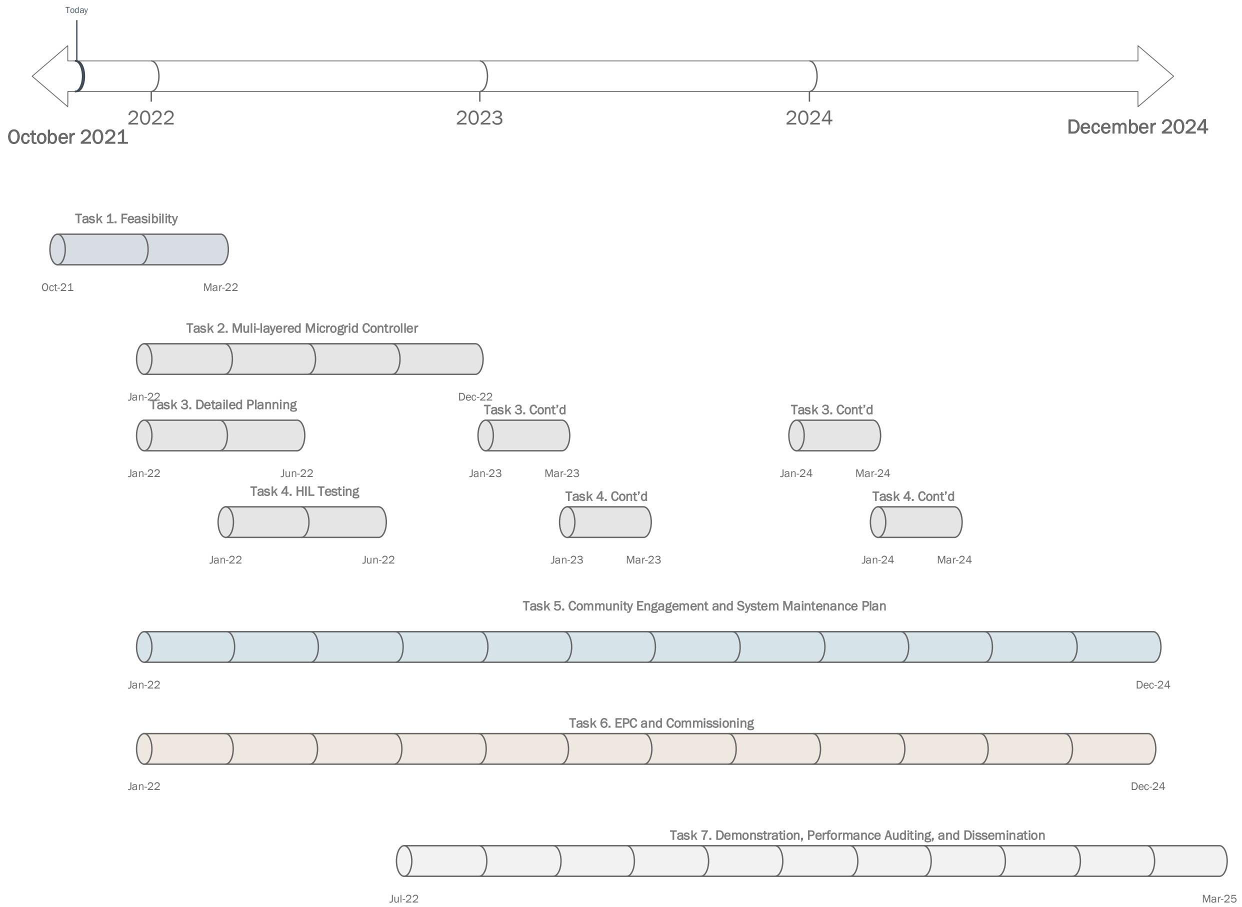


Figure 8 – Vieques and Culebra Project Timeline by Project Tasks

3.10 Supplemental Information

3.10.1 Team Members

The project team will be led by LUMA with support from University of Puerto Rico, Columbia University, Illinois Institute of Technology, Sandia National Laboratories, Argonne National Lab, and Vieques and Culebra community groups, (see Figure 8).

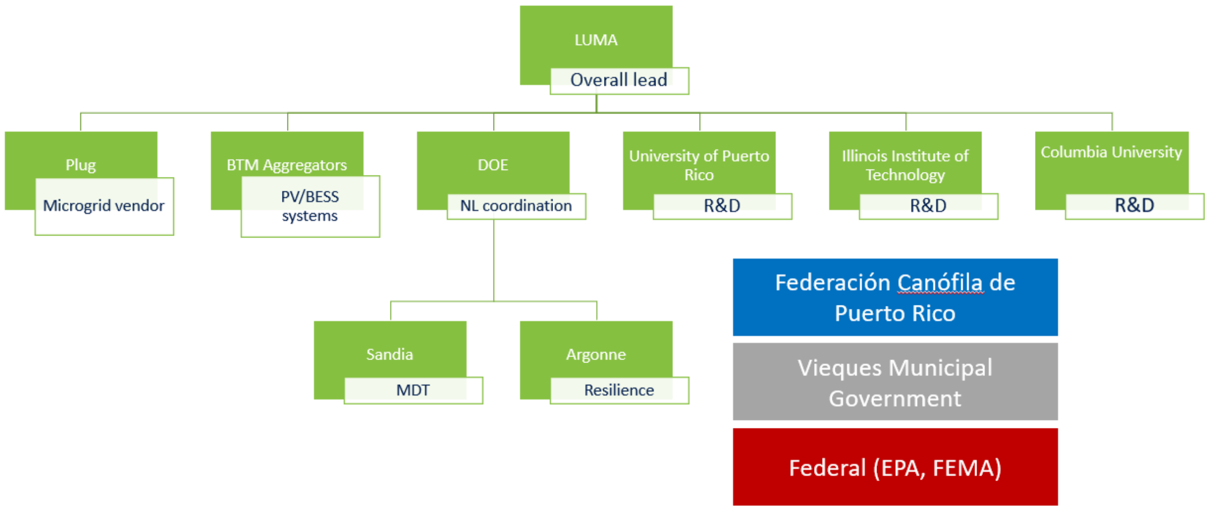


Figure 9 - Partners

3.10.2 Additional Timeline Representations

To complement the task view of the project timeline presented, this section offers two alternate views to help with understanding of the breakdown of the project.

Figure 9 presents the project breakdown by activity, conserving the same color scheme as used for Tasks in Figure 7 to allow mapping from one figure to the other. Here, only the core engineering tasks associated with Task 4 are shown, while the research activities are not illustrated. Engagement with local partners will be required as soon as possible to begin socialization of the project and properly integrate their drivers into the project design. Also, the long-term viability of the project, does require buy-in and local training activities to ensure proper maintenance of microgrid assets. The three phases of implementation from the perspective of EPC activities and milestones are broken down separately in Figure 9, and then further in Figure 10 and Figure 11. Phase 2 begins concurrently with phase 1 due to the longer lead times for PV and BESS equipment. Finally, the full operational livening of the multi-island microgrid toward the end of 2024 triggers the operational stage, which will be supported by a detailed operation and maintenance (O&M) plan and measurement and verification (M&V) plan. These plans will result from prior work in the project, internally by LUMA and through engagement with other stakeholders.

Figure 10 and Figure 11 present the project from the EPC perspective, with the intent of specifically illustrating how those activities breakdown into the three phases. The intent is to add new functionality each year, focusing on achieving concrete resiliency gains in year 1, that are further enhanced in years 2 and 3 through the diversity introduced by the PV systems and the BESS facilities. To accomplish this, an overarching design for the three phases will be completed in year 1, with provisional designs for years 2 and 3, that will be updated at the beginning of each respective year.

Procurement and construction of the Vieques diesel plant rebuild and enhancement of capacity of the Culebra diesel plant will be completed over the first 15 months of the project, see Figure 10. This schedule depends on lead times of the diesel plant equipment, but punctual initiation of the procurement will be critical in ensuring commissioning of phase 1 by early in year 2 of the project. Further details on costs for the diesel plants are detailed in section 5.

Procurement of each of the two DER technologies are broken into two separate stages, both to diversify the responses and to target deployments for each of the islands. The breakdown of PV and BESS capacity will be decided during each of the engineering phases.

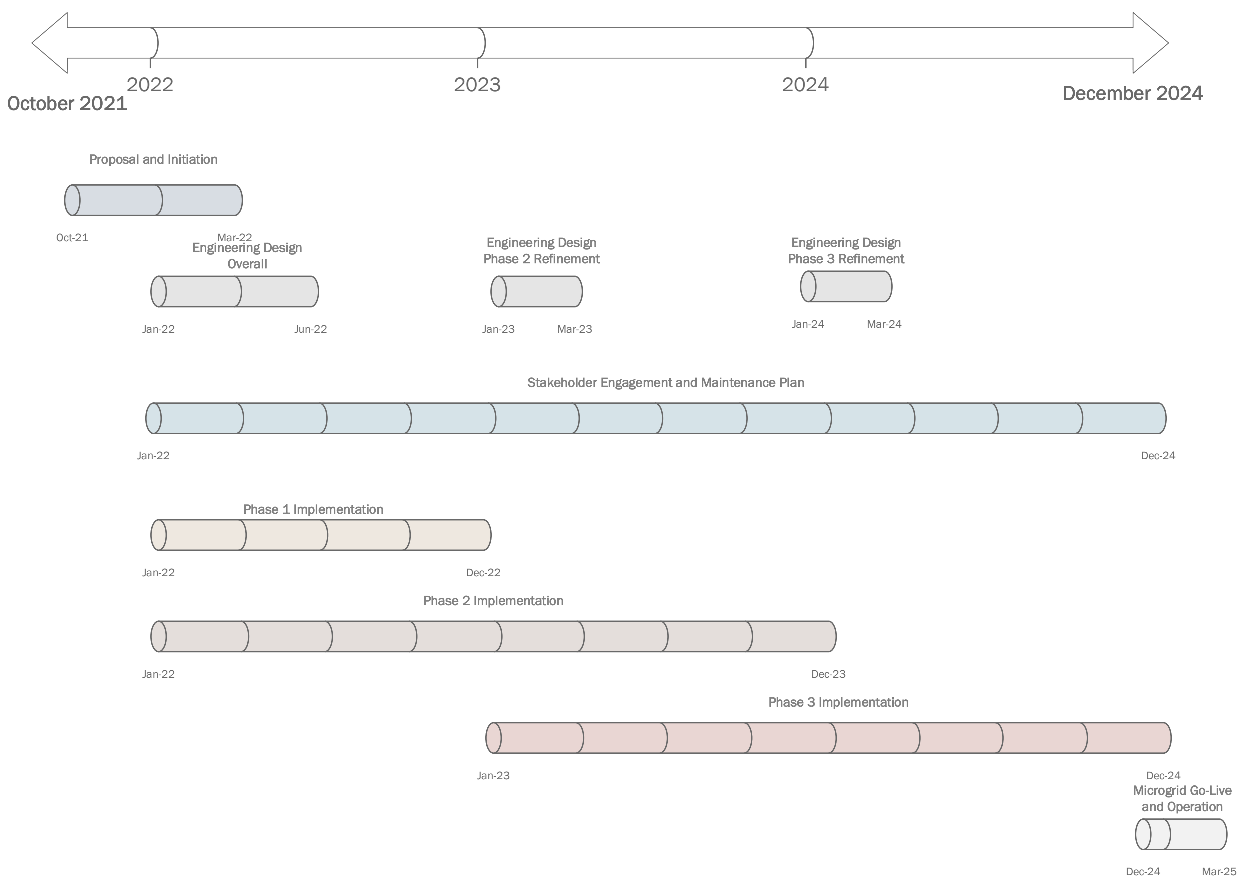


Figure 10 – Vieques and Culebra Microgrid Project by activity types

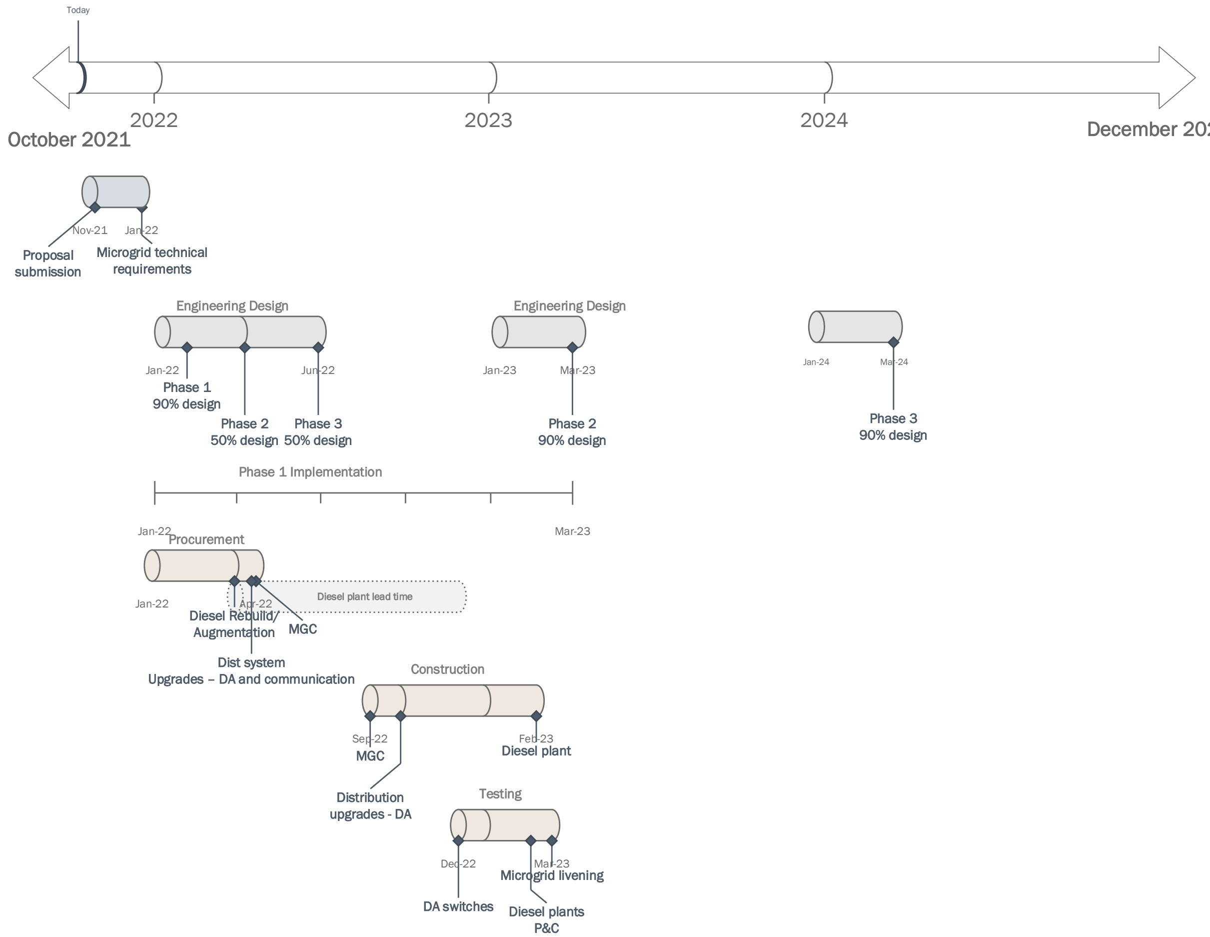


Figure 11 – Vieques and Culebra Microgrid Project by EPC activities – Engineering and Phase 1

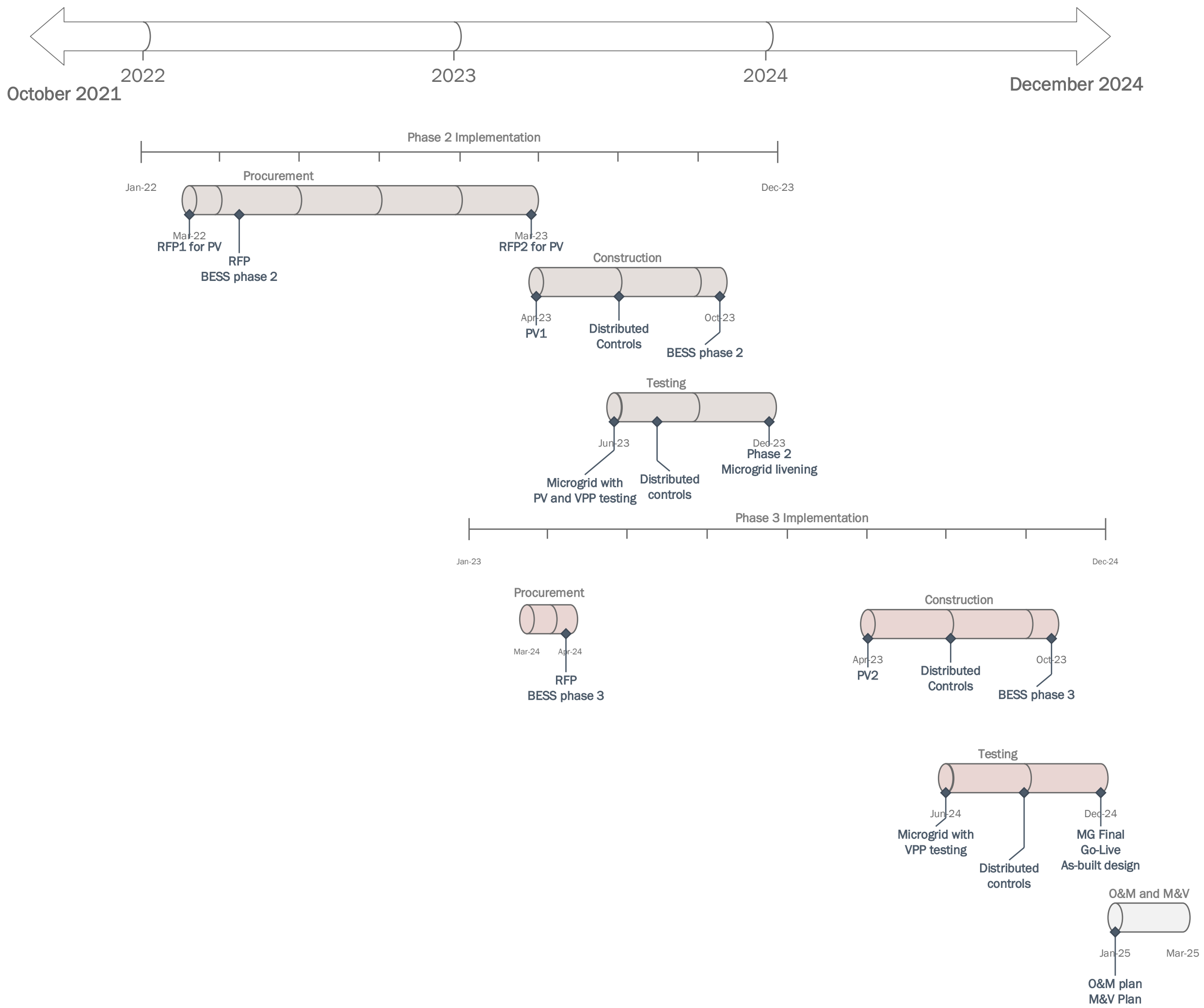


Figure 12 – Vieques and Culebra Microgrid Project by EPC activities – Phases 2, 3

4.0 Vieques and Culebra Submarine Cable

The submarine cables connecting Vieques to the main island of Puerto Rico from Punta Lima, Naguabo and Culebra to Vieques have been installed in 1983 and 2001, respectively. The 38 kV submarine cables are part of Transmission Line 5400. Submarine cable transitions to an overhead line when it reaches Vieques transition station in Punta Arenas.

The sub-transmission and distribution systems in both islands were severely impacted by the 2017 hurricanes.

Figure 13 - Vieques and Culebra submarine cables and transmission line 5400

Hurricanes also destroyed the overhead transmission line 5400 and Punta Lima 38 kV Submarine Transition Station (STS) structure. In Vieques, the transition station structure has been damaged by coastal erosion.

Due to several issues with regards to the Punta Luma structure outlined below, a rerouting has been proposed:

- Difficulty of access
- Archaeological site

- Significantly high repair costs of the damages from Hurricane Maria
- Environmental and Historic Preservation issues

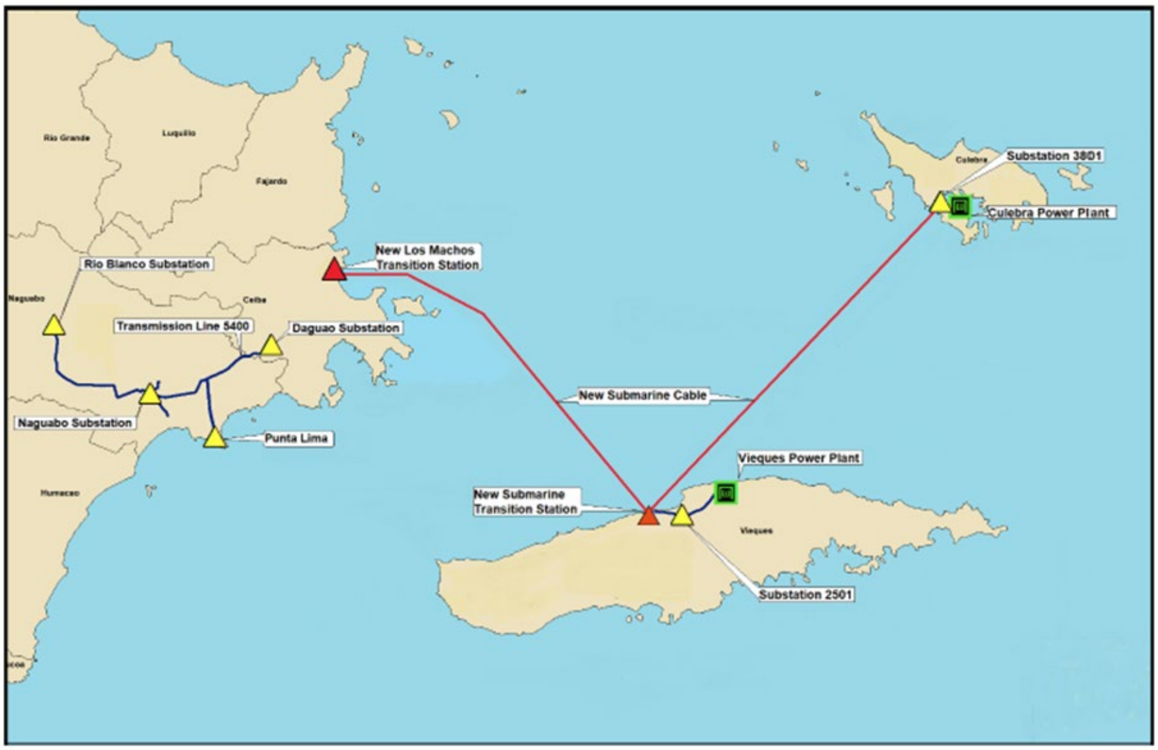


Figure 14 - Proposed new submarine cables by PREPA

PREPA's 10-year infrastructure plan includes the new submarine cables to Vieques and Culebra[14].

4.1 Existing Conditions

The existing submarine cables are operational. The submarine cable (line 5400) is a redundant 38kV line between Punta Lima and Vieques, as well as from Vieques and Culebra. One of the redundant cables' termination was damaged during an attempted copper theft. The second cable is also damaged but operational. It is possible to repair these cables. However, Punta Lima requires extensive upgrades, including the addition of breakers. There are serious issues related to soil integrity where Punta Lima was constructed, and these necessary upgrades are not doable considering the soil condition. For this reason, the transition station will be relocated to Ceiba and the existing Punta Lima station will be decommissioned.

[14] PREPA 10-Year Infrastructure Plan, June 2021 Update. LUMA, PREPA. June 2021.

The protection philosophy of line 5400 is not adequate. Currently, the only two circuit breakers that can isolate the line are in Daguao TC and Rio Blanco. Naguabo and Punta Lima only contain air-insulated switches. An outage anywhere else in the line will cause its entire tripping, interrupting energy flow to Vieques and Culebra. An adequate protection selectivity scheme requires the installation of three circuit breakers at Punta Lima, either through a T-tap or a ring bus. However, as described above, it is not possible to execute a proper repair at Punta Lima due to soil integrity problems, let alone install three large and heavy apparatuses. Hence, the best course of action has been deemed to decommission the transition station in Punta Lima and install a new one in Playa Los Machos, Ceiba.

4.2 Project Goals

Reliable and resilient connection to the main island's grid is crucial to achieve resilience in Vieques and Culebra. This project proposes to replace and reroute existing submarine cables that connect Vieques and Culebra to the main island, as well as new transition stations. PREPA has proposed Playa Los Machos to replace the Punta Lima Station (Figure 13). The new infrastructure will enhance reliability and resilience of power delivered to Vieques and Culebra through the submarine cables. New infrastructure and rerouting will address the issues previously listed with the current location of the transition station in Punta Lima. As such, the new station structures will be located outside the Special Flood Hazard Area, reducing the risk of damages from future hurricanes and severe storms. The project has the following high level scope:

- New transition station design and installation in Vieques and Culebra taking into account the proposed integrated microgrid system

- Design and construction of the new submarine cables (Figure 13) based on latest codes and standards

4.3 Proposed Approach

PREPA has adopted a Transmission Design Criteria Document (DCD) for the recovery of the energy infrastructure in Puerto Rico, ensuring all projects are planned, designed, and constructed in conformance with current applicable codes and standards.

Project tasks are:

- New submarine cables between the main island and Vieques and Culebra
- Installation of terminations and Lighting Arresters
- Installation of grounding assemblies to fulfill system grounding integrity
- Installation of new transition stations in Vieques and Culebra
    - Planning
    - Land and Right of Way acquisition

- Field assessments
- Design
- Land survey
- Soil investigation
- Geotechnical studies
- Staking
- Construction
- Purchase and installation of equipment

The new area for the transition station in Vieques, Matineau Industrial Zone, is outside of the flood zone.

4.4 Potential Impact

This project directly addresses energy and fuel community lifeline. By replacing the existing submarine cables to necessary codes and standards and rerouting transition stations outside flood zones, the aim is to reduce risk of damage to the electrical infrastructure and Vieques and Culebra's interconnection to the main island during a hurricane.

4.5 Project Budget

The project budget is based on FEMA Fixed Cost Estimate based cost for this project:

Table 4 - Project Budget by Task

Task	Total ($k)
Submarine cables (Playa Los Machos to Vieques, Vieques to Culebra)	197,620
Vieques transition station	8,070
Culebra transition station	3,180
Total	**208,870**

4.6 Project Timeline

The project will be completed by Q4/2025. Prelim A&E RFP will be issued in Q2/2022, design will be finalized by Q4/2022, construction will be complete in Q4/2024.

5.0 Vieques Generation Replacement

The diesel plant in Vieques currently has several technical limitations that prevent its integration into the proposed microgrid. This proposal includes replacing the diesel generators at the plant. They will be replaced with larger and modern units (engines, alternators, and protection and control equipment) to ensure these limitations are overcome.

5.1 Existing Conditions

As described earlier, only one of the units is operational in Vieques plant due to control system issues as well as faulted protective relays. The automatic synchronization capability is also out of service, requiring outages before and after any loss of subtransmission supply. In the case of an outage, the single diesel unit is not able to cover the peak demand in the island of Vieques.

The limitations of the Vieques plant can be summarized as:

- The plant lacks the total power generation needed to supply Vieques' peak load.
- The automatic synchronization is currently defective.
- The diesel engines governors are old and mechanical. As a result, they cannot cope with large load pick-up as they are not capable of regulating frequency well. Energizing the feeders requires an onerous manual segmentation process, that is not at all conducive with the advanced microgrid concepts required for improving the resiliency of the island.
- Generation control only allows isochronous operation. The generators at Culebra also have this limitation, meaning it is difficult to parallel the two islands.

5.2 Project Goals

This project proposes to replace the existing diesel generation units and augment generation in Vieques. The high level goals the project will achieve can be listed as:

- Provide short term resilience improvement to Vieques
- Serve as dispatchable backup generation during storm and hurricane emergencies
- Allow integration of diesel generators into the proposed microgrid

5.3 Project Impact

The island of Vieques has suffered from extensive outages during Hurricane Maria and the transmission line 5400 was damaged. The proposed project will provide resilient backup generation during emergencies, replacing the current generators that are insufficient to provide power demand in Vieques. The generators will be integrated into the proposed microgrid project, becoming a part of overall resilience solution, providing power to critical services and mitigating the risk of extended outages that threaten the safety of human life during and in the aftermath of a hurricane event.

5.4 Project Budget

Total budget for the project to rebuild and enhance the capacity of Vieques plant is estimated to be $26.4 million:

Table 5 - Project Budget for Vieques generation replacement and enhancement

Task	Total ($k)
Vieques generation rebuild and augmentation (replace 2-3.3 MW generators and additional 3.3 MW)	26,400
Total	26,400

The cost estimate includes construction, balance of plant, and additional costs such as ensuring synchronization scheme, replacement of relays, and potentially new breakers. To the extent possible, the existing sites and equipment will be leveraged.

5.5 Project Timeline

The project will begin in January 2022 during Year 1 of the proposed microgrid project and will be completed within 15 months, consistent with the timelines previously presented.

6.0 Benefit Cost Analysis for Vieques and Culebra Projects

Connection of Vieques and Culebra to the main island via the submarine cables is essential for reliability as well as resilience. The integrated microgrids and the replacement of submarine cables and transition stations are complementary solutions for Vieques and Culebra. With the completion of the proposed microgrids, the new submarine cables will augment the electrical redundancy that the two islands require to export excess renewable production to the main island and import when power is needed, especially during long duration outages. Redundancy in island electric systems is crucial for resilience. In order to achieve the energy security for low- to moderate-income communities of Vieques and Culebra, the islands should be able to utilize and benefit from diverse set of resources (including resources from the main island through the cable). It is important to note that both the proposed microgrid and submarine replacement projects will directly impact all of the residents of Puerto Rico, hence with direct implications on low- to moderate-income communities. It will not only reduce the diesel consumption of Vieques and Culebra during loss of subtransmission supply, but also increase the renewable portion of the generation mix in Puerto Rico.

The total budget for submarine cables, microgrids, and diesel generators total to $283 million ($209 million, $48 million, and $26 million, respectively). Using FEMA standard values for loss of electricity service ($174 per person per day), Vieques and Culebra Value of Lost Load during the 2017 hurricanes Irma and Maria is equal to approximately $206M USD, assuming these upgrades can reduce the overall outage durations by 95%. To note, the recorded outage in Vieques exceeded 80 days due to continuous problems with the generation plan and the need to bring emergency generators. The breakdown between the two islands can be seen in Table 5. Even though this results in a benefit cost ratio of less than 1, submarine cable together with the microgrids will also bring extensive reliability benefits.

Table 5 - Value of Lost Load in Vieques and Culebra using FEMA standard values

Total VOLL – Irma and Maria	
Culebra	$1,418,160
Vieques	$204,409,214
Vieques + Culebra	$205,827,374

* Assuming the projects can reduce the overall outage durations by 95%.

7.0 Energy Control Center Replacement

Existing RTUs are being replaced due to storm damage or necessary upgrades in 349 substations across Puerto Rico. The existing RTUs date to the early 1980's and communicate via a proprietary serial protocol no longer supported by the industry. New substation automation equipment compliant with IEEE 61850 standards will not only monitor and control additional apparatus values and controls but will communicate with the EMS via modern protocols. The EMS is vital to overall system operations and is the "central brain" to control the system by balancing generation with the system load. In addition, it provides for an automated and remote control of devices in the grid. The existing EMS is past its useful life and is no longer supported by the product vendor. Replacement parts are usually bought off ebay or other repurposed equipment websites.

As with all of these proposed projects, inefficient operations and inadequate capacity of critical infrastructure continue to be major deterrents to preparedness, performance and long-term recovery efforts.

New technology for replacement RTU's is not compatible with the existing Energy Management System (EMS). The existing EMS is not upgradable to integrate the new RTU technology and there is not a cost effective "patch" or data conversion either available or developable. Future improvements to the Electric Power Grid including high integration of renewables, deployment of microgrids, mini-grids, energy storage, and other distributed energy resources including virtual power plants (VPPs) will all have newer technology that will not be controllable by the existing EMS technology. Without new EMS technology visibility and control of the power grid system is non-existent resulting in record breaking outages as experienced from the hurricane damage in 2017.

To mitigate the risk from future events, a modern, replacement EMS with technology that will accommodate the existing RTU's, controllers, provide full visibility of the system, support renewables and integrate the new RTU technology into the new EMS is required. The RTU and EMS replacement is included in the 428 Funding "Damage Inventory 223318 and funding is being pursued as part of the PREPA Consolidated 428 Grant FEMA DR-4339-PR.

The new EMS will require State-of-the-Art facilities to house the new computer systems required to operate the software and integrate into the Control Rooms for the System Operations team to have full visibility and control over the Electric Power Grid 24 / 7 / 365. Current industry standards utilized by utilities include provisions for physical separation of primary and secondary computer systems, secondary power generation and fuel storage, physical security, internal security of control room and data center spaces, and other critical infrastructure (CIPS) requirements.

The current System Operations team manages the grid from six locations across the island with varying degrees of power grid visibility and control. Conditions of the existing facilities are detailed in Section 5.2. None of the existing buildings meet the current Puerto Rico Building Codes. Three of the six existing locations are within the FEMA flood plain per the Flood Insurance Maps.

Industry standard practice for managing and operating a utility power system is from a Primary Control Center and a Secondary Control Center. The facilities are designed to consolidate operators into an efficient, functional configuration that enables full visibility of the power system, perform security constraint economic dispatch of supply and maximizes efficient management, forecasting, outage mitigation and outage resolution. Standard practice is to have an operator training facility including classrooms, an operator training simulator, and a training control room in the primary control center. Standard practice also includes computer room space for an application development system and a Quality Assurance System along with office and meeting room space for staff associated with training, development, and test.

The ECC Replacement project is intended to direct resources toward a forward-thinking solution to the implementation of the needed new EMS that creates an infrastructure which will enhance the continued evolution of System Operation into the future. Rather than investing in modifications required to house, provide 24 / 7 / 365 support, construct flood mitigation systems, upgrade facilities to meet current building code requirements and harden the existing six control center locations across the island, the ECC Replacement project will develop new, State-of-the-Art Primary and Secondary Control Centers on existing PREPA owned land.

The hazard mitigation resulting from the new Control Centers includes:

1. Swifter response to outages due to complete visibility of the power system from one location.
2. Enhanced power resource utilization management based on consolidated operations within one facility.
3. Increased reliability / resiliency to operate 24 / 7 /365 from State-of-the-Art Mission Critical facilities in full compliance with Puerto Rico Building Codes with a Secondary location to provide full redundancy and / or split operation in the event of catastrophic conditions.
4. Diminished outage duration through improved controls, enhanced visibility and System Operations procedures implemented in a consolidated System Operations facility.
5. Ability to conduct operations normally during periods of restrictions on personnel movement such as the recent pandemic.
6. Provide secure and safe facility to house mission critical equipment and personnel.
7. Provide Cybersecurity to mission critical equipment

7.1 Existing Conditions

Currently, there exists six (6) control center facilities, which can be listed as *(i)* Monacillo Primary Control Center, *(ii)* Ponce Secondary Control Center, and *(iii)* Distribution Control Room sites in Monacillo, Ponce, Caguas, and Mayaguez. Several of the current control center facilities including Ponce, Caguas and Mayaguez are located in flood plains or in areas where access is gravely impacted by flooding. Figure 14 shows the location of the Ponce center in relation to the flood plain.

Figure 15 - Existing Ponce control center and flood plain

The existing Control Centers do not meet today's mission critical industry standards with respect to resilience and redundancy. The spaces are deficient in a number of areas including:

i. The mechanical / electrical systems in the existing spaces do not meet current Mission Critical industry standard practices for resilience and redundancy.

ii. The building envelopes are poor and do not provide complete, reliable protection from the exterior environment.

iii. Many of the building doors are not secured or even latched in some cases.

iv. Spaces do not meet current accessibility code requirements.

v. Existing facilities are not in compliance with current applicable codes including the Puerto Rico Building Code

The existing EMS hardware / software are housed in the above deficient buildings and are at extreme risk of outages due to the current conditions. When the existing EMS system is inoperable due to lack of reliable infrastructure, building envelope issues, communication interruption and / or inability to access the building the operation of the power grid is compromised. The results of these highly probable events increase the occurrence of widespread outages and / or increased duration of outages.

7.2 Project Goals

In order to give operators, the necessary visibility over system conditions, which are required to prevent widespread blackouts, an updated EMS system is needed. However, due to the conditions of the existing facilities listed above, new facilities are needed to deploy the new EMS. To that end, this project proposes to operate the grid through the updated EMS from one Primary Control Center and one Secondary Control Center with the goal of improved management, oversight, and functionality of the electric power grid. The new centers will be built to Mission Critical industry standards and codes, hence allowing to operate the grid in a safe, reliable, resilient, and economic manner. Consolidating hence centralizing six centers into two will bring benefits of economies of scale, elimination of duplication service such as staffing and maintenance.

This project proposes to construct new facilities due to the following obstacles with regards to existing facilities:

- Existing Primary Control Center:
    - Constraints of existing equipment
    - Existing building configuration limitations on space configuration
    - Existing substation equipment in the building
    - Risk to existing EMS equipment during renovation
    - Disruption to existing Control Room functionality during renovation

- Existing Secondary Transmission Control Center:
    - Existing location in flood plain
    - Existing building size
    - Existing substation equipment in the building,
    - Proximity to switchyard and other gear

The location of the proposed new control centers will be determined during the planning phase, at a site outside the flood plains. The target location for the Primary Control Center is within the greater San Juan region, preferably on existing PREPA owned land. The focus area for the Secondary Control Center is on the South side of the island on existing PREPA owned land.

The primary goals of the Control Center Projects are to:

- Provide State-of-the-Art Control Centers to support the implementation of a new Energy Management System (EMS) within industry best practice mission critical facilities, deployed outside of flood plains, and in compliance with applicable codes and standards including the PR Building Code.
- Provide Control Rooms with ergonomically designed operator consoles to support System Operations reliability, resiliency and 24/7/365 operation of the restored power grid.
- Consolidate System Operations into one facility that has visualization and control over the entire rebuilt power grid.
- Provide situational awareness to the operators that will enhance the management and forecasting of the power grid.
- Create a new Data Center to house the new EMS with industry best practice resiliency / redundancy for mechanical, electrical, telecommunications and fire protection systems.
- Provide sufficient flexibility within the design to support the continued evolution of LUMA's operation of the power grid and the targeted improvements including but not limited to increased renewables, microgrids and minigrids.

7.3 Proposed Approach

Environmental and Historic Preservation (EHP) considerations will be identified and evaluated during the preliminary design phase. These requirements will be incorporated into the final design and construction documents to be approved by FEMA prior to construction activities. Additionally, applicable building codes and reference standards will be identified and incorporated into the project requirements including the current Puerto Rico Building Code with its updated wind speed structural criteria.

Phase I - REQUIREMENTS DEFINITION / SCHEMATIC DESIGN

- **Task 1.1 Preliminary Project Requirements / Basis of Design (BOD) Document:** The Basis of Design (BOD) document defines the target:
  - Building sizes and occupants

- Functional adjacencies
- Preliminary sizes / capacities for Mission Critical Building Systems
- Building Criteria
- Site Criteria
- Security Criteria

- **Task 1.2 Primary Control Center Site Option Analysis / Selection:**
  - Evaluate the existing PREPA owned sites in the preferred Primary Control Center regional area. Locations in flood plains or with access gravely impacted by flooding are to be excluded.
  - Create an evaluation criteria scoring matrix for the potential Primary Control Center sites.
  - Evaluate the site options identified with input / approval from LUMA project stakeholders.
  - Recommend a site for the Primary Control Center
  - Identify additional site investigation to be completed by vendors / professionals including but not limited to site survey (boundary / topographic / structure / utility), geotechnical investigation, environmental phase 1 study and / or archeological Phase 1 study.

- **Task 1.3 Secondary Control Center Site Option Analysis / Selection:**
  - Evaluate the existing PREPA owned sites in the preferred Secondary Control Center regional area. Locations in flood plains or with access gravely impacted by flooding are to be excluded.
  - Create an evaluation criteria scoring matrix for the potential Secondary Control Center sites.
  - Evaluate the site options identified with input / approval from project stakeholders.
  - Recommend a site for the Secondary Control Center
  - Identify additional site investigation to be completed by vendors / professionals including but not limited to site survey (boundary / topographic / structure / utility), geotechnical investigation, environmental phase 1 study and / or archeological Phase 1 study.

- **Task 1.4 Design Professional Team of Record (DPTR) RFP Development:**

  Along with the BOD document, a detailed scope of work matrix will be created to identify the required efforts / responsibilities for the Design Professional Team of Record. The scope will follow industry standard American Institute of Architects scope of work outlined in the standard form of agreement between Owner and Architect refined to meet the unique criteria of a Control Center facility. The DPTR will be responsible for project design including but not limited to the following:

  - Site Design including municipal approval and permitting
  - Building Design including obtaining the building permit
  - Structural Design
  - Mechanical / Electrical / Plumbing / Fire Protection / Structured Cabling Design

- Sustainable Design
- Acoustical Design
- Audio Visual System Design
- Security Design including coordination with LUMA security vendors

Commercial terms and conditions for the RFP defined by LUMA procurement and contracts representatives will be incorporated into the Request for Proposal (RFP) document. The RFP will be coordinated with the project stakeholders and associated LUMA workstreams.

- **Task 1.5 DPTR RFP – Issue / Response / Analysis / Selection:**

  The DPTR RFP will be published by LUMA procurement. The procurement will follow a typical RFP process that will include a question / response periods and receipt of proposals.

  The project team including project stakeholders and LUMA procurement will create a weighted, prioritized evaluation criteria matrix, identify project team members to be on an evaluation committee, manage the RFP evaluation / scoring process and recommend a Design Professional Team of Record to be selected.

- **Task 1.6. Schematic Design Stage**

The Schematic Design stage will establish the overall concept for the building configuration / orientation; site layout including vehicular traffic patterns, utility pathways, stormwater management approach; and building systems to be considered for the building. The Schematic Design efforts include:

- Prepare building, site and building system Schematic Design options for review / approval by project stakeholders
- Evaluate industry best practices to be incorporated into the design
- Review / evaluate environmental and historic preservation (EHP) requirements
- Complete a sustainability charette to establish a target LEED certification level and the strategies to achieve the certification target
- Update the project budget in accordance with FEMA Class 3 requirements
- Update the outline project schedule
- Prepare updated submission to FEMA for review / approval and obtain funding obligation

<u>Phase II – DESIGN DEVELOPMENT / CONSTRUCTION DOCUMENTS</u>

- **Task 2.1 Design Development Stage**

The Design Development stage will refine the concepts created in the Schematic Design stage and increase the level of detail resolved for building envelope systems; material types and extents (exterior and interior); site engineering calculations; municipal approval requirements; and building system configurations, pathways and resiliency. The Design Development Stage efforts include:

- Recommend materials, system configurations and construction details
- Evaluate systems based on Mission Critical industry best practices and applicable codes and standards Including the PR Building Code.
- Evaluate progress related to sustainability strategies to achieve targeted certification levels
- Update / evaluate project budget
- Update / evaluate project schedule
- Prepare Design Development Documents

- **Task 2.2 Construction Document Stage**

  The Construction Document stage will create the finalized project drawings and specifications defining the building, site and building systems to be constructed. The Construction Document stage provides the final opportunity to refine the project scope and quality to ensure the project is within the established budget and schedule. The Construction Document stage efforts include:

  - Preparation of Construction Documents.
  - Evaluation of the Construction Documents / Details based on Mission Critical industry best practices
  - Finalize approach / details related to sustainability strategies to achieve targeted certification levels
  - Review / evaluate project budget
  - Review / evaluate project schedule
  - Obtain municipal approvals for the building projects

- **Task 2.3 Construction Team (CT) RFP Development**

  Along with the Construction Documents created above, a detailed scope of work matrix will be created to identify the required efforts / responsibilities for the Construction Team. The scope will follow industry standard American Institute of Architects scope of work outlined in the AIA standard form of agreement between Owner and Contractor refined to meet the unique criteria of a Control Center facility.

Commercial terms and conditions for the RFP defined by LUMA procurement and contracts representatives will be incorporated into the Request for Proposal (RFP) document. The RFP will be coordinated with the project stakeholders and associated LUMA workstreams.

- **Task 2.4 CT RFP - Issue / Response / Analysis / Selection**

  The Construction Team (CT) RFP will be published by LUMA procurement. The procurement process will follow a typical RFP process that will include a pre-bid meeting to review the RFP / sites with vendors, question / response issuance and receipt of proposals.

  The project team including project stakeholders and LUMA procurement will create a weighted, prioritized evaluation criteria matrix, identify project team members to be on an evaluation committee, manage the RFP evaluation / scoring process and recommend a Construction Team to be selected.

<u>Phase III - CONSTRUCTION:</u>

- **Task 3.1 Construction / Construction Administration Stage**

  The Construction / Construction Administration stage will include the physical construction of the buildings, site improvements and building systems:

  - Preparation / review / processing of submittals, requests for information, change orders, applications for payment and other construction industry standard documents
  - Construction of the buildings, site improvements and mission critical building systems in accordance with the Construction Documents
  - Preparation / submission / review of test reports, comments from the DPTR and Field Observation reports
  - Identifying potential issues to be investigated, evaluated and resolved
  - Evaluating proposed changes and obtaining direction from project stakeholders
  - Interfacing with project stakeholders to ensure understanding of the evolution of the project
  - Coordinating efforts or milestones with other LUMA workstreams
  - Managing and balancing the competing agendas of a multi-disciplined, mission critical project

- **Task 3.2 Commissioning**
  - Review of the commissioning plan developed in the Design stages of the project and refined by the Construction Team subcontractors.
  - Completion of the commissioning and testing.

  - Review of the reports generated as part of the commissioning process will evolve into a Commissioning Checklist that will be created, evaluated and signed off.

- **Task 3.3 Move In / Startup**
  - Coordination of LUMA staff relocation, dual operation of the Control Rooms and building startup will be completed.
  - Additional items requiring resolution will be identified, assigned and monitored.
  - The DPTR and CT teams will perform project close out tasks.

7.4 Community Engagement

The Basis of Design document will minimize the unknown and ambiguous nature of the project at the early conceptual stage. Project stakeholders, including representatives from System Operations, IT / OT, Security and Facilities, will be engaged to review / approve the BOD document. The Building and Site Criteria included in the BOD shall be used to develop critical, prioritized evaluation criteria for the site option analysis / selection efforts.

The municipal approval process including site plan review / approval will be adhered to in accordance with local requirements. The building design, location and aesthetic will be influenced by local planning board input throughout the site plan approval process. Minimizing impact to neighboring properties and integration of stormwater management will be evaluated and incorporated into the project design through the design development and construction document stages.

7.5 Potential Impact

The outdated and not fully functioning EMS is putting Puerto Rico at the risk of decreased reliability, island wide outages during emergency conditions and hinders fast restoration/recovery efforts. The outdated system also impacts the ability to adapt to high penetration from renewables and distributed generation, which also ties to increasing the resilience of the system by providing backup power to consumers during outages. The existing EMS will not support the new substation technology being implemented as part of the power grid rebuilding efforts.

To support the implementation of the new EMS, LUMA requires a new Primary Control Center (PCC) and Secondary Control Center (SCC) to house the new EMS and provide Real-time System Operators and Operations Support Personnel industry best practice facilities to operate the electric system.

Through implementation / operation of the updated EMS, the new facilities will contribute to:

- Mitigating the risk of extended outage durations

- Reduces the risk of island wide outages during extreme events through situational awareness and load shedding capabilities
- Improve system operation during long lasting outages
- Accommodate high renewable penetration and distributed energy resources
- Increased visibility/situational awareness
- Reduction in crew dispatch (avoided costs)

The proposed project directly addresses the following objective of the State Mitigation Plan:
Objective 2.3.
Reduce the degree of vulnerability of critical and essential buildings and vital and critical state infrastructure.

7.6 Benefit Cost Analysis

Existing control center facilities are vulnerable to flooding and not up to recent building codes. During a hurricane or extreme storm event, the buildings carry a high risk of damage, not being functional and / or not being accessible. This is especially important under recent findings for climate change, where latest UN report has illustrated how the severity and frequency of extreme precipitation events will increase with a higher rate with each increment of global warming.

If the new EMS systems were to be deployed in existing facilities, there is a risk of the system not being operational during emergencies due to the existing vulnerabilities of the buildings, outlined in detail in previous sections. A functioning EMS system is vital during extreme events for the operation of the system, as the contrary would lead to not being able to operate the grid.

An operational EMS system during an extreme event would:

- Preserve the ability to monitor and control the system and provide situational awareness through SCADA,
- Prevent loss of communication between islanded systems in the grid,
- Keep generation and load in balance, hence prevent cascaded blackouts, through real time dispatch and Automatic Generation Control (AGC)

FEMA Standard Values for Loss of electric power is $174 per person per day[15]. Given the 2019 census numbers[16], an island wide outage during an extreme event would translate into approximately $556 million

[15] https://www.fema.gov/sites/default/files/2020-08/fema_bca_toolkit_release-notes-july-2020.pdf

[16] https://www.census.gov/quickfacts/PR

US dollars per day. Given the functionalities and benefits of an operational EMS system through new facilities above, it is plausible that EMS will mitigate at least 25% of the outages in a day, leading to an avoided loss of service of approximately $139 million per day. As a result, a week-long of outage during and in the aftermath of an extreme event equals to a BCA ratio of 11.6.

By comparison, Hurricane Irma and Maria in 2017 have caused record breaking outages in Puerto Rico. In fact, the average outage duration during Maria was 122 days.

7.7 Project Budget

The following shows the total project budget:

Table 6 - Project Budget

Task/Item	Total ($k)
Architectural & Engineering to Design	8,000
Procurement & Construction	76,000
Total	84,000

7.8 Timeline

The project schedule impacts the implementation of the new EMS project and therefore, the buildings need to be completed and available as soon as possible. The approach is to find an existing PREPA owned property to eliminate the need for a lengthy acquisition process which will lengthen the overall schedule and duration of operation under non-ideal conditions.

The final SOW / RFP (construction plans and specifications) will be completed by Q1 / Q2 2023 and construction will be completed by Q2 / Q3 2025.

Table 7 - Project Timeline

5108 - Project - Template Schedule Rev 0

ID		Task Mode	Task Name	Duration	Resource Names	Start	Finish	% Complete
1			Primary & Backup Control Centers	1064 days		Tue 6/1/21	Fri 6/27/25	21%
2			Phase 1 - Project Definition / Design Professional Team of Record RFP	213 days		Tue 6/1/21	Thu 3/24/22	62%
3			Preliminary Requirements / Basis of Design Document	87 days		Tue 6/1/21	Wed 9/29/21	92%
19			PCC Site Option Analysis / Selection	56 days		Fri 7/16/21	Fri 10/1/21	84%
29			BCC Site Option Analysis / Selection	56 days		Fri 7/16/21	Fri 10/1/21	70%
38			Design Professional Team of Record (DPTR) RFP Development	121 days		Wed 8/11/21	Wed 1/26/22	27%
39	✓		RFP Document development with Technical Team	12 days		Wed 8/11/21	Thu 8/26/21	100%
44			DPTR Evaluation Team / Criteria	21 days		Fri 8/20/21	Fri 9/17/21	94%
48			Target RFP Issuance	5 days		Thu 9/30/21	Wed 10/6/21	0%
49			RFP Process from Publish to Contract	4 mons		Thu 10/7/21	Wed 1/26/22	0%
50			Schematic Design Stage	41 days		Thu 1/27/22	Thu 3/24/22	0%
51			Phase 2 - Design / Construction Document / Construction Team RFP	331 days		Fri 3/25/22	Fri 6/30/23	0%
52			Design Development Stage	66 days		Fri 3/25/22	Fri 6/24/22	0%
53			Construction Document Stage	153 days		Mon 6/27/22	Wed 1/25/23	0%
54			Construction Team RFP Development	1 mon		Thu 12/1/22	Wed 12/28/22	0%
55			LUMA RFP Approval	2.35 mons		Thu 12/29/22	Fri 3/3/23	0%
56			Construction Team RFP Issuance	0 days		Fri 3/3/23	Fri 3/3/23	0%
57			Constructoin Team RFP Response	25 days		Mon 3/6/23	Fri 4/7/23	0%
58			Construction Team RFP Analysis / Selection	20 days		Mon 4/10/23	Fri 5/5/23	0%
59			FOMB / P3A review / approval	25 days		Mon 5/8/23	Fri 6/9/23	0%
60			Construction Team RFP Contract	40 days		Mon 5/8/23	Fri 6/30/23	0%
61			Phase 3 - Construction / Construction Administration / Move In	520 days		Mon 7/3/23	Fri 6/27/25	0%
62			Construction	434 days		Mon 7/3/23	Thu 2/27/25	0%
63			Commissioning	43 days		Fri 2/28/25	Tue 4/29/25	0%
64			Move In / Startup	43 days		Wed 4/30/25	Fri 6/27/25	0%

8.0 Glossary

ACRONYM	DEFINITION
ACC	Alternate Control Center
ADMS	Advanced Distribution Management System
AGC	Automatic Generation Control
AMI	Advanced Metering Infrastructure
BPS	Bulk Power System
DER	Distributed Energy Resource
ECC	Primary Control Center
EMS	Energy Management System
GIS	Geographic Information System
OMS	Outage Management System
PREB	Puerto Rico Energy Bureau
PREPA	Puerto Rico Electric Power Authority
RFI	Request for Information
RFP	Request for Proposal
RTU	Remote Terminal Unit (**RTU**) is a microprocessor-controlled electronic device that connects with the EMS and provides statuses and measurements from power system devices in the field.
SCADA	Supervisory Control and Data Acquisition
UI	User Interface

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-012

SUBJECT

AMI

REQUEST

Please provide the AMI Roadmap presented on page 45 of the July 13 Budget Refiling Presentation.

RESPONSE

Please refer to TC-RFI-LUMA-MI-2021-0004-220913-PREB-012 Attachment 1 for a copy of the AMI Roadmap. The Roadmap is for the large-scale deployment of AMI however, LUMA continues to investigate targeted/pilot deployment options mainly associated with demand-side management programs.

LUMAPR.COM

Roadmap for Deploying Advanced Metering Infrastructure (AMI) in Puerto Rico

October 12, 2022

TC-RFI-LUMA-MI-2021-0004-220913-PREB-012 - Attachment 1

Roadmap for Deploying AMI in Puerto Rico

Funding	Design & Procurement	Configuration, Integration & Applications	Customer Education & LUMA Change Management	Deployment
• Work with federal agencies to seek federal funding • Work with regulator (PREB) for rate payer funding in the event federal funding is insufficient or not available	• Develop AMI system specifications, business requirements & Use Cases • Develop initial system design, integration design and deployment plan • Develop "Sandbox Testing" for potential meters • Develop & Issue a Request for Proposals (RFP) for meter and installation • Select AMI vendor, installation contractor and execute contract • Develop Smart Meter Customer Communications	• Configure meter, Head End and MDMS to operate in parallel with existing AMR Head End • Create Meter Information and Data Storage System • Create Integration Bus • Create AMI Operation Platform (MOP) • Create User and Customer Applications • Develop and implement cyber security plan • Develop integration between Head End, MDMS, Meter System, OMS, GIS, MOP, ADMS, DERMS, CIS and other operating systems	• Develop process changes to leverage AMI • Develop customer training for Smart Meter Applications on LUMA website • Develop LUMA Change Management Procedures and Training on the use of AMI • Implement customer experience AMI training • Implement AMI training for operational areas	• Develop procedure for AMI installation and train smart meter installers • Develop AMI Implementation Plan • Develop customer deployment communications • Implement an AMI Operations area and help desk • Install telecom network & smart meters

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-013

SUBJECT

Human Resources

REQUEST

All the positions, titles and compensations, and any increase in salary of the employees

RESPONSE

The increase in salaries from FY2022 to FY2023 is 2.9%.

Note: The table below, and the % increase, include LUMA ServCo employees as well as secondees but not ManageCo employees.

Title	Median Base Compensation
[redacted]	

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-20220913-PREB-14

Response: TC-RFI-LUMA-MI-2021-0004-20220913-PREB-15

SUBJECT
Human Resources

REQUEST
What percentage of the 3500 employees received per diem, lodging, travel (RFI 14) and include any amount for temporary housing (RFI 15).

RESPONSE

The response for RFIs 14 and 15 have been consolidated in this response.

On average in FY 2022, 5.5% of workers received per diem, lodging, travel and any amount for temporary housing.

Of the 5.5%, based on actuals for 9 months of FY 2022, the amount paid on per diem, lodging and travel are as follows:

- Lodging: $0.5 million
- Travel and per diem: $2.53 million
- Transportation: $2.34 million

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-016

SUBJECT

Procurement

REQUEST

Detail the threshold for professional services contractors and how are they are procured. Explain the Procurement process.

RESPONSE

The process to procure professional services contractors is outlined in LUMA's Consolidated Procurement Manual ("CPM") filed on July 22, 2021 in Case No. NEPR-MI-2021-0004 in Section 2.0 "Part A. Processes & Procedures." Specifically for professional services, there are two process options:

1. **Competitive Bid:** For federally funded procurements the process for professional services would be the same as any other services, which is documented in the CPM; and which as a rule requires a competitive procurement process to be followed.

2. **Non-Competitive Bid**: For non-federally funded procurements, the Consolidated Procurement Manual has an exception under Section 4.1.3 Exceptions to Competitive Bidding and Formal Procurements, Subsection 4.1.3.1:

> *"Professional, expert, highly technical, or specialized services ("Professional Services") are required, and these are not contracted to be compensated with Federal Funds or are otherwise not required to be competitively procured by a Federal awarding agency.*
>
> *In The case of any of the above exceptions, no LUMA parent company, affiliates or subsidiaries may be contracted, except for Professional Services.."*

In either case, the threshold of $10 million yearly or $30 million over the life of the contract apply. When exceeded, they require FOMB and P3A approval.

For thresholds, the following would apply if an exception if not used (Section 4.1.2)

Architectural & Engineering and Professional Services (i.e., Environmental, Consulting, etc.) *See Section 4.1.3 Exceptions to Competitive Bidding and Formal Procurement					
Purchase Amount	Up to $5K	>$5K-$10K	>$10K-$250K	>$250K-$10M	>$10M
2 CFR Classification	**Micro-Purchase**		**Small Purchase**	**Large Purchase**	
Minimum Offers Received	1		3 Quotes	3 Sealed Bids (ITT) or Proposals (RFP)	
Invoice / Receipt	Yes				
Purchase Order	Yes				
Contract	Yes				
Contract Registration #	Not Required		Yes		
FOMB Approval	No				Yes

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-017

SUBJECT

Aguirre TC

REQUEST

Who did the preliminary engineering design for the Aguirre TC? If resources stay the same the second way around?

RESPONSE

The Preliminary Engineering Design for the Aguirre TC Breakers project was completed by Stantec. LUMA intends to utilize the same firm for Aguirre TC Phase 2.

Annual Budgets for Fiscal Year 2023

NEPR-MI-2021-0004

Response: TC-RFI-LUMA-MI-2021-0004-220913-PREB-018

SUBJECT

Vegetation Management

REQUEST

For vegetation management FY22 what were the planned trim miles from Transmission, Distribution lines? What was the plan for Right-of-Way (ROW) reclamation (in acres) and restoration and treatment for FY22 and what was completed? What are the plans for FY2023?

RESPONSE

Fiscal Year 2022

The Vegetation Management Plan in FY2022 strived to make a shift from PREPA's processes which involved shifting from a responding to trouble calls mode of operation to a more concerted effort to reclaim the ROW. Seventy five percent of the budget was allocated to ROW reclamation, with the remaining 25 percent allocated to reactive / corrective maintenance.

As shown in the table below, the amount of emergent work required to support service restoration activities during unplanned outages and responding to emergent customer / field requests exceeded the 25 percent target anticipated for these activities. Further, given the state of the grid at commencement, LUMA initially focused on abating, or mitigating immediate vegetation risk in the most critical locations across all three areas (Substation, Transmission and Distribution) and so ROW reclamation work did not start until Q3. This impacted the amount of time and budget spent on ROW reclamation and negatively impacted the original timeline presented in the Vegetation Management Program Brief.

Note the figures are presented in line miles. Acres are not typically used within the industry as a measurement of production.

Vegetation Maintenance Planned vs. Actuals – FY2022

	FY2022 Plan	FY2022 Actuals
Substation	• No substation activities were contemplated	• Cleared brush and weeds at 355 locations • Applied 2 Herbicide Treatments

	FY2022 Plan	FY2022 Actuals
Transmission	• Reactive Maintenance (Outage Response): Maintain 22 miles requiring almost 5 percent of the budget allocated to Transmission • Corrective Maintenance (Reliability issues, Customer Request, and Field Requests): Maintain 65 miles requiring almost 15 percent of the budget allocated Transmission • ROW Reclamation: Maintain 346 miles requiring 80 percent of the budget allocated to Transmission	• No Reactive Maintenance (Outage Response) recorded. • Corrective maintenance (Reliability issues, Customer Request, Mayor Request, District/Field Request) (283 miles) representing approx. 85 percent of the budget spent on Transmission • Reclaimed 75 miles of the ROW representing approx. 15 percent of the budget spent on Transmission
Distribution	• Reactive (Outage Response) Maintenance: Maintain 30 miles requiring 5 percent of the budget allocated to Distribution • Corrective (response to Customer and Field Requests) Maintenance: Maintain 95 miles requiring 15 percent of the budget allocated to Distribution • ROW Reclamation: Maintain 3,059 miles requiring 80 percent of the budget allocated to Distribution	• Supported outage response (reactive maintenance) (149 miles) representing 25 percent of the budget spent on Distribution • Performed corrective maintenance (response to Customer and Field Requests) (304 miles) representing 70 percent of the budget spent on Distribution • Reclaimed 98 miles of the ROW representing 5 percent of the budget spent on Distribution

Fiscal Year 2023

Actions taken in FY 2022 have supported more planned vegetation maintenance within the first months of FY 2023. In FY 2022, LUMA renegotiated and entered into new contracts which resulted in more specialized, safe and effective equipment and contractors coming to the island and a 30 percent average reduction in rates. Along with LUMA's renewed focus on planned work contributed to significant improvement in planned vegetation maintenance within the new fiscal year. This resulted in planned vegetation maintenance improvement from 5 percent (system-wide) to 40 to 60 percent.

With these points in mind, the FY 2023 targets are as follows:

- Distribution: 660 miles
- 38kV: 873 miles
- 115kV: 128 miles
- 230kV: 139 miles

LUMA's vegetation management plan includes a prudent approach to reclamation across Transmission and Distribution over four to six years in order to create sustainable vegetation management cycles. Planned maintenance continues to be prioritized based on system design considerations and funding sources.