INTERSTATE RENEWABLE ENERGY COUNCIL

Puerto Rico Energy Resilience Hubs

Basis of Design for
Small-Scale Photovoltaic and Battery Energy Storage System

Community:

Quebrada Arenas;
Caguas, PR

Date: 5/6/2025
Rev: 0

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Purpose

This document has been generated by the Interstate Renewable Energy Council (IREC) Puerto Rico in collaboration with the University of Puerto Rico Mayagüez Campus as part of the Puerto Rico Resiliency Hubs Program as the Basis of Design and electrical needs declarations. The compiled data comes from community tabletop exercises and field assessments. This document covers the proposed small-scale photovoltaic (PV), and battery energy storage system (BESS) named Distribution Energy Resource (DER) to be installed on:

Asociación Comunitaria Quebrada Arenas
Capilla San Felipe Apóstol,
Carr # 1 KM 27 H5 Int Bo. Quebrada Arenas, Sector La Changa
CAGUAS PR 00725-8935

These guidelines cover the system's proposed design considerations, minimum guidelines, site characteristics, energy needs, operational constraints, and customer requests for essential loads services. Care must be exercised to comply with local, state, and national regulations, as well as safety practices for this class of equipment and installation work. Consult specific instruction manuals and drawings for detailed installation and troubleshooting procedures. IREC-supplied systems have to be installed, operated, and maintained by qualified personnel as defined by OSHA 29CFR1926, OSHA 29CFR1910 and sub-parts, Negociado de Energía de Puerto Rico, OGPE, LUMA energy, GeneraPR, NEC, IREC guidelines and other applicable regulations.(see applicable Laws and regulations and Applicable codes and Standards sections)

Community Background

The community of Quebrada Arenas in Caguas, Puerto Rico, is a community established between Caguas and San Juan municipality and houses over 300 families with limited services or limited mobility. They have formed the organization Asociación Comunitaria Quebrada Arenas in 2007 to address community needs and channelize community issues. They provide community services and assistance to residents they also promote education seminars, athletic events on the existing community baseball/soccer/walking park, offer public service events, provide support to the Escuela Montessori San Cristobal, local micro enterprises, an elderly home and local churches. Their mission is to assist in the economic development of families and the wellbeing of the community of Quebrada Arenas. This area has been defined as a last mile community for energy. The selected facility for the PR Hubs project serves regularly as a Catholic church, but also provides services such as public addressing areas, seminars, small kitchen, wellness fairs and other community services. During emergencies it has been used for emergency gathering area, assemblies, food and water distribution, affected persons treatment and administrative assistance. It includes a main hall assembly area with adjacent bathrooms and kitchen. The facilities have appropriate parking spaces, and recreational green areas.

This complex has main hip type roof building with mixed concrete walls and metal deck roof over steel beams, It has a single electrical service entrance with distribution to restrooms and kitchen. The main services of the facility include electricity and potable water.

Definitions

- **Alarm light** – Indication for an inverter of BESS or battery charger on heavy fault condition. Alarm condition is indicated in the HMI display.
- **Alarm Reset Silence** – Pulse once to acknowledge an alarm and silence the horn/buzzer. Check the equipment manual to reset alarms once the condition has cleared.
- **Anti-Islanding** – A control scheme installed as part of the DER or Interconnection Facility that senses and prevents the formation of an Unintended Island. Refer to UL1541/IEEE STD 1547™.
- **Applicant** – A person or entity that has filed an application to interconnect a DER to an Electric Delivery System. For a DER that will offset part or all of the load of a Utility customer, the Applicant is that customer, regardless of whether the customer owns the DER, or a third party owns the DER.
- **Application** – The Applicant's request, in accordance with these Interconnection Procedures, to interconnect a new DER.
- **Battery Energy Storage System or "BESS"** – An equipment or set of equipment to charge, store, and supply energy.
- **Certified** – A piece of equipment has been tested in accordance with the applicable requirements. Also, an individual who has been trained and holds a certificate attesting to the completion of a course of study or passing a qualification examination.
- **Closed Transition** – A closed transition is also called a make-before-break transfer switch. The switch will operate in a make-before-break mode provided both sources are acceptable and synchronized. Typical parameters determining synchronization are: voltage difference less than 5%, frequency difference less than 0.2 Hz, and maximum phase angle between the sources of five electrical degrees.
- **Contractor** – An individual, firm or entity that submits a proposal in response to a Request for Proposals (RFP) and, if selected, enters into a formal agreement to deliver the specified goods, services, or work in accordance with the terms, conditions, and scope defined in the solicitation.
- **Customer** – The person or entity that receives or is entitled to receive Distribution Service through the Utility's Electric Delivery System or is a retail customer of the Utility.
- **DEG** – Diesel Engine Generator
- **Designer** – A licensed engineer considered a qualified and competent person to design and inspect the proposed DER systems. See also "Licensed Engineer" definition.
- **Distributed Energy Resource, "DER"** – The equipment used by an Interconnection Customer to generate, store, manage, interconnect, and monitor electricity. DER includes an Interconnection Equipment Package. It may be referred to as "RED" for the Spanish translation of "*Recurso de Energía Distribuido*".
- **Distributed Generator or** "**DG**" – same definition as "DER." It may also be referred to as "GD" for the Spanish translation of "*Generador Distribuido*" or **"**RED**"** for "*Recurso de Energía Distribuido*".
- **Distribution Service** – The service of delivering energy over the Electric Delivery System pursuant to the approved tariffs of the Utility other than services directly related to the interconnection of a DER.

- **Durable medical equipment or "DME" -** Equipment and supplies ordered by a health care provider for everyday or extended use. Coverage for DME may include: oxygen equipment, wheelchairs, crutches or blood testing strips for diabetics.
- **Electric Delivery System** – The equipment operated and maintained by LUMA to deliver electric service to end users, including without limitation transmission and distribution lines, substations, transformers, Spot Networks, and Area Networks.
- **Emergency** – A sudden or unexpected incident that requires immediate action to prevent or mitigate the loss of or damage to life, health, property, or services essential to public bodies or the continuity of the latter.
- **Energy Storage Device** – A device that captures energy produced at one time, stores that energy for a period of time, and delivers that energy as electricity for use at a future time. See Battery Energy Storage System or "BESS".
- **Export Capacity** – The maximum Nameplate Rating of a DER in alternating current (AC).
- **Engineering Procurement and Construction "EPC"** – A Contacting firm that provides and will be solely responsible for design, engineering, equipment procurement, supervision, provision of labor, materials, equipment, tools, construction equipment and machinery, utilities (unless Installer makes separate arrangements directly with the Project Site Owner solely with respect to allowing Installer to use electric power and/or water from the Project Site Owner's outlets available at the Project Site), transportation, and Document Deliverables, and procurement of all Permits in conformity with the intended scope and desired operation applicable to the Solar System (the "DER").
- **Fault Current** – Electrical current that flows through a circuit and is produced by an electrical fault, such as phase-to-ground, double-phase-to-ground, three-phase-to-ground, phase-to-phase, and three-phase. A Fault Current is often several times larger in magnitude than the current that normally flows through a circuit.
- **GeneraPR** – Puerto Rico's electrical power generation operator.
- **Generator Feeder Breaker** – Trips on load overcurrent and locks out via overcurrent trip flag (if equipped). Check the load and reset to reclose. This breaker is closed during normal operation and is manually operated for maintenance.
- **Generator Source Breaker** – Trips on load overcurrent and locks out the generator from feeding the same overcurrent condition. This breaker is closed during normal operation and operates based on the generator protection scheme.

  Host Load – The electrical power, less the Auxiliary Load consumed by the Customer, to which the DER is connected.
- **Human Machine Interface, "HMI"** – Local control and operation panel for the DER and ancillary equipment operation (BESS).
- **IEEE** – The Institute of Electrical and Electronic Engineers.
- **IEEE Standards** – The standards published by the IEEE, available at www.ieee.org.

- **Inspector** – Licensed and collegiate engineer or architect to whom the owner of a work entrusts their inspection. Neither the contractor of the work, nor its owners or employees, may act as inspectors of the work they build.
- **Installer** – A licensed electrical engineer or qualified electrician, with current certification as a Certified Renewable Electrical Systems Operator, as regulated by the governmental entity designated by the Commonwealth of Puerto Rico. No person may install photovoltaic systems or electrical components of any other renewable energy system without a valid Renewable Electrical System Installer Certificate.
- **ISP** – Internet Service Provider
- **Interconnection Agreement** – A standard form agreement between an interconnection Customer and LUMA, as well as the ongoing operation of the DER after it is interconnected.
- **Interconnection Facilities** – The electrical wires, switches, and related equipment that are required, in addition to the facilities required to provide an Electric Distribution Service to a Customer, to allow interconnection. Interconnection Facilities may be located on either side of the Point of Common Coupling as appropriate to their purpose and design. Interconnection Facilities may be integral to a DER or provided separately, or they may be owned by either the Interconnection Customer or LUMA.
- **Island or Islanding** – A condition on the Utility's Electric Delivery System in which one or more DERs deliver power to Customers using a portion of the Utility's Electric Delivery System that is electrically isolated from the remainder of the Utility's Electric Delivery System.
- **Licensed Engineer** – All engineers admitted to practice engineering in the Commonwealth of Puerto Rico and members of the Puerto Rico Professional College of Engineers and Land Surveyors with an active status.
- **Limited Export** – The exporting capability of a DER whose Export Capacity is limited by the use of any configuration or operating mode.
- **LUMA Energy or "LUMA" –** Puerto Rico's electrical power grid operator or utility.
- **Nameplate Rating** – The sum total capacity of all of a DER's constituent generating or storage units, regardless of whether it is limited**.**
- **NEC** – National Electrical Code, published by the National Fire Protection Association (NFPA).
- **Non-Export or Non-Exporting** – A DER that is sized and designed such that the DER's output is used for Host Load only and no electrical energy (except for any Inadvertent Export) is transferred from the DER to the Electric Delivery System.
- **Normal Source Breaker – MAIN** (Located at the LUMA metering bank) – Trips on load overcurrent. This breaker is closed during normal operation and is operated for main service disconnect.
- **Open Transition** – An open transition transfer is also called a break-before-make transfer switch. A break-before-make transfer switch breaks contact with one source of power before it makes contact with another. It prevents back feeding from an emergency generator back into the utility line. During the split second of the power transfer, the flow of electricity is interrupted.
- **Parties** – The Applicant and the Utility in a particular Interconnection Agreement. "Either Party" refers to either the Applicant or the Utility.

- **Point of Common Coupling or "PCC"** – The point of connection between the Utility's Electric Delivery System and the Customer's electrical facilities.
- **Point of DER Connection or "PoC"** – The point where a DER unit is electrically connected in a Utility's Electric Delivery System and meets the requirements of IEEE Std 1547™-2018 exclusive of any load present in the respective part of the Customer's facility.
- **Point of Interconnection or "POI"** – The point where the Interconnection Facilities connect with the Utility's Electric Delivery System. This may or may not be coincident with the Point of Common Coupling.
- **Protective Function** – The equipment, hardware, and/or software in a DER (whether discrete or integrated with other functions) whose purpose is to protect against conditions that, if left uncorrected, could result in harm to personnel, damage to equipment, loss of safety or reliability, or operation outside pre-established parameters required by the Interconnection Agreement.
- **Rapid Shutdown or "RS"** – System shutdown switch or device (voltages less than 80 Vdc) that operates by a readily accessible switch to firefighters that plainly indicates if the system is in the "off" or "on" position.
- **Siren or buzzer Alarm** – Sounds together with the alarm light on a heavy fault condition (if equipped). Alarm condition is indicated in the HMI display.
- **Supplemental Study** – Analysis carried out by the Utility to identify and describe the impact in the reliability and safety of the electric generation, transmission, sub-transmission, and distribution system by the interconnection of a DER.
- **Technical Interconnection and Interoperability Requirements or "TIIR"** – Commission-approved public documents, often utility-specific, which include requirements for interconnection, interoperability, DER capabilities and their utilization (settings), and grid integration (e.g., protection coordination, telemetry)**.**
- **Turnover Package or "TOP"** – Set of project documents, drawings, warranties, operation manuals, and systems information that is handled from the installer to the customer as the official project record at the completion of a phase or the entire project. The turnover package must include essential information for the customer's use.
- **Underwriters Laboratories or "UL"** – A safety organization that sets industry-wide standards for new products. UL testing ensures that wire sizes are correct and that electronic devices can handle the amount of current claimed by the manufacturer. UL is one of several companies approved to perform safety testing by the Occupational Safety and Health Administration (OSHA). The UL stamp or mark is placed on products after testing is passed.
- **Utility** – An operator of an Electric Delivery System. In Puerto Rico, this is LUMA Energy.

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Site Details

IREC intends to contact an EPC to perform an electrical supply system upgrade to communities providing a DER with at least 5kW DC photovoltaic generation (PV) and a 13kWh battery energy storage system (BESS) for the essential loads service including new electrical panels that will be integrated into the existing infrastructure. This will enable an autonomous automatic power backup service scheme upon a power outage with updated components and enables the system to perform a closed transition to the Utility/LUMA system once restored.

The system will have capabilities to perform automatic tests, faults logs, individual alarms display and other programmable functions. This system must have manual bypasses to allow system service and generator backup if required. BESS must be able to be charged from any power source available, with genset provisions (when available), PV or main utility.

The new system will maintain the existing operational conditions of the essential loads without any user intervention during normal and emergency conditions. The following table summarizes the site information and existing conditions:

Site Data	
Type of project	New
Type of technology	5kW^{+} DC Photovoltaic with 13 kWh^{+} Battery Storage
Type of Net metering program	Basic
Customer information (Account holder with LUMA/PREPA)	

Name and surname	Iglesia Católica San Felipe Apostol
Phone Number	N/A
Mobile Phone Number	+1 (787) 506-0848
Email	Paulayeric@gmail.com
Mailing Address	HC I BOX 20605 CAGUAS PR 00725-8935
Relationship to Property	Tenant - Right of use
Cadaster Number	172-031-428-47-000
Last Updated	4/26/25

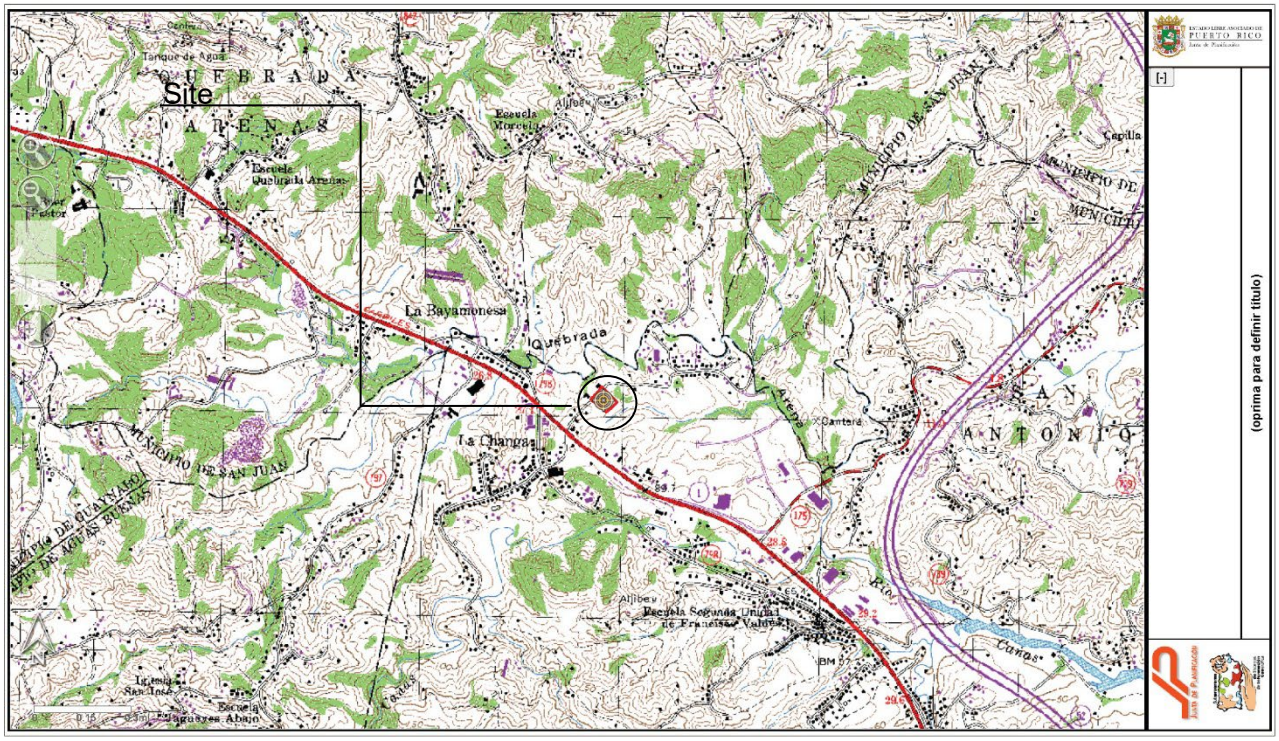
Location

Address	Carr # 1 KM 27 H5 Int
Municipality	Caguas
Zone	Quebrada Arenas, Sector la Changa
Zip Code	00725
Coordinates (NAD 83)	X = 239603.4869; y = 251785.2308
Flood advisory	X; not on floodway
Account Number	1550971000
Locality ID	1550971651
Meter Number	00002489057
Roof Characteristics	Slanted metal roof with an approximate of 50' X 60' footprint for 2,825 sqft

Existing site service

Service transformer capacity:	NA
Site service class	120/240 split phase 60Hz
DG Penetration Class	NA
Substation ID	3014
Substation Name	Rio Cañas
Feeder ID	3014-04
Feeder Peak Demand (MVA)	4.432
Daytime Light Demand (MVA)	1.461
Existing DG Capacity (kW) in the area	Feeder Transferred
DG Penetration	NA
DG Penetration Class	NA
Primary Voltage [kV]	4.16 kV LL
Feeder Requires Supplemental Study?	No

Site Location Plan



Existing Electrical Infrastructure

This facility has one point of interconnection at the front that operates at 120/240VAC, split phase, 60 Hz, and a single-meter bank of 100 A capacity service entry with one meter operating. The building's electrical system is distributed from a single panel located at the main assembly area. This facility's electrical distribution serves circuits for two building areas from the main panel. No manual transfer switch has been installed, emergency backup power service is made through connection of extension cords to a portable generator (if available). Solar exterior lighting has been installed in the building perimeter and parking.

The facility intends to use the emergency power or generator power backup to achieve the following objectives in the event of a utility power failure:

1. Power the assembly area host load by powering A/V equipment, lighting, fans, and outdoor lighting.
2. Keep the kitchen appliances running (refrigerators, microwave) and enable public use receptacles.
3. To supply area lighting to the floor area and the exterior due to dark walkways during power failures.

A tabletop exercise has been performed with the community to identify essential loads and possible installation locations. *Field Assessment* section in this document summarizes a facilities study with customer-provided information and related power calculations.

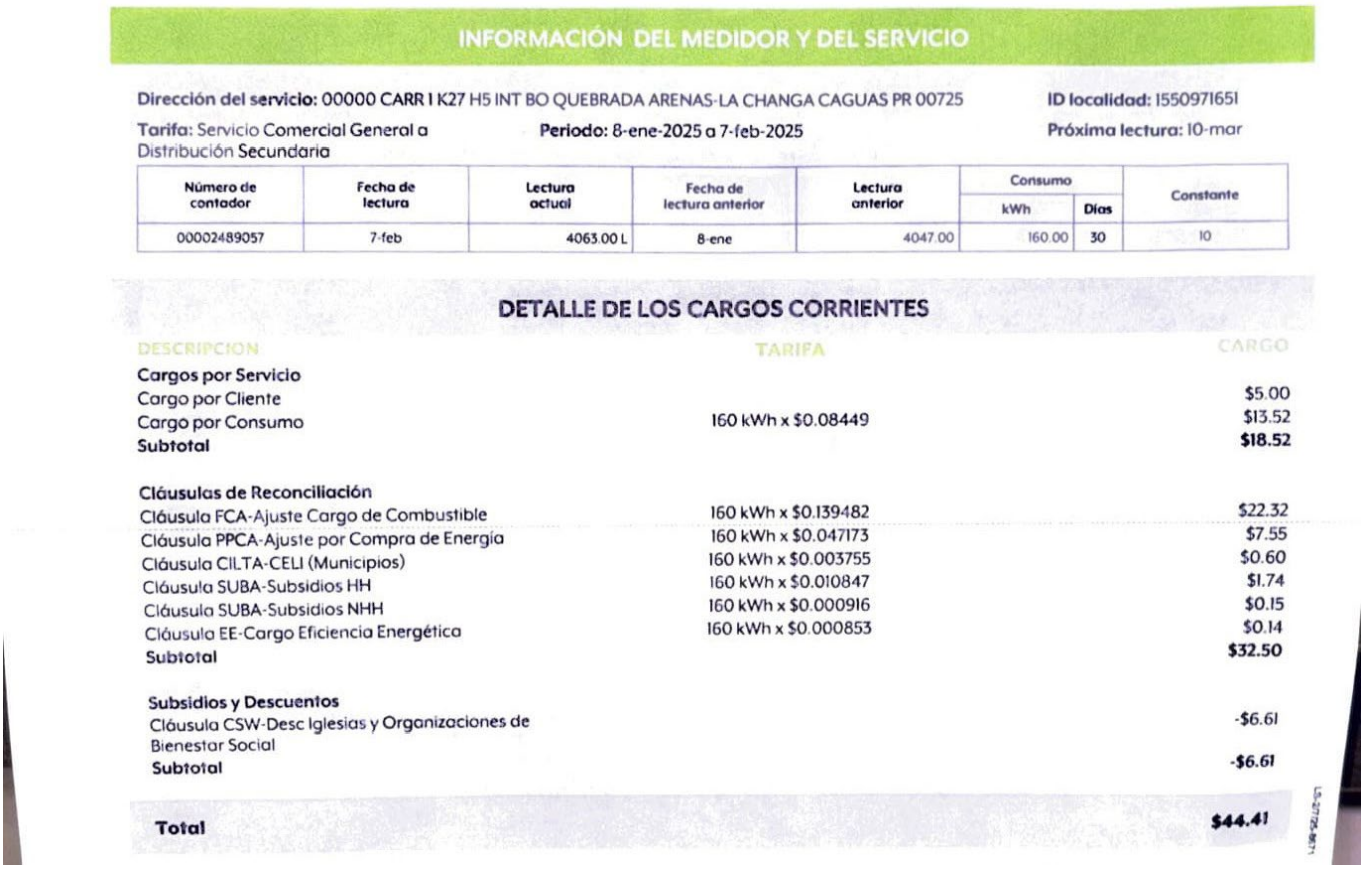
The site is used as an emergency support facility where the community visits to coordinate community response, use audio, video, and charge computerized and mobile phones. It serves as a communications center to distribute response instructions and goods.

The project must be designed to keep essential power by intercepting or relocating the existing essential loads in the following buildings:

- Assembly building
- Kitchen and bathroom building

In terms of site security, the facilities are not equipped with a CCTV camera system nor rebars on windows and doors.

Power Bill



INFORMACIÓN DEL MEDIDOR Y DEL SERVICIO

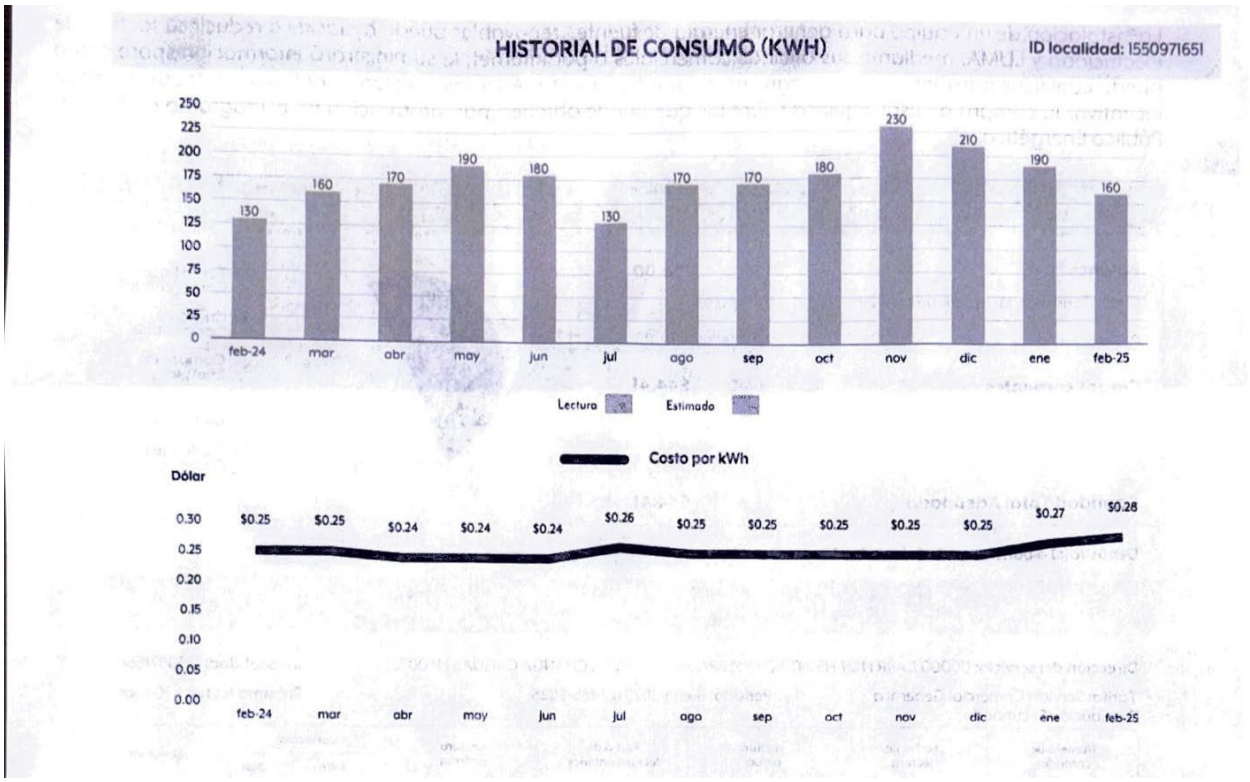
Dirección del servicio: 00000 CARR I K27 H5 INT BO QUEBRADA ARENAS-LA CHANGA CAGUAS PR 00725 **ID localidad:** 1550971651

Tarifa: Servicio Comercial General a Distribución Secundaria **Periodo:** 8-ene-2025 a 7-feb-2025 **Próxima lectura:** 10-mar

Número de contador	Fecha de lectura	Lectura actual	Fecha de lectura anterior	Lectura anterior	Consumo		Constante
					kWh	Días	
00002489057	7-feb	4063.00 L	8-ene	4047.00	160.00	30	10

DETALLE DE LOS CARGOS CORRIENTES

DESCRIPCION	TARIFA	CARGO
Cargos por Servicio		
Cargo por Cliente		$5.00
Cargo por Consumo	160 kWh x $0.08449	$13.52
Subtotal		**$18.52**
Cláusulas de Reconciliación		
Cláusula FCA-Ajuste Cargo de Combustible	160 kWh x $0.139482	$22.32
Cláusula PPCA-Ajuste por Compra de Energía	160 kWh x $0.047173	$7.55
Cláusula CILTA-CELI (Municipios)	160 kWh x $0.003755	$0.60
Cláusula SUBA-Subsidios HH	160 kWh x $0.010847	$1.74
Cláusula SUBA-Subsidios NHH	160 kWh x $0.000916	$0.15
Cláusula EE-Cargo Eficiencia Energética	160 kWh x $0.000853	$0.14
Subtotal		**$32.50**
Subsidios y Descuentos		
Cláusula CSW-Desc Iglesias y Organizaciones de Bienestar Social		-$6.61
Subtotal		**-$6.61**
Total		**$44.41**


HISTORIAL DE CONSUMO (KWH)
ID localidad: 1550971651
250
225
200
175
150
125
100
75
50
25
0
130
160
170
190
180
130
170
170
180
230
210
190
160
feb-24
mar
abr
may
jun
jul
ago
sep
oct
nov
dic
ene
feb-25
Lectura
Estimado
Costo por kWh
Dólar
0.30
0.25
0.20
0.15
0.10
0.05
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$0.25
$0.24
$0.24
$0.24
$0.26
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feb-24
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feb-25

Physical Conditions

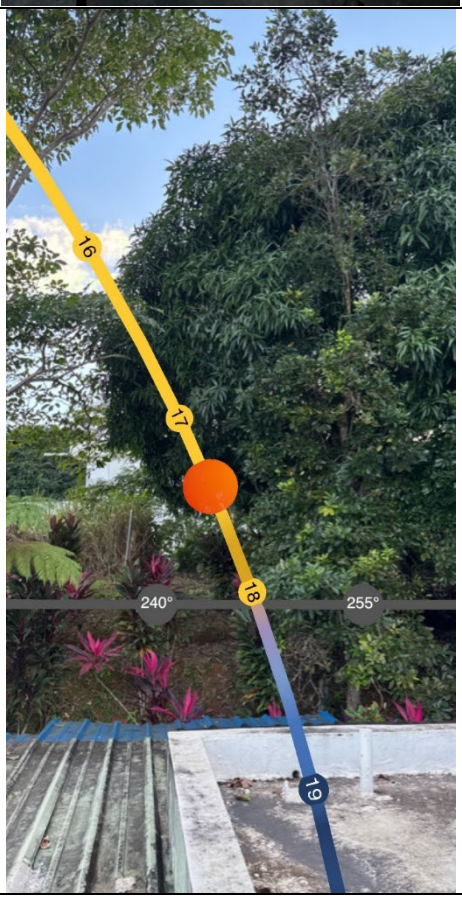
The following table summarizes the existing site conditions from a field assessment and depicts some design and installation considerations:

Roof facing west - NW	
Building front, Luma delivery point	

Building electrical panel located on the main building west wall(requires filler plates)	
Building ceiling as seen from below	

Storage area available for DER installation	
Kitchen area	

Roof Facing North[2]	
Walkway area for conduit runs	

Morning sunpath	
Sky view and estimated shading facing west **Expected shading from various trees on the property line and palm trees in the afternoon**	

Kitchen area and bathrooms roof.[2]	
Building siding and metal roof supporting beams[2]	

Notes:

1. No lead paint or asbestos has been identified by the customer, the designer and the installer must take all precautionary actions prior to any intervention in the structure.
2. Designers must assess the buildings and roof structural capability to support a DER racking system to withstand desired wind rating. Additional supports or reinforcements are considered part of the installation scope.

Design Considerations

All DER components must be permanently affixed to the structure, no portable devices allowed. All equipment must be new and not reconstructed, refurbished, or relocated. Designers must evaluate the permitting requirements, and all systems must be registered in the Single Business Portal and Luma portals[6]. The following table summarizes the technical design considerations for the minimum design specifications for the PV and BESS:

Design Considerations Table	
Generator (Photovoltaic modules)	Generator 1 Manufacturer: Design dependent Model: Design dependent Capacity (W): Design dependent Quantity (est.): 14 - Design dependent Approved by LUMA and OGPE: Yes
DER system operation mode	Hybrid[1]; Capabilities to enable portable generators connection with current infrastructure or implement genset programming capabilities with pass-through options.
Minimum essential loads AC capacity	5kW AC min; Maximum capacity is design dependent.
Minimum PV DC capacity total	The DER capacity must be equal to or greater than the program minimum capacity of 5 KW DC; Maximum capacity is design dependent.
Inverter technologies design considerations	Voltage: 120/240 VAC Manufacturer: TBD by EPC Capacity: 5KW AC minimum Warranty: 10 years LUMA and OGPE-approved. Up-to-date firmware Auto restart: System must be able to provide continuous operation regardless of utility power status without user intervention. Compliance: Grid-tied and off-grid systems IEEE1547-2018, Rule 21, HECO Rule14H and PREPA compliant. UL1741, CSA 107.1 System Isolation capabilities Monitoring capabilities for Utility, inverter and loads (CT,'s, PT's) Communications: WIFI or ethernet capabilities. Coupling Configuration: Design dependent
DER emergency generator capabilities	Able to operate with an emergency power generator and charge batteries. A generator connection port must be provided.
Proposed inverter installation location	Indoor, the designer must assess proper installation within code. Bathroom building closet south-west wall available; see possible location on Physical Conditions section.[2,3] Installation location must be protected from elements and as per manufacturers recommendations clearances.
System monitoring	Local Human Machine Interface (HMI) and remote monitoring capabilities through app or website. Security measures must be used to prevent unauthorized access to parameters or controls. The system must be able to be operated and modified locally without the need for internet service. The system must include monitoring for BESS, Utility, inverter and loads. Design must include the required CT and PT connections.

<table>
<tr><td>Rapid shutdown (RS) capabilities</td><td>The DER system has to be equipped with RS equipment, compliant with local codes and NEC 690.12. RS shutdown must be accessible for emergency response teams.</td></tr>
<tr><td>Programming required in the DER (LUMA requirement)</td><td>
<table>
<tr><td>Voltage Range (% of Nominal Voltage)</td><td>Disconnection time (s)</td></tr>
<tr><td>In < 45</td><td>0.16</td></tr>
<tr><td>45 ≤ V < 60</td><td>1</td></tr>
<tr><td>60 ≤ V < 88</td><td>2</td></tr>
<tr><td>110 < V < 120</td><td>1</td></tr>
<tr><td>In ≥120</td><td>0.16</td></tr>
</table>
<table>
<tr><td>Function</td><td>Frequency (HZ)</td><td>Disconnection time(s)</td></tr>
<tr><td>Low frequency 1</td><td>f < 57.5</td><td>10</td></tr>
<tr><td>Low frequency 2</td><td>57.5 ≤ f < 59.2</td><td>300</td></tr>
<tr><td>Over frequency 1</td><td>60.5 < f ≤ 61.5</td><td>300</td></tr>
<tr><td>Over frequency 2</td><td>f > 61.5</td><td>10</td></tr>
</table>
</td></tr>
<tr><td>Minimum AC nominal capacity (kW)</td><td>5 kW, design dependent.</td></tr>
<tr><td>Battery Energy Storage System (BESS) capacity</td><td>BESS Capacity must be equal to or greater than the program minimum capacity of 13 kWh and withstand the maximum demand(diversified) for the essential loads. Maximum capacity is design dependent.</td></tr>
<tr><td>Battery Energy Storage System technologies accepted.</td><td>Lithium-ion, LiFePo4, others similar UL9540, UL1973, UL9540A, CEC, SGIP, UN38.3 compliant. Approved by OGPE and LUMA.</td></tr>
<tr><td>BESS design considerations</td><td>Mounting location must comply with building codes and NFPA 855[2]
Battery Monitoring System (BMS)
≥6000 cycles @80%DOD
>95% Round-trip efficiency
10 years warranty, up to 20 years design life
Close loop capabilities, battery communication
Coupling configuration: Design dependent
LUMA and OGPE-approved.
Follow all battery manufacturer-specified values to ensure proper charging and discharging</td></tr>
<tr><td>Wind load rating for mounting</td><td>Saffir Simpson Category 4 winds, with a preference for a design that conforms to ASCE 7 3-second design wind speeds for Saffir Simpson Category 5 winds.160 mph[4,7]; refer to ASCE 7-10; See PV Modules Location section.</td></tr>
<tr><td>Wiring</td><td>Copper UL, PV Wire, USE-2 Wire, and THHN Wire. Designers must select proper wiring sizes based on calculated ampacity, voltage drop calculations, equipment lug sizes and site constraints. All wire runs should be sized to be at or below a 2.5% voltage drop at full load.</td></tr>
</table>

Electrical conduits	All installations must be performed in conduit raceways as applicable as per NEC and current building codes. All live exposed parts have to be covered and protected. All raceways must be properly secured and protected from tampering. Conduit routing must be coordinated at the site with the customer to keep site esthetics, safety and operability. Conduit raceways must be properly routed and secured, no conduit must obstruct area access for maintenance or service walkways. IREC reserves the right to request relocation of conduits at any time if there is an understanding of failure to comply with applicable codes, customer request or others.
Proposed roof area	60 X 50 metal roof, additional roof reinforcements must be considered.[4] Some shading is expected from nearby trees during the afternoon.
Protections and service disconnects	All service disconnects and system protections must be provided and sized according to the desired operation, design calculations, fault currents and local codes.
Designer's information	TBD
Installer's information[5]	TBD
Workmanship warranty	5 years minimum.
Applicable standards	See Codes and Standards section.
Solar profile	See Sun path and Solar irradiation section.
Essential loads	See Essential Loads and time of use section.
System acceptance criteria	• DER installation with a minimum of 5 kV DC DER and a minimum 13 kWh BESS serving essential loads. • Permitting[6], Commissioning Report for the installed System. It must include documentation, equipment startup, control system calibration, testing, balancing, and performance testing in accordance with IEC 62446. The report must confirm that all commissioning steps were found in compliance. • All noted IREC inspection items addressed and corrected as noted or as agreed between both parties. • Certification of electrical installations of Distributed Energy Resource (RED, for its Spanish acronym) as per rule 7796, NEC and applicable rulings. • Test Certification for Distributed Energy Resources (RED) to Interconnect with the Electrical Distribution System of the Puerto Rico Electric Power Authority. • 25 kW or Less Capacity Distributed Generation Registration Form ("Formulario de Registro de GD con Capacidad de 25 kW o Menos"), including its supporting documentation, as submitted on the LUMA portal for the DER register with the Utility. See section Net metering required documentation for reference. • All components labeled and properly identified as per regulations and

	best engineering practices. IREC reserves the right to request additional labels for safety, clarity and equipment identification. • System communications capabilities and monitoring enabled. • Warranties – Workmanship, manufacturing, others. • Operations & Maintenance manual customer training. LUMA Training form. • Permitting completed and TOP of System design drawings, and Operation and Maintenance manuals. • Any other item listed on the EPC mechanical completion list as part of the project contract.

Notes:

1. The DER system will be entered into the Net metering program, proper documentation must be completed by the supplier, designer, installer, and commissioner to comply with the Technical Interconnection and Interoperability Requirements.

2. The designer must assess the current facilities infrastructure to determine the final location of the inverter, BESS and essential loads panel, replacement of outdated/panels and breakers and the installation of additional circuits as required for the essential load's operation.

3. The designer must assess the proposed DER installation location to determine compliance with code requirements and equipment temperature ratings. Additional ventilation apparatus must be considered if needed and visual aids specified for clearance purposes.

4. Roof structure additions must comply with local codes and be able to withstand the wind load rating specifications. Alternate locations can be considered upon coordination with facilities management. New structures must be designed and approved by a licensed structural engineer. See PV Modules Location section.

5. Contracted EPC must be the customer representative and must provide assistance for the *Conexión* LUMA portal for Net metering registering. See section *Net Metering Required Documentation* for reference.

6. All Permitting process and documents must be supplied, processed and approved on the Single Business Portal under *Certificación de instalación de sistemas* and LUMA Portal including NET metering (if applicable) by the Designer/installer.

7. Designers must assess the building's structural capability to support a DER racking system to withstand desired wind rating. Additional supports or reinforcements requirements are considered as part of the installation scope.

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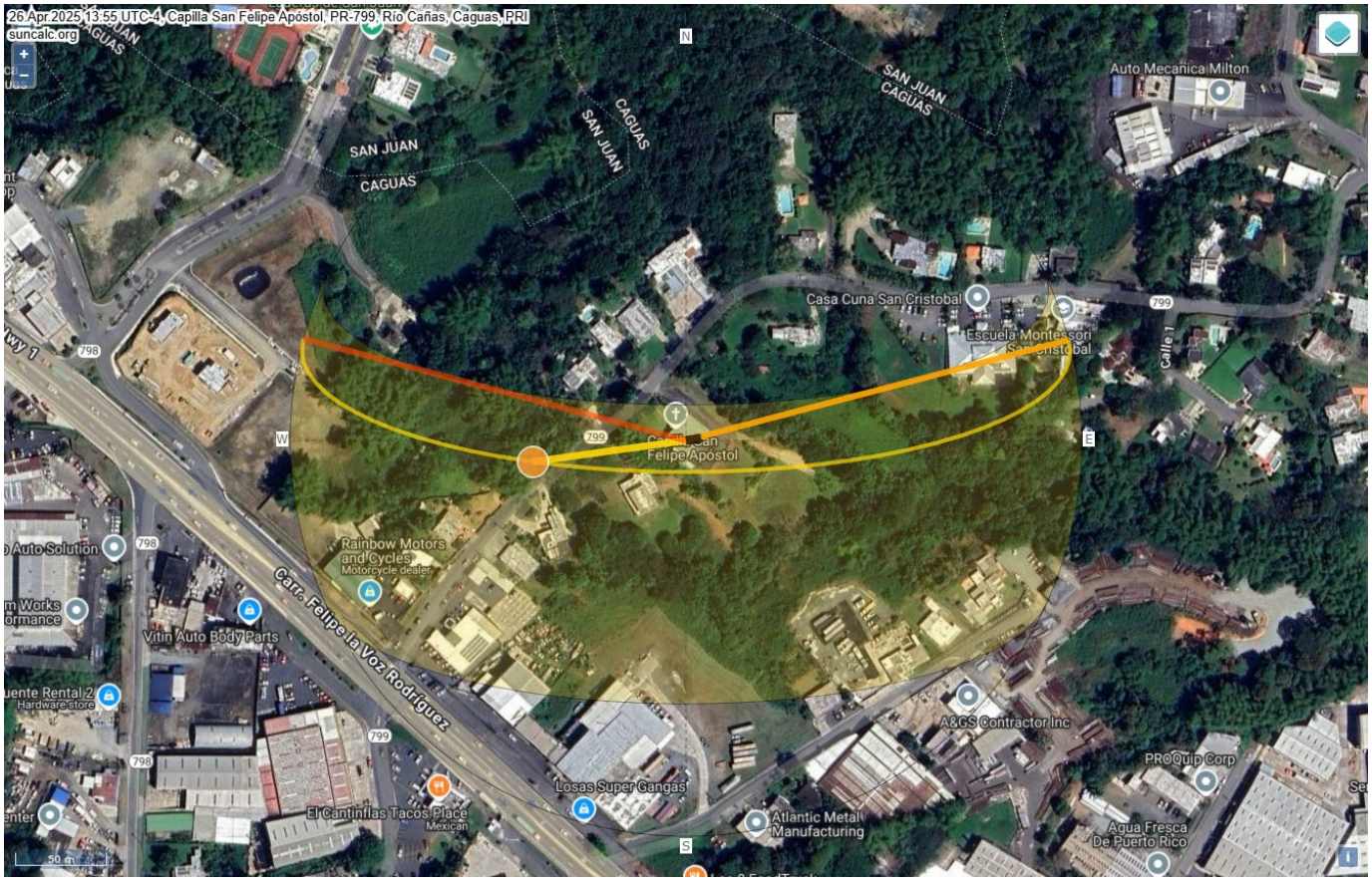
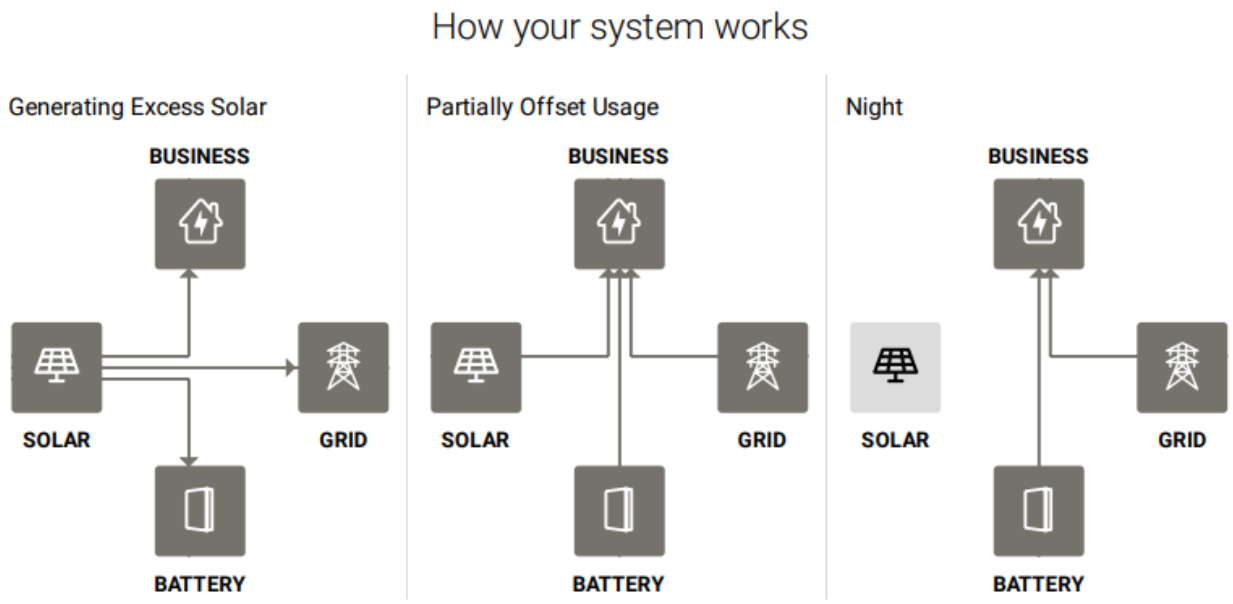
Sun Path Image



PV Modules Location

Concept layout for design consideration. Designers must establish the required setbacks and safety measures for maintenance access as per codes. Final location must minimize shading from surrounding trees and be able to comply with anchoring requirements.



Sun Irradiance Data

Sun irradiance data for an estimated roof area system estimating 0% shading losses.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at //sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

14,999 kWh/Year*

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)
January	5.30	1,279
February	5.71	1,235
March	5.56	1,310
April	5.51	1,254
May	5.30	1,248
June	5.46	1,244
July	5.32	1,259
August	5.36	1,260
September	5.51	1,253
October	5.26	1,232
November	5.07	1,174
December	5.21	1,251
Annual	**5.38**	**14,999**

Location and Station Identification

Requested Location	quebrada arenas caguas pr
Weather Data Source	Lat, Lng: 18.29, -66.06 1.5 mi
Latitude	18.29° N
Longitude	66.06° W

PV System Specifications

DC System Size	10.1 kW
Module Type	Standard
Array Type	Fixed (open rack)
System Losses	14.08%
Array Tilt	20°
Array Azimuth	180°
DC to AC Size Ratio	1.2
Inverter Efficiency	96%
Ground Coverage Ratio	0.4
Albedo	*From weather file*
Bifacial	No (0)
Monthly Irradiance Loss	Jan 0% Feb 0% Mar 0% Apr 0% May 0% June 0% July 0% Aug 0% Sept 0% Oct 0% Nov 0% Dec 0%

Performance Metrics

DC Capacity Factor	17.0%

Net Metering Required Documentation

The following table summarizes the required documentation and responsibility matrix for the system register into net metering with the utility. It is used as a guideline and the most updated Utility version must be used.[1] Contractor is responsible for generating and submitting the applicable documentation.

No.	Documents Binder	Documents Name	Requirement	Responsibility/ Task Owner	Generate / Upload / Sign
1	Customer Orientation	Training Confirmation Document	Required	Customer	Generate, sign
2	Diagram Design & Certification	Illustrative diagram	Required	Designer	Upload
3		CIAPR Seal for Engineering Design	Required	Designer	Upload
4		Design Certification Checklist	Required	Designer	Generate
5	Certification of Electrical Installations	Certification of Electrical Installations	Required	Installer	Generate Sign
6		CIAPR Seal for Inspection and Verification of Facilities	Required	Installer	Upload
7		Electrical Installation Checklist	Required	Installer	Generate
8		Meter Image	Required	Installer	Upload
9	Electrical Installation Certification – Supply Side	Electrical Installation Certification – Supply Side	Optional	Installer	Upload
10	Acceptance Test Certification	Test Certification	Required	Commissioning Engineer	Generate, Sign
11		CIAPR Seal for Evidence or Certification Reports	Required	Commissioning Engineer	Generate, Sign
12		Screenshot	Required	Commissioning Engineer	Upload
13	Construction	Building Permit	Optional	Installer, Commissioning Engineer	Upload
14		Building Inspection Certificate	Optional	Installer, Commissioning Engineer	Upload
15	Corporate Documents	Corporate Resolution	Optional	Customer, Representative	Upload
16	Affidavit	Affidavit	Optional	Customer, Representative	Upload
17	Participation Agreement	Participation Agreement.	Optional	Customer	Generate, Sign
18	NEM/Interconnection Agreement	NEM/Interconnection Agreement.	Required	Customer	Generate Sign

Note:

1. Please refer to *Mi acceso LUMA* for updated requirements: https://miacceso.lumapr.com/

Field Assessment

Nombre edificio evaluado **Capilla San Felipe Apostol**

Fecha evaluación **13 enero 2025**

Equipo que evaluó el edificio: **William Colon**

Comunidad y Municipio: **Quebrada Arenas, Caguas**

Renglón	Pregunta	Si	No	Comentarios generales u otra métrica diferente	Notas de proceso de selección junto a la comunidad
Estado Estructura / edificio / responde el ingeniero(a)	Tamaño techo adecuado para instalación de 5kW	X		Documentar el tamaño aproximado del techo (ancho por largo) y que no tenga otras cosas instaladas.	Edificio con un nivel de techo alto en dos aguas de metal.
	Material del techo adecuado para instalación	X		Techo de metal requiere análisis de anclaje	
	Estado del techo	X		Se observa en buenas condiciones sin daños visibles	
	Problemas obvios de construcción /Grietas por terremoto		X	No tienen filtraciones activas	
	Edificio habitable (humedad de las paredes bajo control)	x			
	Edificio habitable (circulación del aire)	x			
Estado Estructura / edificio / responde la comunidad	Edad del Edificio/construcción #años	X		No es un criterio de exclusión. Documentar.	No fue precisado
Infraestructura / responde el ingeniero(a)	¿Edificio tiene sistema eléctrico funcional?	x			
	Sistema eléctrico adecuado			Edificio en operación y conectado a LUMA, no se reportan problemas eléctricos al momento de la visita.	

	Cuarto adecuado para baterías.	x		Cuarto amplio localizado entre los baños. Covacha que requiere puerta.	La localización final debe cumplir con los despejos de NFPA 855
Infraestructura/ responde la comunidad	Servicios sanitarios adecuados	X			
	Agua potable	X			
	Cisterna de agua		X	No es un criterio de exclusión. Documentar si tienen o no.	Se espera añadir en un futuro
	Señal de celular e Internet satisfactoria	X		No es un criterio de exclusión. Documentar si tienen señal adecuada o les hace falta.	Servicio de telefonía móvil existente en el predio. No existe proveedor de internet para las facilidades.
Propiedad y tenencia (construcción debe ser para verano 2025) / responde la comunidad	Entidad o dueño puede poner a disposición para uso comunitario de centro resiliencia	X		La Iglesia Católica es la dueña de la facilidad.	
	Habrá acceso al uso y disfrute del edificio sin restricciones antes, durante y después de un fenómeno meteorológico extremo u otros desastres relacionados con la red.	X		Miembros de la comunidad tienen llave y acceso a las facilidades.	
	La comunidad ya tiene o puede obtener legalmente la capacidad del uso y disfrute del edificio.	X		Actualmente se usa para reuniones comunitarias.	
	Puede obtener la comunidad el derecho al uso y acceso al edificio para propósitos de construcción y modificación de estructura para poder hacer la instalación del sistema solar con baterías.	X		Carta del arzobispado solicitada.	
Criterios adicionales /responde la comunidad	Seguridad del espacio	X		No es un criterio de exclusión. Documentar si tienen o no.	No tienen cámaras y ni alarma. Existen rejas en el área de la cocina.

Essential Loads and Time of Use

Núm..	Cargas esenciales de cada comunidad	Uso	Prioridad (Inicial) 1 a 5	¿Existe en la comunidad? sí / no	Conectar en el HUB sí o no	Cantidad Máxima a conectar (tentativa)	Potencia MAX estimada por equipos (Tot W)	Horas de Uso Promedio Sugeridas por Equipo	Consumo Energético Diario (Wh)	Consumo Energético Diario (kWh)
1	Equipo Médico para **DME**	Esencial	5	no	si	1	400	12	4,800	5
2	Nevera (alimentos)	Esencial	5	si	si	1	800	**8**	6,400	6
3	Nevera pequeña (medicamentos)	Esencial	5	no	no	1	400	8		
4	Cargador de móvil	Esencial	5	si	si	10	25	4	1000	1
5	Radio recargable	Básico	1	si	si	1	50	2	100	0
6	Equipos de apoyo de comunicación	Esencial	5	no	si	1	100	8	800	1
7	Linterna recargable	Ocasional	3	no	si	1	30	2	60	0
8	Abanico (recargable)	Ocasional	3	si	si	4	60	4	960	1
9	Modem Internet	Esencial	5	no	si	1	20	24	480	0
10	Televisor	Básico	1	si	si	1	110	10	1,100	1
11	Computadora portátil	Básico	3	no	si	1	80	10	800	1
12	Computadora de escritorio	Esencial	5	no	si	1	120	8	960	1
13	Motor de bomba para agua de 3/4 HP (y filtro)	Esencial	0	no	no	0	552	8	0	0
14	Lavadora	Básico	2	no	no	1	1,700	3	5,100	0
15	Cafetera	Básico	2	si	si	1	900	1	900	1
16	Microondas	Básico	2	si	si	1	900	1	900	1
17	Teléfono satelital	Esencial	5	no	si	1	200	1	200	0
18	Baterías de celular recargable	Esencial	5	si	si	4	25	2	200	0
19	Impresora	Esencial	2	no	si	1	900	1	900	1
						Total:	7,372		25,660	20

Desired System Operation

The current normal operation is an electrical system served by the utility and in the event of a utility power failure no backup power is available. If there is the need for power, they connect temporary cables from a small portable generator (when available) through extension cords. The facility operates during established service hours, but in emergency situations it may operate as needed.

Desired facility DER System normal operation is in inverter mode serving all essential loads circuits that include assembly area circuits, exterior lighting, bathroom area and kitchen area circuits, PV system generating, charging batteries and exporting energy to the utility. During a power failure the DER will provide service to the essential loads with its BESS and generator (if available).

The DER must be an autonomous hybrid system and must provide continuous rated power during normal and emergency conditions within its rated capacity to essential electrical circuits regardless of the source. The DER must be capable of charging the batteries from the PV system, generator or the utility sources. Customer will monitor load and battery capacity available to relocate loads from DER served loads to the gensets loads as applicable depending on the required needs.

It is intended to have manual mode capabilities to perform periodic tests, generator tests and other maintenance related testing. The system must have an external maintenance bypass to enable system replacement or maintenance. The DER and all its components must have implemented all power protections and programmed system parameters as per applicable codes, Luma and designer's calculations.

The DER inverter and batteries proposed location is inside the bathrooms closet area (design dependent) in the southwest wall without any live exposed parts, properly identified and with a local HMI. This DER will have the BESS monitor and control integrated into the system and with service disconnect capabilities. This DER will comply with NEC 690.12 for Rapid shutdown capabilities with a service disconnect switch properly labeled, located available to emergency personnel, this enables a local emergency shutdown for firefighters. The system must integrate additional service disconnects/switching capabilities as needed for testing, operation and routine maintenance bypass.

Users must be able to monitor the system operation through a local protected HMI (can be through a physical barrier or software security) but also have to be able to monitor and control system operation by remote communication capabilities through an application or web server/site. A separate monitoring device must be provided if the inverter does not have a local HMI.

PV modules will be installed in the high metal roof area minimizing any shade effects from contiguous trees. Roof condition must be inspected and reinforced if needed to comply with wind ratings. Installation perforations, conduits perforations and anchor points must be properly sealed and painted to prevent water intrusion and blend with existing colors. Designers must define unobstructed maintenance walkways for safe operation as per applicable codes.

The system will integrate local alarms for heavy faults and low batteries. Additional allowed alarms may be programmed at customer request and as per code. Alarms can be accessed at the HMI display and a respective fault indication will be lit and an event logged. Alarms silence; acknowledge/reset button have to be available for easy operator's access.

The DER main goal is to maintain power to essential and supplied loads through a close transition without user intervention regardless of the power source. An operation manual must be created with pictures and diagrams that are easy to follow for Operation and maintenance. All equipment has to be properly identified and ventilated.

Applicable Laws and Regulations

- Regulation 7796 of the Energy Public Policy Program of January 19, 2010, as amended; "*Reglamento Para la Certificación de Instaladores de Sistemas de Energía Renovable."*
- Regulation 8080 of September 30, 2011, amends some articles of Regulation 7796.
- Regulation 8915 Interconnection GD February 6, 2017; Reglamento Para Interconectar Generadores con el Sistema de Distribución Eléctrica a la Autoridad de Energía Eléctrica y Participar de los Programas de Medición Neta
- Law 115 of June 2, 1976, as amended; "*Junta Examinadora de Peritos Electricistas de Puerto Rico*"
- Law 131 of June 28, 1969, as amended; "*Colegio de Peritos Electricistas de Puerto Rico*"
- Law 319 of May 15, 1938, as amended; "*Organización del Colegio de Ingenieros, Arquitectos y Agrimensores de Puerto Rico"*
- Law 173 of August 12, 1988, as amended; "C*rea la Junta Examinadora de Ingenieros y Agrimensores de Puerto Rico"*
- Law 17 of April 11, 2019; "*Ley de Política Pública Energética de Puerto Rico"*
- Law 83 of May 2, 1941; *"Ley de la Autoridad de Energía Eléctrica de Puerto Rico"*
- Law 114 of August 16, 2007; to order and authorize PREPA to establish a net metering program (Net Metering)
- Law 82 of July 19, 2010, as amended by the Public Policy for Energy Diversification through Sustainable and Alternative Renewable Energy in Puerto Rico
- Law 1 of January 3, 2012; Puerto Rico Government Ethics Law
- Law 17 of 11 April 2019 as amended; "*Ley de Política Pública Energética de Puerto Rico*"
- Law 57 of 27 May 2014; "*Ley de Transformación y Alivio Energético de Puerto Rico*"
- Law 120 of 20 June 2018; "*Ley para Transformar el Sistema Eléctrico de Puerto Rico*"
- Federal Law PROMESA; "*Ley de Supervisión, Administración y Estabilidad Económica de Puerto Rico*" (in English: the Puerto Rico Oversight, Management, and Economic Stability Act)
- Law 29 of 8 June 2009; "*Ley de Alianzas Público-Privadas*"
- Law No. 211 of August 9, 2008; "*Para enmendar el Articulo 2, inciso (e) de la ley 114*"
- OSHA 29CFR1926 and sub-parts
- Any other laws or regulations deemed applicable by IREC.

Applicable Codes and Standards

Applicable standard documents have intentionally been listed with the respective publication year for reference. Practice across states and utilities varies in this regard.

1. ANSI/NETA ATS-2021, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
2. IEEE Std 1547™-2018, IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
3. IEEE Std 1547.1™-2020, IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Energy Resources with Electric Power Systems and Associated Interfaces
4. ANSI C84.1-2020, Electric Power Systems and Equipment—Voltage Ratings (60 Hertz)
5. IEEE Std 1547.2™-2008, Application Guide for IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems
6. IEEE Std 1547.3™-2007, Guide for Monitoring Information Exchange and Control of Distributed Resource Interconnected with Electric Power Systems
7. IEEE Std 1547.4™-2011, IEEE Guide for Design, Operation, and Integration of Distributed Resource Island System with Electric Power Systems
8. IEEE Std 1547.6™-2011, IEEE Recommended Practice for Interconnecting Distributed
9. IEEE Std 1547.7™-2013, IEEE Guide for Conducting Distribution Impact Studies for Distributed Resource Interconnection
10. IEEE Std 519™-2022, IEEE Standard for Harmonic Control in Electric Power Systems
11. IEEE Std 1453™-2022, IEEE Standard for Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems
12. IEEE Std C37.90™-2005, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
13. IEEE Std C37.90.1™-2012, IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems Associated with Electric Power Apparatus
14. IEEE Std C37.90.2™-2004, IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
15. IEEE C37.95™-2014, IEEE Guide for Protective Relaying of Utility-Consumer Interconnections
16. IEEE Std C62.92.1™-2016, IEEE Guide for the Application of Neutral Grounding in Electric Utility Systems—Part I: Introduction
17. IEEE Std C62.92.6™-2017, IEEE Guide for Application of Neutral Grounding in Electrical Utility Systems, Part VI—Systems Supplied by Current-Regulated Sources
18. NFPA 70, The National Electrical Code® (NEC) 2011
19. UL 1741, Edition 3, September 28, 2021, Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
20. UL 1741 Certification Requirement Decision for Power Control Systems, March 8, 2019, Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
21. UL 2703 Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels
22. IBC 2018 International Building Code

23. Puerto Rico Building Code
24. IREC Plan Review and Field Inspection guidelines; Model Inspection Checklist for residential Rooftop PV. https://irecusa.org/resources/plan-review-and-inspection-guidelines-model-inspection-checklist-for-residential-rooftop-pv/ as updated.
25. Any other as deemed applicable by IREC.

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