



GOBIERNO DE PUERTO RICO

Junta Reglamentadora de Servicio Público
Negociado de Energía de Puerto Rico

NEPR

Received:

May 12, 2026

2:28 PM

FORMULARIO

SOLICITUD DE CERTIFICACIÓN COMPAÑÍAS DE SERVICIO ELÉCTRICO



Solicitud Nueva



Solicitud Enmendada



Solicitud de Enmienda

Instrucciones:

- Al cumplimentar este formulario, examine las disposiciones de la Sección 3.03 del Reglamento Núm. 8701 y asegúrese de ofrecer la información requerida.
- Complete todos los encasillados e indique N/A donde no aplique.
- De necesitar espacio adicional para sus respuestas, utilice la Hoja Complementaria (NEPR-Z01).
- Incluya los documentos requeridos, conforme al Reglamento Núm. 8701, enumerados en la sección de Anejos.
- Al momento de entregar este Formulario, presente una copia de la evidencia de pago.

A. Información General de la Compañía de Servicio Eléctrico

1. Nombre de Compañía: Agroenergética LLC



Generadores por medio de combustibles fósiles o energía renovable con capacidad agregada cien (100) MW o menos



Generadores por medio de combustibles fósiles o energía renovable con capacidad agregada mayor a cien (100) MW

2. Tipo de Servicio Eléctrico:



Generadores Distribuidos con capacidad agregada de un (1) MW o más



Almacenamiento de Energía



Reventa de Energía



Facturación de Energía



Trasbordo

3. Capacidad agregada de generación de la compañía (MW): 2

4. Energía anual facturada (MWh): N/A al momento

5. Energía anual revendida (MWh): N/A al momento

6. Fuentes de energía utilizadas en las instalaciones: Sistemas Fotovoltaicos

B. Información sobre Instalaciones de Servicio Eléctrico

(Complete la siguiente información sobre cada una de las instalaciones en que prestará sus servicios.)

1. Tipo de Instalación: ☒ Nueva

☐ Existente

☐ Existente Bajo Renovación

Dirección Física de la Instalación:

Camino Los Morones

Carr. 495 Km. 2.2 Interior Derecha

Moca, Puerto Rico 00676

Dirección Postal de la Instalación:

PO Box 2426

Moca, Puerto Rico 00676



Edificio World Plaza, 268 Ave. Muñoz Rivera, Suite 202 (Nivel Plaza), Hato Rey P.R. 00918

Tel. 787.523.6262 • www.energia.pr.gov

NEPR- B04 (Rev. Enero 2019) "Solicitud de Certificación de Compañías de Servicio Eléctrico"

Referencia: Enmienda al Reglamento Núm. 8618, sobre Certificaciones, Cargos Anuales y Planes Operacionales de Compañías de Servicio Eléctrico en Puerto Rico.

Indique si la compañía es titular de la Instalación:

☒ Sí

☐ No

Especifique el título o negocio jurídico en virtud del cual está en posesión:

Impacto
Territorial:

Municipio: Moca

Barrio: Cerro Gordo

Sector: Medina

Otro:

2. Tipo de Instalación:

☐ Nueva

☐ Existente

☐ Existente Bajo
Renovación

Dirección Física de
la Instalación:

Dirección Postal
de la Instalación:

Indique si la compañía es titular de la Instalación:

☐ Sí

☐ No

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Otro:

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Renovación

Dirección Física de
la Instalación:

Dirección Postal
de la Instalación:

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☐ Sí

☐ No

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Impacto
Territorial:

Municipio:

Barrio:

Sector:

Otro:

4. Tipo de Instalación:

☐ Nueva

☐ Existente

☐ Existente Bajo
Renovación

Dirección Física de
la Instalación:

Dirección Postal
de la Instalación:

☐ Sí

☐ No

Indique si la compañía es titular de la Instalación: Especifique el título o negocio jurídico en virtud del cual está en posesión:

Impacto Territorial: Municipio: Sector: Barrio: Otro:

5. Tipo de Instalación: ☐ Nueva ☐ Existente ☐ Existente Bajo Renovación

Dirección Física de la Instalación:

Dirección Postal de la Instalación:

Indique si la compañía es titular de la Instalación: ☐ Sí ☐ No Especifique el título o negocio jurídico en virtud del cual está en posesión:

Impacto Territorial: Municipio: Sector: Barrio: Otro:

6. Tipo de Instalación: ☐ Nueva ☐ Existente ☐ Existente Bajo Renovación

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Dirección Postal de la Instalación:

Indique si la compañía es titular de la Instalación: ☐ Sí ☐ No Especifique el título o negocio jurídico en virtud del cual está en posesión:

Impacto Territorial: Municipio: Sector: Barrio: Otro:

7. Tipo de Instalación: ☐ Nueva ☐ Existente ☐ Existente Bajo Renovación

Dirección Física de la Instalación:

Dirección Postal de la Instalación:

Indique si la compañía es titular de la Instalación: ☐ Sí ☐ No Especifique el título o negocio jurídico en virtud del cual está en posesión:

Municipio: Barrio:

Impacto Sector: Otro:
Territorial: _____

Anejos: (Indique los documentos que incluye con la Solicitud de Certificación)

- ☐ Información sobre contratos o negocios jurídicos con la Autoridad de Energía Eléctrica u otra compañía de servicio eléctrico (Sección 3.03 (A)(2)).
- ☐ Declaración certificada por un Contador Público Autorizado que acredite la disposición de recursos mínimos financieros de la compañía (Sección 3.03 (A)(3)).
- ☐ Declaración de suficiencia de recursos humanos de la compañía (Sección 3.03 (A)(4)).
- ☐ Copia de permisos, autorizaciones y endosos obtenidos para operar, hacer negocios y proveer servicios en Puerto Rico (Sección 3.03 (A)(5)).
- ☐ Certificación de que ha obtenido los permisos de las entidades públicas correspondientes para la construcción de obras nuevas (Sección 3.03 (B)(1)(b)).
- ☐ Certificación que acredite que la compañía tiene capacidad y solvencia económica para financiar la construcción y operación de instalaciones nuevas o bajo renovación (Sección 3.03 (B)(1)(b)).
- ☒ Descripción que incluya especificaciones técnicas de las unidades y equipo, entre otros, que utilice para la prestación del servicio (Sección 3.03 (B)(1)(c)).
- ☐ Cantidad de sistemas instalados, capacidad y número de clientes por región de servicio eléctrico (Sección 3.03 (B)(2)(b)).
- ☒ Listado de equipos utilizados para la prestación del servicio (Sección 3.03 (B)(2)(c)).
- ☒ Hoja Complementaria (NEPR-Z01).
- ☒ Otros: Certificado de Organizació, Certificado de Good Standing

Certifico que la información presentada en este formulario es correcta y completa.

Alexandra M. García Grover

Gerente de Proyectos

Alexandra M. García Grover

8/mayo/2026

Nombre de Representante Autorizado

Puesto

Firma

Fecha

PARA USO OFICIAL

NEPR-CT- _____ - _____

Determinación: Se ha evaluado esta solicitud y sus anejos y se ha determinado que ha sido:

- ☐ Aprobada
- ☐ Condicionada a: _____
- ☐ Requiere Enmiendas
- ☐ Denegada

Observaciones:

Nombre	Puesto	Firma	Fecha
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Nombre del anejo	Aplica (si/no)
Información sobre contratos o negocios jurídicos con la Autoridad de Energía Eléctrica u otra compañía de servicio eléctrico (Sección 3.03 (A) (2))	N/A
Declaración certificada por un Contador Público Autorizado que acredite la disposición de recursos mínimos financieros de la compañía (Sección 3.03 (A)(3))	
Declaración de suficiencia de recursos humanos de la compañía (Sección 3.03 (A) (4))	
Copia de permisos, autorizaciones y endosos obtenidos para operar, hacer negocios y proveer servicios en Puerto Rico (Sección 3.03 (A)(5))	
Certificación de que ha obtenido los permisos de las entidades públicas correspondientes para la construcción de obras nuevas (Sección 3.03 (B)(1)(b))	
Certificación que acredite que la compañía tiene capacidad y solvencia económica para financiar la construcción y operación de instalaciones nuevas o bajo renovación (Sección 3.03 (B)(1)(b))	
Descripción que incluya especificaciones técnicas de las unidades y equipo, entre otros, que utilice para la prestación del servicio (Sección 3.03 (B)(1)(c))	Si
Cantidad de sistemas instalados, capacidad y número de clientes por región de servicio eléctrico (Sección 3.03 (B) (2) (b))	No
Listado de equipos utilizados para la prestación del servicio (Sección 3.03 (B)(2)(c))	Si
Hoja Complementaria (NEPR-Z01)	
Otros: Grant Agreement	Si

MEMORIAL EXPLICATIVO

8 de agosto de 2025

1. Executive Summary

This document outlines the operational logic and control strategy for a third-party microgrid project located in the parcel cadaster no. 098-087-470-36-000 Cerro Gordo ward, Moca, Puerto Rico. The microgrid consists of a 2.2 MWp photovoltaic (PV) system with 1.65 MW AC output and two Tesla Megapack 2XL battery energy storage systems (750 kW / 2,500 kWh each). The system interconnects to a 4.16 kV LUMA-owned distribution feeder in a region with poor grid reliability. While the site lacks on-site load, the microgrid's purpose is to provide high-quality, stable energy to the local feeder and support grid resilience during outages.

2. Regulatory Classification

According to Puerto Rico Energy Bureau Regulation 8920, the system qualifies as a 'Third-Party Microgrid'. This classification applies to microgrids owned and operated by entities other than the load served, typically providing services to external consumers or utilities under specific agreements.

3. Modes of Operation

The microgrid operates under three main modes:

3.1 Interconnected Mode – Controlled Export

- The system exports power up to 750 kVA to the 4.16 kV feeder. The system output is managed and determined by the microgrid controller operation and a 750 KVA interconnection substation. The substation will be connected to the 4.16 KV primary line.
- A microgrid controller (EMS) manages the combined output of PV and BESS to stay within export limits.
- The BESS smooths PV fluctuations, provides voltage and frequency support, and minimizes grid disturbances.

3.2 Standby Mode – Pre-Islanding

- During forecasted grid disturbances (e.g., storms), the system prioritizes charging the BESS to full capacity.
- Export is minimized to reserve energy for potential islanding operation.

3.3 Feeder-Islanded Mode – LUMA-Isolated

- Upon a major outage, LUMA may isolate the feeder at the substation.
- The microgrid controller switches the system into grid-forming mode.
- The BESS re-establishes voltage and frequency; PV contributes depending on solar availability.
- The microgrid energizes the feeder autonomously, supplying critical downstream loads.
- Upon grid restoration, synchronization and reconnection occur under coordination with LUMA.

4. Microgrid Control Architecture

- Central EMS oversees power flows, PV curtailment, and BESS operation.
- Real-time monitoring at PCC ensures export limits and safety.
- BESS units provide grid-forming functionality in island mode.
- Remote SCADA connectivity allows coordination with LUMA for islanding events.
- Protective relays and voltage/frequency sensors ensure compliant interconnection.

5. Export Power Control Justification under PREPA Regulation 8915

Although PREPA Regulation 8915 (2017) limits distributed generation interconnections to 1.0 MW on distribution feeders, this system incorporates advanced microgrid control strategies that ensure compliance by dynamically limiting the power exported to the grid.

The PV array has a peak DC capacity of 2.2 MW and a total inverter capacity of 1.65 MW AC. Despite this, the system's Point of Common Coupling (PCC) export will be restricted to 750 kVA using an integrated Microgrid Energy Management System (EMS) and inverter-level curtailment controls.

Technical Features Ensuring Export Compliance:

1. Export Limiting Control at PPC:
 - Real-time metering system monitors the power exported to the 4.16 kV feeder.
 - Dynamic setpoints ensure exports do not exceed 700 kVA.
 - PV curtailment is triggered if export thresholds are approached.
2. BESS Absorption and Firming Capacity:
 - Two Tesla Megapack 2XL units provide a total of 1.5 MW / 5.0 MWh.

- They absorb PV surplus and provide regulated export to the grid.
- Grid-forming capability enhances system stability.
- 3. Dispatch Logic:
 - EMS manages priority between BESS charging and controlled export.
 - Ramp-rate control prevents sudden injection peaks.
- 4. Grid Services Capability:
 - Includes frequency response, voltage support, and load-following.
 - Supports stable feeder operation.
- 5. Curtailment Assurance:
 - Instant PV curtailment during overproduction or low grid demand.
 - Comply with anti-islanding and ride-through standards.

6. Energy Dispatch Strategy

The microgrid employs a smart dispatch strategy that maximizes solar energy utilization while complying with grid export limitations and preserving battery health.

During peak sun hours (estimated 5.3 hours/day), the PV generation (up to 1.65 MW AC) is managed by the Energy Management System (EMS) to prioritize:

1. Battery Charging: A significant portion of PV output is absorbed by the BESS units, charging them to support later use. The EMS operates the BESS in a self-consumption mode, discharging energy during non-solar hours until a minimum State of Charge (SOC) of 20% is reached each day.
2. Controlled Export: Simultaneously, surplus PV energy is exported to the LUMA feeder at a rate not exceeding 700 kVA, maintaining compliance with PREPA Regulation 8915.

This dual path dispatch—PV to BESS and limited grid export—allows the microgrid to act as a controllable generation source, improve feeder power quality, and mitigate the effects of solar intermittency on the distribution network.

7. Contextual Notes on PREPA Regulation 8915

PREPA Regulation 8915, enacted in 2017, was primarily oriented toward photovoltaic generation systems interconnected directly to LUMA distribution feeders. At the time of its drafting, the regulation did not contemplate the advanced capabilities of modern microgrid architecture, including energy storage systems and intelligent energy management platforms.

In contrast, this proposal presents a fully integrated microgrid solution that includes:

- A 2.2 MWp (1.65 MW AC) solar PV system
- Two Tesla Megapack 2XL BESS units (750 kVA / 2,500 kWh each)
- A dedicated Microgrid Controller (EMS)
- 750 KVA interconnection transformer 4.16 KV: 480 VAC

The interconnection is made through a 750 kVA substation transformer, which serves as the control point for the feeder supported by the Microgrid. With advanced EMS and BESS technologies in place, the system ensures exports are always constrained to 750 kVA, providing a safe, stable, and grid-supportive contribution.

8. Agricultural Integration

The project will utilize existing agricultural land at Hacienda Gosén for cultivation research, new crop development, and commercial production (estimated 100 acres), enhancing food security. It incorporates conservation-agrivoltaics and conservation agriculture management practices (CAMP) for benefits like carbon storage and soil health. The proponent has site control for the designated project area..



Número de Proyecto: 2025-GD-00156

Inicio: 2025-sep-19 11:48 a.m.

Solicitud de Evaluación Sistema de GD con Capacidad Mayor de 25 kW hasta 1 MW

Número de Proyecto	2025-GD-00156																	
Inicio	2025-sep-19 11:48 a.m.																	
Tipo de Proyecto	Nuevo																	
Tipo de Tecnología	Fotovoltaico																	
Tipo de Programa de Medición Neta	Básica																	
Información del Cliente (Tenedor de la Cuenta con la AEE)	<table><tr><td>Nombre y Apellidos</td><td>Empresas Norhen, Inc.</td></tr><tr><td>Número de Teléfono</td><td>(787) 295-9380</td></tr><tr><td>Número de Celular</td><td>(787) 399-4590</td></tr><tr><td>Correo Electrónico</td><td>agrivoltaicssolar@gmail.com</td></tr><tr><td>Dirección Postal</td><td>PO BOX 4365 AGUADILLA PR 00605</td></tr><tr><td>Relación con la Propiedad</td><td>Dueño</td></tr><tr><td>Fecha de Creación</td><td>2025-sep-19 10:15 a.m.</td></tr><tr><td>Última Actualización</td><td>2025-sep-19 10:15 a.m.</td></tr></table>		Nombre y Apellidos	Empresas Norhen, Inc.	Número de Teléfono	(787) 295-9380	Número de Celular	(787) 399-4590	Correo Electrónico	agrivoltaicssolar@gmail.com	Dirección Postal	PO BOX 4365 AGUADILLA PR 00605	Relación con la Propiedad	Dueño	Fecha de Creación	2025-sep-19 10:15 a.m.	Última Actualización	2025-sep-19 10:15 a.m.
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Última Actualización	2025-sep-19 10:15 a.m.																	
¿ Tiene (o es usted) representante para este proyecto?	Si																	
Información del Representante	<table><tr><td>Nombre y Apellidos</td><td>JOSE E. GARCIA SANTIAGO</td></tr><tr><td>Número de Celular</td><td>(787) 230-9070</td></tr><tr><td>Correo Electrónico</td><td>medicionneta@puraenergiapr.com</td></tr><tr><td>Dirección Postal</td><td>Po Box 3215 Aguadilla, PR, 00605</td></tr><tr><td>Compañía</td><td>PURA ENERGIA</td></tr></table>		Nombre y Apellidos	JOSE E. GARCIA SANTIAGO	Número de Celular	(787) 230-9070	Correo Electrónico	medicionneta@puraenergiapr.com	Dirección Postal	Po Box 3215 Aguadilla, PR, 00605	Compañía	PURA ENERGIA						
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Dirección Postal	Po Box 3215 Aguadilla, PR, 00605																	
Compañía	PURA ENERGIA																	
Información del Diseñador	<table><tr><td>Nombre y Apellidos</td><td>JOSE E. GARCIA SANTIAGO</td></tr><tr><td>Número de Celular</td><td>(787) 230-9070</td></tr><tr><td>Correo Electrónico</td><td>medicionneta@puraenergiapr.com</td></tr><tr><td>Dirección Postal</td><td>Po Box 3215 Agudilla, PR 00605</td></tr><tr><td>Número de Licencia Profesional</td><td>9839</td></tr></table>		Nombre y Apellidos	JOSE E. GARCIA SANTIAGO	Número de Celular	(787) 230-9070	Correo Electrónico	medicionneta@puraenergiapr.com	Dirección Postal	Po Box 3215 Agudilla, PR 00605	Número de Licencia Profesional	9839						
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	<table><tr><td>Fecha de Expiración de Licencia Profesional</td><td>2027-ene-09 12:00 a.m.</td></tr><tr><td>Compañía</td><td>PURA ENERGIA</td></tr></table>	Fecha de Expiración de Licencia Profesional	2027-ene-09 12:00 a.m.	Compañía	PURA ENERGIA												
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Compañía	PURA ENERGIA																
Información de Localización	<table><tr><td>Dirección</td><td>INT CAR 495 K2 H2 DER BO CERRO GORDO/SECTOR MEDINA</td></tr><tr><td>Municipio</td><td>MOCA</td></tr><tr><td>Zona</td><td>BO. CERRO GORDO</td></tr><tr><td>Código Postal</td><td>00676</td></tr><tr><td>Número de Cuenta</td><td>8244008769</td></tr><tr><td>ID de Localidad</td><td>2487811944</td></tr><tr><td>Número de Medidor</td><td>56049589</td></tr><tr><td>Supply Side</td><td>No</td></tr></table>	Dirección	INT CAR 495 K2 H2 DER BO CERRO GORDO/SECTOR MEDINA	Municipio	MOCA	Zona	BO. CERRO GORDO	Código Postal	00676	Número de Cuenta	8244008769	ID de Localidad	2487811944	Número de Medidor	56049589	Supply Side	No
Dirección	INT CAR 495 K2 H2 DER BO CERRO GORDO/SECTOR MEDINA																
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Zona	BO. CERRO GORDO																
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Número de Cuenta	8244008769																
ID de Localidad	2487811944																
Número de Medidor	56049589																
Supply Side	No																
Generadores (Módulos Fotovoltaicos, Aerogenerador, Microturbina, etc.)	<table><tr><td colspan="2">Generador 1</td></tr><tr><td>Manufacturero</td><td>HANWHA Q CELL</td></tr><tr><td>Modelo</td><td>Q.PEAK DUO XL G.10.3 480</td></tr><tr><td>Capacidad (W)</td><td>480.0</td></tr><tr><td>Cantidad</td><td>4584</td></tr></table>	Generador 1		Manufacturero	HANWHA Q CELL	Modelo	Q.PEAK DUO XL G.10.3 480	Capacidad (W)	480.0	Cantidad	4584						
Generador 1																	
Manufacturero	HANWHA Q CELL																
Modelo	Q.PEAK DUO XL G.10.3 480																
Capacidad (W)	480.0																
Cantidad	4584																
Capacidad DC Total (kW)	2,200.32																
Inversores	<table><tr><td colspan="2">Inversor 1</td></tr><tr><td>Tipo de Conexión</td><td>Trifásico</td></tr><tr><td>Marca</td><td>SMA</td></tr><tr><td>Modelo</td><td>SHP 125-US-21</td></tr></table>	Inversor 1		Tipo de Conexión	Trifásico	Marca	SMA	Modelo	SHP 125-US-21								
Inversor 1																	
Tipo de Conexión	Trifásico																
Marca	SMA																
Modelo	SHP 125-US-21																

	Cantidad	13
	Voltaje Nominal (Ej: 120/240 V)	480.0
	Corriente Nominal (A)	151.0
	Potencia AC Máxima (kW)	125.0
Capacidad AC Total (kW)	1,625	

Recomendaciones

Agroenergetica, LLC

Datos de Localización

De acuerdo a la información suministrada se propone una actividad: Privada en:

Dirección Física

Carr. CAR 495, Km 2, Secundaria H2
DER, (Int.), Sector MEDINA, Bo. CERRO
GORDO, Moca, Puerto Rico, 00676

Dueño

Jose E Garcia Santiago

Número(s) de Catastro

098-087-470-36

Cabida

Cabida según escritura: 355772.52 metros cuadrados

Calificación

Distrito(s) de Calificación: A-P (99%), R-G (1%)

Distrito en el Mapa de Inundabilidad: X

Tipo de Suelo: CoE (65.5%), HmF2 (18.4%), HmE2 (16.1%)

Casos de Referencia

2025-GD-00156

Infraestructura

La Autoridad de Energía Eléctrica (Ahora LUMA) mediante carta del 7 de mayo de 2026 emite sus recomendaciones y/o requerimientos para el Proyecto propuesto.

Condiciones Especiales

NINGUNA

Condiciones Generales

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Recomendaciones

Agroenergetica, LLC

Firma / Sellos

Fecha de Expedición:

11/MAY/2026



Norberto Almodóvar Vélez
Secretario Auxiliar de la OGPe



**AGRIVOLTAICS PV SYSTEM WITH BATTERY ENERGY
STORAGE AND BACK-UP POWER (AGRIVOLTAICS
MICROGRID) FOR INTEGRATION TO THE GRID AT FARMING
FACILITY IN MOCA, PUERTO RICO**

Revision History

Revision	Originator	Reason for Change	Date
0	José E. Garcia, PE	New Document for Revision of CDBG-ER2 program	OCT 26, 2024
1	José E. Garcia, PE	Removed ICE generator specification	DEC 28, 2024

1. PURPOSE

Agroenergética LLC submitted a proposal under CDBG-DR ER2 program funding in support of the project “Agrivoltaics for Energy and Food Security in Rural Northwestern Puerto Rico”. The proposal was among the 20 proposals selected to proceed to the next phase of project awarding. This document provides the specifications for both main project activities within the AgriVoltaics project, which are the production of continuous, resilient energy for the benefit of a Low- to Moderate-Income (LMI) people while maintaining the main purpose of agricultural land which is the production of food.

The goal of the project is to design and perform strategic project delivery of a 2.2 MW DC photovoltaic (PV) facility co-located with local specialty agricultural crops at Hacienda Gosén, a farm and food processing facility in the Barrio Cerro Gordo of the municipality of Moca.

2. SCOPE

This document intends to present the functional design of the different energy generation and/or management equipment components that will make up the Agrivoltaics Microgrid. Functional Specifications are limited to the integration of the system components that are required to fulfill the energy generation, storage, distribution and interconnection to the utility grid.

This document includes information about:

- Proposed MicroGrid system architecture
- PV Solar system energy generation projection
- Proposed energy export to utility grid
- Proposed point of interconnection, location and coordinates
- Total land area requirements
- Available land for agricultural production
- Energy Impact coverage for neighboring communities
- Benefits for the Utility company
- Operation and Maintenance plan, procedures and template contracts

3. ACRONYMS AND DEFINED TERMS

The following list intends to facilitate the understanding of the terms or acronyms used within the pharmaceutical industry in general, as well as those specific to the client facilities.

Acronym/ Term	Definition
User	A person (or persons) whose job involves the use of a computer system or application but does not need any detailed knowledge of computer programming.
PV	Photovoltaic
EMS	Energy Management System
BESS	Battery Energy Storage system
PPC	Power Plant Controller
MC	Microgrid Controller
SOC	State of Charge
CT	Current Transformer
PT	Power Transformer
POC	Point of Interconnection
KW	Kilowatt
KWh	KW-hour
KWh/day	KW-hour per day
EMS	Energy Management System
DER	Distributed Energy Resources
MPP	Microgrid Power Plant
Grid Forming	The electrical power producer that provides the voltage and frequency reference
Grid Following	Electrical power generation units that will follow the reference provided.
Ed	Energy per day
Pt	Total size of DC solar energy system
Peak hours	Sun irradiation peak hours based on meteorological data
η	Efficiency
PCS	Power Conversion system (i.e. Inverter)
PQ mode	Refers to equipment in grid following mode
UF mode	Refers to equipment in grid forming mode, regulating voltage and frequency

4. SYSTEM OVERVIEW

4.1 Purpose of the System

The Agrivoltaics Microgrid consists of the combination of a photovoltaic solar energy generation system, a battery energy storage system (BESS) as a centralized energy storage and management system, and the microgrid controller who manages the energy assets and the electrical ancillary equipment which provides the electrical combination and interconnection. The combination of these technologies provides the electrical power capacity sufficient to support approximately 400-450 household units in the nearby community. Also, it will serve as an electrical power enhancement to the utility electrical feeder in the vicinity.



Figure 1: Conceptual Layout of PV new solar energy system

From a power generation/electrical systems perspective, this utility-scale PV system will be tied to two (2) units of 750 KVA, 2.5 MWh BESS interconnected to the grid through nearby substation and bus tie-ins. The system's operations and energy delivery to the grid will be regulated, or capped, at a maximum power capacity to ensure consistent power supply during daytime hours when solar power generation is in progress, as well as peak demand hours (between 4 - 9 pm) with BESS discharge. The system will be a local microgrid providing power-as-a-service to the local community and grid operator via a power purchase and operating agreement (PPOA). The most value-added functionality to the grid

operator is the available power during peak demand periods which are usually from 4 PM to 9 PM.

From an agricultural perspective, this project will provide approximately 10 acres of conditioned and enriched soil for the cultivation of horticulture and high value crops. Land between structure rows could become vegetable and greens crops cultivation areas, while shaded soil below structures could become ginger, turmeric and cocoa crop areas. It will also add opportunities for research and agricultural land use, leading to new crop development, product availability, and job creation in the area.

Objectives of this project:

1. Provide an isolated and autonomous power plant with resilience that could provide power in the absence of the utility. Significantly enhanced the power quality and availability within the area.
2. Contribute to support the efforts of enhancing two main critical needs of the community, available energy and food production.
3. Become a model for sustainability by inserting the community and the academics into the development, support and education efforts.
4. Create local jobs for the maintenance and operation of the system. Create jobs for food production.

4.2 Community demographics

The community nearby the Agrivoltaics MicroGrid is the Cerro Gordo Ward accessed via PR-495. The cerro Gordo Ward is the most territorial extensive ward of Moca. Based on US 2020 census data, the population of Cerro Gordo Ward by 2020 was 2,421. There are 1,051 households, where 78% are 2-3 bedrooms units. Population of the household is around 2 people per unit. The average size ranges from 1,100 to 1700 sq ft. 75% of dwelling units are owned. Based on size of houses and population, the average energy consumption ranges from 15 to 25 kWh per day.

4.3 Operating Scenario

The Agrivoltaics Microgrid main energy power generation subsystem will be the PV solar energy system. The 2.25 MW solar system will generate approximately 9,000 kWh during a day, 3,250,000 kWh per year. Based on an average energy demand of 20 kWh per dwelling unit, the MicroGrid would be able to provide energy to 400-450 households.

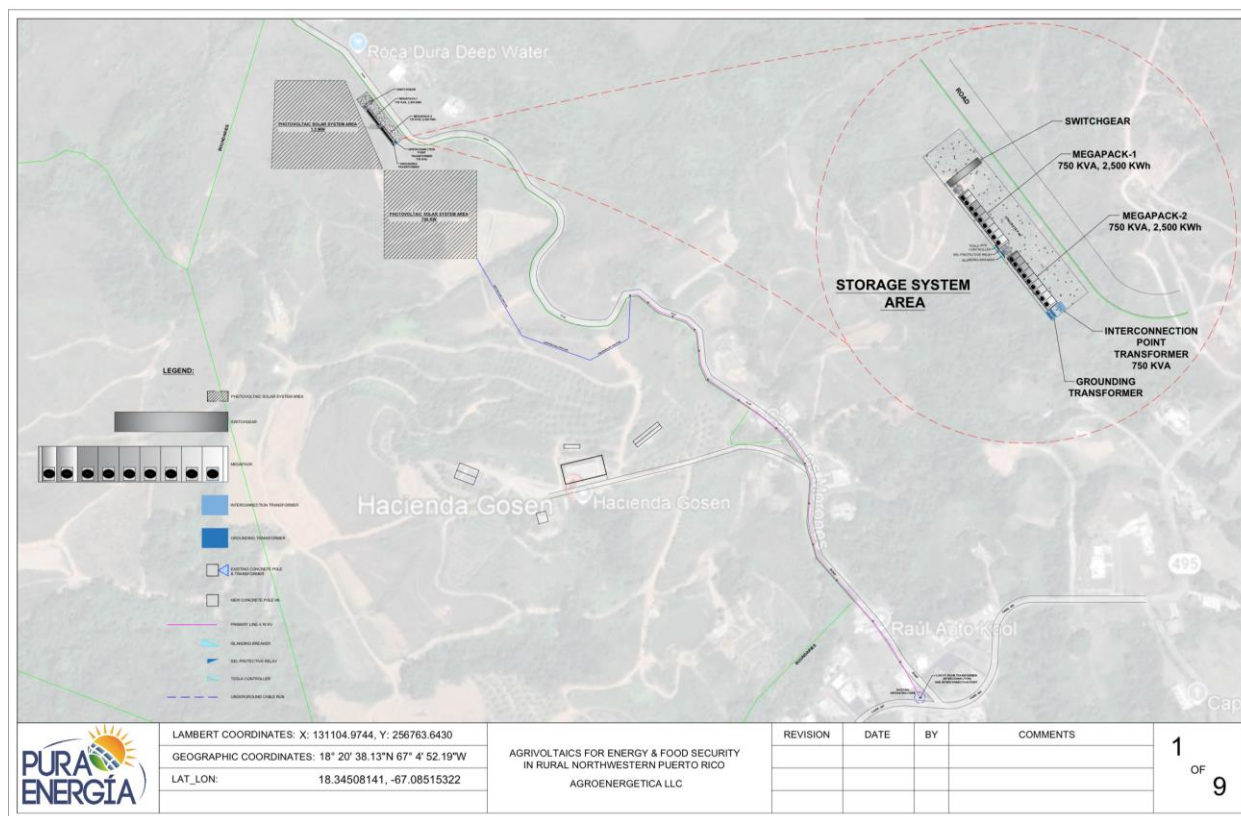
The BESS in combination with the MicroGrid power plant controller will manage the energy to the utility in a continuous, stable and regulated supply within a time

frame of 8-10 hours. As part of the integration, the overall system will also be comprised of other subcomponents that are essential to the main components integration.

- a) An energy network infrastructure that includes equipment for energy generation (usually multiple distributed energy resources, or DERs), energy distribution network(s), and energy data networks.
- b) Sensors and meters
- c) Controls at the DER level (PV System and BESS)
- d) Controls at the microgrid level, aimed at best managing the entire system
- e) SCADA system interface with microgrid op-based services such as demand charge optimization, demand response, self-consumption management, blackout management, CO₂ reduction, etc.

Figure 2: Agrivoltaics Microgrid Conceptual Site Plan

The Agrivoltaics power plant operates in a grid following mode scenario. The solar energy generated during the day will be distributed between the BESS system for the recharge of batteries and the regulated output to feed the grid. Once exported power from grid is not sufficient to reach 750 KVA by the solar system itself, BESS will contribute with the difference required by to achieve the 750-kWh output. The BESS system will discharge to an SOC of 15-20% daily.



The following day's energy generation will mainly be dedicated to BESS charging during morning hours. The Microgrid controller will manage the balance of energy distribution and power output between the BESS and the grid. AC output power will be modulated during AM hours. It will gradually reach 750 KVA, once BESS SOC is restored to 100%.

The regulation of the exported AC output to the grid allows the interconnection to the nearby primary feeder at a voltage of 4,160 Vac. The capped, regulated output will transmit a current of 105 amps to the primary feeder. Therefore, we understand that upgrade to primary feeder cables would not be required. The interconnection point is expected to be 1,900 ft from the interconnection substation. Power lines are required to extend the primary line feeders up to the substation transformer.

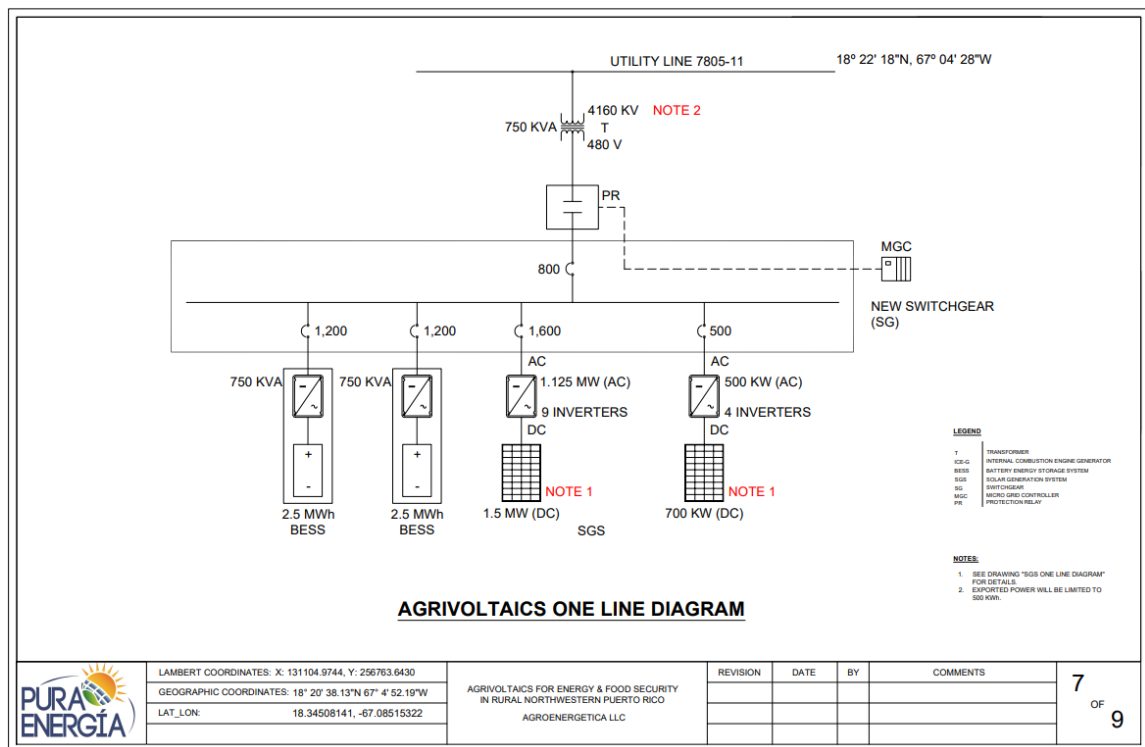


Figure 3: Agrivoltaics Microgrid System Single Line Diagram

4.4 System Configuration

4.4.1 PV Solar Energy System

The Agrivoltaics microgrid will mainly rely upon the PV solar energy generation. The proposed solar energy system 2,250 KW DC solar system with a 1.6 MW AC power output distributed and interconnected to the battery energy storage system. It generates about 9,000 KWh per day.

The estimated energy production by month for the total 2,250 KW solar system is shown in the graph.

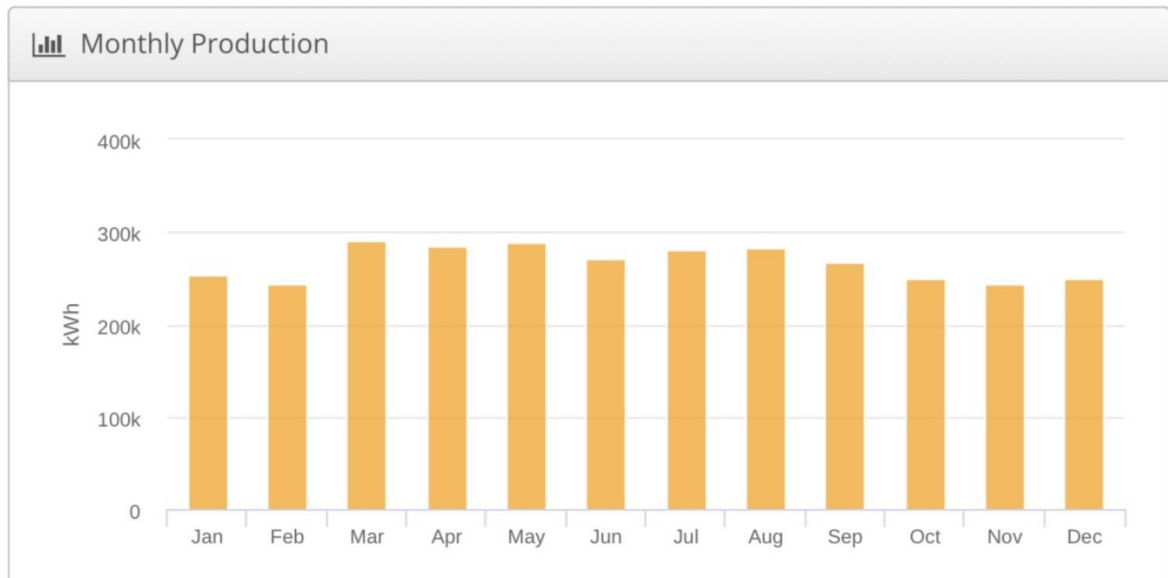


Figure 4: 2.25 MW PV system monthly production

The solar energy produced by month by the system will oscillate between 7,700 to 9,700 KWh/day. The solar energy produced by day is calculated based on the equation below:

$$\begin{aligned}
 E_d &= P_t \times (\text{peak hours}) \times \eta \\
 E_d &= 2,250 \text{ KW} \times 5.3 \times 0.78 \\
 E_d &= 9,300 \text{ KWh}
 \end{aligned}$$

The solar energy production will mainly occur during a timeframe of 5.3 hours. If the energy produced by the new system is divided into the five hours of solar energy production the energy per hour is:

$$E_d \text{ per hour} = 9,300 \text{ KWh} \div 5 = 1,860 \text{ KWh per hour.}$$

During sun peak hours, the Agrivoltaics microgrid system will store about 1,000 kWh to replenish the BESS capacity to 100%. The remaining energy will be exported to the grid, regulated to 750 kWh per hour, not to exceed the interconnection transformer capacity of 750 KVA.

4.4.2 Battery Energy Storage System (BESS)

The BESS provides the following functionality:

1. The storage for the excess of solar energy produces during the solar irradiation peak hours (5 hours).
2. The energy supply during off sun peak hours.
3. The central power provision system that will become the Grid Forming distributed energy resource, in the event of utility power shutdown.
4. A high quality electrical regulated power to be provided to the operations overall electrical loads.



Figure 5: Tesla MegaPack 2XL

The BESS shall be capable of storing energy from the solar system, but also, from other DER present as a source of power generation.

4.5 Critical Design Considerations

- Design shall fulfill the mission of having reliable and resilience energy available for the Cerro Gordo Ward community at Moca, Puerto Rico.
- Design agrivoltaics system that considers agriculture as primary use of land. Of the leased land, a minimum of 30% should still be usable farmland.
- The Microgrid power plant will have the capability to provide energy to the utility feeder even in the absence of power from the utility.
- The main source of energy shall be the solar energy/energy storage DER component.
- The BESS DER component will act as the GRID forming component in the absence of the utility. It will be the master unit establishing and

regulating the voltage and frequency of the distributed power interconnected to the grid.

- THE BESS response time shall comply with standard UPS systems response time (100 ms or less).
- The Microgrid operations shall require personnel from the provider either at the site or remotely monitoring the system operation.
- A SCADA application shall provide real time monitoring and control.
- Major components must be rated for jurisdictional seismic events and hurricane force winds of 175 mph.

PV	2.5 MW - 14 * SMA PEAK3 125 kW
BESS	1.5 MW - 2 * 2,500 kWh Storage
Interconnection Transformer	750 KVA pad-mounted, step-up, 480 VAC to 4,160 V
Application	Main Mode: BESS Grid Following BESS Island Mode: No utility presence

Table 1: Agrivoltaics Microgrid proposed power plant equipment

5. SYSTEM OPERATION

5.1 System Modes of Operation

The system modes of operation are based on the single-line diagram presented in Figure 2.

5.2 Microgrid Controller Hypothesis

Table 1 lists the conditions, or hypothesis made by the Microgrid controller in the execution of the design of the Delivery. It is the responsibility of the Customer to make sure that all these conditions are verified. The provider could not be held responsible if observed controller behavior was not in conformity with one or several items of the List of Requirements if any of the mentioned conditions were not met. These requirements should be met before the beginning of the Commissioning of the Delivery.

Hypothesis	Description
1	The plant configuration should be in conformity with the one represented in Figure 1, including the number of power units, their types, the topology of

	the power plant and the position of power meters. In the following the nomenclature reported there is followed.
2	It is the responsibility of energy system integrator to ensure that all devices to be controlled support Modbus TCP and Modbus RTU, and to provide Elum Energy with the Modbus register maps, and to ensure that the devices are in conformity with the requirement listed in Appendix A - Required IO Access.
3	The system is initially configured to work in UF mode.
4	The system can transition from UF mode (mode in which the utility regulates the voltage and the frequency of the system)) to PQ mode (mode in which the BESS allows the reception and application of active power commands) via a Modbus command to the Tesla site controller.
5	All electrical protections such as reverse power protection, over voltage protection, sync check and any other fast acting protection functions are achieved by third party devices and not included in the Elum PPC controller scope.

Table 2: List of hypotheses

5.3 *MicroGrid Control Requirements*

The plant will operate under the following two modes:

- BESS in command
- BESS in following mode

This section describes in detail each control mode including the control functions enabled and the conditions for the definition of the mode.

5.3.1 BESS in command mode (no utility power presence)

During command, the BESS is regulating the voltage and the frequency of the system while the PV inverters are in PQ mode and will receive active power commands from the Microgrid PPC Controller. Figure 3 below shows a schematic of the plant configuration in both cases of Main mode.

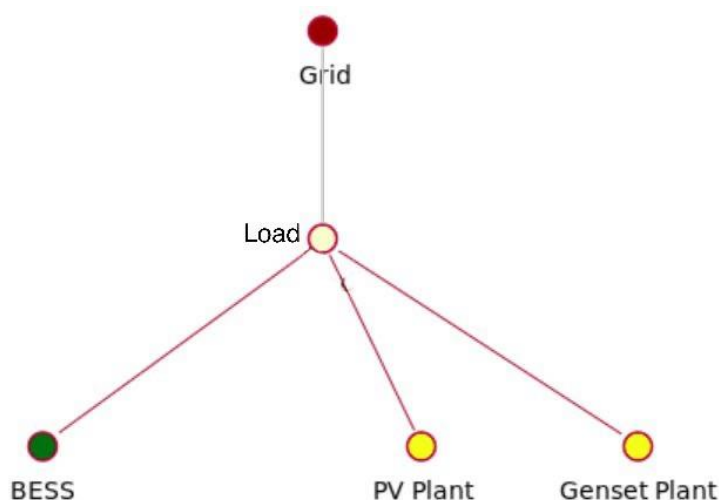


Figure 6: Topological view of the plant configuration. Yellow and green circles represent generation units in grid following mode, red circle represent generation units in grid forming modes. White circles represent load subsystems. This graph view does not respect actual distances and positions.

5.3.1.1 Control functions

Below are the control functions proposed for the BESS in command mode:

Unit	Function	Description
PV	Ramp Rate Control	Constrain PV curtailment setpoints so as to keep setpoint induced ramps of the total PV active power in a configurable range (NB: does not compensate for natural variability of the PV production).
PV	SOC limit management	Curtail PV active power when SOC reaches a configurable limit.
PV	PV fraction control	This function controls the active power setpoints by sending to the inverters to keep the part of active power mix generated by PV under a configurable threshold.
PV	Battery Power Limits	Curtail PV active power to limit the charging of the battery to a configurable maximum.

5.3.2 BESS in following mode

When User Command is received to declare the BESS in following mode, the MicroGrid controller will send a shutdown command to the BESS, switch the operating mode from PQ to UF, and perform a black start with the utility. If utility becomes unavailable, the system will send a stop command, set its operating mode from UF back to PQ, and perform a black start with the BESS.

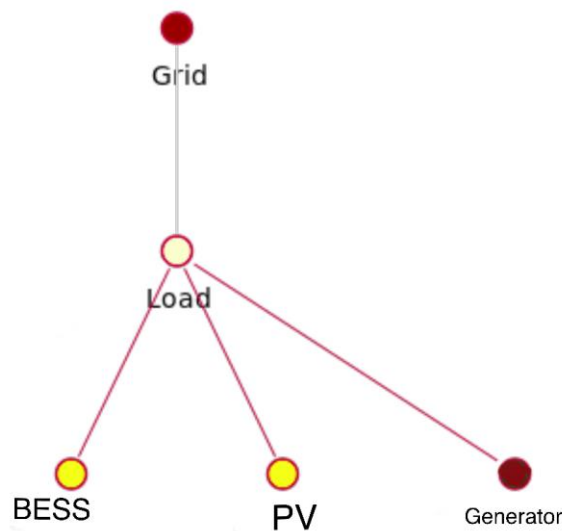


Figure 7: Topological view of the plant configuration. Yellow circles represent generation units in grid following mode. White circles represent load subsystems.

5.3.2.1 Control functions

Below are the control functions proposed for BESS in the following mode.

Unit	Function	Description
BESS	Mode Orchestration (PQ to UF)	Change the operating mode of the BESS from PQ (mode in which the BESS allows the reception and application of active power commands) to UF (mode in which the BESS follows the utility regulates voltage and frequency).
PV	Ramp Rate Control	Constrain PV curtailment setpoints so as to keep setpoint induced ramps of the total PV active power in a configurable range (NB: does not compensate for natural variability of the PV production).
PV	Genset Minimum Loading	Manage PV curtailment setpoints to prevent the genset from operating below a configured minimum loading.

6. DER COMPONENTS DESCRIPTIONS

6.1 Photovoltaic Solar Energy System

The PV solar energy system will have a total capacity of 2,250 KW.



Figure 8: Close-up of conceptual layout of PV new solar energy system

The system is composed of two main areas, the top one of 1.5 MW and the bottom one of 750 KW. Product selection shall consider wind loading capacity of the PV panels, and any PV panels selected shall withstand at least 3500 Pascals of wind uplift pressure.

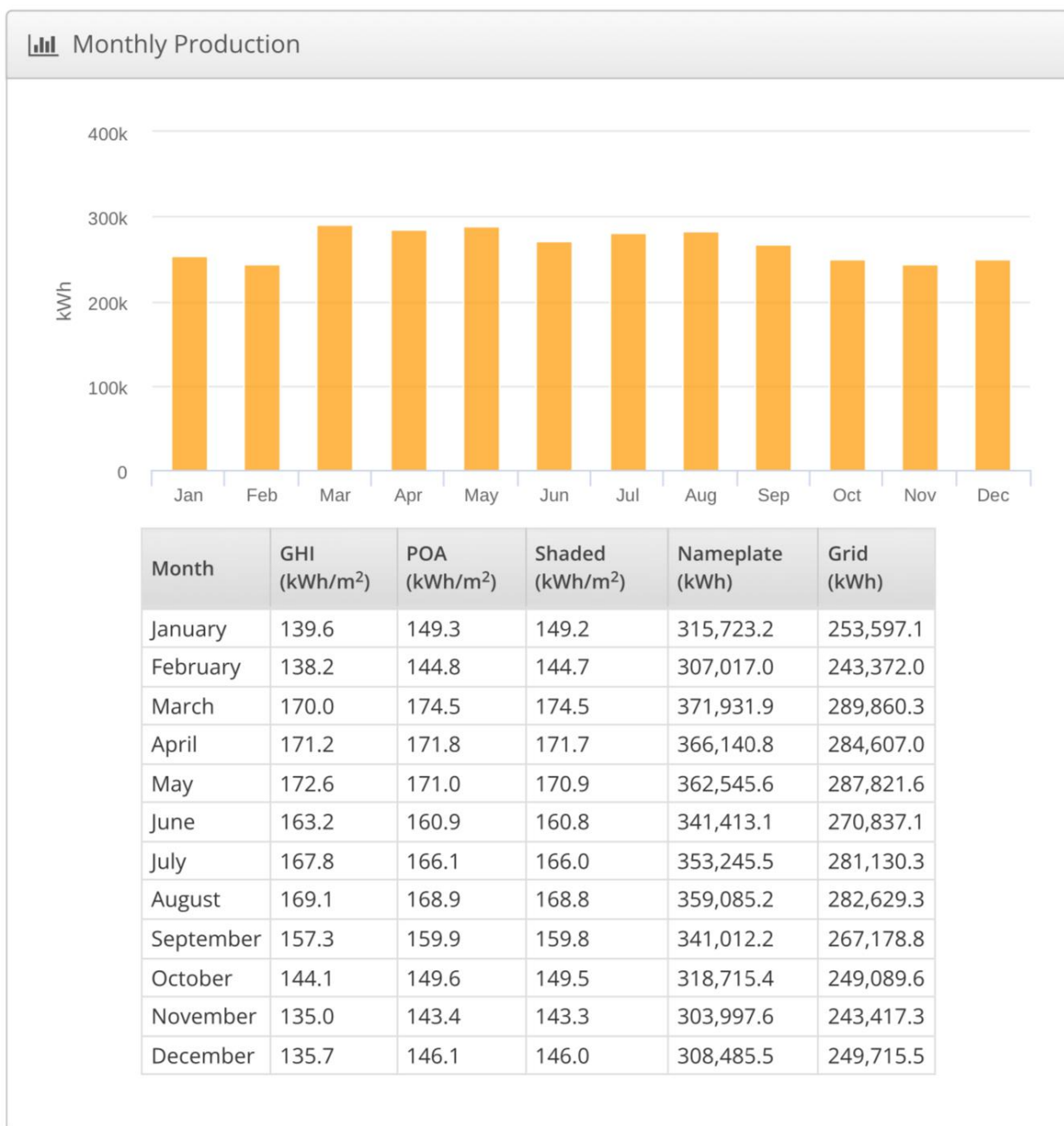


Figure 9: PV Solar system generation by month

As per the graph and table shown the months of least production are November and February. March is the month of the highest production. There are six months with production estimates over 270,000 Kwh per month, that represents 9,000 kWh per day. The total annual production is approximately 3,243,000 kWh.

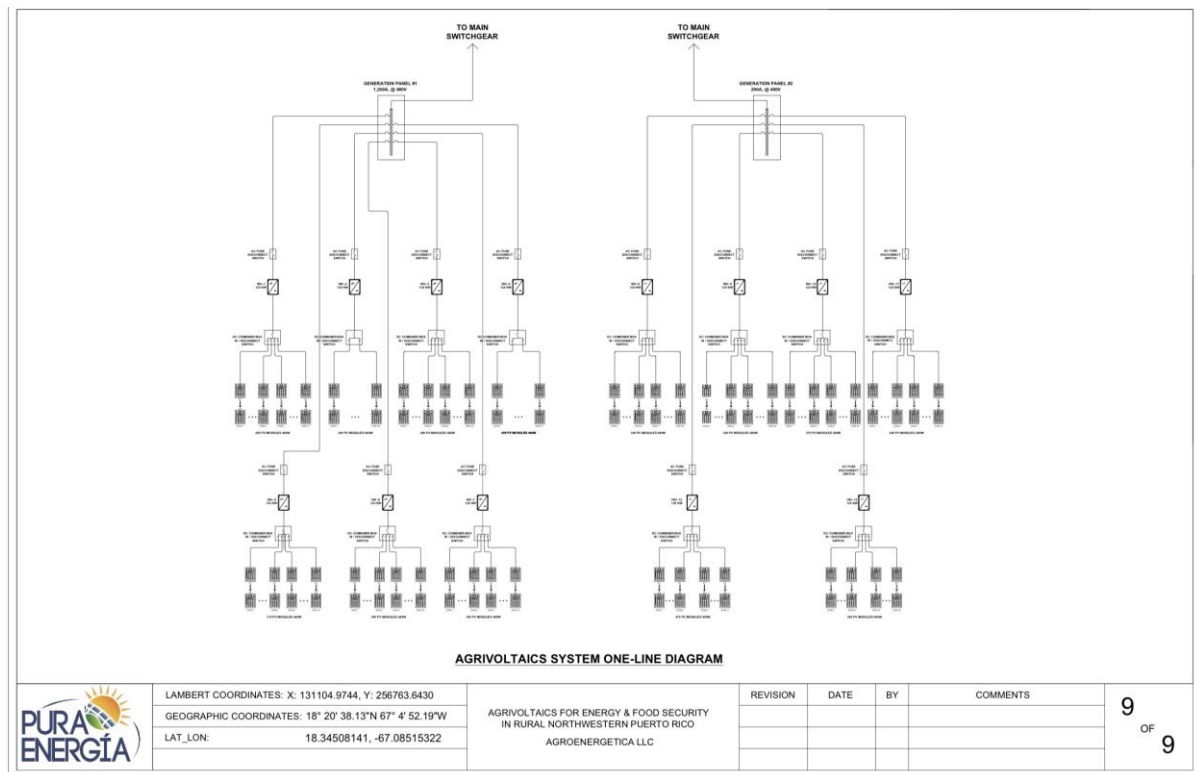


Figure 10: PV Solar system DC side one line diagram

The design of the PV system shall contemplate the addition of instruments to continuously monitor every single solar PV strings. This will ensure that the operation and maintenance department has all tools necessary to monitor, diagnose and repair any solar panel malfunction. The above schematic shows the DC side of the 2.25 MW system. A group of 5 to 7 strings will be wired up to a combiner box with fuse protection and string monitoring instruments. Network communication from each combiner box will be transmitted to the energy control center room located in the vicinity of the BESS area. In case of the need to diagnose any particular string, the combiner box could be switched off from the rest of the system.

The design has taken into consideration the required instruments, tools and safety precaution means for the continuous operation and maintenance of the system, locally or remotely.

6.2 *PV system mounting structures*

Prefabricated carport type mounting structures are planned to be used. Installation time could be reduced significantly and also structural components management is more feasible in a farm environment.



Figure 11: Prefabricated Solar mounting of PV

Design of structures shall tolerate wind gusts of 175 mph. It shall also comply with ASCE 7-16, minimum design loads and associated criteria.

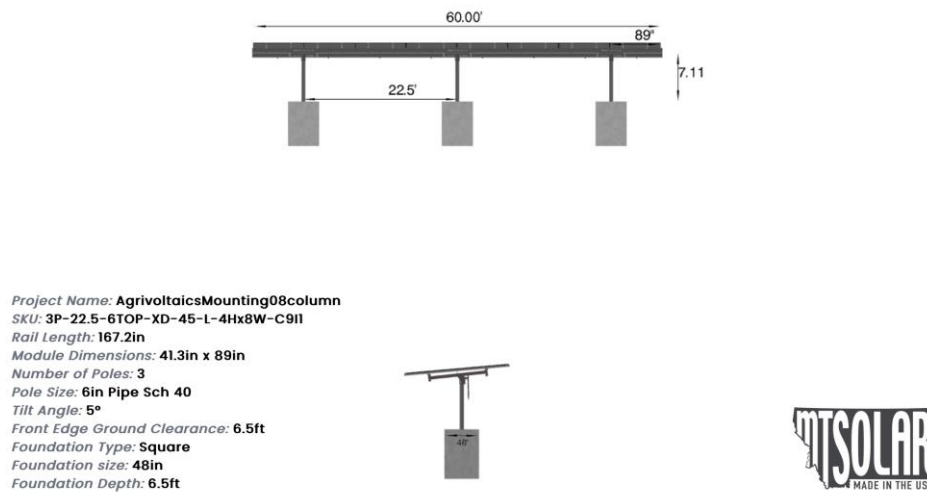


Figure 12: Typical structure for AgriVoltaics project, 32 panels structure

6.3 Battery Energy Storage System (BESS)

The BESS DER consists of five (5) 30-ft. containers as shown below. Each container encloses 2,500 kWh of batteries and a 750 KW PCS. The containers are electrically connected in parallel to the main power bus. The main power bus voltage is 480 VAC. The total energy storage is 5,000 KWh.

The ancillary equipment associated with the BESS are site controllers, instrumentation meters, controls and distribution electrical equipment.

Special considerations need to be made for concrete pad structural support based upon equipment weight.

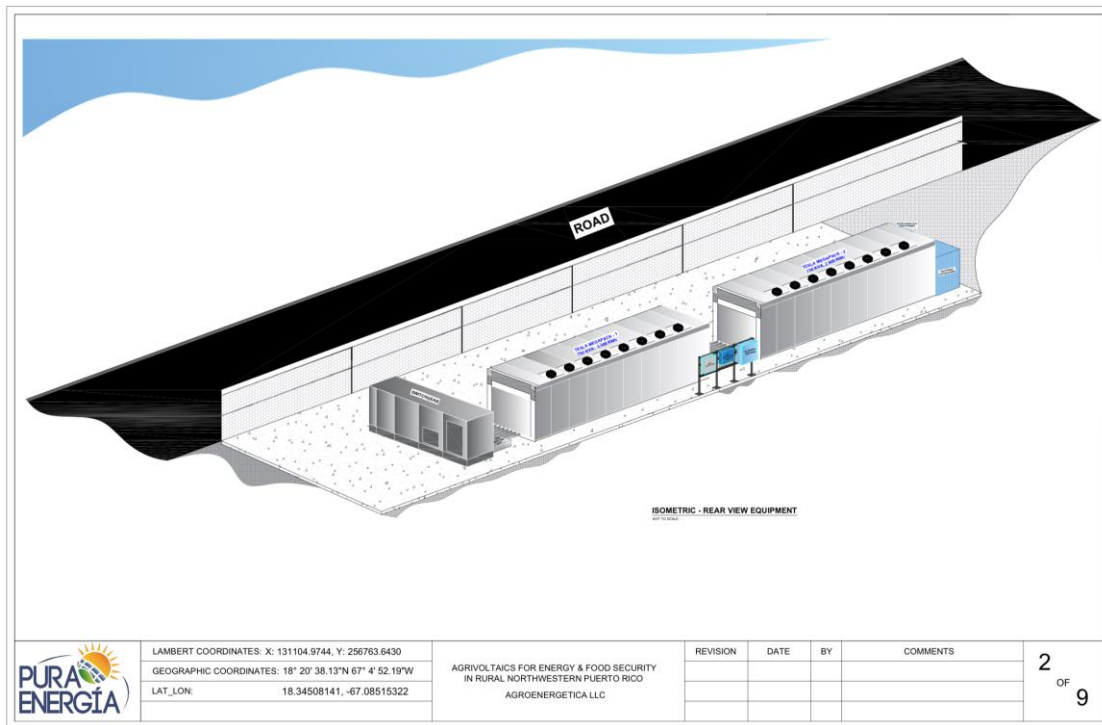


Figure 13: Top View of BESS and ancillary equipment mounting

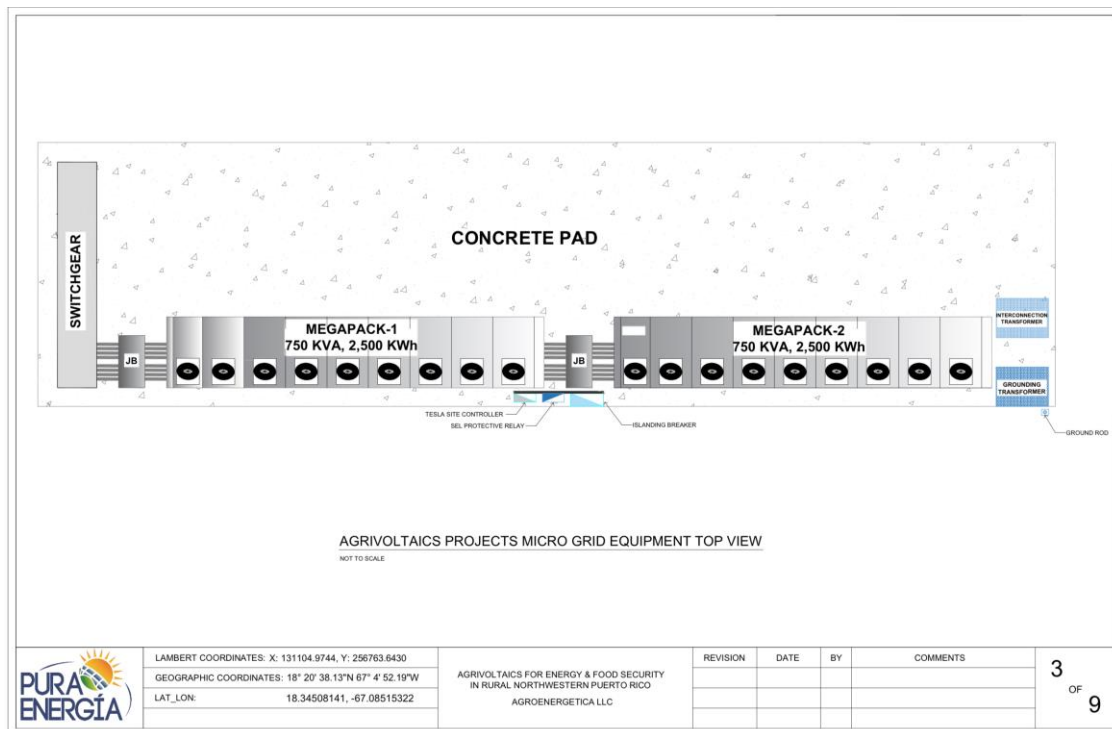


Figure 14: Isometric View of BESS layout

6.4 Intelligent Energy Center (IEC)

The Intelligent Energy Center will become the Microgrid main switchgear. Feeder protection relays and control logic will be integrated into the IEC.

The Microgrid PPC controller will actuate on the feeder protection relays associated to the DER's that are part of the MicroGrid. The SCADA system will communicate via Ethernet to the IEC for continuous monitoring of each of the system components and overall operation.

6.5 MicroGrid controls and communication

The Microgrid system requires continuous remote communication. It should provide redundancy with two different technology carriers. All DER's shall provide ethernet connection ports for remote access monitoring.

There will be an intranet for the equipment communication. The following networks are required:

- 1) DC combiner boxes network
- 2) SMA inverters network
- 3) BESS network
- 4) Intelligent energy center network

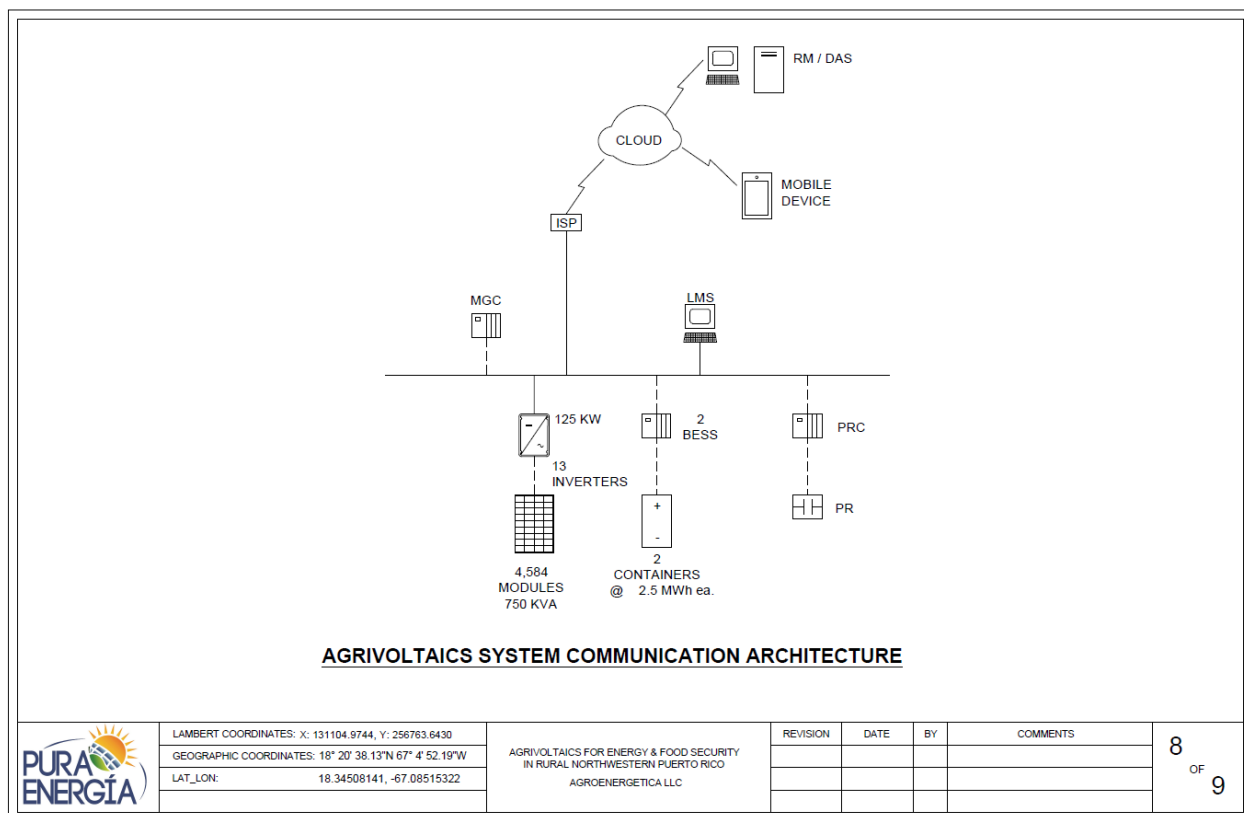


Figure 17: Communication Layout and architecture

6.6 *Utility Point of Interconnection*

Exported power to the utility is maintained at 750 KVA or under. That voltage level is suitable to be interconnected to distribution lines. The interconnection substation rated power is included 750 KVA. The transformer will serve as a voltage step-up from 480 VAC to 4,160 V.

The closest three phase line is approximately 2,500 ft from the Agrivoltaics Microgrid station or the interconnection substation. This project contemplates extending three phase lines from the nearest pole at coordinates 18.3416 N, 67.0736 W.



Figure 18: Possible point of interconnection.

7. DOCUMENTATION AND TESTING

1.1 *PV system commissioning test*

The scope of the PV system commissioning is to demonstrate that wiring up to the combiner boxes and inverters are free of defects, open circuits or

voltage arcs. Strings are tested to verify proper generation by string. Drop of AC voltage levels up to the switchgear, shall be maintained below 3%.

1.2 *BESS Site Acceptance Test (SAT)*

BESS tests will follow Tesla MegaPack 2 XL tests.

1.3 *Documentation*

Contractor will deliver the following documentation as part of the project:

- Design Specifications, schematics and system configuration documentation prior to installation
- Commissioning Acceptance Test document
- Agrivoltaics Microgrid System Manual