

University of Puerto Rico-Mayagüez (UPRM)

The Electrical and Computer Engineering Department

(www.ece.uprm.edu)

Fort Collins 2019 Symposium on Microgrids

Microgrids in Puerto Rico's Reconstruction

Associate Professor: Fabio Andrade, PhD



Universidad de Puerto Rico - Mayagüez



UPR founded in 1903,

Now: 11 campuses, 5,054 faculty, 61,967 students.

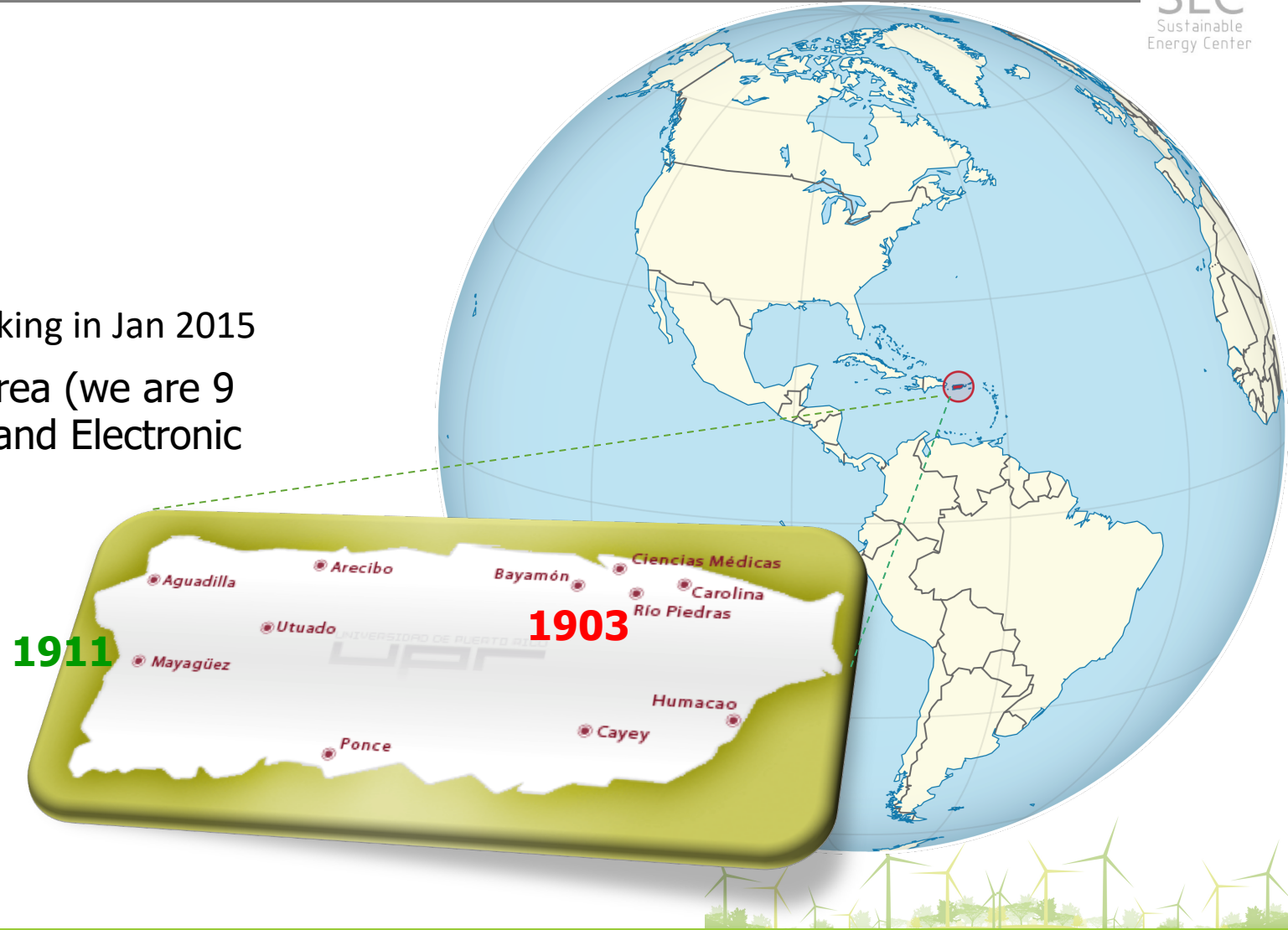
UPR Mayagüez

Electrical and Computer Eng. Dept.: Started working in Jan 2015

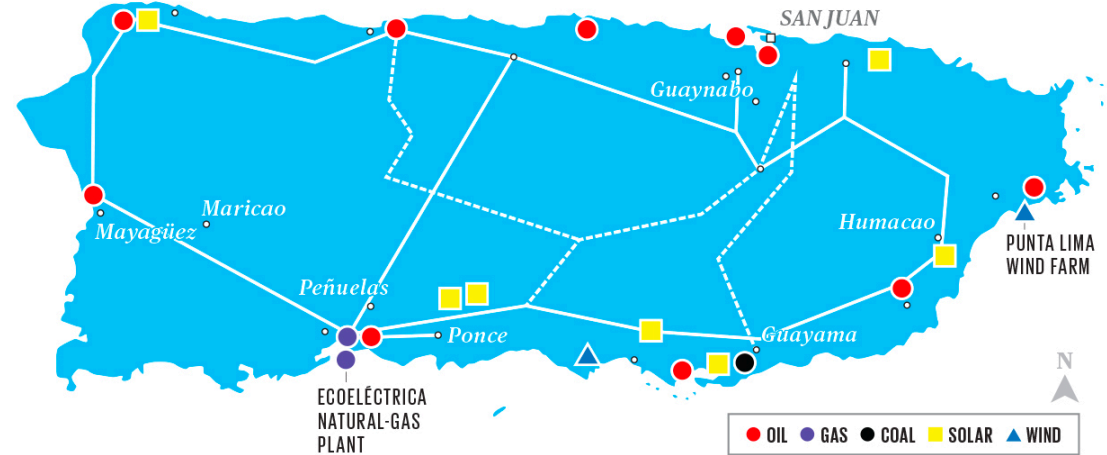
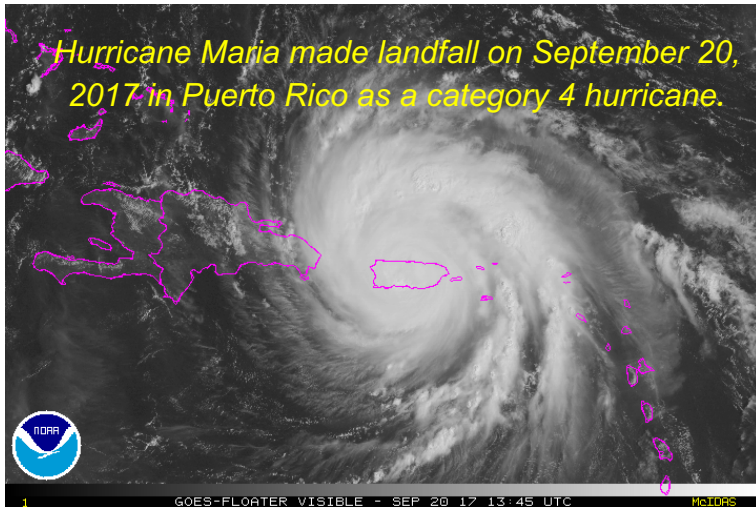
Currently I'm the coordinator of the Power Area (we are 9 Professor) and also collaborate with Control and Electronic areas

Teaching Experience includes:

- INEL 5417: Power Electronics Applied to Renewable Energy Systems
- INEL 4416: Power Electronics
- INEL 6085: Advanced Power Electronics
- INEL 6058: High Frequency Power Converters
- INEL 8496: Distributed Energy Resources



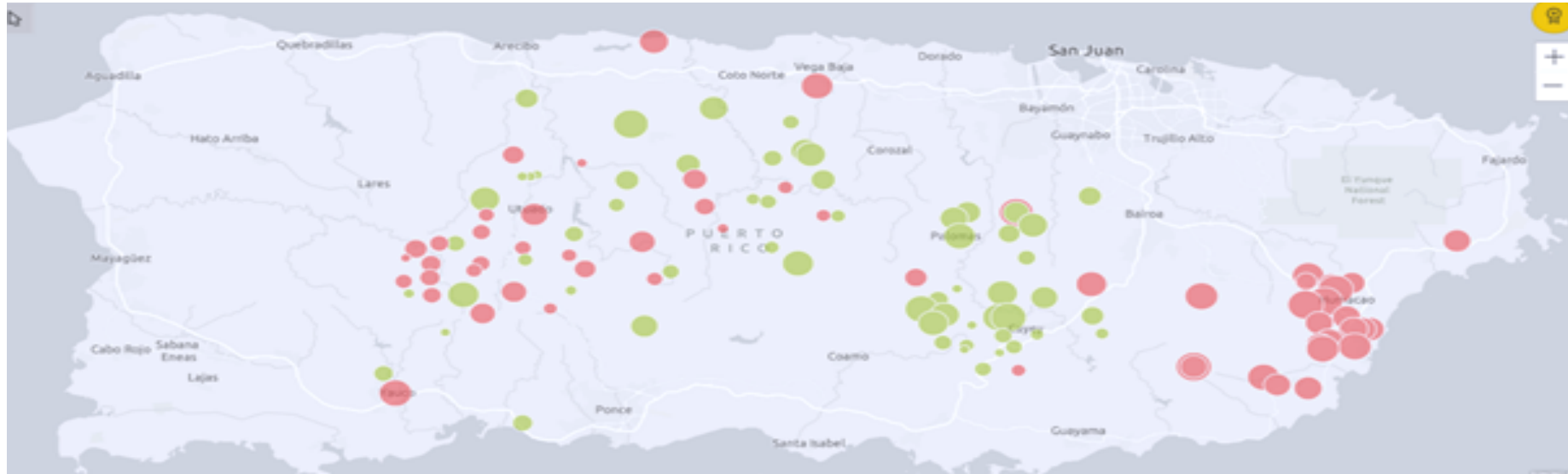
Microgrids in Puerto Rico's Reconstruction -Introduction



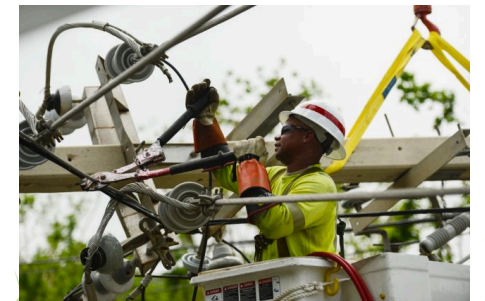
Rebuilding Puerto Rico's power grid: The inside story - M Gallucci - IEEE Spectrum, 2018

Hurricane Maria Effects on Puerto Rico Electric Power Infrastructure - A. Kwasinski, F. Andrade, M. Castro-Sitiriche, and E. O'Neill-Carrillo

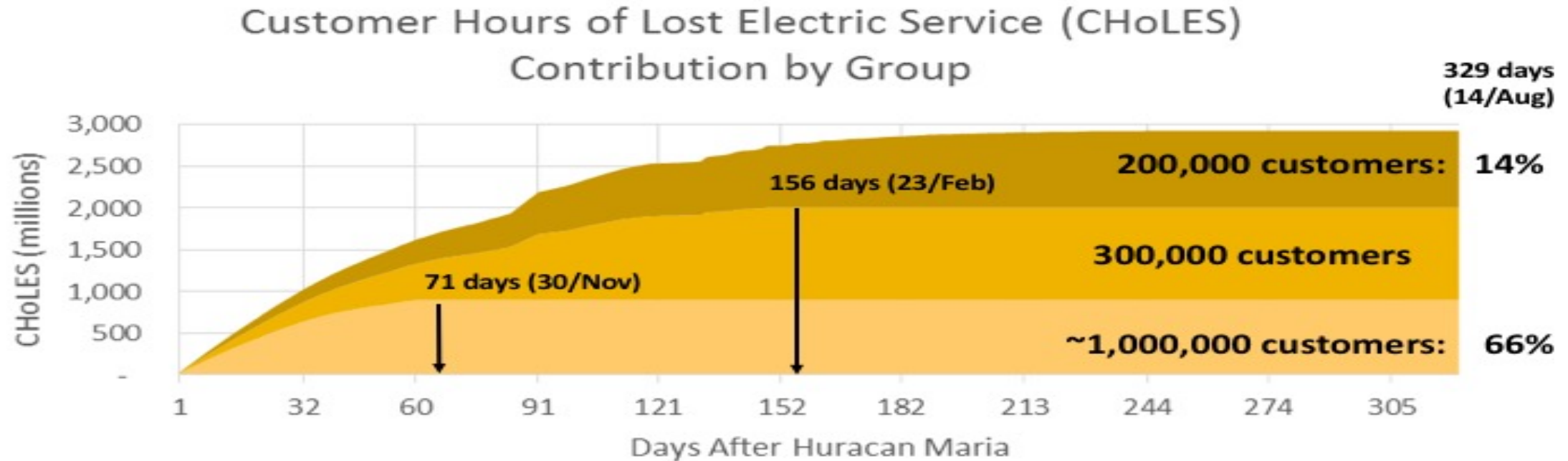
Microgrids in Puerto Rico's Reconstruction After Maria....



Location of last 28,814 homes reconnected to the grid, partial (red) and completed (green)



Microgrids in Puerto Rico's Reconstruction After Maria....



On February 23 of 2018 about 200,000 homes had no power five months after Hurricane María. In the event of an intense hurricane to devastate Puerto Rico, the same communities that were last connected remain vulnerable to long power outages.

If the last 200k households connected to the grid after María had a small rooftop solar PV system with energy storage, the blackout would have accumulated 1/3 less of the 3,000 million CHoLES, and the length of the blackout would have been 156 days instead of 329 days.

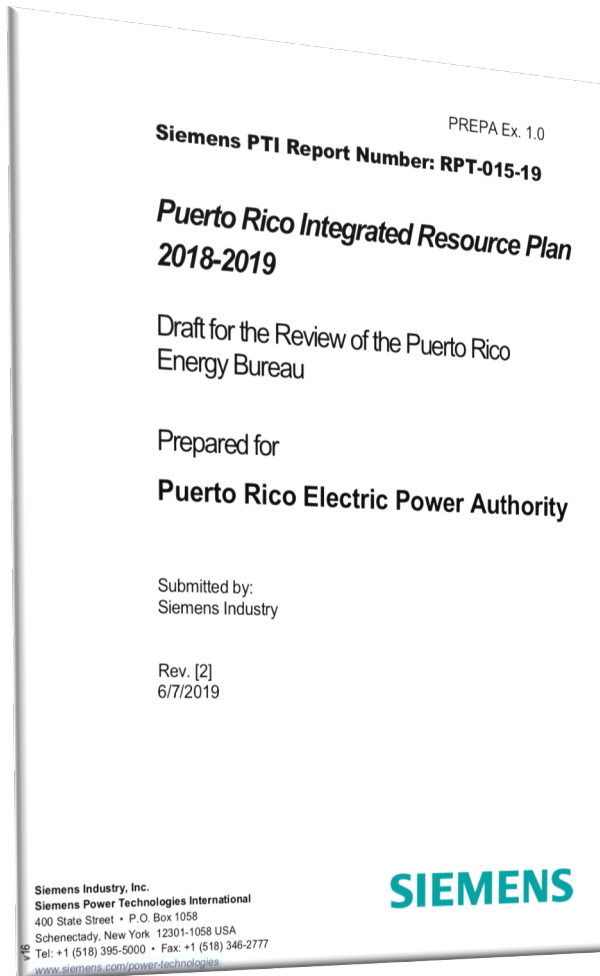
What are doing PREPA*??

*The Puerto Rico Electric Power Authority = PREPA

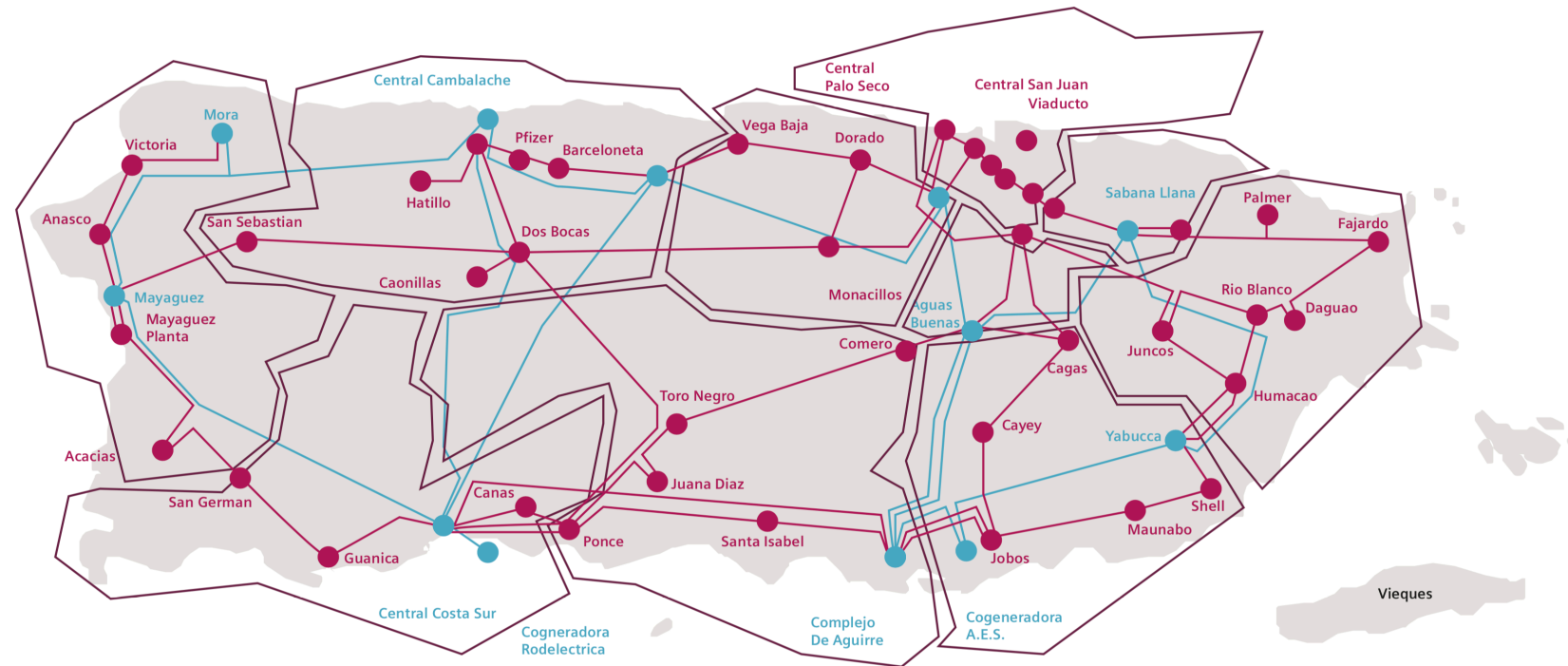
.....The hurricanes forced the Puerto Rico Electric Power Authority (PREPA) to rethink how its power supply and delivery infrastructure should be modified to ensure that the utility infrastructure was much better prepared for future weather events.....

....The IRP recommendations are fully aligned with the five key pillars adopted by the PREPA Governing Board in its Vision for the Future of Power in Puerto Rico:

1. Customer-Centric = Customer participation via energy efficiency
2. Financial Viability = min. the cost of supply and reduces the dependence on imported fuels
3. Reliable and Resilient = Concept of MiniGrids
4. Model of Sustainability = Renewable resources play the predominant role.
5. Economic Growth Engine = Employment opportunities for Puerto Rico



What are doing PREPA*??



These islands or mini-grids must be:

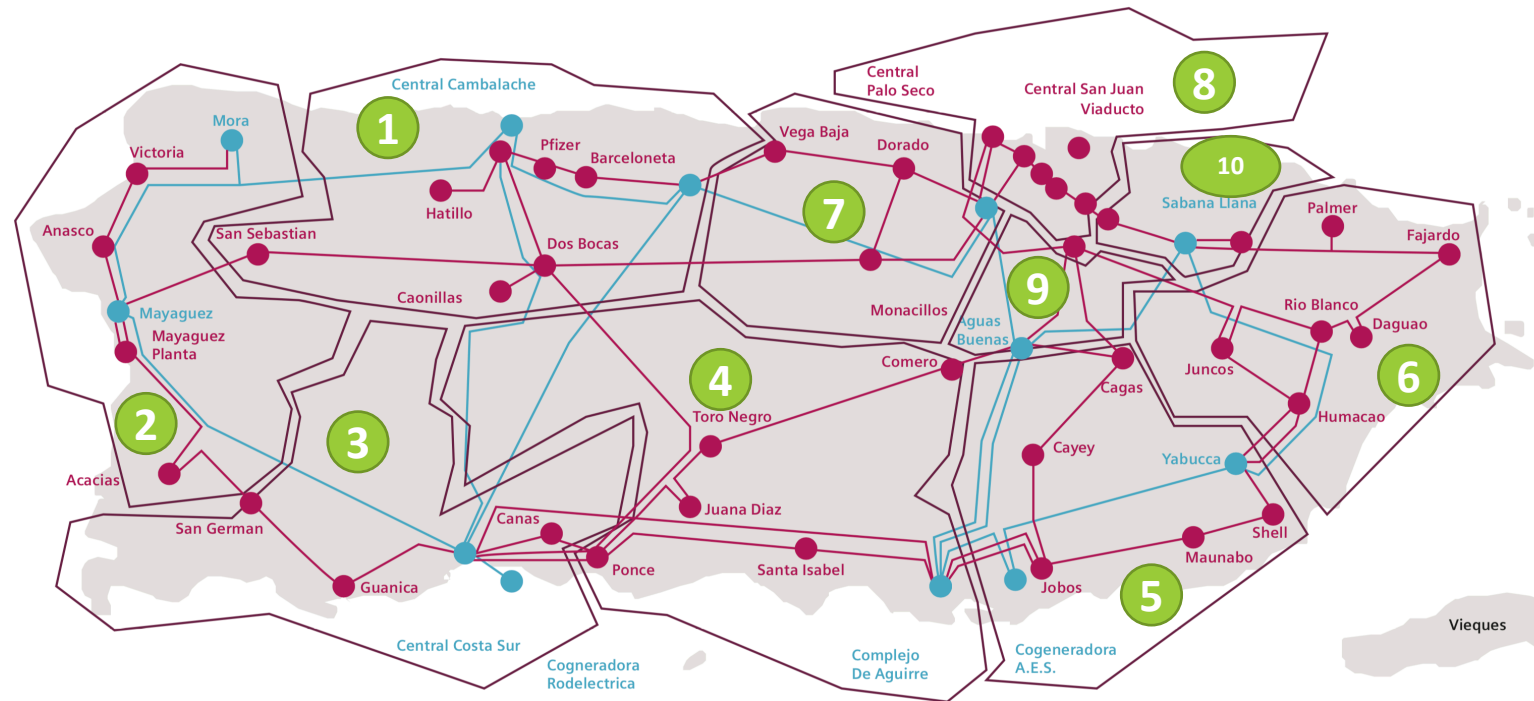
- a) Geographically compact;
- b) Require limited 115 kV and 38 kV facilities for its integration, which could be hardened to withstand major storms, and;
- c) Must have internal generation to substantially supply the load for extended periods of time.

Each mini-grid has a core and periphery

micro-grids would provide service to smaller critical loads (few MWs) until the mini-grids reach them or are connected to the main grid.



What are doing PREPA*??



No	Mini-Grid	Total Load MG	Thermal Gen. MW	Plants/Note
1	BARCELONETA	212	0	Cambalache assumed retired / replaced
2	MAYAGÜEZ	224	220	Aero-Mayagüez
3	COSTA SUR	246	506.9	EcoEléctrica
4	JAYUYA	218	526.9	Aguirre CC repowered
5	YABUCOA	286	454	AES Coal
6	HUMACAO	266	0	Older 21 MW GTs not considered
7	VEGA BAJA	288	0	Small landfill gas may be present
8	SAN JUAN	513	359	San Juan Combined Cycle
9	AGUAS BUENAS	312	0	
10	SABANA LLANA	279	0	
	TOTAL	2844		

What are doing PREPA*??



Siemens, PREPA IRP

- **2,280 MW of utility scale PV** are added starting on 2022 with initial rate of 600 MW/yr.
- **1,580 MW** of battery energy storage with a combination of 2, 4 and 6 hours. 1,280 MW installed in 2022.
- Three large CCGTs are installed, one H Class in Bayamon and one F-Class in Ponce West in 2025. Another smaller F Class is installed in 2030 in San Juan.
- J 5 & 6 converted to gas in 2023. One unit retired later economically by 2025 and the other by 2033.
- **685 MW of peaking generation** distributed throughout the island.



What are doing Communities, citizens, etc ??



Jayuya, noviembre 2017
Foto: Borintek



Jayuya, Noviembre 2017
Foto: marcel

Aibonito, Marzo 2018
Foto: Equipo IEEE-WPR / INESI



Veguita Zamas, Jayuya
Mayo, 2018
Foto: marcel



Veguita Zamas, Jayuya
Mayo, 2018
Foto: marcel

What are doing Communities, citizens, etc ??



Toro Negro Community Solar, Ciales, Puerto Rico:

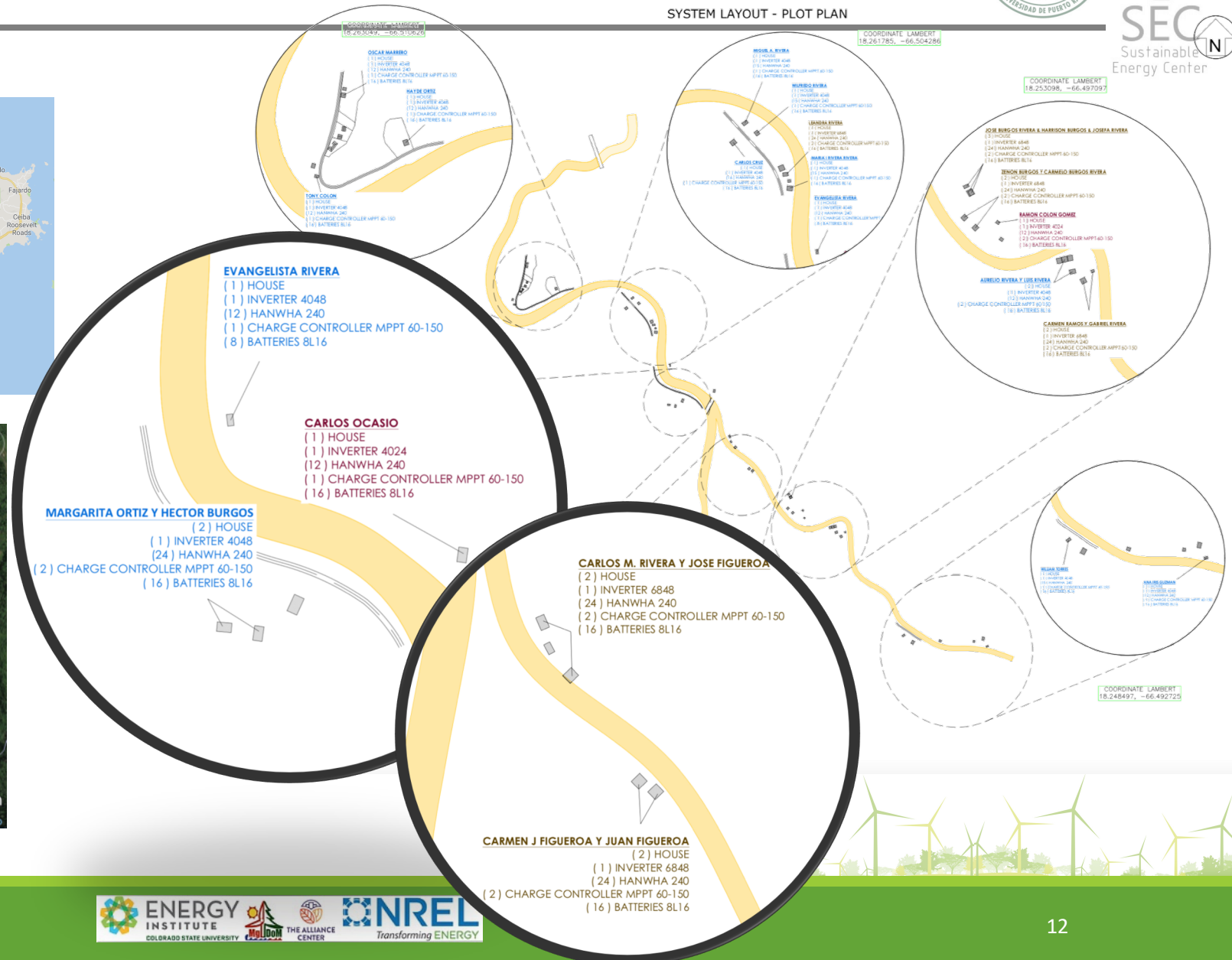
- 28 houses
- 20 Photovoltaic systems with batteries
- 345 PV panels Hanwha 240W
- 6 Inverter Conext XW 6848
- 12 Inverter Conext SW 4048
- 2 Inverter Conext SW 4024
- 312 Batteries DEKA Solar 8L16
- 28 charger controllers



What are doing Communities, citizens, etc ??



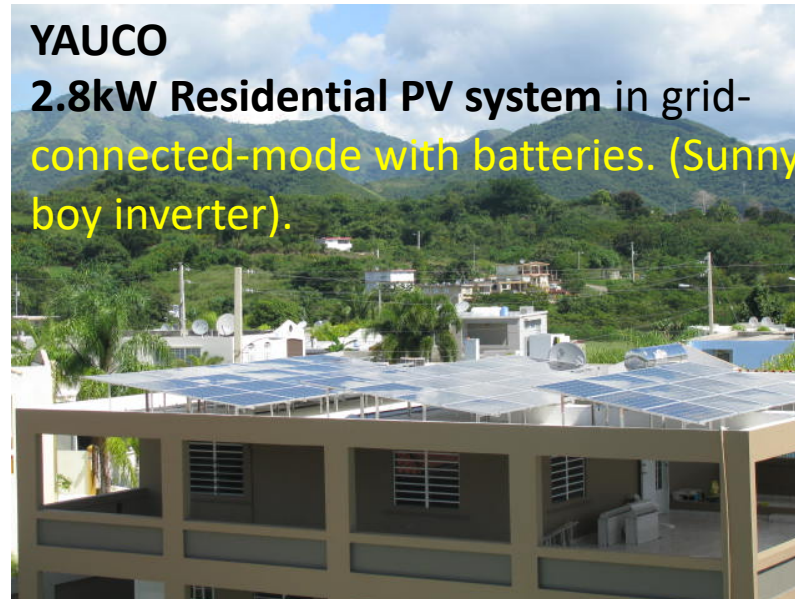
Solar Community of Toro Negro:



What are doing Communities, citizens, etc ??



ISABELA
6kW Residential PV system in grid-connected-mode with batteries.
(Inverter Xantrex XW with 8 batteries Deka Solar 8A8DLTP).



YAUCO
2.8kW Residential PV system in grid-connected-mode with batteries. (Sunny boy inverter).



AGUADILLA
6kW Residential PV system in grid-connected-mode with batteries.
Schneider Electric GT3.3 with 8 batteries Deka Solar 8A8DLTP.

What are doing Communities, citizens, etc ??



Esperanza Village: First microgrid certified by the Puerto Rico Energy Bureau

Fundación Comunitaria de Puerto Rico (FCPR) The project is in the Esperanza Village community, in the town of Juncos, and has nine rental houses. The microgrid has 55 solar panels of 330w and 32 kWh batteries; the majority of the residents are 55 plus and have few economic resources.



What are doing Communities, citizens, etc ??



Casa Pueblo: Adjuntas, Puerto Rico

Casa Pueblo is working to energize their community with solar and renewables include a cinema, a radio transmitter, 50+ refrigerators, 6 neighborhood food markets, 1 barbershop, 2 Restaurants, 20 houses, 2 hardware stores, spaces for workshops, meetings, educational events, thousands of solar lamps, and many more solar projects for the community.



What are doing Communities, citizens, etc ??



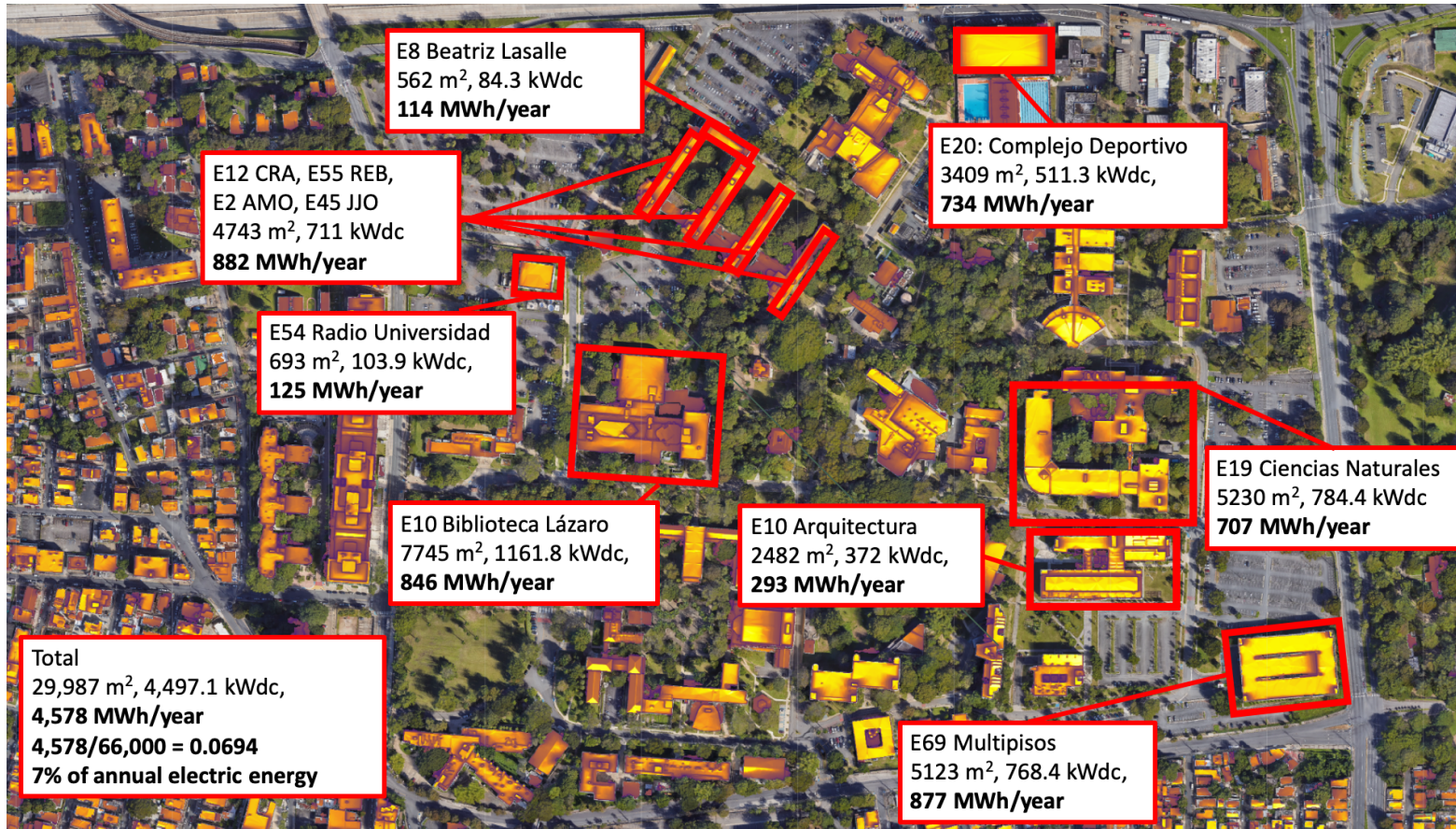
hispanicfederation

They are supporting, through partnerships, the creation of reliable and durable green power sources for home and institutional use, including critical facilities, community centers and homes in isolated areas that can serve as disaster relief hubs when future disasters hit.



Clinic Name and Location	Solar capacity	Battery capacity	Installation Status
Migrant Health Center Western Region (Maricao)	18.02 kW	20 kWh	Completed
Corporacion de Servicios Medicos Primarios y Prevención de Hatillo (Utuado)	15.84 kW	20 kWh	Completed
Profamilias - Clinica Celestina Zalduondo (San Juan)	25 kW	40 kWh	Completed
Profamilias - Clinica Iella (San Juan)	19.47 kW	40 kWh	Completed
Migrant Health Center Western Region (Las Marías)	34.65 kW	40 kWh	Completed
Centro de Salud Familiar Dr. Julio Palmieri Ferri, Inc. (Guayama)	43.23 kW	40 kWh	Completed
Centro de Salud Familiar Dr. Julio Palmieri Ferri, Inc. (Arroyo)	206.25 kW	475 kWh	Installation
Prymed Medical Care, Inc. (Ciales)	173.91 kW	475 kWh	Installation
Hospital General Castañer (Castañer - Lares)	230.34 kW	475 kWh	Installation
Servicios de Salud Primarios de Barceloneta, Inc. (Barceloneta)	263 kW	144 kWh	Installation
Concilio de Salud Integral de Loíza (Loíza)	270 kW	475 kWh	Installation
Salud Integral En La Montaña (Orocovis)	136 kW	456 kWh	Preparation
Centro de Servicios Primarios de Salud de Patillas (Patillas)	97.92 kW	228 kWh	Preparation
Center for Diagnostics and Treatment (Culebra)	50 kW	100 kWh	Preparation
COSSMA, Inc. (Yabucoa)	62.05 kW	170 kWh	Preparation
COSSMA, Inc. (Las Piedras)	187 kW	456 kWh	Preparation

What are doing Communities, citizens, etc ??



The UPRM Power area is working in different projects for 2 campuses (UPR has 11 campuses). We are evaluating different opportunities to create a Microgrid in campuses of Rio Piedras and Mayaguez



Developing socially and economically generative, resilient PV-energy systems for low- and moderate-income communities: Applications for Puerto Rico



Project Team

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University of Puerto Rico-Mayaguez

Cecilio Ortiz
Marla Perez Lugo
Fabio Andrade
Marcel Castro

National Renewable Energy Laboratory

Benjamin Sigrin
Meghan Mooney

(04/2019 – 03/2022)

The project proposes **innovative pathways** for accelerating photovoltaic (PV) technology adoption among **low- and moderate-income (LMI) communities** in ways that generate positive social and economic benefits, including higher levels of energy security and socio-economic resilience.



U.S. DEPARTMENT OF
ENERGY

Office of
Science



What are doing Communities, citizens, etc ??



Working with different municipalities to create energy project proposal to apply to the Hazard mitigation grant program (HMGP).
Currently:

- Microgrid to Añasco town Hall
- Microgrid to Hospital in Añasco



Thank you!!! Questions???

