The Role of Community Microgrids in Improving Resiliency for Puerto Rico's Remote Areas

Yuly V. Garcia, Fabio Andrade
University of Puerto Rico at Mayaguez

Motivation

Puerto Rico's centralized grid has proven fragile against hurricanes and earthquakes, leading to *the longest blackout in modern history* after Hurricane María.

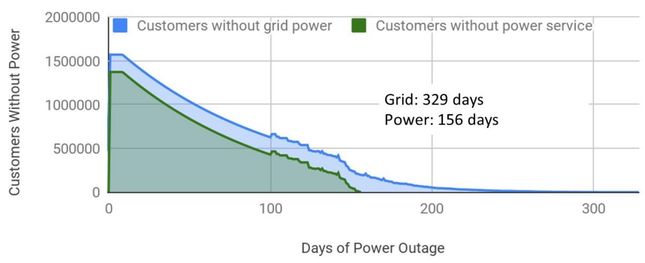
Main Issues:

- 97% of energy comes from imported fossil fuels. Building Resilience Through Microgrids
- Transmission and distribution systems are outdated.
- Frequent and prolonged blackouts.
- Rural and mountainous areas are last to recover power.

Fishing Villas in Puerto Rico

The crisis

- Aging, fossil fuel-dependent electric system made the population highly vulnerable to disasters.
- Hurricane María (2017) exposed this, resulting in the longest blackout in human history.
- Poor energy quality and multiple blackouts are the "new normality".
- The crisis is a matter of energy justice (e.g., 3,000+ deaths post-María)



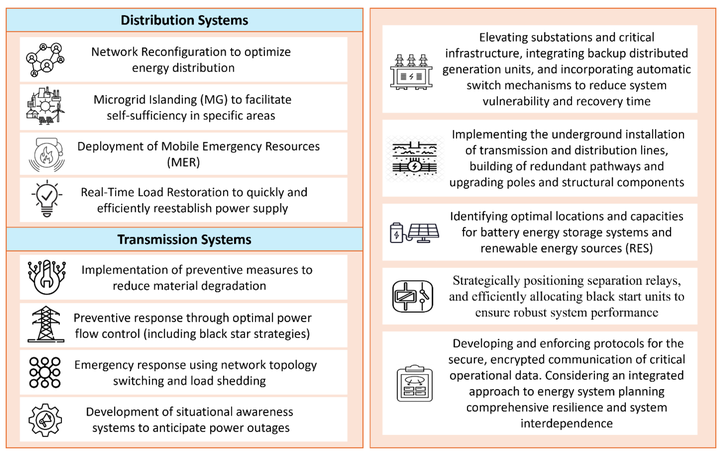
Reduction of blackout duration with rooftop PV → Grid: 329 days → PV: 156 days (≈40% reduction).

Building Resilience Through MGs

Community microgrids are *bottom-up solutions* that decentralize generation and improve resilience by empowering local users.

Main Concepts:

- Locally managed distributed generation (solar + storage).
- Island-mode operation during disasters.
- Prioritization of critical loads (health, communication, refrigeration).

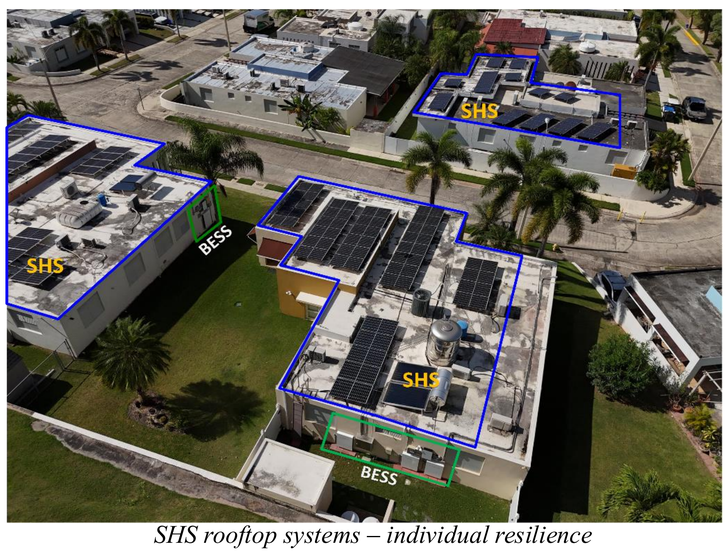


Operational and Planning Strategies for Resilience

System	Scale	Best Use	Advantages
SHS	Individual	Emergency access	Rapid & low cost
Nanogrid	5–10 users	Small communities	Scalable, reliable
Microgrid	100–1000 users	Critical facilities	High resilience

Comparison of Remote Topologies

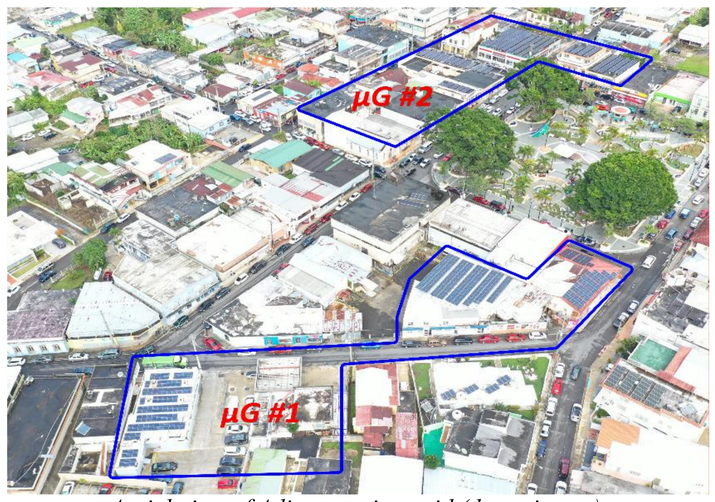
Nanogrid example – daycare and high school powered by PV + BESS



SHS rooftop systems – individual resilience

Case Study: Adjuntas Microgrid Project

The *Adjuntas Microgrid*, developed by Casa Pueblo & Honnold Foundation, is Puerto Rico's first **community-owned** microgrid. It powers local businesses and critical services in emergencies.



Aerial view of Adjuntas microgrid (drone image).

Technical & Social Results:

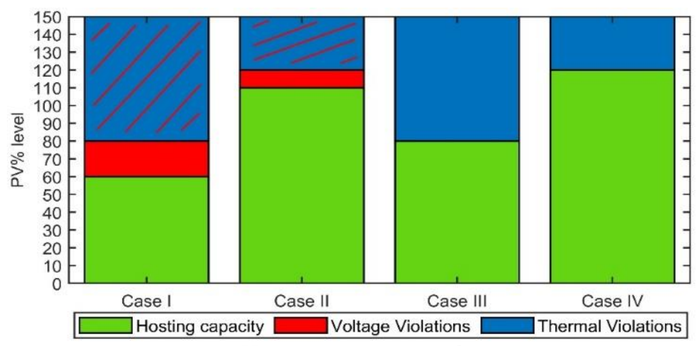
- 1 MW solar + second-life EV batteries → **3 days of autonomy**
- Serves 11 businesses → expanding to 30
- Energy cost: **$0.24 → $0.15 per kWh**
- Resilience hub: pharmacy, nursing home, and communications.

Policy and Regulation Framework

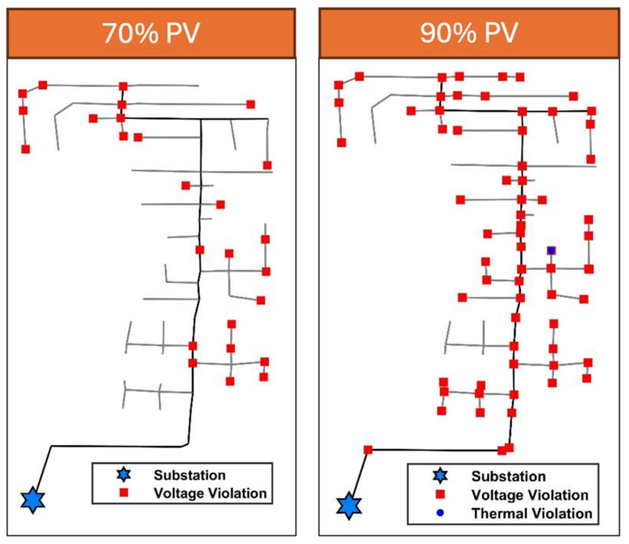
Regulation 9028 (PREB) and Act 17–2019 enable microgrid deployment and set the 100% renewable target by 2050.

Regulation Highlights:

- Defines **personal, cooperative, and third-party microgrids**.
- Simplifies registration (approval within 30 days).
- Encourages renewable and storage integration.
- Promotes resilience and energy affordability.



Hosting capacity analysis



Network topology showing nodes where violations occur

Conclusions

- Microgrids are more than a technical innovation — they are a *social tool for empowerment, climate resilience, and energy justice*.
- Promoting the use of **storage systems** and the efficient **advanced functions of smart inverters** is vital for supporting the grid and facilitating the energy transition.
- The bottom-up microgrid approach is essential for enhancing **grid resilience** and advancing **energy justice** in Puerto Rico.