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Voltage Maintenance Studies for a Microgrid in Salinas, Puerto Rico

Melissa S. Louie[1], Rachid Darbali-Zamora[1], Thad Haines[1], Jimmy Quiroz[1], Wanda Rios[2], and Adam Eberwein[3]

[1]Sandia National Laboratories, Albuquerque, New Mexico, 87185, USA
[2]Abeyno Cooperative, Salinas, 00751, Puerto Rico
[3]EarthSpark International, Washington D.C. 20009, USA

Introduction: *Communities face unique, localized challenges related to the electric grid.*

Case Study: La Margarita, Puerto Rico

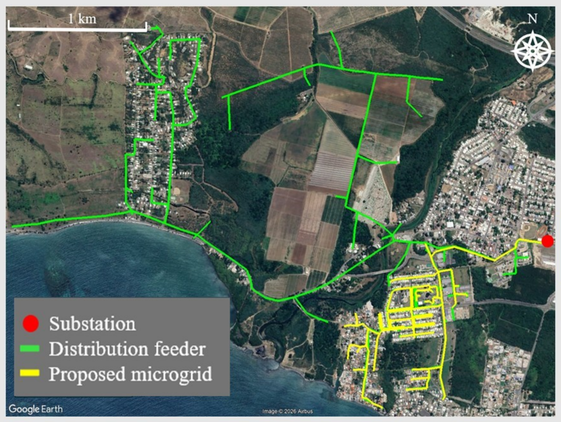
Population Characteristics
- Elderly population
- Many pre-existing health conditions (asthma, cancer)
- High electricity demand for medical devices, refrigeration, A/C, light

Electrical Challenges:
- Aging/damaged infrastructure (e.g., from Hurricane Maria)
- Insufficient backup power for all residents during grid outages

The community is currently developing a feeder-level microgrid to improve grid resilience.

Microgrid Domain Study

Will voltage remain stable if the only part of the existing feeder is used for the microgrid?

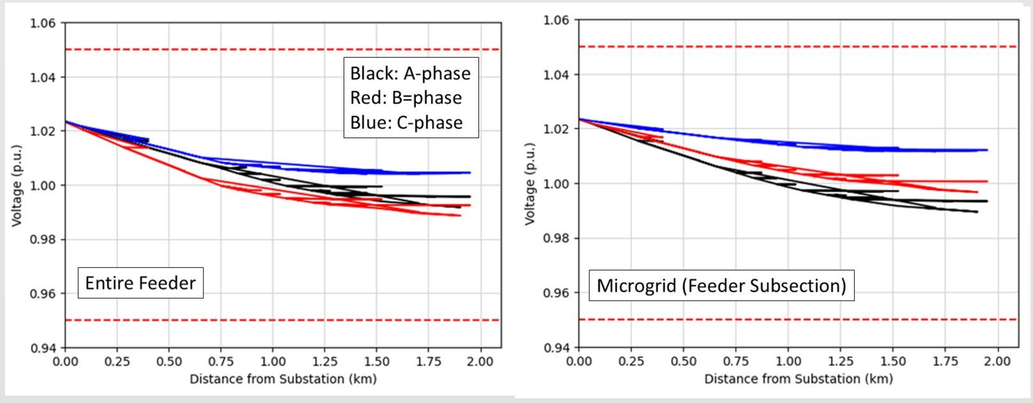


The proposed microgrid (yellow lines) will use a portion of the existing distribution feeder line (green lines).

In this subsection of the feeder, loads are not balanced across phases:

Phase	Feeder Load (kW)	Microgrid Load (kW)
A	770	610
B	700	385
C	740	220

Using a subsection of the feeder for the microgrid domain increases the voltage imbalance across phases from imbalanced loading, but reasonable voltages are still maintained across phases:



The voltage across the system is expected to remain stable and within ANSI/NEMA C84.1 standard limits of +/-5% of nominal voltage for the selected microgrid domain.

PV Limitation and Volt-VAR Control Studies

What are the limits to the amount of PV that can be added?

PV installations under 25 kW (mainly rooftop residential PV) are expected to be connected by individual households.[1]

Large-scale installations (rooftop, carport, ground-mounted) are planned for industrial areas in the neighborhood.

→ PV injection > load can lead to voltage issues (phase imbalance, overvoltage)

→ PV reduction may be necessary

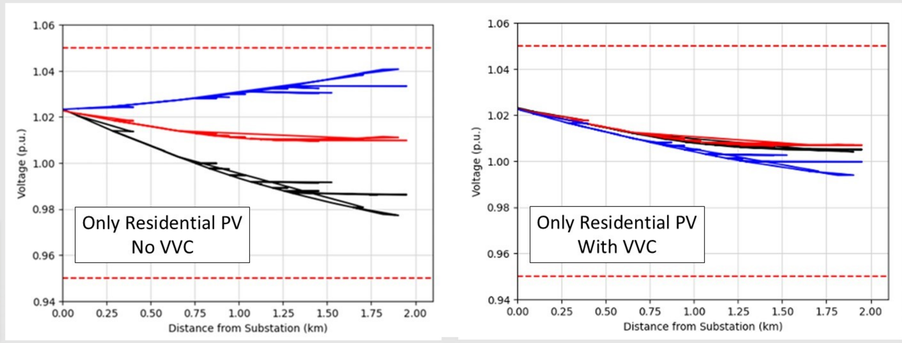
Scenario	# PV Installations	Total AC Nameplate (kVA)
Only Residential	50	170
Residential and Industrial	17	5100
Reduced Residential and Industrial	12	3400

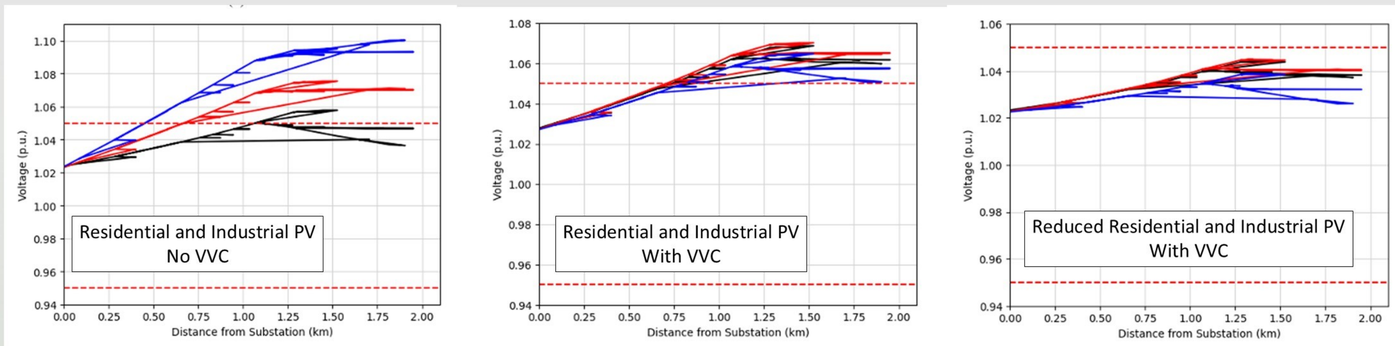
Certain VVC parameters are required by the Puerto Rico utility.[2]

→ VVC can improve voltage levels and phase balance for either PV case.

Smart inverter setting requirements for VVC[2]

V1/Q1 (%)	V2/Q2 (%)	V3/Q3 (%)	V4/Q4 (%)
107/-44	104/0	98/0	92/+44





The expected Volt-VAR control parameters will likely be sufficient for maintaining voltage for the expected residential PV installations as well as some planned large-scale/industrial PV installations.

Industrial PV installations may need to be prioritized/selected to prevent overvoltage from too much PV injection compared to load on the microgrid.

Conclusions

These voltage studies provide context for opportunities and limitations of the proposed microgrid from the standpoint of the electrical system. These considerations may inform decision-making about microgrid design and operations.

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[1] "Agreement to Interconnect Generators with Capacity of 25 kW or Less with the Electric Distribution System of the Electric Power Authority and Participate in Net Metering Programs." LUMA. [Online]. Available: https://lumapr.com/wp content/uploads/2023/11/Interc
[2] "Submittal of LUMA's Revised Smart Inverter Sheets and Responses to Stakeholder Comments to LUMA's Comments of April 25, 2025," Puerto Rico Energy Bureau, Case No. NEPR-MI 2019-0009, Jun. 2025.