

**University of Puerto Rico-Mayagüez (UPRM)**  
The Electrical and Computer Engineering Department  
([www.ece.uprm.edu](http://www.ece.uprm.edu))

**Methods to analyze power quality in communities vulnerable to hurricane events  
and evaluate controllers to improve the power quality using Microgrids**

Profesor: Fabio Andrade, PhD



# Outline

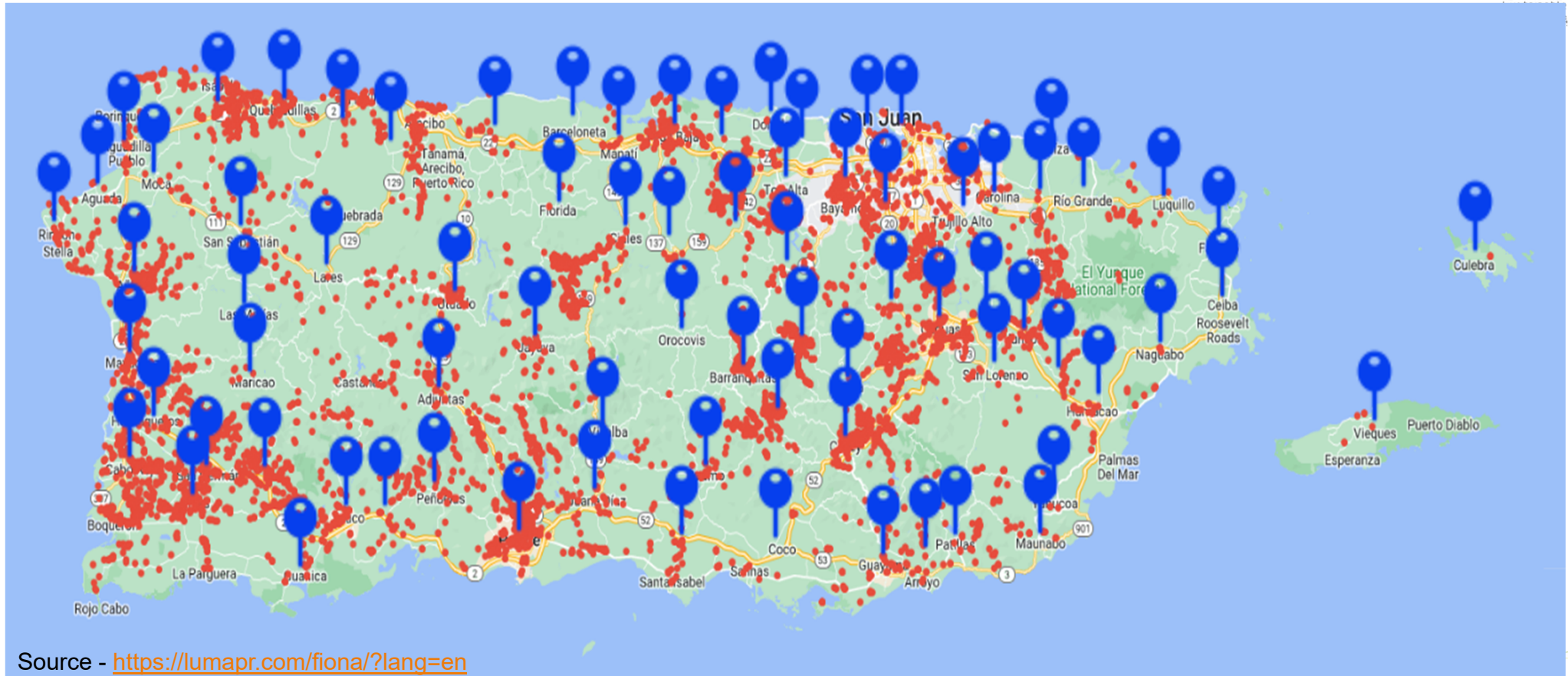
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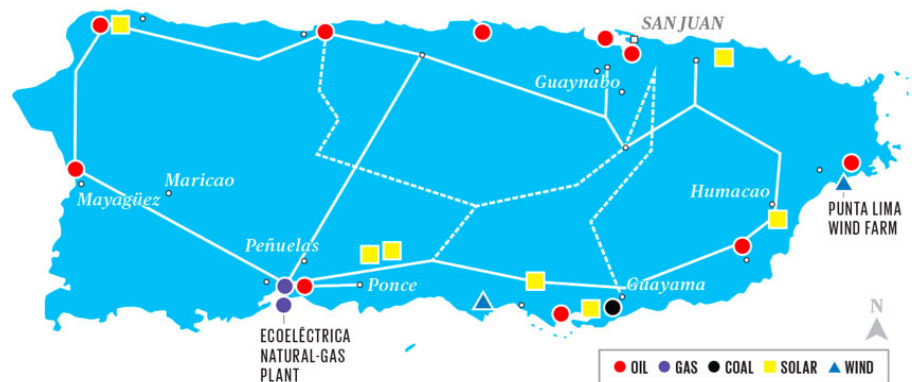
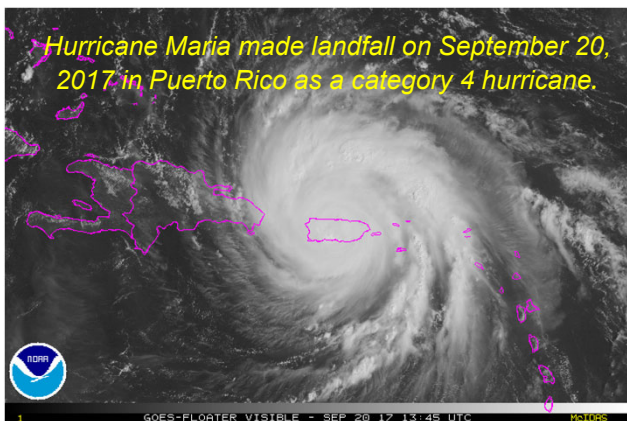
PR Energy Challenges  
Resilient at UPRM Research  
Resilient at LLNL Research  
Activities at LLNL



# Hurricane Fiona: Power Impact



# Hurricane Maria: Power Impact

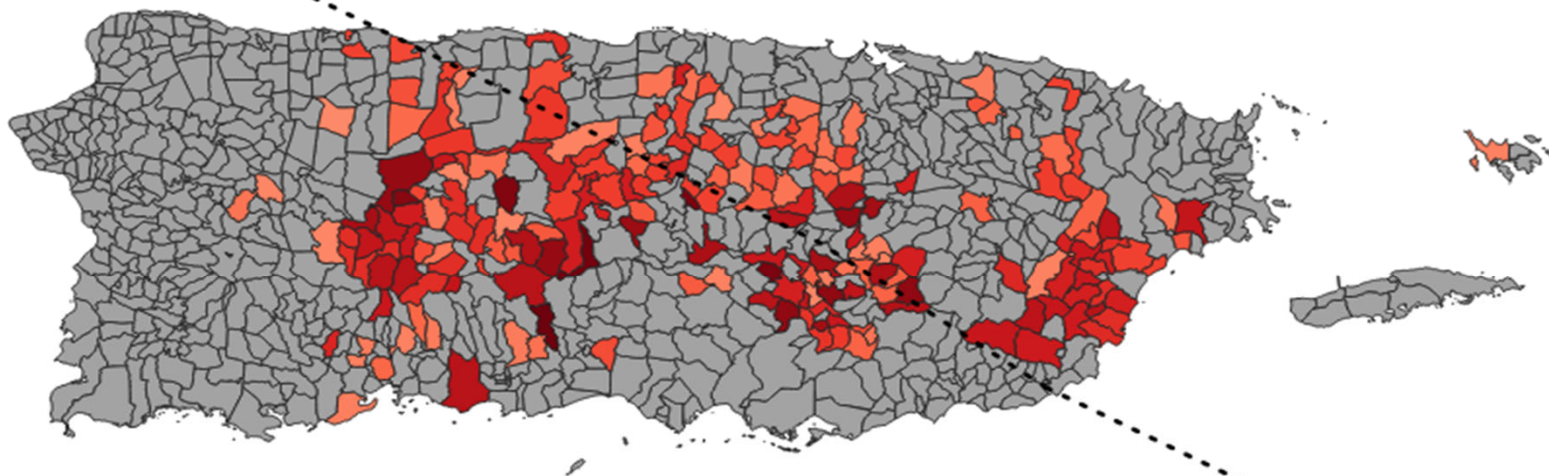


Rebuilding Puerto Rico's power grid: The inside story - M Gallucci - IEEE Spectrum, 2018

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

# Communities with homes that were reconnected to PREPA from April to August 2018: 62,000 families

Energy Center



Shared Drive: barrios\_2015\_geoid\_corrected\_16\_nov17 /11DocumentoEquipo/Marcel 11 (EXPORT)

LLNL-P...  
7/27/2023



# Barrio Salud, Mayagüez PR.



*Photo: Fabio Andrade, June 2020.*

# Solar power potential



Barrio Salud, Mayagüez PR.

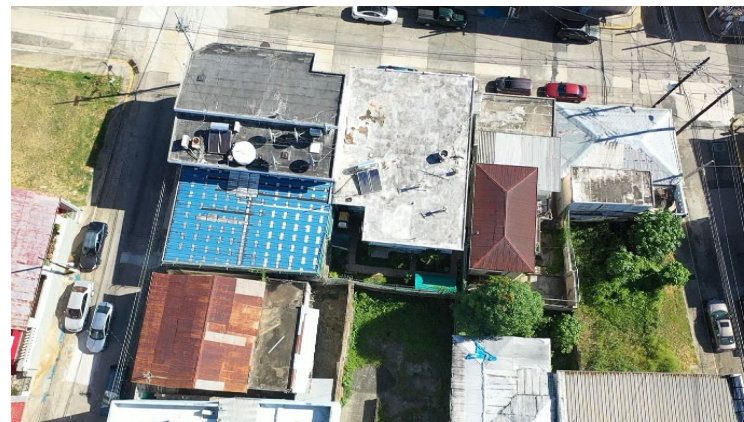
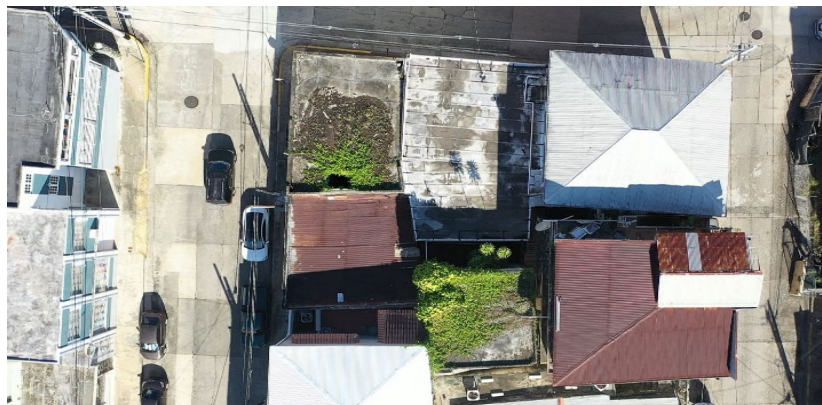
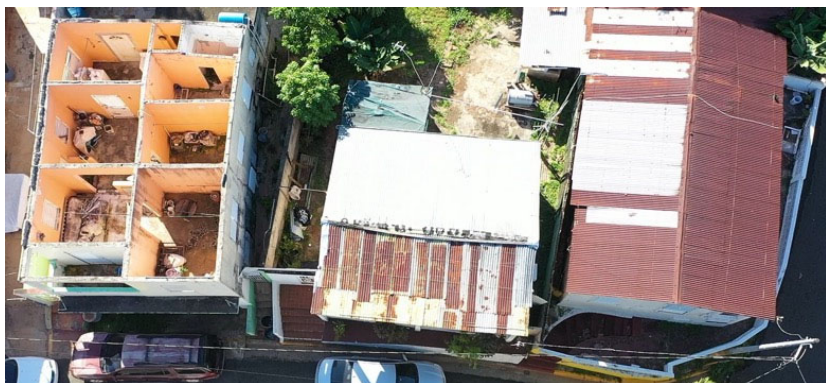


*Source: Google Project Sunroof.*



# Current state of the rooftops

Barrio Salud, Mayagüez PR.



*Photo: Fabio Andrade, June 2020.*



# Outline

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# Energy Justice: Collaboration with Oasis de Luz



Jayuya  
noviembre, 2017

[marcel.castro@upr.edu](mailto:marcel.castro@upr.edu)



Jayuya  
Febrero, 2018

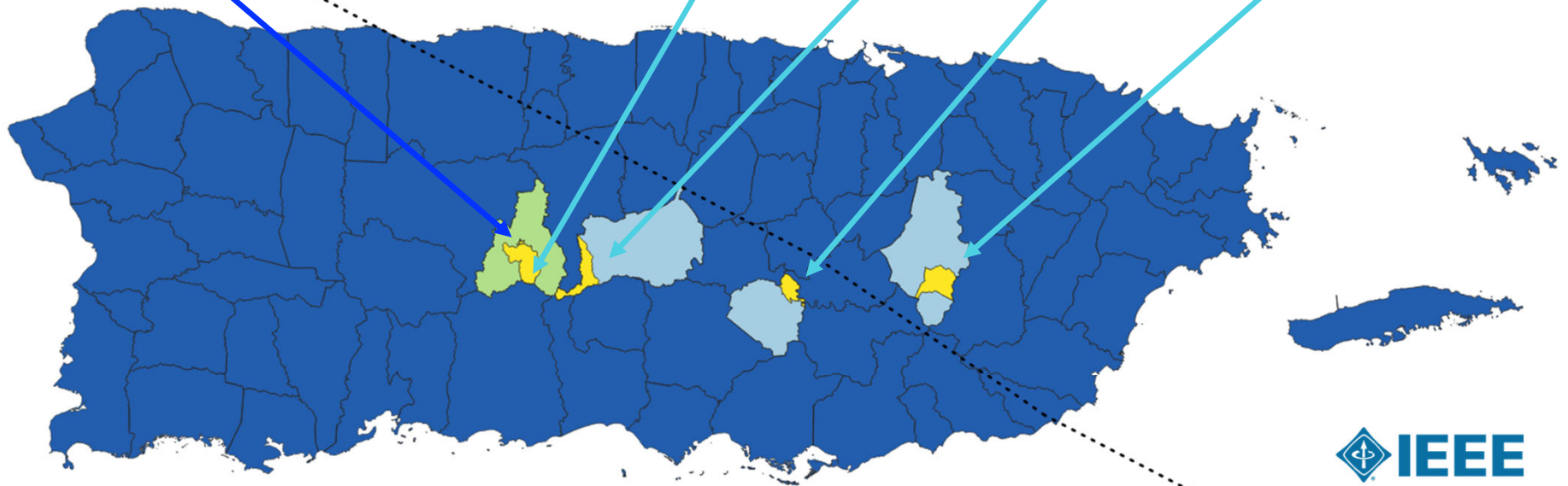
[marcel.castro@upr.edu](mailto:marcel.castro@upr.edu)

# “Oasis de Luz” ... Oasis of Light for the Mountain

November 2017: Jayuya Pueblo

2018:

Jayuya, Orocovis, Aibonito, Caguas





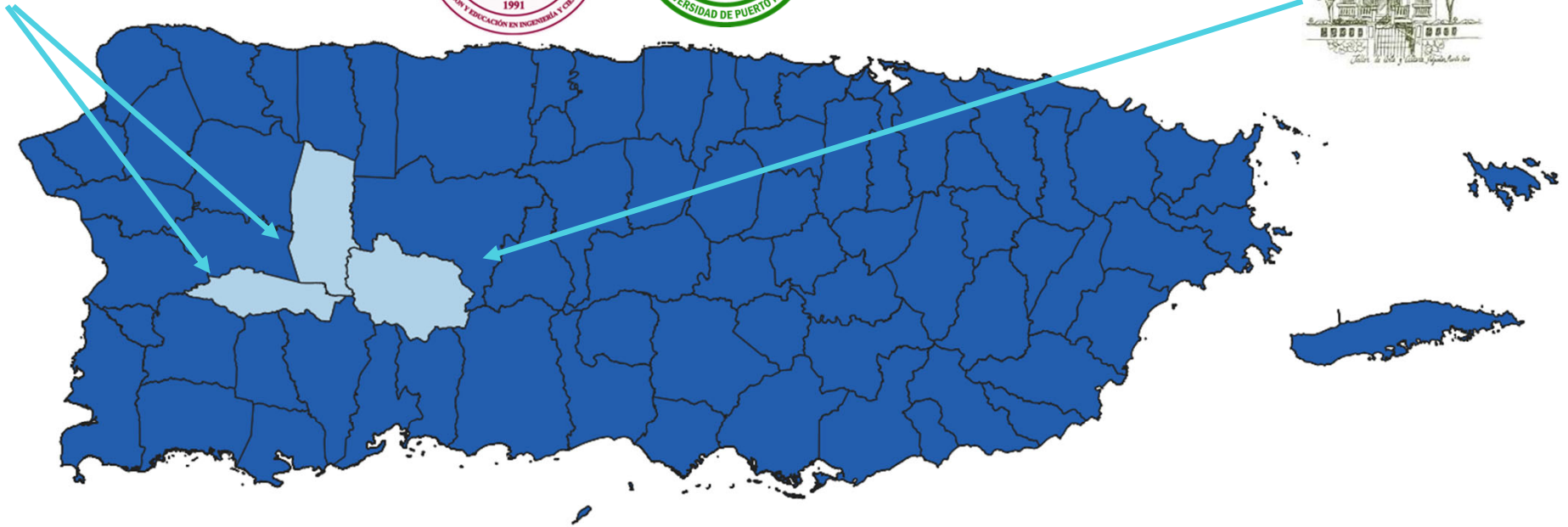
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# Pilot Microgrids in Puerto Rico

Microgrid Laboratory and Solar Workforce Development



# UPRM Power Community Engagement: Community Microgrid Projects

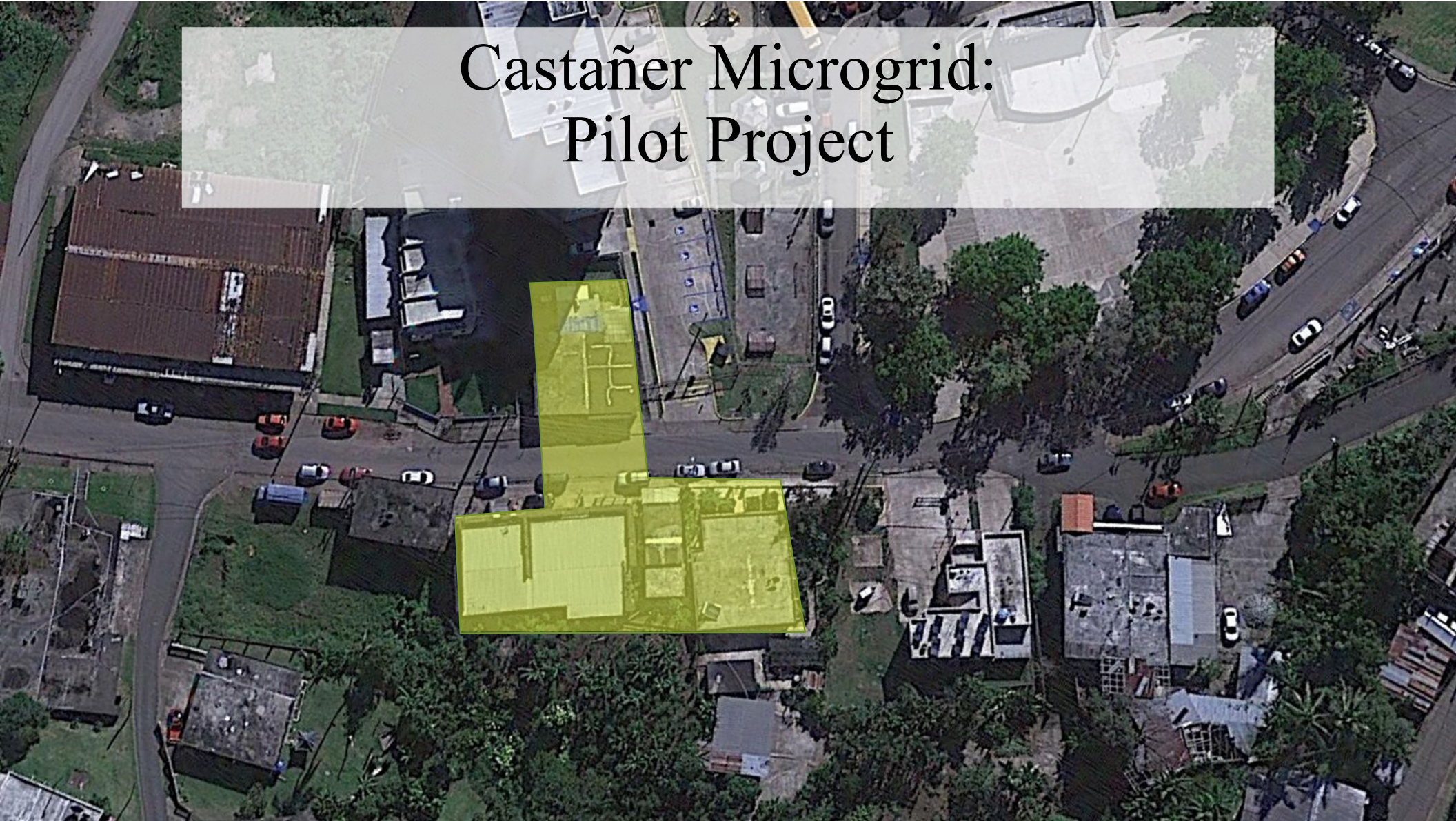


UPRM Team: Marcel Castro-Sitiriche, Agustín Irizarry, Fabio Andrade, Gerson Beauchamp from Electrical and Computer Engineering, Arturo Massol from Biology, Solar Business Accelerator Project, EDA Funds, 2019-2023 and Resilient Operation of Networked Community Microgrids with High Solar Penetration Project, DOE Funds, 2021-2024.



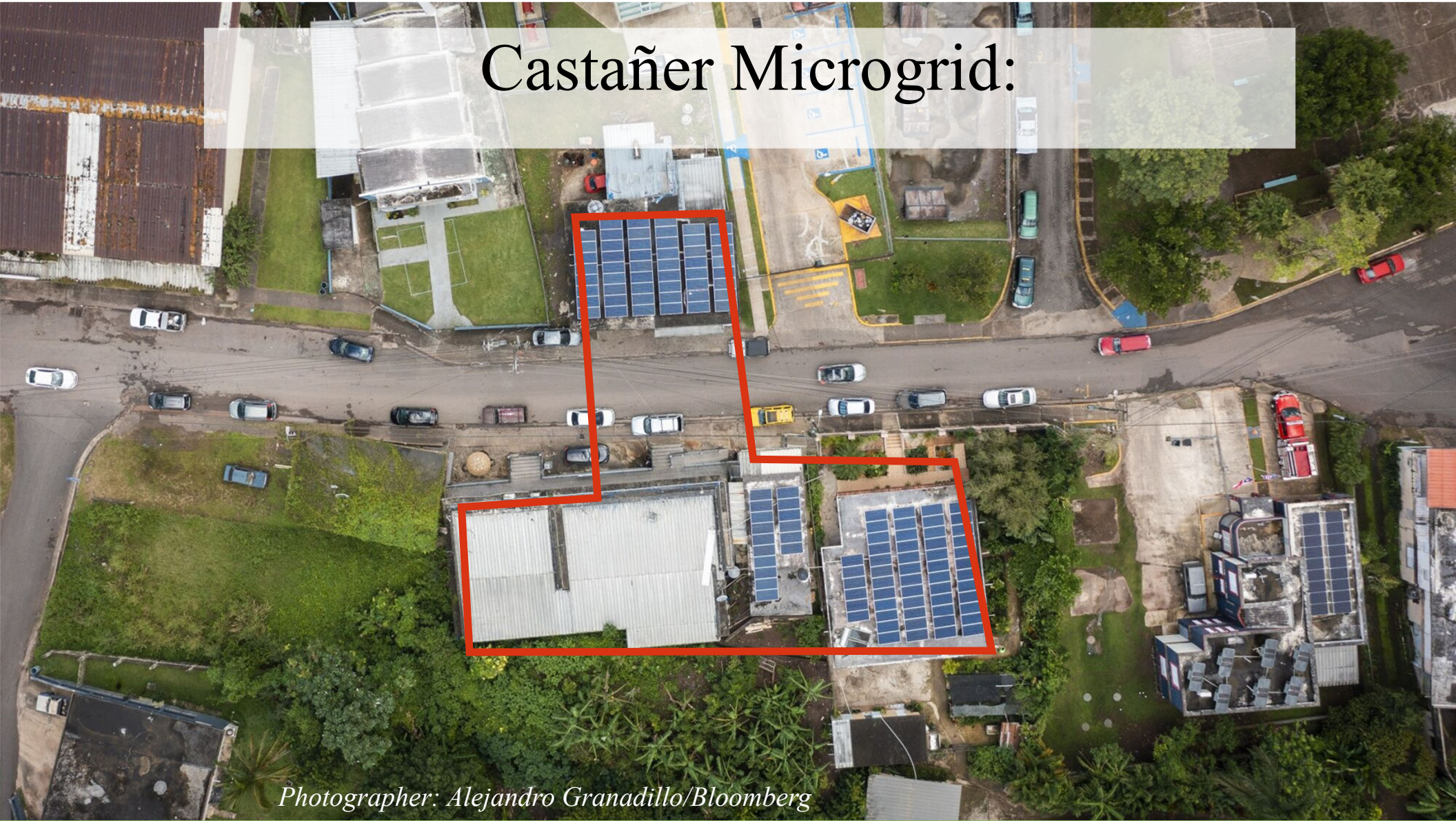
Castañer, Lares  
Noviembre, 2020  
Foto: marcel

# Castañer Microgrid: Pilot Project





# Castañer Microgrid:



*Photographer: Alejandro Granadillo/Bloomberg*



Castañer, Lares  
Noviembre, 2020  
Foto: marcel



Photo Credit: Cooperativa Hidroeléctrica de la Montaña  
<https://www.eesi.org/articles/view/microgrids-in-puerto-rico-keep-rural-communities-connected>

# Adjuntas - Microgrid



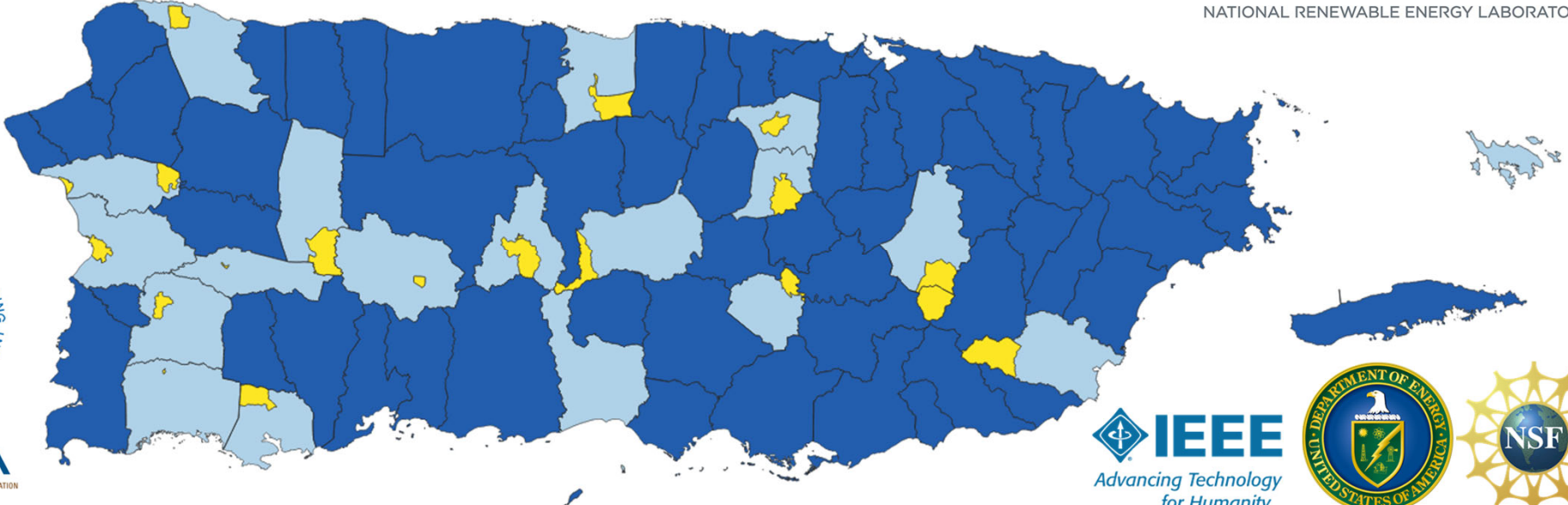
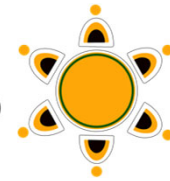
# Maricao Microgrid: In Progress



# UPRM Power Community Engagement: Communities in 19 Municipalities

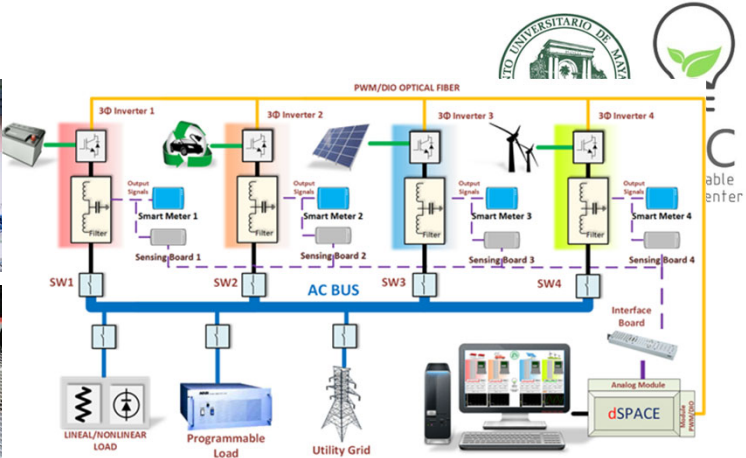
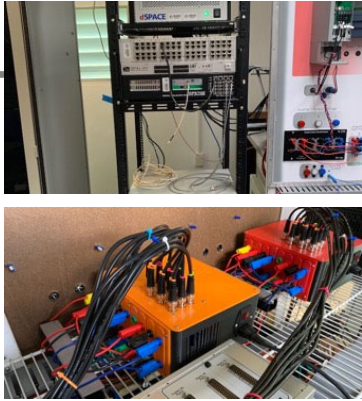


Barrio Eléctrico



UPRM Team: Luisa Seijo from Social Sciences, Ricardo Fuentes from Economics, Lizzette González from Agricultural Science, Reinaldo Rosado from Social Sciences, Ingrid Rodríguez from Social Sciences, Francisco Maldonado from Civil Engineering, Marcel Castro-Sitriche, Agustín Irizarry, Efraín O’Neill, Erick Aponte, Lionel Orama, Eduardo Ortiz, Rafael Rodríguez-Solís Fabio Andrade, Gerson Beauchamp from Electrical and Computer Engineering, Arturo Massol from Biology, Christopher Papadopoulos from Engineering Sciences, William Frey from Business Administration, 2019-2024.

# UPRM's Microgrid Laboratory



UNIVERSIDAD DE JAÉN



Solar House



Community Initiatives



Community Initiatives



# Outline

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Activities at LLNL





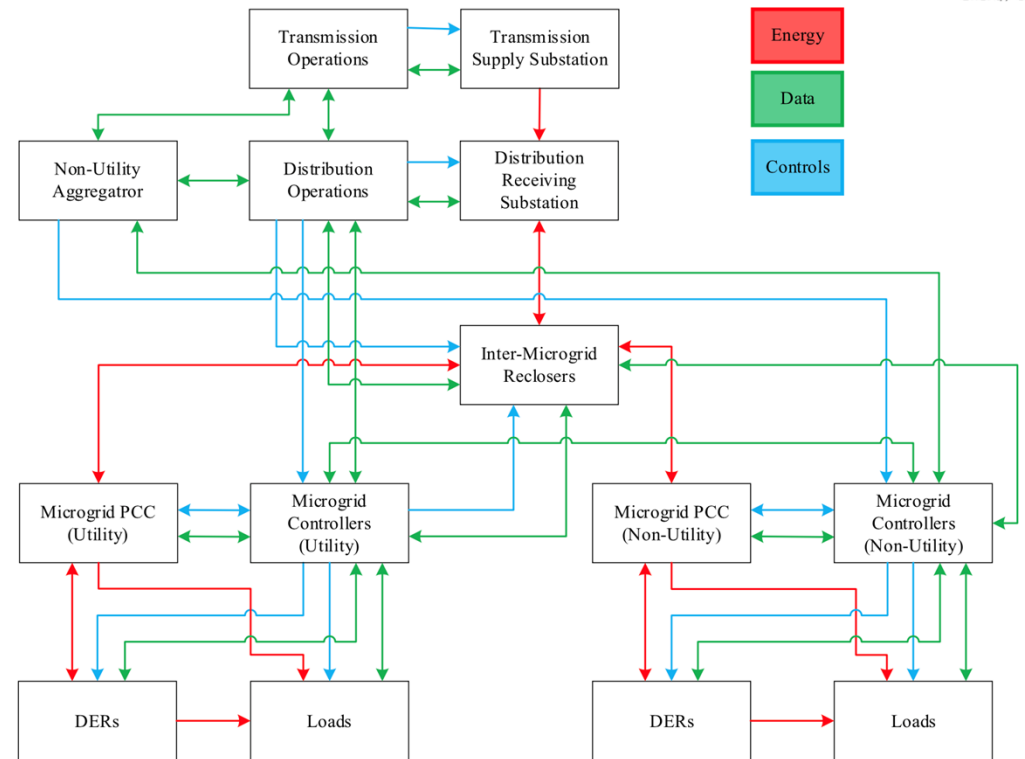
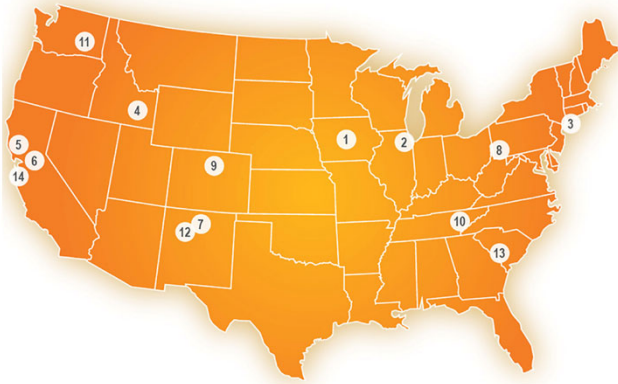
# Resilient at LLNL Research



**GRID**  
MODERNIZATION LABORATORY CONSORTIUM  
U.S. Department of Energy

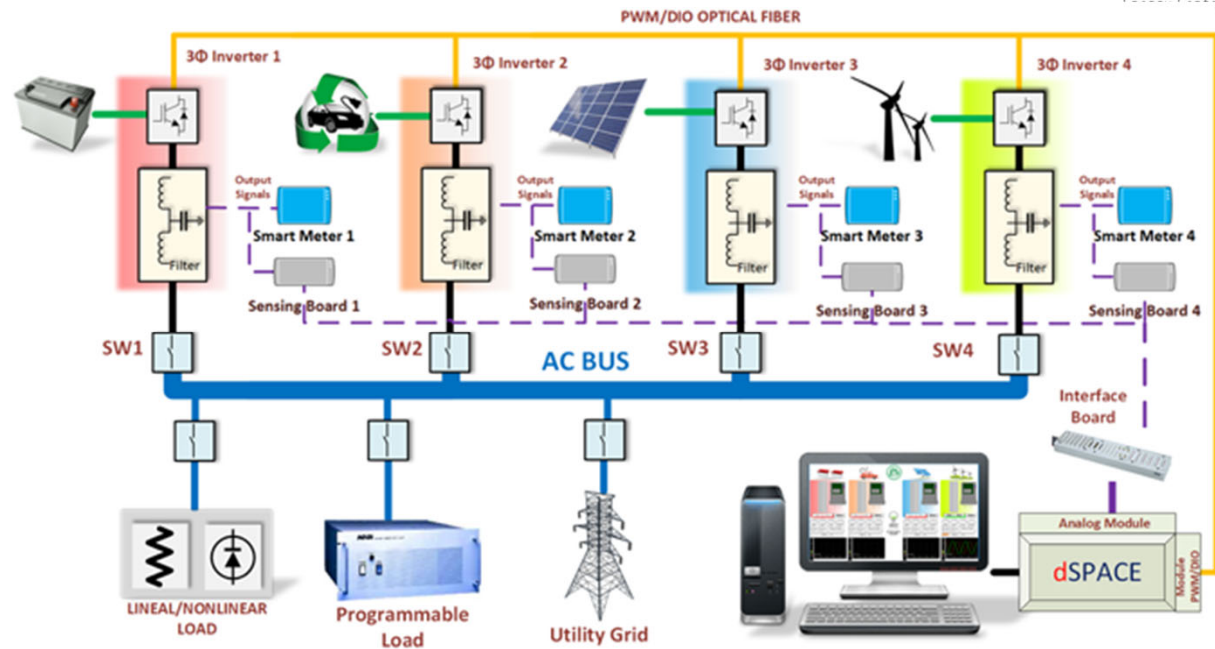
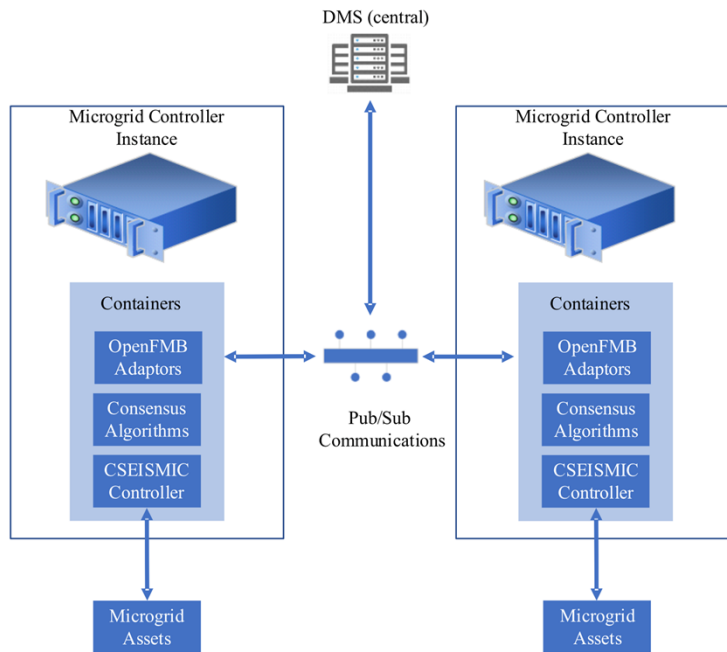
U.S. DEPARTMENT OF  
**ENERGY**

**14 National Laboratories Partnering With Industry To Build A Cleaner, More Resilient Power Grid For The Nation**



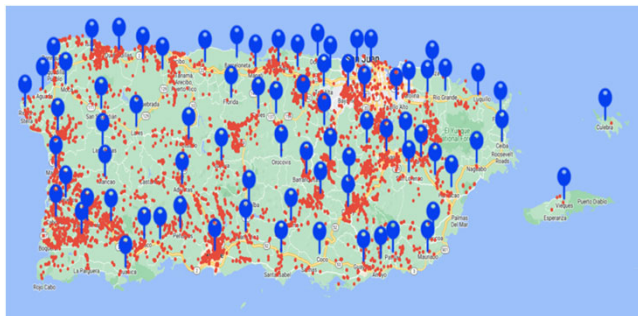
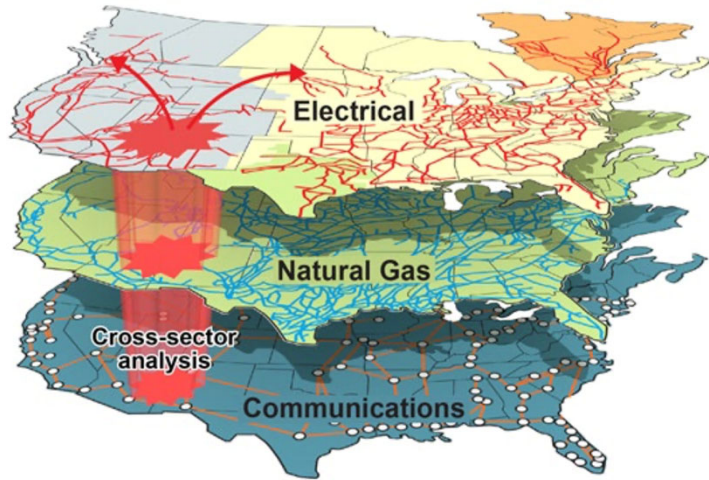
A Framework for Coordinated Self-Assembly of Networked Microgrids Using Consensus Algorithms

# Resilient at LLNL Research



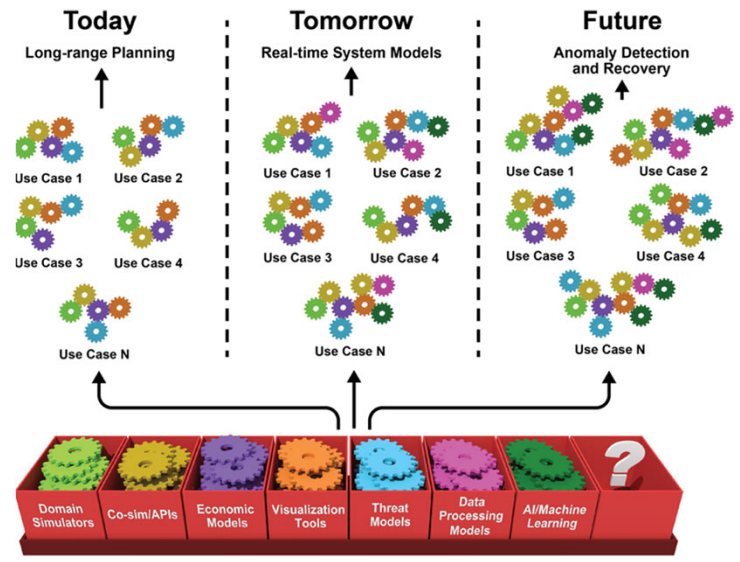
overlapping in microgrid control development and demonstration – LLNL contribution being de-centralized (cyber-secure) control and UPRM contribution being demonstration / testing in microgrid testbed environment.

# Resilient at LLNL Research



## North American Energy Resilience Model (NAERM)

The different elements are assembled in relation to the threat and hazard scenarios being addressed



**Software Toolbox**  
Modular / Adaptable / Flexible



# Outline

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PR Energy Challenges  
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Resilient at LLNL Research  
**Activities at LLNL**



# Activities at LLNL



**U.S. Department of Energy  
Microgrids R&D Program  
Semi-Annual Meeting**  
August 29-30, 2023 @ Berkeley Lab



Thank you!!! ... Questions???



# CHRES

 Lawrence Livermore  
National Laboratory

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