MICROGRID KNOWLEDGE

CONFERENCE SERIES

Microgrid 2018

CONFERENCE

Puerto Rico: From Tragedy to Innovative Model for the World?

Moderator: **Fidel Marquez**, Senior VP of Governmental and External Affairs and Chief Governmental and Community Relations officer, *ComEd*

Presenters:
Jared Leader, Senior Associate, *Smart Electric Power Alliance*
William Heegard, Founder, *Footprint*

Preliminary Microgrid for Resiliency Planning
A Guide to Deployment Strategy

Microgrid 2018 Conference

Jared Leader

Senior Associate

SEPA

Smart Electric Power Alliance

SEPA Background

SEPA's Mission is to to facilitate the electric power sector industry's smart transition to a clean and modern energy future through education, research, standards, and collaboration.

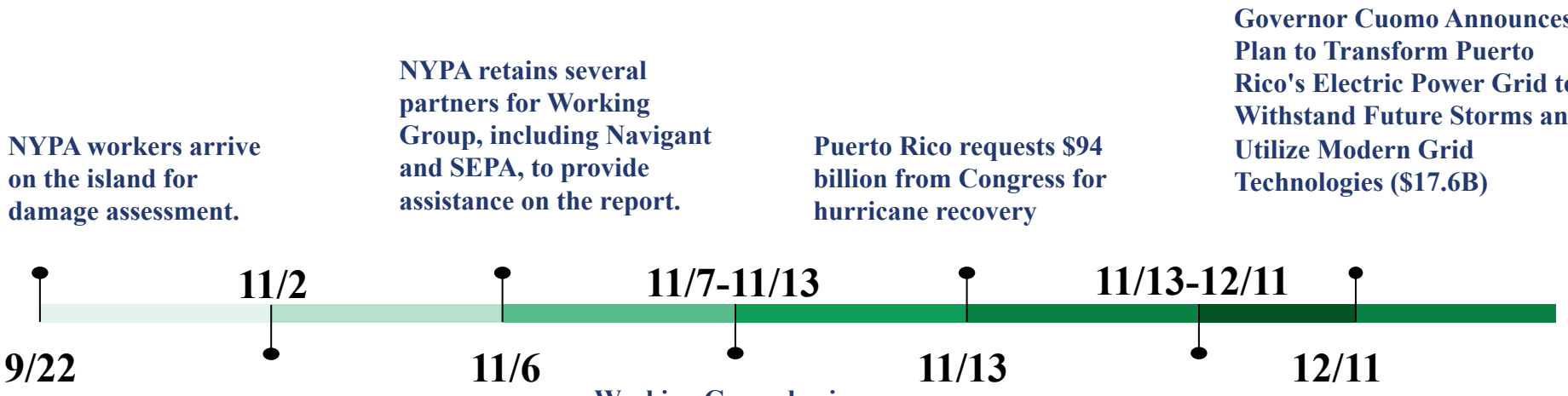
- Approximately 1,180 Members (640 Utilities)
- Founded in 1992
- 501(c)3 membership organization

Puerto Rico Use Case: Island-wide Devastation

Smart Electric Power Alliance

Puerto Rico: Road to Congress

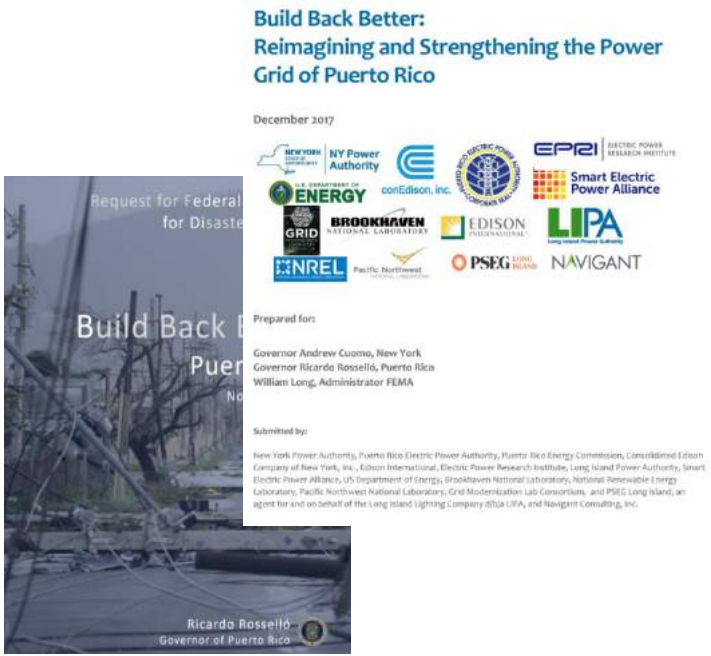
Smart Electric Power Alliance



"New Yorkers have provided unwavering support to our brothers and sisters in Puerto Rico, and we will continue do everything we can to ensure they have a partner in long-term recovery."

Governor Andrew M. Cuomo

Microgrids for Resiliency Build Back Better



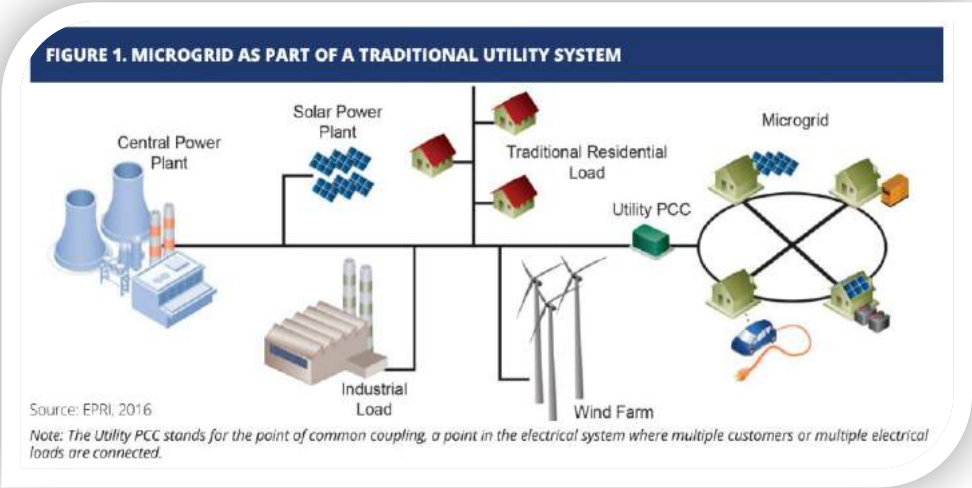
Source: Governors Rossello's request for recovery funding, 11/13/17

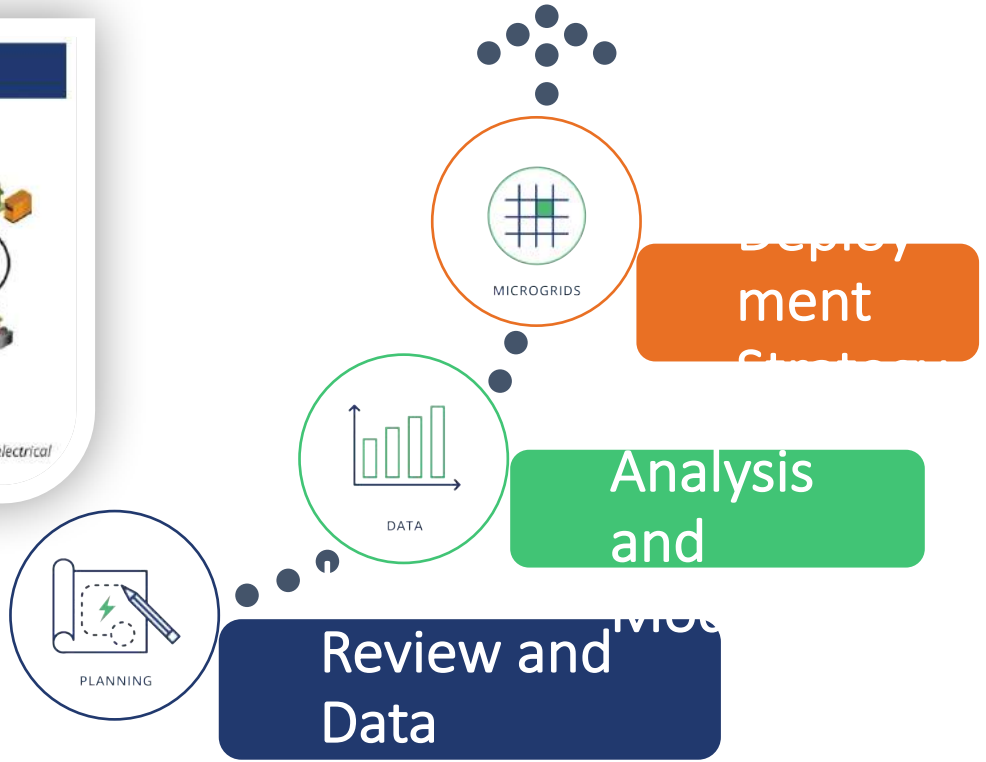
- Total request: **$94.4 billion**
- Power grid: **$17.6 billion**
  - Microgrids for Resilience: $**1.0 billion**
    - 159 Microgrid Applications for Critical Infrastructure (Police, Fire, Hospital, Water, Comms)
    - 3 Microgrid Applications for Remote Communities

SEPA's Contribution to BBB

Planning Microgrids for Resiliency

Smart Electric Power Alliance





Planning Microgrids for Resiliency

Smart Electric Power Alliance

Landscape Review

- Existing generation
- Load density
- Population density
- Vulnerable areas

Data Collection

- Critical facilities
- Existing generation technology
- Actual or model load profiles

Puerto Rico's Power Landscape

Smart Electric Power Alliance

PREPA

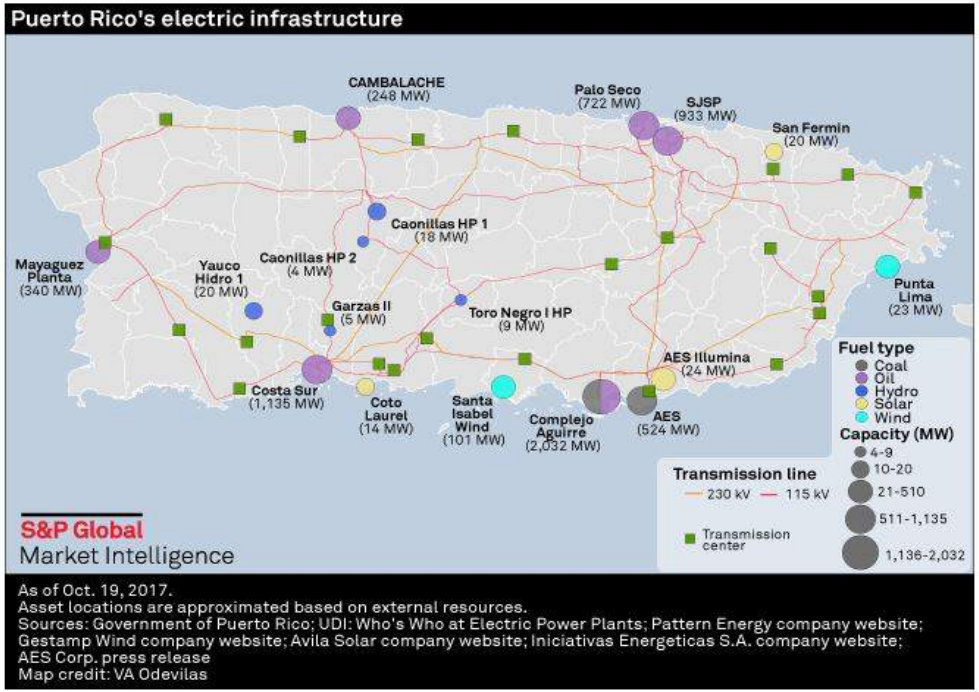
- 1.5 mm customers
- ≅ 3,515 sq mi

Generation

- 5,659 MW
- 181 MW utility-scale renewables
- 2.4% renewables

Transmission & Distribution

- 2,478 mi transmission
- 31,485 mi distribution
- ~25 cents/kWh

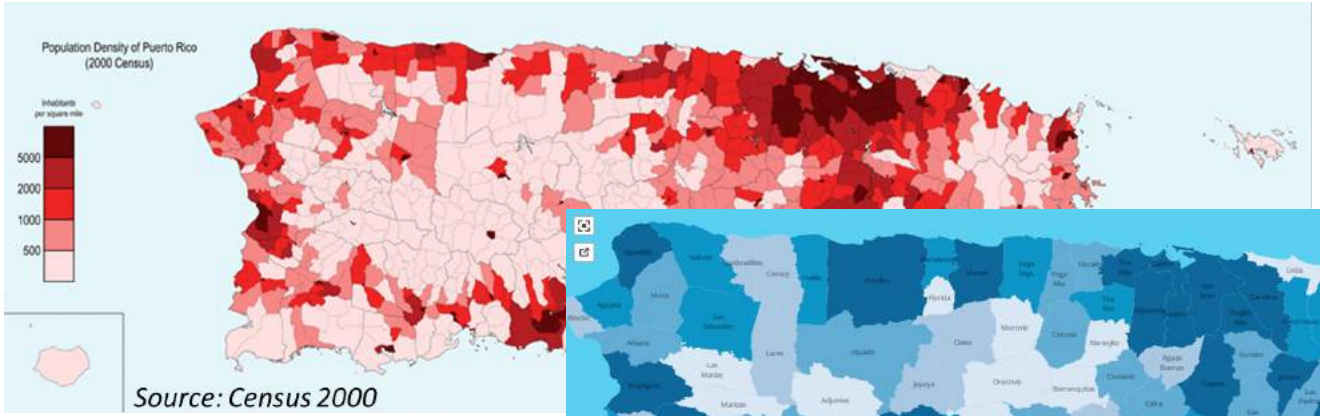


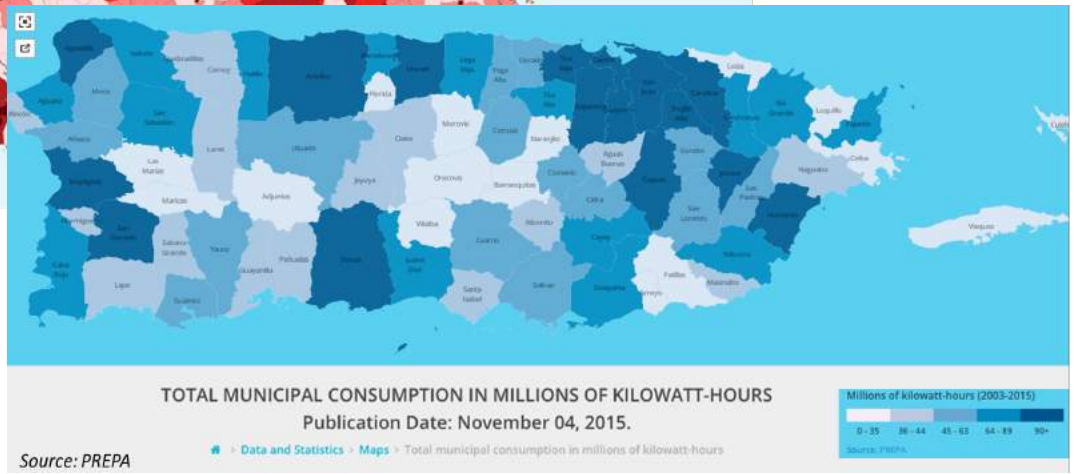
Source: PREPA, SNL, EIA

Landscape Review and Data Collection → Data Analysis and Modeling → Deployment Strategy

Population & Load Density

Smart Electric Power Alliance





Landscape Review and Data Collection → Data Analysis and Modeling → Deployment Strategy

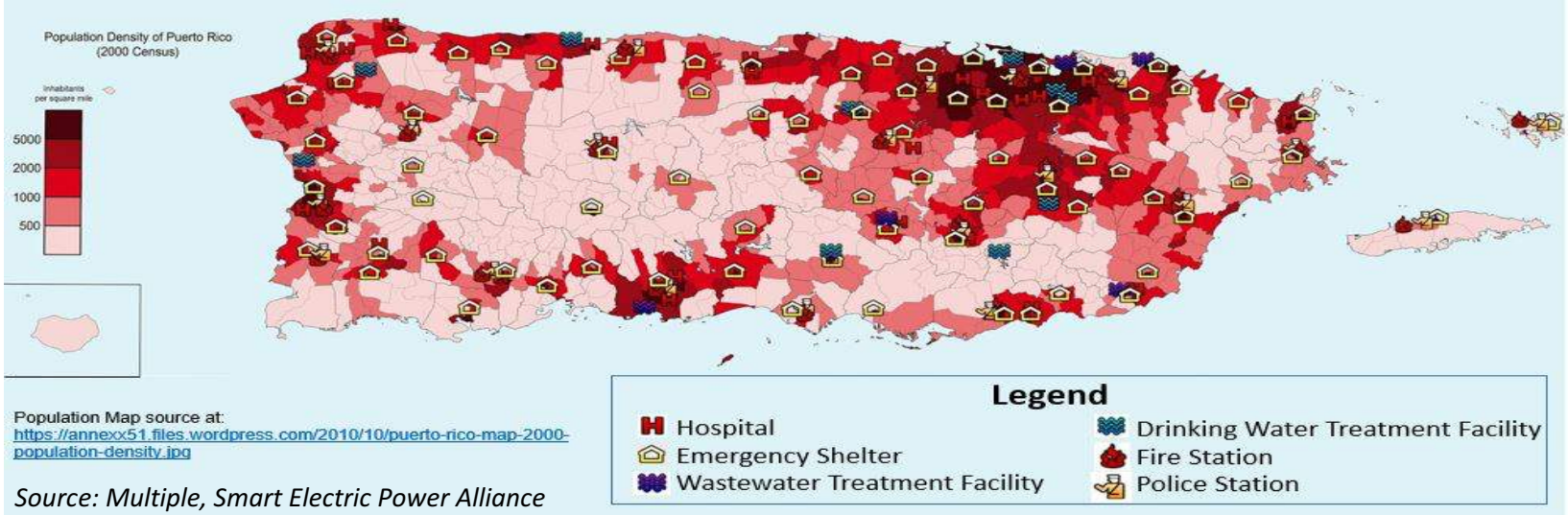
Data Analysis and Modeling

Smart Electric Power Alliance

- Size **facility** microgrid systems to site specific load profiles, existing technologies, and loss of load tolerance
  - Hospitals
    - Solar PV, RICE, CHP, BESS
  - Police and Fire Stations | Emergency Shelters | Water/Wastewater Treatment Facilities
    - Solar PV, RICE, BESS
- Size **remote** microgrid systems to combined critical facility loads and other necessary residential and commercial loads
  - 1 Hospital, 1 Police Station, 1 Fire Station, 1 Emergency Shelter, Additional Residential/Commercial Loads

Deployment Strategy

Identify Hypothetical Islanding of Critical Facilities



Population Map source at:
https://annexx51.files.wordpress.com/2010/10/puerto-rico-map-2000-population-density.jpg

Source: Multiple, Smart Electric Power Alliance

Landscape Review and Data Collection → Data Analysis and Modeling → Deployment Strategy

Deployment Strategy
Estimate Microgrid Costs

Table 3-6. Microgrid Cost Estimates

Facility Type		Number of Sites in Puerto Rico	Technology Required	Estimated Cost per Site	Targeted Microgrid Deployments	Total CapEx Required
Critical Infrastructure	Hospitals	58	PV, BESS, CHP, RICE	$16M	26	$420M
	Police Stations	Approx. 100	PV, BESS, RICE	$206K	20	$4M
	Fire Stations	84	PV, BESS, RICE	$206K	20	$4M
	Emergency Shelters	452	PV, BESS, RICE	$4M	75	$292M
	Wastewater Treatment Facilities	50	PV, BESS, RICE	$3M	5	$15M
	Drinking Water Treatment Facilities	Approx. 100	PV, BESS, RICE	$2M	10	$21M
Remote Communities		Multiple	PV, BESS, RICE	$32M	3	$97M
TOTAL					159	$852M

Source: Smart Electric Power Alliance and Navigant

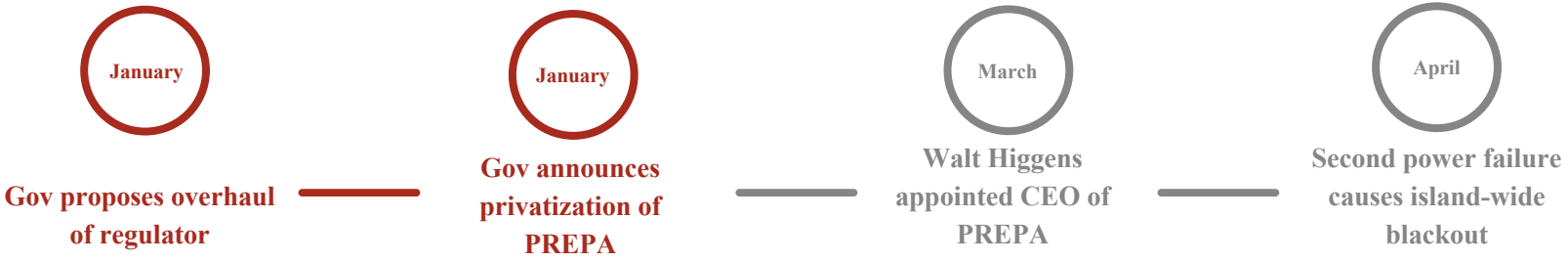
Landscape Review and Data Collection → Data Analysis and Modeling → Deployment Strategy

"I applaud the actions of the Puerto Rico Energy Resiliency Working Group for developing this plan and creating a critical foundation to rebuild and reimagine Puerto Rico's electric power system."

Governor Rosselló

2018 in Review

Smart Electric Power Alliance



$21.17 billion total federal appropriations to-date

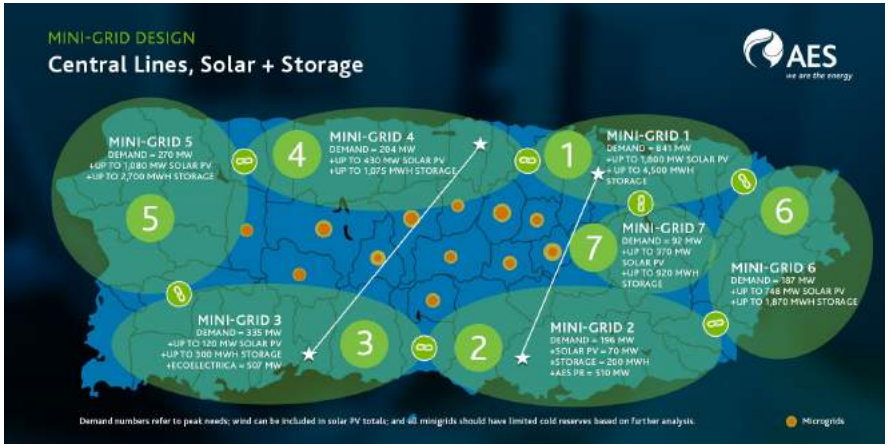
$2 billion allocated for power grid restoration

Source(s): Forbes, Utility Dive, The Atlantic, GTM, NPR

Multiple Independent Visions

Different Scales, but Conceptually Compatible

- Single Customer Solutions (2 kW to 20 MW)
  - Sunrun, Tesla, Sonnen, Pura Energia, Blue Planet Energy
- Microgrids (20 kW to 50 MW)
  - Proposed microgrid regulations from Puerto Rico Energy Commission
  - January 2018
- Minigrids (100 MW to 2000 MW)
  - AES proposed minigrid design
  - November 2017
- Island-Wide Grid (6000 MW)
  - Governor Rosello's plan
  - January 2018



Source: AES Mini-Grid Design, Nov. 2017

Single Customer Solutions

Sonnen & Pura Energia

Smart Electric Power Alliance

Components

- Battery
  - Eco 8 (4kW/8kWh)
  - Eco 14 (8kW/14kWh)
  - Eco 16 (8kW/16kWh)
- Solar PV
  - 3.12-15kW solar PV
- Inverter
  - 4-8 kW inverters

Projects

- 7+ installations
- Combined 50kW
- Combined72kW/142kWh

Applications

- Healthcare clinic (Utuado)
- Community laundry (Morovis)
- Community center (Humacao)
- Refugee centers (Maricao and Lares)
- Schools (Aguadilla and Orocovis)

Donations

- All technology was donated by Sonnen and its partner Pura Energia via Sonnen's del Sol Foundation
- ~ $350,000 value

Community Microgrids

Simpliphi Power

Smart Electric Power Alliance

Components

- Battery
  - PHI 2.5 kWh (multiple)
- Solar PV
  - Rooftop Solar PV

Project Location

- San Salvador
- Combined 1.5 MW
- 250 homes

Benefits

- Cost savings
- Resiliency
- Reliability
- Clean Energy

Phase II

- Phase I in progress
- Total of 900 homes
- Estimated combined 5MW of solar.

Thank you

Jared Leader

Senior Associate

jleader@sepapower.org

Smart Electric Power Alliance

Appendix

Appropriations for Puerto Rico To-Date

Smart Electric Power Alliance

Appropriation	Department/Agency	Program	Total	Status
All	FEMA	Disaster Relief Fund	$ 2,583,597,590	Ongoing
First Supplemental	HUD	CDBG	$ 1,500,000,000	Awarded Feb 2018, awaiting Action Plan from PR Government (for housing and building infrastructure)
Second Supplemental	FEMA	Disaster Assitance Direct Loan Program	$ 4,900,000,000	Awaiting approval from Treasury Dept. (for Medicaid system)
Second Supplemental	USDA	Disaster Nutrition Assistance Program	$ 1,270,000,000	Distributed
Second Supplemental	NFIP	General Fund	$ 121,000	Distributed
Third Supplemental	HUD	CDBG	$ 11,000,000,000	Pending ($2 million for power grid restoration)

List of Single Customer Solution Donations

Smart Electric Power Alliance

Name	Installer / Equipment Donation	Location	NGO Partner	Combined On-Site Solar PV	Battery Energy Storage System (BESS)	Application
Clinica Comunitaria	sonnen / Pura Energia	Mayames Abajo, Utuado	de Sol Foundation	7kW	8kW/16kWh	Health Care Clinic
Lavanderia Microgrids	sonnen / Pura Energia	La Perla	de Sol Foundation		8kW/16kWh	Community Laundry
Lavanderia Microgrids	sonnen / Pura Energia	Loiza	de Sol Foundation		4kW/8kWh	Community Laundry
Morovis Lavanderia micro-grid	sonnen / Pura Energia	Morovis	de Sol Foundation	3.12kW	8kW/16kWh	Community Laundry
Humacao (Mariana)	sonnen / Pura Energia	Humacao	de Sol Foundation	6.24kW	8kW/16kWh	Community Center (Food, Water, Internet, Electricity)
Help Me! Aguadilla micro-grid	sonnen / Pura Energia	Aguadilla	de Sol Foundation	3.12kW	4kW/8kWh	School (Lights, Refrigeration, Microwaves, Fans)
Maricao	sonnen / Pura Energia	Maricao	de Sol Foundation	(2) 3.12kW	(2) 4kW/8kWh	Refugee Center (Lights, Refrigeration, Cellular Router)
Lares (Bartolo)	sonnen / Pura Energia	Lares	de Sol Foundation	9.36kW	(1) 4kW/8kWh (1) 8kW/16kWh	Refugee Center (Community Garden, Education, Mental Health Center)
S.U. Matrullas School micro-grid	sonnen / Pura Energia	Orocovis	de Sol Foundation	15kW	(1) 4kW/8kWh (1) 8kW/14kWh	School (Lights, Refrigeration, Acces to Technology)
Barrio Obrero Fire Station	Sunrun	Barrio Obrero		4kW	6.6kW	Fire Station
Utuado Fire Station	Sunrun	Utuado		(2) 6.6 kW		Fire Station
Utuado Water Purification	Zero Mass Water	Utuado				Solar Power Water Purification System
Maricao Clinic	New Energy / CAM Solar / Soltec / SunPower / Variety Energy		Clinton Foundation / Solar Saves Lives	18kW	20kWh	Health Care Clinic
Resilient Power Puerto Rico	Resilient Power Puerto Rico	San Juan	Resilient Power Puerto Rico	12kW		
Corozal Clean Water	Blue Planet Energy	Corozal	Water Mission	7kW	16kWh Blue Ion 2.0	Pumping Stations
Casa Pueblo	FORWARD Puerto Rico Fund	El Hoyo, Adjuntas	FORWARD Puerto Rico Fund	4 PV modules @ 150W each at 12V	4 "deep cycle" batteries @6V each, 1.5kW inverter, 5,000 solar lamps	Neighborhood Critical Care (8 Buildings: Nursing, Shelter, Radio, Cinema, Refrigerators)

Single Customer Solutions

Sunrun & Partners

Sunrun Partnerships in PR

- Empowered by Light and Aireko E.G. to donate & install solar + storage
- Helped GivePower Foundation and Zero Mass Water install clean water services (production, desalination, purification)

Behind-the-meter storage

- CEO Lynn Jurich says solar+storage will be future for PV
- Launched BrightBox™ in 2017, a behind-the-meter res. energy storage system

Sunrun + Empowered by Light

- Three fires stations (San Juan, Utuado) have received solar + storage
- Plans to reach 8 stations
- Committed to 25,000 lbs of solar PV for medical + food

Components

- 4kW solar array
- 6.6 kWh battery storage
- Partnered to provide off-grid power for three fire stations

Community Microgrids

Casa Pueblo

Smart Electric Power Alliance

Background

- Led by Mrs. Tinti Deya and Mr. Alexis Massol
- Est. in 1980
- Environmental grassroots group serving area with off-grid solar

Projects

- Electrified homes for dialysis, refrigeration
- Plans PV refrigeration for 25-30 homes
- Radio Casa Pueblo
- Solar PV for municipal shelter, nursing home
- Home install (~$1800)
- Operates on donations

"Sometimes you have to be an energy guerrilla" - Massol

(8 homes + radio station)

- 2-4 PV mod @150W each
- 4 "deep cycle" batt (6V)
- 1.5 kW inverter
- 42 solar PV panels (+batt)
- 5000 solar lamps

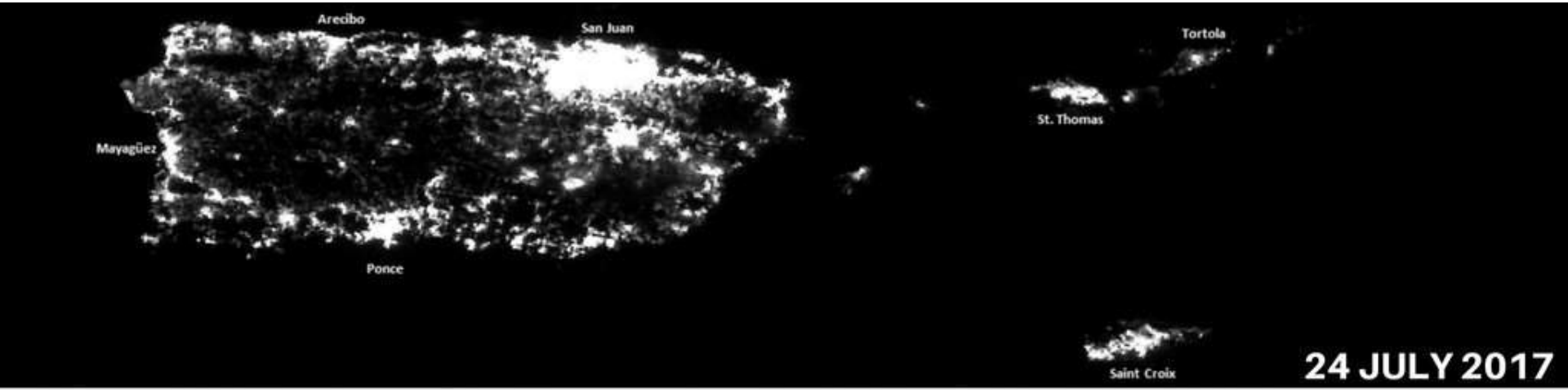
MICROGRID KNOWLEDGE

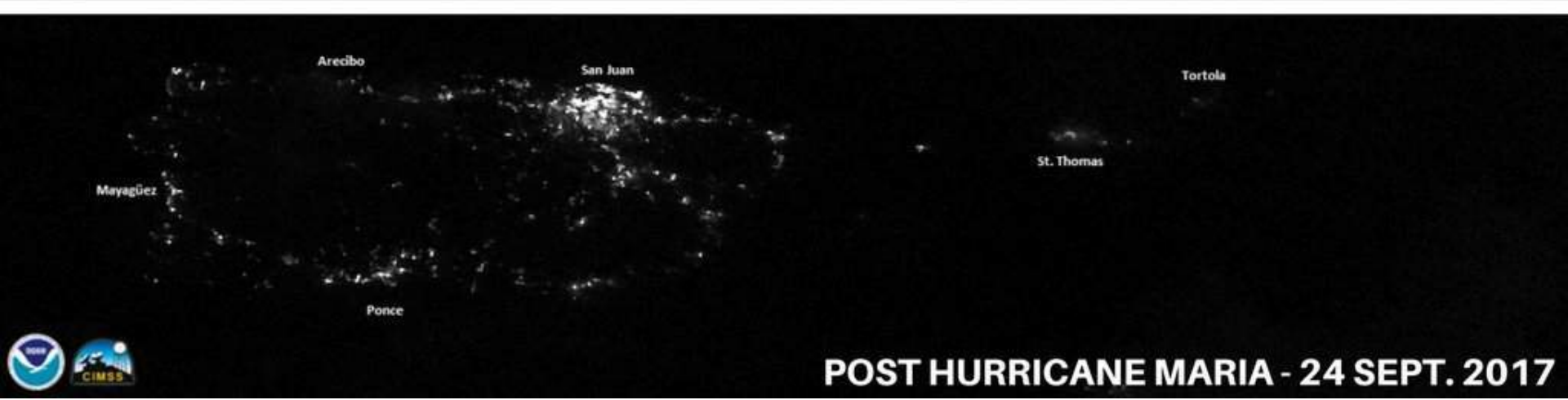
CONFERENCE SERIES

Microgrid 2018

CONFERENCE

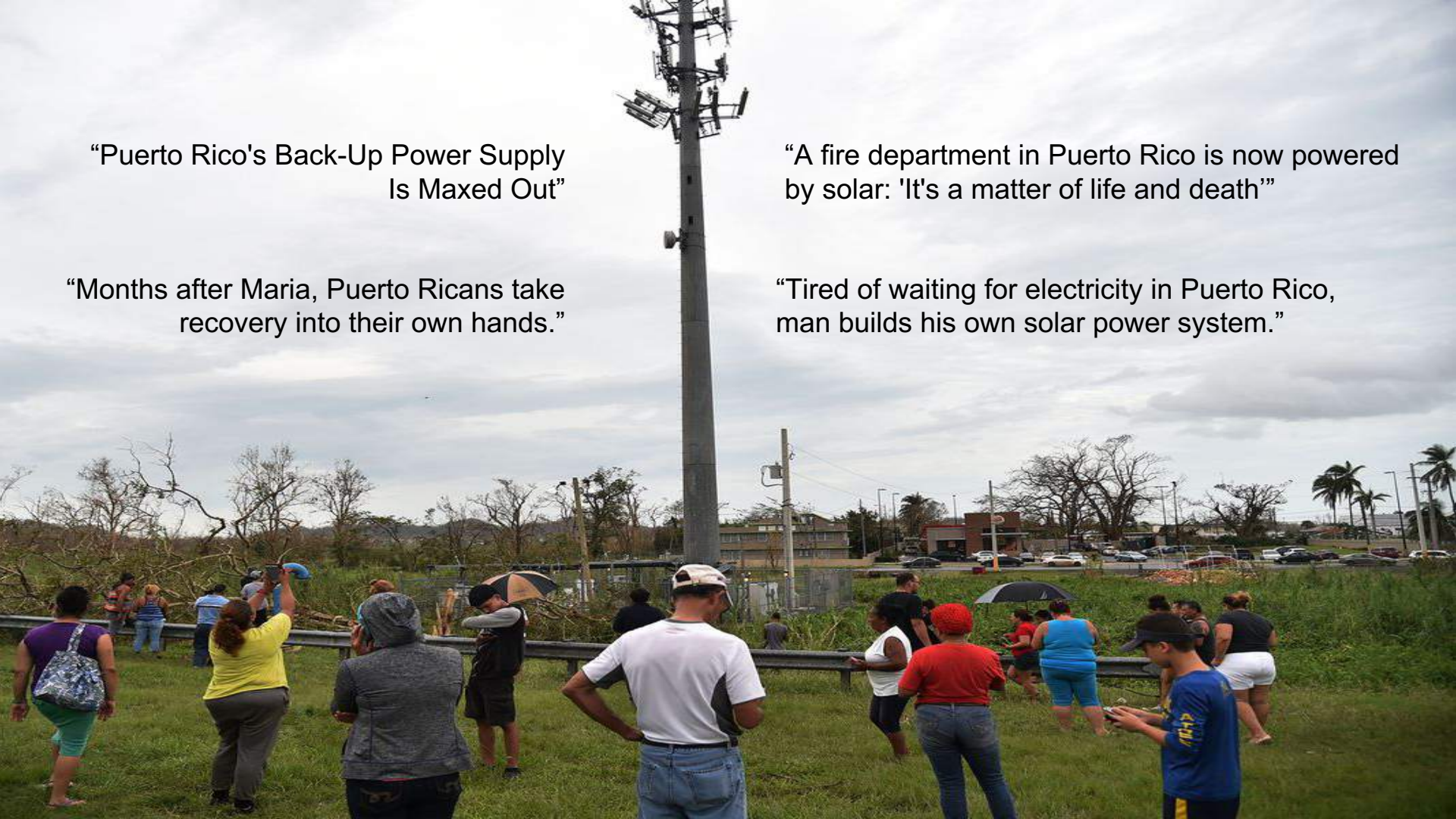

footprint


Arecibo
San Juan
Tortola
St. Thomas
Mayagüez
Ponce
Saint Croix
24 JULY 2017


Arecibo
San Juan
Tortola
St. Thomas
Mayagüez
Ponce
CIMSS
POST HURRICANE MARIA - 24 SEPT. 2017


Gulf


SEND
TESLA


“Puerto Rico's Back-Up Power Supply Is Maxed Out”
“A fire department in Puerto Rico is now powered by solar: 'It's a matter of life and death’”
“Months after Maria, Puerto Ricans take recovery into their own hands.”
“Tired of waiting for electricity in Puerto Rico, man builds his own solar power system.”

Caguas Community Center

Mariana Community Center

DEVELOP THROUGH DISASTER

SUSTAINABLE HUMANITARIAN RESPONSE

Challenges

Aid organizations are near-sighted

Grants dry up

Response is sexy, preparedness isn't

We tend to build back the same

Opportunities

Locals are their own best responders

Donors want sustainability

It's no longer an engineering problem

Private-public partnerships work

"Don't let a good disaster go to waste…"

Thanks

Will Heegaard, CEO
will@footprintproject.org
www.footprintproject.org
001.612.701.5400