RESILIENTPOWER

A project of Clean Energy Group and Meridian Institute

Building Resilient Home Health Care with Energy Storage

June 27, 2019

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Innovation in Finance, Technology & Policy

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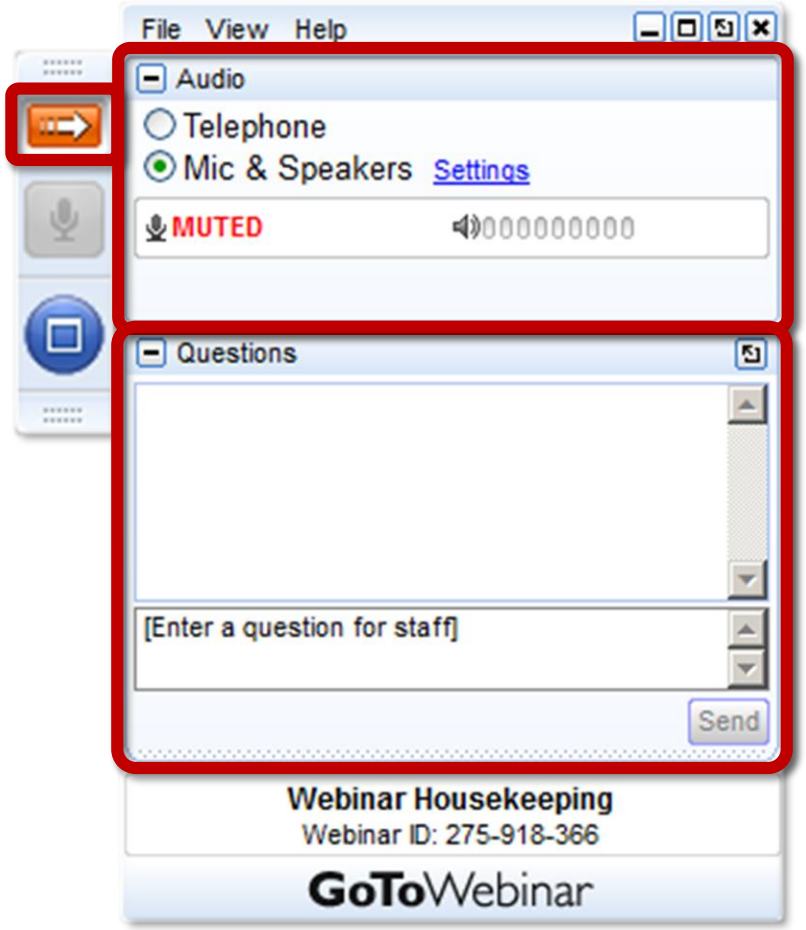
HOUSEKEEPING



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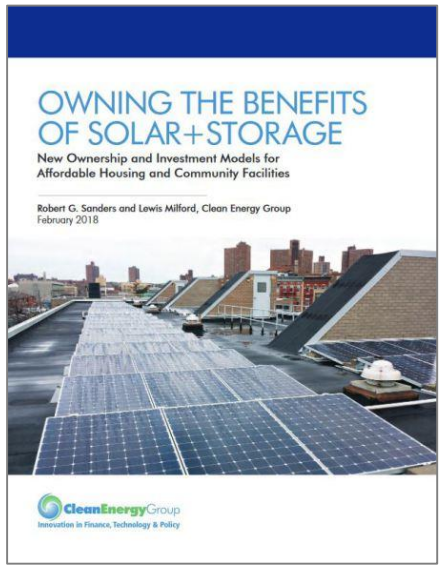
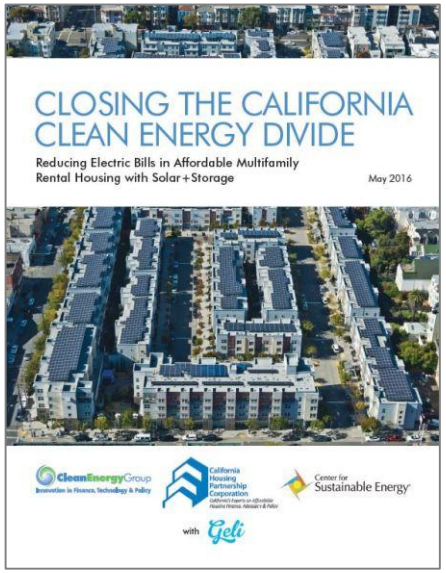
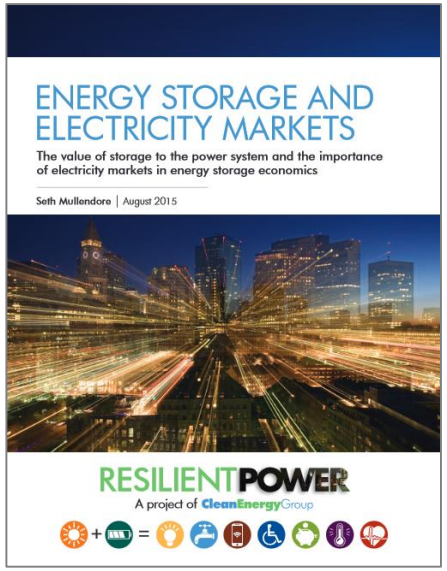
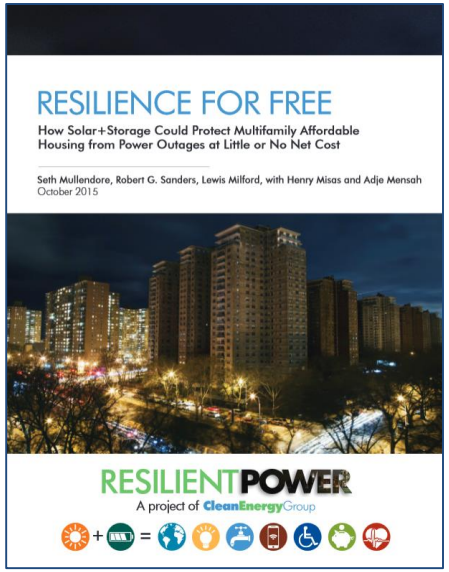
THE RESILIENT POWER PROJECT

- Increase public/private investment in clean, resilient power systems (solar+storage)
- Protect low-income and vulnerable communities, with a focus on affordable housing and critical public facilities
- Engage city, state and federal policy makers to develop supportive policies and programs
- Visit www.resilient-power.org for more information and resources









SUPPORTING 100+ PROJECTS ACROSS THE COUNTRY

Portland: Assessment of 10 LMI properties including affordable housing, foodbanks, medical centers, and shelters

Boston Medical Center: One of the first hospitals in the country to install storage for resiliency

DC: Largest solar+storage installation at affordable housing in the country

Puerto Rico: Supporting the installation of solar+storage at more than 60 medical clinics

California: Multiple housing properties representing hundreds of units of affordable housing

Building Resilient Home Health Care with Energy Storage

Webinar Speakers

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emPOWER Program Director, US Dept of Health and Human Services

Mareldi Ahumada-Paras
Department of Electrical Engineering, University of Washington

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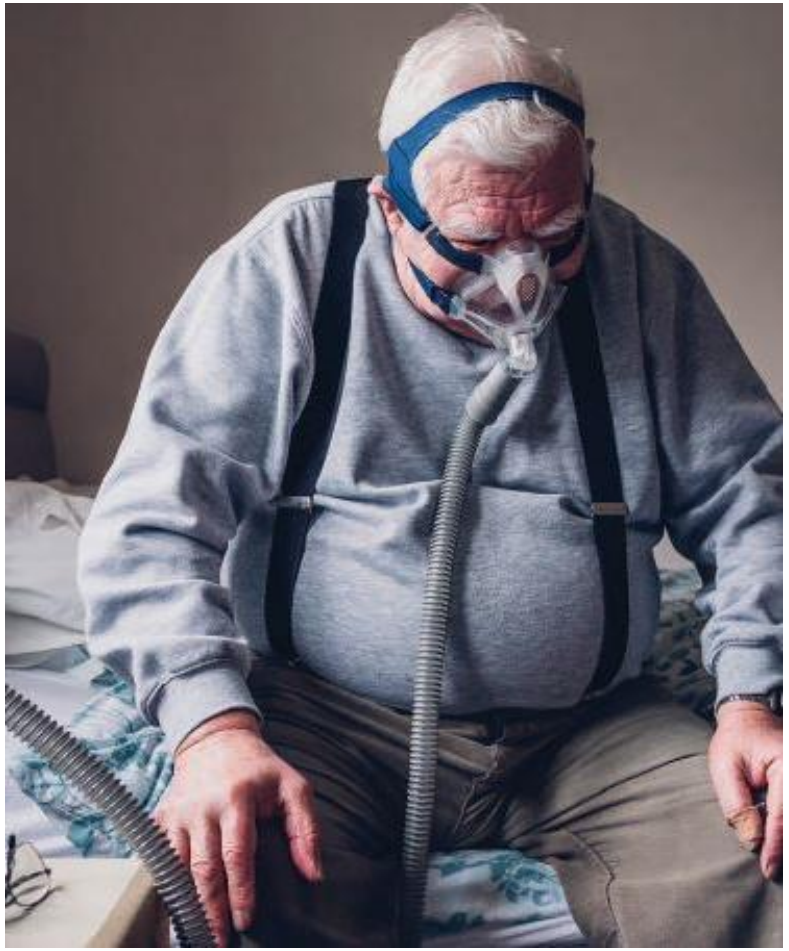
DEPARTMENT OF HEALTH & HUMAN SERVICES · USA

UNIVERSITY of WASHINGTON

WHO'S AT RISK WHEN THE POWER GOES OUT?

MERIDIAN INSTITUTE AND CLEAN ENERGY GROUP



- Home Health Trends and Outages
- Resilient Power as a Solution
- Impact and Demographics
- Existing Solutions, Preparedness, and Support
- Potential Solutions

HEALTH TRENDS AND OUTAGES

- More people receive health care at home than ever before
- At *least* 2.5 million people rely on electricity-dependent medical equipment
  - Majority are senior citizens
- Millions more use electricity for home care services

- Power outages have doubled in duration
- Severe weather is resulting in more frequent outages
- Utility preventative grid shutoffs are resulting in outages, even if there is no disaster

IMPACTS

The loss of power can be life-threatening for the medically vulnerable

- After the Camp Fires, utilities are shutting down power lines to millions to reduce the risk of a wildfire
- These planned outages compromise the safety of electricity- dependent customers

Growing impacts from outages due to severe weather are an increasing threat

- Health care complications, like medical device failure, accounted for nearly 1/3 of the est. 4,645 additional deaths after Hurricane Maria
- After Hurricane Irma, more than 15% of deaths were due to power outages worsening existing medical conditions

GENERATORS

Generators?

Maybe, but generators:

- Require frequent refueling
- Often emit pollutants
- Prone to failure
- Can be difficult to operate and refuel

Generator use during power outage could increase carbon monoxide poisoning risk

Live 5 News, Sept.ember11 2018

Dozens suffer carbon monoxide poisoning from generator use following Irma

AccuWeather, September 14 2078

RESILIENT POWER

Battery Storage is a Reliable, Resilient Energy Solution

- Automatically islands from the grid during an outage
- Does not emit pollutants
- Can deliver electric bill savings
- When combined with solar PV, can operate as long as solar is available
  - Lack of fuel is not an issue

MCKNIGHT LANE DEVELOPMENT PROJECT

- Resilient power for modular affordable housing development
- Solar PV and battery storage systems for each unit
- Systems automatically disconnect from the grid during a utility outage
- Solar panels and batteries provide electricity to the home
- Solar systems anticipated to provide 100% of tenants' electricity needs

EXISTING SUPPORT INFRASTRUCTURE

Even short-term power outages adversely affect public health

- Medically vulnerable households are only slightly more likely to evacuate
- Many seek power from local medical clinics, hospitals, critical community facilities
- This patient influx stresses facilities already dealing with capacity and operational challenges
- Disaster-related costs for Texas hospitals after Hurricane Irma were estimated at $460 million

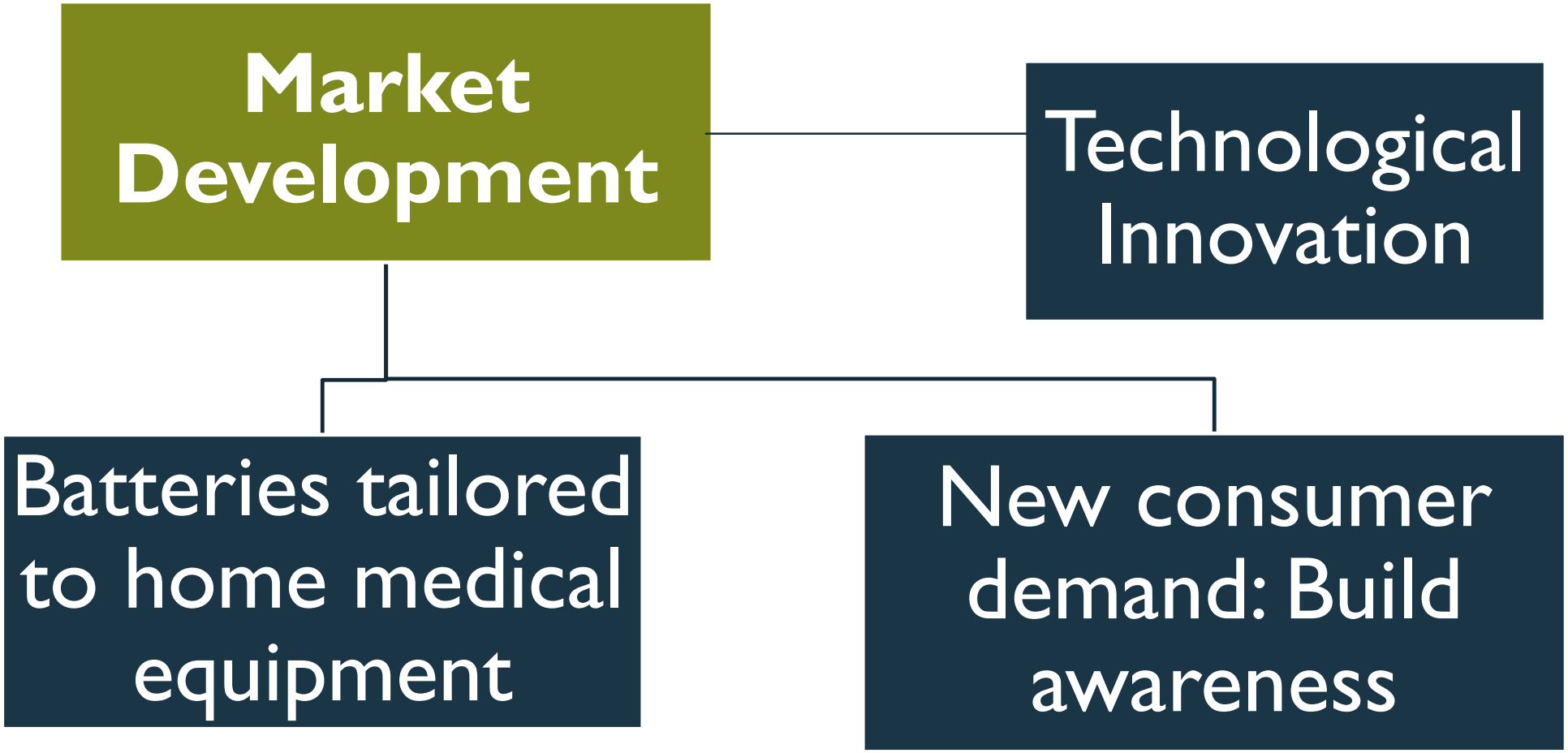
EXISTING SOLUTIONS

- Emphasis on Evacuation Planning and Education
  - Registries
  - If possible, have access to device batteries or alternative non-electrical supplies
- Preparedness Gaps
  - Very few programs that provide backup power systems

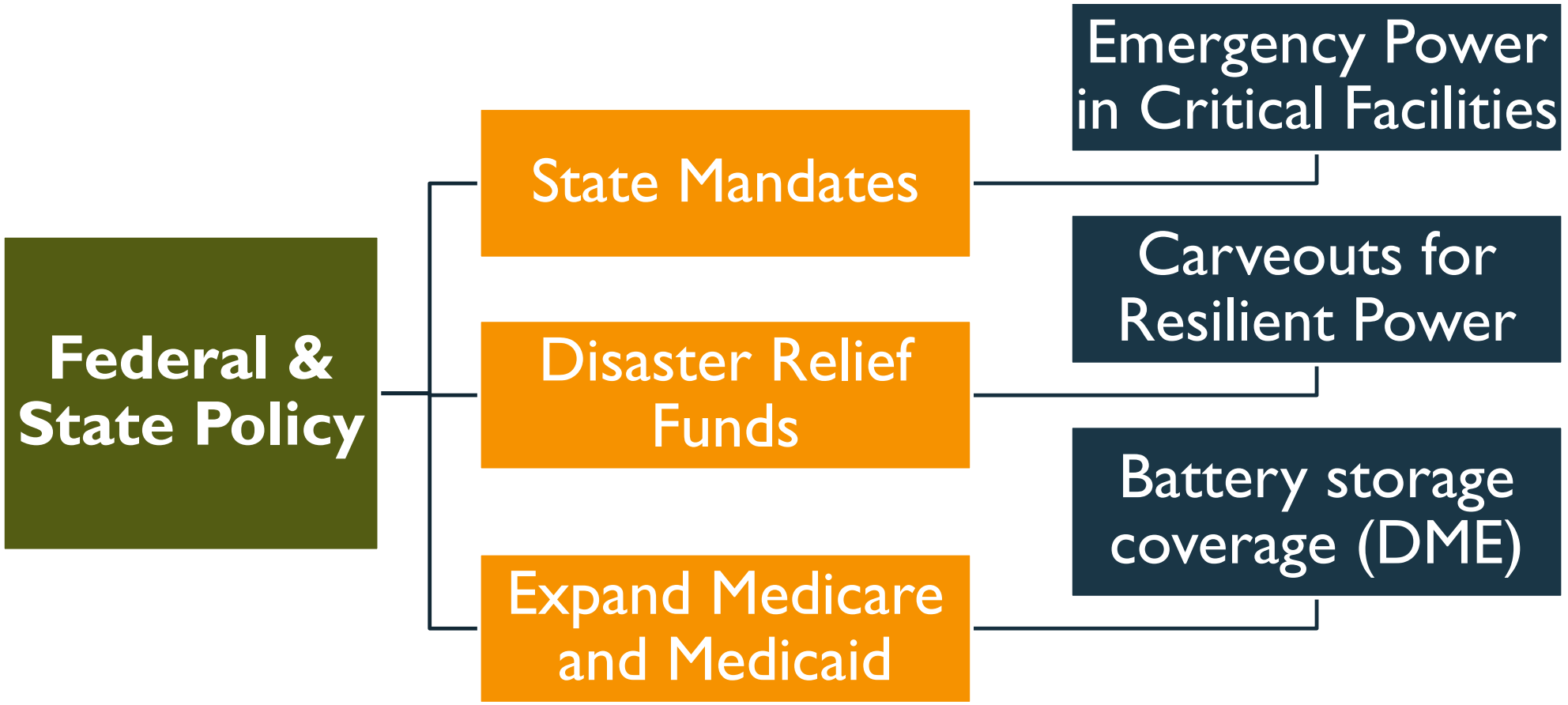
POTENTIAL SOLUTIONS

- Research and Data Development
- Technology Innovation
- Market Development
- Federal and state policy
- Expanded Insurance Coverage
- Cross-sectoral collaboration
- Critical facility preparedness
- Utility Programs

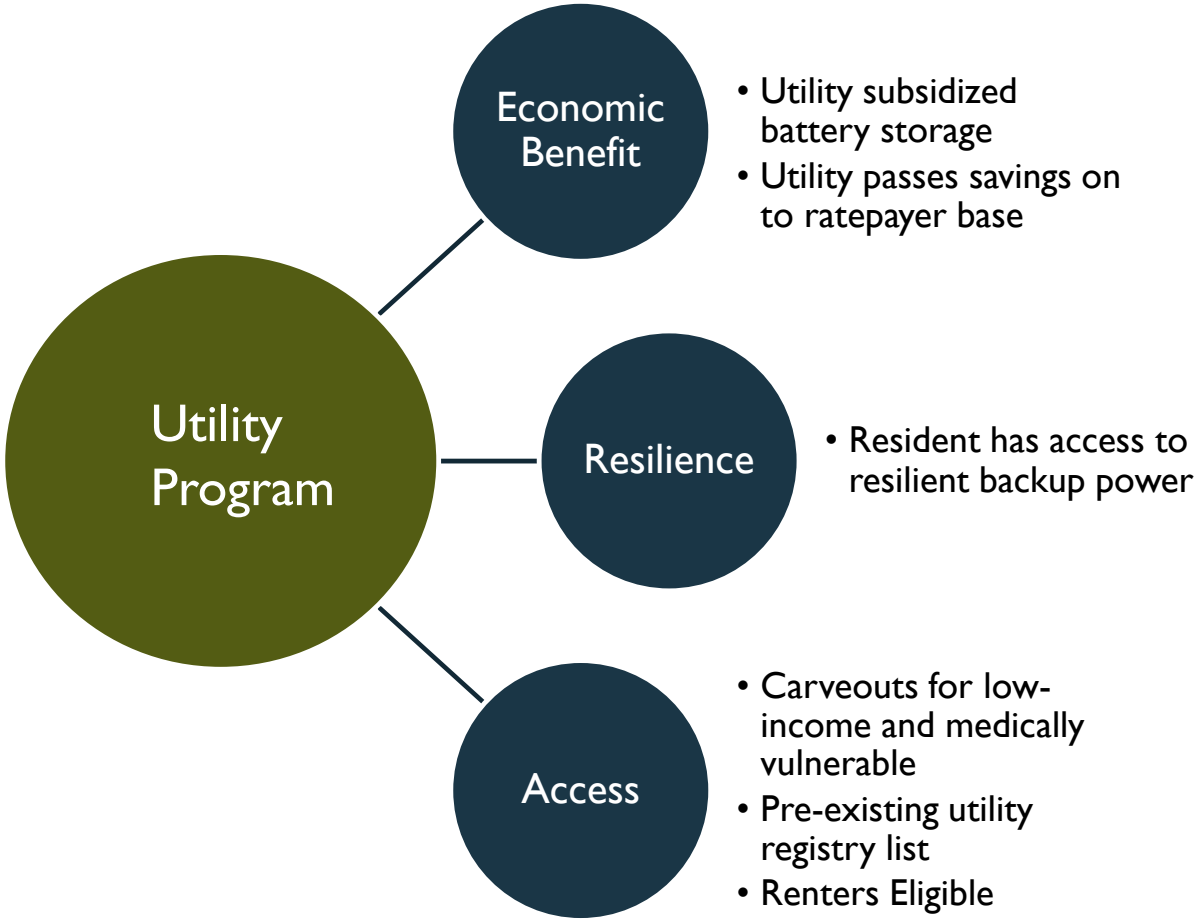
POTENTIAL SOLUTIONS



POTENTIAL SOLUTIONS



POTENTIAL SOLUTIONS



GREEN MOUNTAIN POWER

CONCLUSION

Read the report online here:
https://www.cleanegroup.org/ceg-resources/resource/battery-storage-home-healthcare/

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HHS emPOWER PROGRAM OVERVIEW

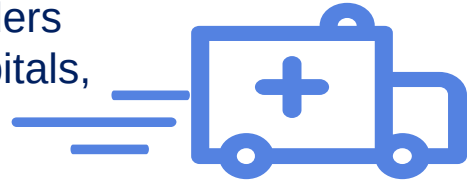
Joint Program of the
Office of the Assistant Secretary for Preparedness and Response (ASPR)
and the Centers for Medicare and Medicaid Services (CMS)
U.S. Department of Health and Human Services

2019

Why was the HHS emPOWER Program created?

Millions of Americans rely on electricity-dependent medical equipment and essential health care services to live independently in their homes

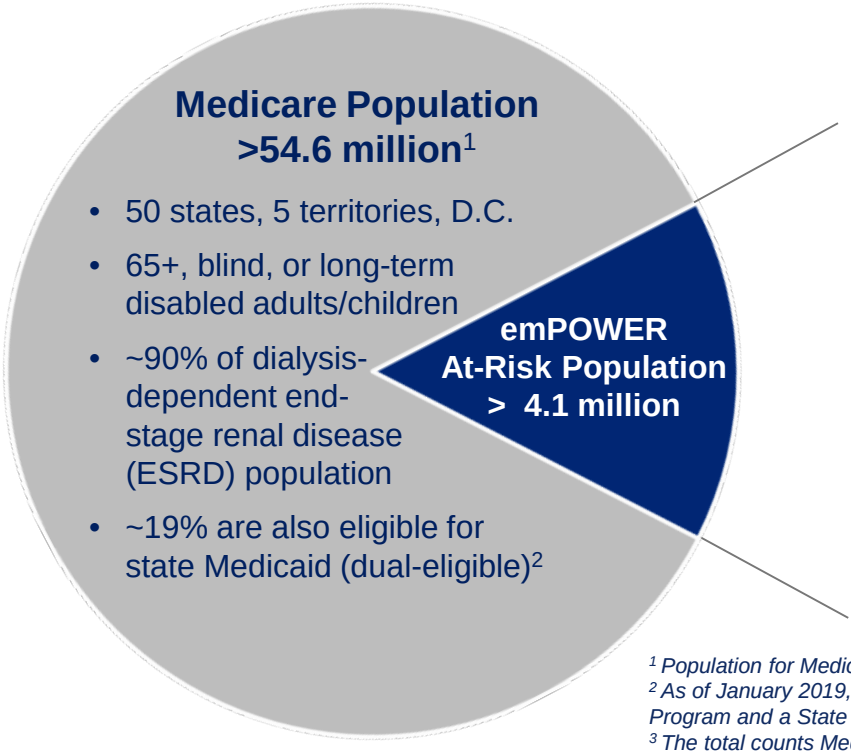
In the event of an **incident**, **emergency, or disaster**, at-risk populations often seek immediate care from first responders (e.g., EMS), hospitals, and shelters

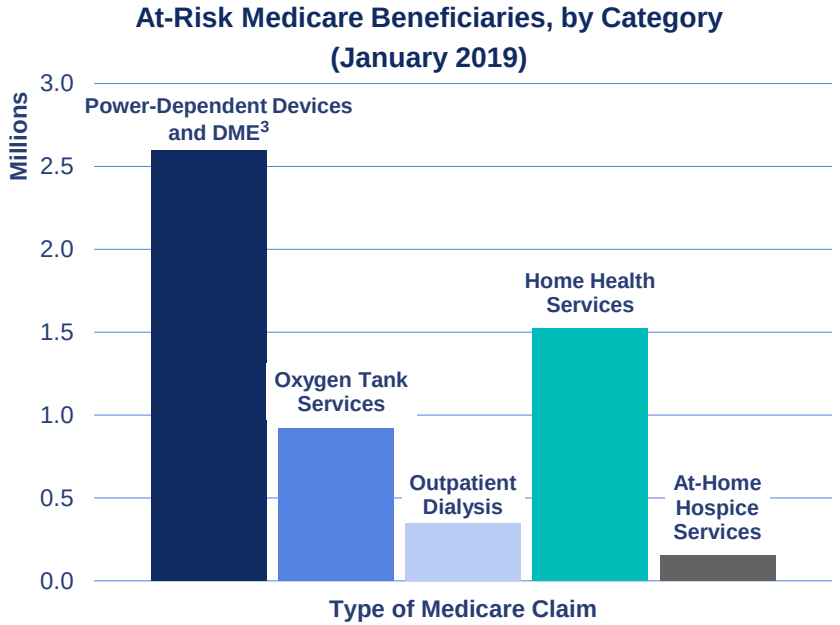


This leads to **surges in health care demand** and **stress** on systems and shelters

Can Centers for Medicare & Medicaid Services (CMS) data help communities **protect the health** of community-based at-risk populations, **ensure continuity of care,** and **reduce system stress**?

Characteristics of the HHS emPOWER Population



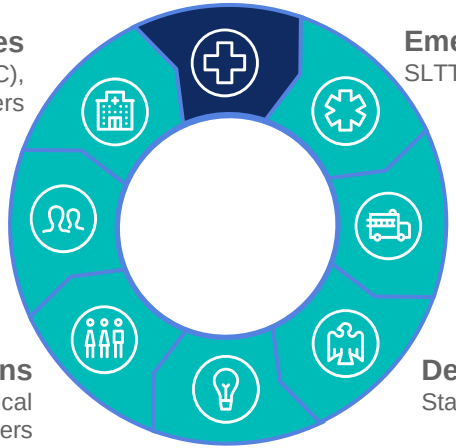


[1] *Population for Medicare (Parts A and B) and Medicare Advantage (Part C) as of January 2019.*
[2] *As of January 2019, 28.6% of the emPOWER population is dual-eligible (beneficiary is enrolled in both a Medicare Program and a State operated Medicaid Program) as compared to 18.6% of the total Medicare population.*
[3] *The total counts Medicare beneficiaries only once, even if they have more than one piece of electricity-dependent DME.*

emPOWER Informs Community Partnerships

The HHS emPOWER Program helps public health authorities engage a variety of national, state, local, and community partners throughout the emergency management cycle

Public Health Authorities [ESF-8]
State, Local, Tribal, and Territorial (SLTT) Public Health Authorities



Health Care Services
Health Care Coalitions (HCC), Providers, Suppliers

Emergency Management
SLTT Emergency Managers

Human Services
Home & Community-Based Human Services

First Responders
Emergency Medical Services (EMS); Fire Department; Law Enforcement; Urban Search and Rescue (USAR)

Volunteer & Community Organizations
Volunteer (e.g. American Red Cross); Medical Reserve Corps (MRC); Other Non-Traditional Partners

Department of Defense (DoD)
State National Guard or Reservists

Public Utilities
Electric, Water, Sewer Companies

The HHS emPOWER Program

emPOWERing Communities, Saving Lives

The HHS emPOWER Program, a partnership between ASPR and the Centers for Medicare and Medicaid Services, provides dynamic data and mapping tools to help communities **protect the health of more than 4.1 million** Medicare beneficiaries who live independently and rely on electricity-dependent medical equipment and health care services

HHS emPOWER Map and REST Service Public

Public

HHS emPOWER Emergency Planning De-identified Dataset

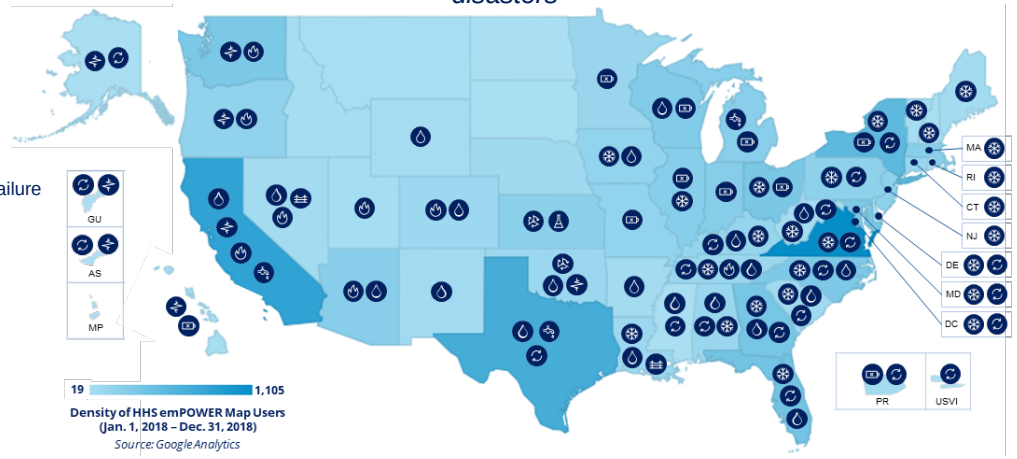
Restricted

HHS emPOWER Emergency Response Outreach Individual Dataset

Secure, Restricted

Communities in all 50 states and 5 territories have used the HHS emPOWER Program prior to, during, and after the following incidents, emergencies, and disasters

- Chemical Spill
- Earthquake
- Flood
- Hurricane/ Tropical Storm
- Infrastructure Failure
- Severe Power Outage
- Tornado
- Water Emergency
- Wildfire
- Winter Storm



Sample Uses of the emPOWER Data

The emPOWER de-identified data can help inform and support decision making by public health authorities and their partners, as they deem appropriate, prior to, during, and after an emergency

- Anticipate potential health system surge and leverage resources to mitigate stress
- Identify optimal locations, staffing, resources, and power needs for shelters
- Develop emergency plans, systems, processes, and triggers
- Assess accessible transportation needs and evacuation routes
- Identify and address potential gaps in emergency resources
- Inform power restoration prioritization decisions

Use Case: Hurricane Matthew in Florida

The HHS emPOWER Program helped Florida quickly identify and provide outreach to tens of thousands of at-risk individuals, setting the stage for life-saving emergency response

Preparedness

In anticipation of Hurricane Matthew, the Florida Department of Health used the emPOWER Emergency Response Outreach Dataset to identify at-risk individuals in seven counties and performed a **reverse lookup of phone numbers**

Response

A life safety call was made to **almost 45,000 residents** by the Florida Division of Emergency Management using the Statewide Alerting and Notification System

Impact

Staff **contacted the 169 individuals** who indicated they might have a health need during and shortly after the hurricane

Supporting partners:

- Florida Division of Emergency Management and Emergency Operations Centers
- Local PHA and Emergency Managers

44,500 at-risk residents identified and called

17,000 residents responded to calls

169 individuals requested assistance

Use Case: Severe Flooding in Nevada

In HHS emPOWER Program tools helped Carson City Health and Human Services (CCHHS) and Washoe County Health District (WCHD) assess its capacity to assist at-risk populations and engage partners to ensure coordinated outreach

Preparedness

In 2017, CCHHS used both emPOWER datasets to **identify and address gaps in resources** (e.g., oxygen tanks) for the at-risk population in the event of required evacuations

Outreach

CCHHS and WCHD used the emPOWER Emergency Response Outreach Dataset to **identify at-risk individuals living in flood-prone, avalanche-prone, and remote areas**, and coordinated with partners to conduct outreach

Impact

CCHHS is expanding use of the emergency planning dataset to help **set up mass care operations and inform umbrella contracts** with DME companies. WCHD and Washoe County GIS developed an effective way to operationalize emPOWER data within 30 minutes

Supporting partners:

- NV Division of Public and Behavioral Health
- NV Aging and Disability Services
- NV Division of Emergency Management
- NV National Guard
- Tribe Emergency Manager

4 counties in Nevada benefitted from emPOWER Program data

300 homes in flood-prone areas contacted by CCHHS

Use Case: Hurricane Irma in US Virgin Islands

HHS emPOWER Program tools helped the US Virgin Islands identify and locate individuals dependent on dialysis for life-saving outreach and evacuation

Preparedness

In 2017, ASPR, CMS, and territorial public health officials used both datasets to **to identify health care and resource gaps for dialysis patients and develop a plan** with End-Stage Renal Networks and dialysis providers to ensure continuity of their life-maintaining health care services

Response

Following Hurricanes Irma and Maria, ASPR used the emPOWER Emergency Response Outreach Dataset and CMS-3178-F reporting requirements to **rapidly identify, locate, and conduct life-saving evacuations** of dialysis patients via ASPR NDMS, USPHS, USAR, FEMA and DOD

Impact

ASPR is developing best practices to assist others in understanding how emPOWER data and the CMS 3178-F reporting requirements[1] can help to inform and protect the lives of at-risk individuals in disasters

Supporting partners:

- ASPR
- CMS
- Dialysis providers
- End-Stage Renal Networks
- FEMA
- DOD
- US Public Health Service (USPHS)
- Urban Search and Rescue (USAR)

235 life-saving evacuations from St. Thomas and St. Croix

[1]A means, in the event of an evacuation, to release patient information as permitted under 45 CFR 164.510(b)(1)(ii).

Additional Resources and Information

HHS emPOWER Program Resources

Training

- **HHS emPOWER Program Web-based Training Program (ID #1083714)** is a free, publicly accessible course designed to help partners better understand the HHS emPOWER Program* and integrate its tools into their emergency preparedness, response, recovery, and mitigation activities. The course is divided into five modules, which provide: an introduction to the HHS emPOWER Program, a detailed overview of each of the mapping and dataset tools, practical application examples and case studies of how public health authorities and their partners have used the program tools in real world emergencies.

Informational Resources

- HHS emPOWER Program Executive Summary
- HHS emPOWER Program Fact Sheet
- HHS emPOWER Map Job Aid
- HHS emPOWER REST Service Public Job Aid
- HHS emPOWER REST Service Public Link
    - The REST Service allows users to consume the HHS emPOWER Map data layer in their own geographic information system (GIS) applications to help them better integrate and use this with other community data to inform and support public health activities across the emergency management cycle.

HHS emPOWER Program

Contact Information

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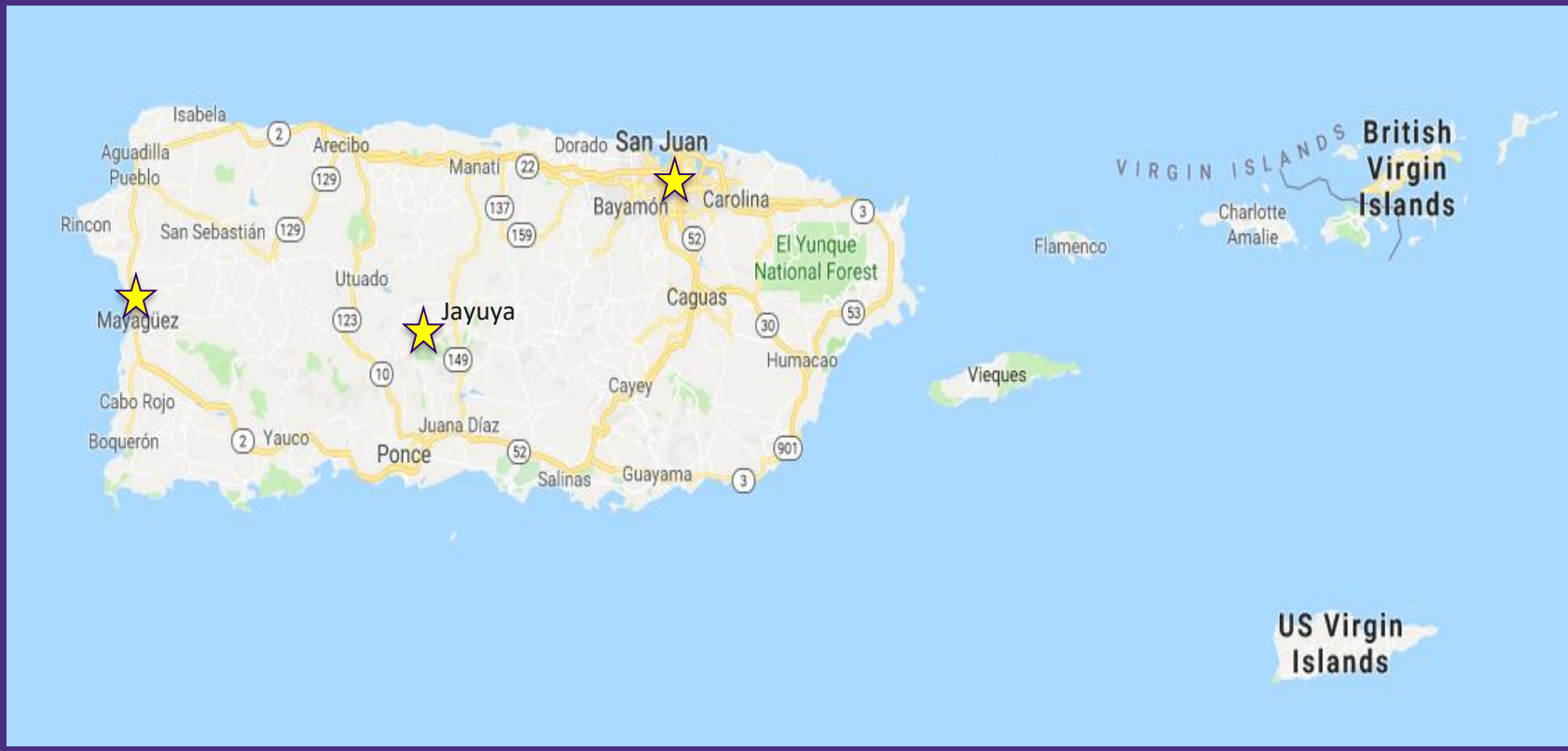
PV-Battery Systems for Critical Loads during Emergencies: Case Study from Puerto Rico after Hurricane Maria

Puerto Rico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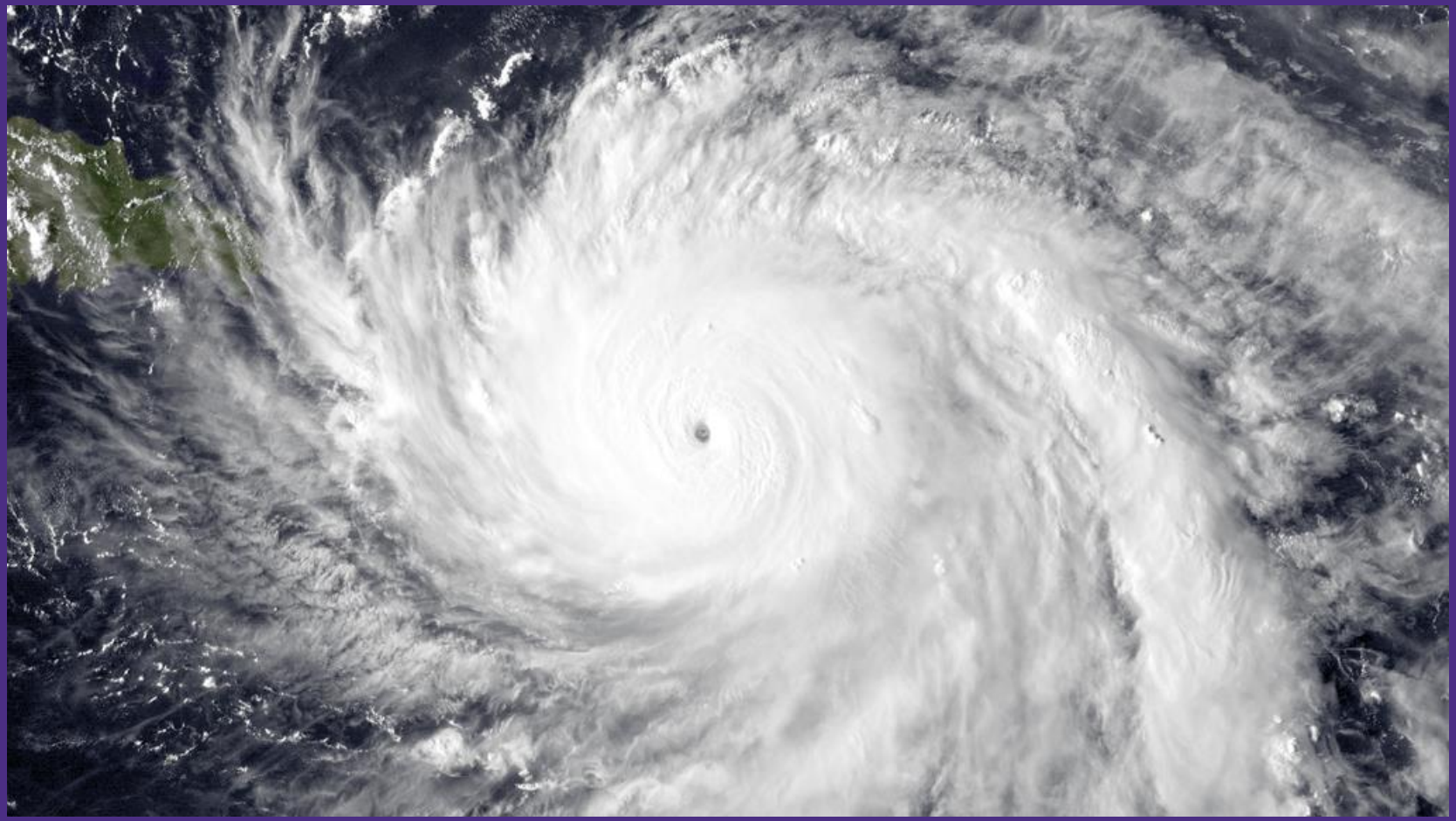
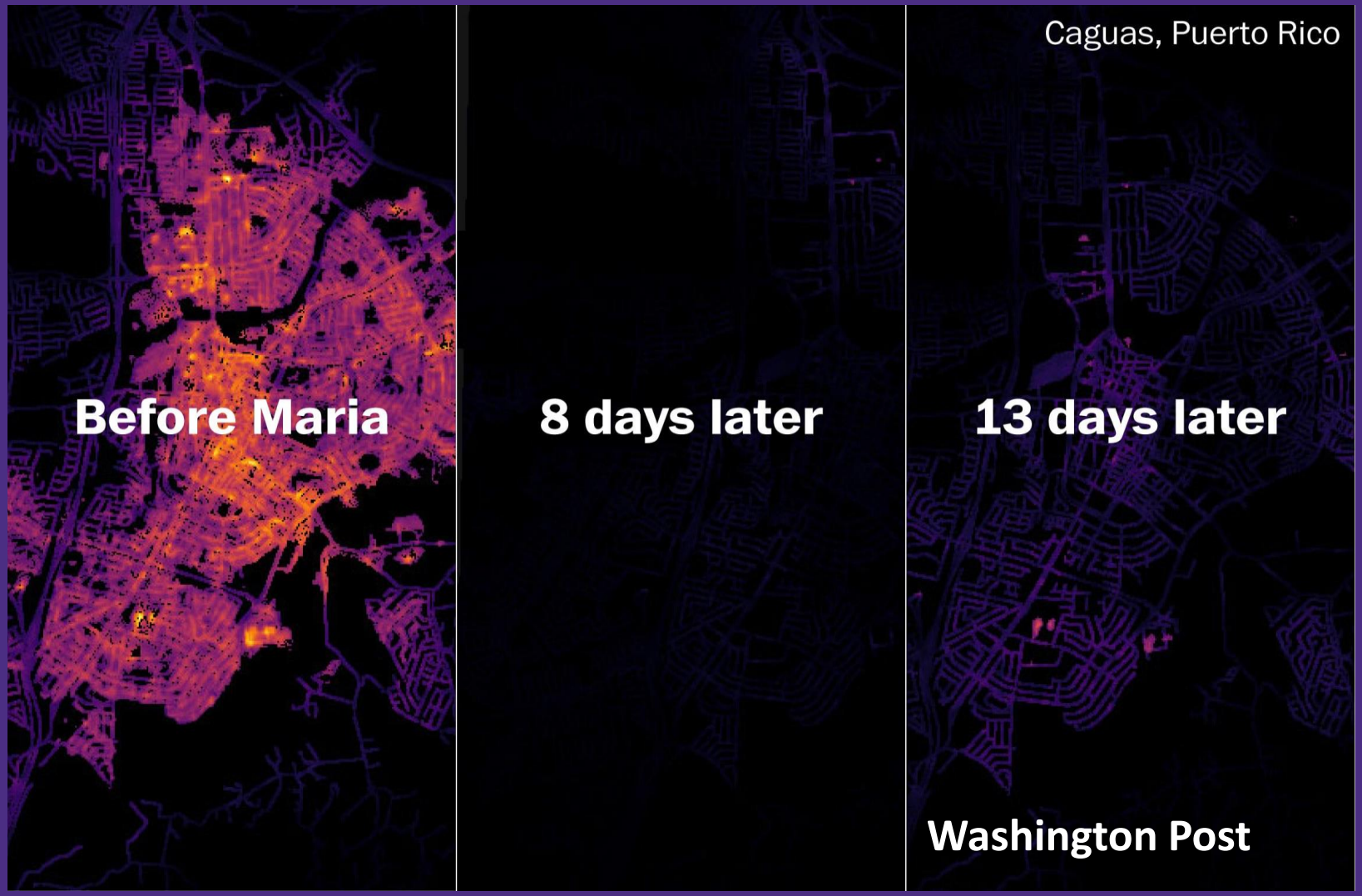
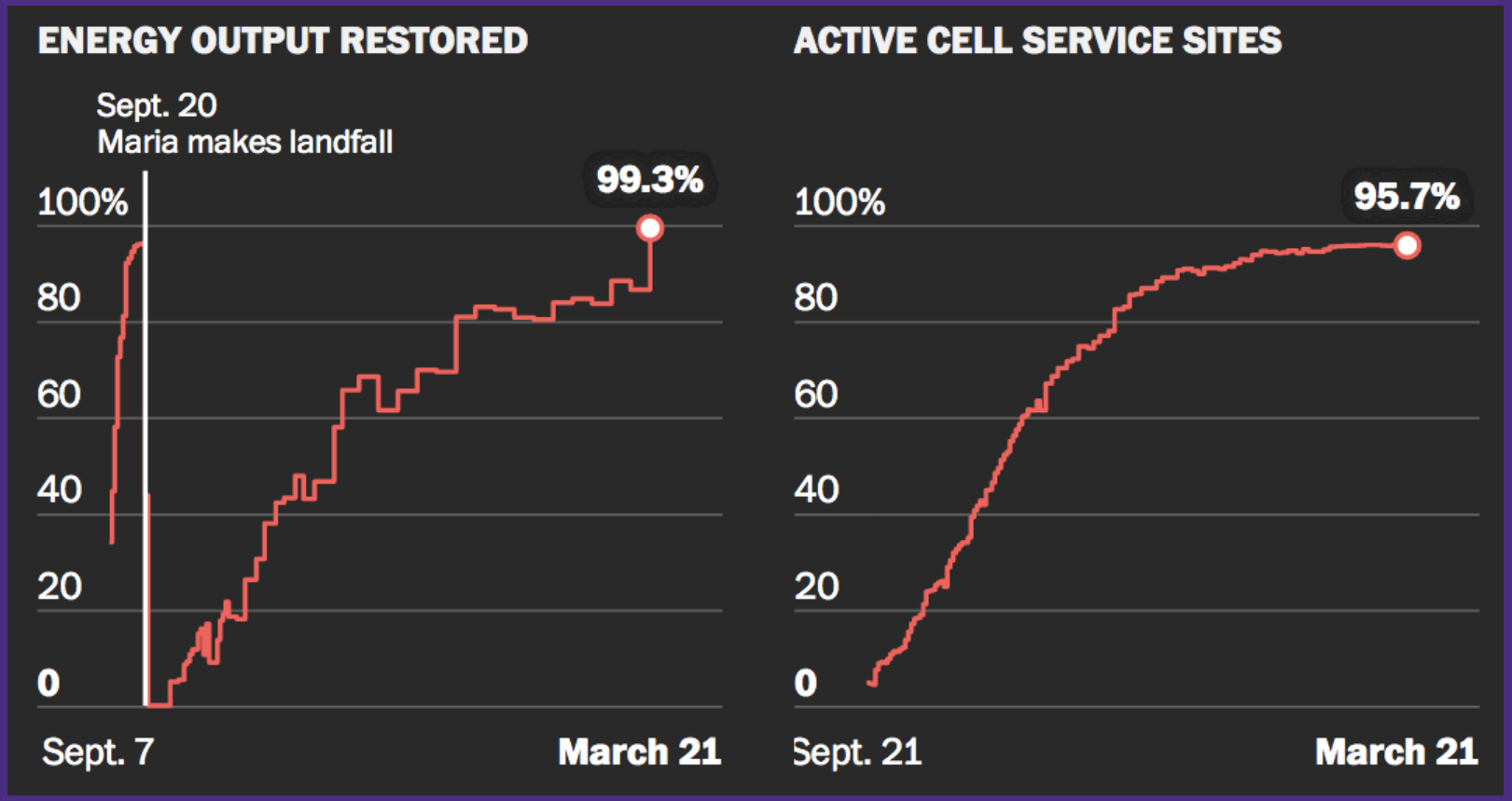
Aguadilla
Pueblo
Arecibo
Dorado
San Juan
Manatí
Bayamón
Carolina
Rincon
San Sebastián
El Yunque
National Forest
Utuado
Caguas
Mayagüez
Jayuya
Humacao
Vieques
Cayey
Cabo Rojo
Boquerón
Yauco
Juana Díaz
Ponce
Salinas
Guayama
VIRGIN ISLANDS
British
Virgin
Islands
Charlotte
Amalie
Flamenco
US Virgin
Islands

Hurricane Maria

Hurricane Maria
150 MPH, Category 5
September 20, 2017
(NOAA)




Caguas, Puerto Rico
Before Maria
8 days later
13 days later
Washington Post



DOE via Washington Post

Who suffers most during extended blackouts?

Recipients of health care at home depend on electricity

1. **Severe: Need electricity and therapy to sustain life**
   A. Dialysis
   B. Respirators
   C. Oxygen Therapy
2. **Serious: Health deteriorates without access to power**
   A. Asthma
   B. Sleeping disorders (Apnea)
   C. Mobility - bedridden
   D. Diabetes and special diets
   E. PEG Feeding

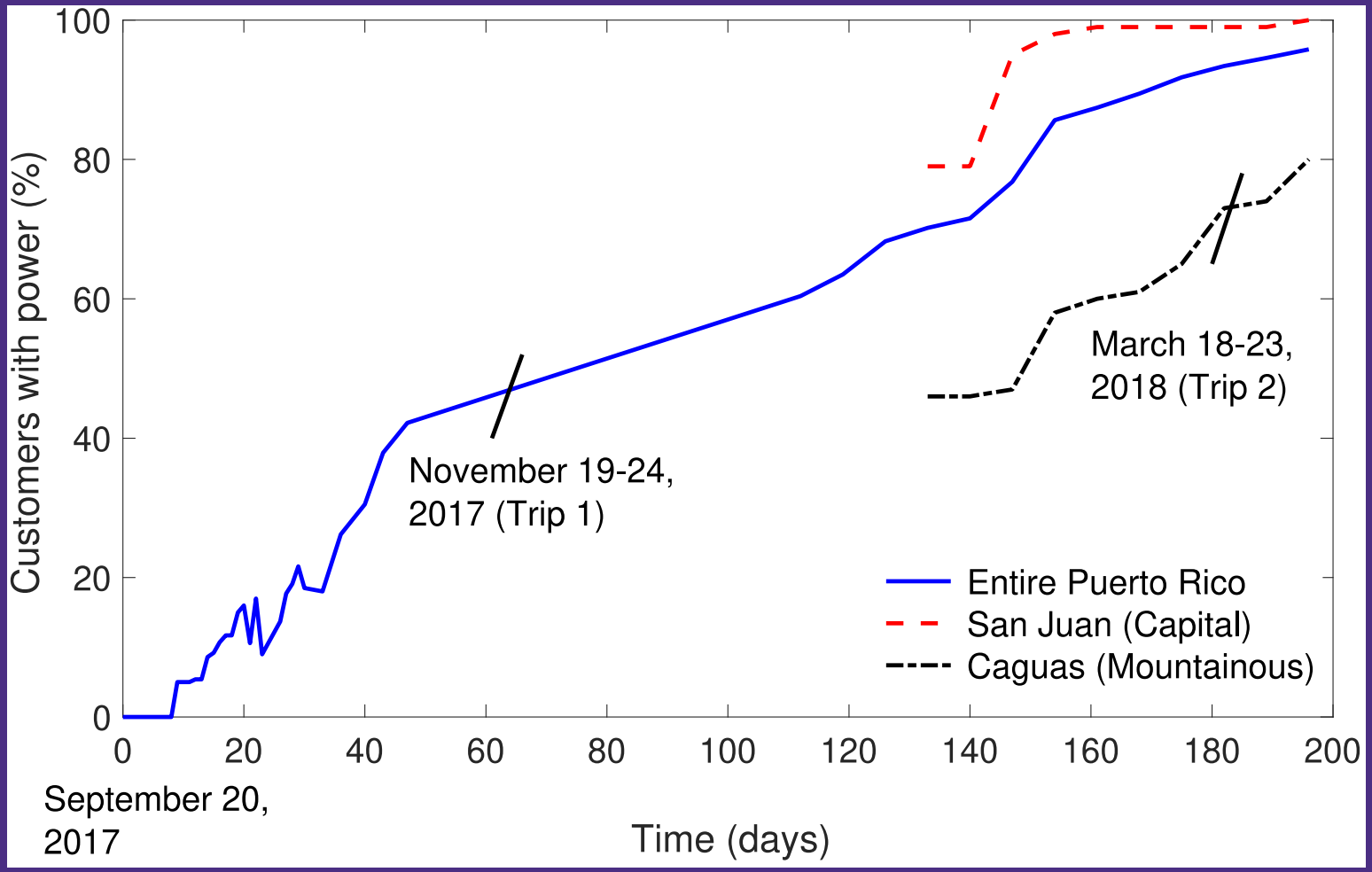
What We Need to Know to Plan Ahead

- How many people are dependent on electricity?
- How many can evacuate? Who? Where?
- How much electricity is required by individuals with specific conditions?
- What are long term effects of power outages on community health?
- How do people adapt during emergencies?

Knowing what we don't know…

- How do alternatives to grid energy perform during emergencies?
  - Gas / Diesel Generators
  - Solar Energy Systems
  - Can micro-grids increase resilience?
- What are technological, educational, social and economic barriers to implementing emergency power?
- What is the vulnerability of a specific community?

Restoration of power to mountainous areas is difficult



UW researchers made three field trips

- ***First Field Trip: Preliminary Needs Assessment***
- ***Second Field Trip: PV-Battery Systems Deployment***
- ***Third Field Trip: Data Collection and Analysis***

Preliminary Needs Assessment

- Identify patients
- Conduct interviews
- Identify the critical medical needs that require electric power at the household level
- Power requirements associated with these needs

The correct information leads to a better design and planning of power systems

UW researchers made three field trips

- ***First Field Trip: Preliminary Needs Assessment***
- ***Second Field Trip: PV-Battery Systems Deployment***
- ***Third Field Trip: Data Collection and Analysis***

Energy Flow in a PV-Battery System

PV system

MPPT charge controller

Electrical Grid

Smart Meter

Battery storage

+

Inverter

+

Electrical energy

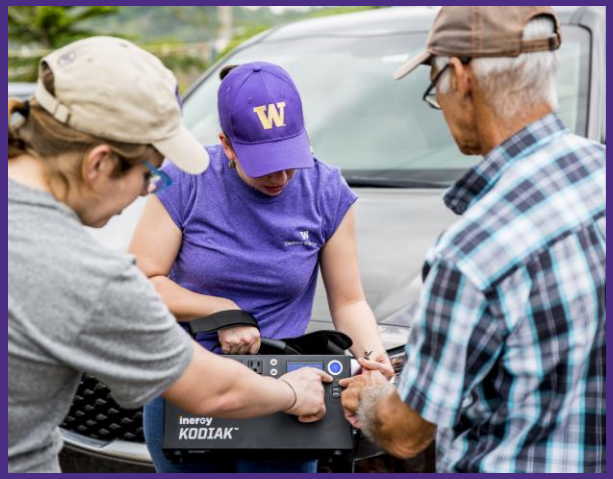
(Note that the additional energy flows in grid-connected systems have blue color arrows)

Electrical Demand

Installed Systems

table 2. A summary of the various systems installed.

	PV Size (W)	Battery	MPPT	Inverter (kW)	Number of Installations
Type A	260	160 Ah (lead acid)	Yes	1	Six
Type B	100–200	80–100 Ah (lead acid)	No	1	Six
Type C	400	1.1 kWh (lithium ion)	Yes	1.1	Five
Type D	100	100 Ah (lead acid)	No	dc system	Four



Solar + Storage Deployment







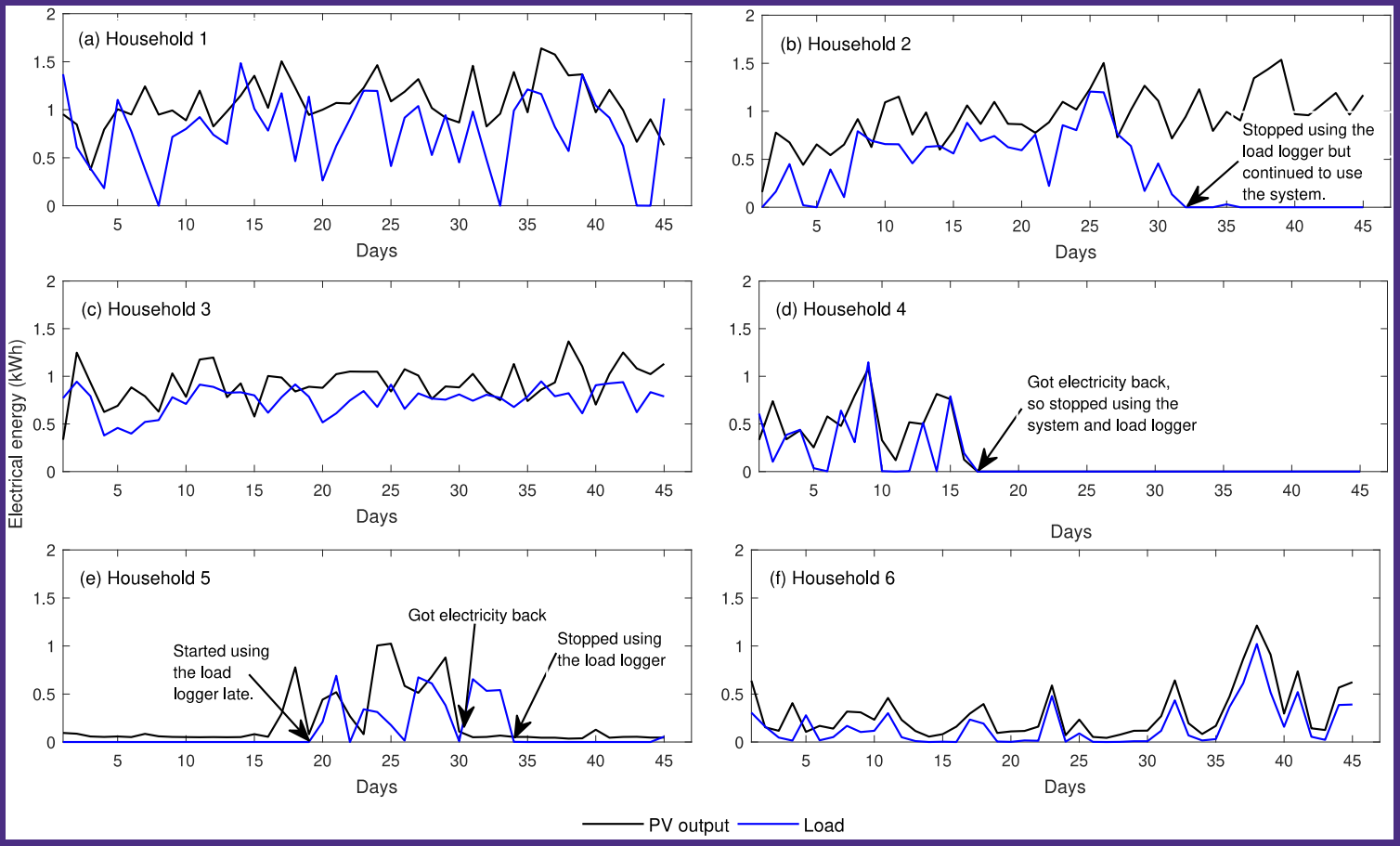
UW researchers made three field trips

- ***First Field Trip: Preliminary Needs Assessment***
- ***Second Field Trip: PV-Battery Systems Deployment***
- ***Third Field Trip: Data Collection and Analysis***

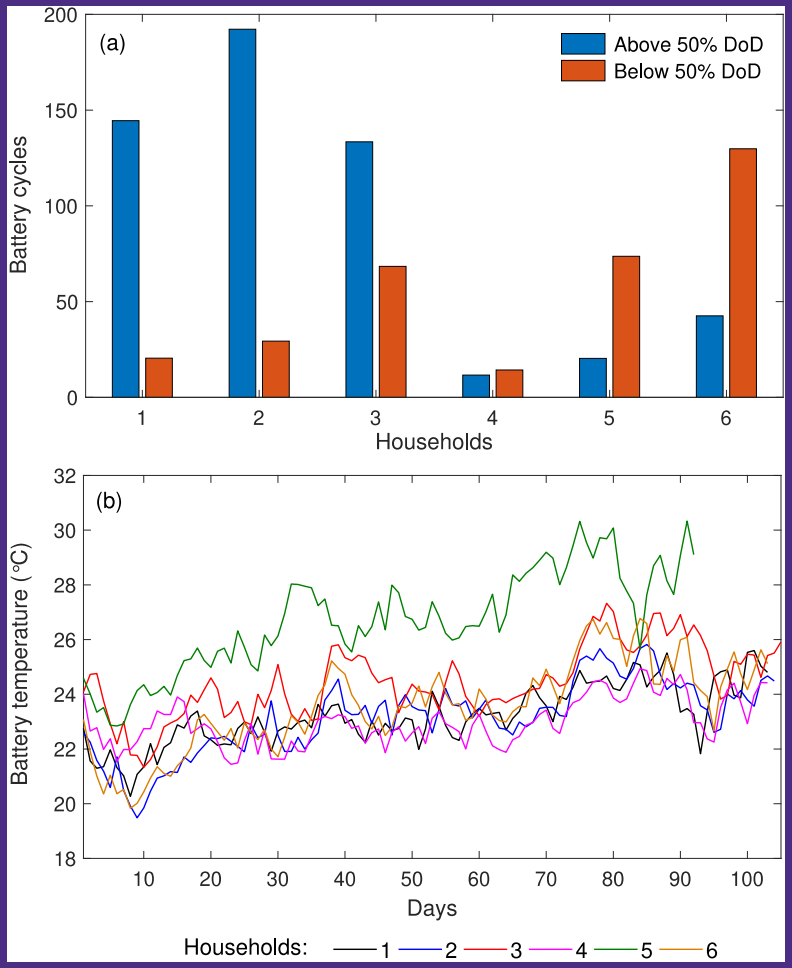
Analysis of Field Data

- *Energy Consumption and Generation*
- *Battery Degradation*
- *Load Profiles*
- *Survey*

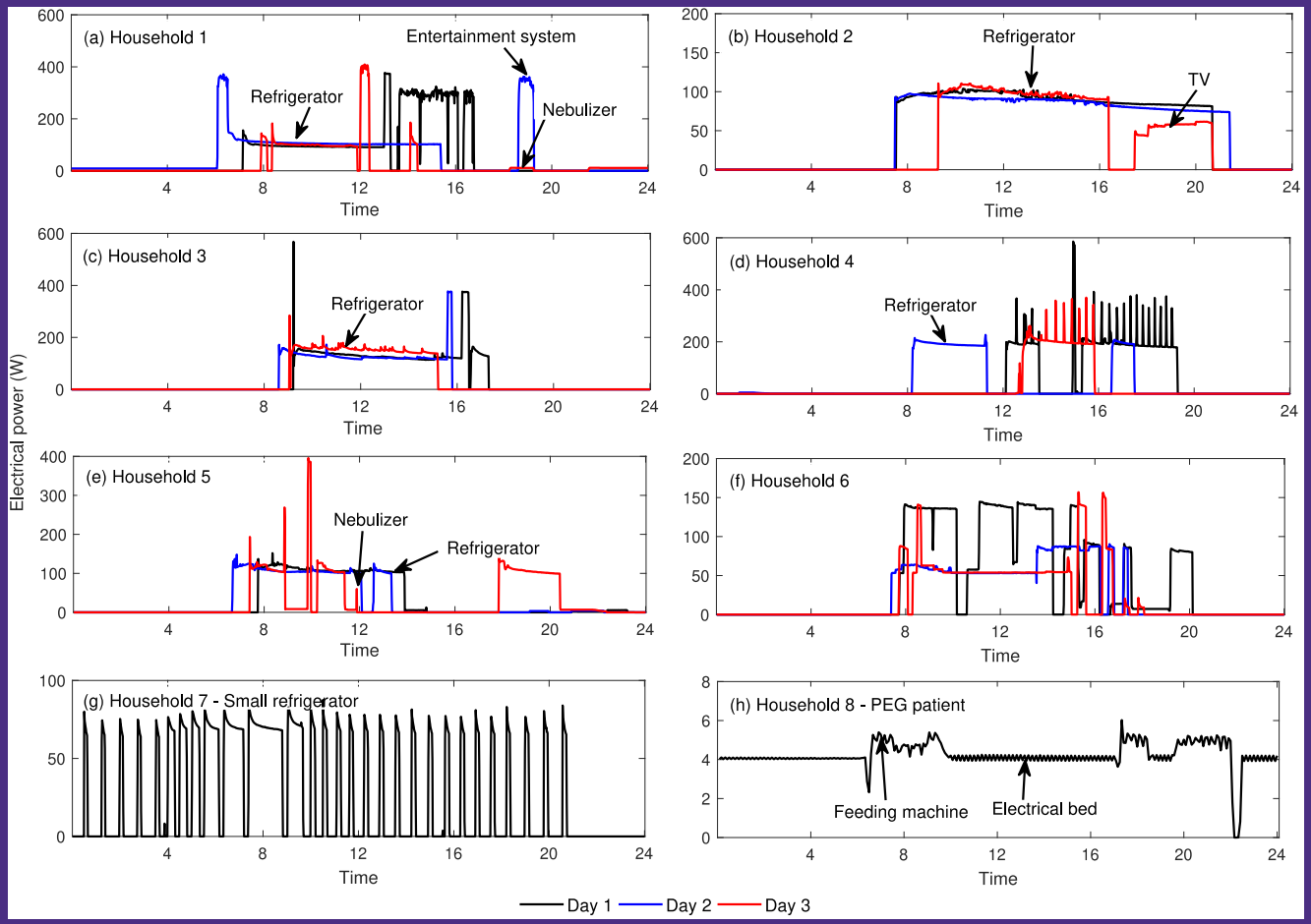
Energy Consumption and Generation



Battery Degradation



Load Profiles



Simulation Results and Discussion

- How do we properly size PV-battery systems to minimize cost but supply power to all the **critical loads** over a year.

- Load profiles for different devices
- PV generation data from NREL (location based)
- Lead-acid batteries (cycles per DoD)

- Linear optimization method, considering demand and PV variations and battery degradation cost.

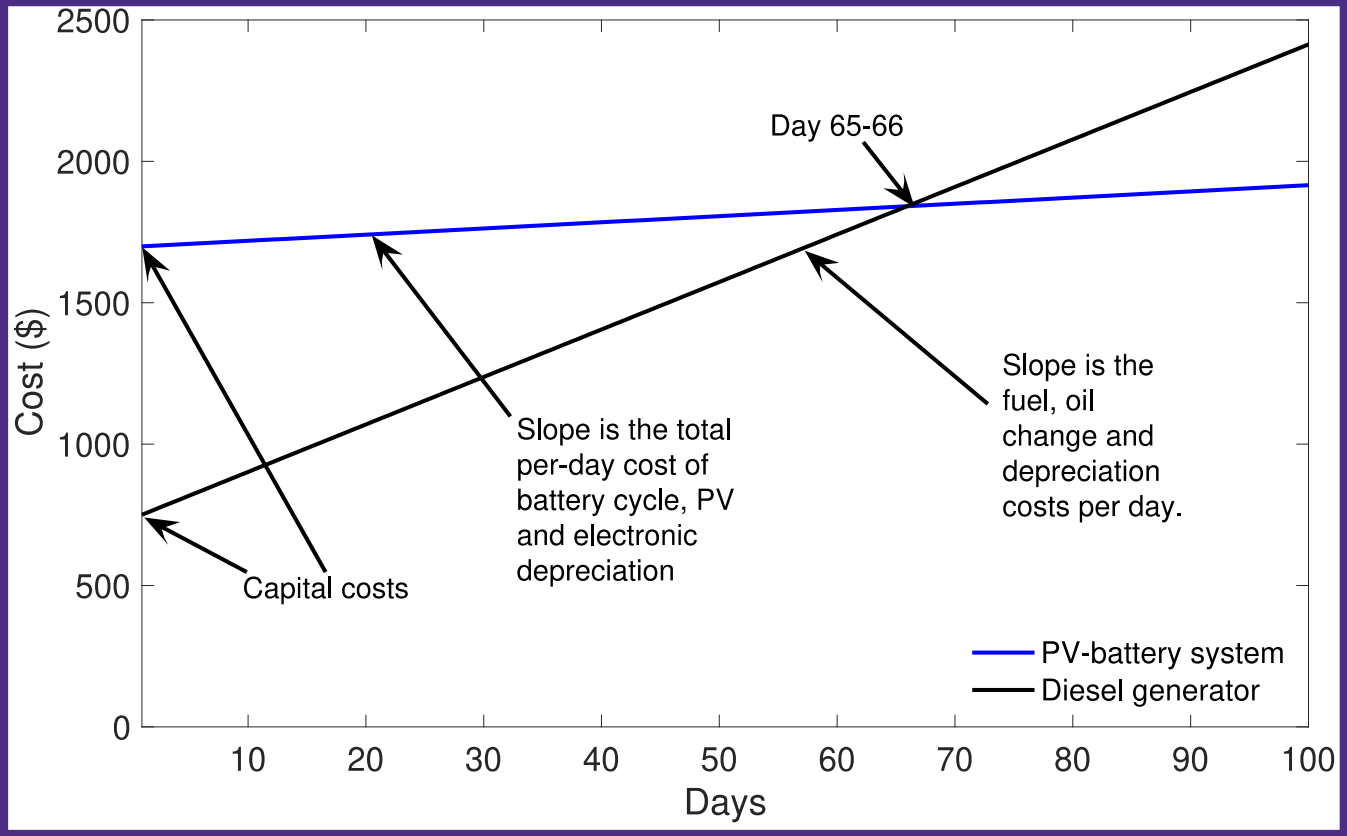
Summary of Simulation Results

table 5. A comparison of various PV battery system designs.

Battery Type and DoD	Battery Size (Ah) at 12 V	PV Size (Wp)	Total PV (kWh), One Year	Total Load (kWh), One Year	Battery Cycles (n)				Cost (US$)			
					One Year	Three Years	Five Years	Ten Years	One Year	Three Years	Five Years	Ten Years
Case A: Refrigerator, nebulizer, and TV												
Lithium ion (100% DoD)	100	800	1,291	484	78	235	392	783	2,150, r = 0	2,150, r = 0	2,150, r = 0	2,150, r = 0
Lead acid (100% DoD)	170	600	968		63	188	313	626	1,291, r = 0	1,291, r = 0	1,682, r = 1	2,464, r = 3
Lead acid (50% DoD)	260	700	1,130		36	107	178	356	1,648, r = 0	1,648, r = 0	1,648, r = 0	1,648, r = 0
Case B: PEG patient and small refrigerator												
Lithium ion (100% DoD)	60	300	484	197	166	497	828	1,655	1,020, r = 0	1,020, r = 0	1,020, r = 0	1,020, r = 0
Lead acid (100% DoD)	120	200	323		92	275	458	916	576, r = 0	852, r = 1	1,128, r = 2	1,680, r = 4
Lead acid (50% DoD)	120	300	484		88	263	438	876	726, r = 0	726, r = 0	726, r = 0	1,002, r = 1
Case C: CPAP, refrigerator, and small TV												
Lithium ion (100% DoD)	120	700	1,130	459	245	735	1,225	2,450	2,190, r = 0	2,190, r = 0	2,190, r = 0	2,190, r = 0
Lead acid (100% DoD)	270	500	807		117	351	585	1,170	1,371, r = 0	1,992, r = 1	2,613, r = 2	4,476, r = 5
Lead acid (50% DoD)	290	700	1,130		108	324	540	1,080	1,717, r = 0	1,717, r = 0	2,384, r = 1	3,051, r = 2
Case D: Oxygen concentrator, refrigerator, and TV												
Lithium ion (100% DoD)	950	4,900	7,907	3,594	219	656	1,093	2,185	5,900, r = 0	5,900, r = 0	5,900, r = 0	5,900, r = 0
Lead acid (100% DoD)	2,070	3,800	6,132		108	324	540	1,080	r = 0	r = 1	r = 2	r = 5
Lead acid (50% DoD)	1,980	5,500	8,875		110	331	552	1,103	r = 0	r = 0	r = 1	r = 2

The cost consists of only the PV and batteries, and r is the number of battery replacements. Wp is the nameplate value, which is a measure of watts at peak production.

PV-Battery Systems vs. Generator



How can we move forward?

- Extended power outages will occur again
- Need to improve our understanding of energy and health dependencies
- Research
  - Accurate critical load profiles and critical load percentages to help with sizing PV-battery systems and large microgrids.
  - Cost of lithium-ion batteries will play a major role

THANK YOU

Global Innovation Fund

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C. Keerthisinghe, M. Ahumada-Paras, L. D. Pozzo, D. S. Kirschen, H. Pontes, W. K Tatum, M. A. Mattos, *"PV-Battery Systems for Critical Loads During Emergencies: A Case Study from Puerto Rico After Hurricane Maria",* in IEEE Power and Energy Magazine, vol. 17, no. 1, pp. 82-92, Jan.-Feb. 2019.

Thank you for attending our webinar

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