



# PUERTO RICO GRID RESTORATION

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US Army Corps  
of Engineers®

2018

Department of Energy  
Project Management Workshop  
*"Managing Uncertainty"*



## INVESTING IN ENERGY INFRASTRUCTURE



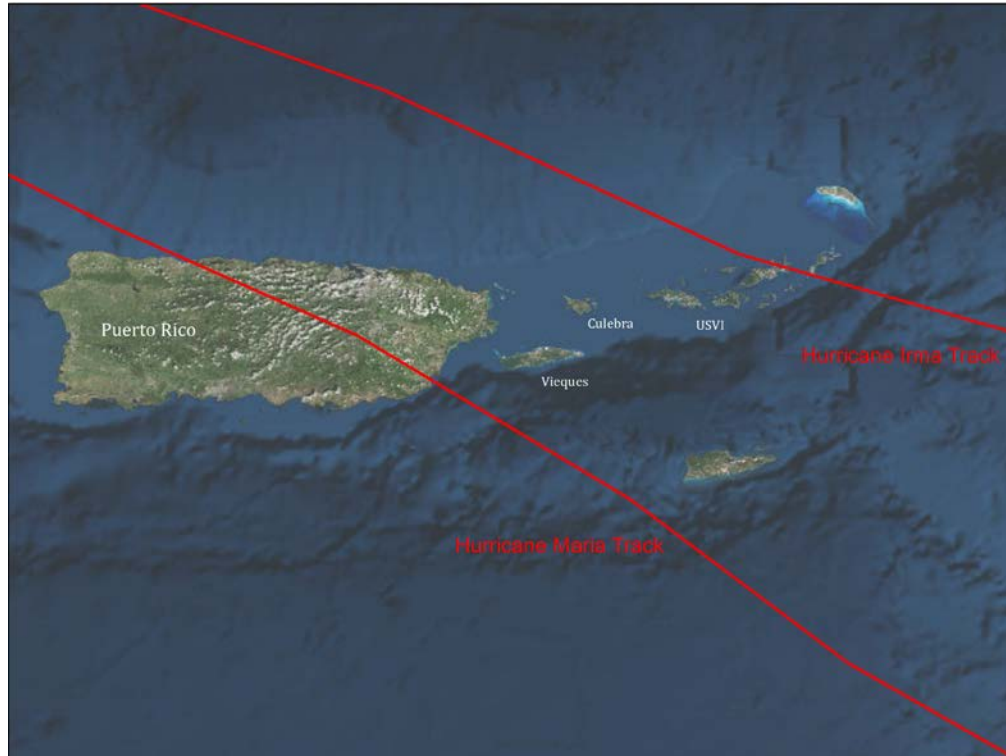
“A resilient, reliable, and secure power grid is essential to the nation’s security, economy, and the vital services that Americans depend on every day.”

“As round-the-clock efforts continue to help communities recover from the devastation of Hurricanes Harvey and Irma, the need to continue strengthening and improving our electricity delivery system to withstand and recover from disruptions has become even more compelling.”

- Secretary of Energy Rick Perry

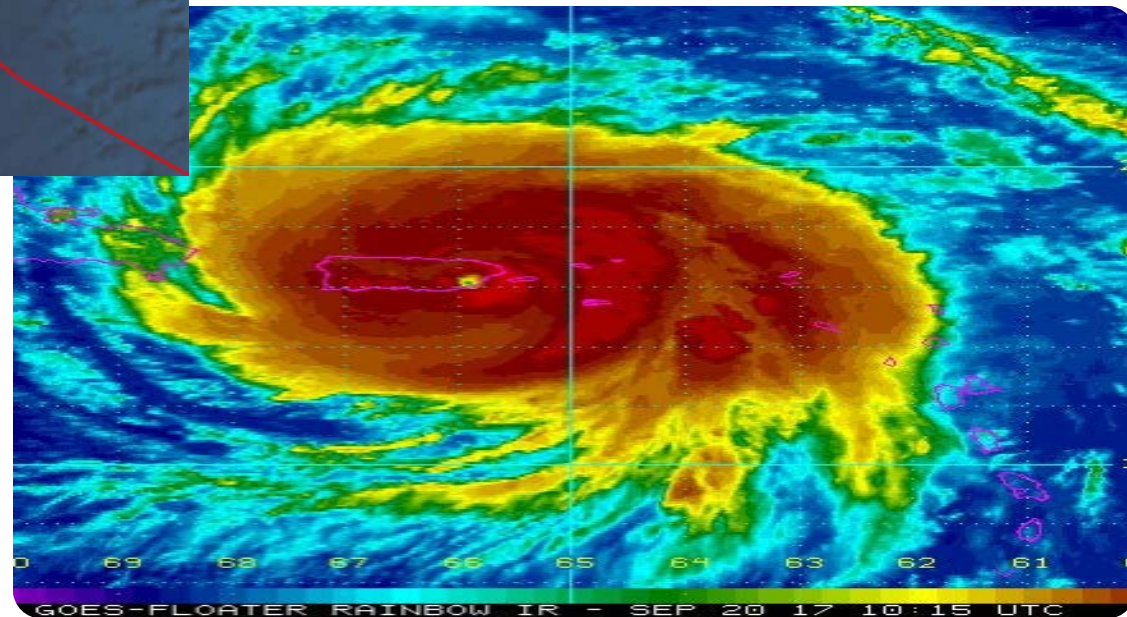


# IMPACTS TO PUERTO RICO FROM IRMA AND MARIA

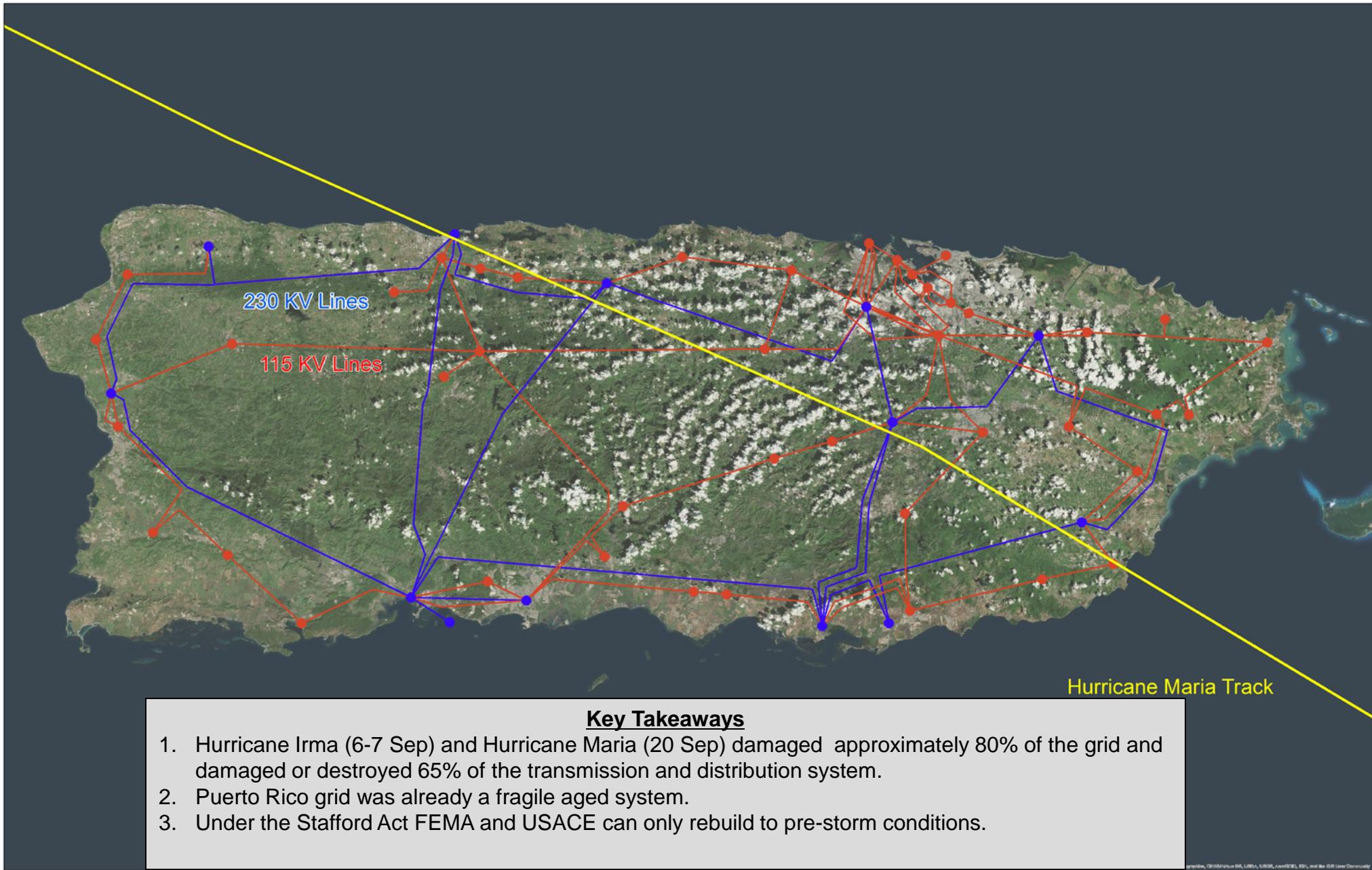


Hurricane Irma struck Puerto Rico's northern coastline on September 6 and 7, 2017 as a Category 5 storm, knocking out power to more than one million residents and crippling critical infrastructure.

Two weeks later, on September 20, 2017, Hurricane Maria made its way up the Caribbean as a Category 4 hurricane, bringing winds of 150+ mph and dumping 25 inches of rain, resulting in catastrophic damage of historical proportion.







- Key Takeaways**
1. Hurricane Irma (6-7 Sep) and Hurricane Maria (20 Sep) damaged approximately 80% of the grid and damaged or destroyed 65% of the transmission and distribution system.
  2. Puerto Rico grid was already a fragile aged system.
  3. Under the Stafford Act FEMA and USACE can only rebuild to pre-storm conditions.



# USACE MISSION AREAS AND ASSIGNMENTS



## Temporary Roofing

- FEMA provided tarps/sheeting
- Right of Entry, assess, install
- Qualify < 50% damage to roof
- ACI Contractor



## Debris Removal

- Debris Clearance – Roadways
- Debris Removal
- Disposal Sites
- ACI Contractor



## Temporary Power

- Install FEMA Generators at Critical Facilities (Life Saving)
- Assess, Haul, Install, Maintain
- 249<sup>th</sup> En Bn & ACI Contractor



## Repair Temp Power

- Non-traditional Mission
- Repair to Non-Fed Generators
- Long duration requirement
- 249<sup>th</sup> En Bn & ACI Contractor



## Critical Public Facilities

- Augment local Public Works Department inspections
- School, Police Stations, Fire Stations, etc.



## Infrastructure Assessments

- Augment local Public Works Department inspections
- Elec., Mech., Geotechnical, WWW Infrastructure



## Local Government Liaisons

- USACE liaison with local Government and FEMA
- Coordinate ESF 3 efforts on the ground with officials/public



## Restore Electric Power Grid

- Non-traditional Mission
- Restore Electric Power Grid
- Coordination with PREPA and contractors to execute





## Afghanistan Infrastructure Fund National Power Grid

## USACE, Transatlantic Division Afghanistan Engineer District



The Northeast Power System (NEPS) and Southeast Power System (SEPS) is a combined effort between USACE, USFOR-A, USAID, and Afghanistan's Ministry of Energy and Water (MEW) to provide increased quantity and better quality power to Afghanistan's two largest cities (Kabul and Kandahar), as well as bringing power to more areas throughout the country. This effort includes constructing new 220kV transmission lines in the North, transitioning to new 110kV transmission lines in the South, constructing new substations, and renovating the civil works side of three existing substations. The programmed amount for the entire NEPS/SEPS scope is over \$940M, with USACE executing over \$450M of that.





# MUTUAL ASSISTANCE – WHY USACE IN PR?



## ELECTRICITY SECTOR MUTUAL ASSISTANCE

### Mutual Assistance Overview

- Electric utilities have established voluntary partnerships to help other utilities restore power efficiently following an event known as “mutual aid” or “mutual assistance”
- Through pre-established mutual assistance agreements, the impacted utility agrees to reimburse utilities providing mutual assistances
- Each segment of the industry (investor-owned; public power; & electric cooperatives) coordinates assistance within their network; however, the whole industry works together during significant regional or national events
- The agreements are managed by three electricity trade associations that represent the different segments of the industry

### Mutual Assistance Process

#### Pre-Event

- Utilities work with regional stakeholders to create detailed restoration plans
- Utilities sign mutual aid agreements
- Utilities may pre-position resources in advance of major event



#### Post-Event

- Impacted utilities conduct damage assessments and evaluate resources required for safe & timely restoration
- Utilities request mutual assistance via established mutual assistance network
- Mutual assistance network coordinates with members, starting with utilities near impacted member, to deploy resources



# MISSION ASSIGNMENT



Overall purpose is to scope, coordinate, and execute interim repairs to segments of electrical grid to allow temporary restoration of grid segments until a comprehensive restoration of the overall power generation, transmission, and distribution systems on Puerto Rico can be implemented, as directed by FEMA.





# HOW WE DELIVERED



FEMA



US Army Corps of Engineers®



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**ENERGY**

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Edison Electric  
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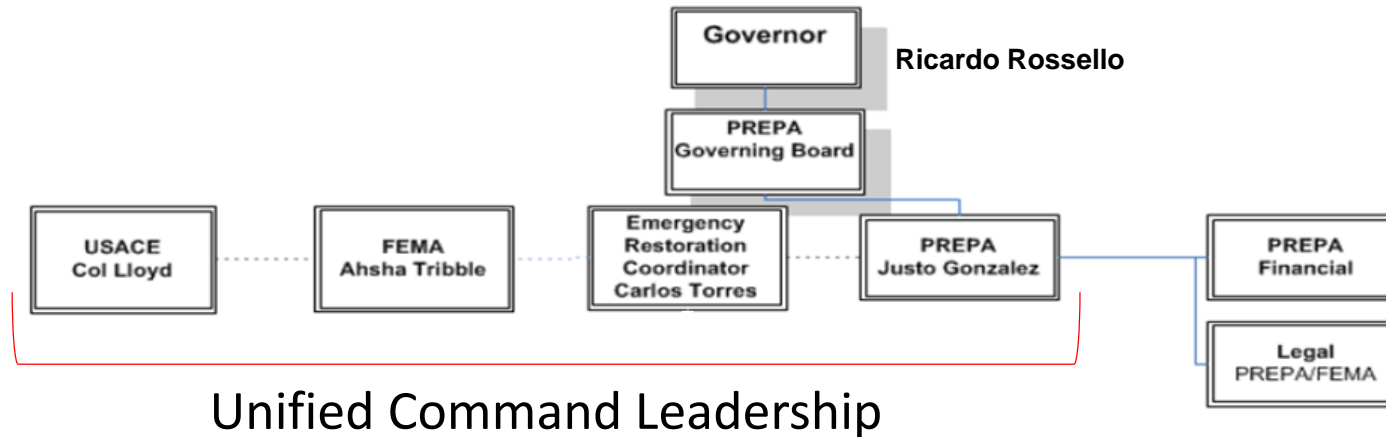
**conEdison**

AMERICAN  
**PUBLIC  
POWER**  
ASSOCIATION

 **New York Power  
Authority**



# TASK FORCE POWER RESTORATION Unified Command

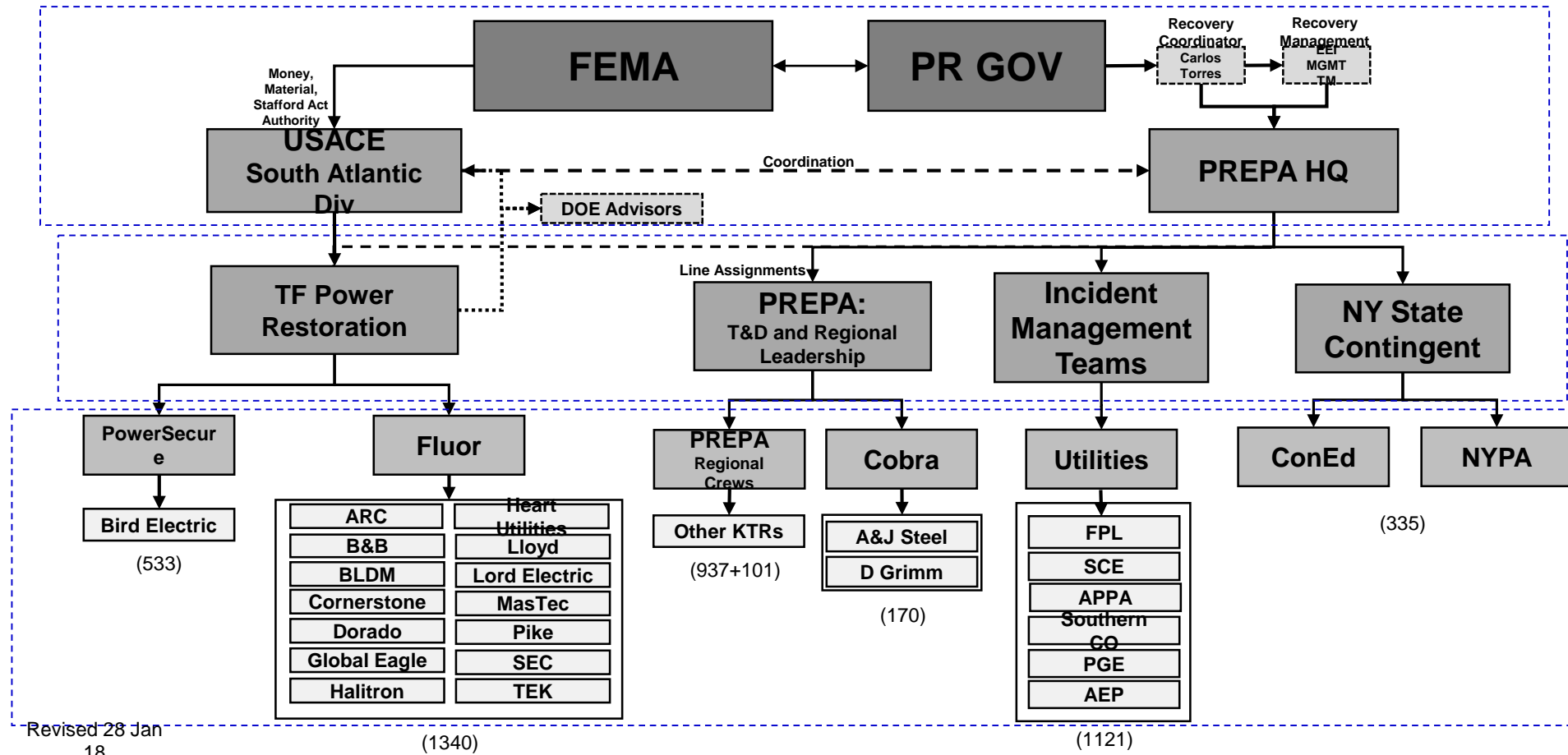


## Engagements/Meetings:

- Unified Command and Stakeholders meet daily (face-to-face).
- Every morning coordination call for line work.
- Weekly Transmission and Distribution sync meetings.
- Daily Logistics sync meetings (stakeholders and contractors)
- Weekly Micro-grid meetings



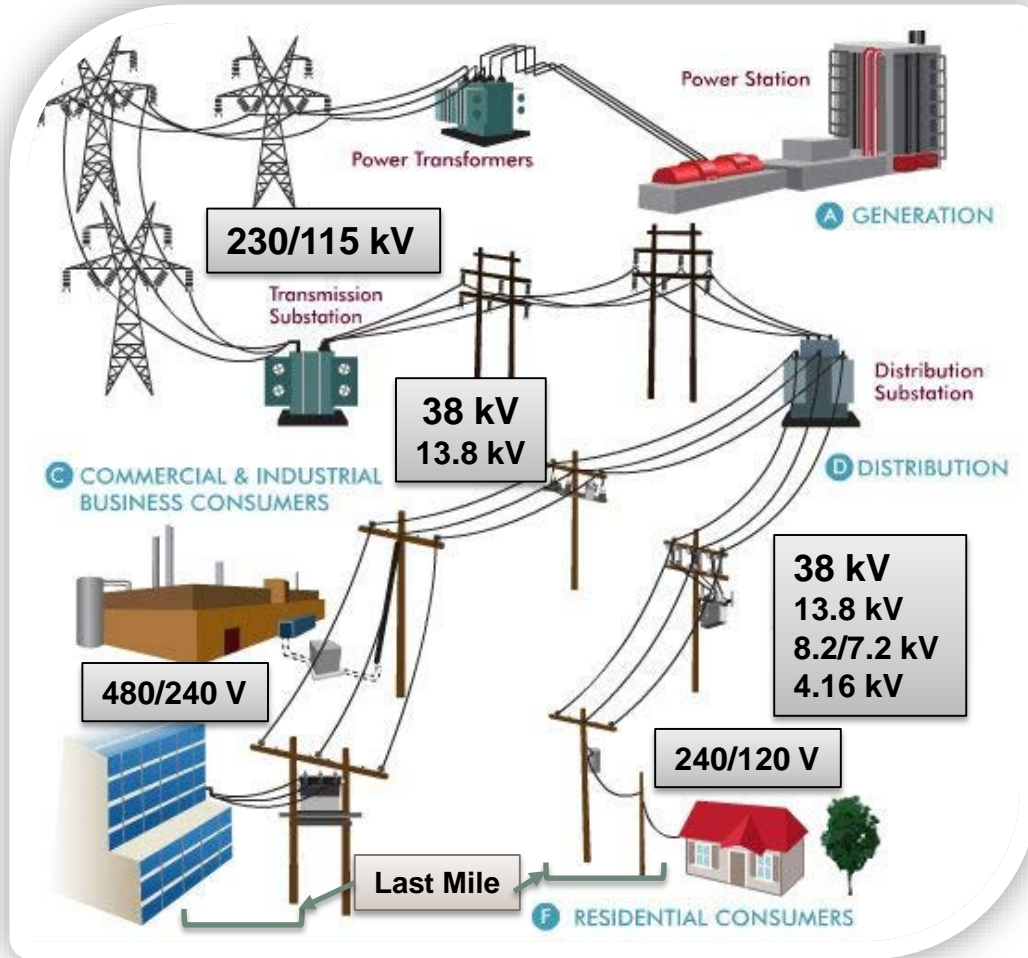
# Grid Restoration Task Org







# ILLUSTRATION OF POWER GRID SEGMENTS



## ❑ POWER GENERATION

- Step Up Transformers

## ❑ TRANSMISSION LINES

- Transmission Towers
- Transmission Centers

## ❑ SUBTRANSMISSION LINES

## ❑ DISTRIBUTION LINES

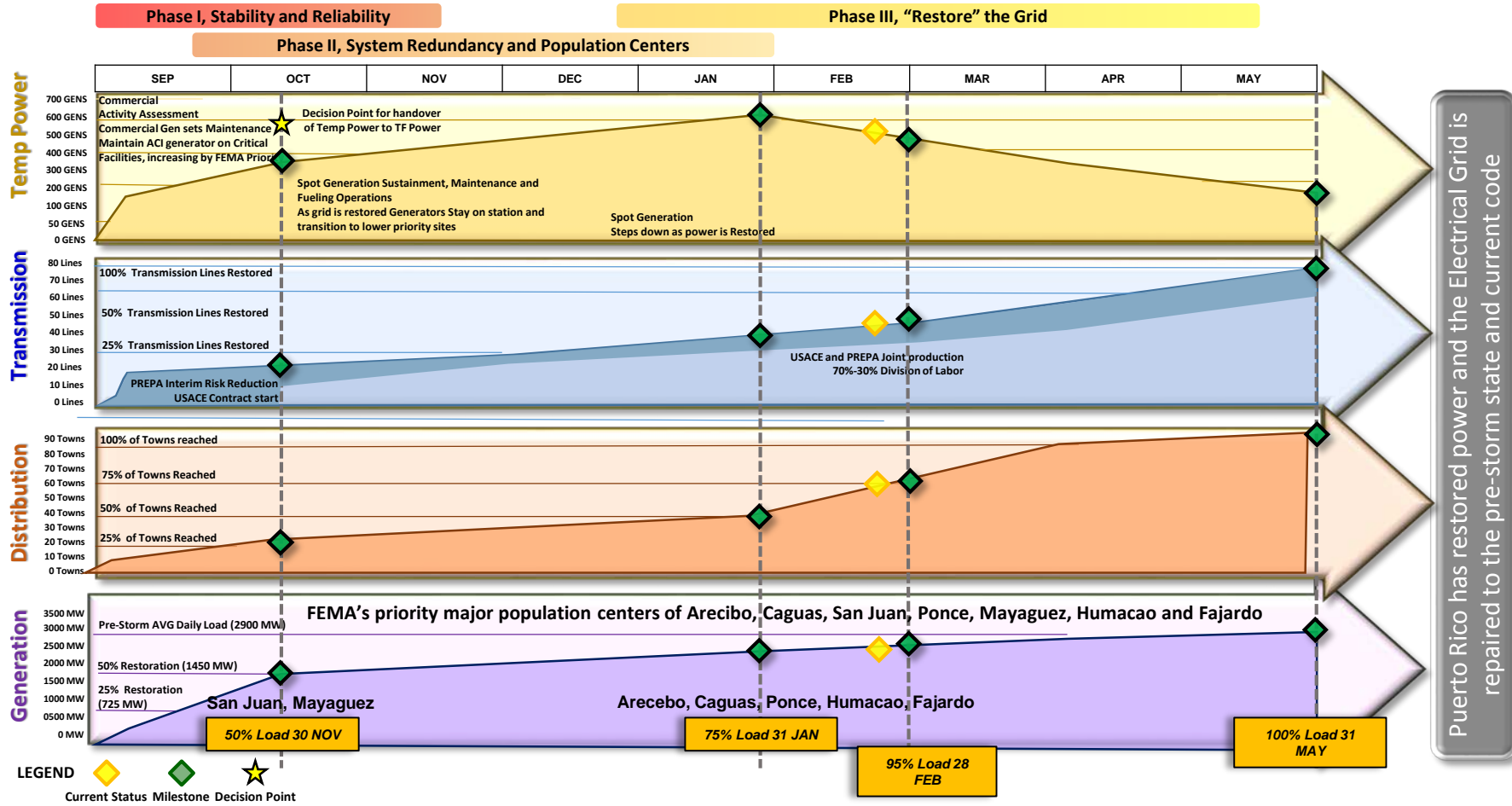
- Distribution Centers
- Distribution Poles
- Step Down Transformers

## ❑ “LAST MILE”

- Commercial Consumers
- Residential Consumers



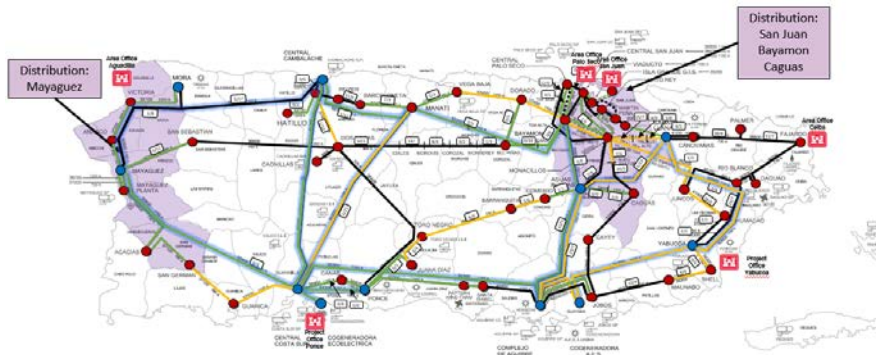
# USACE TASK FORCE POWER RESTORATION LINES of EFFORT



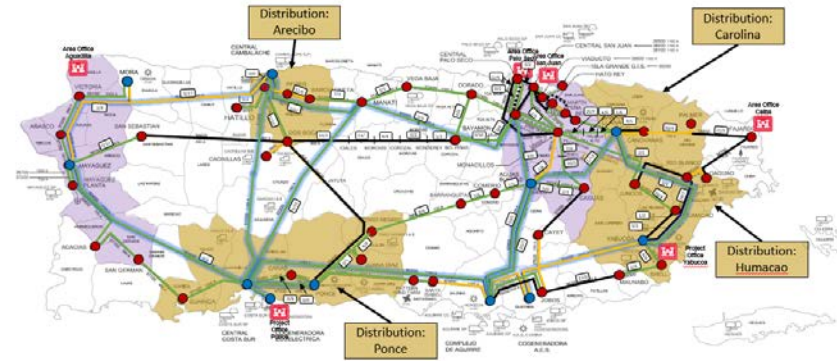


# TASK FORCE POWER RESTORATION

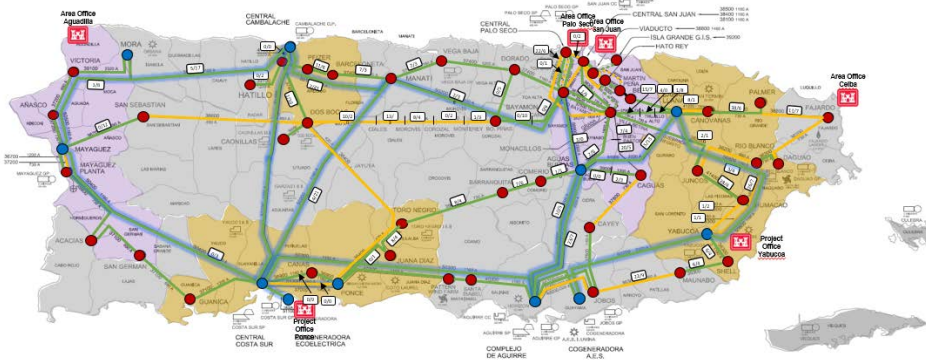
## Overall Concept of Operations



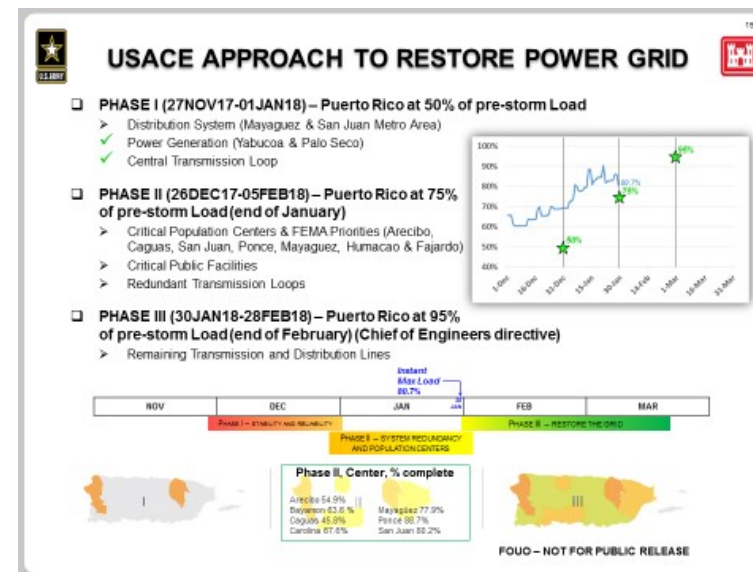
Phase I



Phase II



Phase III





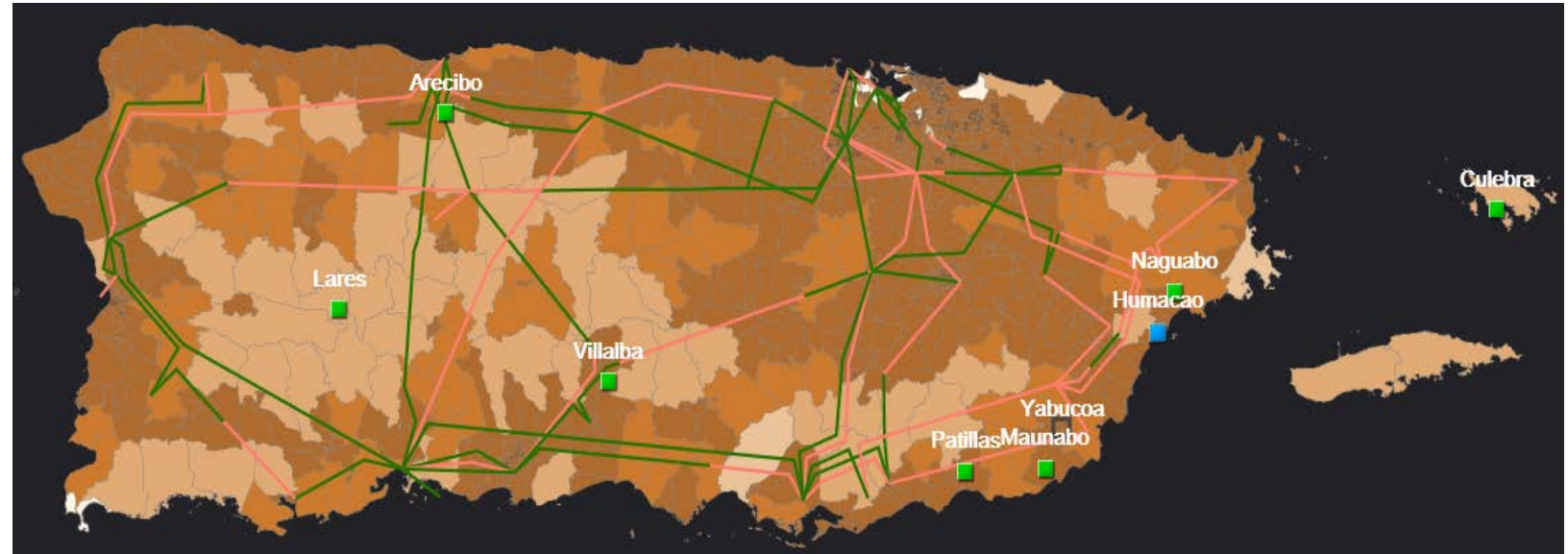


# MICROGRIDS

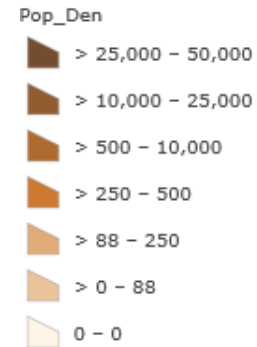


## Microgrid Status:

- **Culebra** – 2 Dec 17
  - Power Produced 28MWh; Peak Power: 1.4 MWh
  - 2x Gen/2x Trans
- **Lares** – 12 Jan 18
  - Power Produced 3.814MWh; Peak Power: 0.227 MWh
- **Maunabo** – 23 Dec 17
  - Power Produced 26.603 MWh; Peak Power: 1.3MWh
  - 3x Gen/3x Trans
- **Naguabo** – 23 Dec 18
  - Power Produced 39.483 MWh; Peak Power: 1.9MWh
  - 1x Gen/1x Trans
- **Patillas** – 21 Dec 17
  - Power Produced 40.250 MWh; Peak Power; 2.3 MWh
  - 3x Gen/3x Trans
- **Villalba** – 13 Jan 18
  - Power Produced 10.015MWh; Peak Power 590KW
  - 1xGen/
- **Yabucoa** – 27 Dec 17 – 6 Feb 18
  - Mission Complete
- **Arecibo** – 01 Feb 18.
  - Power Produced 1.649MWh; Peak Power: .596MWh
  - 2x Gen/1x Trans
- **Humacao** –FEMA Approved, Planning Phase



### Population Density



### Microgrid Locations



### Transmission Line Energized Status



|   | Micro Grid | Substation | Clients served |
|---|------------|------------|----------------|
| 1 | Culebra    | 3801       | 1,217          |
| 2 | Naguabo    | 2701       | 3,899          |
| 3 | Patillas   | 4201       | 3,660          |
| 4 | Maunabo    | 4301       | 1,699          |
| 5 | Villalba   | 5902       | 1,298          |
| 6 | Lares      | 7902       | 400            |
| 7 | Arecibo    | 8008       | 393            |



## TASK FORCE POWER RESTORATION CHALLENGES



- **Logistics** and timely material availability continue to be a challenge
- **Uniqueness** of the PR grid system
- **Terrain and site access** present unique challenges to contractor production rates
- Complete assessment of **grid stability**. Impacts on overall system unknown as parts of system are brought on line
- Establish and de-conflict **priorities of work** through partnering relationships with various stakeholders at all levels of government
- Need to prioritize **critical facilities and industry** centers as backup generator capacity is stretched beyond normal operating assumptions for temp power
- **Power Generation** capability may not keep up with demand
- The “**last mile**” or final hookups to end users presents a challenge as damages to structures are extensive and will preclude final connections
- **Crew saturation point** will eventually be reached due to airspace deconfliction, tower construction, and other limiting factors





## TAKEAWAYS AND QUESTIONS



- **Team of Teams**
  - **USACE, DOE, FEMA, Industry, PREPA, Defense Logistics Agency**
- **Devastating Impacts to the Population**
- **Historic Response by USG, FEMA, USACE, and DOE**
- **Enduring mission for USACE and DOE**
- **Amazing Volunteers**
- **Making a difference for the people of PR**
- **We could not have done it without DOE Support!**

“The use of DOE SME's to be imbedded with USACE was a huge success for this mission. We were united in the end goal of Emergency Restoration of Power to the Puerto Rican people. General Jackson put it well, "USACE and DOE need to be in lockstep with each other" and we were.”

**\*\*1 June starts Hurricane Season!**