



New York State Utility Contingent Emergency Response to Hurricane Maria

After Action Report

August 2018



**NY Power
Authority**

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Source: NYPA

1. Executive Summary

1.1 Introduction

The 2017 Atlantic Hurricane season was predicted to be an above normal season due to the weak or non-existent El Nino episodes by the National Oceanic and Atmospheric Administration (NOAA). Forecasters predicted a 70 percent likelihood of eleven (11) to seventeen (17) named storms (winds of 39 mph or higher), of which five (5) to nine (9) could become hurricanes (winds of 74 mph or higher), including two (2) to four (4) major hurricanes (Category 3, 4 or 5; winds of 111 mph or higher). An average season produces twelve (12) named storms of which six (6) become hurricanes including three major hurricanes.

The 2017 Atlantic Hurricane season produced seventeen (17) named storms, ten (10) hurricanes, and six (6) major hurricanes. Of the six (6) major hurricanes, three (3) of them, Harvey, Irma and Maria, produced significant damage to the United States.

Maria made landfall in Puerto Rico on September 20, 2017, characterized by upper Category 4 winds, a storm surge, sustained rain and flooding, and mudslides. The

unprecedented level of destruction to Puerto Rico caused by Hurricane Maria has been well reported. Particularly noteworthy was the crippling impact of the hurricane on the island's electric power system. Damage to the transmission, distribution, generation and substation infrastructure resulted in a collapse of the power grid across the island.

1.2 Call to Action

The devastating impact of Maria prompted a call to action. Stakeholders from across the electric utility industry—including the community of stateside municipal and Investor Owned Utilities (IOU), State and Federal agencies, trade associations, contractors, among many others—moved to assist the Puerto Rico Electric Power Authority (PREPA) in its efforts to restore power to the island.

On September 21st 2017 Puerto Rico's Governor Ricardo Roselló made an official request to New York's Governor Andrew Cuomo for emergency goods and services. As part of the goods and services provided by New York (NY) resources from the New York Utilities established the New York State Contingent (NYSC)—which organized quickly deploying resources to Puerto Rico from NYPA and NYS DEC on September 22. The NYSC resources

focused their efforts to assist with damage assessment, planning, restoration and recovery of the electric system immediately after the storm. The NYSC was coordinated by the New York Power Authority (NYPA) and Consolidated Edison Company of New York, Inc. (Con Ed), with leadership provided by the Office of the Governor of NY. Over the course of nearly eight months, the NYSC participated in five (5) missions to the island during which numerous damage assessment and restoration efforts were conducted working closely with PREPA counterparts and through the incident command structure that was established by the electric industry.

Several challenges arose for the NYSC and other responding entities almost immediately once they arrived on-island, due in large part to the sheer extent of the devastation. The conditions on the ground in Puerto Rico would have tested even the most resilient and well-prepared utilities. Fundamental aspects of logistics, coordination, and communication were significantly undermined due to the extent of the destruction as well as on-island resource constraints, and the lack of an up-to-date local utility response plan and signed mutual assistance agreements. The extreme impact of the hurricane also illuminated the need for all stakeholders to focus greater attention on preparedness, training, and continuous improvement as fundamental aspects of emergency and mutual assistance planning. These focus areas are especially important for events such as Maria that required transatlantic support for logistics, supply-chain, and wrap around services.

Therefore, while there were numerous successes from the effort in Puerto Rico that can be leveraged moving-forward, there is also much to be learned from the challenges associated with the NYSC's response to Puerto Rico in the aftermath of Hurricane Maria.

1.3 Objective of the After Action Report

The New York Power Authority (NYPA) facilitated the development of this After Action Report (AAR) to comprehensively review all aspects of the NYSC effort in Puerto Rico following recovery from Hurricane Maria. NYPA formed an AAR Working Group comprised of representatives from the NYSC, industry experts, and other stakeholders to lead the development of the report.

An AAR is a form of retrospective analysis that is undertaken to analyze the response to an incident, exercise or event by identifying strengths to be maintained and built upon, as well as identifying potential areas of improvement. Although often used to evaluate

and document the results of emergency preparedness drills or exercises, the AAR report framework is applied to assess and document the effectiveness of actions after a real emergency. The Federal Emergency Management Agency (FEMA) recently published an AAR focused on the 2017 storm season; the American Public Power Association (APPA) and Edison Electric Institute (EEI) are also producing AARs focused on events in Puerto Rico.

While many utilities, State and Federal agencies, trade associations, contractors, and other stakeholders participated in the recovery efforts in Puerto Rico after Hurricane Maria's impact, this AAR focuses solely on the role played by the NYSC. There are two main objectives of this report: First, to conduct a deep dive assessment of events that transpired in the wake of Hurricane Maria as part of an overall effort to facilitate knowledge sharing and communicate "lessons learned". Second, to identify a prioritized set of logical and pragmatic recommendations to improve any NYSC response effort in the future.

Insights contained in this report were derived through focused interviews, surveys, and workshops that involved several NYSC utility representatives, as well as stakeholders from State and Federal agencies, and representatives from industry trade associations. In addition to the experiences of operators, planners, engineers, and logisticians who spent significant time in Puerto Rico or supporting efforts from the mainland, this report also reflects the insights and perspectives of organizations such as the APPA, EEI, FEMA, and PREPA.

The interviews, surveys and workshops provided a unique opportunity to gather deep insight into the strengths of the NYSC response and potential opportunities for improvement. Central to this report is an awareness of prevailing and best practices in utility emergency planning, preparation and response. These practices provide the guidance and framework for continuous improvement.

1.4 Themes, Strengths, and Recommendations

The AAR Working Group collected and reviewed a voluminous amount of information over the course of several months to identify, test, and build alignment around primary themes and recommendations emerging from the NYSC response effort in Puerto Rico.

This report provides a prioritized list of recommendations ("High," "Medium," and "Low), which have been derived considering concepts such as urgency and impact. Although focused on the NYSC's response to the 2017

events in Puerto Rico, the findings in this report can be generalized to serve the electric power industry and to inform the action of other utilities that respond to emergencies throughout the Caribbean and other locations nationwide.

At a summary level, the AAR Working Group identified four major themes, each comprised of several strengths and areas for improvement.

1.4.1 Theme One: Enhance Partnership Arrangements between NYSC, PREPA, and other stakeholders

The NYSC, PREPA, and a multitude of other stakeholders worked closely to rebuild Puerto Rico’s power system. Over time, communication between the entities improved and a unified approach to restoration was developed and streamlined. Opportunities exist for the NYSC, PREPA, federal agencies, and other stakeholders to build upon this momentum to enhance and formalize partnerships and communication channels in advance of the next hurricane season and for the longer-term.

Strengths	Meaning
<ul style="list-style-type: none"> • NYSC’s unwavering commitment to provide swift assistance to PREPA and Puerto Rico. • Commitment of resources on-island helped build rapport and trust among the NYSC and PREPA and other stakeholders. • Over time, public messaging and external affairs improved among the NYSC, USACE, PREPA, and other stakeholders. 	<ul style="list-style-type: none"> • Pre-identify roles and responsibilities of the NYSC in supporting PREPA during an emergency event. • Work with PREPA and federal agencies to develop formal emergency event triggers to ensure future NYSC and PREPA responses are aligned. • Develop a NYSC “fly-away” team to arrive on-island prior to broader deployment teams to work with PREPA to identify immediate resources needs and confirm deployment plan. • Develop communication protocols between PREPA, NYSC, other utility responders, and public officials to provide consistent and centralized messaging during an emergency event. • Establish routine communications between NYSC, PREPA, and federal agencies to continuously strengthen the partnership, confirm expectations and discuss progress on storm preparation initiatives.

1.4.2 Theme Two: Prepare and Train for Significant Events

Proactive planning and training represent core aspects of effective emergency planning. Results from the AAR interviews, surveys, and workshops confirm that emergency preparation requires ongoing focus and commitment. Specifically, PREPA should work with industry partners including the NYSC to review and revise their Emergency Response Plan to incorporate best practices to prepare for and respond to potential extreme nature of weather events in Puerto Rico. This includes regular training that mirrors best practices reflected by the NYSC and other utilities.

Strengths	Meaning
<ul style="list-style-type: none"> • Hurricane Maria restoration efforts have increased the collective knowledge of the NYSC and other relevant stakeholders. • The NYSC, Federal and State government agencies are now better positioned to mitigate and recover faster from any future disaster. • Through regular drills and exercises, response to real world events, and ongoing communication with the New York State Public Service Commission, the NYSC utilities continuously improve emergency response plans and leveraged that knowledge to be successful in Puerto Rico. 	<ul style="list-style-type: none"> • Update the NYSC emergency response plan to comprehensively reflect best practices for preparing for extreme weather events, including those outside the mainland. • Design and facilitate NYSC best practice emergency response training and exercises. • Design NYSC training around more extreme events and scenarios that truly test preparedness. • Design a specific NYSC Deployment Plan that addresses resources, logistics and supply chains to support Puerto Rico. • Identify potential NYSC contractors for engagement in Puerto Rico in case of a significant event. • Work with PREPA to observe drills conducted by the NYSC and other utilities.

1.4.3 Theme Three: Facilitate Resolution of Core Challenges

Several significant and core challenges to initializing, leading, and completing restoration activities were identified through the AAR process. Generally, these fall into the categories of resource acquisition & management (logistics), supply chain, communication, roles & responsibilities, and governance. Focus should be given to identifying new and innovative solutions to these more fundamental challenges that undermined efforts in Puerto Rico.

Strengths	Meaning
<ul style="list-style-type: none"> The utility industry, in coordination with NYSC, PREPA, EEI, FEMA and USACE established an Incident Command Structure (ICS) and Incident Management Teams (IMT) that significantly streamlined restoration processes within PREPA, once operational. This IMT were embedded at the regional level and at headquarters, which was critical to managing crews and coordinating restoration efforts with local agencies. Safety was a major concern from the companies as they prepared to deploy. The utility industry made safety a top priority and dedicated some of their top safety officers as part of the IMTs to enhance lacking safety protocols. This considered a major success through protocols such as assuming “live wire” conditions. NYSC and other supporting utilities provided valuable safety insight on electric infrastructure to PREPA, the USACE and other agencies. This insight greatly contributed to the safety record of the restoration effort. The USACE was able to deploy a significant quantity of generators to restore power to critical facilities. In close coordination with PREPA, the USACE also established numerous microgrids throughout the island to expedite power restoration. The NSYC, PREPA, DOE, and other supporting utilities provided valuable technical expertise when reviewing specifications for materials arriving on island and coordinating with material and warehousing teams. 	<ul style="list-style-type: none"> Establish a formal ICS framework in Puerto Rico that aligns with FEMA best practices. Improve on-island inventory of distribution, transmission, and generation materials needed for electric restoration, and identify mainland infrastructure and material standards that could be incorporated into system for easier procurement in the future. Leverage logistics and supply chain best practices related to pre-staging, communication, procurement, lodging, transportation and other areas, and incorporate into emergency response plan. Establish damage assessment and restoration protocols that define the roles and responsibilities of both NYSC and PREPA. This includes defining standard formats for completing damage assessments and communicating where power has been restored to ensure consistency between NYSC, PREPA, and other supporting entity initiatives. These standards should be vetted by FEMA to ensure it meets all the requirements for reimbursement.

1.4.4 Theme Four: Focus on Continuous Improvement

Continuously enhancing emergency planning is a long-term effort, focused on evaluating and improving processes, skills and capabilities, and tools and techniques. The AAR effort confirms that a commitment to continuous improvement is required, defined by the systematic evaluation of “lessons learned” from training exercises and real-world emergency response to enhanced operations.

Strengths	Meaning
<ul style="list-style-type: none"> Sharing of information, dedication of resources, and commitment of personnel throughout the “Build Back Better” and AAR report efforts represents a commitment to continuous improvement. Personal commitment on behalf of PREPA staff in the San Jan region despite significant challenges. 	<ul style="list-style-type: none"> Build a continuous improvement plan, focused on information-sharing on all aspects of enhanced emergency preparation, including pre-storm planning, damage assessments, material inventory and staging, drills and exercises, and stakeholder communication (among other areas). Leverage this report to formalize and communicate “lessons learned” from Hurricane Maria as well as adopted action plans. Identify plans and accountabilities for achieving improvement measures. Facilitate knowledge sharing on best practices and how they can be adopted for emergency planning as well as broader topics related to utility operations.

Additional improvement areas were identified that should be investigated through a dialogue that includes the NYSC, State and Federal agencies, trade associations, PREPA, and all other responding entities. These include:

- Simplifying and streamlining of the reimbursement process for both utilities and contractors. The AAR Working Group recommends that a high-level task force, comprised of government and industry leaders, investigate the issues related to financial payment, and design and implement a permanent solution for future emergency scenarios. This solution should address the reimbursement uncertainties that created challenges and distractions during the NYSC’s restoration effort in Puerto Rico.

- Swift and thorough restoration requires the use of expedited mutual assistance. All challenges and issues related to securing assistance need to be identified and addressed. A clear evaluation regarding the most effective “tools” for assistance (Emergency Management Assistance Compact (EMAC) or Memorandum of Understanding for Mutual Assistance) should be conducted, with bottlenecks identified and resolved.

1.5 Next Steps

The pre-planning, coordination, logistics, communication, and command & control challenges that faced the NYSC were as unprecedented as the storm itself. Despite these challenges, the response of the NYSC reflects the strong culture of mutual assistance that exists across the electric utility industry. Federal agencies, utilities, and contractors answered the call to support PREPA.

The capacity to respond to comparable events is important, given that the number and severity of the 2017 hurricanes reflects a trend toward more unprecedented storms. The anticipated rise of extreme events calls for a proactive focus on mitigating strategies, such as system resilience. FEMA defines resilience as “a term used in emergency management to describe the capacity of people, organizations or systems to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.” With a significant increase in risk (reflected in the “new normal” of more frequent and extreme events), resiliency plays a much bigger role in the future planning and hardening of the power system. This includes all aspects of emergency preparation, response, and recovery.

The NYSC, State and Federal agencies, trade associations, and other utility companies have a unique opportunity to build on the successes and lessons learned from Hurricane Maria to enhance emergency preparation, response, and recovery in Puerto Rico and elsewhere. Importantly, NYPA is committed to working closely with the Office of the Governor of NY to define the operating principles and protocols necessary to formalize the role of the NYSC as a provider of mutual assistance. Once in place, the NYSC will be prepared to respond to another major storm in Puerto Rico and also play a key role to help Puerto Rico apply Best Practice standards to build a more resilient power delivery system.

2. Purpose & Methodology

2.1 Purpose & Scope

At the direction of the NY State Governor’s office, the New York Power Authority (NYPA) led the development of this after-action report (AAR) to review all aspects of the NY State contingent’s (NYSC) emergency response efforts to restore electric power to Puerto Rico following Hurricane’s Irma and Maria in September 2017. The purpose of this report is to document the strengths, “lessons learned”, and areas of improvement involving the NYSC response in the aftermath of Hurricane Maria. This report will improve NY State’s ability to respond to mutual assistance requests, either through Emergency Management Assistance Compact (EMAC) or traditional mutual assistance requests, to restore electric power following a disaster either on the mainland or in the Caribbean as experienced during this response. This report will also develop a prioritized list of near-term and longer-term recommendations (“High,” “Medium,” and “Low”). The findings of this report can be generalized to serve the entire electric power industry and inform the action of other utilities that respond to emergencies, regardless of location.

2.2 Methodology & Approach

The NYSC is comprised of a diverse set of stakeholders, including government organizations and responding utilities. In addition to NYPA, responding stakeholders included: AVANGRID (New York State Electric and Gas (NYSEG), Rochester Gas & Electric (RG&E)), Long Island Electric Utility Servco LLC (a wholly owned subsidiary of PSEG Long Island LLC), as agent of and acting on behalf of Long Island Lighting Company d/b/a LIPA (PSEG Long Island), Consolidated Edison Company of New York, Inc., Orange and Rockland Utilities, wholly owned subsidiaries of Consolidated Edison, Inc., National Grid, and Central Hudson Gas and Electric. The NYSC worked closely with the following agencies during the response effort: Federal Emergency Management Agency (FEMA), American Public Power Association (APPA), Edison Electric Institute (EEI), Electricity Sector Coordinating Council (ESCC), Ernst & Young, New York State Division of Homeland Security and Emergency Services (NYS DHSES), U.S. Department of Energy (DOE), U.S. Army Corps of Engineers (USACE), Puerto Rico Electric Power Authority (PREPA), and the government of Puerto Rico.

NYPA, supported by Navigant Consulting for project management, data collection, analysis and report development, created online surveys to collect feedback from the broad set of stakeholders. The surveys consisted of one general survey for all stakeholders and a second set of more targeted surveys to delve deeper into the specific areas determined by roles and responsibilities (e.g. government organizations, coordination & management, logisticians, linemen, etc.). The effort kicked off with a workshop at the NYPA corporate office in White Plains, NY, where stakeholders reviewed initial survey responses and facilitated open discussions to gather direct input on the response timeline, experiences, and recommendations for improvement.

Following the initial workshop, a timeline was created to document the sequence of events that transpired before, during and after storm restoration. Refer to **Figure 4-2** for the response and recovery timeline. This effort also included focus interviews with stakeholders and a workshop in Puerto Rico with PREPA to gather additional insights on the response effort. The NYSC and partners survey responses, interviews, and workshops were used to evaluate the response effort following Maria to identify strengths, areas for improvement, and the prioritized list of recommendations to improve preparedness and response in the future. Refer to **Section 4.6** for the prioritized list of recommendations.

3. Overview of Events

3.1 Weather and Climate Disasters in 2017

In May 2017, forecasters at the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center forecasted an above-normal hurricane season. What followed was one of the worst recorded disaster seasons ever, with 16 major events causing an estimated \$306B in damage and destruction. This equaled the highest number (16) of billion-dollar disasters ever in one year (tied with 2011). In fact, the 2017 North Atlantic hurricane season concluded with 17 named storms (ninth most on record), 10 hurricanes (eighth most on record) and six major hurricanes (third most on record).

Hurricane Maria, which hit Puerto Rico on September 20, 2017 with upper Category 4 winds, was the third-strongest storm to make landfall in U.S. history and the strongest hurricane to hit Puerto Rico in more than 80 years. Hurricane Maria resulted in what is considered the single most destructive and longest power outage in U.S. history (on the Commonwealth of Puerto Rico).

These types of hurricanes – as well as other extreme events – place significant pressure on local, regional, and national emergency response systems. Based on historical storm tracks, similar storms can be expected in the future: Experts agree that threats and the level of destruction from these types of storms will continue to grow in frequency and impact in the years to come. It is incumbent on all stakeholders involved, including federal, state and local government, utilities, power producers, infrastructure and technology vendors and others, to come together to review emergency response capabilities, define the required policies and procedures, and identify energy system resiliency solutions to better prepare for major storms in the future.

3.2 State of PREPA Grid before Hurricanes Irma and Maria

The Puerto Rico Electric Power Authority (PREPA) is a vertically integrated utility that supplies power to 1.473 million total customers in Puerto Rico and the smaller islands of Vieques and Culebra. The power generation system includes six fossil fuel and seven hydroelectric sites, owned and operated by PREPA, as well as privately owned generating facilities consisting of two cogeneration plants, two windfarms, and five solar farms. The power delivery system includes 2,478 miles of transmission lines, 31,485 miles of distribution lines across the service territory, and 334 substations. PREPA generates approximately two-thirds of its electricity and purchases the remaining from third parties, which includes the cogeneration and renewable generation facilities cited above.

The power generation and delivery system supports the entire Commonwealth of Puerto Rico, a geographic area approximately 110 miles east to west and 35 miles north to south. The island includes central mountain ranges extending the length of the island from east to west with peaks as high as 4,390 feet. Puerto Rico's geography, climate, and dispersion of its electric power customers across the Commonwealth, as illustrated in **Figure 3-1**, present many challenges in operating and maintaining the electric power grid.

The electric power system consists of generation, transmission, distribution, communication, and control center facilities and is operated as a single integrated system. PREPA's transmission and distribution (T&D) systems, a majority of which are above ground, were particularly vulnerable to the high winds, torrential rains, and erosion-related landslides associated with hurricanes. Significant winds can exceed structural

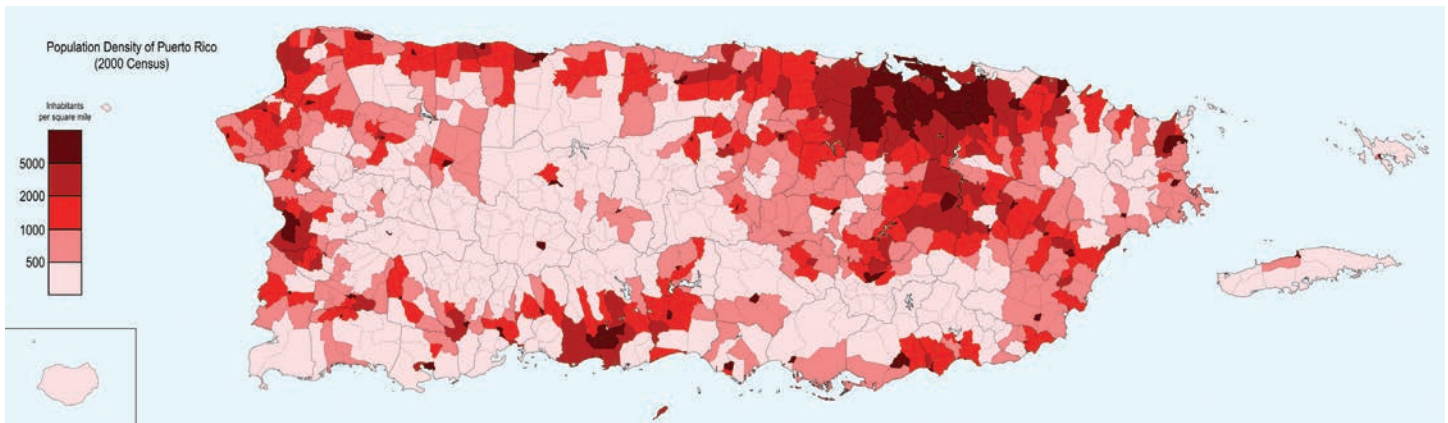


Figure 3-1. Population Density of Puerto Rico

Source: 2000 Census

capacity of electric facilities, and storm water runoff from the mountains can cause serious flooding issues that result in long duration repairs to the power delivery infrastructure – both the transmission and distribution system sustained significant damage during the storm.

The interconnected transmission network includes supply circuits rated at 230 kV, 115 kV, and 38 kV, which transmits electrical power from generation plants to distribution substations, where it is then delivered to customers via lower voltage distribution lines. The transmission system consists of 2,478 circuit miles of lines: 375 circuit miles of 230 kV lines, 727 circuit miles of 115 kV lines, and 1,376 circuit miles of 38 kV lines. Included in these totals are approximately 35 miles of underground 115 kV cable, 63 miles of underground 38 kV cable, and 55 miles of 38 kV submarine cable. The distribution system consists of 29,750 miles of overhead lines and 1,800 miles of underground cable.

PREPA-owned generation is primarily located along the northern and southern coasts. The north area of the island has two electric power generating facilities, while two of the largest and most critical generating facilities—Aguirre and Costa Sur—are located in the south. These two power generation facilities are electrically tied to each other via high voltage overhead transmission lines that span mountainous terrain. Given the physical location of these electrical connections, including high mountainside elevations, they are subjected to hurricane-force winds. When these major transmission pathways are rendered unusable, the bulk of the

electricity generated in the south cannot be transmitted to the north side of the island, where the highest level of electric demand exists. This presents a significant challenge because the largest portion of the island’s electric energy demand is concentrated in the northeast, in and around the city of San Juan, which is an area with a highly concentrated population, a major commercial area, a sea port, the Island’s main port, and numerous manufacturing plants.

3.3 Impact of Hurricanes Irma and Maria in Puerto Rico

Hurricane Irma struck Puerto Rico’s northern coastline on September 6-7, 2017 as a Category 5 storm, resulting in an interruption of power to more than 1 million residents and critical infrastructure. That weekend, PREPA restored service to approximately 70% of its affected customers.

Maria became a tropical storm September 16. Due to high ocean temperatures and light winds, the National Weather Service warned of a rapid strengthening and a trajectory towards the British Virgin Islands (BVI), US Virgin Islands (USVI), and Puerto Rico. Less than two weeks after Hurricane Irma impacted Puerto Rico, Hurricane Maria made landfall on numerous islands in the Caribbean, including Puerto Rico.

At 5am on September 18, sustained winds reached 90 mph, and the National Weather Service issued a hurricane watch for Puerto Rico. By 8pm that same day, the sustained winds were measured at 160 mph, and Maria loomed over the Windward Islands as a Category 5

¹ NOAA National Centers for Environmental Information, State of the Climate: Hurricanes and Tropical Storms for Annual 2017, published online January 2018, retrieved on July 6, 2018 from <https://www.ncdc.noaa.gov/sotc/tropical-cyclones/201713>.

² The pre-storm electric power generating capacity was 5,839 MW, which included 961 MW provided by two co-generators (EcoElectrica and AES-PR) through 20-year power purchase operating agreements (PPOAs). EcoElectrica, L.P. in the Municipality of Peñuelas (507 MW of gas-fired capacity) and AES-PR in the Municipality of Guayama (454 MW of coal-fired capacity) are the two largest sources of generation

storm. The rapid growth of this storm was unprecedented. By 9pm, Maria hit into the Caribbean island of Dominica, causing what Prime Minister Roosevelt Skerrit referred to as “mind-boggling” devastation in a region already devastated by Hurricane Irma. Maria was the strongest hurricane on record to make landfall in Dominica.

The storm maintained its rapid growth on September 19, becoming a Category 5 storm with sustained winds of 175 mph after making its way through the Leeward Islands. Maria then made landfall on Puerto Rico on September 20 as a Category 4 hurricane with 155 mph sustained winds, making it the third-strongest storm to make landfall in the U.S.

Maria triggered heavy flooding and destroyed homes, roads, and bridges. The combined effects of Irma and Maria led to a collapse of the electric power grid across the entire island by causing significant damage to key segments of the transmission system and approximately 75% of the distribution system; as well as substation damage due to high winds, mudslides and flooding. Maria also destroyed 85% of cellular communications towers. The impact of the hurricane and extended loss of the electric infrastructure manifested in several ways: residents faced food and water shortages, shortages

of fuel for vehicles and generators, hospital and school closures due to extensive damage, and, in the immediate aftermath, lack of access to the banking system.

Given the vast devastation described above, Maria is the third most costly hurricane in U.S. history. Puerto Rican authorities have requested \$94 billion to cover all damages from Hurricane Maria, including \$17 billion for damages to the electric grid and related infrastructure. Congress approved \$5 billion in the Fall of 2017 as part of an overall federal aid package of more than \$36 billion allotted for 2017 hurricanes.

3.4 Responding Organizations in Maria Recovery Effort

Numerous organizations from the US mainland were involved in the response and recovery efforts in Puerto Rico after Hurricane Maria’s impact. This included organizations from New York who formed the New York State Contingent (NYSC) and worked on recovery efforts from September 22, 2017 through approximately April 2018 in close coordination with trade organizations, federal agencies, and the Government of Puerto Rico. This AAR incorporates input from the organizations listed below.



Source: NYPA

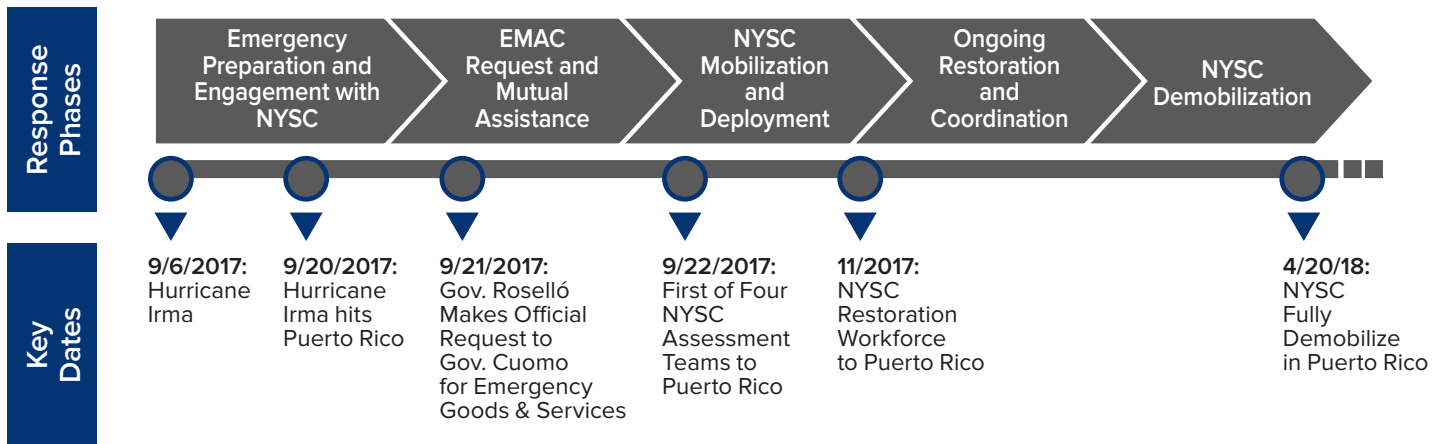


Figure 3-2 – High Level Timeline of NYSC Response Effort in Puerto Rico (PR) by Phase

- American Public Power Association (APPA)
- AVANGRID (NYSEG, RG&E)
- Central Hudson Gas and Electric Corporation
- Consolidated Edison Company of New York, Inc.
- U.S. Department of Energy (DOE)
- Edison Electric Institute (EEL)
- Ernst & Young
- Federal Emergency Management Agency (FEMA)
- National Grid
- New York Power Authority (NYPA)
- New York State Division of Homeland Security and Emergency Services (NYS DHSES)
- Orange and Rockland Utilities (ORU)
- Puerto Rico Emergency Management Agency (PREMA)
- Puerto Rico Electric Power Authority (PREPA)
- PSEG Long Island
- U.S. Army Corps of Engineers (USACE)
- Emergency Preparation and Initial Engagement with NYPA (Early September 2017)
- EMAC Request for NYSC Resources and Mutual Assistance (September 20 – October 31, 2017)
- NYSC Damage Assessment Mobilization and Deployment to Puerto Rico (September 22 – November 2017)
- Ongoing Restoration and Coordination in Puerto Rico (November 2017 – April 2018)
- NYSC Demobilization in Puerto Rico (April 2018)
- Each of these phases is described in more detail in the sections that follow.

3.5 NYSC Response to Maria

The devastating impact of Maria prompted NYSC’s immediate call to action. The NYSC organized quickly and focused efforts to lead emergency planning and recovery efforts immediately after the storm to restore power to the island. Over the course of nearly eight months, the NYSC participated in five (5) missions to the island during which numerous damage assessment and restoration efforts were conducted working closely with PREPA counterparts and other aid providers. As shown in the figure below, this response effort can be categorized into five (5) phases across this time period:

3.5.1 Emergency Preparation and Initial Engagement between PREPA and NYSC

In preparation for Hurricane Irma’s impact on Puerto Rico on September 6-7, 2017, PREPA, NYPA, and the APPA held initial assistance conversations and coordinated for potential mutual assistance. However, Irma, a Category 5 hurricane, did not cause the direct impact that was expected in Puerto Rico and instead passed north of the island resulting in no request for assistance from Puerto Rico. Two weeks later, as Hurricane Maria approached the island, NYPA and APPA believed PREPA would request Mutual Assistance as outlined in the APPA Mutual assistance Playbook and held discussions in preparation for Irma. As a result, the NYSC was prepared to respond to the catastrophic damage that was caused when Maria landed on the island on September 20, 2017. As described above, this included the collapse of the electric grid and other infrastructure as well as significant food, water, and fuel shortages.

3.5.2 EMAC and Mutual Assistance Requests

Puerto Rico ultimately decided to use the Emergency Management Assistance Compact (EMAC) to request mutual assistance from NYSC. EMAC was ratified by Congress in 1996 for the purpose of sharing resources between states or territories during natural and man-made disasters. Membership includes the 50 states, the District of Columbia, Guam, Puerto Rico, and the U.S. Virgin Islands. Typically, resources have included personnel from Fire Departments, Law Enforcement, Emergency Medical Services, Search & Rescue, and the National Guard. The process of activating EMAC begins once a State Governor declares a state of emergency, at which point the State's emergency management agency, in this case PREMA, submits mission specific requests for assistance through the EMAC process.

Contrary to traditional utility mutual assistance, EMAC became the vehicle for NYSC electric grid restoration and response efforts in Puerto Rico which required a unique set of processes, procedures, financial accounting and restrictions which the utilities are traditionally not accustomed to.

3.5.3 Mobilization and Deployment

The EMAC process was utilized to request NYSC resources after Maria's direct impact on September 20. The initial NYSC resources arrived in Puerto Rico on September 22. The NYSC's mission was determined through coordination with PREPA and USACE and initially focused on substation and generation damage assessments.

The following missions were deployed to Puerto Rico through EMAC Resource Requests:

- 1. NYPA Assessment Team 1 –**
September 22, 2017 –
10 NYPA + 2 Department of Environmental Conservation (DEC)
EMAC Resource Request #1288-RR-6754

- 2. NYPA Assessment Team 2 –**
September 29, 2017 – 10 NYPA
EMAC Resource Request #1288-RR-6830
- 3. NYSC Assessment Team 3 –**
October 11, 2017 – 27 Utility Experts
EMAC Resource Request #1288-RR-7004
- 4. Accounting Team –**
October 11, 2017 – 15 NYSC Personnel
EMAC Resource Request #1288-RR-7002
- 5. NYSC Restoration Workforce –**
November 10, 2017 –
450 NYSC Personnel and equipment
EMAC Resource Request 1288-RR-7017

Throughout the five missions, the NYSC worked closely with PREPA, trade associations and their member companies, and federal partners to address the significant challenge of restoration.

- 3.5.3.1 Mission 1: NYPA Assessment Team 1 –**
September 22, 2017 – 10 NYPA + 2 DEC,
EMAC Resource Request #1288-RR-6754

NYSC stakeholders, including the New York Governor, state officials, and NYPA CEO, met with PREPA and the Puerto Rican government. During this first mission, FEMA also named USACE as the lead agency to oversee power restoration. Through direction from PREPA and USACE, NYPA power grid experts commenced an island-wide substation, transmission and generation damage assessment, and began recording FEMA documentation necessary for funding reimbursement.

As part of the first mission, the NYS DEC deployed two drone pilots. These drones were used to conduct transmission line assessments as well as assessments in areas that were not accessible by foot.



Source: NYPA

3.5.3.2 Mission 2: NYPA A NYPA Assessment Team 2 – September 29, 2017 – 10 NYPA, EMAC Resource Request #1288-RR-6830

Additional NYPA relief personnel arrived in Puerto Rico on September 29 to continue the island-wide substation, transmission and generation damage assessment and provide FEMA documentation support. In Mission 2, NYPA began to achieve greater situational awareness and build relationships with the PREPA organization and staff.

3.5.3.3 Mission 3: NYSC Assessment Team 3 – October 11, 2017 – 27 Utility Experts EMAC Resource Request #1288-RR-7004

A third assessment team was deployed on October 11, allowing for the rotation of personnel and completion of distribution damage assessments. Situational awareness and relationship-building continued to improve.

3.5.3.4 Mission 4: Accounting Team – October 11, 2017 – 15 Personnel, EMAC Resource Request #1288-RR-7002

A team comprised of Ernst and Young (EY) contractors were also deployed on October 11 to assist with the FEMA documentation. While the team understood certain FEMA documentation requirements, financial tracking processes were initially unclear.

3.5.3.5 Mission 5: NYSC Restoration Workforce – November 10, 2017 450 Personnel and equipment, EMAC Resource Request 1288-RR-7017

Based on the information collected during the assessments it was apparent the scale and complexity of the restoration was significant. Consequently, by the end of October, New York State received an additional EMAC request to assist with the restoration of the islands transmission and distribution system. In response to this request, up to 450 personnel with the appropriate equipment and management resources began deploying to the island on November 10. The NYSC was assigned the district of San Jan to restore, which included several critical infrastructure facilities as well as a significant number of business and residential customers.

3.5.4 Ongoing Restoration and Coordination between NYSC and Puerto Rico

NYSC restoration crews began arriving in Puerto Rico from early November through Thanksgiving and began restoring sections of Old San Juan. Logistical challenges initially increased as the number of NYSC crews and trucks also increased. Notable challenges faced by the NYSC were related to:

- The availability of adequate staging areas
- Lack of crew guides and language barrier
- Pre-arranged hotels for full contingent
- Critical “must have” supplies
- Incomplete and inconsistent damage assessments
- Clear materials lists and supply chain fundamentals to get needed materials to Puerto Rico
- Damaged IT systems such as Supervisory Control and Data Acquisition (SCADA) and Outage Management System (OMS)
- Availability of feeder maps and circuit information
- Restoration plans
- Clearing protocols for vehicles from the Port
- Damaged communication infrastructure

Given the scope of this response and consistent with National Incident Management System (NIMS) best practices, the NYSC established an Incident Command Post (ICP) and Incident Management Team (IMT) in the regions and headquarters upon arriving in early November. This structure significantly improved communications, coordination, and ultimately restoration efforts on the island. This evolved into a unified command as the NYSC grew on island. Lines of authority and roles became clearer under this Unified Command and the team was able to better prioritize work and direct crews and obtain materials. IMT managers significantly improved coordination at the regional level and helped provide work packages to crews and enhance coordination with local governments and agencies. The NYSC IMT also enhanced restoration coordination and communication with PREPA, the Puerto Rico Government, the USACE, the San Juan Mayor’s office, and other key island stakeholders. The NYSC and other utility safety leads for the IMTs were also critical in establishing safety protocols that greatly contributed to the restoration effort’s excellent safety record.

As restoration efforts continued, the NYSC worked closely with PREPA, USACE, and FEMA logistics. The USACE was the entity assigned by FEMA to procure the necessary materials, manage the flow of key parts and equipment to the island, and to support the review and prioritization of materials. This process was challenging due to the contracting delays, supply chain challenges, and lack of familiarity with the Port of Puerto Rico; however, it was critically important because on-island critical spares, depots, and commonly-used materials were extremely limited. To support this process, the NYSC provided valuable utility insights by reviewing technical specifications for incoming materials and supporting the prioritization of work and dispatching of crews and work plans in the San Juan region.

To continuously coordinate NYSC's response effort and to discuss solutions for the significant challenges noted



Source: NYPA

above, NYSC and other stakeholders held hundreds of status calls covering coordination, requests for supplies, logistics, and work assignments. Communication was initially a challenge due to the extensive damage to the communication infrastructure in Puerto Rico and limited bilingual speakers; however, over time, many teams included Spanish speakers and utilized satellite phone systems to enhance communication. After the ICS was established, NYSC communications were also better coordinated with USACE, PREPA, and other agencies.

3.5.5 De-Mobilization

3.5.5.1 De-mobilization Planning

Demobilization of the NYSC response and recovery effort also faced challenges. Uncertainties in who was going to depart and when, coupled with the question as to whether there were any other NYSC assignments beyond the San Juan region and when federal funding would expire, complicated the planning for a smooth departure. The “when to depart” directive was not clear.

Decisions above the Unified Command level tended to produce “rush” efforts when it came down to the IMT on island. In the case of demobilizing, when a decision was made, the on-scene managers and those in the U.S. mainland supporting the response and recovery effort felt extremely rushed.

The uncertainties around demobilization created challenges for the NYSC members working with the shipper and the Port.

3.6 Conclusion

As reflected throughout this chapter, the pre-planning, coordination, logistics, communication, and command & control challenges facing the New York responders were as unprecedented as the storm itself. However, the response of the NYSC reflected the best practices of incident management and culture of mutual assistance. Responding utilities answered the call, despite uncertainty concerning the true nature of Maria's impact on the island itself, or whether financial processes would ensure timely or comprehensive reimbursement for significant investments made.

Hurricane Maria and other 2017 weather events across the Caribbean also provide confirming evidence that historical expectations of “extreme” events – and the tools and techniques utilized to prepare for emergency response and meet the needs of those impacted – need to be revisited.



Source: NYPA

4. Analysis of Capabilities

This section of the report reviews the performance of the Emergency Response capabilities, activities, and tasks. In this section, observations are organized by capability and associated activities within each capability. The capabilities linked to the Emergency Response objectives of NYSC in Puerto Rico are listed below, followed by corresponding activities. Each activity is followed by related observations, which include references, analysis, and recommendations.

4.1 Capability: Emergency Preparation

Preparedness is critical to an efficient and organized response to an emergency event. Factors involved in preparation include developing, documenting and sharing response plans, coordinating and training with mutual assistance stakeholders, and maintaining familiarity with the mutual assistance and response plans.

4.1.1 Activity: Preparedness Planning

This section presents the state of the preparedness factors described above at the time of coordinating a response to the emergency event.

4.1.1.1 Observation: Through regular drills and exercises, response to real world events, and ongoing communication with the New York State Public Service Commission, the NYSC utilities continuously improves and exercises its Emergency Response Plans. As a result, the NYSC was able to leverage that knowledge to be successful in Puerto Rico. However, the NYSC did not have a formal Mutual Assistance Deployment Plan to lead the coordinated NYSC response in Puerto Rico. While many entities in the NYSC routinely deploy and receive resources under the mutual assistance process, this was their first time providing support to an island-based entity that required significant long-term assistance.

Recommendation: NYSC should continue to develop, train to, and exercise to an up-to-date Emergency Response and Mutual assistance Plan following the best practices identified by FEMA and other industry organizations. The Plan should also incorporate what was learned in the Puerto Rico response in the event that a similar deployment is requested in the future. This will allow NYSC entities to deploy under a single command and enhance logistics and organization for the host entities in Puerto Rico. The plan should provide the necessary plans, processes, and procedures to organize and execute quickly during an emergency event, including:

- A clearly-defined ICS framework.
- Definition of roles and responsibilities (storm duty roles), including regional and overall planning chiefs, communication officers, and liaisons to coordinate with local officials.
- A Logistics, Supply Chain, and Communication Plan that is well-coordinated with federal agencies.
- An applicable financial reimbursement framework and required documentation to follow as defined by FEMA and other federal agencies.
- Processes and procedures regarding contractor management and union regulations.
- Processes and procedures regarding media outreach and communications.
- Processes and procedures for demobilization, including how to extract resources.

Recommendation: The NYSC should work with state and federal agencies and PREPA to build a continuous improvement plan for Puerto Rico, focused on information-sharing on all aspects of enhanced emergency preparation, including pre-storm planning, damage assessments, material inventory and staging, drills and exercises, and stakeholder communication (among other areas). The plan should identify accountabilities for achieving improvement measures.

Recommendation: The NYSC should leverage this report and other AARs to formalize and communicate “lessons learned” from Hurricane Maria. Overall, the “lessons learned” from these AARs should be leveraged to unify response at the national level.

Recommendation: The NYSC should facilitate knowledge sharing with PREPA and the government of Puerto Rico on best practice standards and how they can be adopted for emergency planning as well as broader topics related to utility operations. Potential areas for knowledge sharing are described in more detail in the Economic and Disaster Recovery Plan for Puerto Rico.

4.1.1.2 Observation: There was limited pre-planning with contractors to identify their role in the response and to understand and explain federal procurement rules and reimbursement.

Recommendation: The NYSC should develop a mutual assistance system to select employees and contractors on the mainland and island communities for support in an emergency event. National Grid has an existing system with these capabilities that can be leveraged.

4.2 Capability: EMAC and Mutual Assistance Request

Mutual assistance ensures an entity has sufficient resources to efficiently and expeditiously respond to and recover from a disaster event. For an event such as Maria, these resources include line workers, utility personnel, and other state and federal support. Familiarity and experience with the request process and procedures is critical for both the host entity and supporting entities when engaging in mutual assistance.

4.2.1 Activity: Training & EMAC Preparedness

Trainings and exercises to ensure mutual assistance requests are submitted and responded to in an efficient way is also critical to overall preparedness. This begins with agreement on the vehicle (i.e. APPA Mutual assistance, EMAC, or other agreements) that is going to be used for mutual assistance in response to an event.

4.2.1.1 Observation: Stakeholders in Puerto Rico, the trade associations, NYSC, and other responding entities were misaligned on which mutual assistance vehicle would be used to request aid in response to Maria. The EMAC process that was initiated between Puerto Rico and New York State for the response effort in Puerto Rico is not the usual method of engaging utility mutual assistance, and PREPA and the NYSC did not have experience executing a large-scale EMAC mission. As a result, significant on-island learning

was needed and financial reimbursement procedures for all stakeholders supporting the restoration and recovery effort was not clearly understood. This was a major challenge due to significant concern regarding how and when supporting entities would be reimbursed and how to interact with EMAC, FEMA and Mutual assistance vehicles.

Recommendation: Federal partners, Puerto Rico Government officials, PREPA, NYSC and other supporting entities should consider predetermining the appropriate vehicle for mutual assistance and conduct annual training exercises to build up competency and confidence on how this would be used in actual disaster events such as Maria.

Recommendation: Trade associations to coordinate routine communications between NYSC, PREPA, and federal agencies to continuously strengthen the partnership, confirm expectations and discuss progress on storm preparation initiatives.

4.2.1.2 Observation: Little to no advance EMAC training or exercise of this capability has been undertaken among NYSC, federal partners, supporting entities, the Puerto Rico government and PREPA. As a result, roles and responsibilities for both the host entity and supporting entities were unclear and it was difficult to navigate the political, federal emergency management, and trade association dynamics.

Recommendation: NYSC should continue to conduct Homeland Security Exercise and Evaluation Program (HSEEP) storm response exercises to clearly define roles and responsibilities during Type 1 emergencies outside the mainland.

4.2.2 Activity: Stakeholder Engagement

Stakeholder engagement ensures all parties in an emergency response effort are clear on their roles and responsibilities and well-informed regarding the response and recovery plan.

4.2.2.1 Observation: Because pre-planning was rushed, PREPA did not know the NYSC was coming to Puerto Rico and there were no clear mission assignment or immediate tasks assigned to on-island resources upon arrival.



Source: NYPA

Recommendation: The NYSC should work with the Commonwealth of Puerto Rico and PREPA to identify when and how the NYSC should assist during an emergency event prior to deploying resources. This includes developing formal emergency event triggers to ensure NYSC and PREPA responses are aligned.

4.2.2.2 Observation: The NYSC did not send a formal advance team (fly away team) of diverse skill sets to Puerto Rico before or immediately after hurricanes Irma or Maria to assess potential needs after landfall and to prepare crews for conditions on the ground.

Recommendation: The NYSC should consider having an advance, diversified fly away team of operators and logisticians that is predetermined and always ready to go. Upon its activation, these experts should arrive early and determine with clarity what personnel, trucks and materials are needed in a phased approach. Experts in distribution, transmission and generation as well as logisticians and public affair experts should be part of this team.

4.3 Capability: Mobilization and Deployment

Factors to consider when mobilizing and deploying crews and staff in an emergency event include identifying the scope of restoration operations, and planning and executing logistics and onboarding, a command structure, stakeholder engagement, and communication.

4.3.1 Activity: Resource Acquisition and Management (Logistics)

Resources in an emergency event require logistical planning and ongoing management to ensure the appropriate crews, materials, fuel, lodging, staging areas, and transportation (among others) are in place and well-organized to support restoration. Supply chain plans and processes are an important component of resource management during an emergency event.

4.3.1.1 Observation: Staging areas, lodging, fueling, supplies, and basecamps for NYSC crews were not pre-arranged. Stress levels for all stakeholders were exacerbated due to the lack of logistical preparation and pre-staging for 300-400 people.

Recommendation: In close coordination with federal agencies, a Logistics Plan for Puerto Rico that leverages mainland best practices should be developed. This plan should include defining the role of federal agencies in procuring and expediting mainland transport of trucks, equipment, and Contiguous United States (CONUS) based materials to Puerto Rico (maritime and airlift based). The Plan should also include staging agreements and the wrap around services to provide support to entities involved to the scale previously seen for a Type 1 event of the future. A well-planned Logistics Plan would significantly improve all aspects of mobilization and demobilization of trucks, equipment, materials and people in Puerto Rico.

4.3.1.2 Observation: The NYSC had difficulty getting flights to Puerto Rico.

Recommendation: While some utility teams used chartered flights to get to Puerto Rico, the NYSC should consider investigating chartered flights as a more formal travel solution to have more logistical flexibility, while considering reasonable costs.

4.3.1.3 Observation: Once on the ground, the NYSC had to find more than 250 hotel rooms with limited support. The NYSC often had teams on the mainland that supported all logistics, including resource management.

Recommendation: To the extent possible, NYSC should consider pre-identifying lodging options and confirming their availability through the fly away team prior to deploying crews. This pre-identification would limit logistical challenges as NYSC crews arrive on-island.

4.3.1.4 Observation: Initially, the travel time for some NYSC restoration crews was up to 3 hours each way between the hotel, staging areas, and work sites.

Recommendation: NYPA should work with PREPA to share best practices regarding staging areas in emergency events to better identify and gain pre-authorization for specific staging areas in strategic locations across Puerto Rico. Confirming a number of staging areas would ensure that crews are closer to the work area to maximize on-site work time and cut down on shuttle wait times to and from the staging area.

4.3.1.5 Observation: The decision to mobilize and deploy was made too fast to properly plan and prioritize what NYSC personnel, trucks and materials were needed. The NYSC assumed that PREPA would operate in the same manner as a CONUS host utility and have the needed resources, crew guides, and other materials.

Recommendation: In close coordination with federal agencies (e.g., FEMA, APPA, and EEI), a flexible Supply Plan should be developed that assumes a range of on-island inventory levels for key supplies. A Supply Plan should at a minimum include the on-island inventory and lists of materials used during the last hurricane event so that, if another hurricane should hit Puerto Rico, these materials would already be identified.

As mentioned above, this plan should include defining the role of federal agencies in procuring and expediting mainland transport of trucks, equipment, and CONUS based materials to Puerto Rico (maritime and airlift based) on behalf of PREPA, NYSC, and other support organizations.

4.3.1.6 Observation: There were significant delays in receiving the materials needed for restoration because emergency vendor contracts were not in place, material needs were not well-understood, and USACE lacked familiarity with the materials needed. In addition, the USACE followed the Buy American Act and purchased materials in the U.S., which created additional material procurement delays because some of PREPA's assets are not industry standard.

Recommendation: The NYSC should evaluate opportunities to establish emergency contracts with vendors to deliver the required materials in the event of a large storm that would deplete material spares on-island.

Recommendation: A utility expert should consider working alongside the USACE or other designated agencies to support material management for grid restoration.

4.3.2 Activity: Incident Management & Security

Security during a disaster is a high priority and FEMA emphasizes an Incident Command System (ICS) needs to be in place to support restoration and recovery. ICS is a best practice that establishes clear lines of authority and span of control in an emergency response structure and provides standardized forms and process flows. Security is also needed to ensure crew safety, especially in remote and high-risk areas.

4.3.2.1 Observation: The NYSC, in coordination with EEI, FEMA, the USACE and PREPA, set up an ICP and Incident Management Team (IMT) that tasked work for NYSC resources. This ICS significantly streamlined restoration once it became operational in early November. Specifically, the ICS better organized and deployed work, enhanced communications and external affairs, and improved partnerships with local agencies.

Recommendation: NYSC should continue to leverage its Emergency Response Planning to establish an ICP and IMT that align with FEMA best practices.

4.3.2.2 Observation: Each supporting entity addressed security in their own way; no uniformed security was used by the NYSC.

Recommendation: Supporting entities, including NYSC, should consider working in advance with host entities, local governments and law enforcement to establish security protocols to enhance crew safety. These protocols should identify safety officers during the restoration and take into consideration areas of high crime.

4.3.3 Activity: Communication

Establishing communication channels and protocols is critical to successfully sharing accurate and timely information with stakeholders after an emergency event. Communications should provide consistent messaging by designated points of contacts with significant experience managing communications during emergencies.

4.3.3.1 Observation: Cell and telephone capability was lost due to the storm, including PREPA's hand-held radio system with 13 repeaters across the island.

Recommendation: Communication infrastructure should be treated as critical infrastructure that should be restored to enhance broader restoration planning efforts. The NYSC should consider establishing partnerships with telecom companies to coordinate the operation of emergency cell towers to enable first responders to communicate with the IMT.

4.3.3.2 Observation: Stakeholders initially relied on satellite phones for coordination; however, satellite communications were spotty and the supply of satellite phones was limited.

Recommendation: The NYSC and other supporting entities should prepare to have sufficient satellite phones and radios to communicate in case of telecommunications grid unavailability.

4.3.3.3 Observation: Early on, limited governance over public affairs messaging led to a lack of centralized and unified messaging. There was limited public information sharing as part of the initial response effort and government and response entities were not always aligned with the actual restoration and recovery status and timeline, which resulted in inaccurate messaging.



Source: NYPA

Recommendation: NYSC should consider developing a Communications Plan as part of its overall Emergency Response and Mutual Assistance Deployment Plan. Primary, secondary and tertiary communications need to be set up in advance of going into a national disaster response and recovery operation and should include protocols for cell, satellite phone, and VHF/UHF radios.

Recommendation: The NYSC should consider sending a rotating PIO team to the scene for the duration of restoration and recovery to work closely with the local, regional and commonwealth professionals to ensure a unified message is agreed upon and released.

4.3.3.4 Observation: There were not enough bilingual English/Spanish speakers representing each supporting entity to effectively coordinate during the restoration effort. However, the NYSC did engage local resources, including tour guides, engineering students, and others on island to serve as interpreters during the deployment.

Recommendation: The NYSC and supporting entities should identify a team of bilingual English/Spanish speakers that would be available to support its deployment teams. This effort should continue to leverage on island resources such as those used in the response effort after Maria.

4.4 Capability: Ongoing Restoration and Recovery

Executing restoration operations and recovery requires significant planning to address all aspects of an emergency event. Important factors that impact restoration operations include system knowledge and restoration plans, financial tracking, and health and safety.

4.4.1 Activity: Response & Restoration

4.4.1.1 Observation: PREPA and NYSC utilities completed damage assessments in different formats, which caused challenges when trying to integrate and roll-up the assessment results.

Recommendation: NYSC should develop and recommend a standard damage assessment framework in its Mutual Assistance Deployment Plan that identifies the roles, processes, tools, and technologies to be used for damage assessments. This should include developing a standard format for damage assessments that can be put into the work packages of the deployment teams. A standard assessment framework would improve information sharing and provide consistency across entities to streamline decision making based on assessment findings. This framework should be vetted by PREPA and FEMA to ensure it meets all the requirements for reimbursement.

4.4.1.2 Observation: PREPA and NYSC utilities did not initially have a standard method for communicating when power at facilities was restored. The IMT eventually developed a legend for crews to follow.

Recommendation: NYSC should develop a standard format (e.g., maps, topology, load) and procedure to communicate when and where power has been restored. A standard format would help streamline restoration efforts and ensure consistent messaging across entities.

4.4.1.3 Observation: Transmission and distribution restoration did not include repair of damaged fiber optic cable.

Recommendation: NYSC utilities should integrate fiber optic restoration and other “mission critical” efforts that impact successful utility restoration into plans.

4.4.1.4 Observation: NYS DEC deployed two drone pilots as part of the first mission in Puerto Rico. The drones were used to conduct transmission line assessments, especially in areas that were not accessible by foot.

Recommendation: NYSC and its partners should continue to leverage leading technology such as drones to conduct damage assessments in future storm responses.

4.4.2 Activity: Financial Liability and Tracking & Reporting

All stakeholders should understand the complex reimbursement process prior to providing restoration support. In addition, clear financial liability and reimbursement processes should be identified prior to an emergency event to achieve effective cost recovery and mitigation.

4.4.2.1 Observation: Financial liability is of great and repetitive concern among NYSC utilities. There was significant lack of awareness and uncertainty regarding the process and requirements for reimbursement.

Recommendation: The NYSC should facilitate a dialogue with federal agencies to discuss options for establishing federal funding sources for transport and restoration activities, particularly for contractors that must be paid (e.g. within 30 days) to avoid cash flow problems.

4.4.2.2 Observation: Significant time is required for invoicing, and is still ongoing as of the writing of this report. NYSC had to hire additional resources and faced unexpected tax issues that needed to be addressed for this event. Typically, mutual assistance is invoiced and paid within 90 days; however, this was not what occurred after Maria. Many invoices are still outstanding.

Recommendation: Work with FEMA to define and provide training on a standard reimbursement process; leverage successful approaches adopted by NYSC participants such as National Grid to establish set up a specific accounting codes and tracked all hours and materials dedicated to recovery effort to generate invoices. Facilitate knowledge sharing between NYSC utilities on invoicing and reimbursement practices.



Source: NYPA

Recommendation: Work with FEMA to better understand tax liabilities in the Commonwealth and its municipalities and determine their eligibility in the federal reimbursement process.

4.4.3 Activity: Worker Health & Safety

Worker health and safety is a significant operational concern for restoration after an emergency event. Safety standards for crews from different utilities and organizations should be recognized and integrated, where applicable. Safety officers for both the host entity and the supporting entities are also an important component of the response structure.

4.4.3.1 Observation: Safety was a top priority for restoration efforts and significantly improved through protocols such as assuming “live wire” conditions.

Observation: The initial deployment period for NYSC crews was six weeks and did not initially include overlap plans, which created challenges. The decision was made to return some of the initial NYSC crews home sooner than originally planned due to arduous working conditions. Beginning in January, the deployment period was reduced to four weeks.

Observation: Some NYSC utilities developed Employee Survival Packs and distributed them during a pre-departure orientation to all employees who deployed.

Recommendation: The NYSC should consider shortening deployment cycles to 30 days for crew health and well-being and to enable a better rhythm for preparation and deployment. The deployment cycles should include overlap and relief plans to train and debrief new crews. As noted above, this shortened deployment period was implemented by NYSC crews in January.

Recommendation: The NYSC should continue building Employee Survival Packs for all employees and contractors that contain all mission details, travel requirements, and health and safety protocols for deployment in Puerto Rico.

4.4.3.2 Observation: NYSC internal policies and procedures were challenged to provide NYSC resources with medical vaccinations prior to deployment. Resources were vaccinated in phases across the restoration.

Recommendation: The NYSC should consider improving vaccination processes and policy and procedures on medical devices, like CPAP machines and union requirements, to expedite deployment during an emergency event.

4.4.4 Activity: Family Health & Wellbeing

It is important to maintain family health and wellbeing for all on-island crews and staff through established communication channels for routine interaction with family and morale support.

4.4.4.1 Observation: During the initial assessment phase, little to no communications critical infrastructure was intact, and personnel from NYSC entities were not able to communicate with their families. This created morale issues and challenged the family health and wellbeing of the crews and their families during the first few weeks on-island.

Recommendation: With any type of disaster and long-standing duty to support response and recovery actions, crews will be deployed for long periods of time. NYSC crews should be provided with the ability to “call home” or receive incoming scheduled calls with satellite phones to significantly enhance morale and increase focus on completing the mission safely.

4.5 Capability: Demobilization

4.5.1 Activity: Exit Communication and Coordination

4.5.1.1 Observation: The NYSC had never worked with the USACE, Ports and Customs, and barging companies, which made the extraction of resources (i.e., people, trucks, equipment, materials) difficult. For example, it was difficult to track the resources such as vehicles on their way back to the U.S. mainland. Processes, procedures, and paperwork were all different than past mutual assistance efforts.

Recommendation: NYSC Emergency Response Planning should include processes and procedures for demobilization, including how to extract resources.

4.6 Recommendations Ranking and Prioritization

Section 4.5 reflects 33 recommendations to address the identified areas of improvement. This list was then prioritized (“High”, “Medium”, and “Low”), based on a variety of parameters including complexity, impact, and sequencing.

The following table summarizes the recommendations by priority level and responsible party.

Priority Category	Section	Recommendation Shorthand
High Priority	4.1.1.1	Develop Emergency Response Plan and Mutual Assistance Plan
	4.1.1.1	Develop Continuous Improvement Plan
	4.1.1.1	Communicate Hurricane Maria Lessons Learned
	4.1.1.1	Facilitate Sharing of Best Practices
	4.2.2.1	Hold Initial Coordination Meeting with PREPA Prior to Deploying Resources
	4.2.2.2	Develop & Deploy Advance Team
	4.3.1.1	Develop Logistics Plan for Puerto Rico
	4.3.1.3	Organize Lodging Prior to Sending Personnel
	4.3.1.5	Develop Supply Plan for Puerto Rico
	4.3.2.1	Leverage Emergency Response Plan
	4.3.3.2	Bring Back-Up Communications Equipment
	4.3.3.3	Develop and Follow Communications Plan
	4.3.3.4	Pre-identify Bilingual English/Spanish Speakers
	4.4.2.1	Facilitate Dialogue for Establishing Federal Funding Resources
	4.4.2.2	Streamline the Reimbursement Process
	4.4.3.1	Limit Personnel to 30-Day Overlapping Deployments
	4.5.1.1	Develop De-Mobilization Plan

Priority Category	Section	Recommendation Shorthand
Moderate Priority	4.1.1.2	Develop Emergency Support Employee and Contractor Selection Structure
	4.2.1.1	Determine the Proper Assistance Vehicle for Large-Scale Restorations
	4.2.1.1	Establish Partnership Between NYSC, PREPA, and Federal Agencies
	4.2.1.2	Conduct HSEEP Storm Response Exercises for Outside of Mainland Response
	4.3.1.4	Organize Lodging and Staging Areas Close to Work Areas
	4.3.1.6	Establish Emergency Vendor Supply Agreements
	4.3.2.2	Establish Security Protocols and Agreements
	4.3.3.1	Prioritize Restoration of Communications Infrastructure
	4.4.1.2	Develop Damage Assessment Framework
	4.4.1.3	Develop Standard Format for Communicating Power Restoration
Low Priority	4.4.1.5	Include Fiber Optic Experts in Restoration Crews
	4.4.4.1	Improve Initial Responders' Ability to Call Home
	4.3.1.2	Consider Charter Flights
	4.4.3.1	Build Employee Survival Pack
	4.4.3.2	Enhance Medical Policies
	4.4.1.4	Leverage Drones for Damage Assessments

4.6.1 High Priority

These recommendations are a mix of the “quick hit” items that can be easily implemented and planning-related activities that will establish the foundation for effective emergency response in the future.

1. NYSC should continue to develop, train to, and exercise to an up-to-date Emergency Response and Mutual Assistance Plan following the best practices identified by FEMA and the industry.
2. The NYSC should work with state and federal agencies and PREPA to build a continuous improvement plan for Puerto Rico, focused on information-sharing on all aspects of enhanced emergency preparation, including pre-storm planning,

damage assessments, material inventory and staging, drills and exercises, and stakeholder communication (among other areas). The plan should identify accountabilities for achieving improvement measures.

3. The NYSC should leverage this report to formalize and communicate “lessons learned” from Hurricane Maria. Overall, the “lessons learned” from this AAR and others should be leveraged to unify response at the national level.

The NYSC should facilitate knowledge sharing with PREPA and the government of Puerto Rico on best practice standards and how they can be adopted for emergency planning as well as broader topics related to utility operations. Potential areas for knowledge sharing are described in more detail in the Economic and Disaster Recovery Plan for Puerto Rico.

4. The NYSC should work with the Commonwealth of Puerto Rico and PREPA to identify when and how the NYSC should assist during an emergency event prior to deploying resources. This includes developing formal emergency event triggers to ensure NYSC and PREPA responses are aligned.
5. The NYSC should consider having an advance, diversified fly away team of operators and logisticians that is predetermined and always ready to go. Upon its activation, these experts should arrive early and determine with clarity what personnel, trucks and materials are needed in a phased approach. Experts in distribution, transmission and generation as well as logisticians and public affair experts should be part of this team.
6. In close coordination with federal agencies, develop a Logistics Plan for Puerto Rico that leverages mainland best practices.
7. To the extent possible, NYSC should consider pre-identifying lodging options and availability should be confirmed by through the fly away team prior to deploying crews. This pre-identification would limit logistics challenges as NYSC crews arrive on-island.
8. In close coordination with federal agencies, a flexible Supply Plan should be developed that assumes a range of on-island inventory levels for key supplies. A Supply Plan should at a minimum include the on-island inventory and lists of materials used during the last hurricane event so that, if another hurricane should hit Puerto Rico, these materials would already be identified.
9. NYSC should continue to leverage its Emergency Response Planning to establish and ICS and IMTs that align with FEMA best practices.
10. The NYSC and other supporting entities should prepare to have sufficient satellite phones and radios to communicate in case of telephone grid unavailability.
11. NYSC should consider developing a Communications Plan as part of its overall Emergency Response and Mutual Assistance Deployment Plan. Primary, secondary and tertiary communications need to be set up in advance of going into a national disaster response and recovery operation and should include protocols for cell, satellite phone, and VHF/UHF radios.
12. The NYSC and supporting entities should identify a team of bilingual English/Spanish speakers that would be available to support its deployment teams. This effort should continue to leverage on island resources such as those used in the response effort after Maria.
13. The NYSC should facilitate a dialogue with federal agencies to discuss options for establishing federal funding sources for transport and restoration activities, particularly for contractors that must be paid (e.g. within 30 days) to avoid cash flow problems.
14. Define and provide training on a standard reimbursement process; leverage successful approaches adopted by NYSC participants such as National Grid to establish set up a specific accounting codes and tracked all hours and materials dedicated to recovery effort to generate invoices. Facilitate knowledge sharing between NYSC utilities on invoicing and reimbursement practices.
15. The NYSC should consider shortening deployment cycles to 30 days for crew health and well-being and to enable a better rhythm for preparation and deployment. The deployment cycles should include overlap and relief plans to train and debrief new crews. As noted above, this shortened deployment period was implemented by NYSC crews in January.
16. NYSC’s Restoration Plan should include processes and procedures for demobilization, including how to extract resources.



Source: NYPA

4.6.2 Moderate Priority

1. The NYSC should develop a mutual assistance system to select employees and contractors on the mainland and island communities for support in an emergency event. National Grid has an existing system with these capabilities that can be leveraged.
 2. Federal partners, Puerto Rico Government officials, PREPA, NYSC and other supporting entities should consider predetermining the appropriate vehicle for mutual assistance and conduct annual training exercises to build up competency and confidence on how this would be used in actual disaster events such as Maria.
 3. Establish routine communications between NYSC, PREPA, and federal agencies to continuously strengthen the partnership, confirm expectations and discuss progress on storm preparation initiatives.
- NYSC should continue to conduct HSEEP storm response exercises to clearly define roles and responsibilities during Type 1 emergencies outside the mainland.
4. NYPA should work with PREPA to share best practices regarding staging areas in emergency events to better identify and gain pre-authorization for specific staging areas in strategic locations across Puerto Rico. Confirming a number of staging areas would ensure that crews are closer to the work area to maximize on-site work time and cut down on shuttle wait times to and from the staging area.
 5. The NYSC should evaluate opportunities to establish contracts with vendors to deliver the required materials in the event of a large storm that would deplete material spares on-island.
 6. Supporting entities, including NYSC, should work in advance with host entities, local governments and law enforcement to establish security protocols to enhance crew safety. These protocols should identify safety officers during the restoration and take into consideration any local customs and areas of high crime. In extreme situations, the National Guard should be used to provide the additional protections necessary.
 7. Communication infrastructure should be treated as critical infrastructure that should be restored to enhance broader restoration planning efforts. The NYSC should consider establishing partnerships with telecom companies to coordinate the operation of emergency cell towers to enable first responders to communicate with the IMT.
 8. NYSC should develop and recommend a standard damage assessment framework in its Mutual Assistance Deployment Plan that identifies the roles, processes, tools, and technologies to be used for damage assessments. This should include developing a standard format for damage assessments that can be put into the work packages of the deployment teams. A standard assessment framework would improve information sharing and provide consistency across entities to streamline decision making based on assessment findings. This framework should be vetted by PREPA and FEMA to ensure it meets all the requirements for reimbursement.
 9. NYSC should develop a standard format (e.g., maps, topology, load) and procedure to communicate when and where power has been restored.

10. NYSC utilities should integrate fiber optic restoration and other “mission critical” efforts that impact successful utility restoration into plans.
11. NYSC crews should be provided with the ability to “call home” or receive incoming scheduled calls with satellite phones to significantly enhance morale and increase focus on completing the mission safely.
12. Work with FEMA to better understand tax liabilities in the Commonwealth and its municipalities and determine their eligibility in the federal reimbursement process.

4.6.3 Low Priority

1. While some utility teams used chartered flights to get to Puerto Rico, the NYSC should consider investigating chartered flights as a more formal travel solution to have more logistical flexibility, while considering reasonable costs.
2. Build an Employee Survival Pack for all employees/contractors that contain all mission details/needs/travel requirements, etc.
3. Vaccinations and policy and procedures on medical devices, like CPAP machines and union requirements, need to be worked out in advance
4. NYSC and its partners should continue to leverage leading technology such as drones to conduct damage assessments in future storm responses.

5. Conclusion

Hurricane Maria is one of the most extreme weather events ever recorded and caused unprecedented damage to the island of Puerto Rico. The combined impact of sustained Category 4 and 5 strength winds, massive storm surge, and rainfall & flooding completely disabled the island’s critical infrastructure – including its power delivery system.

The NYSC played a significant role in recovery efforts in Puerto Rico. Over the course of multiple missions to the island, the NYSC worked closely with PREPA, State and Federal partners, and trade organizations to lead critical recovery activities in an extremely challenging environment for which there was no “standard playbook.”

In light of the unique nature of this recovery effort – and the trend toward a larger number of more severe storms – the NYSC and other stakeholders are committed to applying “lessons learned” from Hurricane Maria to improve emergency preparation, response, and recovery practices. Strengths and opportunities from the effort in Puerto Rico have been identified in four key areas:

- Enhance partnership arrangements between the NYSC, PREPA, and other stakeholders
- Prepare and train for significant events
- Facilitate resolution of existing, core challenges in Puerto Rico
- Focus on continuous improvement

Overall, the rise of extreme events places a premium on enhancing the resilience of the power delivery system in Puerto Rico and across the U.S. FEMA defines resilience as “a term used in emergency management to describe the capacity of people, organizations or systems to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.” With a significant increase in risk (reflected in the “new normal” of more frequent and extreme events), resiliency plays a much bigger role in the future planning and hardening of the power system.

The NYSC, PREPA, State and Federal partners, and trade organizations can take advantage of the insights gained from this and other AARs to strengthen all aspects of emergency preparation, response, and recovery in Puerto Rico and beyond. Importantly, NYPA is committed to working closely with the Office of the Governor of NY to define the operating principles and protocols necessary to formalize the role of the NYSC as a provider of mutual assistance. Once in place, the NYSC will be prepared to respond to another major storm in Puerto Rico, and also play a key role to help Puerto Rico apply Best Practice standards to build a more resilient power delivery system.

Appendix A: Acronyms

Acronym	Meaning
NIMS	National Incident Management System
CONUS	Contiguous United States
EMAC	Emergency Management Assistance Compact
PREPA	Puerto Rico Electric Power Authority
NYSC	New York State Utility Contingent
DEC	Department of Environmental Conservation
NYPA	New York Power Authority
IMT	Incident Management Team
ICS	Incident Command System
FEMA	Federal Emergency Management Agency
IOU	Investor Owned Utility
HSEEP	Homeland Security Exercise and Evaluation Program

Table A.1: Acronyms



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