

RE↑MAG↑NA Puerto Rico

Resilient Puerto Rico Advisory Commission

ENERGY SECTOR REPORT

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A black and white photograph of a coastal fortification. In the foreground, a stone wall with a crenelated top runs along the shore. To the right, waves are crashing against the wall, creating white foam. The background shows the ocean with more waves. The overall tone is dramatic and historical.

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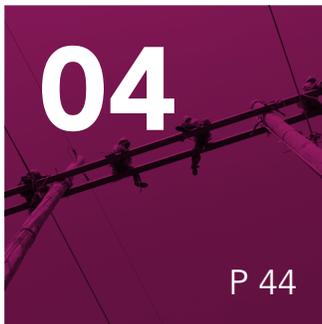
Background



Sector Context



Sector Goal



Opportunity Actions



Resources



Appendix



Acronyms

100 RC 100 Resilient Cities

ACA Affordable Care Act

ACS American Community Survey

ADUs Accessory Dwelling Units

AES Agricultural Extension Service

AGC Associated General Contractors of America

AIDIS Inter-American Association of Sanitary and Environmental Engineering

AMA, by its Spanish acronym Puerto Rico Metropolitan Bus Authority

ARRA American Recovery and Reinvestment Act

ASSMCA, by its Spanish acronym Puerto Rico Administration of Mental Health and Anti-Addiction Services

BLS United States Bureau of Labor Statistics

BTOP Broadband Technology Opportunities Program

Business PREP Business Preparedness and Resiliency Program

CAAPPR, by its Spanish acronym Puerto Rico College of Architects and Landscape Architects

CAGR Compound Annual Growth Rate

CAIDI Customer Average Interruption Duration Index

CBA Community Benefits Agreements

CBO Community-Based Organizations

CCLC United States Department of Education – 21st Century Community Learning Centers

CDBG Community Development Block Grant

CDBG-DR Community Development Block Grant Disaster Recovery

CDBs Community Development Banks

CDC Center for Disease Control and Prevention

CDCorps Community Development Corporations

CDFIs Community Development Financial Institutions

CED Community Economic Development

CHDOs Community Housing Development Organizations

CHIP Children’s Health Insurance Program

CHP Combined Heat Power

CIAPR Puerto Rico College of Engineers and Land Surveyors

CNE Center for a New Economy

COFECC, by its Spanish acronym Corporation for Business Financing of Commerce and Communities (now known as “lendreamers”)

COOP Continuity of Operations Plan

COR3 Puerto Rico Central Office of Recovery, Reconstruction, and Resilience

CRA Community Reinvestment Act

CRF City Resilience Framework

CRIM, by its Spanish acronym Puerto Rico Municipal Revenue Collection Center

CSR Corporate Social Responsibility

DACO, by its Spanish acronym Puerto Rico Office of Consumer Affairs

DEDC Puerto Rico Department of Economic Development and Commerce

DHS United States Department of Homeland Security

DIRS Disaster Information Reporting System

DIY Do It Yourself

DNER Puerto Rico Department of Natural and Environmental Resources

DOLHR Puerto Rico Department of Labor and Human Resources

DOS United States Department of State

DTPW Puerto Rico Department of Transportation and Public Works

EDA United States Economic Development Administration

EOP Puerto Rico Emergency Operation Plan

EPA United States Environmental Protection Agency

EQB Puerto Rico Environmental Quality Board

EQIP Environmental Quality Incentives Program

EWP-FPE Emergency Watershed Protection - Floodplain Easement Program

FAA Federal Aviation Administration

FCC Federal Communications Commission

FEMA Federal Emergency Management Agency

FHWA Federal Highway Administration

FIDEVI, by its Spanish acronym Puerto Rico Housing and Human Development Fund

FIRM Flood Insurance Rate Maps

FOMB Financial Oversight and Management Board for Puerto Rico

FQHCs Federally Qualified Health Centers

FTA Federal Transit Administration

GAR Governor's Authorized Representative

GIS Geographic Information System

HHS United States Department of Health and Human Services

HiAP Health in All Policies

HIPAA Health Insurance Portability and Accountability Act

HMGP FEMA Hazard Mitigation Grant Program

HMP Puerto Rico Hazard Mitigation Plan

HRSA United States Health Resources and Services Administration

HUD United States Department of Housing and Urban Development

INE Instituto Nueva Escuela

IoT Internet of Things

IRP Integrated Resource Plan

IRS Internal Revenue Service

ISWM Integrated Solid Waste Management

KPIs Key Performance Indicators

KW Kilowatt

LIHTC Low-Income Housing Tax Credits

LISC Local Initiatives Support Corporation

LMI Low to Moderate Income

LQ Location Quotient

MA Medicare Advantage

MBA Mortgage Bankers Association of Puerto Rico

MCOs Managed Care Organizations

MGD Million Gallons Per Day

MIT Massachusetts Institute of Technology

MSA Metropolitan Statistical Area

MUSV Movimiento Una Sola Voz

NAICS North American Industry Classification System

NDRF National Disaster Recovery Framework

NERC North American Electric Reliability Corporation

NFIP National Flood Insurance Program

NGOs Non-governmental Organizations

NIH National Institutes of Health

NOAA National Oceanic and Atmospheric Administration

NRCS Natural Resources Conservation Service

NTIA National Telecommunications and Information Administration

O&M Operations and Maintenance

OCIO Office of the Chief Information Officer of Puerto Rico

OCPR Office of the Comptroller of Puerto Rico

OCS, by its Spanish acronym Office of the Commissioner of Insurance of Puerto Rico

ODSEC, by its Spanish acronym Office for the Community and Socioeconomic Development of Puerto Rico

OMB Puerto Rico Office of Management and Budget

OPPEA, by its Spanish acronym Puerto Rico Governor's Office for Elderly Affairs

OSTDS Onsite Sewage Treatment and Disposal Systems

P3 Public-private partnership

PACE Property Assessed Clean Energy

PDM FEMA Pre-Disaster Mitigation Grant Program

PICA, by its Spanish acronym Four Year Investment Program

PMO Puerto Rico Permits Management Office

PPA Power Purchase Agreement

PR Science Trust Puerto Rico Science, Technology & Research Trust

PRASA Puerto Rico Aqueduct and Sewer Authority

PRBA Puerto Rico Bankers Association

PRBC Puerto Rico Building Code

PRCC Puerto Rico Chamber of Commerce

PRDA Puerto Rico Department of Agriculture

PRDE Puerto Rico Department of Education

PRDF Puerto Rico Department of the Family

PRDHe Puerto Rico Department of Health

PRDHo Puerto Rico Department of Housing

PRDOJ Puerto Rico Department of Justice

PRDPS Puerto Rico Department of Public Safety

PREC Puerto Rico Energy Commission

PREMA Puerto Rico Emergency Management Agency

PREPA Puerto Rico Electric Power Authority

PRFN Puerto Rico Funders Network

PRHBA Puerto Rico Home Builders Association

PRHFA Puerto Rico Housing Finance Authority

PRHIA Puerto Rico Health Insurance Administration

PRHTA Puerto Rico Highways and Transportation Authority

PRIDCO Puerto Rico Industrial Development Company

PRIFA Puerto Rico Infrastructure Finance Authority

PRITA Puerto Rico Integrated Transit Authority

PRMA Puerto Rico Manufacturers Association

PRPA Puerto Rico Ports Authority

PRPB Puerto Rico Planning Board

PRPBA Puerto Rico Public Buildings Authority

PRPS Puerto Rican Planning Society

PRTC Puerto Rico Tourism Company

PRTD Puerto Rico Treasury Department

PRTEC Puerto Rico Trade and Export Company

PSHSB Public Safety and Homeland Security Bureau

QCEW Quarterly Census of Employment and Ways

RFP Request for Proposal

RISE Resiliency Innovations for a Stronger Economy

RPS Renewable Portfolio Standard

SAIDI System Average Interruption Duration Index

SAIFI System Average Interruption Frequency Index

SBA Small Business Administration

SMEs Small and Mid Size Enterprises

SOPs Standard Operating Procedures

SSI Supplemental Security Income

SWMA Puerto Rico Solid Waste Management Authority

TIP Transportation Improvement Program

TRB Puerto Rico Telecommunications Regulatory Board

U.S. Army United States Department of the Army

UPR University of Puerto Rico

URA Puerto Rico United Retailers Association

USAC Universal Service Administrative Company

USACE United States Army Corps of Engineers

USDA United States Department of Agriculture

USDOC United States Department of Commerce

USDOED United States Department of Education

USDOL United States Department of Labor

USDOT United States Department of Transportation

USF Universal Service Fund

USFS United States Forest Service

USFWS United States Fish and Wildlife Service

USGS United States Geological Survey

WIOA Workforce Innovation and Opportunity Act

WPSs Water Pump Stations

WTPs Water Treatment Plants

WWPSs Wastewater Pump Stations

WWTPs Wastewater Treatment Plants



01

BACKGROUND

Puerto Rico Background

Hurricanes Irma and María impacted Puerto Rico on September 2017 and caused nearly complete devastation to the Island. On September 6th, Hurricane Irma, a category five storm, skirted the northern part of the Island, causing significant flooding and leaving more than 1 million people without electric power. Two weeks later, on September 20th, Hurricane María, the tenth most intense Atlantic hurricane on record, passed east-to-west across the whole Island. Hurricane María left the entire Island without electricity, and it damaged thousands of housing units, as well as telecommunication towers, roads, bridges, schools, and 80% of the Island's crop value. Furthermore, Hurricane María impacted the physical structure of all hospitals and health clinics, affected 70% of Puerto Rico's potable water treatment and distribution system, and caused immense suffering to all Puerto Ricans. The Government of Puerto Rico's damage assessment estimated that the Island would need \$94.4 billion to fully recover¹. The National Oceanic and Atmospheric Administration estimates the damage from María makes it the third costliest hurricane in U.S. history, behind Katrina (2005) and Harvey (2017)².

The severity of the impacts highlighted the Island's physical and natural infrastructure vulnerability to extreme weather events and the need to better prepare for future events. The hurricanes also exposed structural socioeconomic weaknesses that existed prior to the storms and that exacerbated their impacts, among

them a contracting economy, a bankrupt public sector, declining jobs, high inequality, aging infrastructure, and continuous population loss.

The combination of these physical, natural, and socioeconomic factors tested Puerto Rico's resilience. Resilience is understood as the capacity to respond, survive, adapt, and grow in response to shocks and stresses. Shocks are major crisis events that disrupt the normal operation of communities, as well as their institutions and systems. On the other hand, stresses are chronic conditions that progressively reduce the ability of individuals, businesses, institutions, and systems to function effectively.

Hurricanes Irma and María, however, were only the latest of a series of significant events that have severely affected Puerto Rico over the last decade. The Island has faced multiple environmental and socioeconomic shocks that have tested its capacity and eroded its ability to respond resiliently in the past. Tropical cyclones, floods, and wildfires have been common occurrences in the Island's territory of roughly 9,000 square kilometers.

Also, Puerto Rico's economy has been suffering a staggering contraction for over ten years. The outward migration has resulted in a decrease in population of nearly 388,000 residents, or 10%, from April 2010 to July 2017³. Changing demographic patterns have resulted in reductions in the Island's⁴ overall population, and in an increase in the elderly and the islanders



living below poverty levels. Over 41% of Puerto Rico’s inhabitants are living below the U.S. federal poverty line, proportionally more than triple the U.S. average (11%)⁵. Puerto Rico’s GINI coefficient, an indicator that denotes income inequalities across populations, is the highest in the United States⁶.

Moreover, in May 2017, a fiscal crisis that developed over decades spurred a bankruptcy declaration by the Government of Puerto Rico and several of its public corporations. The bankruptcy declaration⁷ prompted a process to restructure Puerto Rico’s debt obligations, placing additional challenges on its public sector operations and services. As such, any recovery measures that require changes to the budget of Puerto Rico government agencies (from either the revenue or expenditures), could be subject to additional restrictions by the U.S. Federal Court and the Financial Oversight and Management Board for Puerto Rico. All these factors constitute stresses affecting Puerto Rico, and they create additional challenges to the overall

management of local government agencies and their policy implementation processes.

Even in the midst of all this turmoil, Puerto Ricans are clear on one thing: The path forward is not to return the Island to its prior state, normality is not the goal. The story of the new Puerto Rico is yet to be written. The Island must use this catastrophe to leverage the investments that will be made to change its growth and development trajectory. The recovery process should not focus solely on replacing outdated infrastructure. Instead, it should aim at building better assets, unleashing innovation, and coordinating among interested stakeholders. By creating these conditions, the path to address multiple challenges, increase social cohesion, strengthen the economy, and eliminate existing underlying socioeconomic weaknesses will be paved. Only then, Puerto Rico will be a better place for its citizens. This is the vision of the Resilient Puerto Rico Advisory Commission and its core project, ReImagina Puerto Rico.

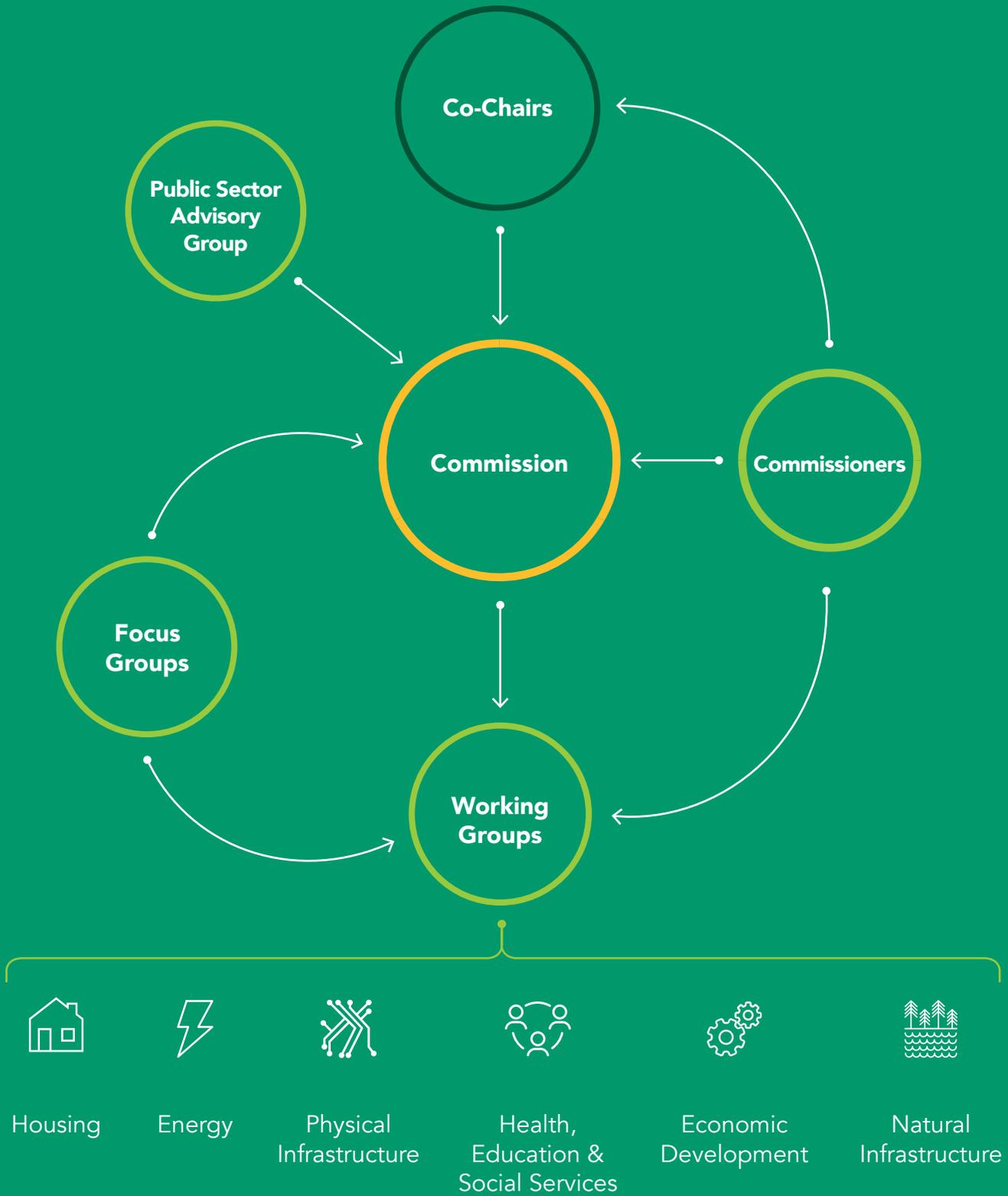
About the Resilient Puerto Rico Advisory Commission

The Resilient Puerto Rico Advisory Commission (the “Commission”) was created in November 2017 as an independent, inclusive, non-partisan and, non-governmental, body led by Puerto Ricans. It is designed to serve as a unifying force among a diverse group of voices.

The Commission is chaired by five Co-Chairs and has 22 Commissioners. The Co-Chairs are leaders from Puerto Rican civil society that represent diverse interests and social sectors. They were selected in consultation with local groups to lead the effort and evaluate, endorse, and approve the overarching recommendations of the Commission’s reports. Commissioners are civic, community, and business leaders appointed by the Co-Chairs, and they represent a broad cross-section of NGOs and academic, civic, and professional communities in Puerto Rico. They are the project’s ambassadors, an integral part of the community engagement, and have contributed their knowledge and technical expertise to the development of this report’s recommendations.

The Commission’s goal is to promote a more resilient Puerto Rico as part of a long-term reconstruction process that improves Puerto Ricans’ quality of life. It envisions a more participatory and transparent recovery process where the people of Puerto Rico take an active role in forging the future of the Island.





The Commission receives no public funding. It is financially supported entirely by **Ford Foundation**, **Open Society Foundations**, and **The Rockefeller Foundation**, with technical support from The Rockefeller Foundation's 100 Resilient Cities, as part of a broad effort to support the resilient recovery of Puerto Rico.

The Commission's core project, ReImagina Puerto Rico, aims to:



Produce an actionable and timely set of recommendations for how to use philanthropic, local government, and federal recovery funds to help rebuild Puerto Rico in a way that makes the Island stronger –physically, economically, and socially– and better prepared to confront future challenges.

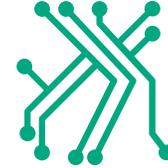
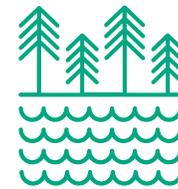




HOUSING



ENERGY

PHYSICAL
INFRASTRUCTUREHEALTH, EDUCATION &
SOCIAL SERVICESECONOMIC
DEVELOPMENTNATURAL
INFRASTRUCTURE

The Commission embarked on a broad, participatory process to achieve this objective, and it focused its analysis on several key sectors, organized under six working groups (see Figure 2).

Working groups met on three different occasions with approximately 15-20 individuals per working group meeting. They included commissioners and other experts and stakeholders with knowledge and expertise within the scope of the working groups. The three working group sessions led to the identification and development of each sector's goal and sector-specific recovery recommendations for Puerto Rico's resilient rebuild (see Methodological Approach on Appendix). Technical discussions within working group meetings were also nourished through a Community Outreach and Engagement Process that was held across Puerto Rican communities to validate and strengthen the identification of unmet needs, sector goals, and recovery actions.

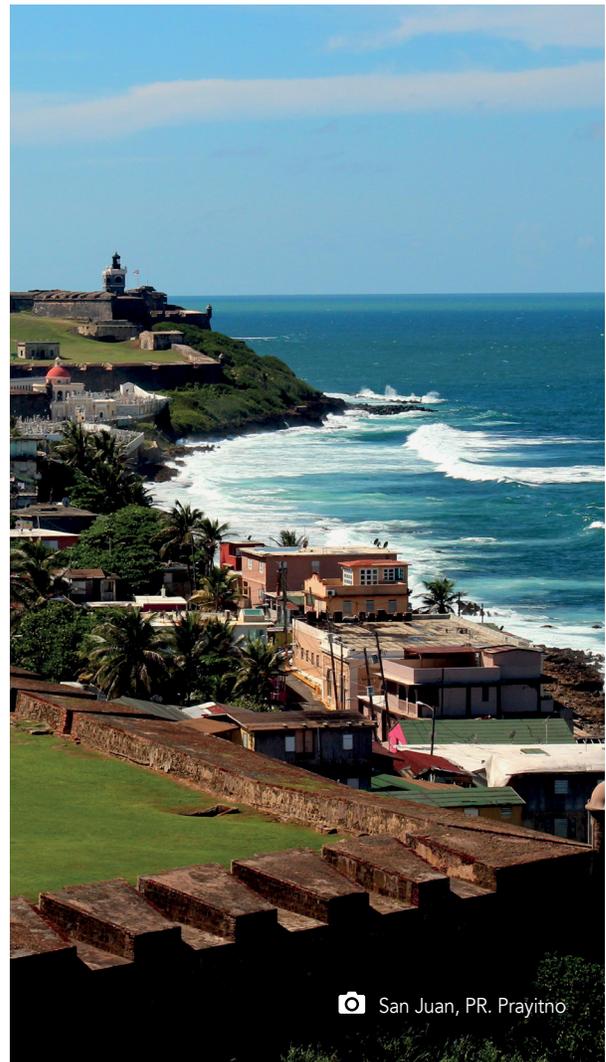
One of the core distinctions of this effort lies

in the broad and participatory outreach approach it has adopted towards Puerto Rico's recovery and reconstruction. The Commission has placed a central focus on enabling a conversation among diverse voices to build consensus and identify opportunities to embed resilience in the rebuilding efforts. As part of the project's Community Outreach and Engagement Process, ReImagina Puerto Rico brought together community members and leaders, grassroots organizations, business leaders, government officials, representatives from professional organizations, and students, among other groups. ReImagina Puerto Rico interacted with more than 750 individuals throughout the engagement process, including representatives from the Puerto Rican diaspora in Central Florida. Furthermore, it provided a common platform to discuss concerns and aspirations regarding a more resilient Puerto Rico. The extensive input gathered throughout this outreach process strongly shaped the development of the recommendations described in this report.

Finding the Path Forward

The Commission’s primary focus was to develop recommended actions with resilience qualities such as being inclusive, integrated, flexible, redundant, reflective, resourceful, and robust and targeting issues of equity, transparency, and sustainability. The process of rebuilding Puerto Rico offers the opportunity to address some of the underlying challenges that have prevented Puerto Rico from overcoming most recent disasters.

Building resilience requires looking at a community holistically and understanding the systems that make up the place, as well as the interdependencies and risks, through precise identification of existing and potential shocks and stresses. Beyond continuing to build its capacity for resilience, Puerto Rico needs to take advantage of the current moment to embark on a unified planning exercise that emanates from a series of consultations and debates with numerous stakeholders and at multiple scales. Such a planning exercise can help strengthen Puerto Rico’s social fabric, as well as help devise and design a more precise set of projects and programs that can improve its development trajectory and the well-being of its citizens. To help jumpstart the required planning efforts, ReImagina Puerto Rico has put forth specific and actionable recommendations that comprehensively, and in a coordinated manner, address unmet needs, ongoing challenges, and mitigate the impact of future disasters.



San Juan, PR. Prayitno

Working Group Mission and Approach

The Energy Working Group served as an advisory group to the Commission and provided input on issues related to embedding resilience as part of the disaster recovery process for Puerto Rico’s energy infrastructure. The mission of the Energy Working Group was to provide technical guidance to develop recommendations that are politically and technically feasible and that are aligned with major funding programs and recovery frameworks.

The Working Group consisted of local technical experts from federal and local agencies, NGOs, academia, and individuals with relevant experience and expertise.

While the energy sector intersects and interacts with all the other areas integrated in the working groups, the all-encompassing character of energy in all aspects of Puerto Rican life and economy meant that this sector merited a working group of its own.

The key energy issues discussed in this report include:

1



Energy resources (generation) and delivery (power transmission and distribution grid)

2



Capacity-building and efficient public participation in all aspects of the energy system

3



The power system's resilience and deficiencies

4



Alternative energy sources and distribution (including renewables, storage, and decentralized systems)

5



Demand-side management

6



Reforms and innovations in business and institutional models to establish, operate, and sustain a resilient energy system

Ultimately, the Working Group identified and selected a set of opportunity actions for the recovery of the energy sector. These recommended actions have the potential to enhance the resilience of the energy system through increased redundancy, flexibility, and inclusivity, with an ultimate impact of economic development and social well-being in Puerto Rico.

02

SECTOR CONTEXT



The following section provides an overview of the pre- and post-hurricane conditions of the energy sector, along with sector-specific unmet needs that pose resilient opportunities and actionable direction for next steps. As a preamble to the discussion, a description of the main energy sector actors in Puerto Rico is presented.

Since its creation in 1941, the Puerto Rico Electric Power Authority (PREPA) is responsible for the production, transmission, distribution, and sale of electricity on the Island. The PREPA is a public power utility that operates as a public corporation of the Government of Puerto Rico. It serves approximately 1.5 million clients, and it is the only entity authorized to conduct such business on the Island. The Governor of Puerto Rico, with the advice and consent of the Puerto Rico Legislature, appointed a board of directors to govern the PREPA. The Governor and the Legislature of Puerto Rico are currently exploring options for the privatization of the PREPA, potentially transforming its whole administrative and operational structure and the energy sector in the Island.

Since 2014, the PREPA has been subject to the Puerto Rico Energy Commission (PREC, or the Energy Commission), created by law through Act 57-2014. The PREC is an independent regulator with similar responsibilities to the ones of Public Service Commissions in the U.S. It is composed of three commissioners appointed by the Governor of Puerto Rico with the advice and consent of the local state Senate. The PREC, which is responsible for the regulation of the energy industry in Puerto Rico, was created with the primary objective of regulating the PREPA and the power sector in general and promoting renewable energy resources,

conservation, and efficiencies in the power system. Before establishing the PREC, the PREPA was self-regulated and was in charge of defining the electric energy policies for Puerto Rico without additional oversight.

The current electric power system consists of generation, transmission, distribution, communication, and control center facilities owned by the PREPA, and it is operated and managed as a single vertical integrated system. The power system supports the entire island, a geographic area of approximately 100 miles east to west and 35 miles north to south. The geography of the Island includes central mountain ranges extending the length of the island from east to west with peaks as high as 4,390 feet. Coastal lowlands formed by the erosion of the central mountains extend inwards on the north coast for eight to 12 miles and three to eight miles on the southern coast. The northern coastal lowlands are humid while those on the south side are semi-arid.

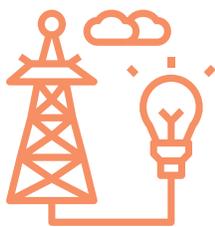
From an electric system perspective, the geographic features of the Island present significant challenges for the expansion and maintenance of the transmission and distribution systems. It is difficult to find suitable sites for new power generation sources in a socially responsible and sustainable manner, where the infrastructure is less susceptible to strong winds caused by drastic changes in elevation and from corrosion, on substations and the power grid, caused by saline and humidity.

The PREPA owns and operates six fossil fuel generation plants, several combustion turbines, and seven hydroelectric generation facilities for a total of 4,780 MW⁸. Additionally, the PREPA holds power purchase agreements with two privately-owned power producers, EcoEléctrica and AES-PR, for a total of



PREPA IS RESPONSIBLE
for the **production, transmission,**
distribution, and **sale** of electricity
on the Island

PREPA serves
approximately
1.5 million
clients



Since 2014, PREPA has
been subject to the **Puerto
Rico Energy Commission**

Central mountain ranges extend
the length of the Island

— from **east to west** —



with peaks as high as
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Coastal lowlands formed by the
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on the north coast and
3 to 8 miles on
the southern coast



2 wind farms
+ 4 solar farms
= only 2%

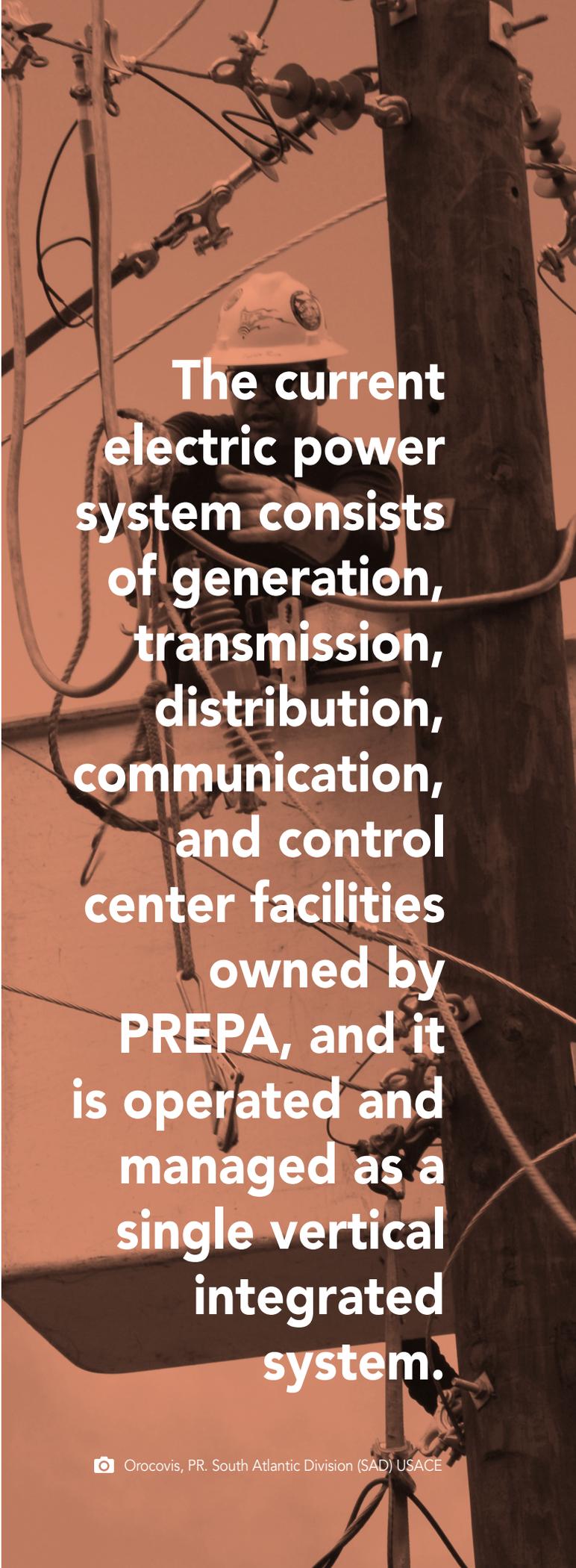
of total energy demand from
renewable sources

961 MW. The PREPA also holds power purchase agreements with renewable energy power producers comprising two wind farms and four solar farms, which currently totalize less of the 2% of the total demand⁹. The PREPA facilities lie along the north and south coasts of the Island, with the larger and more efficient generation located at the south coast, and the highest energy demand on the north coast. The high energy demand in the north is due to the high population density in urban areas, the location of manufacturing plants and commercial areas, and the Island's main seaport.

This geographical and mountainous separation between generation (south coast) and primary areas of consumption (north coast) adds a significant level of risk and challenges due to the dependency on a high voltage transmission system, connecting generation to consumer centers, and its high exposure to weather and terrain impacts.

The current Renewable Portfolio Standard (RPS), per Puerto Rico's Act 82-2010, requires 20% of renewable energy production by 2035. The PREPA Integrated Resource Plan (IRP) presented in 2015 considered a goal of 15% by 2035¹⁰. On September 23rd, 2016, the PREC approved a Modified IRP, sustaining the statutory requirements for renewable energy as well as other important considerations. Before Hurricanes Irma and María, the PREPA signed over 60 contracts for large-scale renewable energy projects, principally for solar and wind. The PREC 2016 Order included the assessment of nonexecuted contracts due to high-cost concerns.

In the first six months of 2017, most of the renewable electricity came from solar energy, resulting in less than 6% renewable energy (hydro, solar, and wind). As of June 2017, Puerto Rico had 127 megawatts of utility-scale solar photovoltaic generating capacity and 88 megawatts of distributed generation (customer-sited and small-scale). A substantial portion of the solar installations was severely affected by the hurricanes.



The current electric power system consists of generation, transmission, distribution, communication, and control center facilities owned by PREPA, and it is operated and managed as a single vertical integrated system.

Pre-Disaster Context

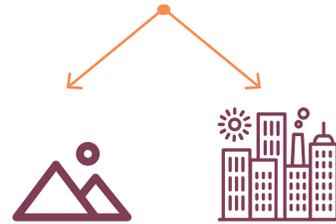
It is important to understand the energy infrastructure vulnerabilities within the context of a Caribbean island.

Puerto Rico is an island where the population is divided between rural and urban areas, surrounded by water, highly exposed to climate hazards, highly economically dependent on imports, and has limited natural resources. The energy infrastructure operates as an isolated system within a challenging terrain that is subject to devastating natural disasters of both climatic and seismic nature. During hurricane events, Puerto Rico's electrical system is vulnerable to hurricane-force winds, storm surge, landslides, and flood events. Having most of the generation on the south of the Island (comprised of Aguirre, AES, Costa Sur, and EcoEléctrica), the trans-mountain high voltage transmission lines are most likely to fail, as experienced during Hurricane María. When these major pathways become unusable, electric generation in the north cannot replace the generating capacity in the south.

In addition to these climatic and geographic exposures, the Energy Working Group highlighted specific institutional and financial stresses that existed prior to Hurricanes Irma and María. These include poor maintenance and operational standards, poor service quality, poor communication and transparency, and general lack of accountability to the state regulator, the Puerto Rico Energy Commission.

The energy infrastructure facilities and business practices do not meet the industry standards due

Puerto Rico is an island where the population is divided between



rural and urban areas,



surrounded by water,



highly exposed to climate hazards,

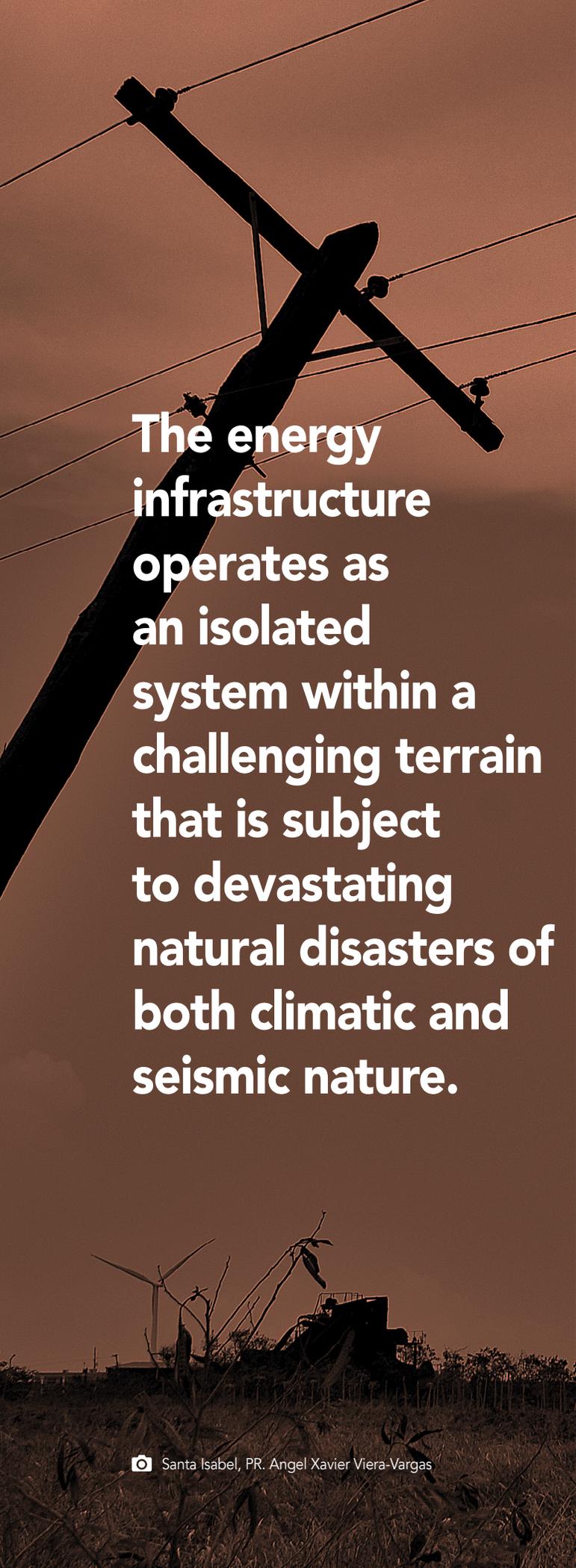


highly economically dependent on imports,



and has **limited natural resources.**





The energy infrastructure operates as an isolated system within a challenging terrain that is subject to devastating natural disasters of both climatic and seismic nature.

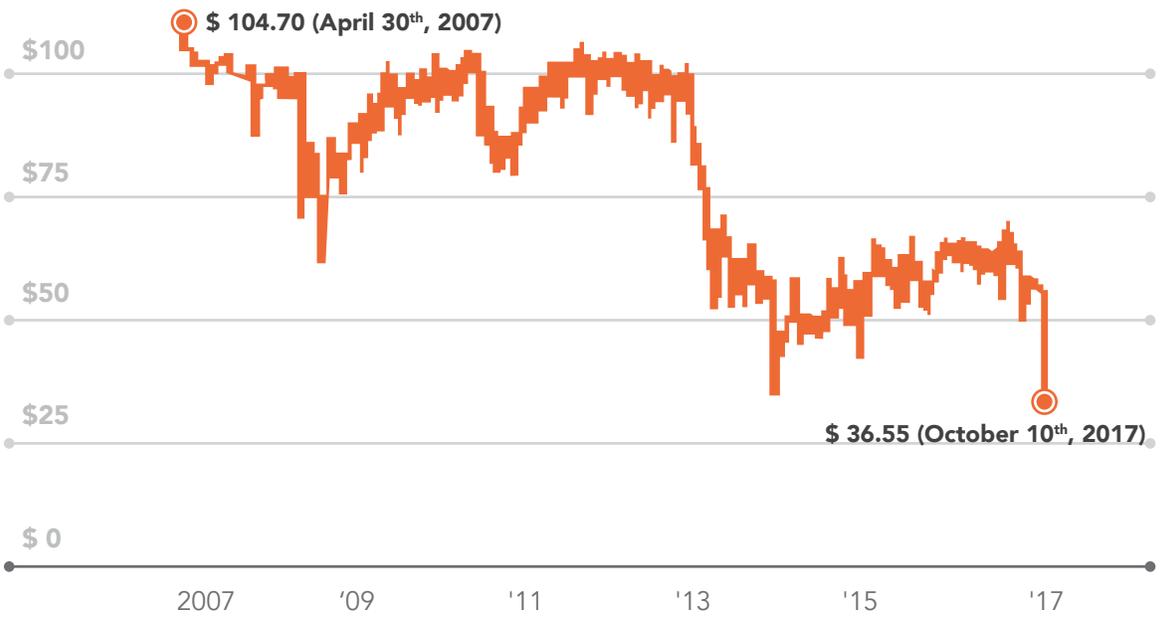
to chronic underinvestment and inconsistent utility management. Significant investment on energy production infrastructure was needed to stabilize and improve operational efficiency, safety, reliability, environmental compliance, and conversion to clean energy, but PREPA¹¹ had no access to the bond market and bank financing. This lack of access to the capital markets further limited PREPA's¹² ability to invest in energy infrastructure and the necessary maintenance of facilities and equipment. The combination of inadequate infrastructure, lack of investment, staff turnover, and a leadership that made inconsistent decisions due to political interference have left the PREPA's system "in a state of crisis."¹³

Meanwhile, out-migration and the accrued decline of manufacturing activity since 2006 reduced electric demand from its historical system peak of 3,685 MW in FY 2006 to 3,060 MW in August 2017. This trend can be expected to continue, as the traditional PREPA customers are turning to distributed generation by installing solar photovoltaic systems with battery storage in residences and businesses. Consequently, the Financial Oversight and Management Board (FOMB) forecasted, in their Certified Fiscal Plan for the PREPA issued on April 19th, 2018, that energy sales will drop a maximum of 30% by 2023, which reflects these historical trends.

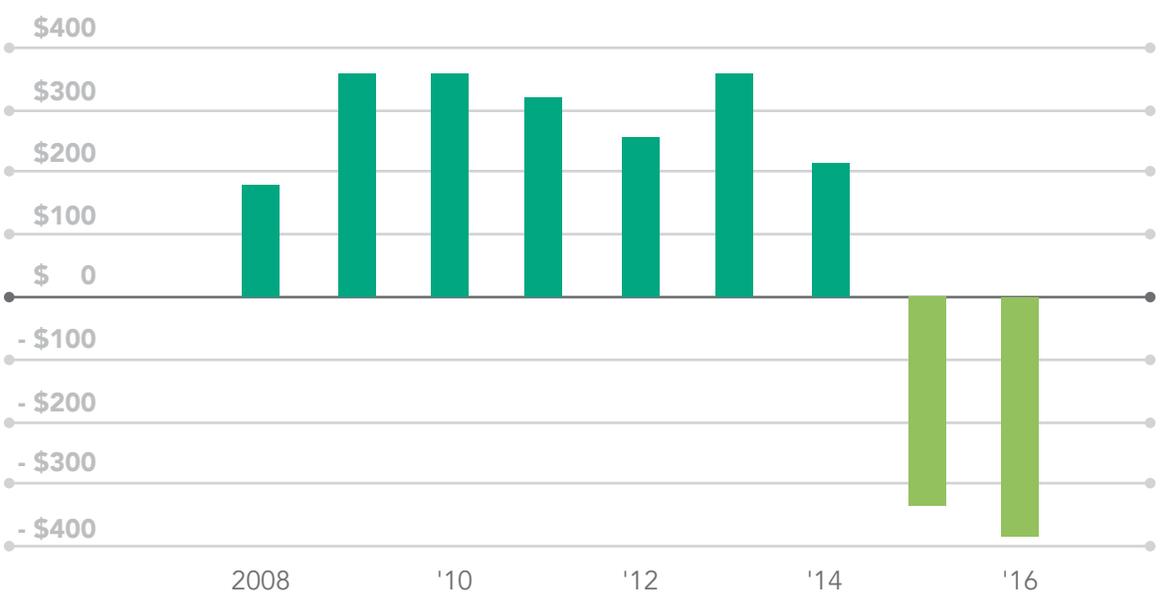
As demand fell over the last decade and the associated revenue stream declined, financial performance suffered and the utility borrowed money to fund operating expenses¹⁴. By 2014, the PREPA was overburdened with debt and had no access to additional liquidity. The significant drop in energy sales, coupled with no access to financing, placed the energy infrastructure on the edge of financial collapse (see Figure 3).

PREPA'S FINANCIAL DOWNTURN

Bond price (secondary market)



Net revenues (in millions)





Before the hurricanes, per data provided during the FY 2017 PREPA Rate Case held by the PREC, the utility required more than \$1.1 billion for fuel needed to feed old power plants that rely mostly on imported oil. The resulting total revenue requirement from the Rate Case, including payments to Power Purchase Agreement (PPA) and creditors, was \$3.95 billion.

Regarding investment required to retrofit PREPA's outdated oil-fired fleet, during the 2015 Integrated Resources Plan review, held by the PREC, PREPA submitted a plan aimed at keeping its centralized generation structure based mainly on fossil fuels. The proposed IRP, in its Volume I, estimated the recommended generation supply portfolio at a capital cost ranging from \$4.67 billion to \$5.72 billion. The PREC rejected such plan and approved a Modified IRP on September 23rd, 2016. The PREC's modified IRP consisted in a different view of the Puerto Rico electric system. As a basis for the development of renewables and distributed energy, the 5-year action plan proposed approximately less than half of the proposed generation by the PREPA, supplemented with energy efficiency

and management programs to respond to load demand.

On the IRP 2016 Order¹⁶, the PREC noted the PREPA's reluctance to follow its guidance toward energy efficiency, demand response, and renewable energy technologies. In the Order, the PREC remarked on the PREPA's noncompliance with the PREC IRP Rule and proceedings. The PREC detailed that the PREPA disregarded their rule, failed to use standard planning techniques, delayed the production of required documentation, and displayed an insufficient appreciation of the potential for energy efficiency and demand response. The PREPA resisted the PREC Order not only by appealing it, which was dismissed by the PREC, but by presenting the rejected plan to the Financial Oversight and Management Board (FOMB) as the core of its 2017 fiscal plan proposal and during the budgetary plan certification process after Hurricane María. Due to a lack of transparent institutionalized operations, nonengagement with the community and procedures, and insubordination to the state regulator, the PREPA was led to an unstable and insolvent condition.



📷 Orocovis, PR. South Atlantic Division (SAD) USACE

Regarding reliability metrics, during the FY2017 (sic) Rate Case Order, the PREC stated:

“PREPA’s current goal for [System Average Interruption Frequency Index] SAIFI is 0.33 interruptions per connected customer per month. On average, PREPA customers experience at least one five-minute outage every month, or **a SAIFI of 11.61 per year, twelve times that of the average U.S. customer. PREPA’s goal for [System Average Interruption Duration Index] SAIDI is 48 minutes per connected customer per month**, or about ten hours of outage per year. In recent months, PREPA’s actual [SAIDI] has been closer to 16 hours per year.

These levels exceed those of other utilities. In 2012, the national annual SAIDI measured about 3.33 hours per year, including storm events. PREPA’s target – excluding storm events – is about 10 hours per year, above the 75th percentile of utilities.

Even with its less ambitious goals, since January 2013 PREPA has exceeded its targets in 64 percent of the months for SAIDI, 51 percent for SAIFI, and 68 percent for [Customer Average Interruption Duration Index] CAIDI. Commission consultants Drs. Fisher and Horowitz found that outage duration has been increasing. **CAIDI has risen from approximately 140 minutes per month in January 2013 to approximately 180 minutes per month in July 2016.**

Shifting the focus from customers to plants does not improve the picture. PREPA’s ‘forced outage factor’ (the probability that a unit will not be available for service) averaged 6.87% from 2010 to mid-2015 but ended that period at a historic high of 27%. As of late 2015, chronic outages have occurred at each of the Aguirre, Palo Seco and San Juan plants¹⁷.

Performance metrics like the SAIFI, SAIDI, and CAIDI are fundamental to measure the performance of the utility. The lack of a regulator and independent oversight resulted in a utility not only with poor reliability metrics, but with lack of enforcement and lack of a record in certain utility areas.

The PREC is currently holding a proceeding titled The Performance of the Puerto Rico Electric Power Authority (docket number CEPR-IN-2016-0002). One of the main purposes of this proceeding is to add key performance indicators (KPIs) to the

PREPA's internal metrics and incentivize the PREPA to report them on a periodic basis. By achieving this, the PREC and other interested parties can transparently obtain important data on how the utility is performing in several key areas.

Another key indicator is the high reliance on oil imports and the inability to diversify fuel mix. PREPA currently generates power with 45% fuel oil, versus the U.S. national average of about 4%. This fuel oil dependency creates continued forecasting of materially higher fuel prices than other U.S. markets.

Since the creation of the PREC in 2014, with the participation of the Puerto Rico private sector, there has been an emphasis in the formation of institutionalized processes aimed at:

1

Creating a rate structure with correct signaling to customers, including the first-ever Rate Case in FY2016.

2

Reviewing and approving the first Integrated Resources Plan (IRP) for the Puerto Rico electrical system in September 2016. Comprising a 20-year planning period, the IRP is in compliance with the current statutory RPS, energy efficiency and demand response programs.

3

Reaching a sustainable debt level that propel affordable energy costs.

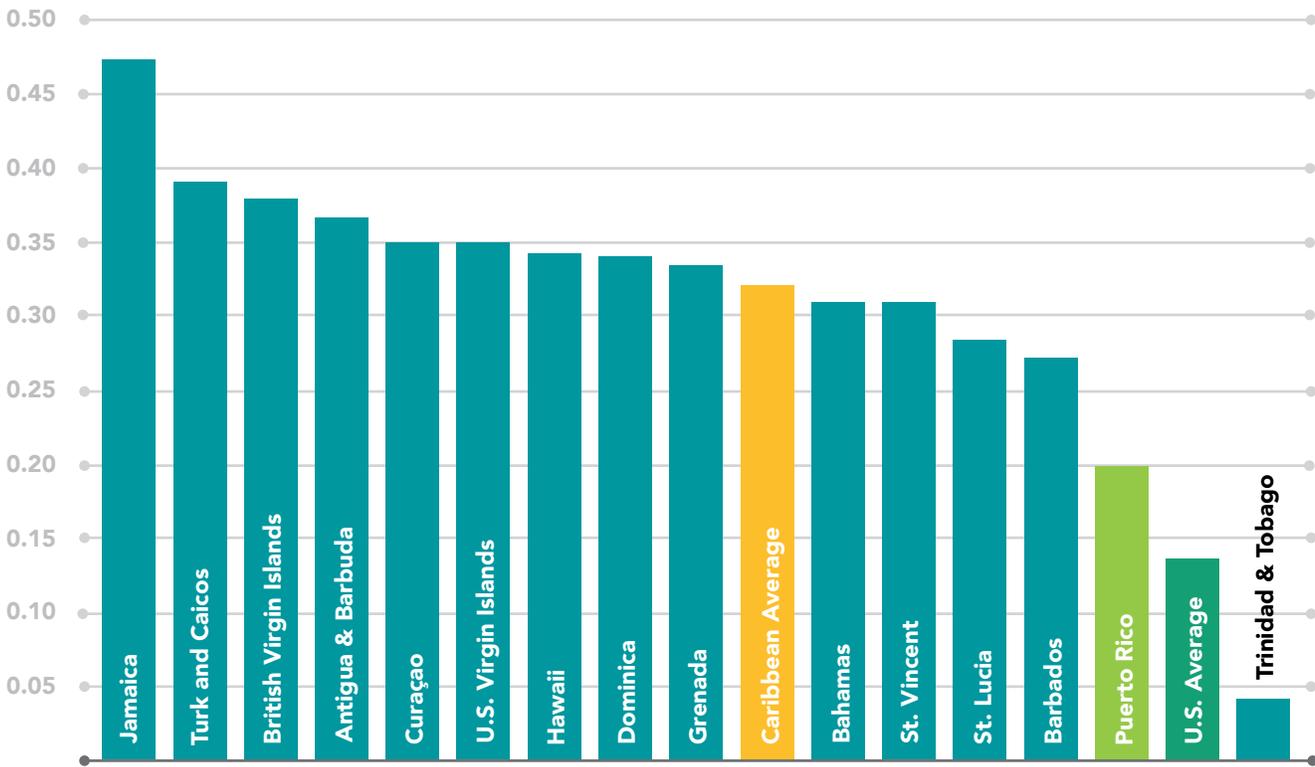
4

Providing a clear path and regulation toward the development of microgrids and distributed generation, including the development of a microgrid regulation that is currently being evaluated by the PREC.

Energy prices in Puerto Rico are substantially higher than in most U.S. states, and Puerto Rico’s energy intensity is less than 65% of that of U.S. states¹⁸. Figure 4 compares the residential electricity cost for consumers in Puerto Rico, other Caribbean small islands, Hawaii, and the U.S. average in 2017.

F4 ELECTRIC RATES FOR RESIDENTIAL CUSTOMERS ON ISLAND TERRITORIES, AND US AVERAGE.
(SOURCE: VARIOUS COUNTRY GOVERNMENTS AND NON-GOVERNMENT SOURCES)

RESIDENTIAL ELECTRICITY PRICES (\$U.S.)¹



Note 1: Prices include a variable fuel surcharge which is heavily weighed by the price of oil. Prices shown are not concurrent in time but are representative of the relative cost of electricity.

Figure 4 shows the relative ranking of residential rates for many islands comparable in the fuel-resources mix to Puerto Rico. The indicated prices are a snapshot in time and vary on a month to month basis based on the cost of generation fuel – predominantly petroleum-based fuels. Although the prices change every month,

the relative ranking will continue since the predominant fuel affects all islands with the same proportionality. These electricity prices will all increase in the near future as a result of the recent increase in petroleum prices, which currently approach 50% above prices in early 2018.

Post-Disaster Context

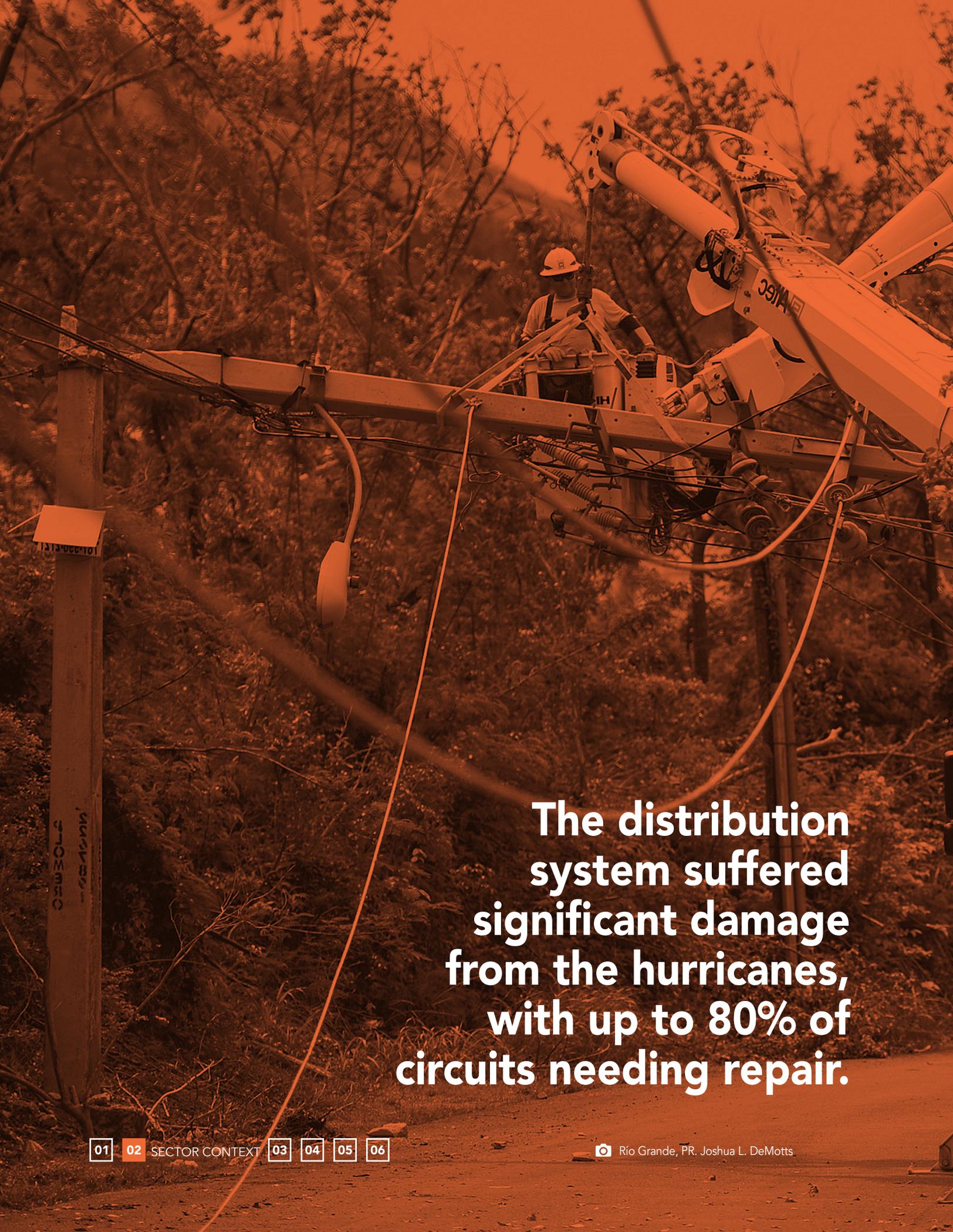
Hurricane María devastated the island of Puerto Rico on September 20th, 2017, while it was still in emergency response mode following Hurricane Irma two weeks prior. The acute shock of hurricane impacts aggravated existing chronic stresses that plagued the energy sector, including the near financial collapse of PREPA, poor reliability metrics and the aging infrastructure. The combined impacts of the two hurricanes, coupled with the underlying chronic stresses, led to a complete collapse of Puerto Rico's power grid. This collapse resulted in the state-level power outage of longest duration in U.S. history.

The distribution system suffered significant damage from the hurricanes, with up to 80% of circuits needing repair¹⁹. Both the overhead and underground systems were affected. Pre-storm distribution poles were not designed to withstand a Category 4 storm and were part of outdated distribution infrastructure. Underground equipment experienced water and contaminant intrusion. The limited use of deadend breakaways on distribution poles led to a domino effect, with long sections of lines failing successively.

However, Hurricane María was so powerful that it disabled radars, weather stations, and cell towers across Puerto Rico, creating an information hiatus.

The future of PREC is uncertain due to proposed legislation to restructure this regulatory commission. Stakeholders are concerned with PREC's role in the government's policy related to PREPA privatization options. Some transactional privatization alternatives being reviewed by the Puerto Rico Legislature – such as the recent House Bill 1481 approved by U.S. Congress – consider substantially limiting the intervention of the Energy Commission, including the IRP approved by PREC. This concern also emerged as a priority topic of discussion in the Energy Working Group meetings.

This cataclysmic event, followed by the failure of the power grid and coupled with the need to address underlying chronic stresses provides an extraordinary opportunity to rebuild and upgrade the energy sector to 21st century technologies and best practices. This would enable the reimagining of power generation and distribution to customers across Puerto Rico.



The distribution system suffered significant damage from the hurricanes, with up to 80% of circuits needing repair.

Shocks and Stresses

After considering the pre- and post-disaster energy conditions in Puerto Rico previously described, the Energy Working Group members, with their combined expertise and in-depth local knowledge, specifically identified the following major “shocks” and “stresses” for the energy sector in the Island.

Key shocks include:



Hurricanes and tropical storms



Failure of backup energy generation systems



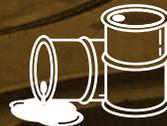
Earthquakes and tsunamis



Stepped increase in fuel cost



Heatwaves



Failure of fuel distribution systems



Floods

Key stresses include:



Obsolete, deteriorated and aging infrastructure



Losses of employment and closures of companies; unemployment and underemployment



Sea level rise



Lack of municipal and other organizations' participation in decision making



Droughts



Increased energy production costs

Unmet Needs

The Energy Working Group identified several unmet needs cross-related to the energy sector. These cover many common areas of concern, such as the need to enhance the energy infrastructure, so that it may be stronger and resilient.

The main unmet needs can be classified into six categories, specifically:



LACK OF COMMUNITY AND STAKEHOLDER ENGAGEMENT IN DECISION-MAKING PROCESSES.

The proposed transformation of the electric power utility, and the associated infrastructure, should proceed with the participation of numerous stakeholders and respond to Puerto Rico's social and community development challenges by reducing social insecurity and inequality.



DERELICT ENERGY INFRASTRUCTURE SYSTEMS,

including the transmission and distribution grid which has not received adequate maintenance. There has been a failure to stock enough spare parts, materials, and equipment to support a rapid mobilization for prompt restoration of electric services.



NONCOMPLIANCE WITH COMMON RELIABILITY ASSESSMENT PRACTICES

established by the PREC in line with national parameters of organizations such as the North American Electric Reliability Corporation (NERC).



FAILURE TO RESTORE POWER TO THE POPULATION

after the Hurricane María grid failure, to the extent that 10% of the population remained without electric power seven months after the event. Further, the partial restoration of the power supply is, at best, inadequate. The energy system is also still fragile, as demonstrated by the frequent continued occurrence of island-wide power failures.



LIMITED FINANCIAL CAPACITIES of local government institutions to fund the maintenance and expansion of the energy system and to address the lack of resiliency to survive or recover as experienced with Hurricanes Irma and María. Policy frameworks and incentives for the development of decentralized systems (localized micro-grids and distributed energy in general) and the rapid adoption of solar and other renewable generation sources were inadequate.



LACK OF FUNDING AND POLITICAL STABILITY from the Government of Puerto Rico to the Energy Commission, results in a threat to effective, independent oversight of the future utility entities, structure, investments, rates, and operations.

Although these unmet needs specifically apply to the energy sector, the failure of the energy system to promptly recover from the storms has affected all other aspects of the Island's economy. Compromised elements include healthcare facilities, educational institutions, water supply and treatment plants, road safety (due to lack of working traffic lights), communications (due to lack of power for the wireless infrastructure), and flood control facilities (due to inoperable electric pumps).

These unmet energy sector needs are rooted, to a large extent, on the limited financial capacities of the PREPA and other public sector institutions and individuals. They were unable to fund recovery actions addressing power generation, the high voltage transmission grid, and the local electric distribution system. All these relate to Puerto Rico's limited fiscal capacity, which requires greater financial assistance from the federal government and philanthropic organizations.

03

SECTOR
GOAL

Address Puerto Rico's energy needs by transforming its electric power infrastructure into an affordable, reliable and innovative system, while reducing adverse impacts on human health and the environment.

This goal will be furthered by actions that are:



Targeted to offer accessible, reliable, and secure services.



Based on endogenous renewable resources that are environmentally sensitive.



Responsive to public interest.



Aligned with a regulated system that fosters transparency, cost-effective prices, and protects consumers and the environment.



Innovative, efficient, and cost competitive.

In order to reach the goal, the design of actions, including demand management, policy and legal reforms, institutional reforms, and investments in grid infrastructure, should take into account the need to make redundant energy available to critical facilities and vulnerable individuals. It should also provide for greater diversity in power-grid structure and technology, including distributed generation, mini-

grids and microgrids, renewable energy, and energy storage, within a framework of overall grid hardening. Diversification is critical in addressing the reliability of the energy system, and it needs to be implemented, not as individual steps, but as a continuum of actions. These actions should address short term needs as the energy system is transitioned to achieve long term resilience goals. The diversification approach needs to address:



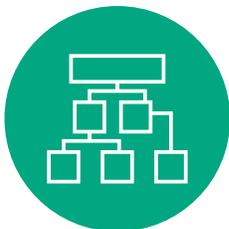
Fuel supply diversity

Provide fuel supply diversity to increase the contribution from clean renewable resources (sun, wind, hydro), energy storage (batteries and hydro pumped-storage), and adopt fossil fuels as transitional (emphasizing natural gas and reducing the reliance on diesel, fuel oil, and coal).



Technology diversity

Institutionalize a rational level of generation technology (base load, peakers, intermittent, gas turbines, and internal combustion, among others) that corresponds to the seasonal and daily load-shapes of the load components (residential, commercial, and industrial) and the grid integration approach. Technological diversity also encompasses the proper balancing of generators' capacities to ensure that the failure of a single generation unit does not overburden the capacity of the remaining generators to immediately respond to the change in generation. It should be noted that large generation units in a relatively small power system result in the need to carry suboptimal levels of a spinning-reserve generation with consequent higher operating costs.



Operating framework diversity

Introduce sufficient smart grid technology, distributed generation, and microgrids to ensure continuous electric power service to selected critical need "load-islands".



PowerSecure

04

OPPORTUNITY ACTIONS



Action Sheet Guideline

Action Number

Action Title

A1

Prepare a new Integrated Resource Plan (IRP), with public, community and private sector participation, to be used as the foundation for the energy sector transformation, and which includes updated analysis and forecast of the demand base, aggressive renewable generation targets, and a risk-based analysis of the sector to strengthen utility oversight and operator decision making.

Description

There is an urgent need for an updated IRP that reflects the changes required in light of the post-Hurricane María scenario. The IRP would be the guiding document for the transformational and transactional processes, in Puerto Rico's energy sector, regarding the energy mix, grid structure and development, and demand management.

The IRP should lay the basis for the incorporation of distributed energy resources and microgrids into the system. To complement the IRP effort, additional regulatory proceedings, such as the development of additional performance metrics and key performance indicators (KPIs), are required to deeply transform Puerto Rico's energy system. A central priority is to shift to dispersed generation sources ("location diversity") that foster greater use of renewables, as well as various generation technologies that match the changing load profile in the near term and forecasted long-term planning, while progressively reducing fossil fuels. Monitoring and updating the IRP is also required. Current Puerto Rico statutory law requires a 20-year planning process that is (1) overseen by the local independent regulator, PREC, and (2) subjected to rigorous external review and public comments.

Potential Lead

Puerto Rico Energy Commission

Potential Co-leads

PREPA; DEDC; PRPB

Potential Funding Sources

PREPA, PREC

Unmet Needs



Crosscutting Benefits



Timeframe

Short term

Potential Lead: Lead organization responsible for execution of action

Potential Co-leads: Partners that will support the development of the action

Potential Funding Sources: Federal, local, and philanthropic resources

Unmet Needs:

- Lack of community and stakeholder engagement in decision-making processes
- Derelict energy infrastructure systems
- Noncompliance with common reliability assessment practices
- Failure to restore power to the population
- Limited financial capacities
- Lack of funding and political stability

Crosscutting Benefits:

- Housing
- Energy
- Physical Infrastructure
- Health, Education & Social Services
- Economic Development
- Natural Infrastructure

Description: The action description addresses expected results and questions such as: What? How?

Timeframe: Short, medium, and/or long term

Goal and Actions

Address Puerto Rico’s energy needs by transforming its electric power infrastructure into an affordable, reliable and innovative system, while reducing adverse impacts on human health and the environment.

A1

Prepare a new Integrated Resource Plan (IRP), with public, community, and private sector participation, to be used as the foundation for the energy sector transformation, and which includes an updated analysis and forecast of the demand base, aggressive renewable generation targets, and a risk-based analysis of the sector to strengthen utility oversight and operator decision making.

A2

Increase the diversity of the energy fuel mix.

A3

Rebuild, harden, and modernize the transmission and distribution system for a minimum of energy security and resiliency.

A4

Promote and enforce public policies and integrated regulations to allow the development of distributed energy.

A5

Integrate microgrids, mini-grids, and renewable energy into the Island’s transmission and distribution grid to the greatest extent possible.

A6

Establish reliable and diversified backup energy systems for vulnerable individuals and critical facilities, such as hospitals, schools, and emergency shelters and services facilities.

A7

Facilitate access to backup energy systems/equipment to fill remaining gaps in individuals' capacity to generate backup electric power for small businesses.

A8

Build capacity across the Island's municipalities to plan, finance, and develop solar renewable energy systems for municipal buildings and facilities.

A9

Create consumer participatory and collaborative mechanisms and public education initiatives to strengthen informed public decision making and engagement on efficient energy usage and the development of resilient energy systems.

A10

Establish a program to increase energy reliability of Puerto Rico's critical water pumps systems.

A11

Promote the revitalization of Puerto Rico's hydroelectric generation resources, as long as it is cost-effective.

A12

Implement an Island-wide energy efficiency and demand response strategy, detailing and prioritizing cost-effective initiatives to reduce and balance energy demand.

Prepare a new Integrated Resource Plan (IRP), with public, community, and private sector participation, to be used as the foundation for the energy sector transformation, and which includes an updated analysis and forecast of the demand base, aggressive renewable generation targets, and a risk-based analysis of the sector to strengthen utility oversight and operator decision making.

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The IRP should lay the basis for the incorporation distributed energy resources and microgrids into the system. To complement the IRP effort, additional regulatory proceedings, such as the development of additional performance metrics and key performance indicators (KPIs), are required to deeply transform Puerto Rico’s energy system. A central priority is to shift to dispersed generation sources (“location diversity”) that foster greater use of renewables, as well as various generation technologies that match the changing load profile in the near term and forecasted long-term planning, while progressively reducing fossil fuels. Monitoring and updating the IRP is also required. Current Puerto Rico statutory law requires a 20-year planning process that is (1) overseen by the local independent regulator, PREC, and (2) subjected to rigorous external review and public comments.

Potential Lead

Puerto Rico Energy Commission

Potential Co-leads

PREPA; DEDC; PRPB

Potential Funding Sources

PREPA; PREC

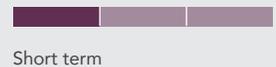
Unmet Needs



Crosscutting Benefits



Timeframe





A2

Increase the diversity of the energy fuel mix.

Description

Diversify the fuel mix with a decarbonizing energy transition by decreasing reliance on fuel oil, diesel, and coal, and increasing the renewable portfolio standard. In the short term, incorporate the energy generated from renewable sources and increase the relative use of existing natural gas fired units on the Island for baseload needs to enable a faster phase out from oil, diesel, and coal units. The phasing-out of peaking units should be complemented with reserve power and other ancillary services. Puerto Rico's current legislation requires the diversification of the energy fuel mix and renewable portfolio standard (RPS), yet it has not been fully implemented. The new IRP, to be prepared post-Hurricane María, needs to review the appropriate diversification of fuel mix and RPS, and PREC, Puerto Rico's independent regulator, needs to ensure its implementation.

Potential Lead

Puerto Rico Energy Commission

Potential Co-leads

PREPA; Private stakeholders

Potential Funding Sources

CDBG-DR; CDLs; Private capital

Unmet Needs



Crosscutting Benefits



Timeframe



Short term

Rebuild, harden and modernize the transmission and distribution system for a minimum of energy security and resiliency.

Description

The existing transmission and distribution system, which was severely affected by Hurricane María, is outdated and vulnerable due to lack of maintenance and underinvestment. As such, it needs to be rebuilt, hardened and modernized.

This effort should proceed as an expansion of the ongoing recovery efforts. It should also incorporate the necessary plans, alternatives, and system flexibilities in a way that does not impede the integration of new local grids and generation within the transmission and distribution grid. The initial focus of attention should be for areas that are more at risk of loss of power during natural emergencies and would benefit the most from the availability of local generation resources.

This action also recognizes that the rebuilding and strengthening of the system can be implemented in the medium to long term (5 to 7 years). In the meantime, distributed energy solutions, including microgrids (composed mainly of photovoltaic systems with battery storage and combined heat power) and mini-grids for residential, commercial and industrial applications need to be incentivized and deployed immediately. Additionally, it recognizes the need for grants, loans, and financing of distributed energy equipment to expedite its immediate deployment and ensure Puerto Rico residents achieve energy security and resiliency.

In order to ensure the provision of energy security and resiliency, the minimum value of distributed energy has been initially estimated, by organizations in Puerto Rico, at 20 percent.

Potential Lead

Puerto Rico Electric Power Authority

Potential Co-leads

Private industry

Potential Funding Sources

Federal funding under HR-1892

Unmet Needs



Crosscutting Benefits



Timeframe



Medium and long term

Promote and enforce public policies and integrated regulations to allow the development of distributed energy.

Description

The enactment of legislative and regulatory changes is expected to codify the required amendments in law and regulation to allow for the orderly development of distributed energy projects. Ideally, the codified regulations should extend the participation of private and public sectors on a “market based” pricing basis to facilitate the capital investment required for the deployment of small and large-scale ventures. Consequently, this action promotes local wealth creation. As a first step toward energy security and resiliency, the minimum value of distributed energy must be determined. Organizations in Puerto Rico established a preliminary estimate of 20 percent.

Potential Lead

Puerto Rico Energy Commission

Potential Co-leads

Private stakeholders;
Community groups;
NGOs

Potential Funding Sources

Government of Puerto Rico;
NGOs

Unmet Needs



Crosscutting Benefits



Timeframe



Short term

Integrate microgrids, mini-grids, and renewable energy into the Island’s transmission and distribution grid to the greatest extent possible.

Description

On a comprehensive basis, the “microgrid” concept is a multiple step process that needs to be initiated at the legislative/regulatory level. This must be followed by the development of standards, guidelines, and codes, as well as its implementation via coordination between the affected load and private developers/investors.

The integration of these elements requires a coordinated effort between communities, the private sector, the government, and the electric utility in order to ensure that the regulations result in:

- Free and unimpeded opportunities to develop microgrids.
- Clear and enforceable guidelines for the implementation of microgrids.
- Opportunities to achieve economic benefits by shifting between local (microgrid) generation and utility generation.

Potential Lead

Puerto Rico Energy Commission

Potential Co-leads

Electric utility and private stakeholders; Community groups; NGOs

Potential Funding Sources

Private capital; PREPA

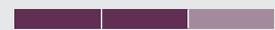
Unmet Needs



Crosscutting Benefits



Timeframe



Short and medium term

Establish reliable and diversified backup energy systems for vulnerable individuals and critical facilities, such as hospitals, schools, and emergency shelters and services facilities.

Description

Recovery funds should be used to identify energy depending individuals and define guidelines to adopt adequate technologies. Also, backup energy systems that are reliable and diversified should be installed in critical facilities, such as hospitals, schools, nursing homes, fire and police stations, water supply systems, wastewater treatment plants, fuel pumping and pressurization stations, cellular communications, community centers, and emergency shelters, among others. Critical facilities are facilities that provide essential services and functions for survival, the continuation of public health and safety, and disaster recovery. These facilities rely on continuous electric service to ensure business continuity or continuity of government and other services. Access to backup energy equipment should also be enabled for vulnerable individuals that rely on electricity for medical aids. These efforts would follow redundancy recommendations as contained in FEMA P-1019 (September 2014). FEMA P-1019 promotes the concept of backup energy systems based on knowledge developed from Hurricane Sandy, and it promotes the nonutility installation and operation of power generation for backup support.

Potential Lead

Governor's Authorized Representative

Potential Co-leads

PREC; Electric utility and private stakeholders; Community groups; NGOs; Local health and human services providers

Potential Funding Sources

USDOC; U.S. Army; USDOED; HUD; HMGP; Federal funding under HR-1892; CDBG-DR

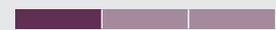
Unmet Needs



Crosscutting Benefits



Timeframe



Short term



01

02

03

04

OPPORTUNITY ACTIONS

05

06

📷 Guánica, PR. South Atlantic Division (SAD) USACE

Facilitate access to backup energy systems/equipment to fill remaining gaps in individuals' capacity to generate backup electric power for small businesses.

Description

Develop and support partnerships with agricultural and housing associations, cooperatives, credit unions, and power cooperatives to co-design and execute an initiative focused on the provision of education, aggregated wholesale purchases, and finance for high-quality emergency backup energy systems for households and small businesses. The initiative should ensure that all households and small businesses have backup access to 2kW of power to cover basic energy requirements. It should focus on emphasizing rooftop solar energy and storage. In order to establish a financing mechanism for discounted equipment and installations, the initiative should be implemented by engaging the banking sector and small business development organizations.

Two possible models to implement this kind of initiative are the Business Preparedness and Resiliency Program (PREP) and the Resiliency Innovations for a Stronger Economy (RISE: NYC) competition. Both efforts were designed and undertaken by New York City, following Superstorm Sandy, and were funded with CDBG-DR dollars.

Potential Lead

Non-Governmental Organizations

Potential Co-leads

Credit unions and other financial institutions

Potential Funding Sources

CDBG-DR; Corporate and cooperative foundations; Social responsibility programs

Unmet Needs



Crosscutting Benefits



Timeframe



Long term

Build capacity across the Island’s municipalities to plan, finance, and develop solar renewable energy systems for municipal buildings and facilities.

Description

Municipalities need to build and strengthen their capacity to integrate, finance, and maintain renewable energy systems at the local level. Reforms that include charging municipalities for power supply for their buildings, facilities, and infrastructure operations should also be implemented. Over the last decades, a wide variety of local government initiatives regarding renewables have been established and scaled. In addition to having generated technical guides and advisory programs on policy, planning, siting, sourcing, and workforce training, these initiatives have also provoked innovative solutions for municipal financing of renewables. A major, recent U.S. program is the DOE/ICLEI/ICMA Solar Outreach Partnership. All of Puerto Rico’s municipalities should participate in such a program. The program should be tailored to each municipality’s specific needs based on their exposure to natural disasters, existing infrastructure, funding needs, and degree of recovery difficulties in light of recent hurricanes.

The focus of the proposed action is to:

- Review established programs and provide municipalities with guidelines on how they should prioritize investments or funding requests from recovery funds or other federal funding.
- Identify context-relevant material that can be readily adopted for distribution to municipalities in Puerto Rico.
- Drawing from the above guidelines and materials, initiate focused energy assessments and renewable plans, for municipalities, that include feasibility, critical locations, impact on residents, and risk-evaluation.
- Establish training and technical support partnerships between Puerto Rico municipalities and municipalities in U.S. mainland, Mexico, the Caribbean, and Europe.
- Determine how to leverage recovery funds to support accelerated financing of renewables’ generation capacity in municipalities across the Island.

Potential Lead

Municipalities

Potential Co-leads

Private sector;
USDOED; DOS; NGOs

Potential Funding Sources

CDBG-DR

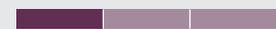
Unmet Needs



Crosscutting Benefits



Timeframe



Short term

Create consumer participatory and collaborative mechanisms and public education initiatives to strengthen informed public decision making and engagement on efficient energy usage and the development of resilient energy systems.

Description

Utility consumers should be considered stakeholders in the decision-making process. Doing so would promote conservation, efficiency, shared accountability, quality of service, and emphasize the use of rooftop solar energy and storage. A public education and outreach program should be established and facilitated by local NGOs and other relevant private stakeholders to address the lack of information, awareness, and reliable communications related to energy systems and reforms in Puerto Rico.

The primary objectives of the educational campaigns should be to:

- Develop a broader understanding of the types of electric power systems and their operations.
- Foster public understanding of efficient energy use.
- Participate in a consumer advocacy system to ensure that the restructured and redesigned energy sector is responsive to consumer needs.

These education and outreach programs should be implemented on a staged basis. Available and packaged information, relevant to the upcoming Puerto Rico energy policy and utility transformation options, should be immediately disseminated. Data about the upcoming hurricane season should also be distributed.

Potential Lead

Non-governmental Organizations

Potential Co-leads

PREC; Academia

Potential Funding Sources

NGOs; PREC

Unmet Needs



Crosscutting Benefits



Timeframe



Medium term

Establish a program to increase energy reliability of Puerto Rico’s critical water pumps systems.

Description

The failure of water pumps in the post-disaster period has resulted in both a lack of readily available potable water and a health risk due to the open release of untreated water. The proposed program aims to mitigate the post-storm failure of water systems, including potable water pumps and treatment plants, as well as sewage treatment facilities. This effort will require government initiatives (for government facilities) and incentive programs (for non-government facilities) to address the need for quick restoration of potable and sewage water treatment and services, particularly during and post major emergencies. The program would address large pumps in government/municipal facilities, pumps in large commercial/industrial private facilities, and small private/residential pumps.

The upgrading measures would variously include:

- Replacement or upgrading of pumps with more durable/resilient pumps.
- Replacement of electric pumps with engine power pumps.
- Installation of backup electric generators.
- Installation of backup engine water pumps to provide the minimum level of necessary service.

Potential Lead

Puerto Rico Aqueduct and Sewer Authority

Potential Co-leads

PREPA; DNER; Farmers; Municipalities; Large water users; Civic and public organizations

Potential Funding Sources

USDA Rural Development Grants; FEMA Disaster Case Management Grant; HMGP

Unmet Needs



Crosscutting Benefits



Timeframe



Short term

Promote the revitalization of Puerto Rico’s hydroelectric generation resources, as long as it is cost-effective.

Description

The redevelopment and revitalization of existing hydro resources can increase existing generation and add new renewable energy sources. Hydro sites with potential for revitalization and opportunity for increased power generation output will need to be selected, and cost effectiveness will need to be determined. Priority and cost-effective sites will undergo redevelopment via a Request for Proposal (RFP) process, in close coordination with regulatory bodies.

Potential Lead

Puerto Rico Electric Power Authority

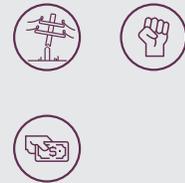
Potential Co-leads

PRASA; Municipalities

Potential Funding Sources

Federal funding under HR 1892; Private funds

Unmet Needs



Crosscutting Benefits



Timeframe



Implement an Island-wide energy efficiency and demand response strategy, detailing and prioritizing cost-effective initiatives to reduce and balance energy demand.

Description

Facilitate and promote reform, in utility regulations, that emphasizes energy efficiency at the residential, commercial, and industrial levels. The changes should include incentives and directives based on viability, as well as the economic benefit for and needs of the impacted customer class. The effort will require mandated programs for the timely replacement of inefficient devices and equipment in order to achieve consumption reductions and more efficient use of energy. Legislation, regulations, or resolutions will need to be adopted to specifically set incentives, targets, and timelines for the selected energy efficiency opportunity areas.

Included in this efficiency drive are:

- Electrical household appliances, such as refrigerators and air conditioners.
- Commercial and industrial motors.
- Municipal and state street and traffic lights using efficient LED lights (or replacement of street lights through rotunda intersection design).
- Use of solar systems.
- Electricity rate reforms to shift consumption from peak period to off-peak periods.

Potential Lead

Puerto Rico Energy Commission

Potential Co-leads

Municipalities; Government of Puerto Rico; PREPA; NGOs

Potential Funding Sources

FEMA Disaster Recovery Grants; Private utilities; USDA Rural Development Grants; CDBG-DR

Unmet Needs



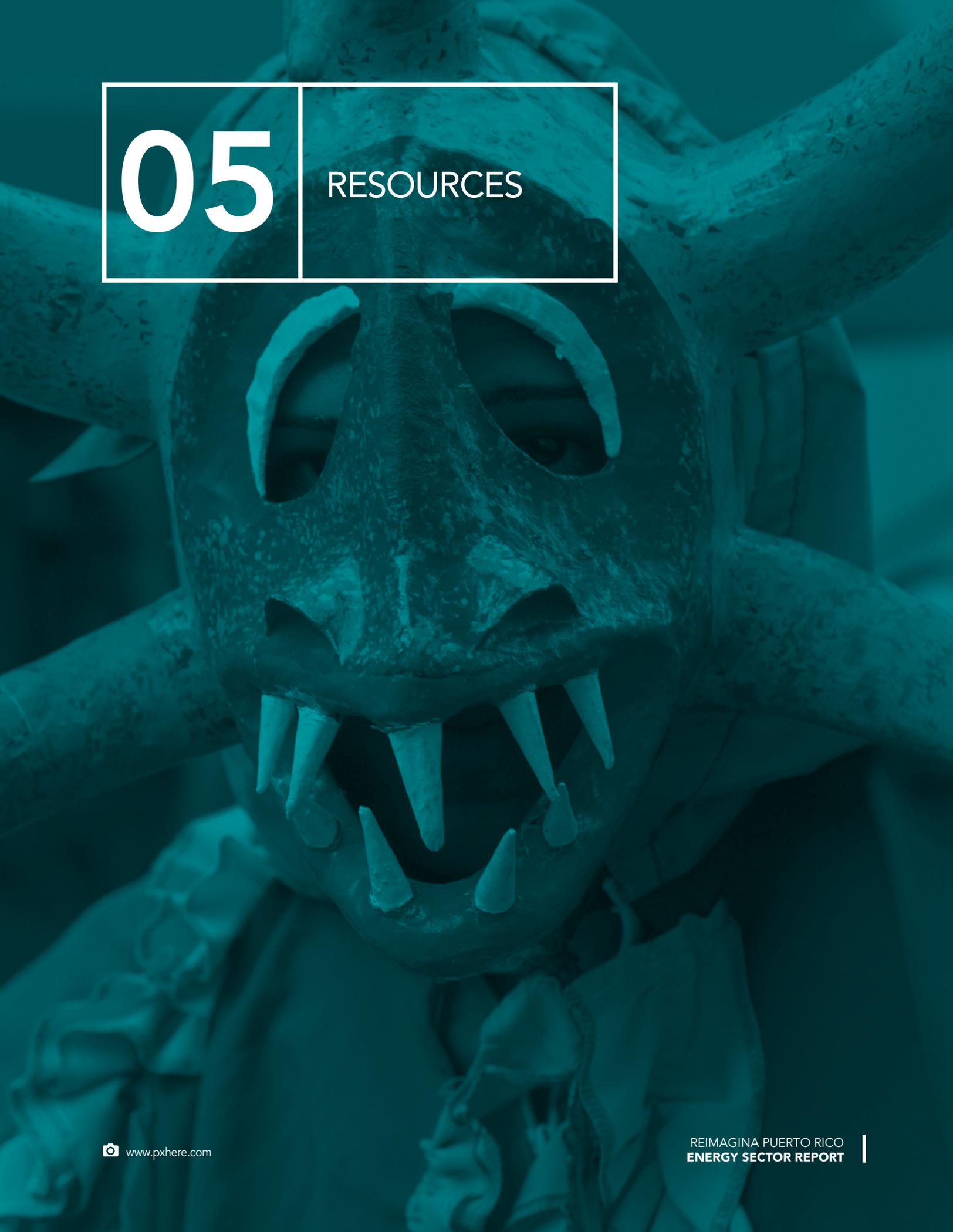
Crosscutting Benefits



Timeframe



Short term



05

RESOURCES

Glossary

Carbon Footprint

The total amount of greenhouse gases that are emitted into the atmosphere each year by a person, family, building, organization, or company. A person's carbon footprint includes greenhouse gas emissions from fuel that an individual burns directly, such as by heating a home or riding in a car. It also includes greenhouse gases that come from producing the goods or services that the individual uses, including emissions from power plants that make electricity, factories that make products, and landfills where trash gets sent.

Disaster

Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery.

Effectiveness

The degree to which something is successful in producing an intended or expected result, success or purpose.

Efficiency

Performing or functioning in the best possible manner with the least waste of time and effort.

Emergency preparedness

Actions taken to plan, organize, equip, train, and exercise with the objective of building and sustaining the capabilities necessary to prevent, protect against, mitigate the effects of, respond to, and recover from those threats that pose the greatest risk.

Exposure

The presence of people, livelihoods, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected.

Flexibility

Flexibility implies that systems can change, evolve and adapt in response to changing circumstances. This may favor decentralized and modular approaches to infrastructure or ecosystem management. Flexibility can be achieved through the introduction of new knowledge and technologies, as needed. It also means considering and incorporating indigenous or traditional knowledge and practices in new ways.

Flood risk management

Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of flood risk, foster flood risk reduction and transfer, and promote continuous improvement in flood preparedness, response, and recovery practices. They have the explicit purpose of reducing the likelihood and/or impact of floods in order to prevent the loss of properties, assets, and life caused by floods.

Fossil fuel

A general term for organic materials formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the earth's crust over hundreds of millions of years.

Geographic Information System (GIS)

A framework for gathering, managing, and analyzing data and spatial location. It uses maps to organize layers of information into visualizations. Rooted in the science of geography, GIS integrates many types of data.

Governance

Structures and processes designed to ensure accountability, transparency, responsiveness, rule of law, stability, equity and inclusiveness, empowerment, and broad-based participation. Governance also represents the norms, values, and rules of the game through which public affairs are managed in a manner that is transparent, participatory, inclusive, and responsive.

Grant Programs

Programs that provide a sum of money given by a government or other organization for a particular purpose. These programs are discretionary or formula grants and/or cooperative agreements administered by a federal agency.

Inclusive

Emphasizes the need for consultation and commitment of communities, including the most vulnerable groups. An inclusive approach contributes to a sense of shared ownership or a joint vision to build resilience.

Infrastructure

Set of works and services that are considered fundamental and necessary for the establishment and operation of an activity. These include communication systems, aqueducts and sewers, electricity, telephone and health facilities, education, and recreation.

Integrated

Integration and alignment between systems promotes consistency in decision-making and ensures that all investments are mutually supportive to a common outcome. Integration is evident within and between resilient systems and across different scales of their operations. Exchange of information between systems enables them to function collectively and respond rapidly through shorter feedback loops throughout society.

Microgrids

A small-scale power grid with distributed energy resources that can operate as a single controllable entity with respect to the utility transmission and distribution system.

Mitigation (for risk)

The lessening of the potential adverse impacts of physical hazards (including those that are human-induced) through actions that reduce hazard, exposure, and vulnerability. (for Climate Change) A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Non-governmental Organization (NGO)

An entity with an association that is based on interests of its members, individuals, or institutions. It is not created by a government, but it may work cooperatively with government. Such organizations serve a public purpose, not a private benefit.

Nonprofit Organization

A tax-exempt organization that serves the public interest. In general, the purpose of this type of organization must be charitable, educational, scientific, religious, or literary. It does not declare a profit and utilizes all revenue, available after normal operating expenses, in service to the public interest. This organization is a 501(c)(3) or a 501(c)(4) designate.

Public-Private Partnerships

A cooperative arrangement between two or more public and private entities, typically of a long-term nature. These partnerships between a government

agency and private-sector company can be used to finance, build, and operate projects, such as public transportation networks, parks, and convention centers.

Reconstruction

The reconstruction or replacement of permanent residential, commercial, or industrial facilities damaged or destroyed in a major disaster, as well as the construction of public or private infrastructure at large scale, the addition of community improvements, and/or the restoration of a healthy economy.

Recovery

Disaster recovery is the phase of the emergency management cycle that begins with the stabilization of the incident and ends when the community has recovered from the impacts of the disaster.

Redundant

Refers to spare capacity purposely created within systems so that they can accommodate disruption, extreme pressures, or surges in demand. It includes diversity: the presence of multiple ways to achieve a given need or fulfill a particular function. Examples include distributed infrastructure networks and resource reserves. Redundancies should be intentional, cost-effective, and prioritized at a society scale.

Reflective

Accepts the inherent and ever-increasing uncertainty and change in today's world. Reflective systems have mechanisms to continuously evolve and modify

standards or norms based on emerging evidence, rather than seeking permanent solutions based on the status quo. As a result, people and institutions examine and systematically learn from their past experiences and leverage this learning to inform future decision-making.

Regulatory frameworks

Frameworks that provide the base on which institutions build and determine the scope and nature of participation in society. It is a complex combination of statutes and legal regulations, judicial rules, and actual practice.

Renewable energy

Energy derived from natural processes (for example, sunlight or wind) that are replenished at a faster rate than they are consumed. Solar, wind, geothermal, hydroelectric, and some forms of biomass are common sources of renewable energy.

Resilience

The capacity of individuals, communities, institutions, businesses and systems to survive, adapt and thrive no matter what stresses or shocks they encounter.

Resourceful

Implies that people and institutions are able to rapidly find different ways to achieve their goals or meet

their needs during a shock or when under stress. This may include investing in capacity to anticipate future conditions, set priorities, and respond, for example, by mobilizing and coordinating wider human, financial and physical resources. Resourcefulness is instrumental to a society's ability to restore functionality of critical systems, potentially under severely constrained conditions.

Risk

Potential consequences in which something of value is in danger with an uncertain outcome, recognizing the diversity of values. Often, risk is represented as the probability of occurrence of dangerous events or trends multiplied by the impacts in case such events or trends occur. Risks result from the interaction of vulnerability, exposure, and danger.

Robust

Robust systems include well-conceived, constructed and managed physical assets that can withstand the impacts of hazard events without significant damage or loss of function. Robust design anticipate potential system failures and ensure failure is predictable, safe, and not disproportionate to the cause.

Sea level rise

An increase in global mean sea level as a result of an increase in the volume of water in the world's oceans.

The two major causes of global sea level rise are thermal expansion caused by warming of the ocean (since water expands as it warms) and increased melting of land-based ice, such as glaciers and ice sheets.

Shock

Sudden, sharp events that threaten a society, including earthquakes, floods, disease outbreaks, and terrorist attacks.

Smart grid technology

Incorporates digital technology and advanced instrumentation into the traditional electrical system. It allows utilities and customers to receive information from and communicate with the grid. A smarter grid makes the electrical system more reliable and efficient by helping utilities reduce electricity losses and detect and fix problems more quickly.

Susceptibility

Society's and ecosystems' predisposition to suffer as a result of intrinsic and contextual conditions that make it plausible for such systems collapse or experience damage due to the influence of a dangerous event.

Sustainable development

Development that meets the needs of the present without compromising the ability of future generations to meet

their own needs. Sustainability has emerged as the guiding principle for long-term global development. Consisting of three pillars, sustainable development seeks to achieve, in a balanced manner, economic development, social development, and environmental protection.

Transmission and distribution systems

The different stages of carrying electricity over poles and wires from generators to a home or a business. The primary distinction between the two is the voltage level at which electricity moves in each stage.

Unmet needs

The needs of communities or families that have not been attended by federal government institutions as a result of a disaster.

Vulnerability

The propensity or predisposition to be adversely affected. Vulnerability comprises a variety of concepts and elements that include sensitivity or susceptibility to harm and lack of responsiveness and adaptation.

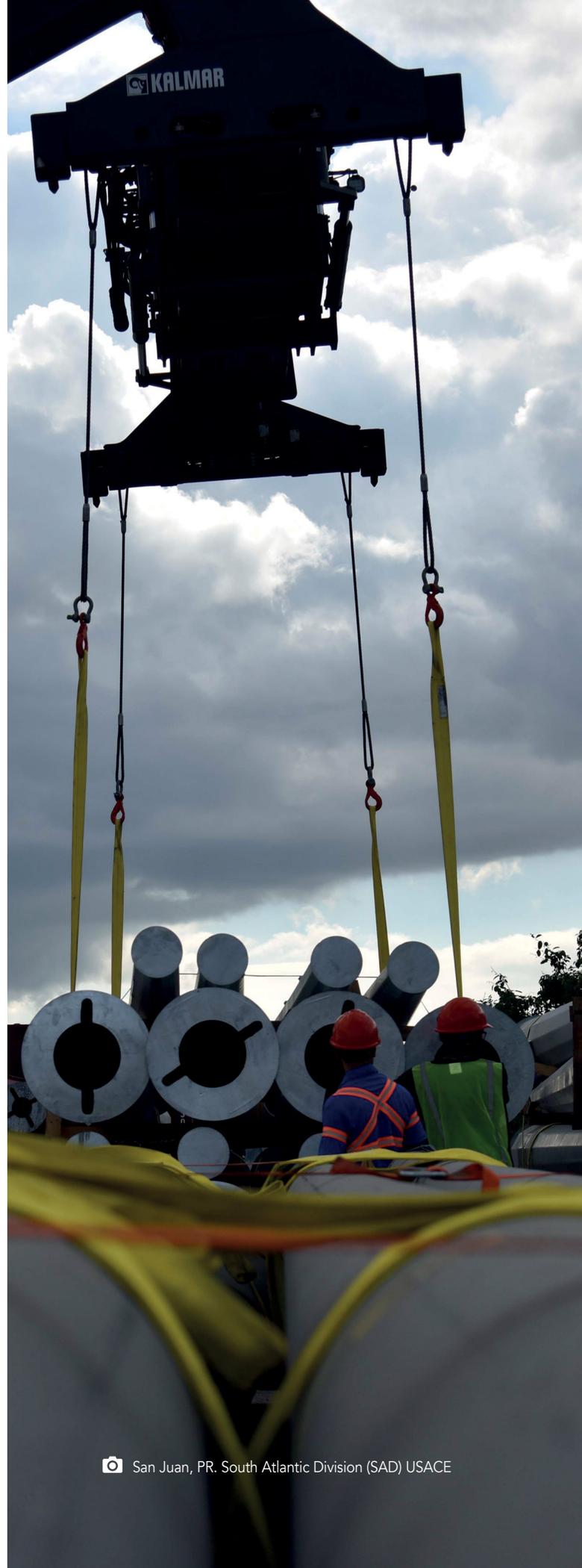
Vulnerable populations

Groups and communities at higher risk as a result of barriers they experience to social, economic, political and environmental resources, as well as limitations due to illness or disability.

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06

APPENDIX



Methodological Approach

The Commission's main objective is to produce an actionable and time-sensitive set of recommendations to guide the use of philanthropic, local government, and federal recovery funds to repair and rebuild the critical systems devastated by Hurricane María and build back an Island more physically, economically, and socially resilient. To achieve this, the Commission applied two primary conceptual frameworks to guide the process of reimagining Puerto Rico's recovery and reconstruction: FEMA's National Disaster Recovery Framework¹⁰ and The Rockefeller Foundation's City Resilience Framework¹¹.

FEMA's National Disaster Recovery Framework (NDRF) establishes a common platform and forum for a comprehensive approach to how a community builds, sustains, and coordinates the delivery of recovery efforts. Under this framework, the concept of recovery under this framework includes the restoration and strengthening of key systems and resources that are critical to the economic stability, vitality, and long-term sustainability of communities. These recovery elements are organized and coordinated under six Recovery Support Functions: 1) community planning and capacity building; 2) economic recovery; 3) health and social services; 4) housing; 5) infrastructure systems; and 6) natural and cultural resources. In the aftermath

of Hurricanes Irma and María in 2017, this framework will guide all federal disaster recovery actions coordinated by FEMA, in close coordination with other federal and Puerto Rican agencies.

The NDRF advances the concept that recovery extends beyond merely repairing damaged structures. It also includes the continuation or restoration of services critical to supporting the physical, emotional, and financial well-being of impacted community members. Among these are: health (including behavioral health) and human services capabilities and networks, public and private disability support and service systems, educational systems, community social networks, natural and cultural resources, affordable and accessible housing, infrastructure systems, and local and regional economic drivers. In turn, these elements contribute to rebuilding resilient communities equipped with the physical, social, cultural, economic, and natural infrastructure required to address future needs.

Arup and The Rockefeller Foundation's City Resilience Framework (CRF) provide a more comprehensive vision of how resilience can be integrated into Puerto Rico's post-disaster recovery process. The CRF, while focused on a city scale, provides a conceptual framework of resilience that is applicable across different geographical scales, including small island nations. This framework



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identifies seven resilience qualities: inclusive, integrated, flexible, redundant, reflective, resourceful, and robust. In addition to these qualities, it suggests that resilience can be enhanced by addressing a combination of 12 factors categorized under four broad dimensions: I) health and well-being of individuals, II) economy and society, III) infrastructure and ecosystems, and IV) leadership and strategy. The 12 factors include: 1) effective safeguards to human health and life; 2) diverse livelihoods and employment; 3) minimal human vulnerability; 4) reliable mobility and communications; 5) effective provision of critical services; 6) reduced exposure and fragility; 7) sustainable economy; 8) comprehensive security and rule of law; 9) collective identity and community support; 10) effective leadership and management; 11) empowered stakeholders; and 12) integrated development planning (see Figure 6).

The NDRF served as the main framework to guide the planning of implementation, execution, and monitoring of recovery and reconstruction actions. To reinforce this approach, we employed a modified version of the CRF to analyze and prioritize the recovery and reconstruction actions with the highest resilience impact.

As described in Section I, the Commission embarked on an ambitious participatory process in order to achieve the primary goals and objectives set forth for ReImagina Puerto Rico. This process consisted of four sets of group meetings: the Public Sector Advisory Group, Sector-focused Working Groups, Community Focus Groups, and Youth Participatory Photography sessions. This process sought to bring the broadest and most diverse set of voices together, facilitating an essential conversation between students, community groups, business sector representatives, high-level government officials, academics, and other Puerto Rican leaders to reimagine a more resilient Puerto Rico.

High-level officials from key local government agencies and several rural and urban municipalities representing the main political parties within the Island comprised the Public Sector Advisory Group. Participants included representatives from the Puerto Rico Planning Board, the Puerto Rico Department of Housing, the Puerto Rico Central Office of Recovery, Reconstruction, and Resilience, the Puerto Rico representative to the Financial and Oversight Management Board, and the mayors of Bayamón, Carolina, Cidra, and Villalba, among other active participants.

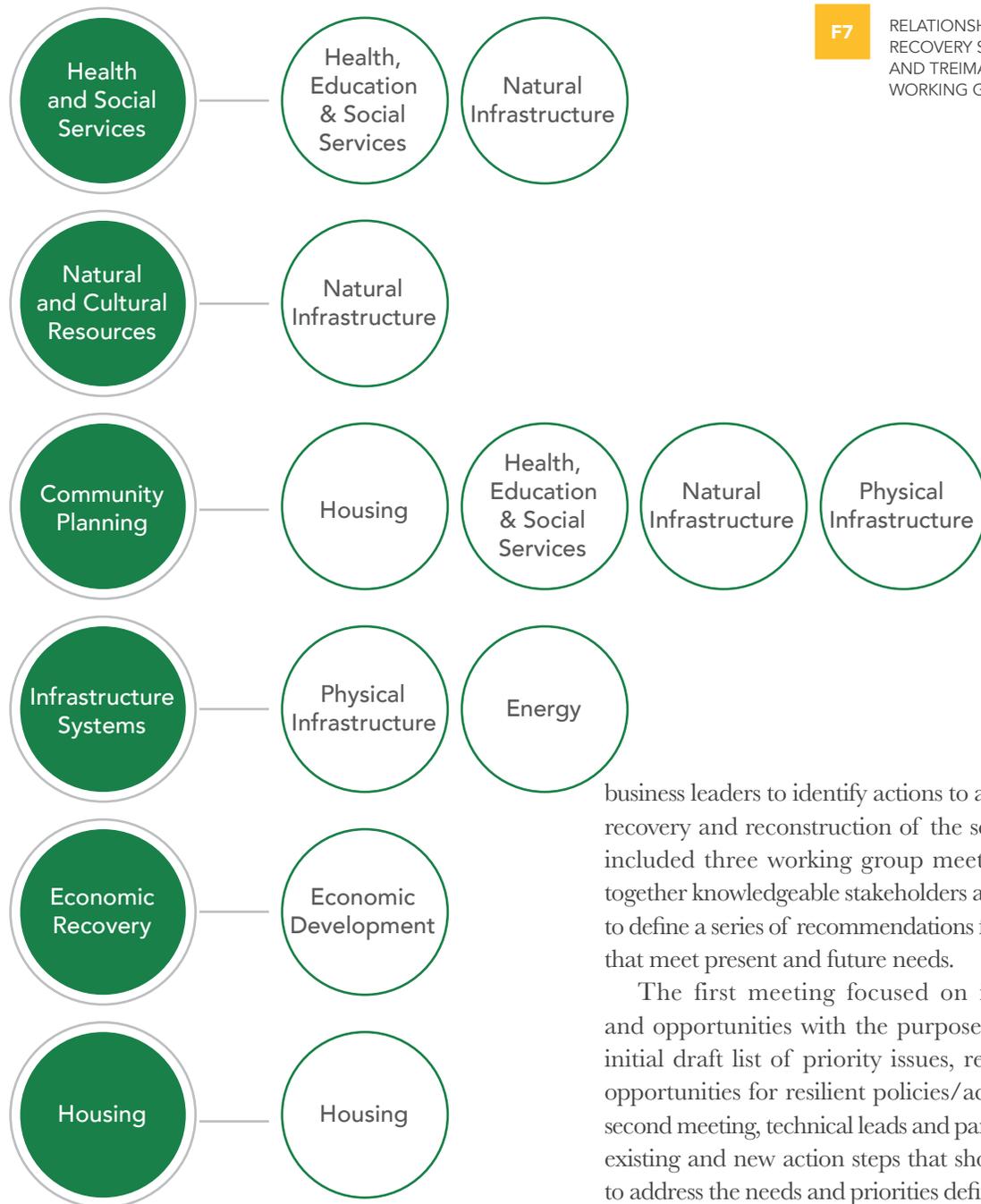
- 1. Effective leadership & management
- 2. Empowered stakeholders
- 3. Integrated development planning

- 4. Minimal human vulnerability
- 5. Diverse livelihoods & employment
- 6. Effective safeguards to human health & life



- 10. Reduced exposure and fragility
- 11. Effective provision of critical services
- 12. Reliable mobility & communications

- 7. Collective identity & community support
- 8. Comprehensive security & rule of law
- 9. Sustainable economy



The Commission divided working groups into the following six key sectors: 1) Housing, 2) Energy, 3) Physical Infrastructure, 4) Health, Education & Social Services, 5) Economic Development, and 6) Natural Infrastructure. These sectors have direct linkages to all the Recovery Support Functions under the NDRE, as described in Figure 7.

The purpose of the working groups was to facilitate a technical discussion among Puerto Rico experts and

business leaders to identify actions to achieve the resilient recovery and reconstruction of the sector. This process included three working group meetings that brought together knowledgeable stakeholders and thought leaders to define a series of recommendations for recovery actions that meet present and future needs.

The first meeting focused on identifying needs and opportunities with the purpose of generating an initial draft list of priority issues, recovery goals, and opportunities for resilient policies/actions. Prior to the second meeting, technical leads and participants presented existing and new action steps that should be considered to address the needs and priorities defined during the first meeting. The second meeting focused on the developing and distinguishing actions that were identified s having the highest potential for impact within each working group, taking into consideration possible interdependencies. During the third meeting, participants refined the proposed recommendations and applied the resilience lens to those actions in order to guide the final recommendations.

The process of developing recommendations for the resilient recovery of Puerto Rico entailed the following analysis criteria of the Island's unique context:



The urban/rural divide on the Island, recognizing that resilient economic development opportunities for rural communities are as essential as the opportunities in the Island's urban centers.



How recommended actions reflect on resilience qualities (i.e., inclusive, integrated, flexible, redundant, reflective, resourceful, robust).



Issues of equity, transparency, and sustainability.



The variety of ecosystems present in the Island and the challenges and opportunities they each present. It is imperative, for example, to consider the state of adaptive capacity of coastal and inland forest ecosystems to continue to provide ecosystem services in a changing climate.



The social, economic, and geographical realities of Puerto Rico (e.g., Is the recommendation fundable? Is it culturally acceptable? Is it politically feasible?).



A recognition that Puerto Rico is bounded by water, and its associated exposure to climate hazards, its dependency on a specialized industry, its overreliance on importing of goods and limited natural resources, and the high cost of infrastructure.

February

PUBLIC SECTOR ADVISORY GROUP

1st Public Sector
Advisory Group
Meeting

WORKING GROUPS

1st Working
Group
Meetings:
Identification of
Opportunities

OUTREACH & ENGAGEMENT

1st Youth
Participatory
Photography
Session

2nd Youth
Participatory
Photography
Session

F8

REIMAGINA PUERTO RICO'S PARTICIPATORY PROCESS. THE DIVERSE SET OF MEETINGS AND DISCUSSIONS HELD BETWEEN THE PUBLIC SECTOR ADVISORY GROUP, THE WORKING GROUPS, AND THE COMMUNITY FOCUS GROUPS HELPED CREATE AND VALIDATE THE INFORMATION PRESENTED IN THIS REPORT.

The Community Outreach and Engagement Process was divided into two sets of activities held in six distinct regions of the Island. These regions were strategically selected to cover all areas of the Island, including the urban/rural divide and other geographical, social, and cultural regional characteristics.

The first activity was the Youth Participatory Photography, which was held in six distinct schools across the Island (one in each region). During this activity, students had the opportunity to identify assets they believe are essential to maintain and improve their

communities. The objective of the Youth Participatory Photography activities was to allow students to identify, through photography, remarkable resilience and recovery challenges in their communities. This process included a forum where students could display and present their photos. During this forum family members and other residents commented and elaborated on the importance of changing or improving specific aspects of their communities after the hurricanes.

The second Community Outreach and Engagement activity of community engagement consisted of



Community Focus Groups in each of the six regions. Two additional Focus Group Sessions were conducted, one for philanthropic and non-governmental organizations and another for the Puerto Rican diaspora in Orlando, Florida, where most Puerto Ricans have migrated to in the past year. The objective of the Focus Groups was to incorporate their voice in the development of the report, understand the Island-wide perspectives on recovery and resilience, and validate the Working Groups’ outcomes through participatory activities and prioritization processes. During these meetings, participants expressed

their issues and concerns regarding the hurricane impacts, they talked about opportunities to consider, and they validated the results from the Working Groups. Their outputs were used to elaborate and refine the needs, goals, opportunities, and actions of each Working Group.

The information derived from the Community Outreach and Engagement Process formed an integral part of the discussions in the Working Group meetings, and, ultimately, served as the basis for the recommendations presented in this report (see Figure 8).





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