PUERTO RICO'S ROAD TO RESILIENCE: AN ISLAND'S CHALLENGING TRANSITION TO A CLEANER, MORE RESILIENT FUTURE

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I. INTRODUCTION

Island energy systems face inherent challenges that will only become more complex in the face of increasingly severe weather events and climate change. Geographic isolation from both traditional energy resources and larger network systems are natural barriers posing both increased costs and risks to reliable supply. The historic impact of hurricanes tested the safety and reliability of the system, even before the increasing onset of severe weather and climate change. For Puerto Rico, there are

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tremendous challenges ahead for transitioning its electric grid rooted in historical context, and economic troubles the utility, the Puerto Rico Electric Power Authority (PREPA), has already facing. Puerto Rico's ability to support an affordable and reliable electric system was a complex undertaking, even before the recent discussions about transitioning to a cleaner, more resilient future. Puerto Rico's road to a resilient and low carbon grid presents an interesting case study of both the challenges and opportunities ahead.

II. PUERTO RICO'S HISTORICAL CONTEXT

Puerto Rico, originally inhabited by aboriginal people, was later largely influenced by the arrival of Spanish colonists and the African slaves they brought to the island. Today, the population of the island is a makeup of Whites, Blacks, and a mix of the three aforementioned races. Puerto Rico, a mountainous and tropical island, was discovered by Christopher Columbus in 1493 and later ceded to the U.S. in 1898, as a result of the Spanish American War.[1] Later, Puerto Ricans were granted U.S. citizenship in 1917. Under the 1920 Merchant Marine Act, more commonly known as the Jones Act, non-U.S. ships are barred from docking in Puerto Rico, if they dock in a U.S. port first. This made Puerto Rico inherently dependent on shipping and trade with the U.S. mainland.[2]

After WWII and New Deal policies, the U.S. economy was on the rise, which spurred spending to stimulate the U.S. economy and, in turn, healthy wages across the states. However, in Puerto Rico the opposite occurred, helping explain why migration from Puerto Rico to the mainland exploded during this period.[3] By 1947, the Federal Government and then-Governor Luis Muñoz Marín of Puerto Rico, launched "Operation Bootstrap," a similar New Deal-like economic policy aimed at bringing development across the island. The first wave of manufacturing was focused on lowest labor costs, like textile and garment factories, followed by capital-intensive businesses, like drug makers, petrochemical plants, and oil refineries.[4] These businesses were also stimulated

1. *The World Factbook: Puerto Rico*, WWW.CIA.GOV, https://www.cia.gov/LIBRARY/publications/the-world-factbook/geos/rq.html (last updated Sep. 24, 2019).

2. Patricia Alex, *Category 4 Complexity*, LAND LINES (July 2018), https://www.lincolninst.edu/pt-br/publications/articles/category-4-complexity

3. *Puerto Rican Migration to the U.S.*, DIGITAL PUBLIC LIBRARY OF AMERICA, https://dp.la/primary-source-sets/puerto-rican-migration-to-the-us.

4. Alexander C. Kaufman, *Puerto Rico's Colonial Legacy Doomed It to Dirty Electricity—And Now Darkness,* THE HUFFINGTON POST (Sep. 28, 2017, 5:46 AM), https://

largely by tax exemptions offered from the United States to set up factories and plants.[5] By the early 1990s, though, the exemptions were under attack from U.S. mainland states who thought the Puerto Rican companies had been operating under unfair tax exemptions for too long. In 1996 Congress passed a law to phase out many of the decades-long exemptions over ten years. As companies left, with the reduction in the tax exemptions, so did many Puerto Rican residents, leading to a higher national unemployment rate eventually reaching 11.5%.[6] The main tax break that withstood time was interest on municipal bonds. These were debt securities issued by the government to pay for day-to-day public expenses, such as utilities, roads, and schools, which remained tax-exempt and is considered common practice across mainland states as well. Because Puerto Rico's credit score remained low enough to keep interest rates profitable but high enough to make bonds appear like a safe route for investors, it turned out to be a deceivingly stable financial situation. As income tax revenue declined from shuttered businesses and more Puerto Ricans continued to leave the country in search of employment, the island's unsustainable debt exacerbated, and bankruptcy issues were inevitable. Financial instability peaked in 2013 when Puerto Rico became shut out of the bond market altogether.[7]

III. THE ESTABLISHMENT OF PREPA, PREC AND PROMESA

PREPA was established in 1941 (originally under a different name) as a vertically integrated, government-owned utility, which owned the electric generation, transmission, and distribution systems.[8] It is the largest supplier of electricity in Puerto Rico, serving 1.4 million customers, and is also one of the largest public power utilities in the United States.[9]

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www.huffingtonpost.com/entry/puerto-rico-history-debt-electricity_us_59cc14f8e4b05063fe0ee086 (last updated Oct. 2, 2017).

5. *Id.*

6. *Id.*

7. *Id.*

8. Lily Bui, *Rewiring Puerto Rico: Power and Empowerment After Hurricane Maria,* MEDIUM (Mar. 28, 2018) https://medium.com/@dangerbui/rewiring-puerto-rico-power-and-empowerment-after-hurricane-maria-7efdff23da6d.

9. PUERTO RICO OVERSIGHT, MANAGEMNENT, AND ECONOMIC STABILITY ACT, 48 U.S.C. § 20 (2016) [hereinafter PROMESA]; U.S. ENERGY INFO. ADMIN., ELECTRIC POWER MONTHLY WITH DATA FOR JUNE 2018, Table 8.3 (Aug. 2018), https://www.eia.gov/electricity/monthly/archive/august2018.pdf; RICHARD J. CAMPBELL ET AL., CONG. RESEARCH SERV., R4503, REPAIR OR REBUILD: OPTIONS FOR ELECTRIC POWER IN PUERTO RICO, at 7, (2017), https://fas.org/sgp/crs/row/R45023.pdf.

In 2014 the Transformation and Energy Relief Act was passed, establishing the Puerto Rico Energy Commission ("PREC") and ending PREPA's long status as a self-regulating utility.[10] The act gave PREC oversight of PREPA's (and other energy companies) rates, generation interconnection, compliance with renewable portfolio standards, and established a new Independent Office of Consumer Protection.[11]

On June 20, 2018 the Governor signed the Puerto Rico Electric System Transformation Act, which authorizes the sale or lease of PREPA's generation, transmission, and distribution assets to third parties. The act grants the Public Private Partnership Authority the power to determine which assets will be transferred or sold and grants the Puerto Rico Energy Commission and the legislature certain approval rights subject to extremely short review timelines.[12] In addition, the act increases the number of commissioners on PREC from three to five.[13] In August of 2018 the Act for the Implementation of the Puerto Rico Public Service Regulatory Board Reorganization Plan was enacted, and it renamed the Puerto Rico Energy Commission the 'Puerto Rico Energy Bureau' (PREB), and established the Puerto Rico Energy Administration attached to PREB to provide support to both PREB and the Independent Consumer Protection Office.[14]

The Puerto Rico Oversight, Management, and Economic Stability Act, or PROMESA legislation, and Oversight Board (OB) enacted at the end of June 2016, addressed the lack of federal bankruptcy options by setting out a process for voluntary collective action agreements and a process that draws on procedures from the U.S. Bankruptcy Code.[15]

PROMESA also established a Financial Oversight and Management Board (OB) for Puerto Rico that required PREPA to draw up a fiscal plan. While PROMESA endowed the OB with wide authorities, the governor and legislature of Puerto Rico retained substantial control over public priorities, within constraints of fiscal plans and other provisions of PROMESA.[16]

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10. Legis. Assemb. No. 57-2014, 17th Leg., Reg. Sess. § 3 (P.R. 2014). http://www.oslpr.org/download/en/2014/A-057-2014.pdf.

11. PROMESA, *supra,* note 9.

12. Emma Foehringer Merchant, *The Regulatory Body Steering Puerto Rico's Energy Future Is in the Midst of a Makeover.* GREEN TECH MEDIA (July 11, 2018), https://www.greentechmedia.com/articles/read/the-regulatory-body-steering-puerto-ricos-energy-future-is-in-the-midst-of#gs.w6D2WE4.

13. *Id.*

14. H.B. 1408, 18th Legis. Assemb., Reg. Sess. § 55 (P.R. 2018).

15. CAMPBELL, *supra* note 9, at 9.

16. *Supra* note 9.

The oversight board attempted to reach debt restructuring agreements and a tentative Restructuring Support Agreement (RSA). The Board approved a fiscal plan in April 2017 that outlined projections for the utility's finances, operations, and capital investments over the next ten years, projecting a 23% reduction in energy sales and calling for a twenty-one cent per kWh target rate by 2023.[17] However, things took a different direction under Governor Ricardo Rossello Nevares. "[B]y July 2017, the OB [terminated] PREPA's RSA [contract] and [filed for a] bankruptcy-like process [under] Title III of PROMESA . . .".[18]

The historical financial context directly impacted the state of the electric system prior to the 2017 hurricanes. PREPA's reliability suffered significantly over the last decade, largely due to deferred maintenance and having insufficient capital resources to cover long-overdue upgrades. "[I]nsufficient revenues ha[ve] led to degradations of PREPA's infrastructure", and the "transmission system [has] deteriorated, [leading] to reduced reliability."[19] The complex debt, bonds, and bankruptcy woes only worsened into 2017, creating a nightmarish economic setting prior to the arrival of Hurricane Maria.

IV. THE STAFFORD AND JONES ACTS

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, more commonly known as the Stafford Act, became law in 1998 and was amended in 2016.[20] The Act defined Puerto Rico as part of the United States to be given the same rights as continental states.[21] "The Stafford Act also define[d] how recovery after a natural disaster should be viewed: recovery, by rebuilding communities so individuals, businesses, and governments can function on their own, return to normal life, and protect against future hazards."[22]

It is important to recognize that the Stafford Act standard specifies that things should be rebuilt to their pre-disaster condition, not improved upon for greater resiliency from future

17. *Supra* note 9, at 9.

18. *Supra* note 9, at 10.

19. Jeremy I. Fisher, PhD & Ariel I. Horowitz, PhD, *In Re: Review of Rates of the Puerto Rico Electric Power Authority,* 13, PUERTO RICO ENERGY COMMISSION (Nov. 23, 2016), http://energia.pr.gov/wp-content/uploads/2016/11/Expert-Report-Revenue-Requirements-Fisher-and-Horowitz-Revised-20161123.pdf.

20. *Puerto Rico and the Stafford Act,* PUERTO RICO REPORT (Dec. 11, 2017), https://www.puertoricoreport.com/untitled/#.W_G5I-hKjct. (quoting 6 U.S.C. § 314 (a)(9)(D) (2018).

21. *Id.*

22. *Id.*

harm.[23] Furthermore, the Stafford Act "prohibits modernizing equipment with federal funds . . . the money is designated for emergency aid, not long-term improvements."[24]

Along similar lines, for Puerto Rico, the Jones Act set limitations to bringing supplies into or out of Puerto Rico. In the wake of Hurricane Maria, Puerto Rico asked for and received a ten day waiver of compliance with the Jones Act, which increased flexibility for aid ships assisting with emergency recovery efforts.[25]

The administrative hurdles created by both the Jones and Stafford Acts, somewhat hamstrung the U.S. Army Corps of Engineers (ACOE) and the Federal Emergency Management Agency (FEMA)'s recovery efforts.[26] FEMA was federally responsible for system restoration and with the system largely deficient prior to the hurricanes, improving resilience was not within the bounds of the federal dollars, but also nearly impossible in a territory with a $73 billion debt, and in its eleventh year of a recession.[27]

In February of 2018, Congress passed the Bipartisan Budget Act of 2018, which gave FEMA authorities under the Stafford Disaster Relief and Emergency Assistance Act of 1988, as amended (Stafford Act).[28] This allowed FEMA to aid critical services to replace components of the system that were not damaged by the disaster, when those repairs were fully necessary to effectuate the replacement or restoration of disaster-damaged components, in order to restore the function of the facility or to industry standards.[29] This was a critical clause, because of Puerto Rico's continually extended deferred maintenance challenges, its grid infrastructure was largely deficient prior to the events.[30]

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23. *Id.*

24. Hannah Wiley, *How the Stafford Act is Challenging Puerto Rico's Energy Recovery*, PLANET FORWARD (Apr. 20, 2018), https://www.planetforward.org/idea/how-the-stafford-act-is-challenging-puerto-ricos-energy-recovery.

25. Niraj Chokhi, *Trump Waives Jones Act for Puerto Rico, Easing Hurricane Aid Shipments*, THE NEW YORK TIMES (Sept. 28, 2017), https://www.nytimes.com/2017/09/28/us/jones-act-waived.html.

26. Wiley, *supra* note 24.

27. Wiley, *supra* note 24.

28. *Implementing Section 20601 of the 2018 Bipartisan Budget Act through the Public Assistance Program: FEMA Recovery Policy FP- 104-009-5,* FEDERAL EMERGENCY MANAGEMENT AGENCY FEMA (Sept. 14, 2018), https://www.fema.gov/media-library-data/1537374589131-e5048390675525d0bc84812759eba5fe/BBA_Policy_9-14-2018_508_FINAL.pdf.

29. *Id.*

30. *Id.*

V. OVERVIEW OF PUERTO RICO'S ELECTRIC USAGE AND FUEL MIX

Electricity sales in Puerto Rico declined by 18% since the 2008 recession and the net migration.[31] In its pre-storm Fiscal Plan, PREPA predicted just over 13 million MWh of sales as its approximate load in 2018.[32] On average, Puerto Rico residents use much less energy than consumed in the mainland United States. Puerto Rico's energy consumption per capita is roughly two-fifths of the average in the fifty states .[33]

In 2017 the total installed generating capacity was approximately 6 GWh with a primary reliance on fossil fuels. In fiscal year 2017 (through June 30, 2017), 47% of Puerto Rico's electricity came from petroleum, 34% from natural gas, 17% from coal, and just over 2% from renewable energy.[34]

In PREPA's 2019 IRP it estimated that thirty-nine existing generating resources totaling 5,010 MW "were determined to be in acceptable operating condition for consideration as available resources."[35] PREPA's electricity generators are twenty-eight years older than the U.S. average and experienced outage rates twelve times higher than the U.S. average.[36]

Puerto Rico does not produce its own liquefied natural gas, and nearly all liquefied natural gas (LNG) is imported at the Penuelas terminal, and re-gasified at the Guayanilla Bay.[37] Also, the territory has no coal resources, and imports 100% of its coal fuel. The one coal-fired generating plant operates at 454 MW and is located at Guayama.[38]

Currently, 2.4% of Puerto Rico's electricity comes from renewable sources (2016-2017), primarily from wind and solar, followed by hydroelectric, and landfill gas facilities.[39] Outside of PREPA's ownership, there are two privately owned wind

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31. *In re* Review of the Puerto Rico Electric Power Authority Integrated Resource Plan, CEPR-AP-2018-0001 (Jan. 22, 2019), http://energia.pr.gov/wp-content/uploads/2019/01/Motion-CEPR-AP-2018-0001-2.pdf [hereinafter *In re PREPA*] (motion for extension of time).

32. *Energy Resilience Solutions for the Puerto Rico Grid*, U.S. DEP'T OF ENERGY (June 2018), https://www.energy.gov/sites/prod/files/2018/06/f53/DOE%20Report_Energy%20Resilience%20Solutions%20for%20the%20PR%20Grid%20Final%20June%202018.pdf.

33. *Puerto Rico: Territory Profile and Energy Estimates*, U.S. ENERGY INFO. ADMIN. (July 19, 2018), https://www.eia.gov/state/analysis.php?sid=RQ.

34. *Id.*

35. *In re PREPA, supra* note 31 at 58 4.1.1.

36. *Puerto Rico Energy Profile, supra* note 33.

37. *Id.*

38. *Id.*

39. *Id.*

farms, the largest is a 101-MW facility at Santa Isabel, and next is the 23-MW facility at Naguabo, and five privately owned solar facilities.[40] In addition, PREPA has twenty-one hydroelectric generating units at eleven sites with a total installed nameplate capacity of 105 MW, although total operational units are estimated at 34-MW.[41]

VI. PROPOSED AGUIRRE OFFSHORE GAS PORT (AOGP)

There had been much speculative planning for the Aguirre Offshore Gas Port (AOGP), a proposed re-gasification facility which would allow the Aguirre Steam and Aguirre Combine Cycle Units (collectively, the "Aguirre Plant") access to natural gas shipped to Puerto Rico as liquefied natural gas (LNG).[42] This project presents an avenue to bring additional liquefied natural gas into the territory for electricity generation at PREPA facilities.[43]

Critics of the AOGP suggest that construction of the port would commit Puerto Rico to an overdependence on fossil fuel capacity.[44] The economic justification for building the port has raised questions and concerns, especially after preferences towards renewables has been mandated in recent legislation.[45]

VII. PREPA'S INTEGRATED RESOURCE PLANS

Under Puerto Rico's Act 57 of 2014, PREPA was directed to prepare an Integrated Resource Plan (IRP) that identified strategies to meet electricity needs through 2035.[46] PREPA's IRP's have faced significant criticism from PREC and other parties. In September of 2016, PREC disapproved PREPA's first IRP requiring submission of a modified IRP by October 26, 2016.[47] In

40. *Id.*
41. *In re PREPA, supra* note 31, at 4.1.14.
42. *Puerto Rico Energy Profile, supra* note 33.
43. *Id.*
44. Phil Mckenna, *Puerto Rico Passes 100% Clean Energy Bill. Will Natural Gas Imports Get in the Way?*, INSIDE CLIMATE NEWS (Mar. 28, 2019), https://insideclimatenews.org/news/26032019/puerto-rico-clean-energy-100-percent-hurricane-recovery-solar-natural-gas-prepa.
45. *Id.*
46. Puerto Rico Energy Transformation and Relief Act, 2014 P.R. Laws 57 § 6C(h)(i) (2014).
47. Commonwealth of P.R. Energy Comm'n [PREC], CEPR-AP-2015-0002, *Final Resolution and Order on the First Integrated Resource Plan of the Puerto Rico Electric*

rejecting PREPA's first IRP, PREC cited significant shortcomings in the IRP including a failure to comply with PREC"s rules.[48] PREC also rejected PREPA's request to "rescind an order for PREPA to seek permitting for a large new combined cycle unit at Aguirre Power Plant and [to] repower two units at Aguirre," as part of repairs from storm damage.[49] They also denied the request for approving the Aguirre Offshore Gasport (AOGP) and the conversion to natural gas.[50]

In February of 2019 PREPA finally submitted its revised IRP which was met with significant criticism for continuing to favor natural gas, failing to support the clean energy transition on the same schedule as policymakers, not having sufficient detail to evaluate its innovative minigrid proposal, and its consideration of costs.[51] As a result, the Puerto Rico Energy Bureau deemed it noncompliant with existing regulations and again required revisions.[52]

VIII. EARLY CLEAN ENERGY INITIATIVES

There are numerous pieces of renewable energy legislation that have laid significant groundwork for Puerto Rico's acceptance and growing preference towards renewable energy:

1. The Renewable Energy Development Act (Law 325 of 2004), exempted Renewable Technologies from taxation with the intention to "stimulate the development of renewable energy" by mitigating the high costs of initial installation, but was later reduced significantly in scope.[53]

2. Net Metering (Law 114 of 2007), authorized PREPA to establish a net meting program that allows customers who have

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Power Authority, at 90 (Sept. 26, 2016) Case No. CEPR-AP-2015-0002/ Final Order. http://energia.pr.gov/wp-content/uploads/2016/09/23-sept-2016-Final-Resolution-and-Order-IRP-CEPR-AP-2015-0002.pdf.

48. *Id.* at 82.

49. Eva Llorens Velez, *Energy Commission Rejects PREPA's Reconsideration of its Resource Plan,* CARIBBEAN BUS. (Feb. 10, 2017), https://caribbeanbusiness.com/energy-commission-rejects-prepas-reconsideration-of-its-resource-plan/.

50. *Id.*

51. Christian Roseland, *PREPA's Long-term Plan is in Chaos*, PV MAGAZINE (Apr. 2, 2019), https://pv-magazine-usa.com/2019/04/02/prepas-long-term-plan-is-in-chaos/.

52. Emma Foehringer Merchant, *Puerto Rico's Latest IRP Increases Solar and Storage Targets*, GREENTECH MEDIA (June 10, 2019), https://www.greentechmedia.com/articles/read/puerto-ricos-latest-irp-proposal-increases-solar-and-storage-targets-includ#gs.p26cyt.

53. Sebastián J. Sánchez Rivera, *Renewable Energy Initiatives for Puerto Rico.*, 81 REV JUR. UPR 1183, 1187 (2012), http://large.stanford.edu/courses/2017/ph240/brown2/docs/rivera.pdf.

installed their own individual solar or wind systems, to interconnect into PREPA's electric grid, and receive a bill credit for excess electricity they produce.[54]

3. Renewable Energy Portfolio Standard in 2010 (Act 82 of 2010), requiring the following set of targets to be attained: 12% for 2015–2019, 15% during 2020–2027, and 20% by 2035, with interim targets ramping up throughout.[55]

4. The Green Incentives Act of Puerto Rico (Law 83 of 2010) created the "Green Energy Fund of Puerto Rico," which amended the clean energy incentives in various ways.[56]

While PREPA's resource mix in 2017 might not reflect it, this impressive list of early clean energy initiatives, demonstrates that there was significant public policy support for the clean energy transition prior to the impacts of Hurricane Maria.

IX. THE DEVASTATION OF HURRICANES IRMA AND MARIA

During the earliest days of September 2017, as the sweltering August heat began its retreat, and Puerto Rican students geared up for the new school year, the eye of Hurricane Irma charged towards the Caribbean archipelago. In anticipation of the storm, on September 4, 2017, Puerto Rican governor Ricardo Rosselló declared a state of emergency.[57] Then, on September 6, the eye of Hurricane Irma, a Category 5 hurricane, made its way approximately fifty miles off Puerto Rico's northern coast.[58] Although Irma never made direct landfall, the hurricane generated thirty foot waves and 185 mile-per-hour winds.[59] As a

54. *Id.* at 1188.

55. Public Policy on Energy Diversification by Means of Sustainable and Alternative Renewable Energy in Puerto Rico Act, No. 82 of 2010, P.R. ANNLAWS ANN. tit. 12, §§ 8121–8136 (2007 & Supp. 2011).

56. Sánchez Rivera, *supra note* 53, at 1203–05.

57. *Hurrican Irma: Puerto Rico declares state of emergency ahead of Category 4 storm,* FOX NEWS (Sep. 4, 2017), https://www.foxnews.com/world/hurricane-irma-puerto-rico-declares-state-of-emergency-ahead-of-category-4-storm.

58. John C. Cangialosi et al., *National Hurricane Center Tropical Cyclone Report Hurricane Irma,* at 3, NAT'L HURRICANE CTR. (June 30, 2018), https://www.nhc.noaa.gov/data/tcr/AL112017_Irma.pdf.

59. Scott Malone, *Puerto Rico breathes sigh of relief as spared Irma's Worst,* REUTERS (Sep. 7, 2017, 1:25 PM), https://www.reuters.com/article/us-storm-irma-puertorico/puerto-rico-breathes-sigh-of-relief-as-spared-irmas-worst-idUSKCN1BI2G1.

result, Hurricane Irma left more than one million Puerto Ricans without electricity and fifty thousand without water.[60]

Two weeks later, on September 20, 2017, Puerto Rico was hit by Hurricane Maria, the strongest storm to hit the island since the San Felipe Segundo Hurricane in 1928.[61] Still in recovery from Irma, the Island's electric grid was at increased risk. Three days before Hurricane Maria made landfall, the Puerto Rico Electric Power Authority (PREPA) reported that 63,503 customers still lacked electricity due to Hurricane Irma.[62] All seventy-eight municipalities located on the island were directly affected by Maria's hurricane force winds and heavy rainfall, which caused catastrophic flooding, especially across the northern half of the Island.[63] Damage to critical infrastructure resulted in cascading failures of lifeline systems.[64]

In particular, Hurricane Maria severely impacted Puerto Rico's electric grid.[65] Despite their age (median age of power plants in PREPA's system is fourty-four years old[66]) and lack of maintenance, most of PREPA's power plants escaped Hurricane Maria with only slight damage.[67] It was PREPA's transmission and distribution infrastructure that experienced the lion's share of inflicted damage. Reports made by the Puerto Rico Electric Power Authority ("PREPA"), the United States Army Corps of Engineers

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60. Jim Wyss, *Puerto Rico Assessing Huricane Irma's Damage Amid Widespead Power Outage,* MIAMI HERALD (Sep. 8, 2017, 1:16 PM), https://www.miamiherald.com/news/weather/hurricane/article172023172.html; *see also* Claire Phipps, *Irma's Destruction: Island by Island*, THE GUARDIAN (Sep. 10, 2017, 5:33 EDT), https://www.theguardian.com/world/2017/sep/07/irma-destruction-island-by-island-hurricane.

61. Scott DiSavaino, *Puerto Rico Power Grid Faces Generational Threat in Puerto Rico.*, REUTERS (Sep. 19, 2017, 2:28 PM), https://www.reuters.com/article/us-storm-maria-puertorico-power/puerto-rico-power-grid-faces-generational-threat-in-hurricane-maria-idUSKCN1BU2HV.

62. *Hurricane Irma & Hurricane Harvey September 18 Event Summary*, at 4, U.S. DEP'T OF ENERGY (Sept. 18, 2017), https://www.energy.gov/sites/prod/files/2017/10/f37/Hurricanes%20Irma%20and%20Harvey%20Event%20Summary%20September%2018%2C%202017.pdf.

63. *Major Hurricane Maria – September 20, 2017*, NAT'L WEATHER SERV. (Sept. 20, 2017), https://www.weather.gov/sju/maria2017.

64. David Ferris, *How Puerto Rico Became the Worst Grid Disaster*, E&E News, (Apr. 19, 2018), https://www.eenews.net/stories/1060079499.

65. *Hurricane Maria, Irma & Hurricane Harvey September 21 Event Summary*, U.S. DEP'T OF ENERGY 4 (Sept. 21, 2017), https://www.energy.gov/sites/prod/files/2017/09/f36/Hurricanes%20Maria%20Irma%20%26%20Harvey%20Event%20Summary%20morning%20September%2021%2C%202017.pdf.

66. Maggie Koerth-Baker, *Why Puerto Rico's Electric Grid Stood No Chance Against Maria.*, FIVETHIRTYEIGHT (Oct. 16, 2017), https://fivethirtyeight.com/features/why-puerto-ricos-electric-grid-stood-no-chance-against-maria//.

67. RASHIDE ASSAD ET AL., *Post-María Puerto Rico Report Global Collaboratory 2017-2018: Final Report.*, at 7, COLUMBIA UNIV., https://sipa.columbia.edu/sites/default/files/embedded-media/20180508_GC_Post%20Mari%CC%81a%20Puerto%20Rico_Final%20Report.pdf (last visited Sept. 28, 2019).

and the Federal Emergency Management Agency estimated that up to 80% of PREPA's 2,478 miles of transmission lines and 31,485 miles of distribution lines were damaged.[68] However, it was not just damage to the transmission and distribution infrastructure that made initial recovery efforts difficult.

First, the island's rough terrain made it especially difficult for repair crews to access the damaged distribution and transmission lines. A majority of the island's electricity is generated at power plants (e.g., at Aguirre, Costa Sur, AES, and EcoEléctrica) on Puerto Rico's southern coast, far away from the major population centers.[69] Approximately 2 million of Puerto Rico's people reside in the large urban areas on the northern coast of the island. As a result, most electricity is sent by transmission lines over the island's forested, central mountain range. In addition to landslides and poor road access, it's this rugged terrain that made it increasingly difficult for distribution and transmission line workers to make repairs.[70]

Second, Hurricane Maria decimated Puerto Rico's communications infrastructure. "Hurricane Maria caused significantly more damage to the telecommunications . . . in Puerto Rico . . ., resulting in much longer recovery times compared to Hurricane Harvey's effect on Texas, Hurricane Irma's effect on Florida, or Hurricane Nate's effects on the Gulf Coast."[71] Puerto Rico's wireless telecommunications network was also down. On September 21, 2017, the Federal Communications Commission (FCC) reported that 95.2% of cell sites in Puerto Rico were out of service.[72] It was this lack of communication networks that hampered recovery efforts.

The devastation that Maria exacted on, what has been described as Puerto Rico's "aging and grossly neglected electricity system," has been described as "unprecedented -- not just for the

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68. *Energy Commission Investigation Regarding the State of the Puerto Rico Electric System after the Passing of Hurricane Maria, Case No. CEPR-IN-2017-0002***,** PUERTO RICO ENEGY COMM'N (Oct. 27, 2017), http://energia.pr.gov/wp-content/uploads/2017/11/Investigacio%CC%81n-Post-Mari%CC%81a-CEPR-eng-.pdf.

69. CAMPBELL, *supra* note 9.

70. *Build Back Better: Reimagining and Strengthing the Power Grid of Puerto Rico*, Puerto Rico Energy Resilience Working Group, (Dec. 2017) https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/PRERWG_Report_PR_Grid_Resiliency_Report.pdf.

71. *2017 Atlantic Hurricane Season Impact on Communications Report and Recommendations, Public Safety Docket No. 17-344*, FEDERAL COMMUNICATIONS COMMISSION (Aug. 2018), https://docs.fcc.gov/public/attachments/DOC-353805A1.pdf.

72. *Communications Status Report for Areas Impacted by Hurricane Maria, September 21, 2017*, FEDERAL COMMUNICATIONS COMMISSION (Sep. 21, 2017), https://www.fcc.gov/document/hurricane-maria-communications-status-report-sept-21.

island but for all of the U.S."[73] Nine days after María hit, approximately 95% of 1.57 million electricity customers in Puerto Rico were without power.[74] Two weeks after landfall, less than 10% of Puerto Rico's 3.4 million people had seen power restored and it was expected that full restoration would take months.[75] The uninterrupted lack of electricity three weeks after María hit was described as "a key factor in a humanitarian crisis as residents with no refrigeration for food and medicine scramble[…] to find open stores and wait[…] in endless lines."[76] According to William Heegaard, a paramedic on the island who later led an initiative to promote solar microgrids, the full human cost of Maria was hard to tally since without electricity, people could not refrigerate their medicinces, and when death resulted "medical examiners say they died out of diebetic complications without reference to the impact of the hurricane. Those numbers do not get catoregized into death-by-hurricane."[77] According to Heegaard, "this is one of the first large scale humanitarian disasters that brought immediate attention to renewable energy." Three hundred thousand people fled the island but "the rest who stayed are asking for Tesla."[78]

The final situation report on Hurricane Maria that DOE provided reported that following seven months of restoration work as of "April 3, PREPA reported restored load was 89.2% of normal peak load and 95.8% of customers (1,411,086) have been restored. All seventy-eight municipalities are at least partially energized. Approximately 62,000 customers remain without power.[79] According to one report, "Puerto Rican households went eighty-

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73. Naureen Malik and Jonathan Levin, *Damage to Puerto Rico's Power Grid is Unprecedented*, BLOOMBERG NEWS (Sept. 25, 2017), https://www.bostonglobe.com/news/nation/2017/09/25/damage-puerto-rico-power-grid-unprecedented/8XnniwOHxWKqs2WYz5J8gM/story.html.

74. *Hurricane Maria, Irma & Hurricane Harvey September 29 Event Summary*, U.S. DEP'T OF ENERGY 4 (Sept. 29, 2017), https://www.energy.gov/sites/prod/files/2017/09/f37/Hurricanes%20Maria%2C%20Irma%20and%20Harvey%20Event%20Summary%20September%2029%2C%202017.pdf.

75. Brian Resnick and Eliza Barclay, What every American needs to know about Puerto Rico's hurricane disaster, VOX (Oct. 16, 2017), https://www.vox.com/science-and-health/2017/9/26/16365994/hurricane-maria-2017-puerto-rico-san-juan-humanitarian-disaster-electricty-fuel-flights-facts.

76. Elisa Wood, *Puerto Rico Issues Final Microgrid Rules as Hurricane Season Looms*, MICROGRID KNOWLEDGE (May 21, 2018), https://microgridknowledge.com/final-microgrid-rules-puerto-rico/.

77. *Id.*

78. *Id.*

79. Hurricanes Nate, Maria, Irma, and Harvey Situation Reports, OFFICE OF CYBERSECURITY, ENERGY SECURITY, AND EMERGENCY RESPONSE (Sept. 20, 2017, to Apr. 4, 2018), https://www.energy.gov/ceser/downloads/hurricanes-nate-maria-irma-and-harvey-situation-reports; *2 More Months to Restore Power in Puerto Rico, Official Says,* CBS/AP (May 31, 2018), https://www.cbsnews.com/news/puerto-rico-power-electrical-grid-2-more-months-hurricane-maria-aftermath-2018-05-31/.

four days without electricity, on average, sixty-eight days without water and forty-one days without cellular telephone coverage" and overall the effects of the hurricane led to 4,645 deaths.[80]

X. PUERTO RICO'S POST-DISASTER LEADERSHIP ON ENERGY RESILIENCE AND A TRANSITION TO A LOW CARBON FUTURE

It did not take long for local organizations, with the support of an array of international solar and battery storage companies, to begin to respond to the crisis following Maria. Since the hurricane, companies such as Tesla, Sonnen, Sunrun, and Blue Planet Energy, as well as nonprofits such as Resilient Power Puerto Rico and Para la Naturaleza, have stepped up to be part of the solution. For example, the battery company Sonnen "installed solar microgrids at eleven sites across the island. One recent installation powers lights, refrigeration, and other equipment at a health center. Another powers a school that is serving as a shelter in Bartolo, a tiny mountain community."[81] A microgrid is "a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid."[82] As seen following Hurricane Maria, "a microgrid offers to electrically link together these important community institutions in a manner which preserves the electrical lifeblood of the community even during the most severe weather events."[83] Looking forward, Marcel Castro-Sitirich, a University of Puerto Rico Mayaguez electrical engineering professor, states that "targeted deployment of solar-plus-storage systems could significantly reduce hours without power for customers" when focused on those who are more remote and likely to be reconnected last.[84]

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80. Cassandra Sweet, *Puerto Rico Sets the Stage for Microgrids*, GREENBIZ (June 5, 2018), https://www.greenbiz.com/article/puerto-rico-sets-stage-microgrids.

81. Adele Peters, *During Puerto Rico's Blackout, Solar Microgrids Kept the Lights On*, FAST COMPANY (Apr. 28, 2018), https://www.fastcompany.com/40562660/during-puerto-ricos-blackout-solar-microgrids-kept-the-lights-on.

82. Merril Smith and Dan Ton, Key Connections, IEEE POWER AND ENERGY MAGAZINE (July/Aug. 2013), at 22, https://magazine.ieee-pes.org/wp-content/uploads/sites/50/2013/06/julyaug2013-2258276.pdf.

83. Kevin B. Jones et al, *The Urban Microgrid: Smart Legal and Regulatory Policies to Support Electric Grid Resiliency and Climate Mitigation,* 41 FORDHAM URB. L.J. 1698 (2014).

84. Emma Foehringer Merchant, *One Year After Maria, Puerto Rico's Energy Future Still in Limbo*, GREENTECH MEDIA (Sept. 20, 2018), https://www.greentechmedia.com/articles/read/one-year-after-maria-puerto-ricos-energy-future-still-in-limbo#gs.qooc10.

Unfortunately, PREPA has been slow to integrate renewable energy and, specifically, microgrid development. Only 2% of the Commonwealth's energy was generated by renewables (solar and wind) at the time of Hurricane Maria, despite passing a Renewable Portfolio Standard in 2010 to achieve 15% by 2020 and 20% by 2035.[85] Furthermore, while there are signs of excitement and innovation among Puerto Rican citizens, local organizations, and the solar and battery storage industry, PREPA continues to show reluctance to embrace distributed solutions, particularly those not owned by the utility. With privatization looming, the role of PREB as the regulator takes on greater importance in ensuring compliance with the existing RPS goals and distributed microgrid development.

XI. THE TRANSITION TO 100% RENEWABLE ENERGY

When Puerto Rico Governor Ricardo Rossello on April 11, 2019 signed into law a 100% renewable energy mandate by 2050, the island joined a select group of U.S states (Hawaii, while California and New Mexico have 100% carbon free targets) in mandating a complete transition away from fossil fuels.[86] The new law also adds an interim step of 40% renewable electricity by 2025 and to stop using coal by 2028 while making it easier for distributed solar to connect to the grid (an important policy given historic delays for PREPA to approve distributed energy interconnections).[87] Advocates in support of the legislation noted that Puerto Rico spends "$2 billion per year importing fuel for power generation" and given that the island already has sun and wind these "funds will reman on the island for our economic development."[88] P.J. Wilson, the President of the Solar and Energy Storage Association of Puerto Rico, called it, "by leaps and bounds, the quickest transition to renewables that's ever happened anywhere on the planet," noting that it also faced challenging political and financial

85. *Puerto Rico Energy Profile, supra* note 33.

86. Gavin Bade, *Puerto Rico governor signs 100% renewable energy mandate,* UTILITY DIVE, (Apr. 12, 2019), https://www.utilitydive.com/news/puerto-rico-governor-signs-100-renewable-energy-mandate/552614/.

87. *Id.*

88. Phil Mckenna, *Puerto Rico Passes 100% Clean Energy Bill. Will Natural Gas Imports Get in the Way?*, INSIDE CLIMATE NEWS, (Mar. 28, 2019), https://insideclimatenews.org/news/26032019/puerto-rico-clean-energy-100-percent-hurricane-recovery-solar-natural-gas-prepa.

circumstances.[89] Other concerns included that the legislation did not consider short term solutions for the most vulnerable, given that a hurricane can impact them again, according to University of Puerto Rico – Mayagüez professor Marcel Castro-Sitiriche.[90]

XII. PREC'S REGULATION ON MICROGRID DEVELOPMENT

The Puerto Rico Energy Commission on May 18, 2018, just 5 months from draft to final order,[91] issued their new Regulation on Microgrid Development which was intended to "provide a stable and predictable regulatory framework, capable of fostering innovation and economic growth through continued investments in the development and deployment of microgrid systems."[92] The rules were immediately heralded as leading guidance for the microgrid industry.[93]

The final microgrid rules established classes of microgrids, defined types of generation they can use, and clarified the role of utilities and municipalities. The three classes of microgrids that can be developed under the rules are:

1. Personal microgrids provide power to one or two consumers and can, with PREC permission, provide excess energy and grid services to neighboring customers.

2. Cooperative microgrids serve three or more cooperative members, under two subcategories, small co-op microgrids of less than 250 kW or large co-op microgrids of more than 250 kW. Like personal microgrids, co-op microgrids can sell excess energy and services to others.

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89. Umair Irfan, *Puerto Rico is targeting 100% renewable energy. The Trump administration has other ideas*, VOX (Apr. 17, 2019), https://www.vox.com/2019/4/17/18306417/puerto-rico-renewable-energy-natural-gas.

90. Emma Foehringer Merchant, *Puerto Rico Legislature Approves 100 Percent Renewable Energy Target*, GREENTECH MEDIA (Mar. 25, 2019), https://www.greentechmedia.com/articles/read/puerto-rico-legislature-approves-100-percent-renewables#gs.pgrh32.

91. Elisa Wood, *Puerto Rico Issues Final Microgrid Rules as Hurricane Season Looms*, MICROGRID KNOWLEDGE (May 21, 2018), https://microgridknowledge.com/final-microgrid-rules-puerto-rico/.

92. *Regulation on Microgrid Development* CEPR-MI-2018-0001, PUERTO RICO ENERGY COMMISSION (proposed May 18, 2018) at 5, http://energia.pr.gov/wp-content/uploads/2018/01/Proposed-Regulation-on-Microgrid-Development-CEPR-MI-2018-0001-2.pdf.

93. Wood, *supra* note 76.

3. Third-party microgrids have owners or operators who sell energy services to customers under rates approved by PREC and set on a project-by-project basis. Owners can earn a reasonable rate of return for the first three years of operation.[94]

For now, only personal and cooperative microgrids can be constructed. That will change when the island utility, PREPA, establishes interconnection rules, paving the way for third-party microgrids. PREC ordered the utility to do so within 120 days. The rules define "renewable microgrids" as those that can generate 75% of their energy from renewables-solar, wind, geothermal, hydropower or biomass—and 25% from fossil fuels.[95] A combined heat and power (CHP) microgrid must produce at least half of its total energy from the useful thermal energy captures from the plant. A hybrid microgrid may incorporate CHP and renewable systems, but the non-CHP system must generate 75% of its energy from renewables. Municipalities may enter into contracts with a third-party provider to develop microgrids or they may develop them on their own. PREC also allowed the island utility to develop microgrids, under the new rules.[96]

Peter Asmus of Navigant Research noted, "the ideal resource mix for regions challenged by hurricanes remains an open question. Nevertheless, I do believe this regulation is one of the most comprehensive approaches to microgrid development put forward and may serve as a model for other countries looking to scale up microgrids."[97] It was also acknowledged that in order to fully implement the vision of the rules, "in the longer term, microgrid development will need to be incorporated into a customer-centric Integrated Resource Plan for Puerto Rico's energy future," according to Tanuj DEoria, executive vice president for the Smart Electric Power Alliance.[98]

XIII. PREPA'S LATEST IRP AND AN EXPEDITED PATH TO RESILIENCE AND THE LOW CARBON TRANSITION

PREPA submitted its second revision to its 2019 IRP on June 7, 2019, covering the twenty year period 2019-2038, which

94. *Microgrid Development,* supra note 92.
95. *Id.*
96. *Id.*
97. Cassandra Sweet, *Puerto Rico Sets the Stage for Microgrids*, GREENBIZ (June 5, 2018), https://www.greenbiz.com/article/puerto-rico-sets-stage-microgrids.
98. Wood, *supra* note 76.

was again developed with its consultant, Siemans.[99] While the IRP is similar to previous versions, it calls for higher levels of solar and storage than the previous plan, recommending 1,800 MW of Solar PV and 920 MW of storage in the plan's first five years.[100] According to Sieman's preferred scenario, by the end of the plan in 2038 emissions would be reduced by 88%, achieving an RPS of 67% (improved from 24% in the February draft).[101] In regards to the controversial inclusion of natural gas in the resource mix, the revised RFP would retire several natural gas units, along with the oil-fired units, but also recommends adding two new 302 MW gas units and eighteen smaller peaking units (23 MW each).[102] Given the long lead times for development and the significant uncertainties, Siemans recommended that "it is prudent to start the process for siting and permitting now and make the final decisions for equipment and construction commitments as future events reveal themselves."[103] Others expressed concern with the long-term repercussions from decisions. Augustin Carbo, former Chairman of PREC and currently with the Environmental Defense Fund, stated that the IRP is "a planning tool for the next twenty years" and "if they want to build something not completely sustainable . . . it is going to be for the long run."[104]

As explained in the revised RFP, the eight minigrids would be capable of islanding during a storm and are "designed to ensure continued supply to critical loads (those loads most necessary for the safety and health) and provide timely recovery of the priority loads (those required to regain normalcy and restart the economy) and balance the loads within the MiniGrid."[105]

While the innovative minigrid approach has received lots of national attention, there remains concern that the IRP and PREPA do not sufficiently support the more distributed microgrid policy encapsulated in PREB's microgrid regulation. According to

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99. Siemens Industry, Siemens PTI Report Number: RPT-015-19**,** *Puerto Rico Integrated Resource Plan 2018-2019,* Draft for theReview of the Puerto Rico Energy Bureau, Prepared for Puerto Rico Electric Power Authority Rev. [2] 6/7/2019.

100. Emma Foehringer Merchant, *Puerto Rico's Latest IRP Increases Solar and Storage Targets*, GREENTECH MEDIA (June 10, 2019), https://www.greentechmedia.com/articles/read/puerto-ricos-latest-irp-proposal-increases-solar-and-storage-targets-includ#gs.p26cyt.

101. *Id.*

102. *Id.*

103. Robert Walton, *Puerto Rico Energy Plan Introduces Minigrids to Avoid Repeat of Hurricane Maria*, UTILITY DIVE (June 12, 2019), https://www.utilitydive.com/news/puerto-rico-energy-plan-introduces-minigrids-to-avoid-repeat-of-hurricane-m/556645/.

104. Elisa Wood, *Scrutiny Begins of New Energy Resource Plan Issued by Puerto Rico's Utility*, MICROGRID KNOWLEDGE (June 11, 2019), https://microgridknowledge.com/prepa-irp-puerto-rico/.

105. Walton, *supra* note 103.

Augustin Carbo, the utility continues to not embrace smaller community microgrids and has not sufficiently advanced the microgrid interconnection process consistent with the PREB regulation. According to Augustin Carbo "they're [PREPA] objecting to the current rules that went through a public participation process" and "the issue could delay approvals of new microgrid systems."[106] Others have also expressed concern, Roy Torbert, with the Rocky Mountain Institute similarly expressed concern with the lack of focus on customer microgrids and solar plus storage.[107] Ruth Santiago, a well-known local clean energy activist, previously criticized the plan for only including customer alternatives "as 10% of the generation mix by 2038, although the Siemans analysis noted that it's the cheapest option."[108]

XIV. CONCLUSION

All things considered, it seems that Puerto Rico has a long road ahead towards resiliency in redeveloping their electric infrastructure. Between a deep-rooted and complex colonial history, an economically challenged commercial sector, and a bankrupt utility with decades of poor planning decisions, Puerto Rico seems predestined for a challenging recovery at best conditions. The pair of catastrophic Category 4 and 5 hurricanes hitting in 2017 added to the "perfect storm" of upheaval, toward an even harsher path towards sustainable recovery. On top of all of this the government's intended policy choice to privatize at least a significant portion of the existing publicly owned electric system, on an accelerated schedule, offers additional complexity and uncertainty.

Yet, the Puerto Rican residents, those who stayed on the island, represent the epitome of resilient perseverance. Stories of neighbors (who had restored power) helping neighbors, volunteer citizens lending a hand at line maintenance or clearing up debris, and the numerous local community efforts are humbling and empowering stories. Non-profits, governmental, and private resources have entered with resources, enthusiasm, and ideas.

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106. Wood, *supra* note 104.

107. *Id.*

108. Lulia Gheorghiu, *As 100% Renwables Mandate Nears, Puerto Rico sees new microgird initiative, resilience focus*, UTILITY DIVE (Mar. 22, 2019), https://www.utilitydive.com/news/as-100-renewables-mandate-nears-puerto-rico-sees-new-microgrid-initiative/551114/.

With much delay to get the lights back on, Hurricane Maria left irreparable marks on the island. But in the words of a resident, "We have gotten stronger, (. . .) If anyone has a doubt, any doubt, that Puerto Ricans are struggling on their own—this is a country that has been fighting for its freedom forever."[109] And one of the indelible impressions left with the average Puerto Rican seems to be the critical need for local microgrids and distributed renewable energy.

The Puerto Rico Energy Bureau has developed a roadmap for the development of microgrids with its leading regulations. The island's government has developed aggressive and meaningful goals for the energy system's low carbon transition. PREPA has produced innovative proposals for breaking the island's electric grid into regional minigrids. With the Energy Bureau's critiques and encouragement for faster reform, PREPA's Integrated Resource Plan continues to move toward a faster clean energy transition and more details on microgrid implementation, although there remains room for further consistency with Puerto Rican policy and resident's demands. Despite its complex challenges, given the perseverance of the citizens and the Governor, legislature, and Energy Bureau's policy leadership, Puerto Rico is bound on a road towards resiliency and a clean energy transition.

109. *Puerto Rico: The exodus after Hurricane Maria*, CBS NEWS (Sept. 21, 2018), https://www.cbsnews.com/news/puerto-rico-exodus-after-hurricane-maria-cbsn-originals/.