

Historicizing Puerto Rico's Energy Present: A Political Ecology and Environmental Justice Approach to Energy Production in Puerto Rico

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ABSTRACT

The collapse of Puerto Rico's energy system after Hurricane María opened the door for a more sustainable and resilient system, as many stakeholders, including community leaders, demanded a move toward distributed and renewable energy sources. Instead, the Puerto Rico Electric Power Authority's (PREPA) and LUMA Energy's new proposals further anchored the system's future developments to "natural" gas and oil. Utilizing grey literature (i.e., reports, books, articles, newspapers and policy documents), this essay applies historical political ecology and environmental justice to explore events that have led to the selection of electricity fuels and infrastructure throughout time, which have had implications for the natural environment and local communities. The paper concludes with lessons learned and why these findings matter for present and future energy-scapes. [Keywords: energy, environmental justice, historical analysis, political ecology, Puerto Rico]

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With the intensity and frequency of hazards (e.g., hurricanes, wildfires, and landslides) associated with anthropogenic climate change, communities with pre-existing vulnerabilities (e.g., fragile physical infrastructure and high unemployment rates) are more prone to heightened vulnerabilities. This problem occurs in the archipelago of Puerto Rico, composed of a larger island and smaller inhabited and unoccupied islands. With a population of roughly 3.2 million people, 8.3 percent of Puerto Rico's residents are unemployed, as of June 2021, and 40 percent are dependent on federal welfare services (e.g., food stamps) (CBPP 2020; Departamento del Trabajo y Recursos Humanos 2021). Additionally, in 2019, Puerto Rico received a D minus from the ASCE Report Card for its physical infrastructure weakness (ASCE 2019). Electrical services are at the core of the archipelago's critical infrastructure, and residents have faced many challenges and disruptions with this system. The Puerto Rico Electric Power Authority, also known as PREPA, is one of the largest power utilities in the United States because of the number of consumers it serves (San Miguel 2021). PREPA's physical infrastructure includes four generation centers: Costa Sur, Complejo Aguirre, San Juan, and Palo Seco.¹

As of 2020, PREPA received approximately 97 percent of its electricity from fossil fuels (i.e., coal, "natural" gas, and petroleum) and 2.5 percent from renewable sources (i.e., hydropower, solar, and wind power) (EIA 2020) (see Figure 1). Throughout time, a combination of internal (e.g., operational deficiencies, fiscal mismanagement), external (e.g., deteriorated and aged infrastructure), and natural hazards (e.g., hurricanes, earthquakes) have tested the robustness of this critical system. The cascading effects of PREPA's vulnerability has affected businesses and residents with higher utility bills, frequent power outages, and environmental pollutants (Alfonso 2016; *Primera Hora* 2016; Atilés-Osoria 2012). As a result, there has been an increasing demand for renewable energy in the past two decades. These demands include reliable electrical services, reduce greenhouse gas emissions, lower the dependence on global markets, and provide alternative economic systems, among other urgent concerns (Onís 2018a, 2018b; O'Neill-Carrillo et al. 2010; Atilés-Osoria 2012; Weinstein et al. 2014). Although there is public policy that brings pathways for the integration of renewable energy sources at a larger scale in Puerto Rico (see Act 57-2014 and Act 33-2019), PREPA decision makers have not adhered to this perspective and instead have supported oil and "natural" gas as part of Puerto Rico's main electricity generation sources (Galluci 2020; Massol-Deyá 2019).

This essay focuses on the past to contextualize the present and to provide an informed reflection on lessons learned from these decisions in Puerto Rico's local communities and environment. To do this, the essay brings together a historical political ecology approach and an environmental justice perspective to address the following question: What can past decisions in selecting electricity fuels and infrastructure teach readers about Puerto Rico's present and future energy-scapes? To answer this guiding question, the essay also considers the following questions for historical analysis: How has Puerto Rico's relationship with the US influenced the electricity fuel sources and associated infrastructure in Puerto Rico over time? What role did Puerto Rican political leaders play in PREPA's challenges? How have local communities and their natural environment been impacted by current energy production and distribution? Based on historical events, what are possible implications of these decisions on electricity fuels for future residents in the archipelago?

Electric power plants and transmission lines in Puerto Rico

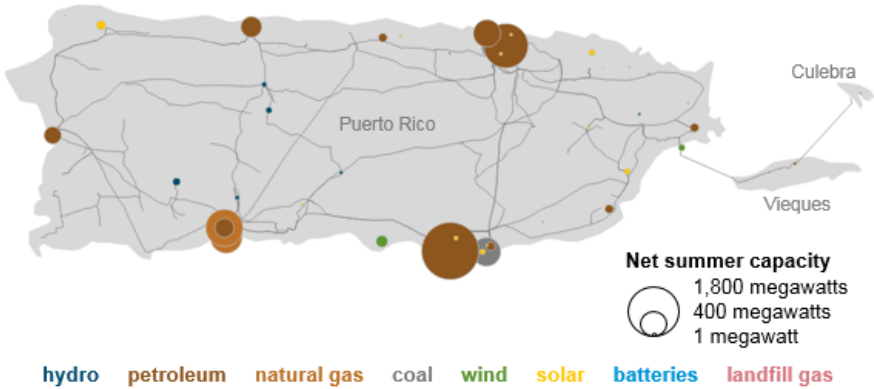


Figure 1. Map of electric power plants and transmission lines in Puerto Rico.
Source: US Energy Information Administration (EIA). Sketched by Jan Cordero.

This essay relies on grey literature to address the previous questions. This piece also draws on Javier Nieves-Torres's (2018) undergraduate thesis, which centers on Puerto Rico's energy transition history from 1893 to 2018. His work narrates a timeline with three distinct phases that are guided by diverse technologies, new policies, and energy governance broadly (with more stakeholders involved). In this essay, I adopt Nieves-Torres's timeline format and restructure his data. I include grey literature to focus on important events that have guided discussions and decisions in electricity fuel selection (e.g., hydropower, oil, solar) throughout Puerto Rico's history. I contend that historical political ecology and environmental justice approaches are helpful for examining events and justifications guiding electricity fuels in Puerto Rico, while shedding light on resource control implications and unequal power relations at different scales. These varied levels include the relations between the Puerto Rico and US governments, as well as the Puerto Rican government's interactions with local communities and the management of natural resources near these electricity generation facilities. With such an approach, the present essay explores these complexities in Puerto Rico to support future work on energy transitions and energy justice studies.

The essay unfolds in several parts. The first section provides a broad review of political ecology and environmental justice literature. This focus is followed by a historical emphasis that discusses key events that shaped Puerto Rico's choices in electricity fuel sources (also referred to as the energy portfolio) from 1893 to 2021. Here, I utilize and expand on Nieves-Torres's (2018) historical overview. While Nieves-Torres's contributions to energy transitions are invaluable, this essay builds and re-structures his historical timeline data to navigate the different justifications and narratives utilized to select electricity generation fuels and associated infrastructure throughout time. Hence, this timeline is modified and divided into periods when Puerto Rico or US decision-making opened pathways for new fuels to enter as electricity sources. This section also includes the implications of those events and justifications from historical political ecology and environmental justice perspectives. The essay concludes by circling back to the guiding questions with an informed reflection on what we can learn from historical accounts to approach the future of Puerto Rico's electricity sources and possible implications for the archipelago's residents and energy-scapes.

A Brief Review of Political Ecology and Environmental Justice

To explore the relationships between nature and society, focusing on power, access, and control of resources, political ecology emerged from dependency theory, peasant studies, and world-system theory during the 1960s and 1970s (Tetreault 2017; Robbins 2012). Political ecology also closely connects to political economy by integrating ecological and political economy concerns (Blaikie and Brookfield 1987; Greenberg and Park 1994; Wolf 1972). Political ecology emerges from studies on the “global south,” in which people (i.e., Indigenous or peasant communities) “have a strong material and cultural attachment to immediate natural resources that both sustain their livelihood and give it meaning” (Offen 2004, 23). Rooted in Marxist perspectives, political ecology challenged the Malthusian ideas of environmental thinking and human behavior, as well as denoted how studies of human ecology were rooted in power and political dynamics (Svarstad and Benjaminsen 2020; Offen 2004). With the changes from ideas of “development” to “environmental conservation” and “biodiversity preservation” in the 1990s, political ecology utilized historical and poststructuralist critiques to further understand resource control (Offen 2004, 25).

Questions in political ecology can expand our understanding on how the construction of discourses or narratives influence distribution and control of resources (Robbins 2012; Svarstad and Benjaminsen 2020). For example, Mullins’s (2004) work in Mendahara Ilir village in the Indonesia coastal region used a political ecology perspective to look at unequal power relations in marine resource management, including the influence of external forces such as the Asian financial crisis and the global phenomenon of El Niño. This work stresses how national environmental laws were impacted by local socio-cultural conditions, including control and access. It also highlighted how unequal power relations among different actors shape local environmental resources (Mullins 2004; Shah and Narain 2019). In the context of energy, following Bridge and colleagues (2018) and their discussion regarding political ecology on European Union energy policy, this frame offers an added lens to understand how social values, knowledge, and political organization have co-evolved with growing energy consumption. At the same time, political ecology observes how energy transitions play a crucial role in creating alternative political futures and challenging power, hierarchies, and assumptions around who is traditionally considered the “expert” in the energy realm (Bridge et al. 2018).

Political ecology utilizes a range of analytical tools to understand these asymmetrical power relations (Zimmerer 2015). For example, historical analysis has been highlighted as a valuable way to identify important stakeholders and events that have shaped social and environmental changes (Mathever et al. 2015; Robbins 2012; Offen 2004). In this sense, historical political ecology (HPE) as an analytical approach “[...] attempt[s] to view nature in light of social issues and the political forces constraining them both” (Offen 2004, 22). Furthermore, HPE has provided the lens to show landscape change and how colonial legacies affect both livelihoods and worsen environmental degradation (Offen 2004).

With similar human-environment concerns, yet different foundations, the environmental justice literature is grounded in social movement studies and empirical analyses that support the claims of civil rights activists in the United States during the 1980s regarding how environmental hazards have disproportionately impacted Blacks and other people of color (Holifield 2012;

Mohai et al. 2009; Bullard 1999). The distribution of environmental burdens (i.e., distributive justice) and the decisions that lead to such distributions (i.e., procedural justice) are amongst the guiding interests of this movement (Banzhaf, Ma, and Timmins 2019). Many studies have demonstrated that ethnically- and racially-minoritized groups and low-income communities receive higher exposure to environmental hazards (e.g., soil pollution, air pollution) that come from industrialization, militarization, and consumer practices (Mohai et al. 2009). Thus, race and class are tied to the environmental justice movement, as well as the research agenda (Mohai and Bryant 1992; Taylor and Cole 2001; Pulido 2000; Banzhaf, Ma, and Timmins 2019).

As described by Mohai and colleagues (2009), environmental disparities can be brought upon a community through developers and corporate actors who are in search of areas with the least resistance to their development plans. Given that low-income communities and communities of color usually have less political power and control over decision-making processes, they become a target for hazardous facilities (Mohai et al. 2009). As grassroots activism and calls to action increased, the environmental justice movement received attention in the policy and regulation arena in the 1990s (Mohai et al. 2009; Cutter 1995). For example, in 1992, the Environmental Protection Agency's (EPA) Equity Workgroup developed a report, which Mohai describes as "the first official acknowledgement by the federal government of the existence of environmental inequalities and the importance of addressing them" (2009, 410). In 1994, Congress reacted with an increased interest to address environmental injustices by having President Bill Clinton issue Executive Order 12898, which made all federal government agencies center environmental justice within their decision-making processes (Mohai et al. 2009). Nonetheless, even with the EPA's enforcement and guidelines for environmental justice, to date, environmental (in)justice is still present in communities across the United States and its territories (Grineski et al. 2013; García-López 2018; Lloréns 2016; Whyte 2016).

To explore environmental injustices, scholars have used a range of analytical tools from spatial to qualitative analysis, including historical analysis. For example, historical analyses have been used to contextualize the origins, causes, and longevity of injustices (Boone and Buckley 2017). Studies also have been used to provide activists and scholars evidence to use in decision making spaces (Boone and Buckley 2017; Das 2015). Similarly, newspapers help to document and evaluate environmental injustices, as media reflect and shape public narratives on environmental concerns (Cutts et al. 2016). For example, Cutts and colleagues (2016) focus on urban gardening and soil issues in Sacramento, California. They utilize archival, media, and geographical data. They report that, by bridging this varied sources, this data set allowed them to enhance their understanding of the phenomenon, including different narratives and environmental concerns across space and time.

Both political ecology and environmental justice have received critiques. For example, environmental justice critics address the lack of ecological focus and propose to elevate the discussion of political-economic systems within capitalist societies (Schlosberg 2007). Some critiques also highlight the lack of political analysis in political ecology.² Nonetheless, scholars have continued to employ these frameworks to explore resource control and the uneven distribution of environmental burdens. Scholars have also shown how these two bodies of literature can be complementary (Lee 2009; Kitchen 2013). Following Lee's (2009) discussion of both fields and the metaphor of "two sides of the same coin," a HPE and environmental

justice approach to electricity fuels in Puerto Rico can better contextualize the complexities in the archipelago, as well as present findings that can further enrich conversations in the energy transitions literature and Puerto Rico's energy future more broadly.

A Historical Approach to Puerto Rico's Electricity Sector Development

Settlement Illumination (1893 to 1941)

In Puerto Rico, the first private electric system was installed in the southern municipality of Villalba by Spanish coffee producer Don José Ramón Figueroa in 1893 (Agosto-Flores 2017; Nieves-Torres 2018). The main purpose of installing this system and the ones that followed was to provide electricity services primarily to private industries (corporate agriculture) in Puerto Rico (AEE 1992; Nieves-Torres 2018; Burrows 2017). Following the Spanish-American War (1894-1898) and the Treaty of Paris, when Puerto Rico became a US possession (i.e., colony), electricity was generated mainly by private electricity companies. With increased modernization goals on the archipelago, in 1915 the Puerto Rican government moved forward the irrigation project in southern Puerto Rico as an opportunity to support electricity from local sources (AEE 1992). This opening led to the installation of systems in other southern municipalities, such as Villalba with Toro Negro, and ultimately the creation of the Utilization of Water Resource in Puerto Rico (UWRPR) in 1927 (Government Development Bank for Puerto Rico 1971; Latimer 1983).

Following Hurricanes San Felipe (1928) and San Ciprián (1932) and the Great Depression of the 1930s, Puerto Rico faced great challenges, including a 60 percent unemployment rate by 1933 (Bolívar-Fresneda 2007; Schwartz 2009; Burrows 2014). The Great Depression spurred President Roosevelt's New Deal programs, which would expand to Puerto Rico to revitalize the economy through modernization projects (Burrows 2017). To support these projects (e.g., Operation Bootstrap), the economy in the archipelago continued to gradually shift from an agrarian to an industrial economy, based on manufacturing and services (Bolívar-Fresneda 2007; González-Mejía and Ma 2016; Burrows 2017). During this time, Puerto Rico's lack of political sovereignty meant that local actions would be dependent on the non-locally elected governor of Puerto Rico, economist Rexford Tugwell, Congress, and related elites' approval (Joffe and Martinez 2016; Bolívar-Fresneda 2007).

Between 1935 and 1943, seven hydroelectric projects began in the Cordillera Central (central mountains) of the large island of Puerto Rico to improve public health via clean drinking water access (Burrows 2014, 2017). This was part of President Roosevelt's Rural Electrification Project. Local elites such as engineer Antonio Luchetti participated in the design and other aspects of the New Deal hydro-electrification program. This involvement opened opportunities to negotiate within the colonial relationship with the United States (Burrows 2017). From 1938 to the 1940s, Luchetti pushed an agenda to make the Water Resource Authority a locally owned public corporation. He received backlash from Puerto Rican elites, such as Rafael Martínez Nadal (former President of the PR Senate) and Santiago Iglesias Pantín (Former Resident Commissioner of PR) due to concerns with local political control (Burrows 2017). Similarly, there were worries in the US Congress. For example, in 1940, when Luchetti attended a congressional hearing to testify in support of the creation of

the Puerto Rico Water Resources Authority, Congressman Fred L. Crawford (R-Michigan) raised concerns about how a public utility could impact private electricity companies' ability to compete. After several attempts, by 1941, Luchetti was victorious and non-locally elected governor Guy J. Swope signed Act 83-1941, which enabled the transition of the Utilization of Water Resource in Puerto Rico (UWRPR) to the Water Resources Authority (WRA) (Bolívar-Fresneda 2007).

Created as a self-financing public corporation, the WRA would have the necessary local independence and support to lift the infrastructure to continue supporting the economic development plans of the last century (Nieves-Torres 2018; Bolívar-Fresneda 2007; Government Development Bank for Puerto Rico 1971). However, with World War II, the WRA faced its first significant challenge. The development of several military bases in the archipelago created a larger energy demand, and facilities often ran out of supply, creating an energy emergency (O'Neill-Carrillo 2010; Bolívar-Fresneda 2008). During this time, the WRA envisioned that by purchasing private companies, such as the Porto Rico Railway Light & Power Company and the Mayaguez Light, Power & Ice Co., it could stabilize supply (along with the hydro plants) and the price of energy for present and future economic development in the archipelago (Bolívar-Fresneda 2008).

The settlement illumination phase was mainly characterized by the goal to turn Puerto Rico into an economy reliant on private industrial capital and foreign (US American) businesses as seen through modernization goals. While this shift was justified with the Great Depression, unemployment rates, health disparities in rural Puerto Rico, and water reliance for electricity, it was driven by an imposed economic agenda and facilitated by local elites, such as Luchetti. From political ecology and environmental justice perspectives, this focus on modernization and development highlights the start of a colonial legacy that left little discussion on these projects' environmental and local ramifications. However, while setting new demands for electricity fuels in Puerto Rico, events such as the energy emergency after World War II also started to shed light on the environmental and social implications of this capital focus.

Industrial Development (1946 to 1979)

From 1946 to 1979, Puerto Rico's electricity sector was marked by various events, including the increased marketing of Puerto Rico for foreign capital, the oil dependency required to sustain these industries, the transition from hydropower to petroleum, and the international oil crisis (Chapman 1982; Nieves-Torres 2018).

In the 1950s, several thermoelectric plants, including the Central de San Juan, Costa Sur, and Palo Seco, were built to meet the new high demand of electricity (Nieves-Torres 2018; Campbell et al. 2017). The process of electrifying the archipelago was finalized in 1962 with an underwater system that provided energy to the smaller islands of the Puerto Rican archipelago (Burrows 2017; Nieves-Torres 2018). To support industrial development, various petrochemical and pharmaceutical industries were established in southern Puerto Rico (Martínez 2014; Bond 2017; Vélez 1992). These facilities were located in the southern region because the south had less winds than the north (Gertz et al. 1970). It was also reported that this region was selected due to the supposed goals of bringing economic assistance through job opportunities (Gertz et al. 1970). It is important also to recognize that prior to the establishment of petrochemicals

in this region, sugar cane production was one of the most important economic activities in the south. Southern municipalities, such as Guayama, were home to this industry, with Black enslaved people composing the bulk of the labor force (Negrón-Portillo and Mayo 2007). Thus, at the time of the transition from agrarian to industrial development and during the installment of petrochemicals and pharmaceuticals in the south, many communities nearby were of African descent and low income. The availability for low-wage labor set grounds for this region to become a niche for this type of industrial development. This arrangement later resulted in electricity generation imbalances, such as having a majority of power plants in the south of Puerto Rico while the main demand is in the northern region (O'Neill-Carrillo 2010; Dietz 1976; Berman Santana 1996). From an environmental justice perspective, the racial and economic demographics of this region are also important factors to consider along with the establishment of these industries in the south.

Examining alternative electricity generation sources, in collaboration with the US Atomic Energy Commission, the Water Resource Authority experimented with nuclear energy through the Boiling Nuclear Superheater (BONUS) project in the western municipality of Rincón in 1964 (Latimier 1983). However, the plant closed quickly in 1968 due to technological obstacles and high costs of modifications (US Department of Energy 2021). Meanwhile, in 1965 and 1968, Puerto Rico received special treatment under the US quota system to import cheap oil and feedstocks from foreign sources (i.e., Venezuela and Middle Eastern oil) (Pantojas-García 1990; Vélez 1992; Pérez 2002; Berman Santana 1996). Law 82 of 1967 also provided an incentive by allowing electricity to be sold to industrial plants at lower prices than residential or commercial consumers, thus attracting heavy industry and capital (Berman Santana 1996). These incentives set the ground for establishing more refineries, transforming Puerto Rico into an attractive location for the installation of energy-intensive industries and the expansion of high-energy technologies, such as construction and transportation sectors (Sánchez-Cardona et al. 1975; Berman Santana 1996). However, the oil-related industries yielded relatively little for the economy (Sánchez-Cardona et al. 1975; Dietz 1976). For example, the petrochemical and petroleum industries, which were one of the areas of most US capital investment, only created eight percent of the jobs promised with their investment (Dietz 1976, citing Morley 1974; Committee for Puerto Rico Decolonization 1976). At the same time, basic and unfinished oil products were exported for further elaboration, and by the early 1970s, 21 percent of the energy consumed on the island enhanced economic growth elsewhere (Sánchez-Cardona et al. 1975).

When the Organization of Petroleum Exporting Countries (OPEC) decided to increase the price of petroleum in 1973, it generated an “oil crisis” and importation affected Puerto Rico, as prices increased and industries decided to close, reducing expected job opportunities (Martínez 2014; Pérez 2002; O'Neill-Carrillo 2010). While these events impacted local economic opportunities, reports also presented the harmful environmental cost from these industries. For example, Vélez's dissertation on community responses to environmental injustices reports that the “major contributor to contamination in Puerto Rico is the industrialization that the government has promoted” (1992, 6). Similarly, Sánchez-Cardona and colleagues explain that “in 1973 to cool the generating plants operating on the island, it was necessary to pump 1.12 million gallons of seawater per minute which was later returned to the coast at the much higher temperature” (1975, 37). Additionally, these industries also produced enormous

amounts of waste that were disposed of in the atmosphere, in underground and surface water, and on fragile tropical coastlines (Sánchez-Cardona et al. 1975). The Environmental Quality Board of Puerto Rico also identified that power plants were the main source of sulfur dioxide, which has adverse effects on public health and soil productivity (Sánchez-Cardona et al. 1975). In this sense, petrochemical and pharmaceutical industries were main contributors to toxic waste in the archipelago. Nevertheless, by 1979, drought challenges and increased reliance on oil made the WRA change its name to the Puerto Rico Electric Power Authority (PREPA), setting a new paradigm in which electricity production would transition from water as a primary resource to petroleum (Latimier 1983; O'Neill-Carrillo 2010).

In the industrial development phase, the dominant discourse emphasized supporting this sector for economic well-being. Electricity sources continued to shift to meet economic development goals in the archipelago (i.e., from hydro to oil). While the combination of drought, cheap oil, and economic development served as justifications to increase oil dependency, electricity fuels served as instruments to continue providing opportunities for external stakeholders (e.g., pharmaceutical corporations). In this sense, the industrial development period represents more external stakeholders establishing business's interests in Puerto Rico and leaving when the relationship was no longer viable for business. This corporate occupation negatively shaped local environmental resources, leaving many residents in situations that threatened their well-being.

The Battle for Diversification (1980 to 2021)

From the 1980s to 2021, a combination of new policies from the the governments of United States and Puerto Rico sought alternatives to oil dependency. Concurrently, local stakeholders (i.e., local community members, businesses, and academics) and allies worked to present the need for renewable energy sources through research and outreach. The events that mark this period include environmental harms from PREPA and related industries through toxic waste, the high cost of petroleum, international economic instability, the impact of extreme climate-related and other events on the electric grid, and Puerto Rico's public debt (Irizarry-Mora 2017; Draitser 2016).

As the US government recognized the increasing costs of dependency on fossil fuels, they enacted a series of federal mandates starting with the Public Utility Regulatory Policy Act (PURPA) of 1978 to diversify energy sources (O'Neill-Carrillo 2010). These initiatives forced Puerto Rico to buy electricity from private cogeneration projects if they could generate power at a lower cost than PREPA, or at least at the same cost. This supported the establishment of the Puerto Rico Eco-Eléctrica Natural Gas Power Plant and the Applied Energy Systems (AES) coal plant in the early 2000s. Other measures taken by the US Congress to diversify electricity sources and increase renewables included the Energy Policy Act (2005) and the Energy Independence and Security Act (2007). As a colony of the United States, these mandates also applied to Puerto Rico. While there was diversification of fuels (i.e., natural gas, coal), policy supporting renewables was not successful. Puerto Rico continued its fossil fuel dependency, which caused economic burdens and environmental harms in the archipelago. As oil prices rose, lack of fiscal transparency and politicians' excessive borrowing to address deficits in public utilities, such as PREPA, increased Puerto Rico's debt (Caraballo-Cueto and Lara 2016; Smith-Nonini 2020).³

As presented by former Governor Luis Fortuño (from the New Progressive Party) in 2009, Puerto Rico was experiencing another “energy crisis” due to fossil fuel dependency and outdated infrastructure (*Primera Hora* 2010). To address this problem, he signed two executive orders following the United States Congress Energy Policy Act (2005) to reduce fossil fuels and produce 12 percent of renewable energy by 2015 and 20 percent by 2020 (*Primera Hora* 2010). The following year (2010), the governor also proposed the creation of La Vía Verde (The Greenway), a ninety-three-mile-long methane gas pipeline that would have transported the fuel from the southern municipality of Peñuelas to northern energy facilities (*80 grados* 2012; Massol-Deyá 2019). This pipeline was expected to negatively impact 234 water resources, agricultural lands, and wetlands (Massol-Deyá 2019). Following protests and other social movement efforts by activists, community members, and other collaborators, whose claims and research showed that this project would severely affect communities and ecological systems, the project was defeated (Irizarry-Mora 2012; *80grados* 2012). Concurrently, Governor Fortuño announced the installment of several wind turbines (Sotomayor Ramírez et al. 2015). This project also received backlash for agricultural concerns (Ramírez et al. 2015). By the 2020 fiscal year, only 2.5 percent of Puerto Rico’s energy portfolio came from renewables (EIA 2020).

Compounded injustices as seen through projects such as the Vía Verde pipeline and the wind turbines have not been the only projects to bring local grassroots groups together to address environmental harms from electricity production sources and infrastructure. For example, the community-led environmental advocacy organization Comité Diálogo Ambiental, Inc. has come together against socio-environmental harms in southern communities, including to address the disposal of the AES coal-fired power plant’s toxic ash since the late 1990s (Lloréns 2017). Located in the southern municipality of Guayama, AES is responsible for approximately 300,000 tons of coal ash a year, and the plant produces 17 percent of Puerto Rico’s electricity (Ellsmoor 2019; Alfonso 2019). Other examples of efforts to address environmental harms are the experiences of the southeast municipality of Humacao and southern municipality of Peñuelas, where neighborhoods have also been impacted by AES production with the EC Waste landfill, which is authorized to receive coal ashes (Bonilla-Soto 2019). This disposal arrangement has led to several protests by local organizations and residents as well as lawsuits against EC Waste (Bonilla-Soto 2019; Alfonso 2019). Since the 1980s, scholars and agencies have increasingly documented some of the environmental effects of Puerto Rico’s petrochemical and related industries in the Guayama and Salinas region. For example, in 1989, of one hundred US-mapped super fund cleanup sites, nine were in Puerto Rico. Similarly due to closeness to these industrial plants, residents have reported cases of respiratory illnesses, cancer, degradation of land for agriculture, water pollution and air pollution (Concepción 1990; Dietrich 2013; Berman Santana 1996; Lloréns 2021; de Onís 2021). Coal ash waste particularly is a threat to ecological systems such as the Jobos Bay, the second largest estuary in the archipelago, and the southern aquifer, the principal potable water source for approximately 140,000 residents in this region (Alfonso 2019; ICADH 2017). In the same region, demographic analysis also shows uneven distribution of burdens through a racial and economic lens (Lloréns 2016). For example, communities here have a median household income of US\$15,000 (with the median being \$19,518) and 17 percent of the residents (in contrast to the 12.4 percent national average) self-identify as Black or African American, according to the 2010 US Census (Lloréns 2016;

US Census 2010). These figures further demonstrate unequal distribution of burdens from political- and economic-driven decisions.

From 2014 to 2021, Puerto Rico's energy challenge made headlines with increased attention to public policy and diverse stakeholders (e.g., academics, environmental grassroots actors, business owners), focusing on PREPA's administrative role. The major first step in addressing PREPA's local public participation and mismanagement was in 2014, when Sen. Eduardo Bhatia (from the Popular Democratic Party) pushed the Puerto Rico Energy Transformation and Relief Act (Act 57–2014). This policy created an oversight and regulatory entity, "the Energy Commission," today known as the Puerto Rico Energy Bureau, to address the many challenges PREPA faces (Fischbach et al. 2020). From a fiscal perspective, PREPA's regulation was overdue, and in 2015 former Governor Alejandro García Padilla (from the Popular Democratic Party) officially declared that Puerto Rico's public debt was "unpayable" and that PREPA had approximately a 9-billion-dollar debt (Fischbach et al. 2020). This debt is a result of exceeding borrowing from external bondholders (see Smith-Nonini 2020).

Puerto Rico's energy controversies continued to make headlines focusing on grid vulnerability, alternatives to PREPA's electricity fuels, and debt reconstruction. In terms of grid dangers, in 2016, Puerto Rico experienced the first major archipelago-wide blackout (not involving a major storm or hurricane), and it took at least 24 hours to restore power due to a fire in one of its stations (*Primera Hora* 2016). During the same time, in the research arena, institutes such as the National Institute for Energy and Island Sustainability (INESI-UPR) created the first portfolio of energy experts, which included more than 90 scholars within the UPR system, to assist in providing resources and information on alleviating socio-technical problems on the island, including energy production (Vega 2016). Members of the steering committee, Drs. Marla Pérez Lugo, Cecilio Ortiz, and Lionel Orama, and activists also participated in public and congressional hearings to document fossil fuel production and disposal damages in Puerto Rico (Onís 2017). Meanwhile, under the Obama Administration, in 2017, PREPA's debt started a restructuring process under Title III of PROMESA (Puerto Rico's Fiscal Oversight Board) (Fischbach et al. 2020).

The impact of Hurricanes Irma and María in September 2017 would become the clearest evidence of the infrastructure challenges and overall mismanagement of PREPA's system, including with electricity generation sources (Ojeda-Matos et al. 2021). The disaster exacerbated the pre-existing vulnerabilities in the archipelago, leading to more than 100,000 people migrating, residents relying on each other for essential resources, and estimates of about 4,000 deaths (from the direct and indirect impact of the disaster) (Flores and Krogstad 2019; Kishore et al. 2018; Roque et al. 2021). It took PREPA up to 11 months to restore services to most clients, and some areas continued to experience shorter power outages, making this period the most prolonged blackout in modern US history (Robles 2018). However, communities with ties to the elected political party (the New Progressive Party) have been associated with greater government responsiveness (Tormos-Aponte et al. 2021). Given the technical maintenance and fiscal failure linked to bipartisanship management, four months after Hurricane María, in January 2018, Governor Ricardo Rosselló (from the New Progressive Party) announced the initial process for PREPA's privatization (Massol-Deyá 2019).

In addition to announcing PREPA's privatization plans, former Governor Rosselló also signed the *Puerto Rico Energy Cooperatives Law* and the *Puerto Rico Energy Public Policy Act*, which brought new hopes to increase renewable energy production in the archipelago. However, while "natural" gas has been argued as a "transition fuel" to renewables, Washington, DC congressional representatives, fiscal oversight members, and PREPA's 2019 Integrated Resources Plan mainly have supported methane gas infrastructure, leaving questions unanswered regarding renewables in this process (Brown 2020; Galluci 2020; Massol-Deyá 2019; Sanzillo 2020).

Following the goals to privatize PREPA, in June 2021, LUMA Energy became PREPA's new operator of the administrative, transmission, and distribution systems. This US-Canadian joint venture has caused many strong reactions in the archipelago, as its policies have impacted workers' retirement funds, among numerous other problems (de Onís and Lloréns 2021). While some were hopeful for LUMA to address PREPA's challenges as an external entity, discontent toward LUMA resulted from the company's inability to address PREPA's challenges, including concerns with corruption, energy injustice, and residents' participation in democratic and inclusive processes to decide their energy future (O'Neill-Carillo et al. 2019; Onís and Lloréns 2021). Likewise, energy bill increases, as well as the lack of plans proposed by LUMA or PREPA to increase renewables, including for low-income communities across the archipelago, caused great problems (Kunkel 2021; Echevarría et al. 2021; Sanzillo 2020). For example, the Institute for Energy Economics and Financial Analysis and the nonprofit CAMBIO (amongst others) have raised these concerns as the Puerto Rico Energy Bureau considers allocating \$14 billion that has been designated for Puerto Rico's power grid (being the only US jurisdiction with such funding) (Kunkel 2021). Moreover, not being able to control constantly reported power outages across the island (including several regional outages that lasted more than a day) is common (*El Nuevo Día* 2022; *Primera Hora* 2021). Yet, in the first year as operator, LUMA requested seven electric rate increases, representing a 53 percent increase (The Associated Press 2022). To put this figure into perspective, in December 2021, the kilowatt hours charge was 21.8 cents and increased to 33.4 cents, while the US average electricity rate is 14 cents per kilowatt hour (US Energy Information Administration 2021, 2022; The Associated Press 2022). In response, the Electrical Industry and Irrigation Workers Union, along with allies from different organizations and frustrated residents, have organized strikes against LUMA and the Puerto Rico government for reforms that can attend to their compounded challenges (Onís and Lloréns 2021; Alvarado 2022).

Although LUMA and PREPA have done little to increase renewables in the archipelago, stakeholders from the environmental non-profit sector and academia have worked to call attention to and reduce this gap. Made public in February 2020, *Queremos Sol* is a proposal that aims to bring a public policy for 100 percent renewable energy, mostly in the form of distributed rooftop solar. The short-term goal is to have 50 percent of electricity come from solar energy by 2035 and 100 percent by 2050. This proposal also strives to support local economic development through job creation and resilience to extreme weather events, with goals such as increased public participation, a new governance model for PREPA, and a development model that seeks to support local economic development. This proposal is similar to other efforts at smaller scales, such as *50conSol*. This additional project in the central mountain's municipality of Adjuntas also aims to "empower marginalized communities in

Puerto Rico through local control of resources,” having “energy self-sufficiency” as a “first step towards decolonization” (Massol-Deyá 2019, 272). These projects represent alternatives to address the reliability of electricity services, local economic growth, environmental protection, and community well-being.

In the last four and a half decades, having oil at the forefront of electricity production became a burden for the Puerto Rican economy, environment, and local residents. Here, PREPA's administrators are at the center to continue colonial legacies that affect communities and their natural environments. Although there have been federal government mandates and public policy to increase renewables, these legal pledges have been performative and not implemented in practice. Instead, the energy crises have been used to push projects that cause environmental harms (e.g., Vía Verde), to bring renewable technologies that do not account for local concerns (e.g., wind turbines), and to advance privatization without concrete plans to increase renewables (i.e., LUMA Energy). Parallel to these administrative decisions, this period is characterized by the impacts and activism from environmental grassroots and allies whose research, proposals, and groundwork provide alternatives to reduce these environmental and human harms, while bringing economic alternatives. Considering the impact of hazards (e.g., hurricanes, earthquakes) on the electrical system in recent years denotes the central role that access to clean and affordable energy plays for residents' well-being and the vulnerabilities of the existing electricity generation and transmission and distribution system. In this sense, the battle for diversification represents top-down and bottom-up projects that serve different interests for the future energy-scape in Puerto Rico and its people. With the search for alternative electricity fuels, control over resources (in this case, electricity fuels) and power are fundamental in determining which projects (e.g., “natural” gas versus solar) will advance Puerto Rico's future.

Discussion: Linking Past, Present, and Future Energy-Scapes

The main questions guiding this essay address what can past decisions in selecting electricity fuels and associated infrastructure teach us about Puerto Rico's present and future energy-scape. Throughout the historical events previously discussed, there are four important lessons. The first lesson from the past to contextualize Puerto Rico's current energy situation is that external demands have guided the selection of electricity fuels. From the 1900s to 1970s, the decisions to increase hydropower and later transition to petroleum were guided primarily by the demands for modernization and industrial development. Industrial development was driven by the US view of Puerto Rico's economic dependency on private industrial capital and foreign business, alongside promises of economic growth for the archipelago. From the 1980s to 2021, demands came as a result of the 1970s oil crisis, an economic crisis in the archipelago, environmental and academic claims of burdens from fossil fuels, the impact of climate hazards on the electric grid, and PREPA's fiscal mismanagement. While the former demands represent the imposition of ideas and modes of development, the latter includes responses to these decisions in the search to implement alternative electricity sources, considering past challenges. However, these alternatives have been largely ignored, resulting in only 2.5 percent of electricity coming from renewables.

A second lesson from this historical overview is that prioritizing capital (through different justifications) leads to social and environmental harms. Historically, in Puerto Rico, there has been a prioritization of capital over social and environmental harms because the development model is dependent on imports and intended to be controlled by and benefiting external forces, with local political leaders supporting this process. In this way, when viewing electricity fuels as resources, fossil fuels are attached to external stakeholders that prioritize profits, leaving local and environmental well-being out of main concerns. Therefore, for the present and future energy-scape, if the goal is to adhere to local claims and research, future electricity fuel decisions will need to develop plans that balance economic, social, and environmental factors.

Focusing on the past 40 years, a third lesson is that implementing policy to support renewables does not translate into action. Examples of this include Fortuño's energy policies in 2010 and Rosselló's 2018 *Puerto Rico Energy Public Policy Act*. These policies and others have been signed in response to federal mandates and local events, such as electric grid impacts from Hurricanes Irma and María. However, the lack of proposals (or proposals that do not consider local concerns and scholarly research) represent vague "pledges" for action, while residents and their natural environment pay the consequences of not implementing them. Linked to action and the future energy-scape in Puerto Rico, this work shows without a shift in local decision-makers, including political leaders, and overall administration to acknowledge and move forward local demands and proposals, the future energy-scape will continue to be one dominated by fossil fuels that ignores environmental conservation and local well-being. The continuance of top-down decisions in favor of electricity fuel sources such as "natural" gas could lead to similar environmental concerns raised by the Vía Verde pipeline.

As a fourth lesson, in the context of PREPA's weak physical infrastructure and climate change, not considering renewables could bring another significant migration wave. After Hurricane María, more than 100,000 people left the archipelago, and approximately 4,000 died due to this disaster's direct and cascading effect on the electrical grid and built environment. With the growing intensity of hurricanes, more hazards are likely, and supportive infrastructure will be needed to avoid or to at least mitigate future disasters.

Historical political ecology and environmental justice also open an opportunity to reflect on what a shift towards renewables could mean for current fossil fuel providers. Calling into account the economic benefits for external and private corporations, a change in electricity source to increase renewables, such as solar generation, would impact power relationships at various levels (e.g., private generation companies and PREPA; residents and PREPA; bondholders and PREPA). In other words, a shift toward renewables is prone to expand energy governance stakeholders challenging established decision-makers and potentially challenging contract arrangements (i.e., economic source). For the environmental justice movement, in communities such as those in southern Puerto Rico, acknowledging the racial demographics, economic cruelties in the region, and grassroots claims for a shift toward renewables signifies new opportunities for this area that range from economic (e.g., green jobs) to social (e.g., technical education about renewables) to environmental (e.g., preservation of the estuary bay and similar ecosystems). Additionally, there would be opportunities for their local knowledge to be at the center of these decisions and hence support local well-being rather than have external impositions. In this sense, while there is conscious decision making that perpetuates

environmental injustices that sustain economic interests in the southern region in the past 70 years, changes in electricity fuel and infrastructure have the potential to bring new opportunities for this region's lands and peoples.

While communities and households are making tremendous efforts to bring renewable alternatives to Puerto Rico, historical political ecology and environmental justice frames allow us also to reflect on the important role that political leaders play in determining electricity fuels. In this sense, political leaders who value human livelihood and ecological well-being over capital are critical to scaling up these initiatives. Individual or community organizing efforts, while addressing much needed energy services, if not scaled up, leave external stakeholders and local politicians space to continue to damage natural resources for economic goals disguised as local wants (e.g., energy security). Therefore, engaging more in the political arena through political leaders that align with democratic values and benefits of renewables can potentially influence decisions that can lead to transformative ways of thinking about increasing renewables and bringing economic goals to the archipelago. Along with support in the political arena, mobilizing as environmental organizations have done in Puerto Rico presents another critical step to increasing renewables, as mobilization in the past has influenced public policy and stopped negligent projects. Although it is outside the scope of this work, forcing the resignation of former Governor Rosselló during the summer of 2019 is an example of potential collective action toward supporting a united agenda.

Conclusion

There is a famous saying that people who do not know their history tend to repeat it. This work has presented the political dynamics and environmental impacts that utilizing fossil fuels has brought to Puerto Rico's people. The archipelago's colonial relationship with the United States, mismanagement of funds, and neglect of the petitions presented by environmental justice activists provide a backdrop for discussing challenges toward increased use of renewables at large scales in Puerto Rico. Issues of power and control of resources have been at the center of these conversations throughout time. The challenges have increased because the prioritization of economic development goals has led to an electrical system that does not respond to many local claims and research findings. A key lesson from these historical accounts is that when decision-makers design and implement models that do not address local needs and concerns, this oversight will result in extractive agendas, while leaving the cascading negative impacts to residents. In this sense, the usage of historical political ecology and environmental justice perspectives serves as lenses to explore the development of extractive agendas throughout time, including their impacts on local communities and natural environments. At the same time, this focus creates space for an informed reflection on lessons learned for present and future energy-scapes in the archipelago and beyond.

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NOTES

¹ PREPA also has 48 distribution centers, 293 distribution substations, and 27 technical offices. For more on PREPA's structure, see INESI (2018).

² For more on these discussions, see Schlosberg 2007; Walker 2006.

³ For more on PREPA's and Puerto Rico's public debt see Smith-Nonini 2020 and Joffe and Martinez 2016.

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