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Term: Summer 2018
May 29,2018

Rethinking Puerto Rico's Electricity Grid

Puerto Rico's Electricity Grid has been dysfunctional since the 1940's, long before Hurricane Maria even touched its shores in late September, 2017 [1]. Hurricane Maria only delivered the killing blow to a system that had long been teetering on the edge. The weakness of Puerto Rico's grid has been the result of the political nature of the body that oversees it. The Puerto Rico Energy Power Authority (PREPA) is a public utility with a loosely regulated monopoly on the electricity markets of Puerto Rico. Its public status means that many of PREPA's top officials have, in the past, been politically appointed. This coupled with the corrupt spirit of some appointed government officials has caused the state of PREPA to be in a constant state of flux that depends on the ruling party of any particular term. This fact has turned energy into a political issue.

One of the most important challenges to providing Puerto Rico with a consistent, affordable source of energy in the past has been the fact that PREPA's administrators have been negligent in their maintenance of the power grid. This severe negligence has led to a civilians death [2]. Illustrative examples of this mismanagement include a particular year during the month of December, when PREPA executive officers increased the electricity rates by 4¢/kWh in order to subsidize Christmas bonuses for all of the PREPA employees. Top public officials in the utility have even gotten away with pocketing a salary of$1,000,000 over the course of 3 years [3]. For these reasons the residents, industry leaders and even other public officials of Puerto Rico have lost faith in PREPA's engineering capabilities and its role as a public utility for the benefit of society.

Once Hurricane Maria hit Puerto Rico, the power grid was completely decimated and 75% of the population was without electricity for 4 months. Currently there are still around 144,000 people without reliable electricity [4].PREPA, and Puerto Rico in general , has been operating under deficit for several years before Hurricane Maria hit [5]. As a result, it does not

have the money to repair its facilities and it is currently relying on federal funds from the Financial Oversight Board for Puerto Rico (PROMESA) in order to rebuild its facilities [6].

The Financial Oversight Board for Puerto Rico is an entity established by Congress in 2016 in order to lift Puerto Rico from its current financial crisis [7]. The PROMESA board is very stringent on how it allocates money for Puerto Rico and has often rejected the Fiscal Plans submitted by the Government of Puerto Rico[8]. The Revitalization Coordinator of PROMESA Noel Zamot ,a fellow MIT alum, has stated in his visits to MIT that PROMESA will allocate around $9 billion dollars in order to create a model electrical grid for Puerto Rico.

As Puerto Rico takes steps to rebuilds its electrical grid the Governor of Puerto Rico and the board of PROMESA are interested in redesigning the electrical grid to be a model for the rest of the world. Knowing this, the MIT Association of Puerto Rican students reached out to the MIT Energy Initiative to see if they would be interested in hosting a conference to think about the best ways to rebuild the Puerto Rican electricity grid. In December 2018, the Governor of Puerto Rico, Dr. Keith Mitchell (Prime Minister of Grenada) and Noel Zamot (Revitalazation Chair of PROMESA) all attended a conference held by MITEI in order to think about how to rebuild the Caribbean in a more efficient way[9] . This conference has spun a flurry of projects within MIT focused on the bettering of the Puerto Rican electrical grid and Caribbean infrastructure as a whole.

Shortly after the governor of Puerto Rico, Ricardo Roselló , attended the MIT conference he decreed that PREPA would be sold and that its replacement will be a privately owned and managed electric utility [10]. Once the hardware and the private utility has rolled in, it will be necessary to build a regulatory framework within which all of these entities interact with each other and safeguard consumers interests.

My project over the summer will be to determine the best blend of generation throughout the island (Distributed vs. Centralized & Renewables vs. Non-Renewables) with the REM model developed by MITEI [11] and to determine a regulatory framework that would best help the people of Puerto Rico. The Rural Electrification Model (REM) is a MATLAB based modeling software that takes in a piece of land, identifies all relevant buildings within it and then draws out the optimal electrification scheme for that piece of land. This software is currently being used for grid & microgrid development throughout India by MIT's TATA Center. My project will involve analyzing the following: the current regulatory framework of the island of Puerto Rico,

its current generation capacity, its types of generation, the geography and the ways in which other successful regulatory frameworks have been developed and implemented there.

Over the summer I will be working with Rob Stoner(Deputy Director of the MIT Energy Initiative) and Pablo Duenas-Martinez(Post-Doc Researcher) in order to decide the best ways to implement a regulatory framework for the new Puerto Rico electric utility.. Pablo will help me to understand what the field of regulation is like, determine the best regulations for Puerto Rico and teach me how to operate the REM model towards the island of Puerto Rico. Over the summer I will also be interacting with political officials of Puerto Rico such as Glorimar Ripoll (Chief Innovation Officer of Puerto Rico) and Jose Roman (former Puerto Rico Energy Regulator) in order to determine the feasibility of our recommendations and find out what the state of the island of Puerto Rico is actually like. I also see myself interacting with Erik Limpaecher from Lincoln Labs, Marija Ilic from LIDS & Lincoln Labs, David Hsu from DUSP & Ignacio Perez-Arriaga in MITEI in order to determine the best possible blend of Distributed Energy Resources (DER's) in Puerto Rico and to implement a stress test on our proposed model for Puerto Rico that can show how it responds to future hurricanes.

Goals for the Summer

Throughout this summer I want to gain the analytical skillset to analyze an electricity grid and come up with ideas to improve its generation, transmission &distribution efficiency while maintaining rates relatively low. Also I want to learn how to determine what is the most efficient way to run such a large system (PR's electrical grid) and what are the appropriate control schemes to do so. I also want to learn from Pablo, Ignacio & Rob how to read through dense regulatory documentation and extract the necessary information from it. I believe that this skill will help me later in life if I ever want to be involved in legal affairs. I also think that by doing this project I will increase my computational skills and data sifting skills through the use of the REM model developed by MITEI. Finally, I want to be able to improve the lives of ordinary Puerto Ricans by lowering the cost of electricity for all consumers while increasing reliability.

Timeline

Week 1:

1.Logistics & Proposal Writing

Week 2-3:

1.Educate myself on the current Puerto Rico regulatory framework.

2. Educate myself on Regulation of power systems.

3. Educate myself on the electric utility regulatory and technical experience of Hawaii and other island nations.

Week 4:

1. Determine Different Type of Generation Scenarios (i.e. 30% DER's vs. 70% centralized)

2. Determine a Draft Regulatory Framework for each of the Different Generation Scenarios

3. Draft a Proposal on the Merits & Cons of all of these different generation scenarios

Week 5-Week 7:

1. Learn to use the REM Model
2. Implement REM Model to Determine Best Blends of DER Models
3. Start Draft Proposal for Regulatory Framework Based on the Best DER Model Determined

Week 8:

1. Finalize Proposal and Submit for Journal Review

Personal Statement

I am very interested in this UROP because I have been interested in Puerto Rico's electricity grid situation since I was a high schooler. I have lived in Puerto Rico for the majority of my life and my housing district is in a "dispensable" area, which meant that I used to spend at least 15 days per year without electricity. Many of Puerto Rico's residents need to worry on a constant basis on whether or not they can pay for their own electricity bills due to the ever-increasing & volatile electricity rates set by PREPA. I would like to help the citizens of Puerto Rico by helping to craft a regulatory framework that can provide them with the cheapest and most reliable form of electricity possible.

References

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