Using Sun and Wind to Combat Caribbean Hurricanes.

Posted by Okachinepa 07/11/2024

Courtesy of SynEvol
Credit: Andy Sproles/ ORNL, U.S. Dept. of Energy

When hurricanes threaten tropical coastlines, "super grids" may come to the rescue.

Caribbean islands are beginning to turn away from importing expensive fossil fuels and toward harnessing their own abundant sun and wind to generate electricity. However, their regular hurricanes might have a negative impact on solar energy generation. Researchers at the Department of Energy's Oak Ridge National Laboratory created a comprehensive modeling system to better estimate the reduction in electricity generation when storm clouds obscure solar panels. The researchers investigated how to compensate for these energy losses using super grids, which are a network of interconnected grids that allow electricity to flow across island chains or between continents.

According to lead researcher Rodney Itiki, this type of infrastructure planning is critical to ensuring fair access to energy in the Caribbean's 12 island governments, as well as the US territories of Puerto Rico and the Virgin Islands. The historically underserved island population are unable to readily flee from the path of the numerous hurricanes that hit the Caribbean each year. The loss of solar energy during hurricanes is projected to become more crucial on islands such as Puerto Rico, which has set a goal of converting to 100% renewable energy by 2050.

Itiki's model can be used to analyze the effects of hurricane clouds on any electrical system. In this study, he and his team of experts in grid integration, renewables, and sophisticated computing technologies applied his algorithm to investigate several grid connection approaches, simulating how each might effect electricity availability. The model examined how a big cyclone would diminish power from known solar arrays while traveling along ten different pathways over 10 to 14 days.

"This is one of the major contributions of the research, because when we design the power system, we must consider all possible cases, most notably the worst-case scenario," said Itiki, a postdoctoral research associate with ORNL's Power Systems Resilience group.

Researchers used models to see how much power would be available during hurricanes if electric grids were connected via high-voltage cables on the ocean floor. To determine whether these super grids would balance energy flow between regions, the team simulated four different scenarios: a standalone U.S. grid, a standalone Caribbean super grid that linked all of the islands, a U.S.-Caribbean super grid, and a super grid that connected the U.S., Caribbean islands, and South America.

The greatest super grid arrangement featured 90 photovoltaic plants along the storm belt, as well as solar farms in non-hurricane-prone areas such as California and Brazil. The model showed that some solar facilities lost up to 88% of their generating power for two days while being shadowed by hurricane clouds.

Researchers discovered that the US-Caribbean supergrid improves power reliability the greatest. The solo Caribbean super grid was least useful, in part because storm tracks usually coincide with the chain of islands. The South American addition had little effect on electricity variability because the continent has few solar plants. However, it might provide energy security as an alternative power source if the islands were cut off from one another or from the US system.

Itiki was intrigued as a doctoral student by the successful undersea link between the United Kingdom and Germany's energy grids. He investigated the possible advantages of similar links until a 2017 natural disaster limited his geographic scope.

"Soon after Hurricane Maria hit Puerto Rico, I started thinking about interconnecting Puerto Rico with Florida," Itiki told me. Maria left some Puerto Ricans without power for nearly a year, the longest blackout in US history.

Itiki's primary focus was wind energy during hurricanes. He investigated how a US-Caribbean super grid could lessen power outages caused by hurricanes that damage Puerto Rican wind turbines. After turbine technology improved, he investigated how a surge of hurricane wind energy could be distributed throughout the Caribbean, the United States, and South America.

Itiki plans to use his solar and wind algorithms to assess how super networks could significantly improve electricity reliability in both the Caribbean and the mainland. For example, during a major weather event in the United States, could the Caribbean grid supply additional power to the country?

The findings have far-reaching consequences for the United States' energy independence from fossil fuels, as well as for the reliable integration of renewable projects. "I don't think people are planning photovoltaic [solar] plants while taking hurricane shading into account," Itiki told me. "Utilities select areas with the most sun exposure, but they must also consider hurricanes' typical trajectory. If all the plants are concentrated in Florida and a hurricane strikes, it will result in a maximum power valley."

Itiki stated that more research is needed to determine the environmental and economic sustainability of building submarine cables. Even without these interconnections, Itiki's model provides an important new tool for calculating solar energy during harsh weather and constructing compensatory transmission systems. Utilities might utilize the algorithm to plan for the solar energy shortfall during storms, utilizing options like batteries or pumped-storage hydropower.

https://synevol.rf.gd/index.php?file=News&op=index_comment&news_id=746.