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Our Power Grid Must Be Reliable and Resilient

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When Hurricane Irma slammed into the Florida coast, it caused one of the largest natural-disaster related power outages in U.S. history. The blackouts were far worse than those caused by previous hurricanes that hit Florida.

The damage caused by Hurricane Irma emphasizes the need for a power grid that is both reliable and resilient.

What is the Difference Between Reliability and Resiliency?

I live in a rural area in New Jersey. Our power is delivered to our home via elevated wires carried by telephone poles. The wires run under thousands of tree branches on their way from our local substation to our house.

Our power company regularly trims overhanging tree branches to prevent them from falling on power lines and breaking them. However, it is not unusual for a tree to fall on the power lines and to cause a power disruption. We suffer a power outage usually one or more times per year. Oftentimes, the power is restored by utility crews in a matter of hours. Sometimes it may take days.

We have a generator that is wired into the house that provides power to critical systems such as our water pump, furnace, and refrigerators. That keeps us going unless there should be a power outage so long and so severe that we can't get gasoline for the generator. So far, that hasn't happened.

Our street is served by two power routes. One comes in from the left and terminates a few houses past ours. The other comes in from the right and picks up where our power line ends. During one recent power outage, we were without power for several hours. However, the homes down the street that were served by the other power line were without power for two weeks.

Reliable power is power without interruptions. When we flick a light switch, we expect the light to turn on. This is power reliability.

Resilient power means that a power outage is quickly restored. If it takes an hour to restore power following an outage, this is power that is somewhat resilient. If it takes days or weeks to restore power, then power is not at all resilient.

How Can Reliability and Resiliency Be Improved?

There are two methods that are being employed to improve both the reliability and resiliency of power. Though in their early stages of deployment, it is expected that these techniques will be increasingly used in the future.

One technique is microgrids. A microgrid is a small electric grid that services a small community of users. It generates power via its own generators or via renewable resources such as solar and wind (or a combination of these techniques). It is normally connected to the larger electric grid and supplies excess power that it may generate to the grid. However, should the primary electric grid fail, the microgrid disconnects from the main grid and continues to service its own community of users.

Customer-sited energy storage is another technique. The installation of on-site residential and commercial energy storage systems (750 kwh batteries) are increasing every quarter, spurred by the falling prices of large battery technology such as lithium ion batteries. Paired with microgrid technology, on-site energy storage can protect critical infrastructure, help businesses stay open and keep the lights on during power outages.

Irma's Power Outages Worse Than Previous Hurricanes

Unfortunately, microgrid and on-site storage technology has yet to make it to the forefront. These techniques were not yet available to protect the power grid when Hurricane Irma hit the U.S. Hurricane Irma caused far more damage to the power grid than did earlier hurricanes. In 1992, Hurricane Andrew knocked out power to 1.4 million people. In 2002, Hurricane Wilma caused 3.2 million Florida Power and Light (FPL) customers to lose power, the largest in the company's history to that point. In 2012, Hurricane Sandy cut power to 8.2 million households in seventeen states along the Eastern seaboard.

Irma crushed that record. FPL serves 4.9 million customers, half of Florida's residents. The storm caused 4.5 million FPL customers to lose power. All in all, half of Florida's 20 million residents lost power due to the storm. 80% of FPL accounts in Miami-Dade County were affected, as were 70% of all accounts in Palm Beach.

Especially hard hit were the Florida Keys. The Governor of Florida urged everyone in the Keys and in southern Florida to evacuate to the north, and many did.

Other states up the East Coast suffered as well. One million Georgia residents were without power.

FPL proactively shut down certain substations before they flooded so that they could be recovered more quickly. It shut down one of its two nuclear reactors near Homestead Air Force Base in southern Florida, but kept the other reactor active, as it did with its other nuclear reactors across the state.

Irma has set the record for power outages except for two failures that were helped by human failings. In 1965, most of Connecticut, Massachusetts, New York, and Rhode Island lost power when a power line went down and the remaining lines couldn't handle the extra load. Thirty million people were affected. 800,000 were trapped in the New York City subways.

A mass outage in 2003 took out power to about fifty million people when an overheated power line sagged into trees. An emergency alarm system that should have notified staff that a power line was lost failed. The result was that the power was shifted to other power lines, which then overheated and failed. This resulted in the largest blackout in the history of North America.

FPL Warned That Restoration of Power Could Take Weeks

FPL warned customers and businesses that restoration of power to more than two million homes could take weeks. As it did after Category 5 Hurricane Andrew struck Florida in 1992, FPL noted that its crews could not get out and begin restoration activities until the hurricane had passed. Not only was Florida power not reliable, it was not resilient.

Power workers came from California, Massachusetts, Texas, Colorado, and Wisconsin to help FPL with its power restoration efforts.

FPL set priorities for power restoration:

1. Its own power plants, substations, and damaged transmission lines.

2. Critical facilities such as hospitals, police and fire stations, communication facilities, water treatment plants, and transportation providers.

3. Major thoroughfares that host supermarkets, pharmacies, gas stations, and other needed community services.

Puerto Rico Gets Hit Hard – Twice

The island of Puerto Rico is heavily in debt. It has accrued more than USD $70 billion in liabilities and an additional USD $50 billion in pension obligations. Because of this debt, Puerto Rico has been unable to build resilience into its power grid.

As a consequence, when Hurricane Irma skirted Puerto Rico to its north, a great deal of the Puerto Rican power grid was decimated, leaving the island with little power. Hurricane Maria followed on the heels of Hurricane Irma and took out the rest of Puerto Rico's power infrastructure.

As of this writing, Puerto Rico is totally without power anywhere on the island. Clearly, Puerto Rico's power grid is neither reliable nor resilient.

Critical Application Availability

No matter how protected we think our systems are from power failures, we must always protect our most critical applications from the unthinkable. We must have backup systems that are geographically remote from our production systems to which we can failover should we lose a production system. As Hurricanes Irma and Maria showed, having one system in the Florida Keys and one in Miami is not going to provide the needed protection.

Rather, backing up a production system in Florida with a backup system in Michigan is a much better plan. It is unlikely that a single disaster would affect both systems separated by this distance.

Summary

Massive power outages caused by hurricanes and other natural disasters such as the devastating earthquake that recently hit near Mexico City can be ameliorated through the proper deployment of systems that can make power more reliable and resilient. Microgrids can continue to power their local communities even if the major power grid should shut down. On-site storage facilities can continue to power their sites in the absence of power from the power grid.

Acknowledgements

Material for this article was taken from the following sources:

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