Using the
Hidden In Plain Sight™ (HIPS)
Wind Energy System
to
Achieve Storm Resiliency

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BACKGROUND

Extreme Climate Events

The intensity and frequency of extreme weather events seems to be increasing, placing pressure on coastal and island communities to strengthen their coastal resiliency[1]. Simply put, a community's resiliency describes their ability to bounce back after a major storm. To the extent a community's infrastructure recovers and resumes operations more quickly, the more suffering can be avoided and the quicker quality of life can be restored. This was highlighted during the 2017 Caribbean Hurricane season with multiple, back to back extreme storms. When Hurricane Maria made landfall in Puerto Rico while the people there were still assessing the damage from Hurricane Irma days before, the result was catastrophic. "For months, most families and businesses remained without power, cell phone service was limited, and clean water, food, medicine and fuel were all in very short supply — for some, the struggle to access such basic essentials is still a daily reality. Less than half of residents had their power restored two months after the storm had passed. For many, it will take years to fully recover."[2]

Performance of Other Power Generation Technologies

Communities rely on a diversified array of fossil fuel and renewable power producing technologies to provide for its energy needs. However, extreme climate events highlight the weaknesses of all power producing technologies. Furthermore, the portfolio of power production may appear diversified, but if the technologies share the same vulnerabilities, then the entire portfolio remains vulnerable. This is what we saw in the Caribbean during the 2017 Hurricane season. Many communities diversified their generation across wind, solar and traditional fossil fuels. But all of those generation technologies proved unable to survive the sustained extreme conditions of the Category 5 hurricanes and so the entire energy infrastructure was vulnerable. Transmission lines were destroyed, blades ripped off wind turbines, and solar panels torn apart.

[1] Natural Disasters and Improving Community Resiliency: Proactive Energy Approach, Dickerson, Feb 2018

[2] https://reliefweb.int/report/puerto-rico-united-states-america/quick-facts-hurricane-marias-effect-puerto-rico

Consequently, after the storm passed, the power production and transmission components were so badly damaged that these then isolated island communities, lacked the infrastructure, specialization and material to restore functionality.

Challenges of the Transmission Infrastructure

Even with the diversified generation portfolio, most communities still rely primarily on centralized, capital intense fossil fuel based power plants and the network of transmission lines that accompany them. Power poles and lines are unable to survive the high winds, areas of dense vegetation, and flooding and therefore present a significant threat to service during a severe storm and an obstacle to recovery afterwards.

Dickerson observed, “Using Puerto Rico as an example, much of the generation is on the coast and quite vulnerable to hurricane damage. Most of this generation is also remote from the loads. Consequently, vulnerable overhead transmission and distribution lines are required to deliver energy to critical loads. The efficacy of hardening the existing system to the point that critical loads are quickly recovered is highly questionable, and comes at a high cost. As an alternative, microgrids could be developed near the critical loads to avoid the vulnerability of long transmission and distribution lines.”

Lessons Learned

From the eastern Caribbean to the Gulf Coast of the Continental US, it was clearly evident by the time the damage had been done during the 2017 hurricane season that there was much room for improvement. Any solution would have to be able to survive catastrophic natural events and limit reliance on London distance, vulnerable transmission lines. More importantly, in order to enhance rather than hinder a community’s storm resilience, every component and sub-system of the energy infrastructure would have to possess a certain set of attributes. We can apply these lessons specifically to wind energy.

Survival of winds in excess of 200mph (90m/s)

- First and foremost, all systems and components used in a threatened community must be designed to survive a Category 5 hurricane. Similar standards are used in other industries; for example, the seismic rating on communications gear used in communities located in seismically active areas, or 100 year snow loads for roofs on buildings in locations subject to snow storms. For the case of a wind energy system, designing to survive Category 5 winds (155 mph) is not enough. Hurricane Irma exceeded these speeds (it reached 180mph for 37 hours) and it is reasonable to expect storms with winds reaching 200mph in the future as a result of the climate change induced intensification of weather phenomena.

Operation immediately after a storm.

- Once the storm is passed, the role of the distributed generation equipment changes from complementary to primary source of power. For a wind energy system intended as a component of a storm resiliency plan, this means that it must start producing at very low wind speeds and reach rated power quickly. To translate that to wind energy system specifications, Rated Power Wind Speed must be between 12 - 15 mph (5.5 - 6.5 m/s) and Cut In Wind Speed should be much less than 10mph (4.4 m/s).

Fault Tolerance

- All systems in the storm resiliency plan, including the wind technology, should be designed for mission critical applications, with (a) fault tolerance resulting from redundant drive components so that the equipment continues to operate even in a compromised condition; (b) spares on the ground with a team ready nearby who possesses the skills to maintain and repair the equipment; and, (c) designed such that local generalized trades can be trained to maintain and service the equipment.

Distributed Generation

- Power generation must occur local to the population needing the power. The closer the power source, the less dependence on transmission infrastructure and the smaller the probability community members will be unable to access power produced due to inability to connect. Ideally, the source of power generation should accommodate direct connection in the event of an emergency to service the immediate vicinity while the transmission infrastructure is under repair.

IMPROVING COMMUNITY STORM RESILIENCE WITH THE HIPS™ WIND ENERGY SYSTEM

Behind Hidden In Plain Sight Wind Energy Technology

CBC Wind Energy's HIPS technology provides community scale (20kW - 160kW), distributed wind generated power for community micro-grids. It is designed to be deployed in scalable wind farm arrays, provide power security communities in locations world-wide.

The HIPS System is designed to survive environmental extremes, while significantly outproducing similarly name-plate-rated state-of-the-art solar and wind turbine technology.

The principle behind wind turbines is simple: to generate more energy, intercept more wind. Traditional wind turbines do this by increasing the size of the turbine's blades. But this approach is self-limiting. It requires more energy to move the blades. Big blades become less reliable, make more noise and on and on. Big blades require complicated gearing, pitch, yaw and braking mechanisms that degrade reliability, complicate service and maintenance and increase the probability of failure. So we relegate them to remote locations; in the ocean or on mountain-tops. Doing so requires a vulnerable transmission infrastructure to transport the power back to the population consuming the power.

CBC Wind Energy's HIPS technology re-imagines wind energy.

The keystone element of the system is its stationary wind concentrating enclosure. It intercepts a greater amount of wind energy without increasing the size of the blades. It collects wind from all directions without having to be pointed into the wind; and it increases performance by creating a vortex in its dynamic chamber. The dynamic chamber changes size and shape as the wind speed and direction change to constantly optimize airflow on the rotor.

Sure, the enclosure dramatically increases performance, but it also eliminates the noise, complexity, and unsightliness of traditional wind turbines and so the HIPS technology operates harmoniously with the people and wild-life it serves and with which it co-exists. It's also much more durable and fault tolerant than traditional wind turbines and so can withstand extreme winds, harsh environments and intense temperatures. The enclosed rotor technology of the HIPS system revolutionizes renewable energy.

Surviving Winds in Excess of 200mph

Since the HIPS technology relies on a stationary enclosure instead of a large moving mass of blades to intercept the wind, the enclosure can be scaled and strengthened to survive extreme winds. Essentially, the enclosure of the wind turbine is a structure, a specialized building housing the rotor, designed and built to survive a Category 5 hurricane.

Using an enclosure to house the rotor lends itself in other ways towards withstanding Category 5 force winds. For instance, the rotor is supported at two points, top and bottom, distributing the load over two points versus at one, central complex hub (where all the forces are concentrated and is subject to failure). Consequently, the rotor is supported independently from the power and drive system meaning that the system is not relying on the drive components to absorb the forces of the mechanical supports.

All these factors result in a system that is more fault tolerant than the larger moving mass of blades intercepting the same amount of wind, one that can survive Category 5 hurricanes.

Low Rated Power and Cut In Wind Speed

Using the stationary enclosure to intercept the wind lends itself to providing storm resilience in two other ways. First, the rotor, i.e., the moving mass, is lighter and requires less wind to start it moving and so the system is much more productive in low wind speeds. And when deployed in concert with storage devices, it becomes a distributed generation power station capable of powering mission critical applications immediately following natural disasters.

Second, the enclosure of CBC Wind Energy's Hidden In Plain Sight Wind Energy System optimizes airflow around the rotor. At the center of the enclosure is a dynamic chamber which changes size and shape in response to changes in wind speed and direction. It focuses the wind energy on the rotor and creates a vortex around the rotor. Consequently, the system is much more efficient than traditional wind energy systems and reaches rated power at lower wind speeds.

Fault Tolerant

As the role of the Wind Energy System migrates from complementary to primary power source, approaching one-hundred percent uptime becomes more important. To achieve maximum uptime, system design must address three sources of downtime: component failure, wait time, and repair time.

Downtime due to component failure can be minimized through system design; use materials that are known and readily available, avoid complicated mechanisms and delicate components, make the system simple to maintain. Onerous maintenance plans are difficult to meet. Complicated mechanisms are more subject to failure and difficult to replace. Designing the system to maximize Mean Time Between Failure (MTBF) by definition results in maximum uptime.

But even the designs must plan for failure of critical components. Redundancy is the answer. And while the redundancy of power stations inherent in a Distributed Generation infrastructure is important, redundancy within the wind energy system also has its place. The HIPS system is unique in this respect because its rotor is supported independently of the drive components, and can therefore utilize multiple independent power generators. For example, each 100kW Mission Critical HIPS unit would feature five independently operated 20kW generators. In the event one of the generators fails, the generator can be quickly disconnected, the other generators pick up the load maintaining output until the failed generator can be replaced.

Designing the system such that local, general tradespersons are capable of maintaining and servicing the equipment is the last piece of the puzzle. Critical spare parts can be kept close by. Local talent can be used for regular maintenance ensuring the the equipment is ready when needed. More importantly, the community can eliminate the need to wait for specialists to be transported into the disaster zone to make repairs after the catastrophic event.

Distributed Generation

By locating HIPS Systems in and around populated areas, the required reach of the transmission infrastructure is dramatically reduced and therefore so is the probability that the transmission lines will be broken.

After extreme weather events have passed, having a locally accessible power source allows impromptu connections to make due while the efforts to rebuild and restore power are underway.

CONCLUSION

The Hidden In Plain Sight Wind Energy Systems are designed to enhance the storm resiliency of communities threatened by extreme weather events. The HIPS System is designed to survive a Category 5 hurricane and then function as a primary power source in low wind before and immediately after the storm. It's simple, durable, redundant yet high performance design can be deployed solely, or as a component of distributed generation interconnected in microgrids. Used in conjunction with other new microgrid, storage and intelligent metering technologies, the HIPS systems distributed generation to enhance and fortify the storm resilience for entire at-risk communities.