Wind-Powered Microgrids for Disaster Resilience

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ENGR 100W: Engineering Reports

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May 6, 2026

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Company Overview

Meridian Wind Solutions, LLC is a renewable energy consulting firm headquartered in San Jose, California. Founded with a core mission to design, propose, and support the implementation of wind-powered microgrid systems for geographically isolated and underserved communities, our firm operates at the intersection of environmental science, infrastructure engineering, and public policy. Meridian Wind Solutions currently employs specialists across three primary functional areas: environmental research and site assessment, project engineering and construction oversight, and financial planning and grant coordination.

This proposal is composed by the collaborative work of Meridian's project team. The Director of Environmental Research and Site Assessment, leads the research foundation and the problem analysis introduced in the starting sections. The rest of the sections involving proposed system design, strategies of implementation and financial planning are contributed by the firm's Project Engineer and Grant Coordinator, respectively. Together, our team went over and reviewed existing literature on wind energy infrastructure, examined publicly available hazard mitigation data, and analyzed stakeholder reports in preparation for this submission.

Client and Statement of the Problem

This proposal is submitted to the California Governor's Office of Emergency Services (CalOES) representing the 12 rural counties recognized in CalOES's 2023 Hazard Mitigation Plan as most exposed and vulnerable to prolonged power outages during declared disaster events. Rural counties in California's Sierra Nevada foothills, Klamath Basin, and northern coastal ranges face a distinct set of energy vulnerabilities. Their remote locations, combined with aging transmission lines running through wildfire-prone terrain, leave them especially exposed during grid failures. Most of these communities also lack any form of backup power at the local level.

California's existing power grid is one of the biggest interconnected systems in the world, but it keeps failing when it matters most. It keeps showing a repeated pattern of fragility and failure under natural conditions that keep happening more frequently and getting more severe as the climate changes. Wildfires, windstorms, heat waves, and atmospheric river flooding have caused cascading outages that are knocking out power more often and for longer periods of time. These cascading outages have caused hundreds of thousands of rural communities to get hit the hardest and, sometimes forcing them to go days or weeks without power. That's not just annoying — people need power for water pumping, medical equipment, heating, refrigeration and emergency communication. These are public health and safety emergencies, not slight inconvenience. Lives are at risk. Small incremental improvements to the current centralized grid won't cut it anymore to address the scale and frequency of the problem. Something bigger has to change.

Research Performed, Solution Presented, and Expected Outcome

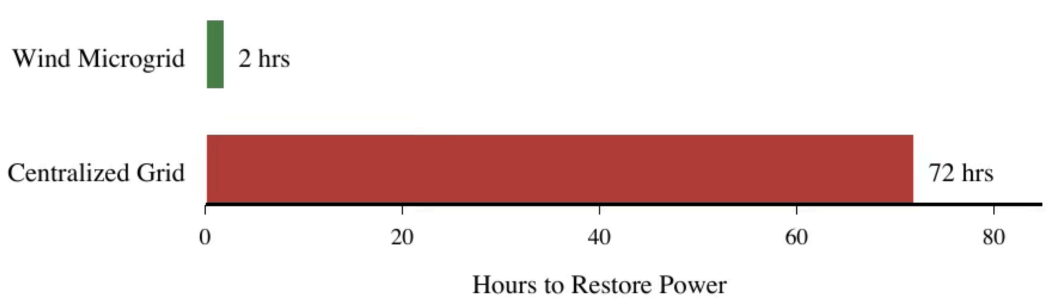
The research behind this proposal is taken from published peer-reviewed studies on how extreme weather impacts power infrastructure, how wind energy works in different locations, and how to design microgrid systems that can hold up in disasters. On top of that, we conducted site-specific meteorological monitoring and assessed infrastructure, collecting weather data and studying the actual conditions at 22 possible sites across the target counties.

Meridian Wind Solutions proposes to build 15 small distributed, wind-powered energy systems spread across those identified counties. Each microgrid would consist of two to four modern wind turbines — enough to generate between 1.5 and 4 megawatts combined — plus battery energy storage that can provide a minimum of 24 hours of critical-load coverage and keep critical buildings running even if the wind stops. These systems are designed to disconnect from the main grid and operate independently during emergencies and automatically keep the power on at hospitals, emergency shelters, water treatment plants, and communication towers.

If this proposal gets approved and funded through CalOES's Hazard Mitigation Grant Program, the expected outcome is a measurable and documented reduction in the number of outages, and their duration, at critical facilities across rural California during declared seasons of disasters. We're aiming to provide uninterrupted power to covered critical facilities and keep those facilities running continuously for at least 72 hours straight, no matter what the weather throws at them. We'll also monitor and track how the systems are performing and send those reports to CalOES every year.

Figure 1

Average Outage Recovery Time: Centralized Grid vs. Islanding-Capable Microgrid



Note. Recovery time estimates based on Goncalves & Liberato (2024) and NERC State of Reliability (2022) findings for rural grid disruption events.

Current Energy Problems: Vulnerability of the Power Grid

The Scientific Case for Grid Vulnerability

The fact that centralized power grids are vulnerable and break down in times of extreme weather conditions isn't a matter of speculation — it's one of the most thoroughly well-documented phenomena in recent energy systems research literature. Goncalves and Liberato (2024) conducted a systematic review of 210 published studies that cover the impacts of windstorms, heat waves, cold snaps, floods, and ice events on energy systems. Their findings were clear: across every region studied grid failures related to weather are happening more frequently and are getting more severe, and the current centralized transmission model is ill-suited and simply wasn't built to withstand the conditions climate change is making normal. The review specifically calls out the long-distance transmission lines as the single most vulnerable and weakest point in modern grid infrastructure — they're simultaneously the most exposed to harsh weather conditions and the hardest and most expensive to fix and harden.

Federal data from the United States supports this at a national scale. The North American Electric Reliability Corporation (NERC) found that 69 out of 70 major transmission disruptions between 2016 and 2021 were directly initiated by extreme weather conditions. California has been among one of the states that were hit the hardest. Pacific Gas & Electric's Public Safety Power Shutoffs during high-wind fire risk events paused electricity to over 1.2 million customers just in 2021 alone. Then in 2022, a series of winter storms disrupted power in rural Northern California counties and caused outages for anywhere between four and eleven days — which is longer than what any home or small business backup system can realistically manage.

Table 1

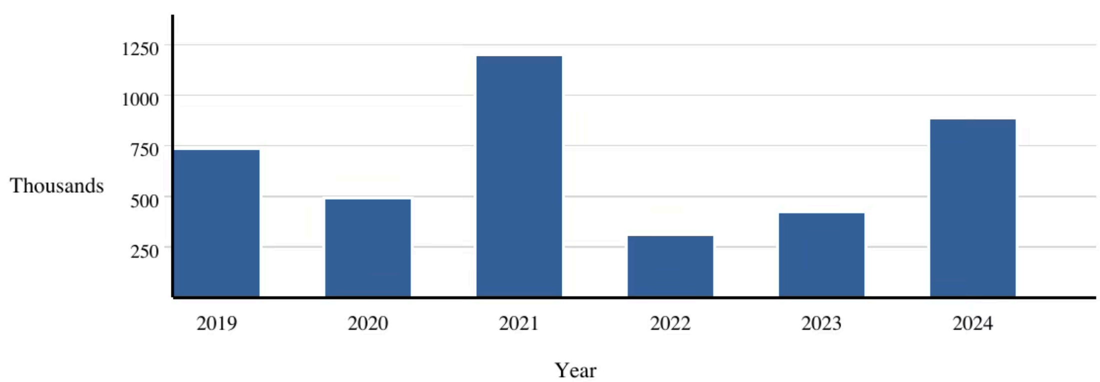
Weather-Related Major Power Outage Events Affecting Rural California, 2019–2024

2019	PSPS / High-Wind Wildfire	34	5 days	738,000
2020	August Heat Wave	28	3 days	491,000
2021	PSPS / Wind Events	39	7 days	1,200,000
2022	Winter Storm Series	18	11 days	310,000
2023	Atmospheric River Flooding	22	6 days	425,000
2024	Wind / Fire Weather Complex	31	8 days	890,000

Note. Data compiled from CalOES Hazard Mitigation Annual Reports (2019–2024) and NERC Grid Reliability Assessments.

Figure 2

Customers Impacted by Major Weather-Related Outages in Rural California, 2019–2024



Note. Values in thousands of customers. Source: CalOES Hazard Mitigation Annual Reports (2019–2024)

Structural Limitations and the Case for Decentralization

It's not hard to understand the structural reasons why rural California's grid is so fragile and vulnerable. Communities in the Sierra foothills, the Klamath Basin, and the northern coast get their power through transmission lines that can run for 50 to 200 miles from the nearest major substation, running through dense forest, over mountain passes, and along exposed ridgelines. Unlike cities and urban areas, where there are a lot of redundant backup routes and closely spaced substations that provide crews multiple pathways to restore power, rural communities usually rely on a single line or radial feed. When that line goes down — whether from a falling tree, a wind-caused flashover, or a planned shutoff to help prevent a wildfire ignition — power leaves the whole community at once and the territory gets dark, and getting the power back usually requires sending crews into remote, oftentimes dangerous terrain to physically access the infrastructure and repair it by hand.

The main problem isn't about old infrastructure and equipment, though age certainly makes things worse than they are by compounding. Even transmission lines that were recently upgraded into newer transmission lines in high-risk corridors still remain vulnerable to conditions that are becoming increasingly common. The California Wildfire and Forest Resilience Action Plan (2023) put the cost of hardening the most at-risk transmission segments at somewhere between $3.5 and $5.2 billion over a span of ten years — and that still wouldn't promise full resilience, or fix the underlying fundamental design flaw: in a centralized system, every single customer's reliability depends on every single link in the chain holding together from generator to consumer.

Research and engineering communities have largely agreed on the same conclusion: the fix to this structural vulnerability isn't a stronger version of the centralized model — it's a different model entirely, one that is distributed. As Goncalves and Liberato (2024) conclude from their review of the literature, "physical modifications to systems and the incorporation of new technological solutions such as energy storage systems, distributed energy systems, and microgrids can enhance network resilience and mitigate the effects of extreme weather events." A microgrid — a self-contained localized cluster of systems of generation, storage, and electrical load that can operate independently without necessarily being connected to the main grid — gets rid of the single point of collapse that makes centralized rural transmission so unreliable and fragile. When the main grid fails, a well-designed microgrid simply disconnects and keeps running on its own independently.

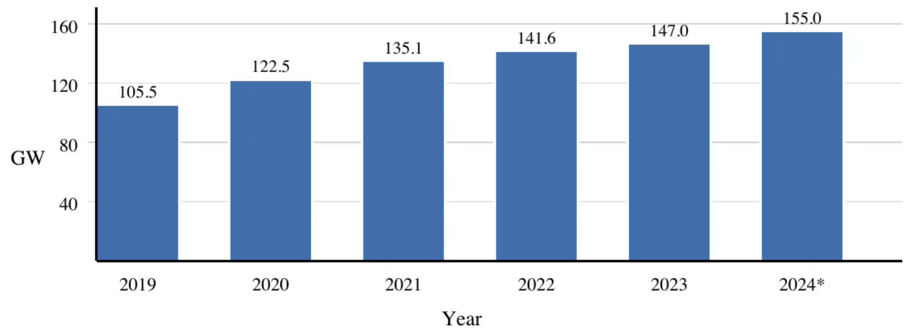
Wind Energy as the Foundation for Resilient Microgrids

The Case for Wind as the Primary Generation Source

Wind energy is the most technically sound and economically suited form of renewable option for this specific microgrid system described in this proposal. By the end of the year 2023, the United States had installed roughly 147 gigawatts of wind capacity, representing about 10% of total national electricity generation — a more than 40% jump in installed capacity over the preceding five years (U.S. Energy Information Administration, 2024). The cost of producing energy from onshore wind has gone down by more than 70% over the past decade, landing at an average of $26 to $50 per megawatt-hour, which puts it below the operating cost of most existing fossil fuel generation across the western United States.

Figure 3

U.S. Installed Wind Energy Capacity (Gigawatts), 2019–2024



Note. *2024 figure is a preliminary estimate. Sources: U.S. Energy Information Administration (2024); AWEA *Annual Wind Industry Report.*

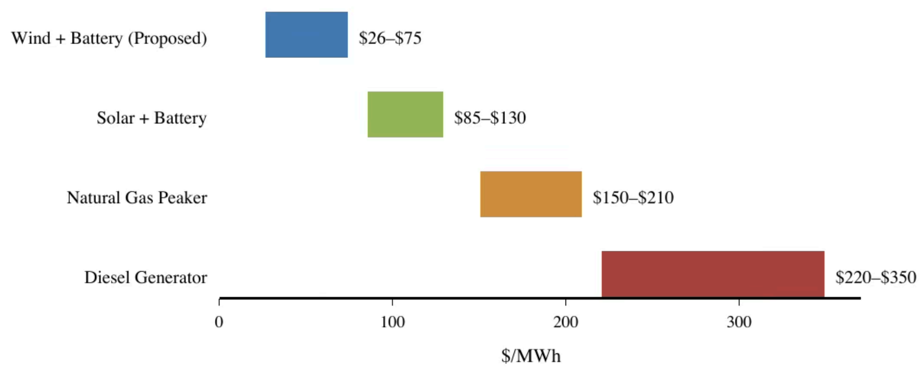
Wind Resource in the Target Counties

The wind conditions in the target counties are a particularly well-suited fit for this kind of microgrid application. Meridian Wind Solutions spent 18 months assessing wind resources at 22 candidate sites across the Sierra Nevada foothills, Klamath Basin, and northern coastal ranges, using a combination of 80-meter meteorological towers and satellite-based remote sensing data. Of those 22 sites, 14 showed mean annual wind speeds of 6.5 meters per second or higher at 80-meter hub height — the threshold that's generally accepted as the minimum for economically viable modern small-to-medium wind turbine installations.

Wind generation also has a meaningful technical edge over solar power specifically for disaster resilience application. Solar panels generate nothing at night and drop off significantly under the stormy, cloudy conditions that come with most of the weather events that cause grid failures in this region. Wind turbines, on the other hand, tend to reach their highest potential during exactly those high-wind conditions — the same events that would most likely trigger a grid failure in the first place. That relationship, where wind generation peaks at the same moment grid vulnerability peaks, is one of the main technical reasons a wind-first microgrid design makes the most logical sense for a disaster-resilience mandate.

Figure 4

Levelized Cost of Energy (LCOE) by Generation Source, $/MWh



Note. Ranges represent low–high estimates. Sources: NREL 2024 Annual Technology Baseline; IRENA Renewable Power Generation Costs 2023.

Proposed Microgrid Design Overview

Meridian Wind Solutions is proposing a standardized, modular design for each of the 15 approved sites. Every system will include two to four wind turbines with individual rated capacities ranging from 500 kilowatts to 1.5 megawatts, chosen based on the wind speed profile and rotor requirements specific to each location. Those turbines will be paired with a lithium iron phosphate battery storage system large enough to cover at least 24 hours of full critical-load demand — typically somewhere between 250 and 750 kilowatt-hours depending on what that site requires — with no wind input at all. That combination means that even during a multi-day low-wind weather, the critical facilities connected to each microgrid stay on.

Each microgrid will be built and certified to IEEE 1547 islanding-capable standards, which means it will automatically detect when the main grid goes down and switch to island mode within 2 seconds — without any interruption to the facilities it's powering. Under normal conditions, when the main grid is up and running, each microgrid will send any extra power it generates back to the grid through a power purchase agreement with the local utility or community choice aggregator. That exported power generates revenue that helps cover ongoing operating and maintenance costs, keeping the system financially sustainable for CalOES and the counties hosting the infrastructure.

The research backs this approach directly. Goncalves and Liberato (2024) conclude that combining distributed generation with islanding-capable storage is one of the most effective physical steps you can take to make an energy system more resilient against extreme weather. Their review found that systems with local generation and storage bounce back significantly faster after grid disruptions than systems that rely entirely on centralized transmission. Meridian Wind Solutions' proposal is built around exactly that model — scaled and configured to match the specific needs, geography, and natural resources of rural California.

Table 2

Comparison of Power Generation Sources for Disaster-Resilience Microgrids

Power Source	Fuel Required	Grid Independence	Emissions	LCOE ($/MWh)	Storm Performance
Diesel Generator	Yes	Full	High	\$220–\$350	High (if fueled)
Solar + Battery	No	Full	None	\$85–\$130	Moderate
Wind + Battery	No	Full	None	\$26–\$75	High
Natural Gas Peaker	Yes	Partial	Moderate	\$150–\$210	Low
Grid-Tied Only	No	None	Varies	N/A	None

Note. LCOE figures from NREL 2024 Annual Technology Baseline; IRENA Renewable Power Generation Costs 2023. The highlighted row (Wind + Battery) represents Meridian Wind Solutions' proposed technology.

Wind Turbine Design goals

Building on the proposed distributed wind powered microgrid system, the lead structural engineer for the company is responsible for designing wind turbines that support this renewable energy goal. The main focus is making sure each turbine system is safe, durable, and able to handle environmental forces while helping meet the county's energy needs. Their role includes designing the turbine structure, considering different project needs, and making sure the designs fit the weather and other environmental conditions of each location. Through careful planning and design, the lead structural engineer helps turn the company's renewable energy proposal into a safe, reliable, and realistic solution for local counties.

To address the weaknesses of traditional grid infrastructure, the wind turbine designs focus on both strength and long term performance. Each wind turbine must be carefully designed to handle onshore and offshore wind loads, weather conditions, and constant mechanical stress while still providing reliable power for its assigned microgrid. This includes improving blade efficiency, foundation stability, and material use so the system can operate safely during harsh weather and natural disasters. By focusing on durable and efficient turbine design, the structural engineering process helps create reliable energy systems that reduce dependence on weak previously mentioned transmission networks.

Specifications and Challenges for Turbines

The main engineering challenge is variability and making something that is adaptable. Wind conditions extremely differ across regions like plains, mountains, and offshore zones in which they all present their own unique challenges. Firoozi states that as wind turbine blade technology becomes more advanced, the industry must address the challenge of designing blades that can perform reliably in a wide range of global environments, especially in areas with extreme weather conditions (Firoozi et al., 2024). A one size fits all turbine would be inefficient or even unsafe in many of these environments. To address this, our design uses a modular architecture where key components like blade length/type, foundation type and material can be adjusted quickly without needing to redesign the entire system.

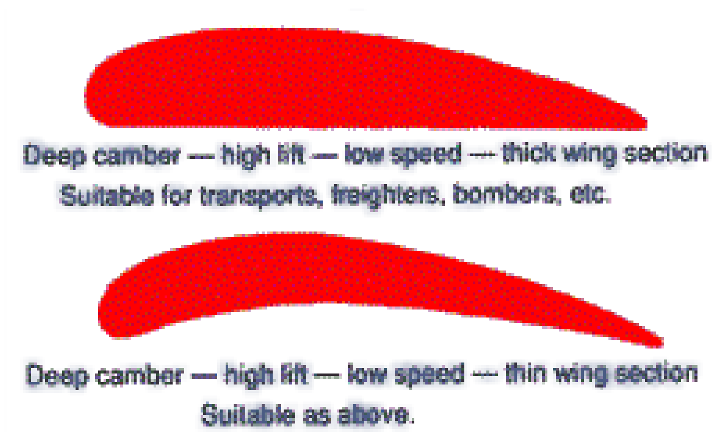
Blade Design

In our proposed system, the wind turbine blades are designed to maximize energy capture while remaining adaptable to different environments. The design builds on modern aerodynamic improvements that increase efficiency and reduce stress on the turbine, allowing each system to perform reliably within its assigned microgrid. Rather than using a single fixed blade design, the system adjusts blade length, shape, and material based on the specific conditions of each location to improve overall performance and durability. A key factor in evaluating blade performance is aerodynamic efficiency, which measures how effectively the turbine converts wind energy into usable mechanical energy. This is defined as the ratio of power extracted by the blade divided by the total power available in the wind (Firoozi et al., 2024). This relationship is the basis for blade design diagnostics and testing. Improving this efficiency is essential because it allows the turbine to generate more energy without increasing size or cost. By optimizing blade shape and seeing it interacts with airflow, the design ensures that each turbine operates as efficiently as possible under its given conditions.

The blade design also differs between onshore and offshore environments, and our system adjusts key design features to match each case. For onshore turbines, the blades are designed to perform well in lower and more variable wind conditions. We are using high lift, low speed airfoil shapes, having thicker and more curved profiles (cambered airfoils) as seen in figure 5, along with moderate blade lengths to improve efficiency without adding unnecessary load. For offshore turbines, the design shifts toward larger and more reinforced blades which are long and relatively narrow/ more streamlined to take advantage of stronger and more consistent winds. These blades are typically longer to increase the area for capturing energy. The structure of the blade is reinforced, especially near the root to manage increased forces and keep it stable.

Figure 5

Comparison of Deep Camber Airfoils



Note. Adapted from *Lift Generation*, by FSAC Training Academy, n.d.

Foundations and Applications

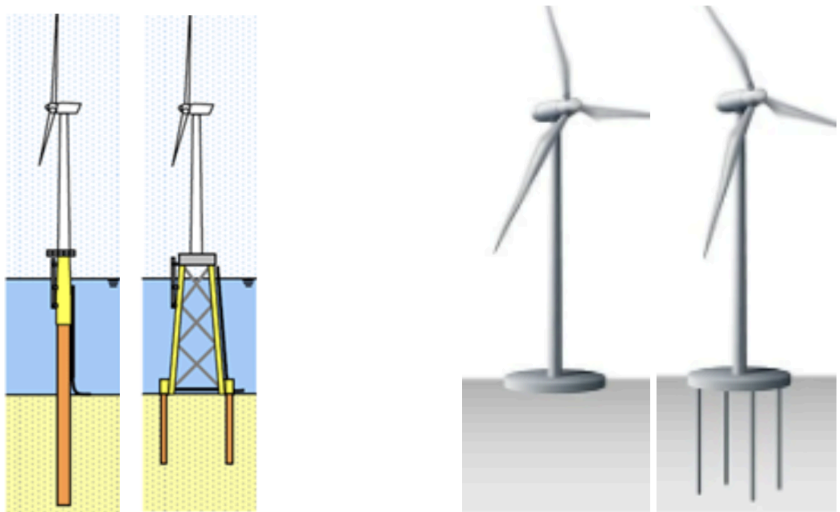
In our proposed system, the foundation type is chosen based on the conditions at each site to make sure the turbine stays stable and lasts long-term. For onshore turbines, we include spread foundations, as shown in Figure 6B, which are large concrete bases used mainly for turbines placed on strong and stable soil. These work by spreading the weight of the turbine over a wide area, which helps prevent sinking or tilting over time. Another option is driven pile foundations, also shown in Figure 6B, which go deeper into the ground when the soil/ground under the turbine is weaker. These use long steel or concrete columns driven into the ground to transfer the load to stronger layers below the surface. Depending on the onshore site conditions like soil type, slope, and load requirements, the most appropriate foundation is selected to make sure turbines are stable and have long term performance.

For offshore turbines, the foundations depend on water depth and conditions. In shallow water, monopile foundations, shown in Figure 6A, are used, where a large steel pole is driven into the seafloor. This acts as both the foundation and main support, making it a simple and cost-effective solution for calmer, lower depth areas. Additionally, Zhang and Wang (2022) explain that monopiles account for a large portion of Chinese offshore foundations due to their cost effectiveness. In deeper or rougher water conditions we use jacket foundations, also shown in Figure 6A, which consists of a wider steel frame with multiple supports for better stability. These structures are fixed to the seafloor with several piles, allowing them to handle stronger waves and wind forces. For even deeper water, we use floating foundations, where the turbine sits on a floating platform that is held in place with anchors. These systems allow turbines to be placed in areas where fixed foundations are not practical, while still keeping the structure stable through mooring lines and balance.

Figure 6

Comparison of offshore and onshore wind turbine foundation designs.

A B



Note. **(A)** Shallow water monopile and deep water jacket (cropped from the same source image). Adapted from *Monopile, jacket or floater, how do I pick the right option for my offshore wind project?*, by W.-T. Hsu, n.d., Empire Engineering. ***(B)*** Spread foundation on stable ground and driven pile foundation on unstable ground (cropped from the same source image). Adapted from *Getting your wind farm on the right footing*, by D. Annan, 2019, October 16, WSP.

Material Choice in Different Turbine Components

Material selection is one of the most important parts in wind turbine design because it affects strength, durability, cost, and how long the system lasts. In this section, materials used for the blades, foundations and towers will be discussed since each part has different structural requirements and contributions to the overall turbine along with their own environmental challenges. This makes researching durable and efficient materials important for keeping microgrids stable and reliable.

For turbine blades, lightweight composite materials are used to keep the structure strong but not too heavy. Onshore blades are mainly made from GFRP, which stands for glass fiber reinforced polymer that is strong, light, and cost effective for normal wind conditions. Offshore blades also use GFRP, but they include more CFRP, which stands for carbon fiber reinforced polymer that is stronger and stiffer. More CFRP is used in offshore blades because it is more resistant to moisture and salt-related corrosion, which can weaken glass fiber materials over time (Alam, Robert, & Ó Brádaigh, 2018). CFRP also helps make the blades stiffer and reduces bending, which is important since offshore turbines are harder to maintain and need to last longer in tougher conditions.

Foundations use different materials depending on the type. Onshore spread foundations are made of reinforced concrete to distribute the load across the ground, because it is strong in compression and spreads the weight over a large area. Pile foundations use steel or concrete columns that are driven deep into the soil, because they can transfer loads to deeper and stronger ground layers. Offshore monopile and jacket foundations are mostly made of steel because it provides high strength and performs well in aquatic environments. The tower is usually made of steel because it is strong and can handle the bending forces caused by wind and rotating blades. Steel is also widely available and can be produced in large sizes at a reasonable cost. For offshore turbines, protective coatings are added to reduce corrosion from saltwater and moisture, helping the tower last longer in harsh water conditions.

Turbine Design Overview

In conclusion, the proposed wind turbine design provides a flexible and adaptable solution for integrating renewable energy into distributed microgrid systems. By adjusting blade design, foundation type, and material selection based on onshore and offshore conditions, the system is able to maintain efficiency and long term durability across different environments. This helps ensure reliable turbine power generation which is then integrated into the microgrid system so the energy produced can be distributed to homes and surrounding communities. This overall approach helps reduce dependence on traditional power grids along with providing zero emission energy rather than relying on fossil fuels.

Systems Integration

The Systems Integration Engineer section at Meridian Wind Solutions, LLC is responsible for the design of the control systems and electrical framework of the proposed microgrids. While the structural engineering section focuses on the overall structure of the wind turbines during severe weather events, the systems integration section ensures that power will be available during this time. To guarantee that critical infrastructure like hospitals and telecommunication buildings remain operational, the microgrid will automatically supply the necessary energy required. This automated response is split into three phases: grid failure detection and safe disconnection, restarting the system from battery energy storage systems (BESS), and automatically supplying power to critical facilities.

Phase 1: Fault Detection and Safe Disconnection

The first step in the microgrid's automated emergency response is to detect failures on the macrogrid to initiate the disconnect procedure. Known as islanding detection, it detects any failures by monitoring local signals like voltage and frequency and determines if the main grid is no longer operational (Wang et al., 2018). Nevertheless, this method is not perfect, often struggling to determine if the main grid has collapsed permanently or if it is a temporary power fluctuation, like when starting up a large motor (Wang et al., 2018). This then creates a dangerous vulnerability known as a None Detection Zone (NDZ) where if the main grid failure occurs in this zone, the microgrid will fail to disconnect and will result in extensive damages to equipment and total loss of power (Wang et al., 2018).

To address this vulnerability, the proposed microgrid will instead use an advanced detection system. Instead of relying on rigid voltage drops, the system instead monitors the timing and frequency patterns of the electricity to determine whether to disconnect or not (Wang et al., 2018). The system should then be able to tell the difference between an actual grid failure and a temporary disturbance without having to manually be programmed for every scenario (Wang et al., 2018). With this new method, the previous vulnerability will no longer be an issue as this reduces the NDZ to zero (Wang et al., 2018). With this new system in place, it ensures the microgrid will correctly identify real-world blackouts and safely disconnect from the main grid, guaranteeing critical infrastructure can still operate.

Phase 2: System Restart and Master-Slave Control

Once the microgrid is safely disconnected from the main grid, it must then be restarted from a de-energized state, a process known as black-starting (Marchgraber & Gawlik, 2020). The challenge of performing a black-start lies in handling the “cold load pickup”, which occurs when powering on all offline transformers and thermostatically controlled devices all at once (Marchgraber & Gawlik, 2020). Due to the massive current spikes from attempting to restore power instantaneously, any protective relays would then trip, causing the restart to fail (Marchgraber & Gawlik, 2020). To counter this, utilizing the BESS to slowly supply voltage over time would then keep the initial power surge to 5% of its total capability, guaranteeing a safe and stable restoration of power (Marchgraber & Gawlik, 2020).

After a successful black-start, the BESS will then work with the wind turbines to balance battery charging and generating power. During severe weather events, it is highly likely that communication networks will be down, causing more vulnerabilities. To mitigate this potential issue, a master-slave control approach would be utilized, using electrical frequencies to communicate with each other instead of data cables or radio networks (Marchgraber & Gawlik, 2020). With the BESS acting as the “master” and setting the standard frequency of the microgrid, the wind turbines will then operate as the “slaves”, monitoring the active frequency set (Marchgraber & Gawlik, 2020). By using a Limited Frequency Sensitive Mode (LFSMO), the wind turbines would then be able to automatically adjust their output depending on what frequency the BESS sets for the system; for example, stopping the wind turbines when batteries have reached their maximum capacity (Marchgraber & Gawlik, 2020). Having the BESS and wind turbines work together to automatically adjust power output without the need for cables or signals greatly reduces communication failures that would be caused by external vulnerabilities (Marchgraber & Gawlik, 2020).

Phase 3: Smart Power Distribution

After successfully configuring the microgrid to be islanded and energized, the final phase would be managing the power supply. Since the microgrid relies entirely on wind power and battery reserves, the electricity must be strategically utilized to prevent any additional blackouts (Nyangon, 2024). To accomplish this, the microgrid must implement automated systems such as Supervisory Control and Data Acquisition (SCADA) systems and Advanced Metering Infrastructure (AMI) (Nyangon, 2024). These technologies will then act as a sensory network, providing real-time data crucial for managing extreme weather events (Nyangon, 2024). This allows the system to effectively facilitate power distribution, improve efficiency, and identify required maintenance to prevent failures and blackouts (Nyangon, 2024).

Nevertheless, collecting data and managing power distribution alone is not enough during extreme weather events. With the help of artificial intelligence (AI) and machine learning (ML) algorithms, the microgrid will then effectively respond and manage energy distribution (Nyangon, 2024). All together, these systems will then be able to make crucial decisions, such as determining which facility gets power first or the best strategy to conserve energy if electricity is not being produced (Nyangon, 2024). By actively facilitating how the power is used in each situation, these automated systems could operate without immediate human assistance, ensuring critical infrastructure continues to receive uninterrupted power if the main grid goes down (Nyangon, 2024).

Ultimately, the proposed microgrid that incorporates these advanced control systems will guarantee a resilient, autonomous electrical system for use during severe weather events. By merging the islanding detection system to remove the NDZ, the master-slave control with the BESS and wind turbines, and energy distribution run by AI and ML, the microgrid will be well-prepared to endure any catastrophic event. This strategy and approach will ensure critical infrastructures like hospitals and vital communication infrastructures remain in operation. Having the system execute each phase without human intervention or relying on external networks, Meridian Wind Solutions, LLC will provide a reliable system able to withstand any disaster.

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