Energy Resilience– Uncovering the Unique Electrical Grid Challenges that Exist in the State of Louisiana

Jackson Bourgeois, Evan Dardar, Ethan Hoggard, Harley Nelson

Abstract and research Questions

Abstract: This project aims to explore energy resilience in electrical engineering, including current challenges, ongoing efforts, and future improvements at global, national, and state levels. We'll examine how systems are assessed for resilience and explore experimental work to enhance resilience.

1) What are the key indicators and metrics for assessing the resilience of energy systems to natural disasters and extreme weather events?
2) How do different energy resilience strategies, such as microgrids, distributed generation, and energy storage, contribute to enhancing the resilience of power systems?

Status of Investments on Energy Resilience :

- World-→ Globally, an estimated 274 billion was spent on grid improvement in 2022.
- USA-→ In recent years the government has allotted around 20 billion dollars in funds that will be used for general grid improvements.
- Louisiana-→In 2023 Louisiana was granted 249 million dollars to fund the Hubs for Energy Resilient Operations (HERO) project.

(2009) The American Recovery and Reinvestment Act (ARRA) was implemented which included resilience projects that would enhance energy efficiency and renewable energy facilities.

(2014) The Department of Energy began their initiative for grid modernization so that systems would be more robust and resistant to disruptive events.

(2017) US Congress passed the Bipartisan Budget Act which was a funding act that would allocate funds to areas that were prone to natural disasters nationwide.

(2019) FEMA increased their spending towards pre-disaster mitigation to ensure that any vulnerable infrastructure was reinforced to withstand natural disasters.

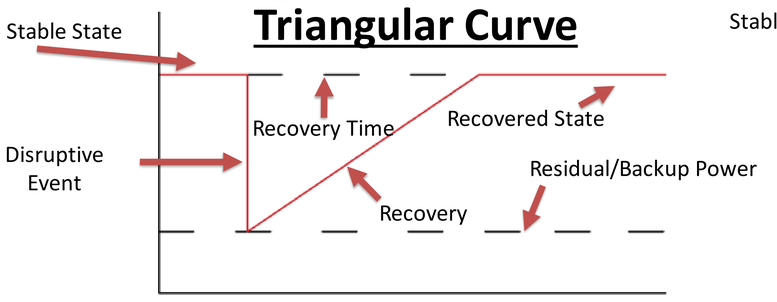
(2021) The Infrastructure Investment and Jobs Act (IIJA) was instated to continue investing in the modernization of grids to further enhance resilience throughout the United States.

(2023) The state of Louisiana was granted $250 million to pursue the (HERO) project, which aims to make grid improvements that would enhance response to disruptied power events.

Technical Analysis

Two primary methods of technically analyzing a system's resilience are using triangular or trapezoidal curve models and "figure of merit" curves. The former depict outage and recovery events linearly, while the latter offer a natural curve to illustrate recovery. Both measure resilience as the time it takes for recovery during a disruptive event.

Triangular Curve



Trapezoidal Curve

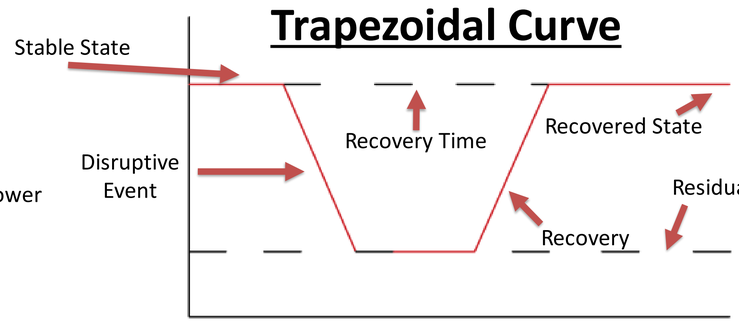
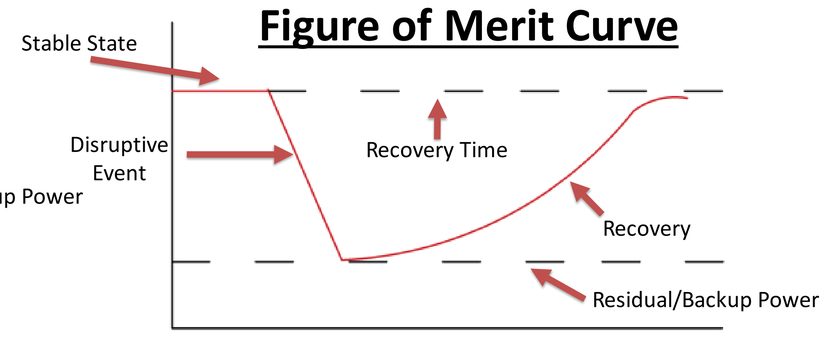
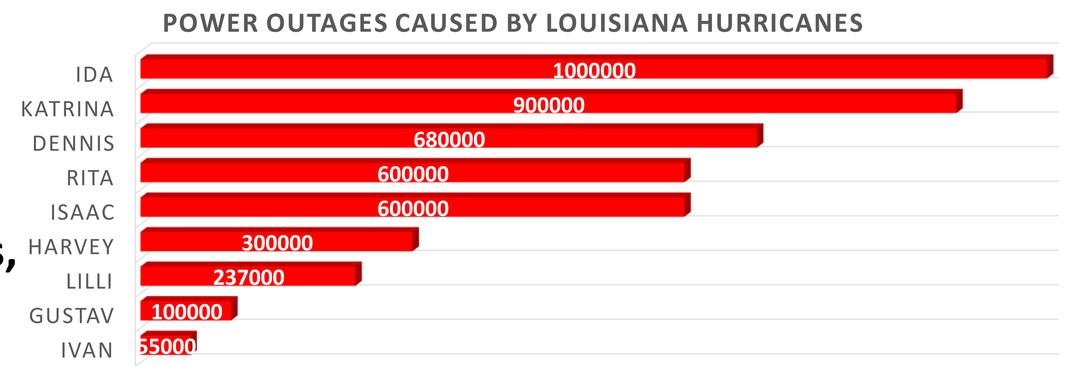


Figure of Merit Curve



What are the Challenges?:

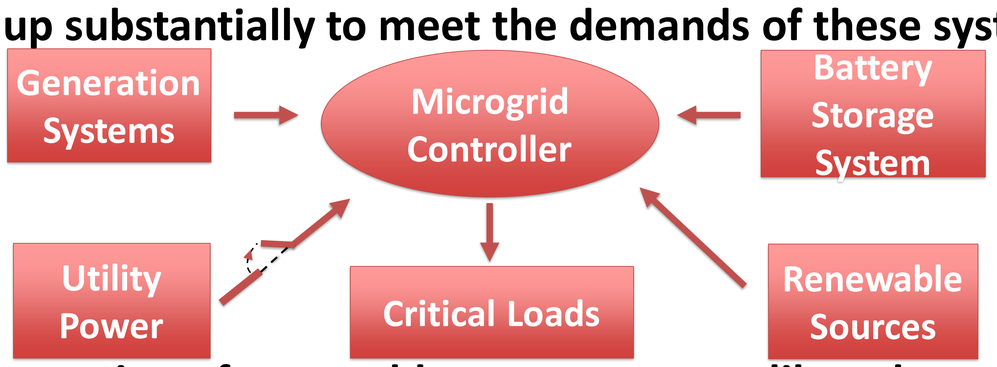
One major issue affecting the resiliency of power systems in Louisiana is our heavy reliance on fossil fuels to power our grid. Another major challenge is the strain put on the grid in the event of extreme weather events (i.e. floods, hurricanes, etc.) Such events cause mass destruction which lends to mass outages.



How to Solve Challenges?

One way to enhance resilience is by adding auxiliary systems to aid in the production of electricity in the event of major generation failure; some styles of this are backup generation systems, large-scale renewable generation facilities, etc. This improves resilience by adding robustness and redundancy to a system. Additionally, microgrids, smart grids, and energy storage systems are added to grids. This allows systems to be more adaptive in the event of system failure. To accommodate for these additions, these projects are funded by both government grants as well as utility investments in the grid. The drawback associated with this is that the cost of electricity has gone up substantially to meet the demands of these systems.

Simple Microgrid Configuration:



The idea behind a microgrid is to have a back up system in place separate from a primary grid so outages are minimized in disruptive events. Resilience is increased since the inclusion of a subsystem limits the risks associated with a centralized electrical fault.

Forecasting

- There will be enhanced integration of renewable energy sources like solar and wind power into the grid.
- Implementation of advanced grid technologies such as smart grids and microgrids.
- Development of robust energy storage solutions to store excess renewable energy and provide backup power during outages.

Economics

- U. S. lost $200 billion due to outages during the 2021 winter storms alone
- By increasing resilience, financial losses due to disruptive event can be mitigated.

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