Electrical Engineering Capstone Design Project

Uninterrupted Power Microgrid for ASU Research Lab

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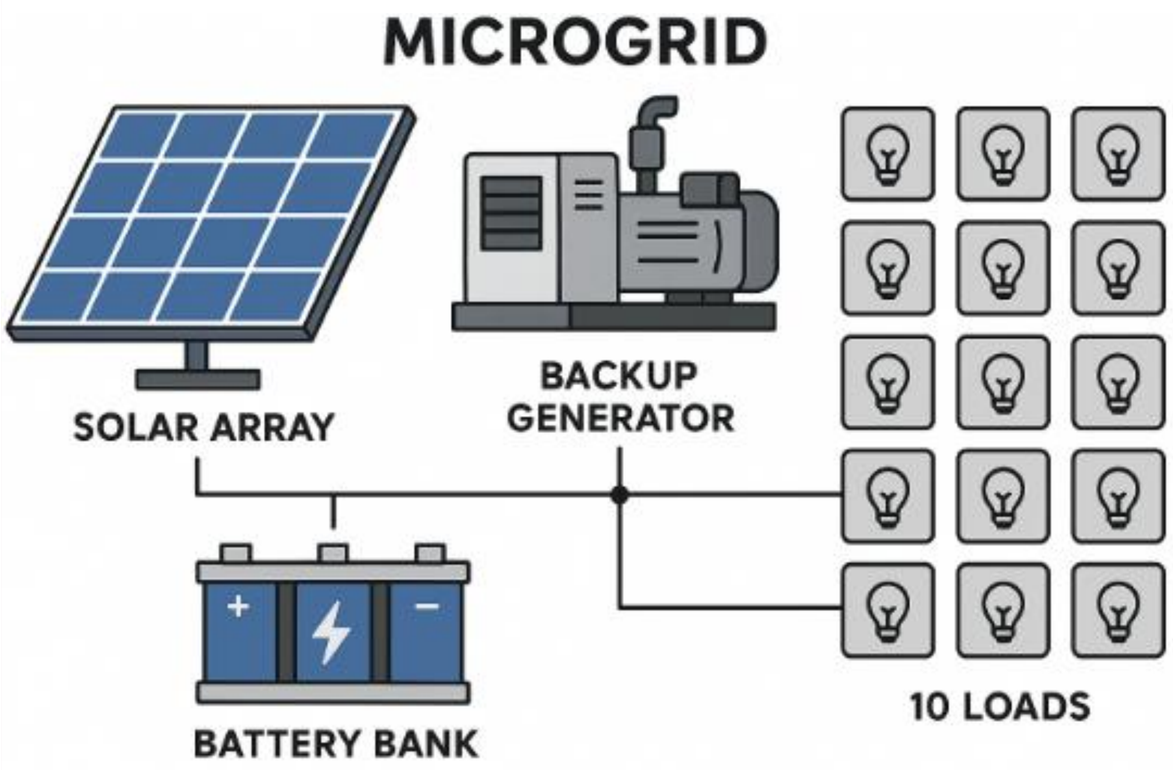
Introduction

Uninterrupted power is critical for research labs where even brief outages can disrupt sensitive experiments, damage expensive equipment, and jeopardize research outcomes. This project aims to design a reliable and scalable Uninterruptible Power System (UPS) tailored to the specific needs of ASU's research lab, ensuring continuous power during utility outages. By integrating renewable energy sources, battery storage, and a backup generator, the system addresses both sustainability and reliability goals.

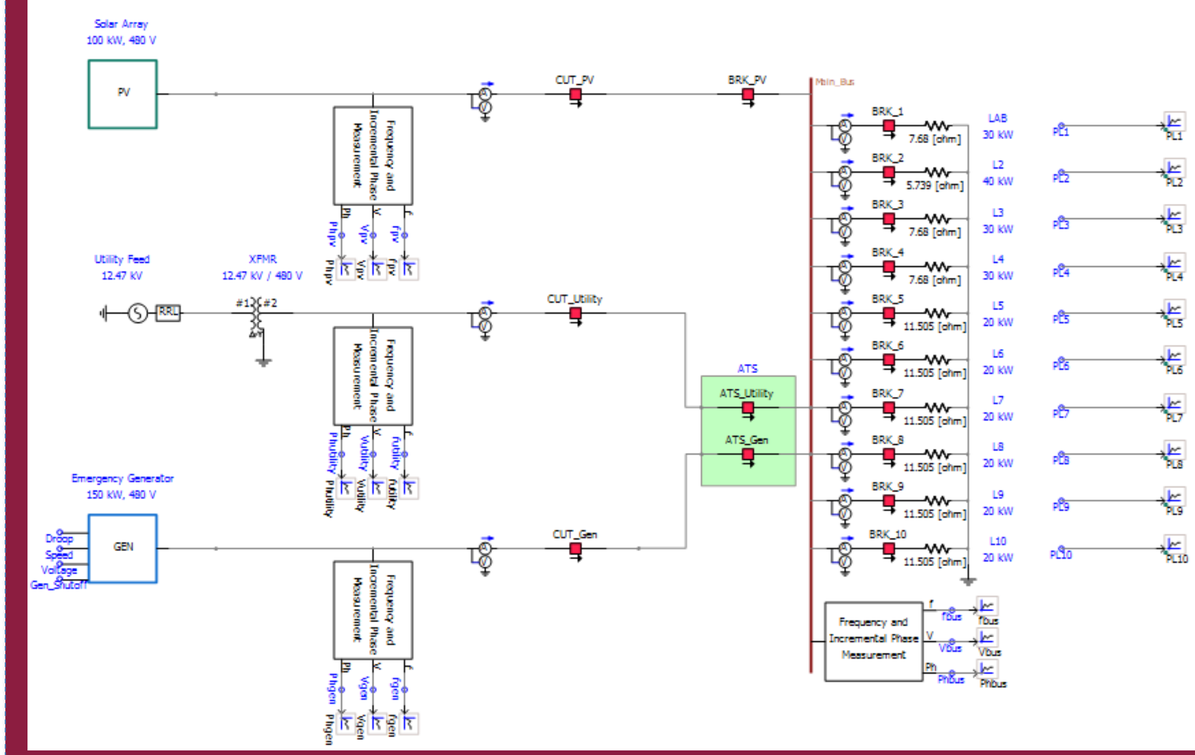
Project Scope

The uninterrupted power system will be designed to manage the lab's critical power loads during utility outages. The battery bank will be sized to provide at least 5 minutes of ride-through power, giving the backup generator time to start. Other key elements of the system will include features such as, automated island detection and isolation, load shedding for non-critical equipment, and generator synchronization for seamless transitions.



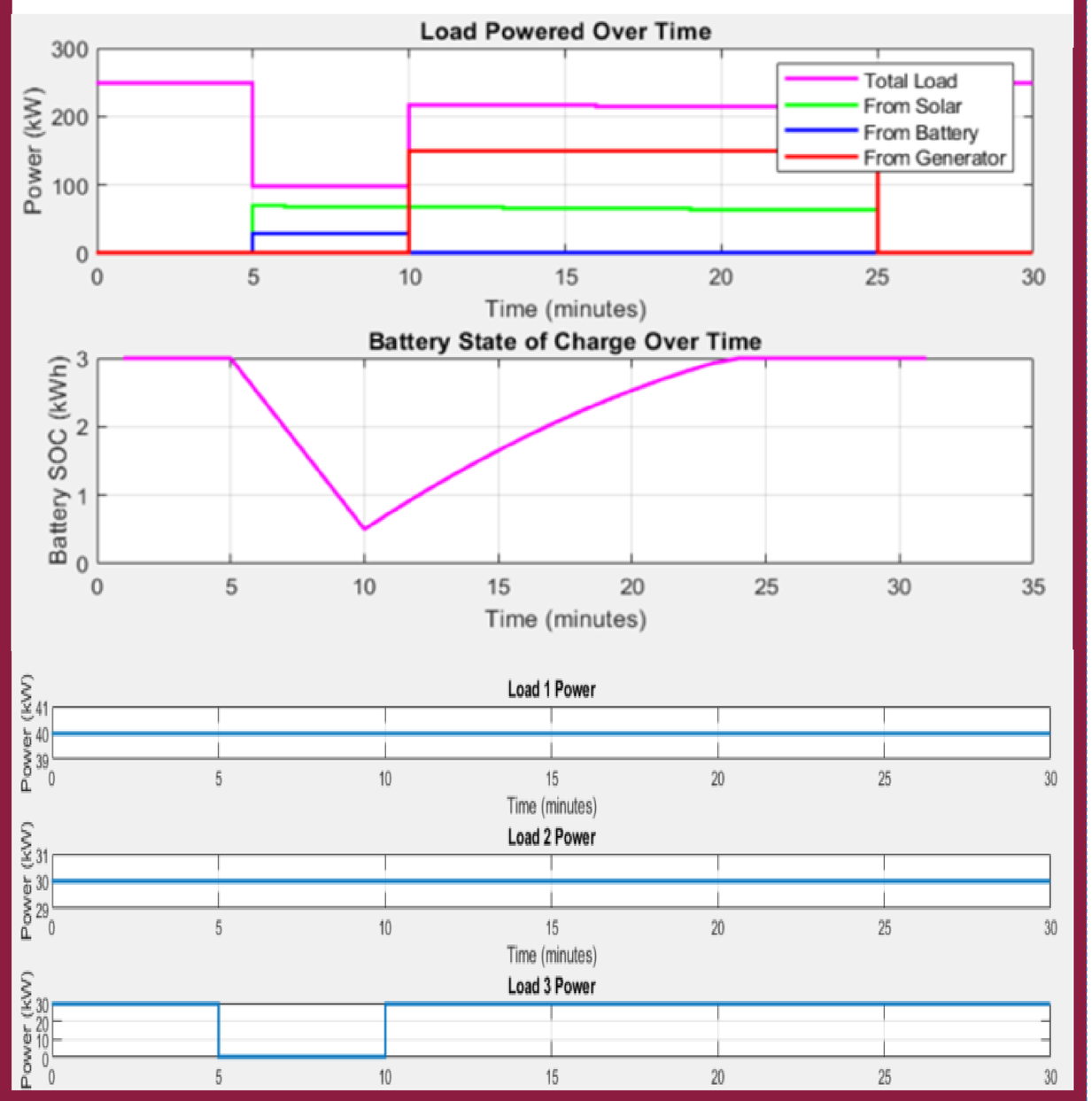
System Design

The final simulation for this project was created using PSCAD which allowed the validation of the system's performance under various conditions, such as grid outages and load transitions. The model below shows the master schematic for the system. Behind this model there are numerous networks, to include, logic operations, generator controls, circuit breaker operation, and power transition.



Test Results

The first graph below illustrates some of our simulation results. At the 5-min mark, the utility grid disconnects, after which the battery and solar array supply power for the next 5 mins. At 10 mins, the generator activates as an additional power source. This graph also displays the total power contribution from all sources at any given moment. The second graph tracks battery state of charge throughout the system's operation. The final graph, a snippet from a larger dataset, shows which loads were powered at any given time, aiding in the verification that load shedding was functioning correctly. This simulation successfully validated our calculations and confirmed that the design goals were achievable.



Conclusion

The microgrid system simulation proved that the calculations and design that was created will operate as intended if this system were to be implemented. The system had the capability to detect when grid power was lost, allow the battery bank to provide temporary power, and then transition over to the PV array and generator once it was fully brought up to speed.