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Configurable Microgrid Modelling with Multiple Distributed Energy Resources for Dynamic System Analysis

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Background

- Microgrids are smaller power systems with the ability to disconnect from the larger power grid and operate independently by serving the load with local power generation.
- Configurable dynamic microgrid simulation model based on both the Global Laboratory for Energy Asset Management and Manufacturing (*GLEAMM*) microgrid and the Sandia National Laboratories Scaled Wind Farm Technology (*SWiFT*) facility.
- A dynamic and configurable *MATLAB/Simulink* model is used to study the system performance.
- Short term simulation results are presented at varying loads and generation conditions.
- Transient results for system frequency and voltage dynamics under varying microgrid configurations are presented to help understand the dynamics of the microgrid.

Microgrid Description

The *SWiFT* test site is the first public facility to use multiple wind turbines to measure turbine performance in a wind farm environment. The *GLEAMM* microgrid possesses photovoltaic inverters, energy storage and a diesel generator.

To demonstrate the flexibility of the system, a case study that considers both the *GLEAMM and SWiFT* sites operating in an islanded mode is considered.

Generation Source	Voltage (V)	Current (A)	Power Rating (kW)
Solar Panel	480	333.3	150
Diesel Generation	480	1041.7	500
Energy Storage System	480	56.3	50
SANDIA Wind Turbine 1	480	416	200
SANDIA Wind Turbine 2	480	416	200
SANDIA Wind Turbine 3	480	416	200

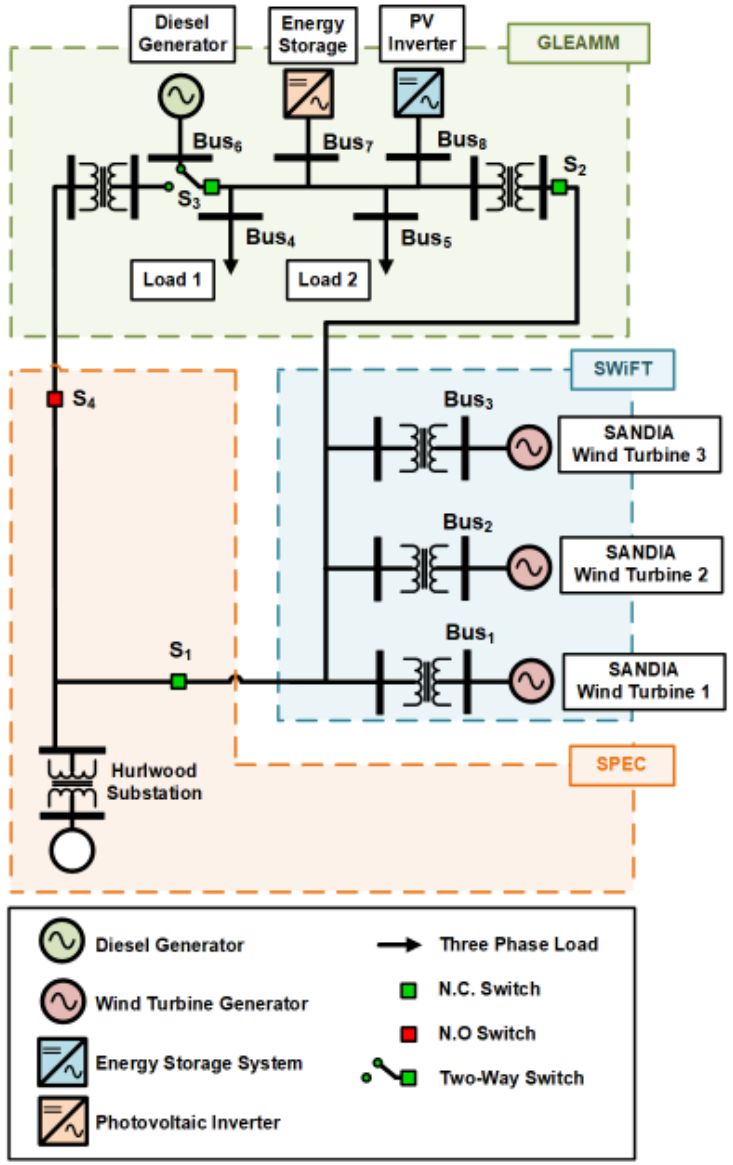

Fig. 1. Microgrid One Line Diagram.

Results

In this simulation, the *GLEAMM* microgrid is operating in islanded mode, and then the *GLEAMM* microgrid connects to the SWiFT test site to help supply the load demand.

The shaded region denotes when the *SWiFT* test site is connected to the *GLEAMM* microgrid.

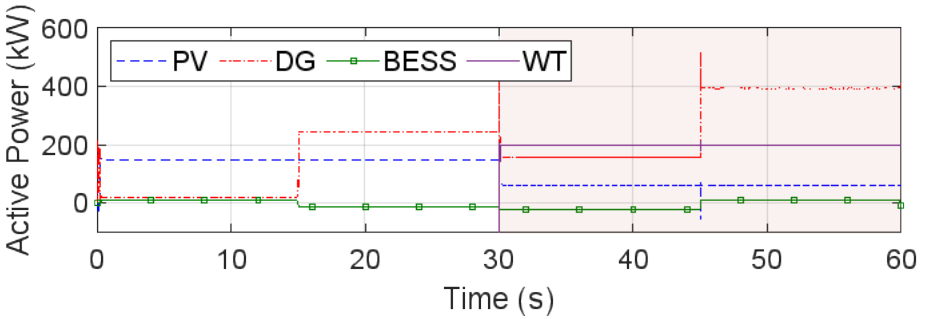

Fig. 2. Results for the GLEAMM Microgrid Generation.

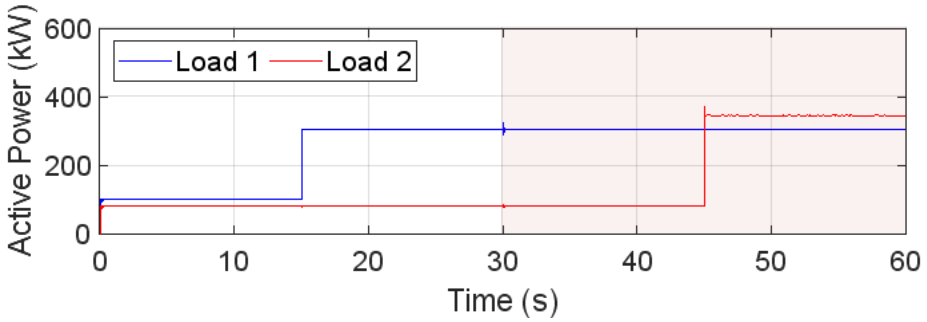

Fig. 3. Results for the GLEAMM Microgrid Load.

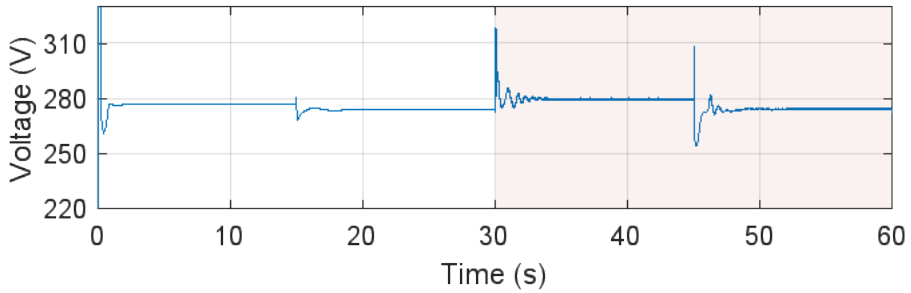

Fig. 4. Results for the GLEAMM Microgrid Voltage.

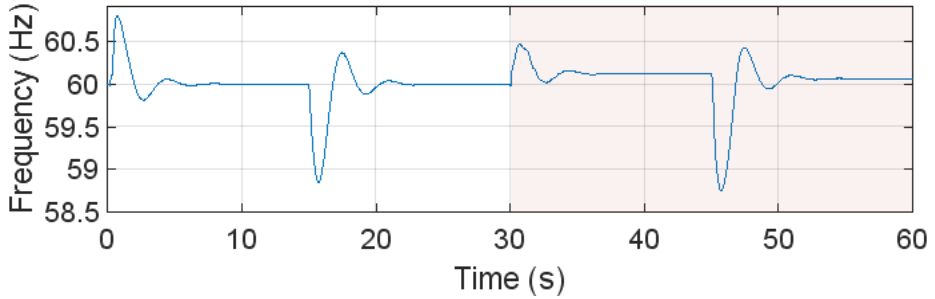

Fig. 5. Results for the GLEAMM Microgrid Frequency.

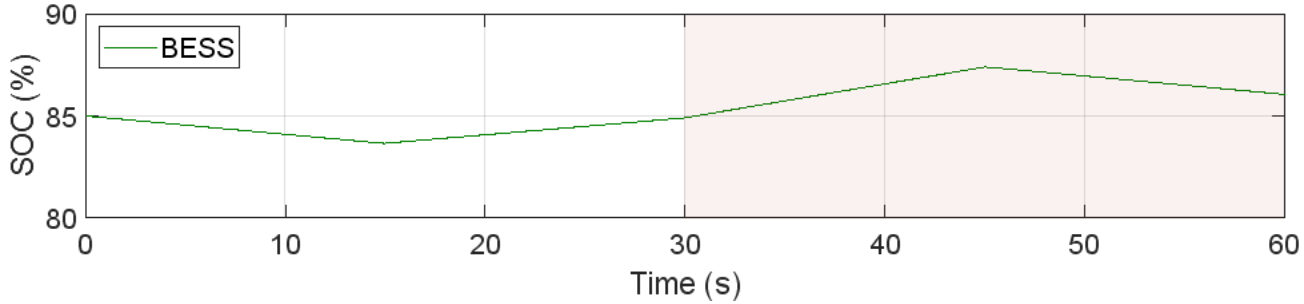

Fig. 6. Results for the BESS State of Charge.

Conclusions and Future Work

- This paper presents a dynamic *MATLAB/Simulink* model of the *GLEAMM* microgrid and *SWiFT* test site.
- This is a high-fidelity model that can be used in detailed power systems simulations to estimate expected voltage and frequency impacts of source fluctuations due to intermittent resources.
- The model contains controllable DERs such as: photovoltaic inverters, wind turbine generators, diesel generators, and energy storage, and can operate in multiple configurations such as grid connected and islanded modes.
- Simulation results demonstrate the ability to leverage wind and solar distributed energy resources assets depending on the microgrid mode of operation.