

Optimal Storage System Management to Enhance Dynamic Microgrid Frequency Control

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INTRODUCTION & AIM

This paper deals with the design of an optimal storage management system to enhance microgrid frequency stability and control in the presence of Renewable Energy Sources (RESs) including a solar PV generator and wind farm. In a classical power system, a Load Frequency Control (LFC) loop is applied to cope with frequency deviations by acting on the selected conventional power generation unit such as thermal or nuclear power plants. On the other hand, in the case of small or islanded areas, this option is not applicable due to the lack of power generation units with such inertia. In this context, implementing a storage system seems to be a good solution to handle dynamic frequency deviation in microgrids, which is the main contribution of this paper. The main idea was to create a centralized multi-storage system that can support frequency control using a smart power management strategy using nature-inspired optimization algorithms. A hybrid energy storage system was employed including an electrical vehicle, redox flow batteries, super conducting magnetic energy storage and fuel cells. Each storage unit was controlled using an optimal Fuzzy-PIDN controller. A recently developed optimization algorithm named Mountain Gazelle Optimizer (MGO) was used to find the best controller parameters, aiming to improve the storage units' control and management to support the microgrid frequency control in case of load disturbances or climatic changes. The proposed control strategy ensures efficient energy sharing and enhances dynamic microgrid stability. Several scenarios were performed to demonstrate the validity of the proposed method. Firstly, the proposed strategy was simulated in presence of static and dynamic load changes, and then the study was extended to study the impact of climatic changes on green power generation sources such as wind speed variation and solar shading to reduce the maximum frequency deviation and find a robust solution to avoid power outages and load shedding.

METHOD

This work focuses on the optimal power management and load balancing of Microgrid connected with multiple loads system. The main contribution was the use of an optimal multi-stage method involves both of frequency control and power management system to enhance islanded microgrid stability using Fuzzy-PIDN controller and Hybrid Storage System, as illustrated in Fig 1.

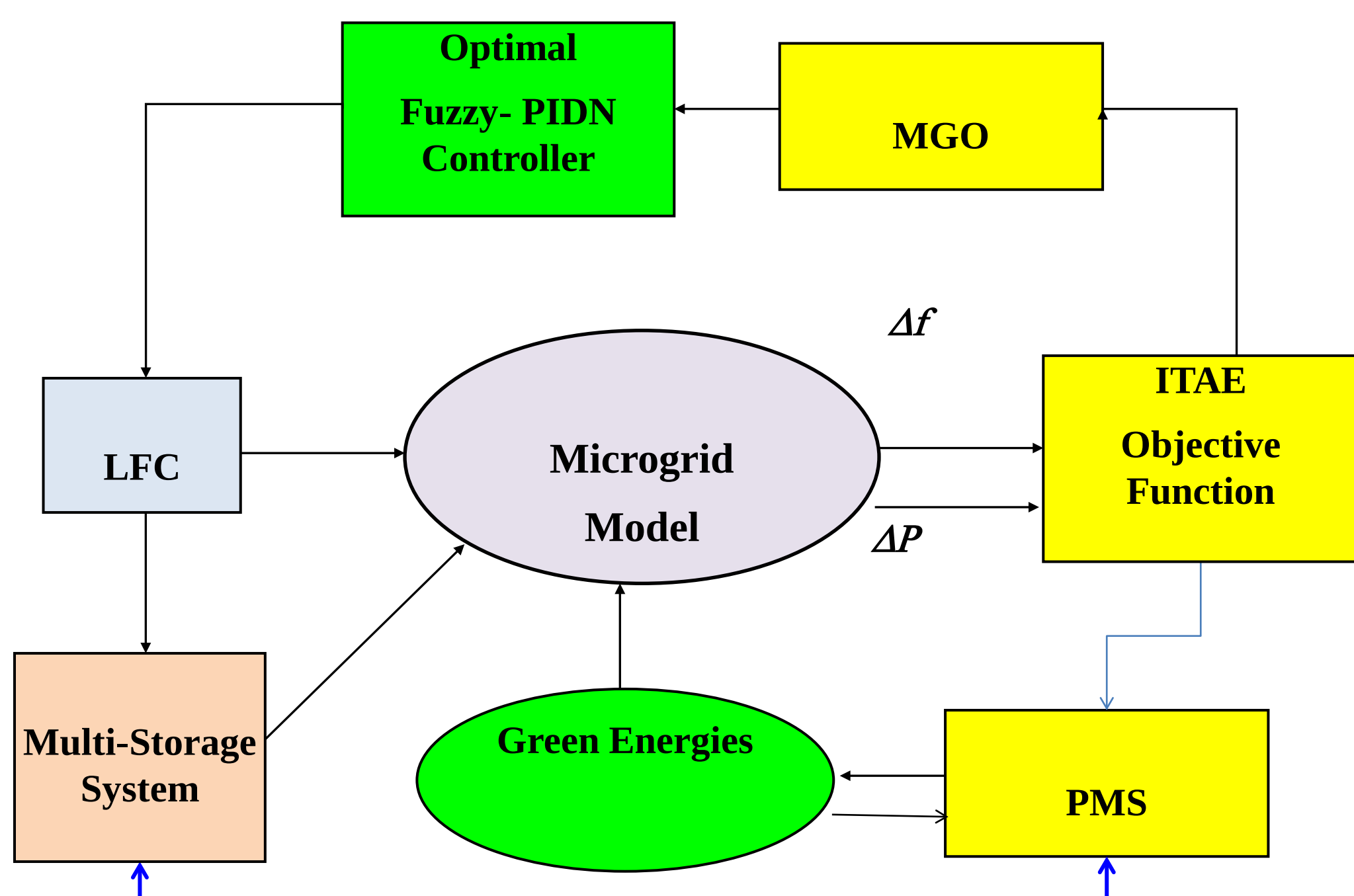


Fig.1. Proposed Multi-Stage Active Power Management and Frequency Control.

RESULTS & DISCUSSION

In this section, an isolated Microgrid (MG) was investigated for the simulation to show the contribution of the proposed method. In the first case, the microgrid was simulated only with a step load at $t=10s$, as a static load variation, Fig.2, then, the microgrid was faced with a dynamic fluctuation to demonstrate the validity of the proposed strategy to cope with climatic changes in case of large share of renewable energies, Fig.3.

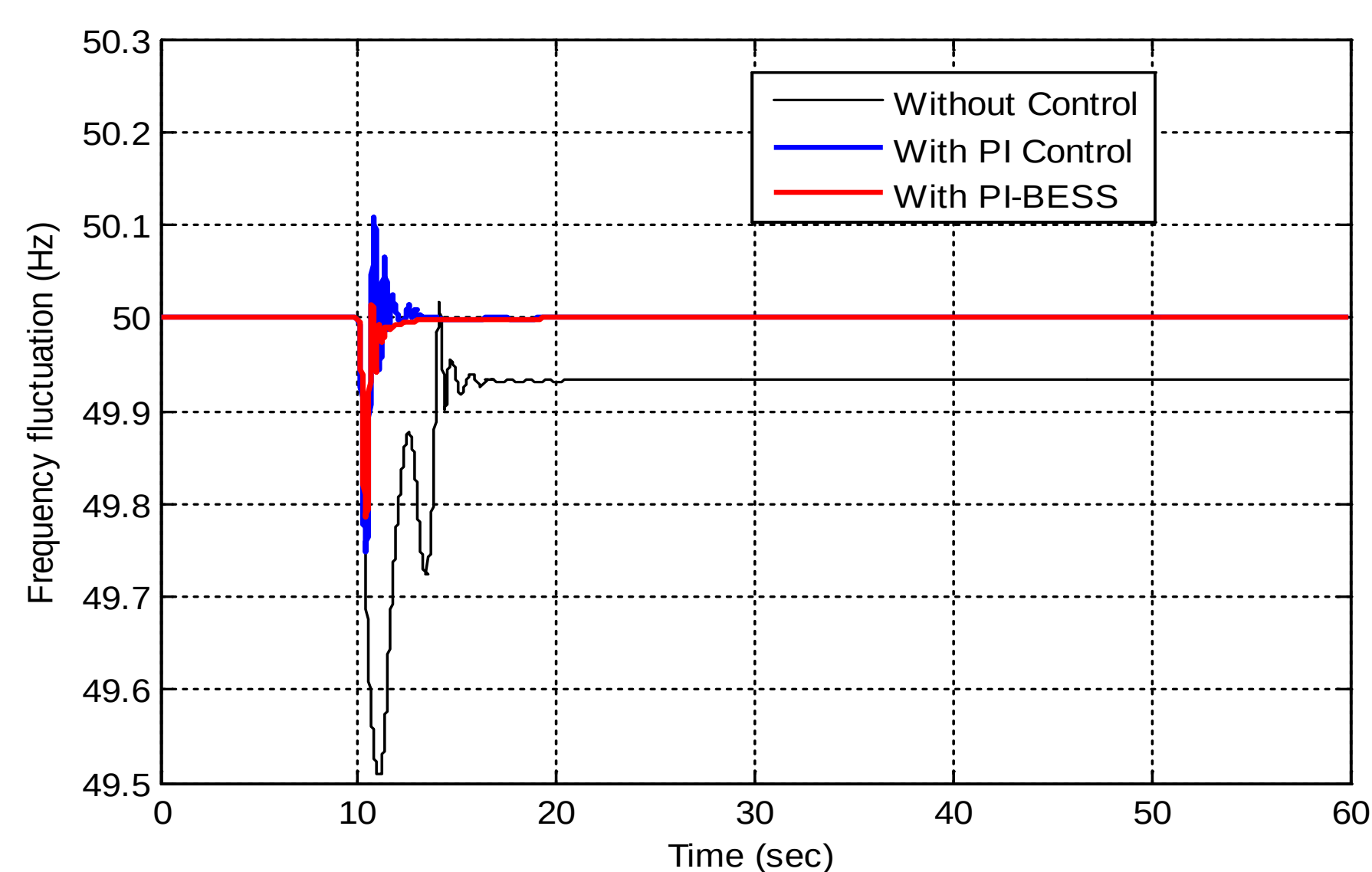


Fig.2. Microgrid Frequency in case of Static Load Variation.

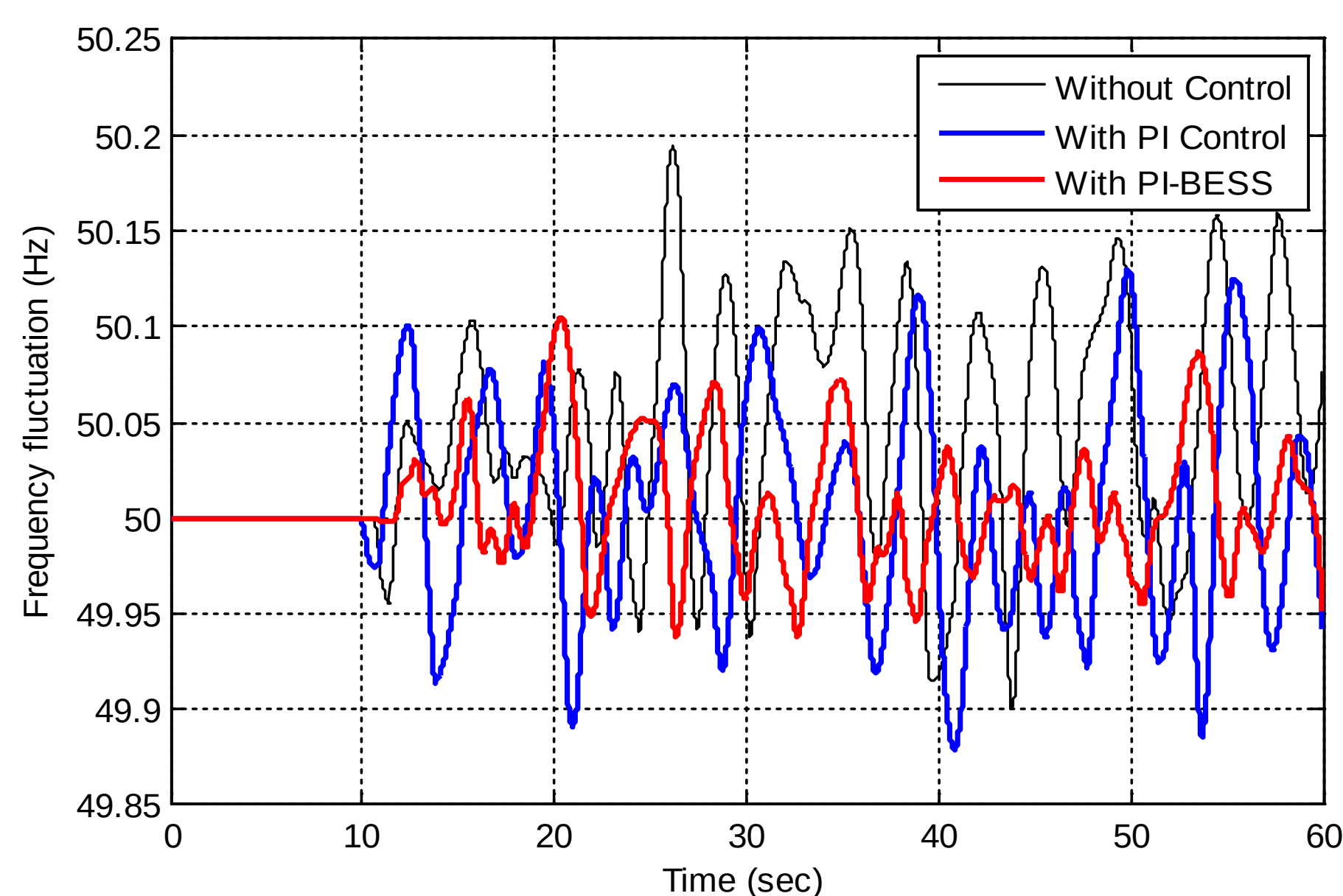


Fig.3. Microgrid Frequency in Case of Dynamic Variation.

CONCLUSION

- In this work, an effective optimal active power management and frequency control method was proposed.
- A Hybrid energy Storage System was used to support microgrid frequency stability and control.

REFERENCES

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