

Multi-Nanogrids Power Management and Control Using Nature-Inspired Optimization Algorithms

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INTRODUCTION & AIM

This paper deals with the design of an optimal power management and control scheme to improve dynamic behaviors of renewable power generation sources in multi-nanogrids system. The investigated nanogrid includes solar PV generator and wind turbine. A storage was also employed to support active power management. Three novel nature-inspired optimization algorithms, namely Marine Predator, African Vultures, and Gorilla Troops, have been used to enhance nanogrid power management. The main tasks were to design a robust controller applied to the storage system, coordinated with an intelligent power management tool that allows increasing the integration of green power in small distributed systems such as nanogrids. In this context, several scenarios have been performed to show the effectiveness of the proposed method. The storage system was firstly used to support the power supply, then the application was extended to participate in the frequency control. A comparative study between the employed optimization algorithms was carried out in view of peak minimization and settling time. Further, robustness analysis was conducted using different rate of renewable energy penetration. It can be observed from the presented results, that using optimization algorithms can create a powerful and smart tool that can manage the generated power from the green units and ensure power equilibrium during load variations.

METHOD

In this section, an isolated microgrid connected with multiple nanogrids under renewable energies variability was presented. An intelligent DMS tool was designed to cope with renewable energies climatic changes and load variations using three novel nature-inspired optimization algorithms, namely Marine Predator, African Vultures, and Gorilla Troops. Further, a storage system was employed to support the frequency regulation in case of large integration of green power.

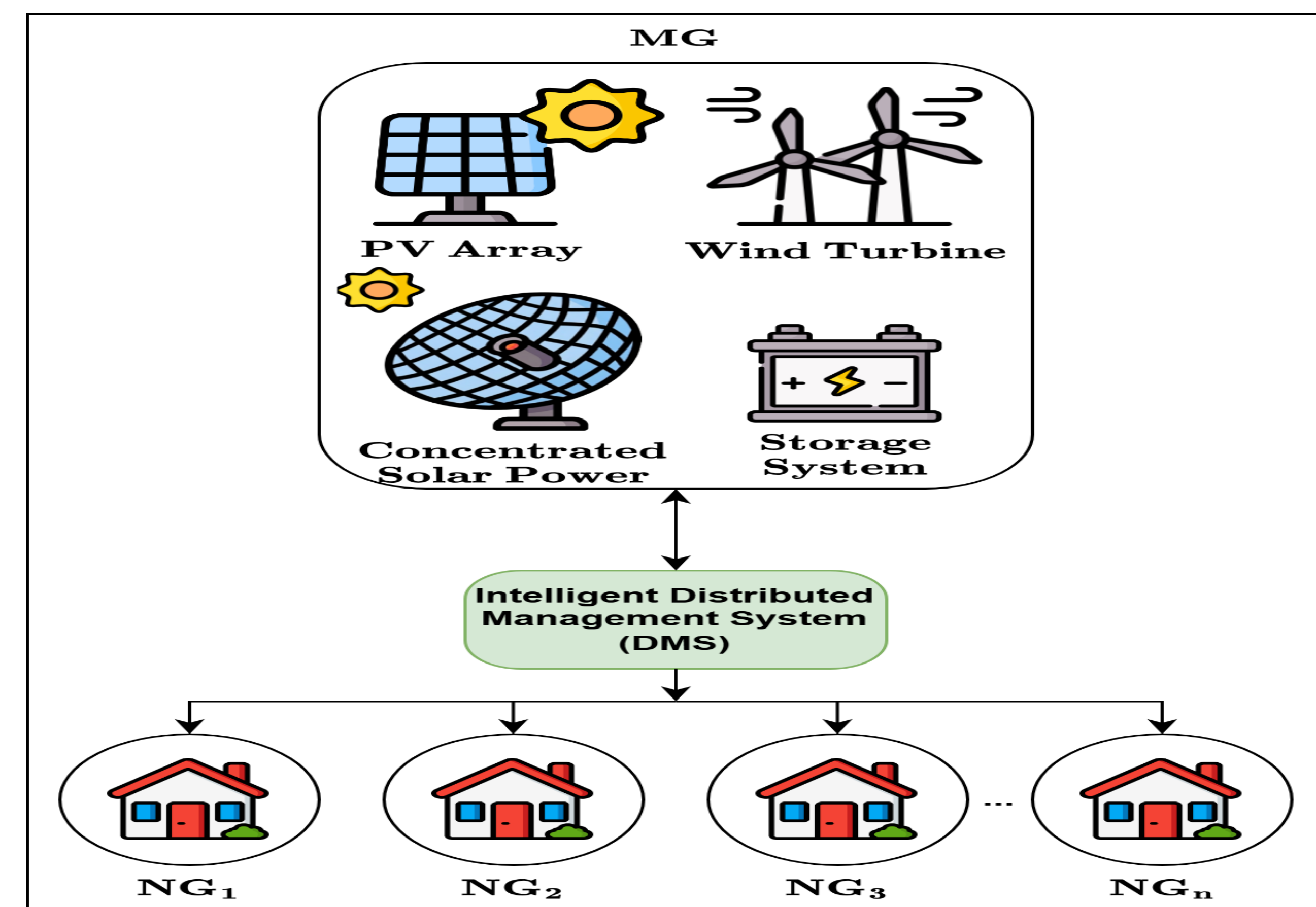


Figure 1. Proposed Distributed management System.

RESULTS & DISCUSSION

In this part, a multi-nanogrids connected microgrid was simulated under load changes and in presence of renewable energy sources integration. Two case studies were conducted. The microgrid frequency stability was analyzed, and the results are presented in Figures 2, 3 and 4. The obtained results show that using optimal DMS can improve power system stability. Also, it can be noticed that the storage system can support frequency regulation during fluctuations.

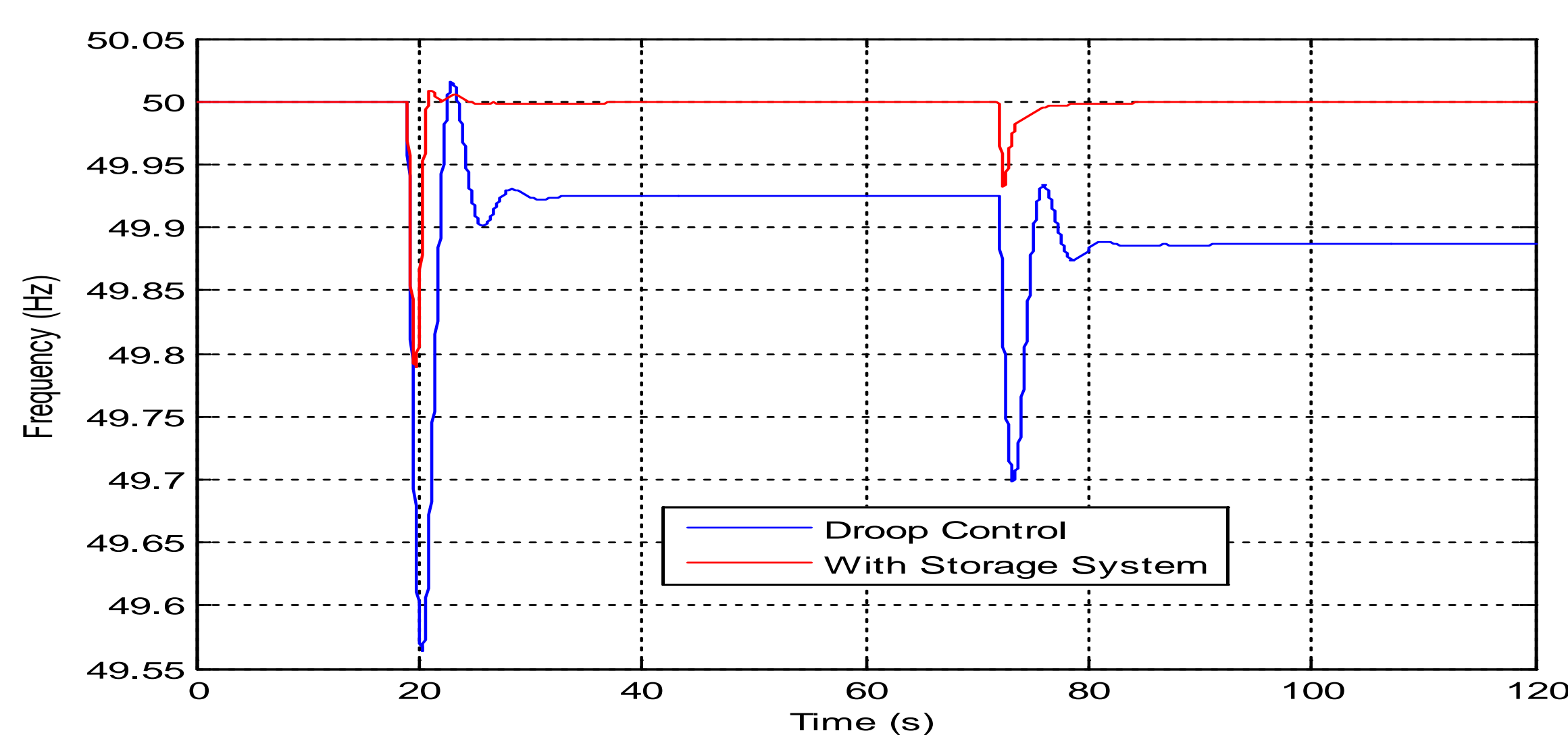


Figure 2. Frequency Deviation With Static Load Variation in Nanogrids.

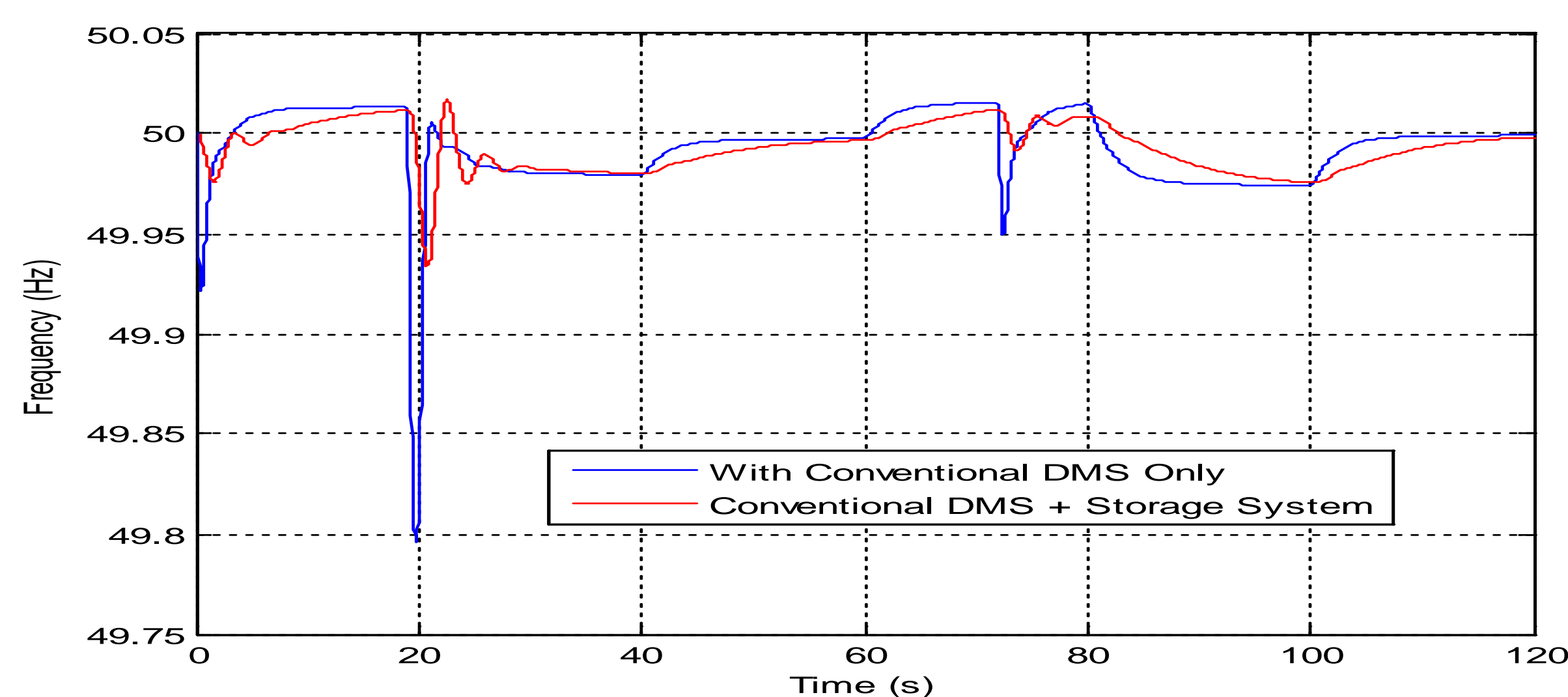


Figure 3. Frequency Deviation Using Storage System.

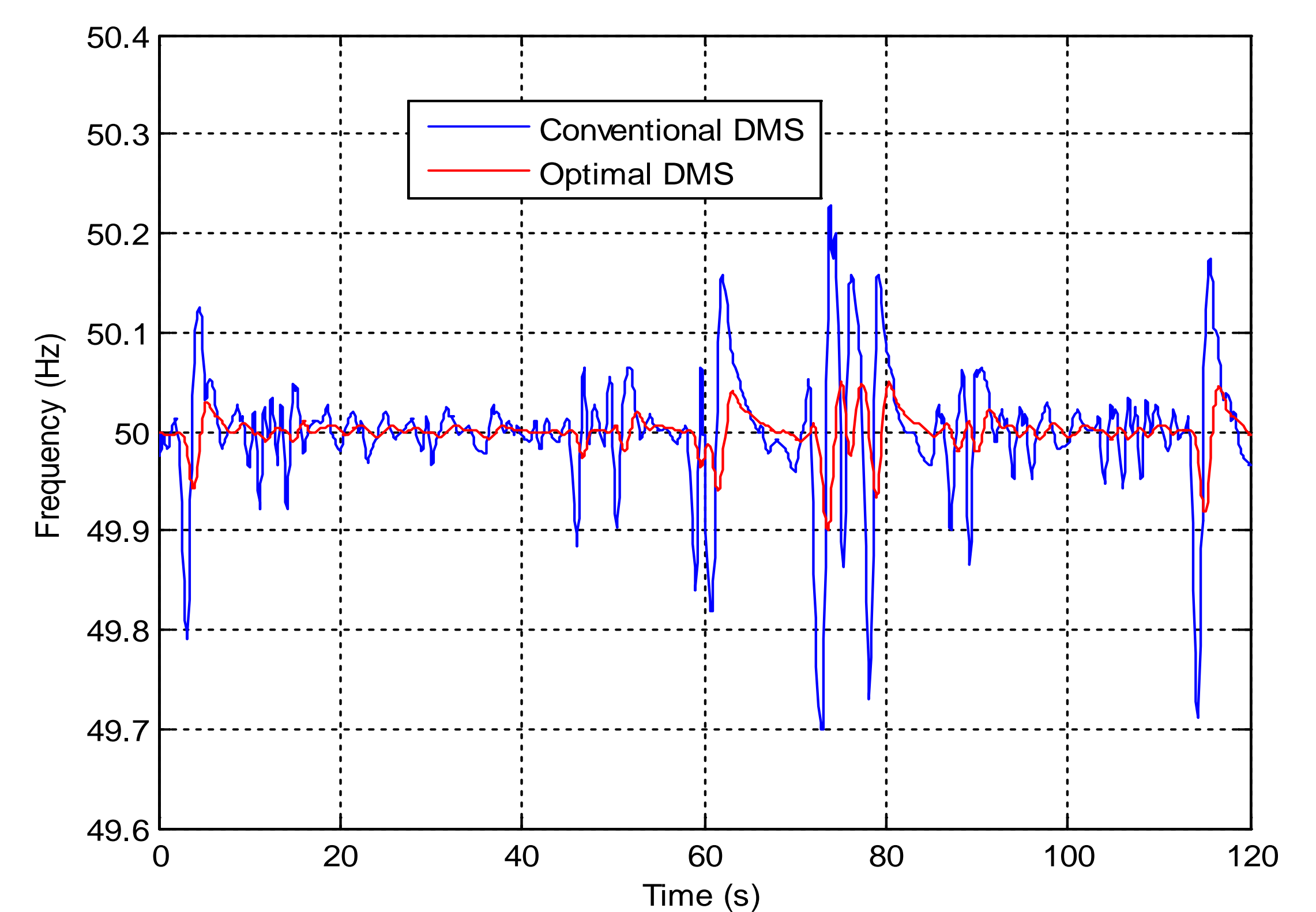


Figure 4. Frequency Deviation With Optimal DMS.

FUTURE WORK/ REFERENCES/ACKNOWLEDGMENT

CONCLUSIONS

This paper presents an intelligent Distributed Management System (DMS) based on nature-inspired optimization algorithms to enhance the dynamic stability of microgrids under the interconnection of multiple nanogrids. In addition, the contribution of the energy storage system was analyzed with respect to frequency stability improvement. As a future perspective, this work will be extended to investigate the integration of a Peer-to-Peer (P2P) electricity market under renewable energy variability.

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