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Contribution Of Energy Storage System To Enhance Power System Voltage and Frequency Stability In Presence Of Distributed Generation Units

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INTRODUCTION & AIM

Modern power systems will integrate a large number of renewable energy sources (RES). In a small power system such as a microgrid, which mainly includes various types of RES such as wind, solar, wave energy, etc, control devices, such as frequency and voltage regulation, must offer high performance to prevent system instability. In modern power systems, automatic generation control (AGC) mainly relies on two loops: the load frequency controller (LFC) and the automatic voltage regulator (AVR). LFC and AVR are currently the focus of attention to improve the quality and reliability of power supply. The intermittency of renewable energy poses a major challenge to maintain the balance between generation and consumption, jeopardizing the stability and reliability of the power grid. Significant research efforts have been conducted to develop viable solutions, such as electrical energy storage (EES), demand response management by load transfer or interconnection with other networks. Much work has been carried out on the control and energy management of autonomous microgrids. It is essential to improve the frequency regulation of microgrids in the face of renewable energies through more robust control strategies with artificial intelligence (AI) and optimization algorithms inspired by nature.

METHOD

The generalized block diagram of the proposed hybrid energy generation and storage system is presented in Figure 1. The microgrid comprises a load frequency regulator (LFC), an automatic voltage regulator (AVR), and a power grid stabilizer (PSS) to maintain power system stability.

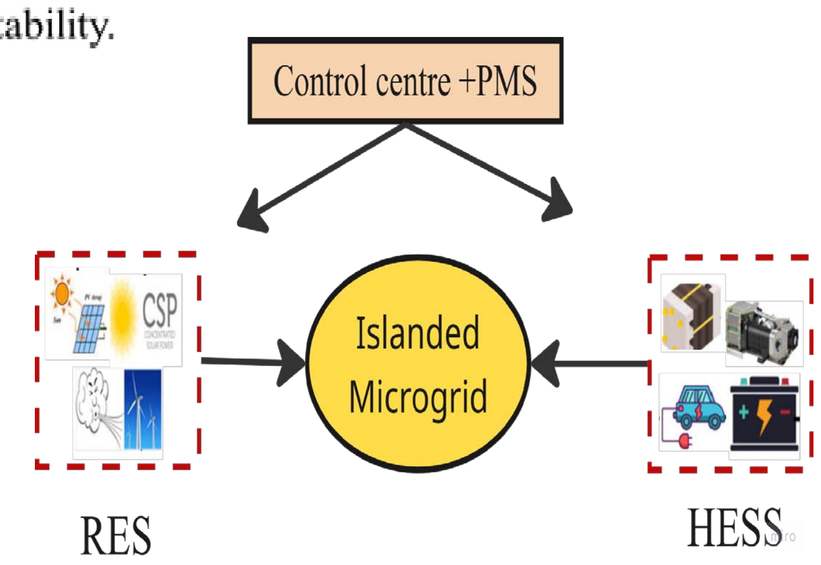

Figure 1 : Proposed Microgrid Model.

The proposed study is carried out in two main stages: the first aims to automatically control the AGC generation of conventional generators using a PID regulator optimized by the PSO algorithm and the management of renewable sources via the PMS; the second involves using the HESS storage system to compensate for fluctuations caused by RES.

The optimization problem is formulated using the same objective function, which is the integral time multiplied by absolute error (ITAE) as given in Eq.

$$ITAE = \int_0^t t.(|\Delta f| + |\Delta V|)dt$$

RESULTS & DISCUSSION

This section presents the simulation results of the proposed energy management and control strategy to avoid fluctuations related to load variation and the integration of renewable energy. It involves the use of a hybrid energy storage system to ensure energy balance and smooth regulation of frequency and voltage in stand-alone microgrids.

- ***Integration of renewable energy and storage system***

In this case, renewable energies (PV, WT and CSP) are integrated, the load is connected to the microgrid. The capacity of the LFC is compensated by the hybrid storage system (EV, RRB, PAC, PME). The results are presented in the following figures.

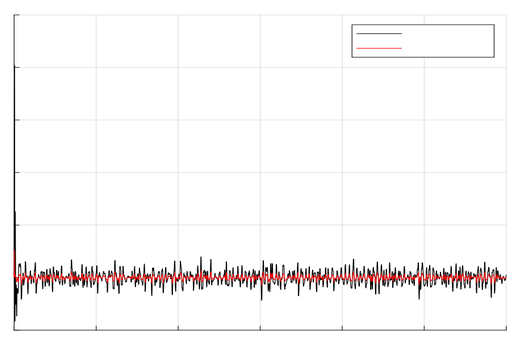

Figure 2 : microgrid frequency.

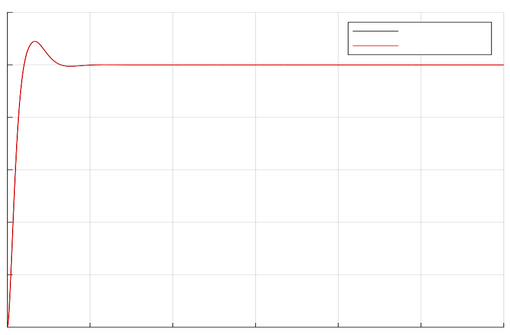

Figure 3 : Voltage profile

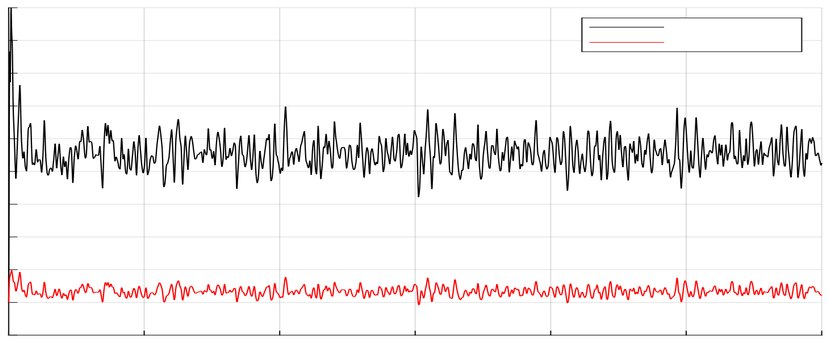

Figure 4 : Rotor angle

Intermittent production is subject to system fluctuations. To mitigate these fluctuations, the integration of hybrid energy storage systems (HESS) is a suitable solution for renewable installations. The proposed control strategy stabilizes the system in the face of load variations and fluctuations in power injected by renewable sources.

CONCLUSION

The study proposes a combined AGC-PMS strategy, associated with a hybrid energy storage system and optimized by artificial intelligence (PSO), to limit fluctuations linked to load variations and renewable sources and improve the frequency and voltage stability of micro-grids.

FUTURE WORK / REFERENCES

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