

Optimal Power Management and Control of Hybrid Solar–Wind Microgrid including Storage System

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INTRODUCTION & AIM

This work aims to propose an application of artificial intelligence and nature-inspired optimization algorithms to design an optimal power management and frequency control loop that allows the integration of a large number of distributed generators, such as wind farms and solar PV generators, in isolated and islanded power systems. In addition, the proposed strategy was coordinated with a Hybrid Energy Storage System (HESS) including a redox battery and fuel cells. The HESS was used to support the frequency regulation loop and reduce frequency oscillations during disturbances. An optimal Fuzzy-PID controller was employed to cope with system fluctuation using a recently developed optimization algorithm named Marine Predator Algorithm (MPA). The MPA algorithm was used to optimize the parameters of Fuzzy Logic and the PID controller. Furthermore, the proposed power management method was used to minimize the use of diesel generators by maximizing the participation of wind, PV, and storage systems to satisfy the load. To show the effectiveness and validity of the proposed strategy, various case studies have been simulated and presented in this work. A comparative study between some metaheuristic algorithms such as PSO and GA have been carried out. Finally, robustness analyses have been performed in the presence of high-penetration wind farms and solar PV arrays with different load disturbances.

METHOD

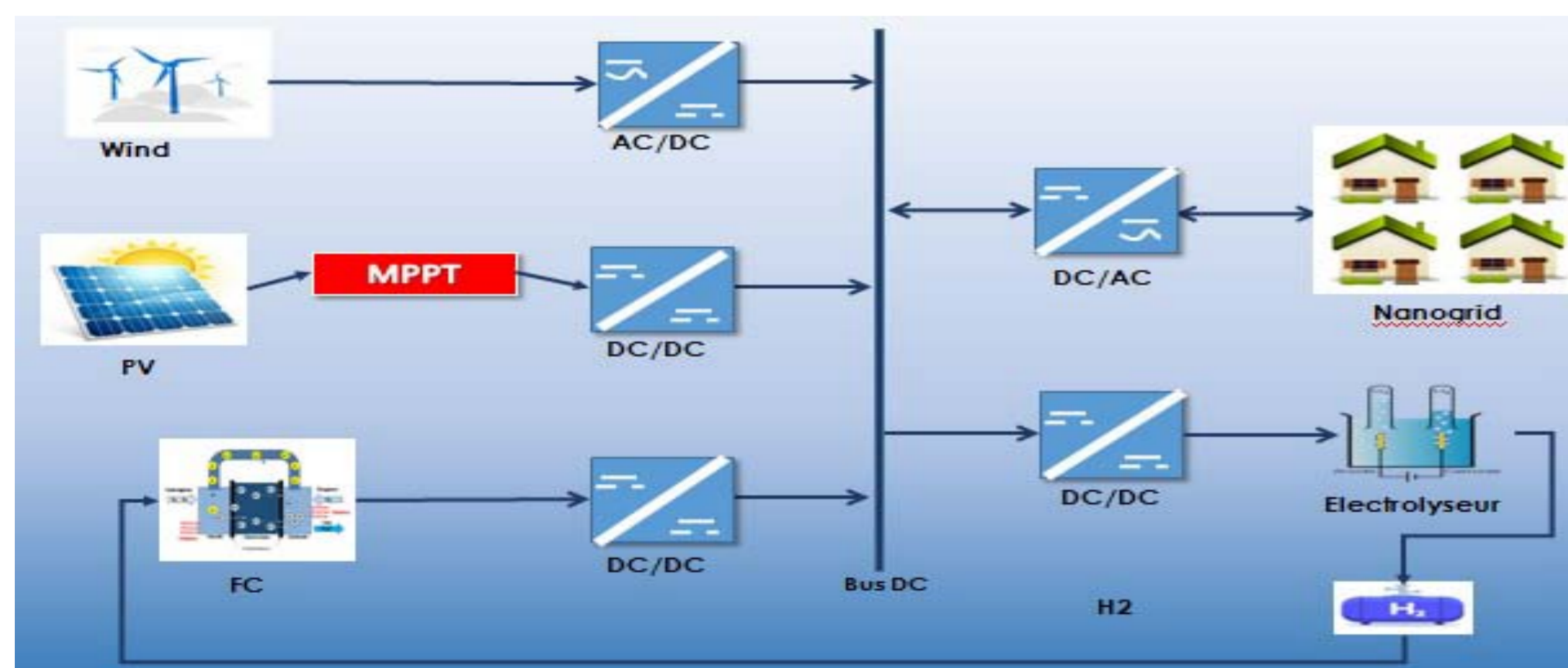
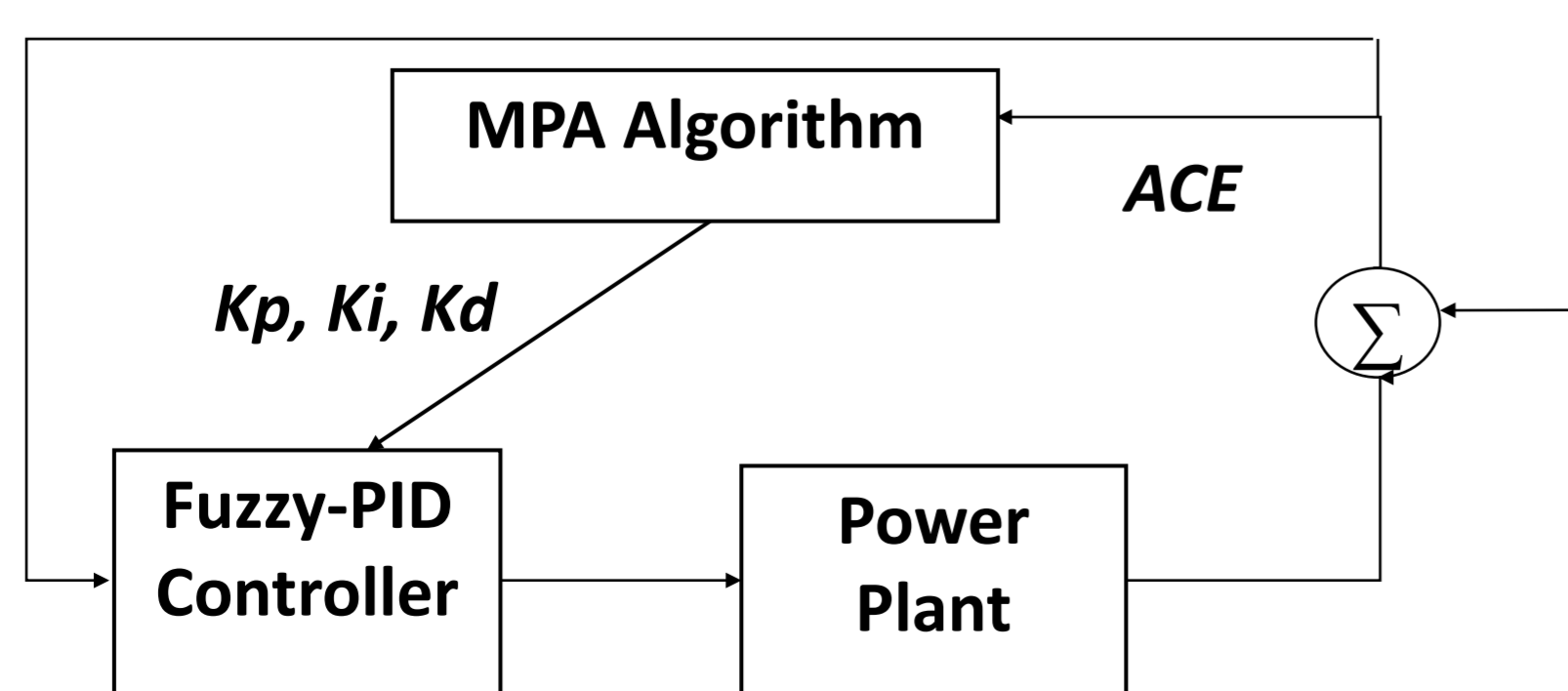


Fig.1. Isolated Micro-Grid Model.

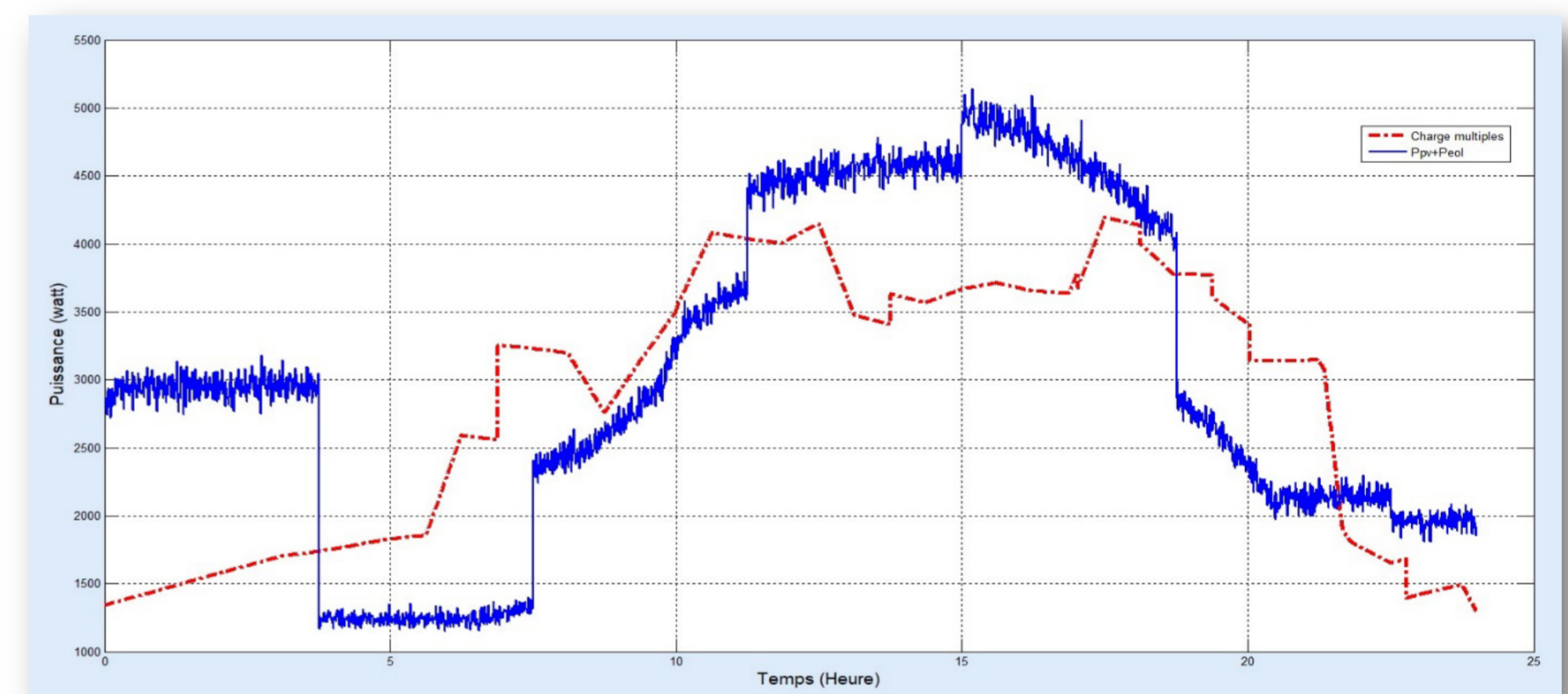
In this paper, the MPA algorithm was employed to find the best optimal Fuzzy-PID controller parameters in the LFC loop for the investigated isolated micro-grid. The global objective function of the LFC problem aims to minimize the frequency fluctuation using the proposed fitness function, where the problem constraints are the PID controller parameters (K_p, K_i, K_d).



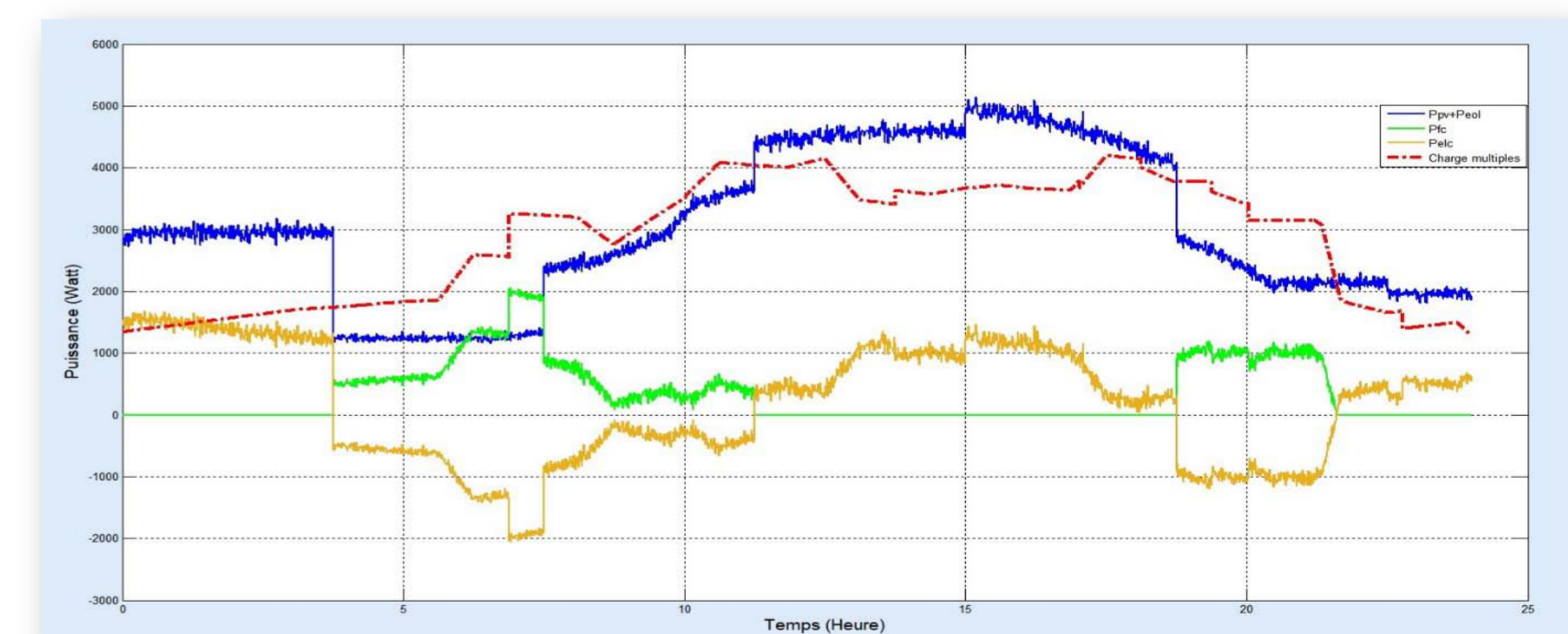
RESULTS & DISCUSSION

Two scenarios have been analyzed to show the potential of the proposed control strategy in monitoring an isolated micro-grid integrated solar PV generator and wind farm without and with storage system. The simulation results of the proposed intelligent LFC loop based optimal PID controller using Marine Predator Algorithm (MPA) strategy were presented.

Firstly, the micro-grid was simulated for a load disturbance to show the effectiveness of the proposed strategy. Then, a hybrid PV solar and wind farm were installed and the LFC control loop was supported with both EVs and RFB. The dynamics responses of the proposed method under load change and wind farm integration were analyzed with and without consideration of the LFC loop.



Without Storage System



With Storage System

It is clear from the presented results that the proposed optimal controller based MPA algorithm gives good responses and their implementation presents encouraging results to face disturbances.

CONCLUSION

- This work has proposed a new intelligent LFC scheme coordinated with storage system to enhance the monitoring of isolated microgrid.
- The proposed controller was coordinated with Hybrid Energy Storage System (HESS) including a redox battery and fuel cells to act quickly over wind energy fluctuations and load disturbance.

REFERENCES

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