Ain Shams University
Faculty of Engineering

Effect of Demand Response and Energy Storage on Power System Operation

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A Thesis Submitted for the Requirement of Master of Science Degree in Electrical Power Engineering

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Cairo
2020

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Statement

This thesis is submitted to Ain Shams University in partial fulfillment of the requirements for Msc. degree in Electrical Engineering.

The included work in this thesis has been carried out by the author at the Electrical Power and Machines Department, Faculty of Engineering, Ain Shams University. No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

Name : Mohamed Abdallah Mahmoud Shaheen
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To

My Parents, and my family.

Acknowledgements

The author would like to express his sincerest gratitude to **Prof. Dr. Hossam Eldeen Abdallah Talaat, Prof. Dr. Hany Mohamed Hasanien, and Prof. Dr. Said Fouad Mekhamer** for the great support, excellent supervision and encouragement shown during the period of this study.

Special thanks to the Electrical Power and Machines Department, Faculty of Engineering; Ain shams University and Future University in Egypt (FUE), for the great support and encouragement.

ABSTRACT

The penetration level of Renewable Energy Resources (RESs) in the electrical power system is increasing as they provide a cleaner and a cheaper alternative as compared to conventional electricity generators. The main challenge to the spread of these RESs is that they are not dispatchable due to their intermittent nature. Hence, their coincidence with demand is not guaranteed, and this affects system reliability.

The main aim of this research is to assess the effectiveness of utilizing new metaheuristic optimization algorithms; namely the SunFlower Optimization (SFO) algorithm, the Hybrid Firefly and Particle Swarm Optimization (HFPSO) technique, and the Harris Hawks Optimization (HHO) in solving a constrained Optimal Power Flow (OPF) problem. The principle target is to minimize the generating units' fuel cost under the power system' practical constraints. At initial stage, the objective function is solved to find the optimal locations of photovoltaic (PV) generators and/or wind generators within the system under study. Then, different scenarios are performed to solve the OPF problem including and excluding renewable energy sources. The generators' real output power defines the exploration field for the OPF problem. The SFO, the HFPSO, and the HHO algorithms are applied, one at a time, to minimize the fitness function and yield the best solutions of the problem. The suggested techniques are applied to four standard test systems to check the validity of the proposed algorithms. These test systems are the IEEE 14-bus, 30-bus, 57-bus, and 118-bus networks respectively. Simulations, with different scenarios, are implemented on these networks. To obtain a realistic result, real daily load curves are considered in this study. The results of simulations are investigated and analyzed. Results confirm the feasibility, effectiveness, and superiority of the introduced SFO, HFPSO, and HHO -based OPF methodologies, especially when compared with the genetic algorithm and particle swarm optimization.

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