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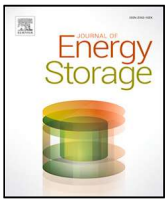

Research papers

Solving multi-objective probabilistic optimal power flow with renewable energy sources and Battery energy storage in transmission networks using Quasi Oppositional Sine Cosine algorithm

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ABSTRACT

The use of renewable energy sources (RESs) is becoming an essential component of the current electrical power production process. It is because renewable energy sources (RESs) are abundant in nature and emit no pollution, and fossil fuels, which power conventional power plants, are running out. Despite being plentiful and pollution-free RESs have a very unpredictable character. Thus, adding RESs to the power network makes the system more complex. With RESs incorporated, the current endeavor seeks to find the best possible solution to the optimal power flow (OPF) problem in the IEEE 57 & 118 bus standard networks. The standard OPF problem becomes a probabilistic OPF (POPF) problem when RESs exhibit unpredictable behavior. There are four test modules that make up the current investigation. The test module one only takes into account conventional thermal power sources. In test modules two and three with thermal power sources, solar photovoltaic (SPV) power and wind power (WP) are used as RESs. Battery energy storage (BES) technology has been deployed in addition to RESs in the third test module. Moreover, the module four comprises of RESs and BES on IEEE 118 bus test network is studied. The problems are solved using the quasi oppositional sine cosine algorithm (QOSCA), a hybrid of the sine cosine algorithm (SCA) and quasi oppositional-based learning (QOBL). The results are achieved by using OSCA, SCA and Chaotic driving training based optimization (CDTBO) techniques. This research study aims to minimize the total cost of generation, emissions, , improve voltage profile (VP) and stability index while meeting all the equality and inequality restrictions. In each of the four test modules, the previously described objectives are first achieved as a single objectives, and then all three are concurrently achieved as multiobjectives. For an average day, solutions are found. Uncertain quantities for this day are calculated using appropriate probability distribution functions (PDF) for each hour of the day, including power from wind plants, power from SPV sources, and load demands. Based on these anticipated hourly data, experiments are carried out. The findings acquired from the use of QOSCA, OSCA, SCA and CDTBO are statistically assessed at each test module on the test systems examined in order to achieve the aforementioned objectives. The numerical analysis using QOSCA for single objective over cost minimization after incorporating wind-solar-BES reduced to 12.9% whereas voltage profile is improved by 6.17%. Furthermore the proposed approach (QOSCA) implemented on multiobjective function considering with cost, emission and voltage profile where cost reduced to 11% which is the evidence of superiority of the proposed approach. It also proofed the computational efficiency in complex system with 25% faster rate than other optimization techniques. These statistical evaluations demonstrate how significantly more robust and effective QOSCA is in solving POPF issues than OSCA, SCA and CDTBO. To establish the robustness and effectiveness of QOSCA in optimization issue in contrast to other considered algorithms, statistical analysis and hypothetical test named ANOVA test have been conducted over the results on IEEE 118 bus test network.

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