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Optimal allocation of STATCOM for multi-objective ORPD problem on thermal wind solar hydro scheduling using driving training based optimization

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On IEEE 30, 57, 118 & 300-bus experimental networks, this work aims to solve the optimal reactive power dispatch (ORPD) problem. Initially, the conventional network is countered, and subsequently, renewable energy sources (RESs) such as wind power (WP), solar photovoltaic (PV) sources, and hydro power (HP) are combined with the traditional network. This study examines both single and multiple type objective functions (OFs). The Objectives include lowering active power loss (APL), lowering aggregated voltage deviation (AVD), lowering the voltage stability index (VSI), lowering reactive power loss and concurrently lowering AVD, APL & VSI. There are five test modules that comprise a total of 30 cases. Cases 5-8 and 13-30 are being conducted using STATCOM in conjunction with the test setup. The Driving Training Based Optimization (DTBO) method has been used to achieve the goals, and its performance has been compared to that of other optimization algorithms that have been reported in recent ORPD studies. Both stable load demand and uncertain changing load demand scenarios are included in the study. Appropriate probability density functions (PDF) are employed to estimate the uncertain WP, PV source, HP, and load demand. Uncertain scenarios with variable load demand, wind speed (WS), solar irradiance (SI), and water flow rate (WFR) are created using Monte Carlo simulations (MCS). Based on a range of studied cases, the experiment results show that the DTBO has a significantly stronger ability to solve ORPD challenges than the optimization methods discovered in the most recent ORPD literature. The usage of STATCOM improves power network performance for the ORPD issue, which is another significant finding. From simulation results it has been observed that for IEEE 30 bus the average power loss (APL) is 4.5086 MW, utilizing STATCOM the APL is reduced by 5.3% MW, with integrating renewable sources the APL is reduced 41%, and for both STATCOM and renewable sources (RESs) system it decreases to 43.6%. Hence, STATCOM and RES help to reduce the power losses using DTBO approach. Furthermore, average voltage deviation (AVD) improved by 97.4 % with incorporating STATCOM-RESs. Voltage stability index (VSI) improved by 26.9% with scheduling STATCOM and renewable sources (RESs). For the multi-objective situation APL & AVD both simultatiously improved to 5.0701(MW) & 0.1221 (*p.u.*), respectively, with incorporating STATCOM and RESs using DTBO. Voltage deviation converges at 40 iterations for with STATCOM but for without STATCOM it takes 80 iterations to converge. Similarly for voltage stability index with STATCOM converge 4 iterations earlier rather than without STATCOM system. Again for large scale IEEE 57 bus system The DTBO approach incorporating STATCOM and RESs provided optimal results. So, for IEEE 30, 57, 118 & 300 bus systems DTBO proves its superiority and robustness satisfactorily. **From simulation results it has been observed that for IEEE 30 bus the average power loss (APL) is 4.5086 MW, utilizing STATCOM the APL is reduced by 5.3% MW, with integrating renewable sources the APL is reduced 41%, and for both STATCOM and renewable sources (RESs) system it decreases to 43.6%. Hence, STATCOM and RES help to reduce the power losses using DTBO approach. Furthermore, average voltage deviation (AVD) improved by 97.4 % with incorporating STATCOM-RESs. Voltage stability index (VSI) improved by 26.9% with scheduling STATCOM and renewable sources (RESs). For the multi-objective situation APL & AVD both simultatiously improved to 5.0701(MW) & 0.1221 (*p.u.*), respectively, with incorporating STATCOM and RESs using DTBO. Voltage deviation converge at 40**