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RESEARCH ARTICLE-ELECTRICAL ENGINEERING

Hybrid Optimization Technique for Siting and Sizing of Distributed Generators and DSTATCOM to Minimize Power Loss and Voltage Deviation with Time-Domain Analysis

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Abstract

This paper introduces a hybrid African drive training optimization (HADTO) algorithm, which aims to optimize the sizing and placement of solar photovoltaics (PVs) and wind turbines (WTs) while taking power losses and voltage deviation into consideration. Considering the unpredictable nature of renewable energy sources and the excessive use of distributed generations, which can only supply active power, an optimized distributed static synchronous compensator (DSTATCOM) will also be deployed. This aims to address the reactive power demand associated with solar PV-based distributed generation sources while simultaneously improving the performance of the distribution network in the absence of DG sources. In addition, time-domain analysis is performed to observe the behaviour of the DSTATCOM under varying generation from renewable energy sources. The proposed methodology is implemented and validated on two test systems, IEEE 33 and IEEE 69-bus systems. For the IEEE 33-bus system, a 90.26% loss reduction and a voltage deviation drop from 0.0561 to 0.0052 were achieved, while for the IEEE 69-bus system, losses were reduced by 95.74% and voltage deviation improved from 0.0268 to 0.0028. These results clearly demonstrate the efficiency and effectiveness of the proposed HADTO algorithm in optimizing DG placement and improving overall system performance.

Keywords Distributed generation (DG) · Optimal location and size of distributed generation (OLSDG) · Power losses · Distributed static synchronous compensator (DSTATCOM) · Distribution network (DN)

List of Symbols

P_a	Active power flows from bus-a to bus-b
$Y_{loss}(a, b)$	Power loss between a and b
$V_{pi,min}$	minimum bus voltage
i_{max}	Is the maximum rated current
$V_{deviation}$	Signifies the voltage deviation
D	Is the population of the candidates
N	is the total number of population
l_j and u_j	lower and upper boundary problem variable
F	Signifies the objective function
X_L	Is the reactance of the line
Q_a	reactive power flows from bus-a to bus-b
Y	Power
$V_{pi,max}$	Maximum bus voltage
V_a	Voltage of bus-a
J_a	Resistance of the a^{th} branch
D_{ij}	Variable examined by candidate solution
m	Defines problem variable
λ	Is the random number
F_i	Objective function obtained from i^{th} candidate solution
V_D	Is the voltage of DSTATCOM

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