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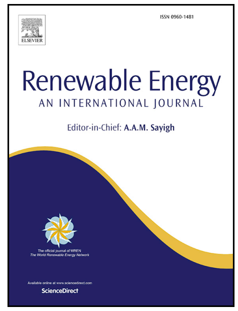

Day-ahead thermal and renewable power generation scheduling considering uncertainty

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Day-Ahead Thermal and Renewable Power Generation Scheduling Considering Uncertainty

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Abstract

This paper proposes a multi-objective optimization (MOO) based optimal day-ahead scheduling of thermal and renewable (wind and solar photovoltaic) power generation problem considering the intermittent/ uncertain nature of renewable energy sources, load demands and thermal generators. System operating cost (i.e., cost of thermal, wind, solar PV and battery powers), reliability and emission cost are considered to be optimized simultaneously. The uncertainties due to generator outages, wind, solar PV and load demand forecast errors are incorporated in the proposed optimization problem using Expected Unserved Energy (EUE) and Loss Of Load Probability (LOLP) reliability indices. In the proposed approach, the amount of spinning reserves (SRs) required are scheduled based on the desired level of system reliability. The proposed multi-objective optimization problem is solved using NSGA-II algorithm. Different case studies are performed considering two or three different objective functions that may be selected by the system operator (SO) based on his/her preference. The simulation results obtained on a sample test system validate the benefits of solving the hybrid power system scheduling problem as a transparent and realistic MOO problem considering the uncertainty.

Key Words: Day-ahead scheduling, renewable power generation, uncertainty, operating cost, reliability, generating unit outages, unit commitment.

Nomenclature

a_i, b_i, c_i	Fuel cost coefficients of i^{th} thermal generator.
a_{ei}, b_{ei}, c_{ei}	Emission cost coefficients of i^{th} thermal generator.
$b_{0,i}$, $b_{1,i}$, k_i	Startup cost coefficients of i^{th} thermal unit.
d_T	Time duration of each period (1 hour).
dc_j	Direct cost coefficient of j^{th} wind generator.
e_k	Direct cost coefficient of k^{th} solar PV plant.
E_{max}	Allowed maximum limit of expected unserved energy (EUE) reliability index.