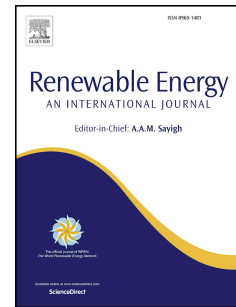


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Real-Time Optimal Power Flow with Reactive Power Dispatch of Wind Stations Using a Reconciliation Algorithm

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Abstract—It is extremely difficult to realize real-time active-reactive optimal power flow (RT-AR-OPF) in distribution networks (DNs) with wind stations (WSs) due to the conflict between the fast changes in wind power and the slow response from the optimization computation. To address this problem, a new lookup-table-based RT-AR-OPF framework is developed in this paper. According to the forecasted wind power for a prediction horizon, scenarios are generated based on its stochastic distribution. The corresponding mixed-integer nonlinear programming (MINLP) problems are solved online which simultaneously optimize the active and reactive power dispatch of WSs, active-reactive reverse power flow, and discrete slack bus voltage, resulting in a lookup table. Based on the actual wind power available in a sampling time, one of the solutions will be selected and realized to the DN. A new reconciliation algorithm is proposed to ensure both the feasibility and optimality of the realized operation strategy. The applicability of the proposed framework is shown using a medium-voltage DN.

Keywords—Active-reactive reverse power flow, mixed-integer nonlinear programming (MINLP), real-time active-reactive optimal power flow (RT-AR-OPF), wind power curtailment.

Nomenclature

Sets and indices

i, j	Indices for buses.
n	Index for sampling intervals.
k	Index for prediction horizons.
n_c	Index for wind power scenario combinations.
n_s	Index for wind power scenarios for each individual wind station (WS).
n_w	Index for WSs.
sb	Set of buses.

Functions

F	Objective function.
F_T	Total objective function for one day (proposed approach).
F_{TD}	Total objective function for one day (deterministic approach).
f_p / f_Q	Network active/reactive power function.

Variables

P_{loss} / Q_{loss}	Active/reactive power losses.
P_S / Q_S	Active/reactive power injected at slack bus.
P_w / Q_w	Active/reactive power of a WS.
$\mathbf{P}_w$	Vector of active power of WSs.

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