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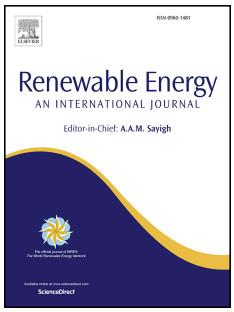

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Real-Time Optimal Power Flow with Reactive Power Dispatch of Wind Stations Using a Reconciliation Algorithm

Erfan Mohagheghi*, Aouss Gabash, Mansour Alramlawi, Pu Li
Simulation and Optimal Processes Group, Institute for Automation and Systems Engineering
Ilmenau University of Technology, Ilmenau 98693, Germany

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.
m	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.

* Corresponding author. Tel.: +49 3677 69-4193.
E-mail Addresses: erfan.mohagheghi@tu-ilmenau.de (Erfan Mohagheghi), aouss.gabash@tu-ilmenau.de (Aouss Gabash), mansour.alramlawi@tu-ilmenau.de (Mansour Alramlawi), pu.li@tu-ilmenau.de (Pu Li)