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Multi-objective Demand Responding Micro Grid Operation With Uncertain Renewable Energy and Load Demand

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ABSTRACT

Micro grid (MG) is defined as a small-scale power supply network with a group of distributed energy resources and could connect with outer electric power grid, when utilizing MG to satisfy the load demand of user, two important objectives: economic operation cost and environmental pollution emission, should be taken into consideration. In this paper, two operations: Demand Response (DR) and Energy Storage (ES) are introduced into MG system to reduce the operation cost and pollution emission. A multi-objective optimization model of MG operation is built and a hybrid Multi-Objective Particle Swarm Optimization (MOPSO) is presented to minimize operation cost and pollution emission simultaneously. Besides, since the uncertainty of load demand and Renewable Energy Source (RES) power generation, power supply service level of MG is utilized to ensure the power supply balance between MG and user. Moreover, a stochastic sampling method, termed as Monte-Carlo simulation, is combined with MOPSO to ensure the required service level could be satisfied by obtained power supply solution. The simulation results show that introduced DR and ES operation could reduce operation cost and pollution emission of MG efficiently. Moreover, under different uncertainty of RES power generation and load demand, compared with original MG operation without DR and ES, the stability of solutions obtained by proposed DR and ES operation, refers to the both robustness of operation cost and pollution emission, could be improved well. Finally, sensitivity analysis of different DR policies with virous incentive price and user acceptance are analyzed for providing decision support for manager of MG.

Keywords: Micro Grid Optimization, Demand Responding Operation, Energy Storage Operation, Uncertainty, Multi-objective Particle Swarm Optimization

NONMENCLATURE

T	Total hours for one-day
d_t	Load demand in time t
$P_i(t)$	Power output of the i^{th} fuel generator
$a_i,\ b_i,\ c_i$	Emission coefficient of the i^{th} fuel generator
$u_i,\ v_i, w_i$	Cost coefficient of the i^{th} fuel generator
D_{Ri}, U_{Ri}	Ramp rate constraint of the i^{th} fuel generator
$P_W(t)$	Power output of wind turbine
$P_S(t)$	Power output of photo voltaic
$R(t)$	Charging/Discharging power of battery device in time t
$Storage\ price$	Average depreciate price of battery device
$O(t)$	Purchasing power amount from outer grid in time t
$Purchasing\ price$	Electric price of outer grid
$DR(t)$	Actual DR amount in time t
$DR_{proposal}(t)$	DR proposal amount in time t
$DR_{max}(t)$	Maximum DR capacity in time t
π_k	DR incentive price

1. INTRODUCTION

The full paper version will be submitted later.

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ACKNOWLEDGEMENT

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