Logistic and scheduling optimization of mobilized and distributed battery for maximizing the renewable penetration

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Abstract: High penetration of renewable energy and the random real-time charging of large-scale electric vehicles are challenging to traditional urban power system technically and economically. This urgently calls for accelerating the development of smart energy solutions to improve the resilience of urban power system, and mobilized and distributed battery is believed to have the potential to provide the solution due to the advantages of high energy density, fast response, and convenient installation. Aiming at effectively satisfying the enormous urban power demand and realizing the cost-effectiveness and environmental-sustainability of power supply, this paper develops a two-stage method to achieve logistics and scheduling optimization of batteries at various temporal and spatial scales between renewable energy power plants and cities. The stage-one model is a battery transportation and logistics optimization problem, in which the objective function is to minimize the total cost of battery purchase and transportation considering the railway transport capacity, battery balance and other technical constraints. Based on the forecast results of available supply and demand of fully charged batteries in each renewable energy power plant and city, the detail battery transportation route and volume can be obtained. The stage-two model is a railway scheduling problem to determine the departure time of railway loaded with fully-charged batteries to achieve the purpose of maximizing the peak load regulation of urban power system. Finally, the proposed approach is applied to six cities in China, and the results demonstrate that the battery logistics and scheduling model can effectively improve the penetration of renewable energy and alleviate the peak power consumption of urban power system, thereby realizing the low-carbon development of urban energy system.

Keywords: Logistic and scheduling optimization; mobilized and distributed battery; low-carbon development; urban energy system