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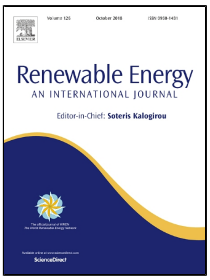

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Optimal stochastic scheduling of cryogenic energy storage with wind power in the presence of a demand response program

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Abstract

This paper provides a stochastic method to conduct the optimal scheduling of the combination of wind power and new-type large-scale energy storage with considering the demand response program in the electricity market. The integration of ASU and CES make the opportunity to store energy in the form of liquid in the off-peak periods and recovering the electricity in the peak periods. The uncertainty of electricity price, load demand and wind speed considered as the stochastic model uncertain parameters. The optimal operation of wind turbine, CES, and conventional generation units, considering the stochastic models for price, demand, and wind speed, was formulated as a mixed-integer non-linear programming (MINLP) problem. The constraints of CES operation, liquid and gas product demands, and ASU production were considered in ASU-CES modeling. The startup cost, minimum on/off time constraints, ramp rate, and capacity limits were considered in the formulation of conventional power generation. The demand response (DR) program was adopted to increase the total expected profit and decrease the total operational cost. The results revealed that the application of CES to attest system containing ASU increases the total profit of power generation units and decreases the total cost of generating power to serve load demands.

Keywords: Optimal scheduling, Wind power, Stochastic programming, Cryogenic energy storage (CES), Optimization

Nomenclature

Indices

i	Index for conventional thermal units
k	Index for wind turbines
t	Index for the time interval
$r,\ r'$	Liquid products of air separation unit

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