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ORIGINAL PAPER

State of the art for moth-flame optimization applied electric vehicles–solar–wind–hydro–thermal power system

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Abstract

The widespread adoption of electric vehicles (EVs) has a significant impact on the safe and reliable operation of the power system, and the widespread integration of wind power also possesses serious problems with predictability. In contrast, solar power is less efficient than wind power in terms of converting sunlight into electricity. Moreover, combination of wind power and solar power is most popular green energy alternatives among the various renewable energy sources because solar energy cannot be harnessed at night while wind energy can be harnessed even at night. So, it is getting harder to use renewable energy sources (RESs). However, fossil fuels are the main reasons for toxic and most dangerous pollution. In this research, hydro–thermal scheduling (HTS) problem integrating wind, solar, and EVs is examined using a novel method called the moth-flame optimization algorithm (MFO). The suggested HTS problem's main goal is to reduce the cost of power generation while satisfying several kinds of constraints, including losses occurring in the transmission, the effect of valve point on the thermal unit, and the unpredictability of RESs. Many electric vehicles (EVs), often referred to as cloud-based distributed power plants, are being developed as virtual power plants (VPPs), which are combined with clean energy sources to efficiently manage energy control. The objective of this presentation is to meet every constraint while reducing fuel costs. This is accomplished by balancing load demand and losses occurring in the transmission line while meeting every condition. By analyzing the generation cost using MFO, the effectiveness of the system is carried out and being compared with the others newly developed existing optimization methods to show the higher efficacy, usefulness, as well as robustness of proposed optimization technique. The result shows that a group of electric vehicles participating in renewable energy integrated hydro–thermal scheduling arrangement by consuming the power from grid.

Keywords Electric vehicles (EVs) · Wind energy · Solar energy · Hydro–thermal generation scheduling (HTGS) · Moth-flame optimization (MFO)

List of symbols

$f_{P_v}(P_v)$	PDF of the power output of EV unit
l	Mean deviation of the normal distribution function for EV
σ	Standard deviation of the normal distribution function for EV
N_l	Number of vehicles in fleet
f	Electrical vehicle fleet index
t	Time index
$\mathrm{soc}_{s,t}$	SOC of sth EV at time t
$\mathrm{soc}_{\mathrm{initial}}$	Initial value of state of charging
L_M	Capacity of EV battery
η_{charging}	Charging efficiency of battery
$\eta_{\mathrm{discharging}}$	Discharging efficiency of battery
$E_{s,q}^{\mathrm{driving}}$	Driving power of s_{th} vehicle at q_{th} time.
$C_{\mathrm{veh}}^{\mathrm{dr}}$	Direct cost of the mth EV unit
$C_{\mathrm{veh}}^{\mathrm{Ur}}$	Underestimation cost of the mth EV unit
$C_{\mathrm{veh}}^{\mathrm{Or}}$	Overestimation cost of the mth EV unit
d_m^v	Direct cost coefficients for the mth EV unit
n_v	Number of EV units
P_{vshl}	Scheduled power of the mth EV unit
P_{vl}	Output power of the mth EV unit
$Gf(*)$	Gauss error function
$PF_{\mathrm{vl}}^{\mathrm{Ur}}$	Underestimated penalty factor of the mth EV unit

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