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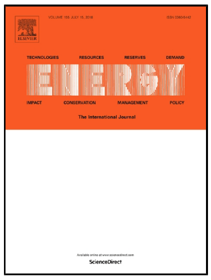

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Simultaneous Determination of Optimal Capacity and Charging Profile of Plug-in Electric Vehicle Parking Lots in Distribution Systems

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***Abstract*— Although future widespread use of plug-in electric vehicles (PEVs) will considerably reduce the greenhouse gas emissions, their charging demand will pose significant challenges to the grid. Aggregated charge scheduling of PEVs in parking lots (PLs) can mitigate the challenges, if the size and place of the PLs for PEVs are optimally determined. This paper proposes an optimization-based problem to not only determine the optimal size and place of PLs for PEVs, but also optimally schedule the charge and discharge of PEVs in the located PLs. The operation costs of distribution system, including the cost of purchasing energy from upstream grid and the cost of PEV charging in PLs, are considered as the objective of the proposed optimization problem, subject to the distribution system constraints. The proposed method is examined in a test system, considering different penetration levels for PEVs. In addition, the impact of results is investigated on the reliability of distribution system. The results show that decrements in the total cost of operation may lead to a lower reliability for the distribution system. The sensitivity of the results to the maximum charging rate of the parked PEVs in the located PLs is also reported in this paper.**

***Keywords*—Plug-in electric vehicle; Parking lot; Energy management; Charging profile; Reliability of distribution system.**

Nomenclature

Indices:		$SOC_{\min}^{i}$	Minimum allowable state of charge for battery PEV i
i	Indicator of PEV	$V_n^{\min}$	Minimum allowable voltage of load point n
l	Indicator of distribution system line	$V_n^{\max}$	Maximum allowable voltage of load point n
m	Indicator of parking lot	Ynj	Admittance of the line between n^{th} and j^{th} load points
n	Indicator of load point	Δ	Duration of time interval
t	Indicator of time interval	η_{Ch}	Efficiency of charging PEV battery
Constants:		η_{Dch}	Efficiency of discharging PEV battery
a^i	Arrival time of PEV i to parking lot	**Variables:**	
Cap_i	Battery capacity of PEV i	C_m	Optimal capacity of parking m
$C_m^{\max}$	Maximum allowable capacity of parking m	I_n	Amount of injected current of load point n to the system
$C_m^{\min}$	Minimum allowable capacity of parking m	I_l	Current of line l
d^i	Departure time of PEV i from parking lot	$I_m^i(t)$	Binary indicator of i^{th} PEV's place, which is one, if the PEV is located in PL m at time interval t; otherwise, it is zero
$D_n(t)$	Demand of load point n at time interval t	$P_{Ch}^i(t)$	Charging power of PEV i at time interval t
$I_l^{\max}$	Maximum allowable current of line l	$P_{Dch}^i(t)$	Discharging power of PEV i at time interval t

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