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Initiative Control Capability of Electric Vehicle and New Energy Consumptive Control Strategy

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Abstract

For the parked electric vehicle (EV) load in a specific area, its initiative controllability was studied and make targeted optimization and control within controllability to achieve the goal of using EVs to consume new energy output and improve the regional load characteristics. In the premise of the reliable two-way communication system, the upper dispatch department can monitor the real-time controllability of EVs based on the EV load margin boundary in this paper, so as to provide load balancing for the area by using the EVs' load.

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*Keywords:*electric vehicle; ordered charging; initiative controllability; regional wind and photovoltaic generation; consumption of new energy

1. Introduction

With the declining quality of the environment around the world, people are increasingly advocating the concept of green living [1]. As is in response to the energy conservation and emission reduction policy, electric vehicle (EV) is developing rapidly [2]. On the other hand, the traditional fossil fuel resource is depleted, wind and solar energy is widely studied and utilized as promising new energy.

Large-scale wind, solar and other new energy connected to the grid will produce corresponding power fluctuation [3]. Also, it will result in a waste of resource, when new energy output is too large. Meantime, Wind, solar and other new energy power generation is uncontrollable because of changeable natural factors. On the other hand, large-scale EV load will cause load tension in local area and power push on grid [4]. Meantime, as it can response grid control strategy, EV load is controllable. Making full use of wind, solar and other new energy to charge EV can not only consume new energy output by EV load, achieving efficient use of energy, but also reduce the impact on the grid. Thus, for the parked EV load in a specific area, its initiative controllability in timing sequence helps the upper dispatch department to make targeted optimization and control of EV load, reaching purposes of consuming new energy output and improving the regional load characteristics, which is of great practical significance.

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Nomenclature

n	current charging status of electric vehicles
$SocN$	current state of charge
$SocE$	expected state of charge
$L\%$	minimum percentage value of electric vehicle state of charge
$H\%$	maximum percentage value of electric vehicle state of charge
TS	the start time when electric vehicle is rechargeable
TE	the end time when electric vehicle is rechargeable
Ts	start time of actual charging
Te	end time of actual charging
T	rechargeable duration
T_{fact}	actual charging duration
P_{ev}^{0}	natural power consumption of regional EV when the system is not in control of electric vehicle
P_{ev}	power consumption of EV after response control
$P_{ev,max}$	the upper boundaries of EV load margin
$P_{ev,min}$	the lower boundaries of EV load margin
P_{rated}	EV charging power

Before grid side control and make use of electric vehicle load, it need to fully understand the load characteristics of electric vehicle and the controllable ability of electric vehicle load[5][6], so as to make effective guidance of electric vehicle according to the demand of grid load control to improve the system's operating condition[7][8]. Therefore, based on the existing achievements, this paper studied the initiative control capability of electric vehicle for the parked electric vehicle load in a specific area. Under the constraint of initiative control capability, for regional wind, solar and other new energy output, the generation method of electric vehicle charging behavior control strategy collection was proposed, to provide decision support for guiding electric vehicle to ordered charging through specific measures such as time price, and then achieve the purpose of using electric vehicle load to balance wind, solar and other new energy output and improve regional load characteristics [9][10].

1 Controllable electric vehicle load model

1.1 EV status matrix

EV in driving condition typically do not have controllable feature, and for parked EV, there is a five-dimensional row vector representing the state, that is,

$$Status=(n,SocN,SocE,TS,TE) \quad (1)$$

When EV is in charging mode, n=1.When EV is not in charging mode, n=0.$SocN$ and $SocE$ are in the $L\%$~$H\%$ range. TS and TE are ranged from 0 to 24.

After comprehensive consideration of all EVs in the region to be analysed, state vectors for each EV can combine into EV status matrix. The matrix can be updated in real time. If the time-step to obtain information is 1h, the status matrix needs to be updated once every hour.

1.2 Electric vehicle controllable status grouping

To make sure the generality of EV's controlled state, first of all, make the following assumptions: ① The charging power of EV in per unit time is same. ②State vectors of parked EV are known information. ③Once start charging, EV won't stop charging midway unless it has reached the desired state of charge or rechargeable terminal.

For parked EV, TE-TS is the rechargeable duration T, and Te-Ts is the actual charging duration T_{fact}. T_{fact} is determined by $SocN$ and $SocE$. According to actual situation, The actual charging time should be less than or equal to the duration of rechargeable, that is, $T_{fact} \leqslant T$. If $T_{fact}<T$, EV is in controllable state and power operation department can control the moment when EV start charging. If $T_{fact}=T$, EV is in uncontrolled state and must make full use of rechargeable time charging to meet