The Strategy of the Scale and Charging Optimization Based on the Distribution Network

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Keyword: Distribution network; Safety and efficiency; Electric vehicle; Charging load; Optimal operation

Abstract. The Electric Vehicle Charging Infrastructure Development Guide (2015-2020) and The Action Plan of Distribution Network Construction Reforming (2015-2020) have been analyzed and comprehended. Based on meeting a lot of rapid development of electric vehicle charging load, the optimal operation method of introducing the scale electric vehicle charging infrastructure is studied from the distribution network of safe, reliability and economic operation, which improve safety and efficiency in planning scale electric vehicle charging load to distribution network and charging facilities.

Introduction

According to the plan of The Development Guidelines for Charging Infrastructure of The Electric Car(2015-2016)and the requirement of the Plan of Distribution Network's Construction and Renovation Action(2015-2020), the power department should achieve the connection between the distribution network planning and charging electric facility planning, strengthen the construction and reform of the charging electric facilities that matched with power network, and guarantee the barrier-free access of charging electric facilities. They also should accelerate build the intelligent service network for electric vehicle charging, promote the operation technology of the electric vehicle charging orderly, V2G,as well as charging storage integration, and achieve the interconnectivity of charging facilities between cities and inter-cities. By 2020, 12 thousand charging electric station will have been satisfied, and 4.8 millions charging piles will have been connected, which provides charging electric service for 5 millions electric vehicles. Because most of the charging infrastructure consist of power electronic components, or it will cause some interferences, and the large-scale planning as well as rapid development of charging electric facilities accessing will affect the power quality of distribution network. Therefore carrying out the detection and evaluation to large-scale charging load power quality not only has important meaning to ensure the power network safe, reliable and highly efficient operation, also promote the better development of the national electric vehicle industry.

A Review of Domestic and Foreign Research

Started relatively late compared with the developed countries, electric cars in China has fast development. To meet the needs of the electric car development of infrastructure, the provinces and energy companies are promoting the building of charging infrastructure. In April 2010, issuing four national standards, namely The Experiment Method to The Light Hybrid Electric Vehicle Energy Consumption Amount, The General Requirements for Electric Vehicle Charging Station, the Communication Protocol between The Management System of The electric Vehicle Battery and Off-board Charger, The Charging Interface of Electric Cars Conduction Type, the nation will implement the subsidy and supporting policies to new energy vehicles, such as the electric cars. At present, the electric vehicle charging infrastructure has entered a rapid large-scale implementation stage ,and some running charging infrastructure has been affecting continuously to the power grid voltage, unbalance, loss, sag, voltage flicker and harmonic, and so on.

At present, although the strategy of controlling electric vehicle charging orderly has been researched already, it was conducting coordinated control in the whole area to reach the purpose of improving the load characteristics, and it didn't consider the effect of regional power grid structure and charging load distribution. So it can't guide the controlling process of charging orderly. This paper sets every charging station as a whole research object within the distribution network supplement ,and put forward a control model as well as strategy of accessing optimally between the distribution network and the charging station. Under the condition of meeting the demand of regional charging load, the network structure factors is considered and the load balance is set a goal in substation and power distribution line. The safety, reliability and economical efficiency of the distribution network will be optimized under the condition of satisfying the electric vehicle charging.

The Strategy of Large-scale Charging Optimization

According to the current and future developing type as well as operation characteristics of charging infrastructure, the strategy of charging load optimal operation can be divided into three aspects on the researching stage .The first is charging optimization control to a single electric vehicle. The second is charging optimization control to the group of electric car, usually studying of the aggregate and distribution network levels .The third is charging optimization control to regional power system electric vehicle.

The strategy of charging load optimal operation is analyzed and compared by considering marginal quantity of charging load carrying and combining with the regional power grid energy structure evolution on the result of benefit. Because of only considering the impact to the distribution network, this paper doesn't research the above first level, then analyze and compare with the above second and third level.

Under the condition of lacking of hardware and software facilities, the government's incentives will be a easy and effective control measures to guide the users avoid the peak charge. Based on the characteristics of Jiangsu daily load curve, the power supply departments divide a day into 8:00 - 21:00 (peak time), 21: 00- 8: 00 (off-peak time). According to the current domestic time division thought of shifting peak, and the delay charging mode, meanwhile on the basis of analyzing the user driving laws, this project raises a strategy to subsection control electric vehicles charging for Jiangsu power grid.

The optimal control target should be determined firstly. This article mainly considering the safe, reliable and efficient operation of the distribution network, so the first constraint condition is keeping the stability of the power grid (including slow filling, quick charge and a variety of access ways) when the large-scale charging infrastructure access. The second constraint condition is maximize economic benefits for charging stations, which differs from the constraint conditions that is researched commonly at present. On this basis, the optimal solution should be sought from the two phases under the constraint conditions. The concrete solving method is adopting genetic algorithm and support vector machine.

There are a few main methods to realize the optimal control of charging orderly: (1) the combination of centralized and distributed optimization control method.(2)the orderly charging policy by adopting two-stage optimal model of electric vehicle charging stations.(3) the electric car charging strategy aims at reducing the loss of power grid.

The optimization method of combining centralized with distributed is shown in Fig. 1

The third is the charging strategy that aims at reducing the loss of power grid. This strategy is divided into local charging strategy and global strategy, whose goals are minimizing the peak load, and trying to make the load curve smooth when the electric vehicles are connected to the power grid, resulting in reducing network loss. But both in the method, the complexity, the requirements and the results are not the same.

Local charge policies independently control single charging pile in charging stations. The foundation load of single charging pile is given for setting local charge strategy to electric vehicles, which determines the amount of charging power in each period. So the local charge strategy can

only be local optimum, it doesn't consider the other charging pile in global area. Local charge policy, although not optimal, is implemented easily ,just controlling themselves by setting management facilities at each single pile installation, and to some extent ,which can have very good optimization effect.

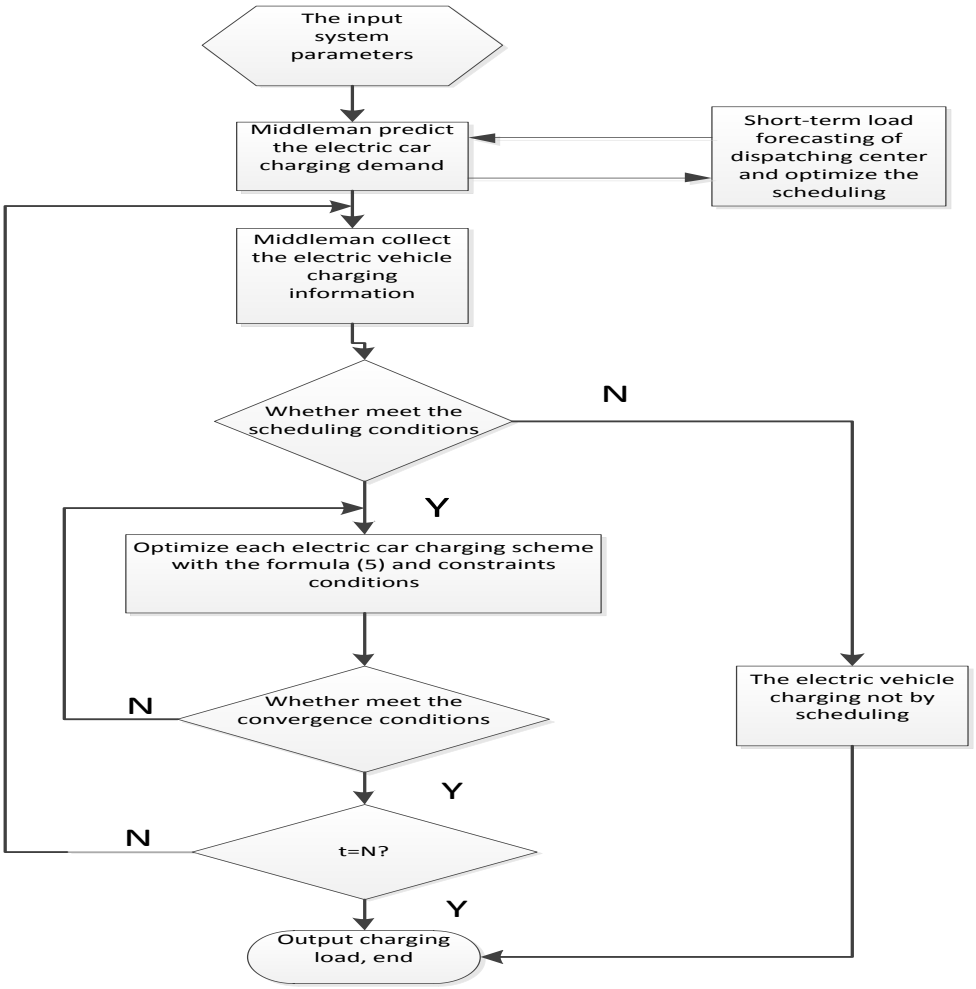

Figure 1. The combination of centralized and distributed optimization method

The global charging policies control and coordination all electric vehicle charging process within a distribution network. The same as the local charging strategies, the global charging policies also set charging strategies after electric cars connect to the power grid. Differently, the global strategies require all charging stations communicating charging information to each other in all areas, in order to get the global load, which will be constantly changing with the electric vehicle accessed and exited in all charging stations. So the global charging policies need communication network and global energy controller to collect information and charging control, although which is relatively complex, it can get the optimal results.

Although the constraint conditions of the above scheme is not the same , the main generally is maximum economic benefit to charging station, which has rationality .Because of only arouse the enthusiasm of charging station construction department , the large-scale charging station and the construction of charging pile can be better implemented . With the growing of accessing capacity, its influence will also increase to power system. Then the stability of the power system, risen to a new height, should be given priority consideration. In addition, the algorithm should not be too complicated .When large-scale charging infrastructure enabled, the control center calculation will grow into a geometric series, time-consuming for complex algorithm and take up too much resources, which is not conducive to online scheduling timely. This project aims to compare the existing optimization control strategy and improve as well as put forward the strategy of

optimization scheme by giving priority to the stability of electric power system, and secondary considering the economic benefit of charging stations.

Conclusion

On the basis of researching the charging optimal control problem for future electric vehicle, this paper builds an optimal control strategy between distribution network and charging station, and put forward two phase optimization scheduling and allocation strategy after considering the reliable constraint of the substation and the line. The results show that the optimal control of electric vehicle charging can effectively improve the safety and reliability of the substation, reduce the line loss, improve equipment utilization, limit the maximum load increasing of transformer substations and lines, low the peak valley difference, and increase the enterprise benefit. With the increasing of the electric cars penetration ratio, the effect of peak load shifting is more obvious, and the power supply equipment may cause overload, which affect the power grid maintenance and failure load transfer. The power supply scheme must be improved to ensure the power supply reliability.

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