# Analysis on Distributed Electric Auto Grid Technology Based on the Power Load of Distribution Network Planning

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**Abstract:** Peak shaving is to keep power output of the power system and power load balance, traditional way of load can be divided into the energy storage type load, a load of load based on the demand side management and energy storage type 3 kinds. Traditional ways of peak shaving are usually from the Angle of the power grid by the large capacity units, USES a unified power grid scheduling and management mode. With the continuous development of electric cars, electric cars, mobile storage capacity will continue to increase, and it has low storage cost. Therefore, the use of electric cars V2G technology in power grid peak shaving becomes possible. This article will be to load distribution network planning based on grid distributed technology on the electric vehicle power grid is studied.

**Keywords:** power grid peak shaving; distribution network planning; distributed electric cars; access network

## 1. Introduction

At present, the battery capacity of electric vehicles is generally between 15 and 200kWh, in which the capacity of passenger cars is like 15 to 30kWh. Because of the small battery capacity, it is difficult for individual electric vehicles to participate in the power grid interaction independently. By 2020, the production capacity of pure electric vehicles and plug-in hybrid vehicles reached 2 million, and the juice production and sales exceeded 5 million vehicles. Taking the capacity of 5kW for household electric vehicle as an example, the electric vehicle will have 25 million kW peak shaving capacity by 2020, and it will become the load response capacity [1] which cannot be ignored. It is one of the important characteristics of smart grid to make full use of renewable energy to generate electricity, optimize the structure of power grid, and improve the efficiency and economy of power grid operation. But renewable sources such as wind and solar is uncertain and intermittent nature, the direct access to the distribution system will cause the fluctuation of power system, when the power fluctuation caused by the traditional power supply cannot make effective rapid response, it will reduce the reliability and stability of power grid, power grid safety hazards. Electric vehicle has the characteristics of large scale, convenient control, rapid response and mobile energy storage, which provides a platform for the coordinated development of renewable energy.

The following we will discuss the influence of 1 large-scale electric vehicle access on network loss.

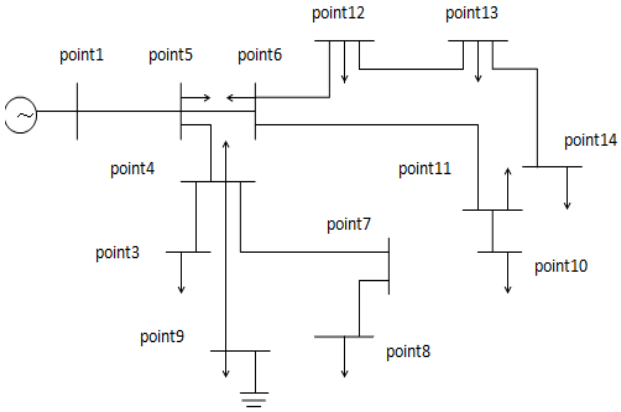


**Figure 1.** Wiring diagram of radial distribution network with IEEE standard 13 nodes.

The large-scale distribution of electric vehicles will lead to significant changes in distribution network power flow distribution. In a specific period of time, centralized charging behavior in specific regions, will cause the power demand of some nodes increased, so that the node power supply line load increase, line loss increased and voltage drop, network congestion is deteriorating rapidly, even the power demand exceeds the limit value of line capacity and instability, tripping phenomenon, increase the probability of [2] power failure. But the access of electric vehicles will not necessarily increase the network loss or deterioration of network congestion, in certain circumstances, the trend of distribution of access of electric vehicles can improve the distribution network, such as in the night when 22:00 increased part of the node load, the section can continue to run in a normal working

load, distribution network the trend of decline because the other load at night and changed, so as to reduce the line loss in the whole network to a certain extent.

## 2. Model Establishment

### 2.1. Objective Function and Constraint Conditions

The realization of intelligent charging and discharging strategy for electric vehicles is a kind of mathematical optimization problem. It is necessary to select different optimization objectives according to the actual situation and establish different mathematical models. The objective functions of intelligent charging and discharging strategy for electric vehicles can be either an index or a combination of some indexes. The objective function of peak shaving and valley filling is generally [3]:

$$\max P = \min\left[P'(t) + \sum_{i=1}^{N} P_{\mathrm{i}}(t)\right] \tag{1}$$

In this formula, the meanings of the parameters are as the following:

$P$ ——Electric vehicle rear load

$P'(t)$ ——Regardless of a load of electric vehicles

$P_i(t)$ ——Charge and discharge power of I electric vehicle.

The constraint conditions of electric vehicle charging and discharging are usually calculated:

The power constraint of electric vehicle charging and discharging is

$$-P_{\max} \le P_t \le P_{\max} \tag{2}$$

The battery capacity of electric vehicles is

$$0 \le E_t \le E_{\max} \tag{3}$$

The number restriction of electric vehicles entering the network is

$$N_{V2G} \le N_{V2G}^{\max} \tag{4}$$

The battery charging state is

$$SOC_e \le SOC \le SOC_c \tag{5}$$

$SOC_e$ --Charged state of user requirements

$SOC_c$ --Full load state.

### 2.2. Algorithm Optimization

The state of charge and discharge of electric vehicles can be represented by 0, l and -l based on (0 in the idle state, 1 is charging, -l said it is the discharge of electric vehicles), electric vehicle charging and discharging, so to peak for the target belongs to the large scale 0-1 programming problem, the optimization of this kind of problem in general the interior point method, dynamic programming and intelligent algorithm [4].

The interior-point method is an algorithm based on linear programming to solve unconstrained optimization problems. According to the different search path, the interior point method can be divided into the projection method (projective method), (affine scaling method) affine method, reduction potential method (potential reduction method) and the primal-dual path-following method (primal-dual path-following method), the original dual interior point method is widely used in power system optimization the problem in [5]. This algorithm can deal with the large-scale nonlinear programming problem, and it has two convergence and good robustness, but it cannot handle discrete variables effectively, thus resolving the problem of electric vehicle charging and discharging 0 - 1 variable characteristic, must be combined with other algorithms.

Dynamic programming (dynamic programming) is a mathematical p method for solving the multi-stage decision process. The optimization problem of the door dimension is transformed into 7 l dimensional optimization problems, and the hierarchical processing of the optimization problem greatly reduces the amount of calculation, and also subtly eliminates some solutions which need not be considered. However, the dynamic programming method requires that the solution of the problem has a distinct phase, so it is difficult to consider the time dependent constraint [6].

## 3. Power Grid Peaking Distribution Network Planning and Distributed Electric Vehicle Access to Power Grid Technology

According to GB/T 24337-2009 “power quality public power grid harmonic” requirements, the charger is facing more stringent network audit, need to take corresponding measures to compensate and reduce the harm of harmonics. The harmonic generated by the charging station of an electric vehicle is related to the power supply voltage level, the distance between the charging station and power supply, the distribution transformer of the charging station, the number of chargers and the power of the charger. The charging station is powered by the power supply with a low voltage level is good, can bring more charger in order to meet the national standard; power line long lead harmonic current decreases slightly, so the charging station should be higher power supply distance; charging station distribution transformer with the Dynll connection helps to suppress 3 harmonic [7]. The practical value of each harmonic current increases with the increase of the number of chargers, but the harmonic currents between each other cancel each other so that the total harmonic current is less than the algebraic sum of the harmonic currents produced by each charger. Therefore, when the harmonic suppression device is installed, the capacity of the device can be reduced because of the mutual cancellation of harmonic currents.

**Table 1.** Harmonic simulation value of charging station under different power supply voltage levels.

| Simulation values of each harmonic | | | | |
|---|---|---|---|---|
| Harmonic number | Harmonic limit | number | | |
| | | 1 | 3 | 9 |
| 5 | 0.15 | 0.06459 | 0.1893 | 0.5253 |
| 7 | 0.18 | 0.04272 | 0.1113 | 0.2485 |

### 3.1. Realization Between Electric Vehicle and Power Grid

The realization of an interactive interface between the electric vehicle and the power grid. Charging and discharging pile and intelligent charging and discharging motor is the interface between an electric vehicle and power grid, which can control the bidirectional interaction between the electric vehicle and power grid. The electric vehicle users upload the charging demand information to the upper control center, and the upper control center reasonably arranges the charging and discharging of the electric vehicle according to the real-time operation state of the power grid and the charging demand information of the users. Therefore, the intelligent charging and discharging device is the hardware foundation for the realization of V2G function of electric vehicles.

### 3.2. Optimization Control Strategy

Reasonable charging and discharging control strategy is the guarantee of electric vehicle V2G function realization. Electric vehicle V2G integrated control strategy of electric vehicle charging analysis, load forecasting, analysis, evaluation of renewable energy and electric vehicle charging and discharging coordination control strategy of electric vehicle mobile storage multi-temporal characteristics, grid coordination control strategy of a comprehensive. V2G intelligent and efficient optimization control strategy can ensure that under the premise of meeting the changing needs of users, as much as possible to participate in the grid frequency modulation, peak shaving, and other auxiliary functions, to achieve a win-win situation between users and power grid [8].

### 3.3. Operation Capacity and Parameter Prediction of V2G

The realization of V2G function is based on the prediction of the number of electric vehicles and battery capacity, which can participate in the grid interaction. It is necessary to accurately predict the various parameters that V2G needs in the process of scheduling, which will become one of the concerns of power grid dispatching and operation institutions [9]. It is because of the interactive interaction between V2G, and the user's energy, the prediction of the available capacity is more complex than the traditional load forecasting. From the technical point of view, the available capacity of V2G energy storage can be realized in two ways: signing a short-term contract with users and forecasting based on historical data. Although some electric vehicles may not operate by the present status and contract, the expected available capacity and actual available capacity may be biased [10].

## 4. Conclusion

Through the existing research results show that: on the one hand, the scale of electric vehicles will lead to access grid (especially residential local area electric vehicle load increasing, aggregation) may cause a new peak load, impact generation adequacy and power generation plan, on the other hand, a reasonable charge (change) electric mode can be reduced the load on the peak valley difference, improve the load characteristics of power grid. Therefore, the large-scale access to electric vehicles is not only a challenge but also an opportunity for the power grid.

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