Research on the impact of different charge and discharge modes of electric vehicles on power grid load

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Abstract. The rapid development of the economy has made the scarcity of traditional fossil energy increasingly prominent. At the same time, with the proposal of the beautiful China strategy, electric vehicles have become an important choice for people to travel. Different charging and discharging modes of electric vehicles have different impacts on the power grid load production. Reasonably controlling the impact of electric vehicle charging and discharging loads on the power grid, narrowing the peak-to-valley difference, and ensuring the reliability of grid operation have become urgent issues to be resolved. This paper selects electric private cars and electric buses that have a large effect on the power grid load as the research object, and uses qualitative and quantitative research methods to extract the main influencing factors of electric vehicle charge and discharge. A charge and discharge daily load calculation model for electric vehicles under three modes of disorderly charging, one-way ordered charging and bidirectional ordered charging and discharging was constructed, and a typical Tianjin electric vehicle charging behavior research sample was selected. Monte Carlo method was used to predict the daily load of Tianjin electric vehicles under three charging and discharging modes, and the results were analyzed and discussed, and the corresponding management inspiration was given.

1. Introduction

In recent years, with the transformation and upgrading of the global economy, oil resources have become increasingly tight, and environmental pollution and energy consumption caused by fuel vehicles have become more and more serious. Countries have been committed to finding new energy sources that can replace traditional fossil fuels. Electric vehicles using electricity instead of oil have developed rapidly with the advancement of battery and other key technologies. Their low energy consumption and environmentally friendly characteristics will help the sustainable development and green development of the automotive industry in the future. This has become an important research hotspot to solve energy consumption and environmental pollution at this stage. At present, academia has done a lot of research on related issues. From the perspective of quick-change charging station scheduling, Zhang Qian and other scholars [1] constructed a fuzzy gray GA-BP neural network load prediction model based on Hadoop. It will be brought into the model to obtain the load of the day to be measured, and the electric vehicle charging load at different temperatures and in different traffic conditions areas will be simulated.
Dong Yan et al. [2] analyzed the causes of the Monte Carlo method errors and used the improved string division method to optimize the charging load prediction model of electric vehicles based on the randomness of the charging behavior, and improved the Monte Carlo method optimization Paths increase computation speed significantly. Denholm P. and other scholars [3] show that under different charging and discharging control strategies, the load curve of the electric grid after the electric vehicle is connected shows different characteristics, and the infrastructure construction cost and energy consumption structure of the grid also have certain differences. Sun Xiaoming et al [4] put forward a method to divide the peak valley TOU price period considering the charging cost of electric vehicles and the starting time of charging. The calculation results show that the more users respond to the peak valley TOU price, the more favorable to restrain the load fluctuation of power grid. Sun Q.M. and other scholars [5] proposed an electric vehicle load forecasting method that considers weather and date type using SVR, and verified the accuracy of the method through an example. Chen JJ. Et al. [6] studied the division of the optimal time period of regional electric vehicle charging prices by using the membership function method in the context of peak-valley time-of-use electricity prices. The elasticity coefficient method studies the responsiveness of users. Zhu Lan et al. [7] based on the uncertainty of the charging and discharging behavior of electric vehicle users, and aimed to maximize the expected net income, to build a decision model with electric vehicle agents as the main body. Guille C. and other scholars [8] showed that two-way energy exchange between electric vehicles and the power grid can be achieved through V2G technology, and electric vehicles can provide peak and frequency modulation services for the power grid. These studies have achieved many results in the prediction of electric vehicle charging and discharging loads, but their research perspectives are limited to a specific type of electric vehicle or a specific charging mode, and do not comprehensively consider the different types of electric vehicles in different charging and discharging modes. The charge and discharge load prediction is based on electric private cars as the main research object. There is no further detailed study on the situation of other types of electric vehicles such as electric buses participating in orderly charge and discharge control. Therefore, this article attempts to study the charge and discharge daily load prediction of different types of electric vehicles under three charging modes: disordered charging, unidirectional ordered charging and bidirectional ordered charging and discharging from a more comprehensive perspective. The feasibility of orderly charging control makes the load prediction results more scientific and comprehensive, and then provides a theoretical basis for analyzing the impact of different charging and discharging modes of electric vehicles on the grid load.

2. The electric vehicles charging and discharge load influence factors extraction

There are many factors that affect the charge and discharge load of electric vehicles. From the perspective of electric vehicle users, different types of electric vehicle users have different travel rules. Different travel times will cause their charge and discharge times to be different, which will affect the electric vehicle Charge and discharge daily load; From the perspective of the electric vehicle itself, different battery characteristics make the charge and discharge duration of the electric vehicle different, and the resulting daily charge and discharge load varies greatly. By studying the relevant literature at home and abroad and using the frequency analysis method of the literature, the influencing factors of the charge and discharge load of electric vehicles with a high frequency of 10 or more occurrences in 50 articles are extracted, as shown in Figure 1:
Figure 1 Statistical chart of frequency of influencing factors charge and discharge load

Combined with relevant information and expert opinions obtained during the investigation of power grid companies, among the above-mentioned high-frequency influencing factors, some factors do not directly affect the charge and discharge load of electric vehicles, and from the perspective of grid companies, they can only be identified and difficult to control, such as the charging location; some factors can be summarized into one category, where the initial state of charge and battery capacity can be summarized as battery characteristics; some factors are determined by other factors, such as the charging power is determined by the charging method, and the charging and discharging time. Therefore, the influential factors with different names but similar meanings or greater relevance in Figure 1 are classified and unified, and the less controllable influencing factors are excluded. Six major influencing factors of the charge and discharge load of electric vehicles are extracted. It is the charging method, the start time of charging and discharging, the daily mileage, the battery characteristics, the amount of electric vehicles and the type of electric vehicles.

3. The electric vehicle charging and discharging daily load forecasting

3.1. Electric vehicle charging daily load forecasting on disordered charging mode

The disorderly charging mode is V0G mode (Vehicles plug-in without logic/control), which means that electric vehicle users are connected to the grid for charging according to their own travel rules and charging habits. The initial charging time and charging time are not controlled by the grid. According to the data released by the Tianjin Municipal Bureau of Industry and Information Technology, it is known that the predicted value of electric private car ownership in Tianjin in 2019, 2025, and 2030 is 115.61 million, 231,800, and 355.37 million; the predicted value of electric buses were 39.9 thousand, 80.1 thousand and 124.2 thousand respectively. According to the 2018 travel data released by the Tianjin Traffic Police, the time when the electric private car user traveled and finally returned home was normalized, and based on the maximum likelihood estimation method using MATLAB to fit the data, the electric private car charging started The moment approximately obeys the normal distribution N (18.12, 3.23²). Electric buses have the characteristics of two charging a day due to operational needs. Based on measured data from a bus charging station in Tianjin, the charging start time is 10:00 a.m.-17:00p.m. and 19: 00p. m.-21: 00 p.m. Internally obey uniform distribution. According to statistical verification, the initial state-of-charge SOC of electric private cars follows the normal distribution N (0.6, 0.12²) [9], and the initial state-of-charge SOC of electric buses follows the normal distribution of μ=0.5 and σ=0.12[10]

According to the above conditions, the Monte Carlo method is used to predict the daily load of disorderly charging of electric private cars and electric buses in Tianjin in 2019, 2025 and 2030. After
2000 simulation calculations, the coefficient of variance is less than 0.05%, which satisfies the calculation accuracy, its charging daily load curve is shown in Figure 2 and Figure 3.

![Figure 2 Daily load curve of disordered charging of electric private cars in Tianjin](image1)

![Figure 3 Daily load curve of disordered charging for electric buses in Tianjin](image2)

It can be seen from Figure 2 that in the disorderly charging mode, the charging load of electric private cars is time concentrated. After the user returned from the last trip, most electric private car users began to recharge electric cars, and the charging load peaked. With the arrival, the peak value appeared between 18:00 p.m. - 20:00 p.m., Which coincided with the peak period of the power grid system, which easily caused the phenomenon of “peak plus peak” in the load of the power grid; At first, with the charging of most electric vehicles ending, the demand for charging gradually decreased, and the charging load of electric vehicles was at a low level between 0:00 a.m. - 10:00 a.m.

It can be seen from Figure 3 that under the disorderly charging mode, there are two load peaks in the daily charging curve of Tianjin electric buses. After the morning rush commute ends and before the evening rush commute starts, the electric bus starts the first day operation. The first charge peak occurs during the 10:00 a.m.-17:00p.m. Recharge time; after the end of the evening peak after work, the electric bus needs to supplement the electricity for the next morning operation. Two charging peak periods followed, and the charging load began to rise rapidly. The peak value appeared between 19:00 p.m.-23:00p.m., Which was just during the peak period of the grid load, and the peak level was higher than the first charge. The peak value has increased, and the maximum load within a day appears, which will
easily increase the power supply pressure during the peak hours of the power grid. Then most of the electric buses are charged, and the charging load begins to drop 0:00 a.m.-9:00 a.m., which is the low period of the charging load of electric buses.

Table 1 Daily peak-to-trough value and peak-to-trough difference of Tianjin electric vehicle disorderly charging during 2019-2030

| Year | Peak charging load (MW) | Charging load valley (MW) | difference (MW) |
|------|------------------------|---------------------------|-----------------|
| 2019 | 385.044                | 207.204                   | 384.646         |
| 2025 | 772.130                | 420.669                   | 771.345         |
| 2030 | 1183.270               | 645.166                   | 1182.076        |

From the above table, it can be seen that from 2019 to 2030, with the increase of the number of electric private cars in Tianjin and the large-scale application of electric buses, the peak value and the valley value of the daily charging load are gradually rising, and the peak valley difference is increasingly aggravating, which will reduce the utilization rate of the grid equipment, affect the balance of supply and demand of the grid, and pose a threat to the stable operation of the grid system.

3.2. Electric vehicle ordered charge and discharge daily load forecasting

3.2.1. Daily load forecast of electric vehicle charging under one-way ordered charging mode. The one-way ordered charging mode is the V1G mode (Vehicles plug-in with logic control), which refers to the electric vehicle charging as far as possible under the guidance of the grid company's peak-to-valley time-share price mechanism, but does not provide power to the grid in the reverse. If the electric vehicle charging time exceeds the valley period, the electric vehicle starts charging at the beginning of the valley period; if the electric vehicle charging time is shorter than the valley period, the electric vehicle can choose to charge the battery during the valley period start charging at any time, that is to say, electric vehicle users should try to ensure that the charging time is within the valley electricity price period.

The electric private car is parked for most of the day, and you can choose the starting point of charging more freely. At present, most of the charging time of the electric private car is concentrated after returning from the last trip, that is, returning home from work at night 19:00 p.m.-21:00 p.m. Electric buses are charged twice a day. In order to meet the needs of operation during the day, they cannot participate in the one-way ordered charging mode. After the operation ends, electric buses can participate in the ordered charging mode at night. Like electric private cars, try to ensure that the charging time is within the grid price period. The starting time of daytime electric bus charging is still at 10:00 a.m.-17:00 p.m. Based on the above conditions, the Monte Carlo method was used to predict the daily load of one-way ordered charging of electric private cars and electric buses in Tianjin in 2019, 2025 and 2030. After 2000 simulation calculations, the coefficient of variance was less than 0.05%. Satisfying the calculation accuracy, the charging daily load curve is shown in Figure 4 and Figure 5.
As can be seen from Figures 4 and 5, under the one-way and orderly charging mode, Tianjin electric private cars and electric buses charge two daily peak load curves. Most electric private car users respond to the peak-to-valley time-sharing electricity price mechanism and choose to charge electric vehicles during the valley hours when the electricity price is lower, that is, 0:00 a.m.-7:00 a.m. Significantly increased, forming the first load peak; while other electric private car users did not respond to the one-way ordered charging mode, and still started to charge the electric vehicle immediately after returning from the last trip, forming a second load peak. The peak load occurs between 18:00 p.m.-20:00 p.m., Which coincides with the peak load period of the power grid. With the increase of the number of electric vehicles connected to the grid for charging, the peak-to-valley difference is still increasing, but the peak value of the charging load during the peak period of the power grid is significantly lower than the disorderly charging mode, and the load value during the valley period is significantly increased.

Electric buses elect to charge electric vehicles during the valley hours during the night when the electricity price is lower, that is, 0:00 a.m.-7:00 a.m., Forming the first charging peak, which increases the charging load level during the valley hours. Because electric buses have to meet the needs of operation, they cannot respond to the peak-to-valley time-of-use electricity price mechanism to participate in the one-way ordered charging mode, still after the morning peak ends and before the evening peak start 10:00 a.m.-17:00 p.m Within the centralized charging, resulting in the second charging
peak between 12:00-16:00. With the increase in the number of electric buses, although the peak-to-valley gap has continued to increase, the peak load of the electric grid has decreased significantly during peak hours.

| Year | Peak charging load (MW) | Charging load valley (MW) | difference (MW) |
|------|-------------------------|---------------------------|-----------------|
|      | Electric private car    | Electric bus              | Electric private car | Electric bus |
| 2019 | 342.321                 | 147.577                   | 3.087           | 0            | 339.234 | 147.577 |
| 2025 | 686.991                 | 298.401                   | 6.227           | 0            | 680.763 | 298.401 |
| 2030 | 1052.798                | 458.339                   | 9.602           | 0            | 1043.196 | 458.339 |

From the above table, it can be seen that under the unidirectional orderly charging mode, the daily peak load of electric private cars and electric buses will decrease year by year in 2019, 2025 and 2030. Compared with the disordered charging mode, the peak load of electric private cars will increase significantly, and the peak load level of electric buses will remain unchanged. Although the peak valley difference of daily charging load continues to increase with the increase of the number of electric vehicles connected to the grid, compared with the disordered charging mode, the peak valley difference has been significantly reduced. Therefore, it is feasible for electric private cars and electric buses to participate in the one-way orderly charging mode based on the peak valley time-sharing price mechanism, which can not only improve the utilization rate of equipment in the grid valley period, but also greatly save the charging cost of electric vehicles without affecting the operation demand.

3.2.2. Daily load forecasting of electric vehicle charging and discharging under bidirectional orderly charging and discharging mode. The two-way orderly charging and discharging mode is V2G (vehicles plug-in with regulated charge / discharge), which refers to the bidirectional interaction of information and energy between electric vehicles and power grid through V2G technology in the context of smart grid. If the time required for electric vehicle discharge exceeds the peak time, the electric vehicle will start discharging at the beginning of the peak time; if the time required for electric vehicle discharge is less than the peak time, the electric vehicle can choose to start discharging at any time in the peak time. Under the bidirectional orderly charging and discharging mode of V2G technology, in order to maximize the total revenue, the electric vehicle users will increase the discharge revenue and reduce the charging cost as much as possible, and will decide their charging and discharging behaviors according to the peak valley time-sharing price. Assuming that the electric vehicle users are rational, the users will generally choose to discharge in the peak period and charge in the valley period. Due to the limitation of battery conditions and technology, V2G demonstration projects at home and abroad are mainly used in electric private cars. Because the electric power obtained by electric buses in a day needs to meet the passenger demand first, there is basically no surplus energy that can be transmitted to the grid in reverse, and the feasibility of electric buses transmitting power to the grid in reverse remains to be discussed. Therefore, in the bidirectional orderly charging and discharging mode, the electric bus only participates in the orderly charging.

According to the Tianjin Peak and Valley time-of-use electricity price policy, the selected peak hours are 8:00a.m.-11:00a.m. and 18:00pm.-23:00pm. According to statistical verification, the daily mileage of electric private cars follows the logarithmic distribution of $\mu=3.22$ and $\sigma=0.88$, and the power consumption $W_{100}$ per 100 kilometers is 15kW·h. The electric vehicle's discharge power is reduced to constant power, and considering the battery discharge performance, the discharge power is 2.5kW. Based on these conditions, the Monte Carlo method was used to predict the daily load of two-way ordered charging and discharging of electric private cars in Tianjin in 2019, 2025 and 2030. After 2000
simulation calculations, the coefficient of variance was less than 0.05%, which satisfies the calculation accuracy. The charging daily load curve is shown in Figuer 6, where a positive value indicates a charging load and a negative value indicates a discharging load.

Figure 6 daily load curve of bidirectional orderly charging and discharging of electric private cars in Tianjin

It can be seen from Figure 6 that when considering the V2G technical conditions, most electric private car users respond to the two-way ordered charge and discharge mode, during the peak hours of the power grid at 8:00 a.m.-11:00a.m. and 18:00p. m.-23: 00p.m. to the power grid in the opposite direction, forming two discharge peaks, the excess power is reversely transmitted to the power grid to assist the power grid peak and frequency regulation; as the number of electric vehicles connected to the power grid discharge Increasing the discharge load will continuously increase the formation of huge backup resources and the formation of considerable clean power during the peak period of the power grid. It will play a role in alleviating the pressure during the peak hours of the power grid and maintaining the stability of the power grid; The charging load curve of electric private cars is basically the same as in the one-way ordered charging mode. Part of the peak load is transferred to the grid valley period, which plays a “valley filling” role to a certain extent.

Table 3 daily peak valley value and peak valley difference of bidirectional orderly charging and discharging of electric private cars in Tianjin from 2019 to 2030

| Year | Peak charging load (MW) | Charging load valley (MW) | Difference (MW) | Peak discharge load (MW) |
|------|------------------------|--------------------------|----------------|-------------------------|
| 2019 | 342.408                | 3.094                    | 339.314        | 110.964                 |
| 2025 | 686.791                | 6.267                    | 680.523        | 222.630                 |
| 2030 | 1052.922               | 9.567                    | 1043.355       | 341.209                 |

As can be seen from the table above, compared to the disorderly charging mode, the peak value of the daily load of charging in the two-way ordered charging and discharging mode significantly decreases, and the valley value of the daily charging load significantly increases, although the daily charging is increased with the increase in the number of electric vehicles connected to the grid. The peak-to-valley difference of the load continues to increase, but compared to the disorderly charging mode, its peak-to-valley difference has been greatly reduced. With the increase in the number of electric private cars in
Tianjin, considering the two-way ordered charging and discharging mode of V2G technology, the daily discharge load of electric private cars in these three years can become a backup resource of the power grid during the peak load period to regulate the supply and demand of the power grid. Balance and other contradictions, reduce the lack of voltage during peak periods, and maintain the safe and stable operation of the power grid.

4. Influence of different charging and discharging modes of electric vehicles on grid load
Based on the typical daily load data of Tianjin power grid in 2019, according to the prediction in the 13th five year plan of Tianjin electric power development, the annual average growth rate of the whole society's electricity consumption in 2015-2020 and 2020-2030 is 3.91% and 3.22% respectively, the daily load of Tianjin power grid in 2025 and 2030 is predicted, and the daily load prediction results of electric vehicles under the three charging and discharging modes are superposed to according to the daily load curve of power grid, the influence of different charging and discharging modes of electric vehicles on power grid load is analyzed. Compare the daily load curve of the grid under the three modes of disordered charging, unidirectional orderly charging and bidirectional orderly charging and discharging in 2019, 2025 and 2030, as shown in Figure 7 to Figure 9.
This article uses the index of peak-valley difference improvement to compare and analyze the impact of electric vehicle charging and discharging behavior on the daily load of the power grid in three modes. The peak-valley difference improvement refers to the difference between the peak-valley difference rate and the original after changing the charging mode. The ratio of the peak-to-valley difference ratio, and the greater the improvement of the peak-to-valley difference ratio, the more obvious the "peak-cutting and valley-filling" effect of this charging and discharging mode on the power grid, and the higher the stability of the power grid. V1G mode and V2G mode improve the daily load peak-valley ratio of V0G mode, as shown in Table 4.

Table 4 Peak-to-valley improvement of V1G mode and V2G mode compared to V0G mode

| Year | V1G mode | V2G mode |
|------|----------|----------|
| 2019 | 15.20%   | 16.61%   |
| 2025 | 24.66%   | 26.63%   |
| 2030 | 31.05%   | 33.67%   |

Based on the above chart, the daily load characteristics of the power grid under three electric vehicle charging and discharging modes are compared and analyzed, and the following conclusions are drawn:

(1) In the disorderly charging mode (V0G), the load curve formed after the electric vehicle is connected to the power grid and the original load curve of the power grid have a similar change trend from 23:00 p.m. At night to 10:00 a.m. During the day, but at 10: During the period of 00 a.m.-23:00pm, more and more electric private cars and electric buses connected to the grid for charging generate a large amount of load, causing the grid load to rise rapidly. At the same time, because there are fewer electric vehicles charged in the grid during the valley hours at night, the load during this period has not been increased, thus further exacerbating the peak-to-valley difference in grid loads. From the time dimension, the peak-to-valley difference is increasing year by year, which not only poses a certain threat to the security and stability of the grid system, but also increases the investment cost of the grid operation, which has an impact on the economics of the grid operation.

(2) In the one-way ordered charging mode (V1G), with the introduction of the peak-to-valley time-sharing electricity price mechanism, some electric private cars and electric bus users change their charging behavior under the guidance of price signals, respond to the ordered charging mode, and try their best to At night, the electric grid is charged during the valley period of the power grid, which makes
the power grid at 8:00 a.m.-11:00 a.m. And 18:00 p.m.-23:00 p.m. Two peak time load levels are significantly higher than those in the V0G mode. It has been reduced, effectively transferring part of the charging load into the valley hours 0:00 a.m.-7:00 a.m., Reducing the peak-to-valley difference in power grid load. From the perspective of time, the improvement of the peak-to-valley difference ratio will gradually increase from 2019 to 2030, and the effect of V1G mode on grid shifting and valley filling is becoming more and more significant.

(3) In the two-way ordered charge and discharge mode (V2G), although the daily load curve of the electric vehicle after connecting to the power grid in this mode is similar to that of the daily load curve of the power grid in V1G mode, at 8:00 a.m.-19:00 p.m.-23:00 p.m., Electric private car users are reverse-discharged to the grid through V2G technology under the inspiration of price signals. The load level during peak hours of the grid is compared to V1G mode. The load has been reduced, and the internal load during the valley hours 0:00 a.m.-7:00 a.m. Has not changed significantly from the V1G mode, thereby further reducing the peak-to-valley difference in power grid load. From the time dimension, the improvement of the peak-to-valley difference ratio from 2019 to 2030 is greater than the V1G mode and gradually increases with the increase in the number of electric vehicles. Therefore, the V2G mode further implements the "peak and valley filling" based on the V1G mode. "the goal. It can be seen that the two-way ordered charging and discharging mode has a very significant regulation effect on the grid load, which not only helps to reduce the peak-to-valley difference of the grid and maintain the load balance of the power system, but also provides backup capacity for the grid and assists the operation of the grid.

In summary, both V1G mode and V2G mode can improve the phenomenon of "peak plus peak" caused by V0G mode on the power grid, which is conducive to smoothing power fluctuations and improving the power quality of the power grid; V2G mode can further improve on the basis of V1G mode Reducing the power supply pressure during peak hours of the power grid, the effect of "peak shifting and valley filling" is more significant, and the electric energy delivered by electric vehicles to the grid as a green energy source will also improve the power quality and environmental protection. However, with the large-scale development of electric vehicles, under the V1G mode, the power grid still has the phenomenon of “peak and peak” during the daytime peak hours of 10:00 a.m.-12:00 p.m., Grid companies need to adopt targeted technologies or Economic demand-side management strategies to participate in the load regulation and scale development of electric vehicles.

5. Conclusions and implications

5.1. Conclusions

This paper comparatively analyzes the effects of three modes of electric vehicle disorderly charging, one-way ordered charging and two-way ordered charging and discharging on the grid load. The research results show that:(1) The peak value of electric vehicle charging load in disordered charging mode appears at 19:00 p.m.-22:00 p.m., This period coincides with the peak period of the power grid, causing the adverse consequences of "peak plus peak". (2) In the one-way ordered charging mode, the charging load of electric vehicles during the peak hours of the power grid at night is shifted to the valley hours by the time-of-peak electricity price. The phenomenon of "peak plus peaks" between 10:00 a.m. And 12:00 p.m. During peak hours still exists. (3) In the two-way ordered charging and discharging mode, electric vehicles are discharged during the peak time of the power grid and charged during the valley time of the power grid, which can not only reduce the power grid at 10:00 a.m.-12:00 p.m. And 19:00 p.m.-22:00 p.m. The load during the two peak periods can increase the power consumption level during the valley period. At the same time, it can provide reserve capacity for the power grid and ensure the stability of the power grid operation.
5.2. Implications

Based on the above research conclusions, the management implications of this paper are:(1) Under disordered charging mode, grid companies should reasonably plan the charging infrastructure construction, reduce input costs, and actively carry out research on orderly charging and discharging strategies to promote development of sequential charge and discharge mode.(2) Under the one-way and orderly charging mode, grid companies should promote the application of intelligent and orderly charging piles, improve the charging and replacement methods, and optimize the peak-to-valley time-of-use electricity price mechanism to increase user incentives.(3) Under the two-way orderly charging and discharging mode, power grid enterprises should promote the construction of intelligent charging and discharging integrated machines, improve charging and discharging services, and reasonably arrange the charging and discharging plan of electric vehicles to optimize the charging and discharging power.

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