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Shared Energy System Construction Scheme of PV Array and Energy Storage Technology

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Abstract: My country's ecological and environmental problems are fundamentally the problems of high-carbon energy structure and high-energy-consuming, high-carbon industrial structure, which must must be solved from the source of energy structure and industrial structure transformation and upgrading. Energy consumption patterns for operation, production and living, build a high-level energy and resource-saving society, further strengthen the intensive and efficient use of fossil energy, improve the electrification level of the whole society, and build a cleaner and more efficient green and low-carbon energy production, supply and consumption system. On this basis, we propose a shared energy system construction plan of photovoltaic array and energy storage technology: taking electricity as the main energy, combining the park's photovoltaic energy storage system with shared energy storage to achieve source-grid-load-storage Coordinated and optimized to meet the user's own electricity demand and the rational use of energy.

Keywords: Photovoltaic, Energy Storage, New Energy.

1. Introduction

During the peak period of electricity consumption, when self-generated electricity cannot supply a large amount of electricity load, the energy storage device can provide electricity supply or purchase electricity from community operators.Receive and deliver to the operator. The operator is responsible for the transmission of power distribution, and the power in the park can be used with each other.When the power in the park is insufficient, the power will be purchased from the large grid to meet the user's power demand.The user needs to pay a certain amount of rental fee to the operator, and the operator needs to provide reasonable power dispatching optimization arrangements for the park, as well as coordinate power transactions with the large power grid.This solution effectively solves the intermittent problem of renewable energy power generation and reduces the electricity cost on the user side.

2. Market and Industry Analysis

2.1. Overview of the New Energy Market

Renewable energy, with its clean, safe and sustainable advantages, has continuously improved its status in the energy strategies of various countries.Wind energy and solar energy, as renewable energy sources with lower cost, more mature technology and higher reliability, have developed rapidly in recent years and have begun to play an important role in energy supply.Figure 1 shows the proportion of some new energy consumption to total energy consumption in the past decade.As can be seen from the figure, the total consumption of new energy is increasing at an average annual growth rate of 0.6 percentage points. As for power generation, according to a report released by the National Bureau of Statistics on April 16, the share of thermal power generation continues to decline.

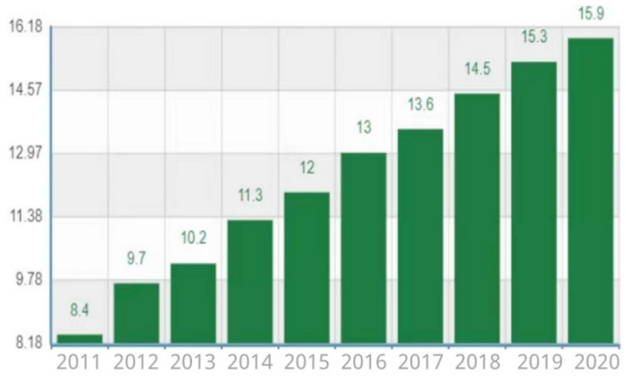

Figure 1. Proportion of primary electricity and other energy in energy consumption market (%)

2.2. PV Power Generation Market Capacity Analysis

The photovoltaic power generation industry has become one of the strategic emerging industries with the most core competitiveness in my country, and photovoltaic power generation will become one of the main ways of generating electricity in my country in the future.In 2020, my country's newly installed PV grid-connected capacity was 48.2GW, a year-on-year increase of 60%, and the cumulative grid-connected installed capacity was 253GW, ranking first in the world in both new and cumulative installed capacity.In 2020, my country's photovoltaic power generation will be 0.26 trillion kWh, accounting for about 3.5% of the country's total annual power generation, and the photovoltaic utilization rate will be 98%. The cumulative photovoltaic power generation is nearly 0.93 trillion kWh, which is equivalent to a reduction of 290 million tons of standard coal consumption and a reduction of 740 million tons of carbon dioxide.Many technologies in my country's photovoltaic field rank first in the world, and the photovoltaic industry occupies a leading position in the world.

2.3. Energy Industry Strategies for Future Development

Assist the low-carbon transformation of energy and accelerate the construction of a flexible and efficient power system. Strengthen the research on the impact of the new development pattern superimposed on carbon emission constraints on my country's energy and power industry. Optimize the planning and layout of medium and long-term power grids, and build a power system that adapts to the full interaction of source, grid, load and storage, and large-scale access to new energy.

Promote joint energy development and strengthen the capacity to ensure energy security supply. We will promote the clean utilization of fossil energy and the coordinated development of all kinds of new energy sources, strengthen the comprehensive planning of regional energy, and improve the level of energy security and supply.

2.4. Key Competitive Advantages

Photovoltaic power generation uses the photovoltaic effect generated by the semiconductor interface to directly convert light energy into electrical energy, reducing carbon emissions and improving the carbon-free rate of energy development and utilization.

Flexible installation location. The open roof of the building has the advantages of being unaffected by the orientation of the building, receiving light for a long time, and avoiding the interference of shadows to the greatest extent.

Compared with conventional energy storage projects, shared energy storage can not only give full play to the operational benefits of energy storage assets, reduce the idle time of energy storage assets, but also help the safe and stable operation of the power system, with significant economic and social benefits.

Shared energy storage can give the grid more backup resources and enhance the ability to cope with extreme situations such as peaks and troughs, which is of great significance to ensuring the smooth operation of the grid.

Electricity consumption is one of the huge costs of factories. Through energy storage power stations, the difference between peak and valley electricity prices can be used to save electricity costs or sell low-cost electricity for profit.

Using the electric energy of the energy storage power station can reduce the distorted harmonics from the power generation side, and the electric energy used is a perfect sine wave, thereby improving the power quality.

2.5. Weaknesses and Shortcomings

Unstable energy supply. Photovoltaic power generation is affected by seasonal changes, weather conditions, day and night, and solar radiation intensity. Long-term rainy and snowy days, cloudy days, and even changes in clouds will affect photovoltaic power generation. When there is no sun, it cannot generate electricity or the power generation is very small, which will affect the normal use of electrical equipment.The technical and economic indicators such as reliability, energy storage capacity, energy storage density, equipment life, and energy storage cost are not perfect.

3. System Control Methods

Due to the increasing changes in the demand side of the grid, distributed energy storage will gradually participate in the power system deeply. In the power distribution system, distributed energy storage is deployed at key nodes of the system in the role of third-party mediation. It can effectively solve the contradiction between distributed power and load, and then participate in auxiliary functions such as peak regulation, frequency regulation, and voltage regulation of the power grid, and improve the stability of power grid operation. By collecting and collecting signals and sending corresponding functional signals to all battery energy storage systems, the charging and discharging of battery energy storage systems can be controlled to achieve the purpose of "shaving peaks and filling valleys" and improving the efficiency of power grid operation.

In order to achieve peak shaving and valley filling, considering the power and capacity of the energy storage system, factors such as the energy storage battery state of energy (SOE) limitation and the energy storage system charge and discharge efficiency η limitation are added in the optimization process. On the premise of satisfying the system power balance, the output of the distributed energy storage system can be optimized.Taking photovoltaic power generation as an example, in the distribution network, due to the uneven daily load distribution, it is difficult for photovoltaic power generation to match and track the load output, resulting in a larger peak-to-valley difference between the distribution and the power grid, which reduces the quality of power supply. Based on this, the distributed energy storage system is cited. By reasonably controlling the operation mode of the energy storage system, it is very suitable for adjusting the peak-to-valley difference of the power system, which can effectively improve the quality of power supply. Taking a photovoltaic power station and two energy storage systems B1/B2 as an example, the schematic diagram of the output is shown in Figure 2.

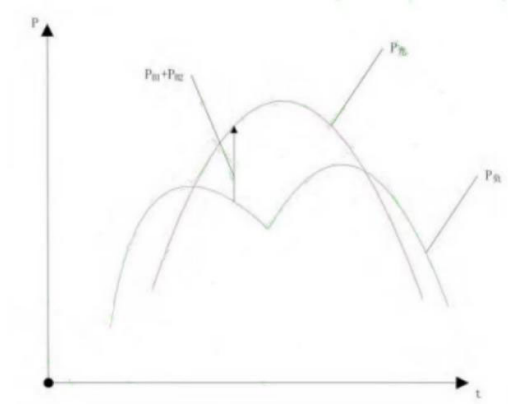

Figure 2. Schematic diagram of light, storage and load power

In the charging mode, the charging power of the energy storage system is the actual power required by the system power balance constraints. At this time, it is not necessary to consider the influence of the charging and discharging efficiency of the energy storage system. The mathematical representation is as follows:

4. Application Mode of Distributed Energy Storage System

At present, the application scenarios of distributed energy storage systems mainly include three aspects: user side, distributed power supply side and distribution network side.

4.1. User Side

The application of distributed energy storage on the user side mainly focuses on three aspects: user time-of-use electricity price management, capacity cost management, and power quality management. Among them, the realization of time-of-use electricity price management and capacity cost management functions depends on the existence of electricity market, time-of-use electricity price and capacity electricity price system. Another application mode of distributed energy storage on the user side is achieved by building distributed generation and microgrids on the user side.

4.2. Distribution Side

The applications of energy storage on the distribution network side mainly include reactive power support, alleviation of power distribution congestion, and delaying the expansion of power distribution equipment. The application of energy storage in relieving the blockage of power distribution equipment and delaying the expansion of power distribution equipment is relatively simple, which is more flexible, reduces the risk of investment, and improves the utilization rate of power assets.Power transmission and distribution system with maximum load close to installed capacity,install the energy storage in the downstream position of the transmission and distribution that needs to be upgraded to delay or avoid the expansion, and use the energy storage equipment of smaller capacity to delay the power grid that requires a lot of investment Investment in expansion. Doing so can improve the utilization rate of power assets, use the funds of power companies more efficiently, and reduce the risk of large-scale capital investment.

4.3. Distributed Power Side

The connection of distributed power to the power grid will mainly cause problems in voltage control, power quality and so on. The application of energy storage technology can provide effective support for the access of distributed power sources, including suppressing power fluctuations, improving power quality, promoting the consumption of distributed power sources, improving the utilization rate of distribution facilities, and enhancing the voltage control of distribution networks. and self-healing ability.

5. Main Application Scenarios

The operation status of distributed energy storage is closely related to its application scenarios. At present, most of the current research on application scenarios is combined with the optimal configuration modeling of energy storage, and the application scenarios are distinguished according to environmental conditions, output characteristics of energy storage, and configuration methods.

According to the different control subjects and the impact on the power grid, this paper divides the distributed energy storage system into four basic application scenarios: improving power supply reliability, shaving peaks and filling valleys, absorbing renewable energy, and delaying power grid upgrades.

5.1. Improve Power Supply Reliability

Due to the many important loads carried by modern power distribution systems, the requirements for power quality are getting higher and higher. In addition, the nonlinear characteristics, harmonic interference, and start-stop shocks of a large number of renewable energy power generation and power electronic equipment will bring the power grid. Improving the reliability of power sources is a major task of distributed energy storage. In power systems under normal operation, during peak load periods, due to output restrictions on the power generation system and transmission capacity restrictions on the transmission line,transmission congestion may occur in some locations, resulting in the loss of power supply for part of the load.In the scenario of improving the reliability of power supply, the distributed energy storage system can not only use the electric energy stored by itself to supply power for part of the load, but also reduce the impact of renewable energy generation on the power system and reduce the possibility of power shortage for the load. For the distribution network line, the configuration of distributed energy storage can realize emergency power supply for itself in the event of a power outage, which well guarantees its own emergency power demand. For society, distributed energy storage can better protect the basic interests of the people and minimize economic and political losses during normal power interruptions. In some areas where energy storage systems are not installed or when temporary load growth in a certain area requires power supply, mobile energy storage such as emergency power supply vehicles is used to ensure the quality of power supply. The advantage of mobile energy storage lies in its flexibility, but usually limited power supply capacity.

5.2. Peak Shaving and Valley Filling

With the development of modern technology and economy, the load peaks and valleys of the power grid will gradually increase.The application of renewable energy power generation is becoming more and more extensive, and the penetration rate in the power grid is increasing, which makes the power grid's peak regulation pressure more and more serious.Due to the large initial investment of energy storage and the long capital payback period, the energy storage system was rarely applied to the peak shaving and valley filling of the power system in the past.However, with the reform and opening up of the electricity sales side market of Xindian, the competition of various electricity sellers makes the electricity price difference in different regions and at different times continue to increase. While completing the goal of peak shaving and valley filling, energy storage can take advantage of its low electricity price moment. Arbitrage between charging and discharging at high electricity prices, coupled with the state's subsidy mechanism for energy storage, greatly increases its benefits, shortens the capital payback period,and it expands the coverage of energy storage and the application effect of peak shaving and valley filling. Using distributed energy storage for peak shaving and valley filling provides spatio-temporal shifting of loads. This will ease the peak regulation pressure on the power grid and reduce congestion on the power grid during peak loads.

5.3. Consume Renewable Energy

Using the flexible adjustment characteristics of distributed energy storage can improve the system's ability to accept distributed power. In the future, the proportion of volatile renewable energy such as photovoltaics and wind power will continue to increase, and the development of renewable energy may become the most important driving force for the long-term development of energy storage. However, at present, the levelized cost of energy storage is still relatively high compared to that of renewable energy generation, and

the economics of energy storage simply relying on renewable energy consumption is insufficient. Domestic energy storage projects purely serving renewable energy consumption are still in the demonstration stage.

5.4. Delay Grid Upgrades

In the current electricity market environment, power grid companies not only need to provide safe and stable electrical energy, but also reduce their own operation, maintenance, renovation and upgrade costs as much as possible, and provide users with cost-effective electrical energy. The static safety constraints of the power system require that the system can still run stably after any component in the power grid fails, and other components do not exceed the limit. In order to complete this task, the cross-section transmission capacity of the power grid needs to reserve the transient stability limit, so the cross-section capacity is less than the sum of the thermal stability limits of the line, and the existence of the energy storage system can realize fast charging in the event of line failure, absorb the rotor acceleration energy, Improve the transient stability, thereby increasing the transmission capacity of the section. In this process, energy storage improves the system safety check capability and increases the cross-section transmission capacity, thereby achieving the purpose of delaying investment. When the load of a line or substation exceeds its rated capacity, it is necessary to upgrade or transform the power grid. The traditional measures are mainly to upgrade or transform the capacity of substations and distribution lines. However, with the development of distributed energy storage technology and the decline of the unit cost of energy storage equipment, distributed energy storage is more and more widely used in the distribution network, which can replace the traditional power grid upgrade and transformation measures to delay investment and save costs.

6. Conclusion

Photovoltaic and energy storage systems, as emerging technologies in the domestic photovoltaic industry, are sunrise industries in the field of photovoltaic power generation. This product is based on distributed photovoltaic and energy storage technology, developed with carbon emission reduction as the background, combined with energy sharing technology, and strives to reduce the carbon emissions of enterprises while seeking greater benefits for enterprises.

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