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Research on Monitoring Technology of Energy Storage Power Station Based on Discharge Control Scheduling Algorithm of Energy Storage Power Station

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Abstract: In the process of practical application, it can be found that the battery energy storage system has the advantages of short construction period, fast response speed, diversified application modes and so on. In this paper, based on the construction of the algorithm system framework of the discharge control and scheduling of the energy storage power station, we will discuss how to monitor the energy storage power station based on the discharge control and scheduling algorithm of the energy storage power station, so as to ensure its application effect and quality.

1. Introduction

The application and development of energy storage power stations have good economic and social benefits. Therefore, with the vigorous promotion of national and local governments, their application is becoming more and more extensive and the construction scale is also expanding. Moreover, the application of large-scale energy storage technology has become the key point of China's energy transformation and one of the important contents to realize the sustainable development of resources. Therefore, in-depth research is needed to ensure the application efficiency.

2. Framework of Discharge Control and Scheduling Algorithm for Energy Storage Power Station

With the continuous progress and development of energy storage technology and the diversification trend of investors, there are some differences in battery types, capacity and price among the current power storage stations. Moreover, the application of automatic generation control (AGC) in power system can realize the function optimization of energy storage power station, which has the characteristic of being able to collect a large number of energy storage characteristic parameters. However, if the AGC system is directly connected with the energy storage power station in a large number, it will cause the data transmission burden in the process of dispatching communication data, thus affecting its response speed and operation reliability. Therefore, it is necessary to adjust the system architecture based on "energy storage FM auxiliary service controller", and we can call it SFAC.

In the process of practical application, AGC system can obtain the operating parameters of the current whole network state, and the parameters related to it include frequency, time deviation, tie line power and power generation status of each unit, and then calculate the area control error (ACE) in combination with the pre-selected control mode. After that, the SFAC dispatching control layer decouples the power of its conventional units and the energy storage power station, and thus realizes the frequency modulation power distribution between the energy storage fleet and the conventional units. Furthermore, SFAC can decouple the power on the original AGC control system by combining with the newly added scheduling control layer, and through its feature that it does not need to change other parts on the coordination agent layer, it only needs to add a corresponding energy storage frequency modulation command distribution module, which can realize the mutual coordination of frequency modulation resources on the premise of minor changes to the AGC module. Moreover, based on its proposed scheduling framework, energy storage can also be encouraged to participate in the grid-side frequency modulation market through the method of market mechanism, thus ensuring the stability of the whole network frequency.

3. Monitoring of Energy Storage Power Station Based on Discharge Control Scheduling Algorithm of Energy Storage Power Station

3.1 PCS response test

When monitoring the energy storage battery, the PCS response test can complete the monitoring of the input of the hard contact of the source network and the current waveform by using an oscilloscope on the PCS side, and calculate the response time required for the process of changing the PCS from 100% rated power state to 100% rated power discharge state by combining with the monitoring waveform diagram. At the same time, combining with the corresponding time point data, it is also possible to analyze the time from the time when a single PCS device launches its own corresponding action to the time when it completes its own charge-discharge conversion. In addition, in the monitoring waveform diagram, the dark blue area is usually used to represent the waveform of PCS hard junction, while the purple curve is used to represent the sampling current waveform in PCS.Taking the data obtained when a power storage station uses PCS for monitoring as an example, it can be found by judging the time point that the time from the hard contact to the completion of PCS charging is only 94.8ms, which indicates that the discharge switching delay of PCS in the system is very small, and the required time is within 100ms, with a very fast response speed.

3.2 Source Network Load Response Test

Source network load response test refers to the whole process test when the system responds to dispatching emergency control instructions, and needs to be implemented by the cooperation of EMS and PCS. However, in the process of testing it, it is first necessary to connect the corresponding recorder to the power acquisition point on the 10kV side to complete the monitoring of the active power of the energy storage system. In the energy storage station where it is located, it is divided into two sections to connect the 10kV bus, and the recorder is respectively connected to the two sections of bus acquisition points to complete the adjustment of relevant contents in combination with power detection. Moreover, in the process of actual investigation, it can be found that the response power curves of the two bus sections tend to maintain consistency. After receiving the corresponding dispatching emergency control instruction, the power storage station can rapidly switch from the full-power charging state to the full-power discharging state, then continuously keep in the full-power discharging state and wait for the EMS system to take over, and adjust the power output according to the actual state in which the power storage station is currently located, and the power storage station can not be restored to the full-power charging state until the power storage station receives the corresponding recovery instruction.

Taking the process of curve management and monitoring in a certain place as an example, the response time of the energy storage system on 2 sections of 10kV bus is analyzed by defining the curve at five times. Among them, the starting time when the energy storage system receives the command and switches from the Wally state to the full-scale state can be defined as t1, the time when the full-scale state is reached is t2, the EMS takeover time is t3, the time when the recovery command is received is t4, and the time when the Wally state is restored is t5. Therefore, it can be found in the monitoring process that the time when the energy storage system enters the full-scale discharge state is kept at 100ms, while the EMS conducts a comprehensive judgment on the system state and takes over about 3 seconds after the full-scale power output is given. However, after receiving the dispatching and recovery instruction, the EMS will control the energy storage system to recover the charging state from the discharging state within about 2s.

3.3 AGC control test

When monitoring the energy storage power station, through the AGC regulation test of the power grid, the effect of responding to AGC instructions can be evaluated through comprehensive comparison and utilization of multiple indexes such as dispatching quality, regulation precision of the energy storage system, response time, regulation time, etc. However, in the actual testing process, the initial active power of the energy storage system needs to be adjusted to 0 first, and the active power setting values need to be adjusted to -0.25PN, 0.25PN, -0.5PN, 0.5PN, -0.75PN, 0.75PN, -PN, PN(PN is the rated power of the system) step by step. After each power is kept above 30s, the timing power is measured based on the energy storage system junction point. Secondly, the average value of active power corresponding to the second 15s after each active power change needs to be obtained. Finally, it is necessary to calculate the control precision, response time and adjustment time of the active power at each point, while the control precision of its power setting value needs to be calculated according to $\Delta P\% = \frac{P_{set} - P_{\text{meas}}}{P_{set}} \times 100\%$. In this calculation formula, Pset is the set active power value; Pmeas is the average value of active power for the second 15s after each step after actual measurement; ΔP% is the control accuracy of the current power setting.Taking an actual test as an example, in the process of investigation and research, the average adjustment accuracy of the energy storage system is -1.03%, and its response time is 10% of the time that the dispatching master station follows the instruction after issuing the instruction to the energy storage power station. The longest morphological response time is 2.71s, the shortest time is 0.59s, the average time is 1.49s, and the longest adjustment time is 2.76s s.The shortest time is 0.65s and the average time is 1.622s s. According to the data obtained from these tests, it can be found that the overall adjustment accuracy is high, and it has a rapid response speed and adjustment time.

4. Conclusion

To sum up, when monitoring the energy storage power station, it is first necessary to optimize the framework of its discharge control and scheduling algorithm, and combine PCS response test, source network load response test and AGC control test in the discharge control and scheduling algorithm of the energy storage power station to complete relevant monitoring contents in the work of the energy storage power station, so as to ensure its application effect and quality.

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