Research and application of water light complementary power station

Recherche et application sur les centrales hydro-solaires

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Abstract: After years of development, solar photovoltaic power stations have become increasingly mature and have made great breakthroughs. Building solar photovoltaic power stations in hydropower station reservoirs can not only use the rich sunlight on the water surface of the reservoir, but also make full use of the load regulation speed. The problem of unstable load of solar photovoltaic power plants realizes "water and light complementation" and provides high-quality, reliable and clean energy for the power grid.

Résumé. Après des années de développement, les centrales solaires photovoltaïques ont beaucoup évolué et ont connus de grandes évolutions et progrès. La construction de centrales solaires photovoltaïques dans les réservoirs hydroélectriques permet non seulement d'utiliser l'énergie de la lumière solaire sur la surface de l'eau du réservoir, mais aussi d'utiliser pleinement la vitesse de régulation de la charge. Le problème de la charge instable des centrales solaires photovoltaïques est résolu par la complémentarité énergétique de l'eau et de la lumière et fournit une énergie de haute qualité, fiable et propre pour le réseau électrique.

1 Introduction

As a kind of clean energy, after years of continuous development, there have been many large array photovoltaic power stations with more than 1 million kilowatt hours in China. The photovoltaic technology is increasingly mature, and the life of solar panels has also made a new breakthrough. However, the photovoltaic power station still has the disadvantages of being greatly affected by sunlight and unstable power generation.

Most of the reservoirs in China have relatively broad water surface and rich sunshine, which can be used as the base of solar photovoltaic power station, creating more economic

benefits for hydropower station. Moreover, hydropower units can quickly adjust the load, which can make up for the unstable load of photovoltaic solar power station, and better realize the "water light complementary".

2 Advantages of solar photovoltaic power station

At present, the solar photovoltaic power generation technology has become increasingly mature, and the construction cost is at a low level. In general, the reservoir of hydropower station has small wave and good sunlight, which is suitable for the construction of photovoltaic solar power station. It can not only avoid occupying a large amount of land area, but also can produce more clean energy, making contributions to the green and sustainable development of enterprises. The construction of solar photovoltaic power station on the lake has the following advantages:

1) It can greatly save land resources. The construction of solar photovoltaic power station by using the water surface of the reservoir area can effectively avoid land leveling, excavation and other ground construction, reduce the engineering amount, and will not cause soil erosion and other situations.

2) It can make full use of light energy resources and improve power generation efficiency. The water surface of the reservoir is generally flat without shading of trees and buildings, which is conducive to the stable and efficient operation of the battery panel.

3) Solar panels cover the water surface of the reservoir, which can reduce the evaporation of the reservoir and provide more water resources for hydropower units.

4) Due to the shielding effect of solar panels, the photosynthesis of algae and other plants in the water is weakened, and the growth and reproduction ability is reduced, which can effectively avoid the crazy propagation of algae after water eutrophication, which is conducive to the ecological environment of water body.

5) Surface photovoltaic power station can save cost. Compared with the ground photovoltaic power station, the two axis tracking system is reduced and the construction cost is greatly saved.

6) The daily maintenance and maintenance amount of surface photovoltaic power station is small. The surface power station is less polluted by dust and so on, so it does not need to be cleaned frequently, which greatly saves the amount of maintenance.

7) The photovoltaic power station of the reservoir can also be used for aquaculture. The existence of photovoltaic power station can provide a better incubation environment for fish and improve the aquaculture yield.

8) The surface photovoltaic power station can also represent certain tourism income. The array type large area surface photovoltaic power station can become a characteristic scenic line, bringing certain tourism and catering industry benefits.

3 Feasibility analysis of photovoltaic solar power station

3.1 Application of new technology of solar cell chip

For some years, the power generation cost of solar photovoltaic power station is high, and the service life of the solar panel is generally in the period of 20-30 years. After the service life exceeds, the power generation efficiency of the solar photovoltaic power station will drop sharply. Therefore, only by relying on the state subsidies can the photovoltaic power station survive. At present, crystalline silicon solar chips are commonly used in domestic solar photovoltaic power plants. Although they have the advantages of affordable price and high power generation efficiency, their short service life is the hard injury of this kind of solar photovoltaic chips.

With the continuous development of technology, copper indium gallium selenium thin film solar chip has the characteristics of no thermal spot and no attenuation. Although the cost is about 20% higher than that of crystalline silicon solar chip, it is still more cost-effective to use large-scale photovoltaic power station for a long time.

3.2 Cost benefit analysis

The power generation cost of solar photovoltaic power station, i.e. the cost per kilowatt hour of power generation, cannot be simply analyzed according to the installation cost. It is related to the following five factors: 1) initial cost of installation; 2) sunshine abundance of the construction site; 3) capital status, whether bank loan and loan interest rate are required; 4) service life of photovoltaic power station; 5) operation and maintenance cost of photovoltaic power station.

The floor area of 1MW solar photovoltaic power generation project is related to the efficiency of modules and the installation angle. Assuming that the high-efficiency modules are used, the installation angle is 40 degrees, and the array spacing and area are calculated based on the principle that the solar cell array is not covered by each other from 9:00 a.m. to 3:00 p.m. every day, then: 1 MW covers an area of 256 thousand square meters = 38.4 Mu = 2.56 hectares.

Taking a Hydropower Station Reservoir in China as an example, the drainage area above the dam site is 69.46 square kilometers. Assuming that 50% of the basin area can be used to install solar photovoltaic generating units, the installed unit capacity is: 69.46 * 100 * 50% / 2.56 = 1356mw, i.e. 1356000 kwh units, and its power generation benefits are considerable. The investment cost is calculated by 10 yuan per watt, which is estimated to be 135 yuan

4 Joint operation of solar photovoltaic power station and Hydropower Station

For the solar photovoltaic power station built in the reservoir of hydropower station, the DC power generated should be rectified into AC through the inverter, and then the voltage should be raised to the voltage level corresponding to the hydropower unit through the transformer, and then be integrated into the State Grid together with the hydropower unit. In this way, AGC and AVC systems can be used to realize deep integration with hydropower units. When the provincial grid company only needs to send out the total load of the Shuiguang power station, the Shuiguang power station adopts the strategy of giving priority to photovoltaic power generation. When the photovoltaic power cannot meet the requirements, the active power of hydropower units can be adjusted in time to maintain the

total active power of Shuiguang power station within the range required by the provincial grid company.

4.1 AGC system

AGC (automatic generation control) automatically distributes single machine active load according to the set value of total active load of the whole plant, which is divided into closed-loop mode and open-loop mode. In closed-loop mode, AGC program automatically calculates the power load value of a single machine, and directly sends it to the single machine for execution, and simultaneously sends it to the upper computer for display; in open-loop mode, the AGC program automatically calculates the power load value of a single machine, and only sends it up Upper computer display, not issued to a single machine for execution. The load distribution strategy of Shuiguang power station is to give priority to the full load power generation of photovoltaic power station, that is, the load value issued by the provincial grid company in the daytime should be greater than the total load value of the photovoltaic power station. When the power consumption of the provincial grid increases, hydropower units will be used for power generation. For the rivers with low water content in the north, this kind of water light complementary power generation can make full use of water energy resources and solar energy to produce more clean energy.

4.2 AVC system

AVC (automatic voltage control) distributes reactive load of single machine automatically according to bus voltage. It is divided into closed-loop mode and open-loop mode. In closed-loop mode, AVC automatically calculates the reactive load value of a single machine, and directly sends it to the single machine for execution, and simultaneously sends it to the upper computer for display; in the open-loop mode, after the AVC program automatically calculates the reactive load value of the single machine, it only sends it to the upper computer for display, but not to the single machine for execution. The joint use of AVC system can ensure the constant grid voltage and improve the quality of Shuiguang power station.

5 Conclusion

The surface solar photovoltaic power station is less polluted by dust, which reduces part of the maintenance workload. After completion, it can produce more clean energy and economic benefits for enterprises, which is conducive to the green and sustainable development of enterprises. The construction of solar power station in the reservoir can also achieve water and light complementary, and provide high-quality clean energy for the grid.

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