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Research on Solar PV Grid-connected Inverter Selection

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ABSTRACT. The selection of photovoltaic grid-connected inverters plays a vital role in the feasibility study of solar photovoltaic systems. It is directly related to the solar energy utilization rate of solar photovoltaic systems and the normal operation of solar photovoltaic power generation systems. This paper combines the author's actual work experience, from the introduction of the working principle of the inverter, discusses in detail several important factors that should be considered in the selection of photovoltaic grid-connected inverters. Finally, through actual engineering examples, it has reached the full use of solar energy resources and improved solar photovoltaics. The purpose of system stability.

KEYWORDS: Inverter, efficiency, island

1. Introduction

Nearly 70% of China's current energy supply is supplied by coal. This energy structure that relies excessively on fossil fuels has caused great environmental, economic and social negative impacts. A large amount of coal mining, transportation and combustion have caused great damage to our environment. The preliminary estimate of the economic losses caused by coal power generation and the resulting environmental pollution control costs amounted to 160.6 billion yuan. Vigorously developing and utilizing renewable energy such as solar energy and wind energy is an inevitable choice to ensure the safe and sustainable development of China's energy supply. As the inevitable result of its entry into power scale, photovoltaic grid-connected power generation will be the largest photovoltaic power generation market in the future. Solar panel arrays and inverters are the two most important components in photovoltaic grid-connected power generation systems. The solar panel array converts the solar light energy into electrical energy and outputs direct current. However, civil power is mainly based on AC power supply, so the DC power output by the solar panel must be converted into AC power through the inverter before being integrated into the power grid. It can be seen that

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the inverter plays an important role in the solar grid-connected power generation system.

2. Photovoltaic grid-connected inverter works

2.1. Overview of the inverter

Generally, the process of converting AC power into DC power is called rectification, the circuit that completes the rectification function is called a rectification circuit, and the device that implements the rectification process is called a rectification device or a rectifier. Correspondingly, the process of converting DC power into AC power is called inverter, and the circuit that completes the inverter function is called an inverter circuit, and the device that implements the inverter process is called an inverter device or an inverter.

2.2. Grid-connected photovoltaic inverter

The grid-connected power generation system is a photovoltaic power generation system that is connected to the grid and delivers power to the grid. The solar radiant energy received by the photovoltaic module is converted into high-voltage direct current after high-frequency direct current conversion, and after being inverter-inverted and converted, the sinusoidal alternating current of the same frequency and the same phase as the grid voltage is output to the grid. The core of the inverter device is an inverter switch circuit, which is simply referred to as an inverter circuit. The circuit completes the function of the inverter by turning on and off the power electronic switch.

3. Factors to be considered in the selection of photovoltaic grid-connected inverters

3.1. Rated output power

The rated output power represents the ability of the photovoltaic inverter to supply power to the load. A PV inverter with a high rated output power can carry more power loads. When selecting a PV inverter, it should first consider that it has sufficient rated power to meet the requirements of the equipment for electric power under the maximum load, as well as the expansion of the system and the access of some temporary loads. When the electrical equipment is a purely resistive load or the power factor is greater than 0.9, the rated output power of the photovoltaic inverter is generally 10%-15% larger than the total power of the electrical equipment.

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3.2. Output voltage adjustment performance

The output voltage adjustment performance represents the voltage regulation capability of the photovoltaic inverter output voltage. In general, PV inverter products give the percentage deviation of the output voltage of the PV inverter when the DC input voltage varies within the allowable fluctuation range, which is usually called the voltage adjustment rate. A high performance photovoltaic inverter should also give the percentage deviation of the output voltage of the photovoltaic inverter when the load changes from zero to 100%, commonly referred to as load regulation. The voltage regulation rate of a photovoltaic inverter with excellent performance should be less than or equal to ±3%, and the load regulation rate should be less than or equal to ±6%.

3.3. Inverter efficiency

The efficiency of the inverter refers to the ratio of the output power to the input power under the specified working conditions, expressed as a percentage. In general, the nominal efficiency of the PV inverter refers to the pure resistance load, 80% load s efficiency. Due to the high overall cost of the photovoltaic system, it is necessary to maximize the efficiency of the photovoltaic inverter, reduce the system cost, and improve the cost performance of the photovoltaic system. At present, the nominal efficiency of mainstream inverters is between 80% and 95%, and the efficiency of low power inverters is not less than 85%. In the actual design process of the photovoltaic system, not only should the high-efficiency inverter be selected, but also the reasonable configuration of the system should be used to make the photovoltaic system load work near the best efficiency point.

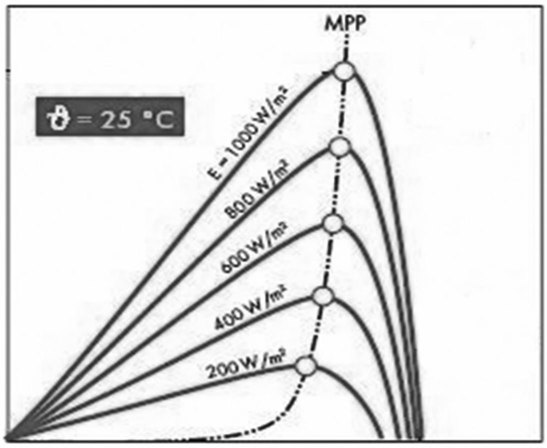

Figure 1. Solar cell output characteristic curve under different solar radiation intensity

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The radiant intensity of sunlight varies with the weather and the time of day, and solar arrays are rarely stable. When operating in an external environment, the output characteristic curve will also change. As shown in Figure 2 and Figure 3. The PV inverter is responsible for managing the power output of the entire PV grid-connected system. It must dynamically respond to changes in the solar cell output curve, and use the maximum power point tracking (MPPT) technology to adjust the operating point of the solar cell in real time. To keep it working near the maximum power point, this is the only way for solar cells to continue to achieve maximum conversion efficiency and thus improve the overall efficiency of the system. The mathematical expression of MPPT efficiency is:

$$\eta_{MPPT} = \frac{\int_0^{T_M} P_{dc}(t)dt}{\int_0^{T_M} P_{mpp}(t)dt}$$

Where $P_{dc}(t)$ indicates that the real-time power $P_{mpp}(t)$ obtained by the inverter from the solar cell represents the real-time maximum power point power theoretically provided by the solar cell.

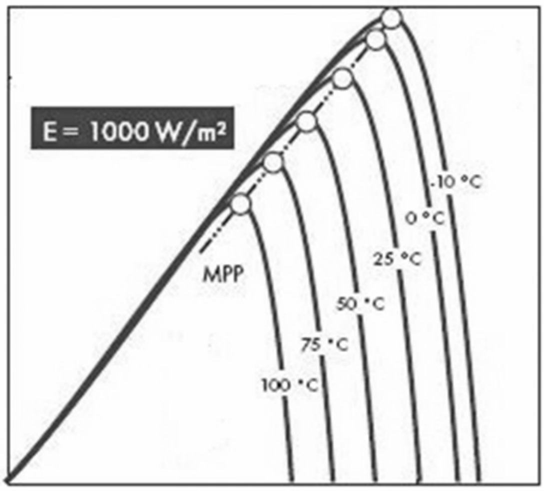

Figure 2. Solar cell output characteristics at different battery temperatures

3.4. Anti-islanding effect

3.4.1 Island effect definition

According to a report provided by Sandia National Laboratories, the islanding effect is a photovoltaic grid-connected power generation system installed at each user's end when the power company's power supply system stops working due to

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malfunctions or power outages. A self-sufficient power supply island phenomenon that cannot be controlled by a power company that is powered by a photovoltaic grid-connected power generation system to the surrounding load is not detected in time to detect the power outage state. In general, the islanding effect may adversely affect the entire power distribution system equipment and the equipment of the customer premises. Therefore, the inverter of the photovoltaic inverter should be selected to detect the island effect in time.

3.4.2. Detection and control of islanding effect

The detection of the island effect is generally divided into passive and active. Passive detection is the use of grid monitoring status such as voltage, frequency, phase, etc. as a basis for judging whether the grid is faulty. The active detection rule is to generate interference signals by timing the power inverter to observe whether the power grid is affected, such as pulse current injection method, output power change detection method, active frequency offset method and sliding mode frequency offset method. All grid-connected inverters must have over/under frequency (OFP/UFP) and overvoltage/undervoltage (OVP/UVP) protection methods to prevent the inverter from being installed when the grid voltage or frequency is outside the acceptable range. Power grid. The output power of the inverter is P + jQ, the local load is Pld + jQld, and the rest of the power is provided by the grid ΔP + j ΔQ. After the grid is disconnected, whether the system is running is determined by the values of ΔP and ΔQ. When the voltage amplitude and frequency variation range is less than a certain value, the above method cannot detect the islanding effect, that is, there is an undetectable area. The concept of undetectable area (NDZ) is used to determine the effectiveness of the anti-islanding algorithm given the values of ΔQ, ΔP. The reaction time for island detection depends on the NDZ. The formula for calculating the NDZ value of ΔQ is as follows:

$$\Delta Q_{NDZ} = \frac{V^2}{\frac{1}{X_C} - \frac{1}{X_L}}$$

In order to solve this problem, the active and reactive integrated control methods for photovoltaic grid-connected are often proposed. Therefore, when selecting the inverter model, the inverter with relatively advanced islanding detection and control technology should be selected as much as possible. Detection area.

4. Engineering example

The following is a detailed introduction of the solar photovoltaic grid-connected project of Guangzhou Asian Games Village Gymnasium in 2011. This system selects three SMA SC100 centralized grid-connected inverters in Germany. The maximum input voltage of the grid-connected inverter is 820V, the input voltage

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range is 450-820V, and the open circuit voltage of the module is 44.2V. The peak power voltage is 35.2V.

In order to obtain solar energy to a greater extent, the overall power generation efficiency of the system is improved, and the reliability of the power station is enhanced. In the system design process, the function of Sunny Team is added. It is applied to the system of multiple inverters. The DC input terminal in the parallel group can control one of the inverters to be activated when the DC power is low. The state assumes the inverter work, while other inverters can stop working. This will greatly increase the system efficiency in the low power input state where the sunshine is weak. From Figure 3 it can be seen that the optical power station can achieve 95% high efficiency even when operating at 10% of rated power.

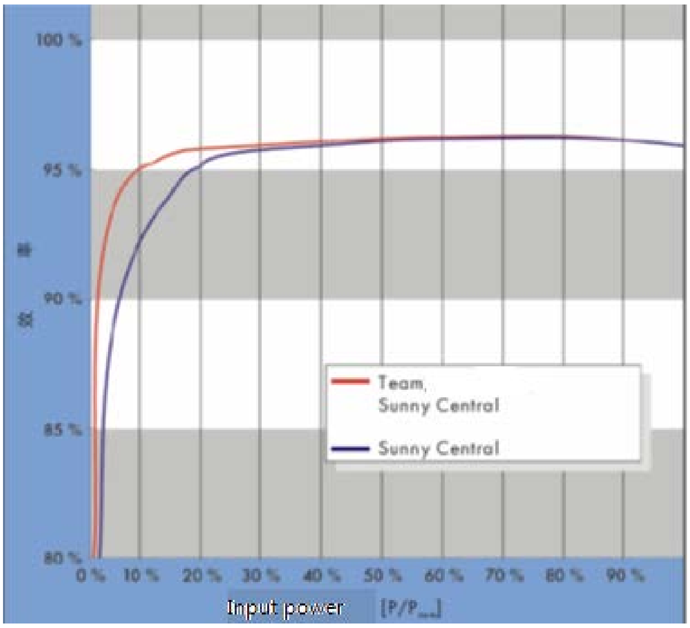

Figure 3. sunny Team technical solution work efficiency curve

In terms of anti-islanding effect, when the grid is powered off, the system cannot independently supply power to the grid, and the computer control system can quickly cut off the connection with the grid, keep the system in an independent state, and ensure the safety of the system.

5.Conclusion

Whether it is from the perspective of social and economic development, or from the perspective of the environment, the research of photovoltaic power generation

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technology has great practical significance, and the inverter plays an important role in the solar grid-connected power generation system. This paper discusses the rated output power, output voltage, inverter efficiency, discharge and anti-islanding effects of the inverter. After considering various factors, the suitable PV inverters are determined, which has improved the solar energy utilization rate. Improve the safety and stability of the system operation.

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