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Control Strategy To Maximize The Power Capability Of Pv Three-Phase Inverters During Voltage Sags

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ABSTRACT

This paper analyzes the power transfer limitation of the PV power plant under the ultra-weak grid condition, i.e., when the Short-Circuit Ratio (SCR) is close to 1. It explicitly identifies that a minimum SCR of 2 is required for the PV power plant to deliver the rated active power when operating with the unity power factor. Then, considering the reactive power compensation from PV inverters, the minimum SCR in respect to Power Factor (*PF*) is derived, and the optimized coordination of the active and reactive power is exploited. It is revealed that the power transfer capability of PV power plant under the ultra-weak grid is significantly improved with the low *PF* operation. An adaptive reactive power droop control is next proposed to effectively distribute the reactive power demands to the individual inverters, and meanwhile maximize the power transfer capacity of the PV power plant.

INTRODUCTION

Benefiting from the significant technical advances in solar cells and power electronics, the costs of the utility-scale Photovoltaic (PV) power plants have become competitive with other intermittent renewable power sources. Large scale PV power plants have been increasingly installed worldwide, and the accumulative global utility-scale PV capacity is heading towards 100 GW. Due to the low energy densities and uneven distributions of solar resources, these PV power plants are deployed in remote areas or even desert with high solar irradiance. As a consequence, the long-distance power transmission lines with low Short-Circuit-Ratio (SCR) have become the major bottleneck to effectively transmit the generated power to the load center. To unblock the bottleneck caused by the high-impedance grids, power-electronic-based power transmission technology based on the High Voltage Direct Current (HVDC) system, and Flexible Alternative Current Transmission Systems (FACTS) devices, has recently been used to improve the power transfer capability.

However, this solid-state power electronic equipment is featured with low inertia and fast dynamics. A wide frequency range of dynamic interactions among the HVDC systems, FACTS devices and grid-connected inverters of renewable energy sources pose new challenges to the system stability and power quality. It hence becomes more appealing to utilize the power controllability of PV inverters for increasing the power transfer capacity under weak grid conditions, which is also more advantageous by sharply cutting down the cost of upgrading grid infrastructure. The PV power plant can be controlled as FACTS devices, which provides a cost-effective solution to damp the sub-synchronous oscillations and improve transient stability of the power system. The prerequisite of these control functions is that the excessive power capacity is available from the PV inverters.

EXISTING SYSTEM:

To avoid disconnection of the distributed generation (DG) source due to over current, the injected phase currents must be safely controlled at any time. In this regard, different strategies have been proposed.

This paper proposes a compact LVRT control strategy that guarantees the complete use of the power capabilities of the distributed PV system under voltage sags.

The proposal comprises a set of reference currents that provides flexible positive and negative active and reactive power injection characteristics that can be tuned to fulfill two objectives during voltages sags: first, to inject maximum rated current independently of the sag profile and, second, to avoid active power oscillations.

Both objectives will be always accomplished, although the achievement of first objective could be affected by the amount of the generated power. In this concern, two main possible scenarios may be considered, i.e., high- and low-power production scenarios.

PROPOSED SYSTEM

The power transfer limitation of the PV power plant under the ultra-weak grid condition. The reactive power compensation from PV inverters, the minimum SCR in respect to Power Factor (PF) is derived, and the optimized coordination of the active and reactive power is exploited. The power transfer capability of PV power plant under the ultra-weak grid is significantly improved with the low PF operation. It contains numerous generation units and each unit

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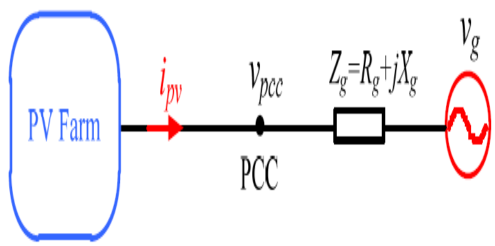
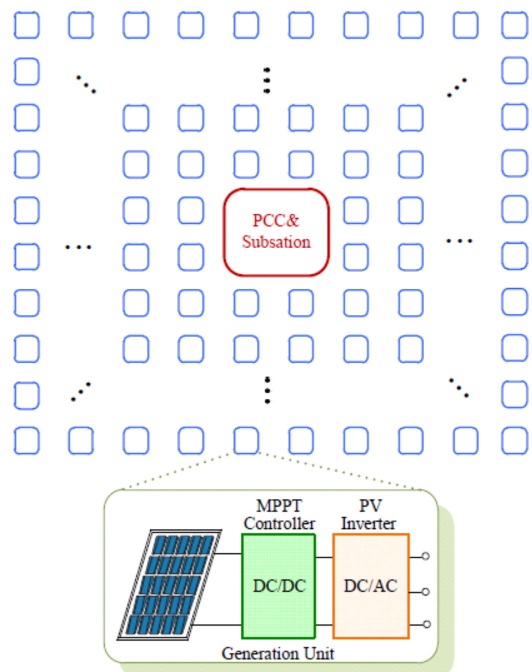
contains a DC/DC converter for local maximum power point tracking (MPPT) control and a DC/AC inverter for grid-connections. All the generation units are connected to the PCC through low-voltage power cables and then fed into the high-voltage transmission network through the substation. To minimize the power loss on the low-voltage cable, the generation units are distributed evenly around the substation in order to minimize the length of the low-voltage cables.



The equivalent circuit of grid connection system.

The PV inverters are usually current-controlled to improve the power quality, so the whole farm can be treated as an ideal current source at the fundamental frequency. Meanwhile, the grid can be represented by its Thevenin equivalent circuit. Therefore, the simplified circuit of the whole grid-connection system, where ipv is the grid current injected by PV power plant, vpcc is the voltage at PCC, vg and Zg are the equivalent grid voltage and grid impedance at the PCC. Here, a resistor Rg and a series inductance Xg are used to model the grid impedance Zg that is introduced by a long transmission line and a step-up power transformer.



The configuration of a PV power plant.

The stiffness of the grid at the PCC can be depicted by the SCR,

CONCLUSION

The power limitation of a PV power plant under ultra-weak grid condition with SCR close to 1 is investigated. It is revealed that low R/X ratio of the transmission line will impose more severe power limitation on the PV power plant. A minimum SCR of 2 is required for the PV power plant to ensure the rated real power injection when it is operated with unity power factor. This paper investigates the power limitation of a PV power plant under ultra-weak grid condition with SCR close to 1. It is revealed that low R/X ratio of the transmission line will impose more severe power limitation on the PV power plant. A minimum SCR of 2 is required for the PV power plant to ensure the rated real power injection when it is operated with unity power factor. This requirement can be reduced when the inverters in the PV power plant can provide the reactive power compensation, and the minimum SCR with different *PF* is derived. Moreover, the optimized coordination of the active and reactive power is studied. It reveals that the power transfer capacity of PV power plant can be maximized by outputting the reactive power as much as possible until the PCC voltage achieves its limitation. Moreover, an adaptive reactive power droop control method is proposed which can improve the power transfer capacity of the PV power plant to its theoretical limitation under the ultra-weak grid condition with an SCR as low as 1.25.

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