DOI: https://doi.org/10.24113/ijoscience.v4i12.185

Study on Power Enhancement Technologies of Inverters in Pv Wind Energy Systems

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Abstract: For energy systems in remote and remote communities, an autonomous energy system based on renewable energy can be a particularly interesting and economically advantageous solution, since the expansion of the network is often impractical due to economic and technical constraints. The driving force and main causes of voltage instability are analyzed. Different methods and devices used to enhance voltage stability are also explained. The steady-state and dynamic modelling of the power system devices including wind generators and photovoltaic units have been discussed.

Keywords –photovoltaic, cell,high-voltage DC transmission

I.INTRODUCTION

Power system stability has been recognised as an important problem for secure system operation since the beginning of last century. Many major blackouts caused due to power system instability have illustrated the importance of this phenomenon [1, 2]. Angle stability had been the primary concern of the utilities for many decades.

However, in the last two decades power systems have operated under much more stressed conditions than they usually had in the past. There are number of factors responsible for this: continuing growth in interconnections; the use of new technologies; bulk power transmissions over long transmission lines; environmental pressures on transmission expansion; increased electricity consumption in heavy load areas (where it is not feasible or economical to install new generating plants); new system loading patterns due to the opening up of the electricity market; growing use of induction machines; and large penetration of wind generators and local uncoordinated controls in systems. Under these stressed conditions a power system can exhibit a new type of unstable behavior, namely, voltage instability.

A) POWER SYSTEM STABILITY

Power system stability is the ability of an electrical power system, for given initial operating conditions, to regain a state of operating equilibrium after being subjected to a physical disturbance, with most system variables bounded so that practically the entire system remains intact. theoverall picture of the power system stability problem, identifying its categories and subcategories.

The concept of voltage stability addresses a large variety of different phenomena depending on which part of the power system is being analysed; for instance, it can be a fast phenomenon if induction motors, air conditioning loads or high-voltage DC transmission (HVDC) links are involved or a slow phenomenon if, for example, a mechanical tap changer is involved. Today, it is well accepted that voltage instability is a dynamic process since it is related to dynamic loads.

Voltage stability refers to the ability of a power system to maintain steady voltages at all buses in the system and maintain or restore equilibrium between load demand and load supply from its given initial operating conditions after it has been subjected to a disturbance. Instability may result in progressive voltage falls or rises at some buses. A possible outcome of voltage instability is the loss of load in an area, and possible tripping of transmission lines and other elements by their protective systems which can lead to cascading outages.

II.LITERATURE REVIEW

Linney Coo et al. [1]This paper presents the stability improvement of a multimachine power system connected with a large-scale hybrid wind-photovoltaic (PV) farm using an energy-storage unit based on supercapacitor (SC). The operating characteristics of the hybrid wind-PV farm are simulated by an equivalent aggregated 300-MW wind-turbine generator (WTG) based on permanent-magnet synchronous generator and an equivalent aggregated 75-MW PV array. The WTG and the PV array are connected to a common dc link through a voltage-source converter and a dc/dc boost converter, respectively. The power of the common dc link is transferred to the multimachine power system through a voltage-source inverter, step-up transformers, and a connection line. The SC-based energy-storage unit, which is integrated into the common dc link through a bidirectional dc/dc converter, is employed for smoothing out the power fluctuations due to variations of wind speed and/or solar irradiance. A PID supplementary damping controller (PID-SDC) is designed for the bidirectional dc/dc converter of the SC to enhance the damping characteristics of the low-frequency oscillations associated with the studied multimachine power system.

Li Wang et al. [2]This paper presents the stability improvement of a multimachine power system connected with a large-scale hybrid wind-photovoltaic (PV) farm using an energy-storage unit based on supercapacitor (SC). The operating characteristics of the hybrid wind-PV farm are simulated by an equivalent aggregated 300-MW wind-turbine generator (WTG) based on permanent-magnet synchronous generator and an equivalent aggregated 75-MW PV array. The WTG and the PV array are connected to a common dc link through a voltage-source converter and a dc/dc boost converter, respectively. The power of the common dc link is transferred to the multimachine power system through a voltage-source inverter, step-up transformers, and a connection line. The SC-based energy-storage unit, which is integrated into the common dc link through a bidirectional dc/dc converter, is employed for smoothing out the power fluctuations due to variations of wind speed and/or solar irradiance. A PID supplementary damping controller (PID-SDC) is designed for the bidirectional dc/dc converter of the SC to enhance the damping characteristics of the low-frequency oscillations associated with the studied multimachine power system.

Anton V. Prokhorov et al. [3]This paper evaluates the dynamic stability of a hybrid wave and photovoltaic (PV) power generation system integrated into a distribution power grid. The wave power-generation system (WPGS) is simulated by a linear permanent-magnet generator (LPMG) driven by an Archimedes wave swing (AWS). The outputs of the WPGS and the PV system are connected to a common dc link through a voltage-source converter (VSC) and a dc/dc boost converter, respectively. The common dc link is interfaced to the distribution power grid via a voltage-source inverter (VSI). A supercapacitor (SC) is utilized to smooth the generated power delivered to the distribution power grid. This paper proposes a control scheme to maintain stable operation of the studied system while achieving maximum power extractions for the wave system and the PV system. Both root-loci analysis of the system eigenvalues under various operating conditions and the time-domain simulation results of the studied system subject to disturbance conditions are presented to demonstrate and verify the effectiveness of the SC combined with the proposed control scheme on performance improvement of the studied hybrid wave and PV system.

III.VOLTAGE AND ANGLE INSTABILITY

Power system instability is essentially a single problem; however, the various forms of instability that a power system may undergo cannot be properly understood and effectively dealt with by treating it as such. Because of the high dimensionality and complexity of stability problems, it helps to simplify models in order to analyse specific types of problems using an appropriate degree of detail of the system representation and appropriate analytical techniques. There is no clear distinction between voltage and angle instability problems but, in some circumstances, one form of instability predominates over the other. Distinguishing between the two types is important for understanding their underlying causes in order to develop appropriate design and operating procedures but, although this is effective, the overall stability of the system should be kept in mind. Solutions for one problem should not be at the expense of another. It is essential to look at all aspects of the stability phenomena and at each aspect from more than one viewpoint.

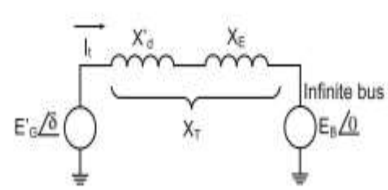

Figure 1 Pure angle stability

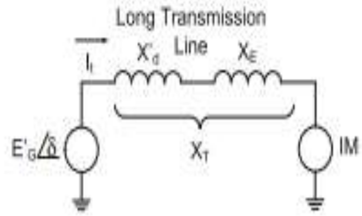

Figure 2 Pure voltage stability

Voltage stability is concerned with load areas and load characteristics. For rotor angle stability, we are often concerned with integrating remote power plants to a large system over long transmission lines. Basically, voltage stability is load stability and rotor angle stability is generator stability. In a large interconnected system, voltage collapse of a load area is possible without the loss of synchronism of any generator. Transient voltage stability is usually closely associated with transient rotor angle stability but longer-term voltage stability is less linked with rotor angle stability. It can be said that if voltage collapses at a point in a transmission system remote from the load, it is an angle instability problem. If it collapses in a load area, it is mainly a voltage instability problem.

IV.VOLTAGE STABILITY AND NONLINEARITY

Power systems were designed and operated conservatively. It was comparatively easy to match load growth with new generation and transmission equipment. So, systems were operated in regions where behaviour was fairly linear. Only occasionally would systems be forced to extremes where nonlinearities could begin to have significant effects. However, the recent trend is for power systems to be operated closer to their limits. Also, as the electricity industry moves towards an open-access market, operating strategies will become much less predictable. Hence, the reliance on fairly linear behaviour which was adequate in the past, must give way to an acceptance that nonlinearities are going to play an increasingly important role in power system operation. One important aspect of the voltage stability problem, making its understanding and solution more difficult, is that the phenomena involved are truly nonlinear. As the stress on a system increases, this nonlinearity becomes more and more pronounced. The nonlinearity of loads and generator dynamics are important factors when determining voltage instability. Therefore, it is essential that the nonlinear behaviour of power system devices should be taken into account when designing controllers and analysing dynamic behaviours.

V.METHODS FOR IMPROVING VOLTAGE STABILITY

The control of voltage levels is accomplished by controlling the production, absorption and flow of reactive power at all levels in a system. In order to function properly, it is essential that the voltage is kept close to the nominal value throughout the entire power system. Traditionally, this has been achieved differently for transmission networks and distribution grids. In transmission networks, a large-scale centralised power plant keeps the node voltages within an allowed deviation from their nominal values and the number of dedicated voltage control devices is limited. In contrast, distribution grids incorporate dedicated equipment for voltage control and the generators connected to the distribution grid are hardly, if at all, involved in controlling the node voltages. The most frequently used voltage control devices in distribution grids are tap-changer transformers that change their turns ratio but switched capacitors and reactors are also applied. However, a number of recent developments challenge this traditional approach. One of these is the increased use of WTs forgenerating electricity. When large-scale wind farms are connected to thegrids, itwill be difficult to maintain node voltages using the traditional reactive power control devices. In these cases, some dedicated equipment, such as flexible AC transmission system (FACTS) devices will have to be used as well. FACTS devices offer fast and reliable control over the three AC transmission system parameters, i.e., voltage, line impedance and phase angle, and make it possible to control voltage stability dynamically.

VI.VOLTAGE STABILITY AND FACTS DEVICES

The increase in electrical energy demand has presented higher requirements for the power industry. In recent years, the increases in peak load demands and power transfers between utilities have elevated concerns about system voltage security. Voltage instability is mainly associated with a reactive power imbalance. Improving a system’s reactive power-handling capacity via FACTS devices is a remedy for the prevention of voltage instability and, hence, voltage collapse. With the rapid development of power electronics, FACTS devices have been proposed and installed in power systems. They can be utilised to control power flow and enhance system stability. Particularly with the deregulation of the electricity market, there is an increasing interest in using FACTS devices for the operation and control of power systems with new loading and power flow conditions. For a better utilization of existing power systems, i.e., to increase their capacities and controllability, installing FACTS devices becomes imperative. In the present situation, there are two main aspects that should be considered when using FACTS devices: the flexible power system operation according to their power flow control capability; and improvements in the transient and steady-state stability of power systems. FACTS devices are the right equipment to meet these challenges and different types are used in different power systems.

VII.ENERGY STORAGE DEVICE

The energy storage system (ESS), as an enabling infrastructure technology, provides ride-through over outages, improves profitability in high-energy applications, increases system reliability and dynamic stability, improves power quality and enhances transmission capacity of the transmission grid in a high power application . For a high power application, the use of short-term (cycles to seconds) energy storage integrated with a power electronics-based controller, well known as a FACTS controller, could offer the following three distinct advantages:

• provide system damping, while maintaining constant voltage following a disturbance;

• provide additional damping in situations where the dynamic reactive power provided by traditional FACTS controllers with similar ratings is inadequate (alternatively, it could provide the same amount of damping at less cost. The damping of oscillation, by repeatedly interchanging small amounts of real power with the system, would be an excellent ESS application); and

• provide energy to maintain the speed of locally connected induction motors during a power system disturbance (This may prevent a voltage collapse in areas where there is a large concentration of induction motors that would otherwise stall).

VIII. CONCLUSION

The dynamic modeling of a large power system and to provide a reliable model for implementation in a standard simulation tool, several factors must be taken into account. The first important process is to clearly define the purpose of the study. Each type of power system study requires a particular frequency bandwidth and a simulation time-frame depending on how fast the system dynamics needs to be investigated. Subsequently, the nature of the system being modelled must be carefully understood and the simulation tool used to simulate the models must be appropriately utilized. We can then design a hybrid PV-wind energy system which can be used as a distributed energy source in the remote areas.

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