ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 4, Issue 3, March 2018

Review on Grid Interconnected Wind Generator System

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***Abstract*: -- Integrated system consists of the number of generating station that carries power from distance sources to distribution lines and demand centers. But there occur certain issues during the short circuit and frequency stability after the sudden loss of generation. The major issue of wind Generating System is the Inherent variability and uncertainty of wind during the performance which leads to the insecurity of the whole system. In this paper, the two phenomena having the vital role in the whole wind power system are discussed namely behaviour of wind generation plants in the steady state and frequency stability. The integrated system is consists of the number of generating stations that carry power from distant sources to distribution lines and demand centers. But there occur certain issues during the short circuit and frequency stability after the sudden loss of generation.**

I. INTRODUCTION

I. INTERACTION OF LARGE OFFSHORE WIND PARKS WITH THE ELECTRICAL GRID

This paper deals with the impact of increased wind power generation on the behavior of the interconnected system in steady state as well as during and after a contingency situation. The issues specifically considered are performance during a severe short-circuit and frequency stability after a sudden loss of generation. The results of the short-circuit simulation are then evaluated vis-à-vis the grid code requirements placed on wind generating plants. Using a large interconnected system encompassing several conventional synchronous generators, the effect of increased wind power generation on the frequency stability of the system after a loss of generation has been discussed. It was found out that at the conceptual level there are a range of options which would place wind generating plants in a position to support system frequency in an emergency situation.

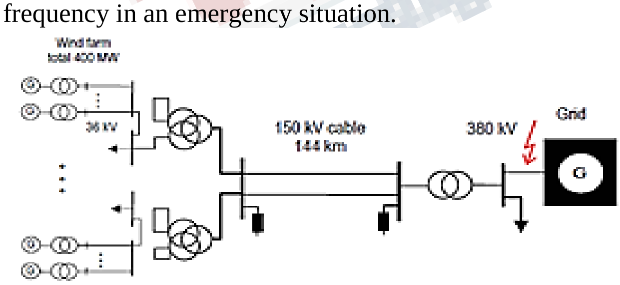

Fig. 1 Simulated offshore wind farm

The dependence of wind on the prevailing weather conditions means that the installed capacity does not guarantee firm dispatch-able energy. As a result, traditional power stations with sufficient capacities must be held on hand to fill the gap. Following the emergence of wind as a major power technology during the last several decades, in addition to devising ways to overcome this drawback, the proper integration of wind turbines into the system by maintaining the existing reliability and performance standards has become an issue of immense interest. In this paper, three phenomena were singled out for in-depth discussion, namely behavior of the wind generation plants in steady state, fault-ride through capability and frequency stability. Wind generation plants reduce the overall inertia of the system due to shielding by the converter. Wind plants also achieve a much faster real power rate of response as a result of the electrical control of the real power. On the other hand, in spite of the additional features that enable a swift voltage recovery, wind generators cannot achieve the same level of reactive power output as that of the conventional plants during fault. The smaller inactiveness of wind turbines has another implication in that it leads to a steeper drop in frequency following a loss of generation. Wind generators with frequency dependent voltage control are able, not only to maintain the grid voltage, but also to provide a considerable contribution to frequency stability by utilizing the voltage dependency of the loads. The need for voltage control of wind generation is must for the plants therefore needs to be balanced against the advantage that a softer voltage characteristic offers in terms of frequency stability.

II. IMPACT OF WIND VARIABILITY ON WEAKLY GRID INTERCONNECTED POWER SYSTEMS

Mounes Alhajali, Brendan Fox, Jason Kennedy and D. John Morrow, Member, IEEE

The inherent variability and uncertainty of wind power generation is a major issue for countries attempting to harness large quantities of wind-based renewable energy. Such properties of wind make optimal balancing of demand

and generation a much more complex task. Clearly the flexibility of thermal plant in the electrical power system is of key importance, especially in smaller systems with high penetrations of wind power, as is the role of interconnectors with neighbouring countries. This paper examines the power system of Ireland as a test case for systems with high wind penetrations and limited interconnection to neighbouring countries, such that wind variability must be managed using indigenous methods. The analysis highlights problems other power systems will encounter as they in turn reach high penetrations of wind generation. Feasible operation of a system with a high penetration of variable wind generation requires flexible generation, or interconnection with neighbouring systems, or a combination of the two. In the case of the Irish system, the prospects of interconnection with the GB system will indoubtly help with system operation. However, the fact that the GB system will, in time, host significant wind generation itself should be taken into account. The opportunity for import and export at times of wind power excess and deficit will consequently be limited. It is shown here that combining OCGT with CCGT capacity provides sufficient flexibility to enable wind generation to supply 33% of energy demand without relying on interconnection. Adding one OCGT unit instead of a larger CCGT unit, without reliance on an interconnector, would effectively smooth the ramping of the main conventional units as the new participant would share the task of balancing the system in response to the variation of wind power.

III. PROBABILISTIC ANALYSIS FOR MAXIMIZING THE GRID INTEGRATION OF WIND POWER GENERATION

Leonel de Magalhães Carvalho, Student Member, IEEE, Mauro Augusto da Rosa, Member, IEEE,Armando Martins Leite da Silva, Fellow, IEEE, and Vladimiro Miranda, Fellow, IEEE

This paper presents a sequential Monte Carlo simulation algorithm that can simultaneously assess composite system adequacy and detect wind power curtailment events. A simple procedure at the end of the state evaluation stage is proposed to categorize wind power curtailment events according to their cause. Furthermore, the dual variables of the DC optimal power flow procedure are used to identify which transmission circuits are restricting the use of the total wind power available. In the first set of experiments, the composite system adequacy is assessed, incorporating different generation technologies. This is conducted to clarify the usual comparisons made between wind and thermal technologies which, in fact, depend on the performance measure selected. A second set of experiments considering several wind penetration scenarios is also performed to determine the operational rules or system components responsible for the largest amount of wind energy curtailed. The experiments are carried out on configurations of the IEEE-RTS 79 power system. This paper presented a SMCS algorithm that, along with the estimation of the traditional loss of load indices, makes it possible to detect and estimate indices to characterize wind power curtailment events. A simple model that includes the operators dispatch preferences, when large portions of the generating capacity are intermittent, was included in the dispatch procedure. Moreover, an algorithm was proposed to detect whether wind curtailment events are due to the enforcement of the inertial constraint and/or load deficit, the failure and/or capacity limits in transmission circuits or the simultaneous occurrence of both of these events. Finally, based on the sensitivity coefficients of the equality constraints for the OPF, it was shown that the circuits involved in the wind curtailment event can be identified, making it possible to assess useful statistics that can be useful in the planning process for the system. Wind power curtailment events under a strategy of maximum usage of wind power were also analyzed. It was shown that, for the cases studied, the level of congestion for the transmission network does not limit the use of wind power as severely as the inertial constraint. Furthermore, the amount of wind energy curtailed has grown very rapidly with the amount of inertial load. It was observed that, when the penetration of windpower increases, the combination of the inertial constraint with insufficient load to accommodate the additional generating capacity may lead to huge quantities of wind energy not being used. Finally, there may be systems with more relevant transmission congestion events and, surely, the proposed approach will capture these characteristics and will allow system planners to adequately cope with them. The value of inertial load and the units capable of supplying it depend on the system. As stated previously, these are normally set according to the dynamic characteristics of the generating units and to the operational procedures adopted by the system operator. New wind farms in the network will influence the dynamic behaviour of the system and, consequently, the value of inertial load. Since the wind power not used increases with the inertial load, these new units must be able to ensure that the inertial load remains unchanged. Clearly, the inertial constraint model is a simple approximation that accounts for security issues when performing generating unit dispatch. Future work will focus on enhancing this model by developing a fast dynamic security assessment method, which helps decide, in an adaptive way, the minimum set of units required to guarantee the stability of the system.

IV. A LABORATORY BASED MICROGRID AND DISTRIBUTED GENERATION INFRASTRUCTURE FOR STUDYING CONNECTIVITY ISSUES ON OPERATIONAL POWER SYSTEMS

O. A. Mohammed, Fellow, IEEE, M. A. Nayeem, Student Member, IEEE and A. K. Kaviani, Student Member IEEE
This paper presents an infrastructure and laboratory implementation of a hardware test-bed system emulating alternate sources and conventional power plant emulators connected as a complete power system. The distributed generation components were connected to the test-bed to study the issues of connecting alternates and various types of loads during operations. The various sources and loads can be connected in varying architectures through transmission and distribution lines as well as bus hardware emulators. Also SCADA, communication network and control system layers were developed and placed around the various test-bed components. Wind turbine model, PV array and micro turbine based generator were developed to emulate alternate resources and integrated with battery banks and flywheel based storage system. These emulators are real time hardware-in-the-loop models based on dSPACE control development modules and Simulink real time workshop. Labview is also used along with measurement studio for control and communication applications. The system also employs a multi agent platform based on JADE for developing intelligent agent based systems. The system is intended for studying and analyzing the interconnection issues on the power system and microgrid due to interconnected operation and to develop solutions and devise better techniques for smart grid operation. Other agent modules for control, various flywheel models, wind emulators, PV arrays and Fuel Cell emulators can be connected to this system as additional resources. The response of the grid can be studied by their integration. The system is also intended to be used as an educational tool for students to become more familiar with the new concepts of Alternate and green energy and other issues related to the future power systems. Alternate source emulators were designed and developed. The response of these sources was verified to resemble the actual sources. A cluster between a load center and these sources was made to create a microgrid. The microgrid management system was developed in Labview for monitoring and controlling the generation resources and loads within the microgrid. Also the communication network and control systems were developed for the microgrid as well as the ower system components. The microgrid was connected to the power system test bed for studying the connectivity issues and its responses to actions. It has been determined that the microgrid is represented accurately. This real time system is also providing hands on experience to students relating distributed generation and microgrid concepts apart from basic power system concepts. The test setup was also used for studying and developing better techniques for operating microgrids. New techniques and components were developed for the microgrid to deal with connectivity issues such as unit commitment, agent based control, economic operation, smart distribution, flywheel use in transient operation and intelligent load control. These issues, among others, can now be verified and studied by on the developed test bed architecture.

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