Grid Connection of Wind Farms

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Abstract. The aim of this paper is the assessment of the wind generation influence on the voltage quality. First of all, the dynamic behavior of a complete network, composed by more than 120 buses and which contains nuclear, hydroelectric, wind and thermal generation, has been simulated by PSS/E. Afterwards a simpler grid, which permits the control of the different parameters of the network in an easier way, is analysed.

The effect of the wind energy on the grid can be appropriately mitigated with a grid reinforcement. To achieve it, several studies have been carried out. The purpose of these studies are to select the best options to modify the existing network: adding substations, branches, transformers, as well as correctly calculate the influence of the wind generation on power quality.

Key words: wind energy, voltage fluctuations, wind farm connection.

Introduction

The influence of wind energy on the grid behaviour mainly depends on the wind power and the short circuit power arcs of the grid connection.

The interaction between wind farms and their impact on the voltage quality in the point of common coupling with the grid is a matter of current concern. The maximum allowable wind power for a network normally requires the assessment of the influence of wind fluctuations.

This paper analyses the influence of wind parameters on the dynamic behavior. An electrical network has been simulated in PSS/E, applying a gust to the windmills. The state of the study has been obtained by analysing the voltage fluctuations through different parameters from the network and its own configuration. The voltage fluctuations are measured according to the IEC 61400-21.

The dynamic behavior of a large system to be studied by PSS/E requires a great deal of time. Moreover, the wind turbines power model is sensibly time-consuming. In this reason, a secondary objective of this study is to reduce the simulation time by means of an equivalent network.

STUDY

Several dynamic simulations have been carried out in order to analyse the influence of wind generation on voltage fluctuations. First, in a complete network at more than 120 buses and afterwards in a reduced network. Therefore, the paper is divided into two different parts.

A. Analysis of the complete network

1. Analysis with the complete network

The simulation network consists of models of conventional generation provided by nuclear, hydroelectric, and wind plants, with equivalent sag and suitable load distribution generators. It is composed of three zones represented by a bus.

B. Analysis with the equivalent network

The influence of the grid parameters can be analyzed by means of the simple network shown in the figure.

The grid has been simulated in PSS/E. The wind power has been distributed over the grid.

Wind power influence

The nominal power installed in the wind farm is progressively increased. At the same time, the structure of the network is held.

As it was expected, a rise in the wind farm production implies a large diminution on the taps at the buses in points of interconnection. The minus a bigger value of the grid is a sign of the voltage fluctuations. As it can be observed in the figure, in the case of the network without wind power, the voltage fluctuations are far more important than in the case of the network with wind power.

In the case of increased wind power, the voltage fluctuations tend to decrease.

Conclusions

The performance of the two networks is comparable, the grid stiffening implies a rise in the short circuit power, which permits to ameliorate the grid stability. If the short circuit power is adequately risen, the voltage fluctuations are limited even if wind power increases.

Therefore, the allowable wind power for network has depends on the network making. The effect of the wind energy on the grid can be strongly mitigated with an appropriate network reinforcement.

In this paper several studies have been carried out to demonstrate it. In each study a different network condition is considered. The network evolution has consisted in increasing the wind power installed, at the same time the network has been stiffened by adding substations, branches, transformers, etc.