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Influence of the wind farm integration on load flow and voltage in electrical power system

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ABSTRACT

The present paper describes the behavior of a wind farm integrated into the electrical power system and the effect of this energy on the different grid parameters such as the voltage, the load flow and the frequency. A proposed solution for these kind of complications whilst inserting the wind farm is discussed also.

Initially in this work a simple five nodes grid are studied, this network containing two power plants, feeding a load over a distribution system, then one of these power plants is replaced by a wind farm. Finally a UPFC is inserted at the transmission system trying to improve the electrical system profile.

The main aim of this study is to get an idea about the impact of the wind turbine on the voltage, load flow and the frequency and to find the solution. Furthermore, a comparison between the simulations results is carried out at the end of this paper.

Introduction

For centuries human beings have exploited the kinetic power from wind force in different domains, using it to drive mechanical devices. The earliest known use of wind power was wind mills; then through the years this idea developed and it became of huge interest. Scientists and researchers discovered the great importance of wind power which exceeded all expectations and it became the fastest-growing energy source in the world [1].

Wind power has given the entire world, especially the electrical power system, the opportunity to produce electricity with minimum cost. Let us say that one of the most interesting applications of this renewable energy is the wind turbine.

It's not really clear who was the first basic concept inventor of the wind turbine, a lot of scientists and professors' names are linked such as Professor James Blyth and the inventor Charles brush.

This basic concept has been developed through the years to become as it is now.

Wind turbines come in all different shapes and sizes with various designs dealing with the various demands put upon them. Amongst the different designs of the wind turbine, the horizontal and vertical axis, also the fixed and the variable speed, each type has its own advantages and disadvantages.

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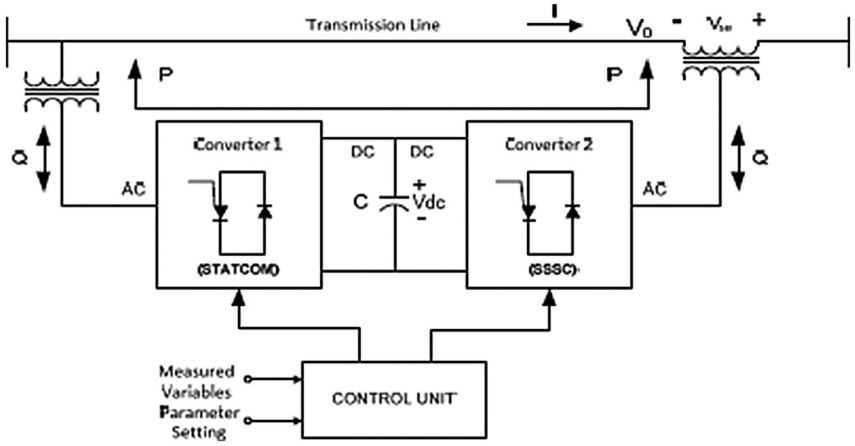

Fig. 1 – Schematic diagram of UPFC [20].

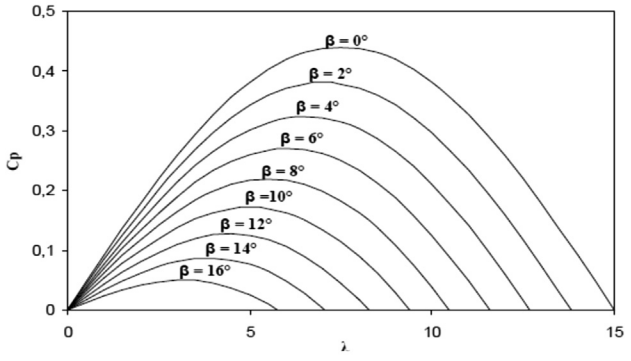

Fig. 2 – The variation of the power coefficient (C_p) in function of the ratio (λ) for different values of the blade pitch angle (β) [12].

Through a comparative study the best choices have been made and introduced to the power industry.

Whereas this wind turbine integration is not without impact especially on the voltage stability and the load flow.

The question that remains to be asked is what will happen if we insert a wind farm in the power system ?

Voltage stability or stable load operation can be defined as the power system's ability to keep up the steady states acceptable (the voltage levels and the load flow) within defined limits at all buses, generators, transmission lines, loads and all the devices in the system.

Likewise, the increasing penetration of this kind of renewable energy causes a several variations on the behavior of the power system profiles: The protection selectivity, the system stability, the fault elimination time; the voltage profile, frequency and the load flow.

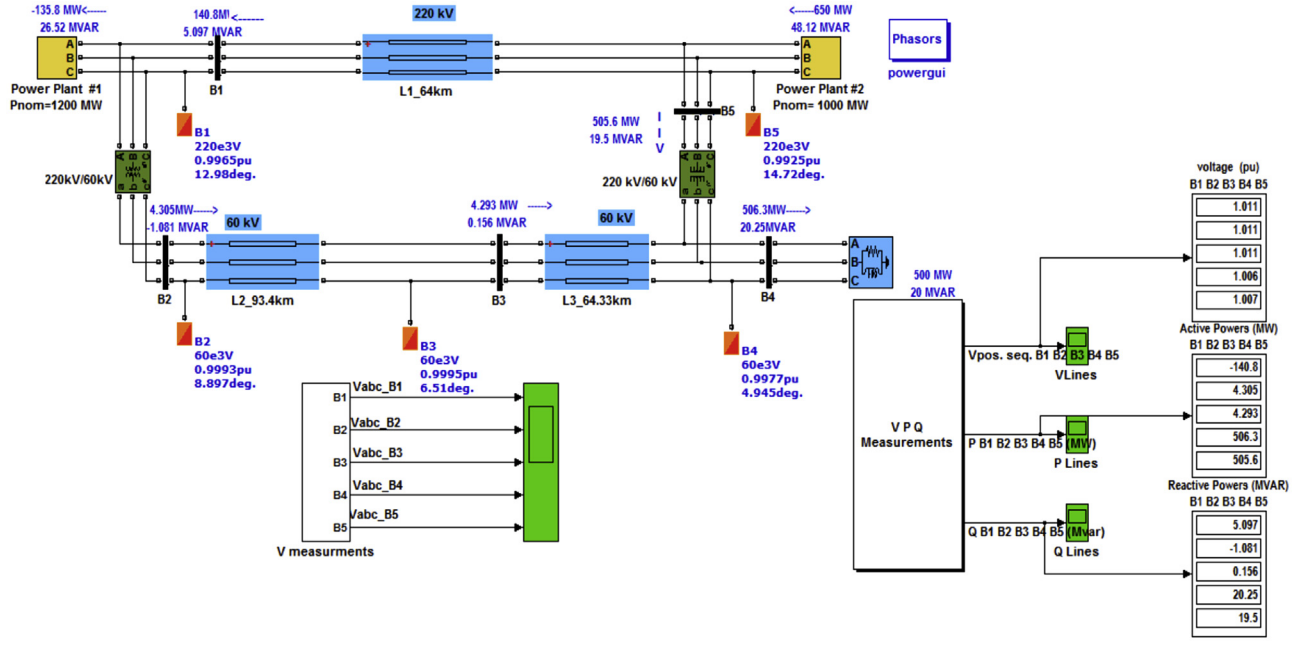

Fig. 3 – The simulated system.