OPERATION OF WIND TURBINE IN GRID CONNECTION

Galidevara Madhu Ganesh[1], Chaladi S Ganga Bhavani[2], Shanmukha Sriram Saladi[3]

[1,2,3]Assistant Professor, Department of Electrical and Electronics Engineering,

Bonam Venkata Chalamayya Institute of Technology & Science,

Amalapuram, Andhra Pradesh, India.

ABSTRACT: Wind power industry is developing rapidly, more and more wind farms are being connected into power systems. Integration of large scale wind farms into power systems presents some challenges that must be addressed, such as system operation and control, system stability, and power quality. This paper discuss the impact of wind turbine generation systems operation connected to power systems, describes the main power quality parameters and requirements on such generations. Furthermore, it deals with the complexities of modelling wind turbine generation systems connected to the power grid, i.e. modelling of electrical, mechanical and aerodynamic components of the wind turbine system, including the active and reactive power control. In order to analyze power quality phenomena related to wind power generation, digital computer simulation is required to solve the complex differential equations.

KEYWORDS: Wind Turbines, Wind farms, Power quality, Wind power generation, Stability, Grid code, Connection requirements.

I.INTRODUCTION

Wind turbine technology has undergone a revolution during the last century. A wind turbine is a machine for converting the kinetic energy in the wind into mechanical energy and mechanical energy is then converted into electricity. The machine which converts mechanical energy into electrical energy is called wind generator or aero generator. If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is called a windmill. A WECS (Wind Energy Conversion System) is a structure that transforms the kinetic energy of the incoming air stream into electrical energy. This conversion takes place in two steps, as follows. The extraction device, named wind turbine rotor turns under the wind stream action, thus harvesting a mechanical power. The rotor drives a rotating electrical machine, the generator, which outputs electrical power.

Wind turbines are classified into two general types: horizontal axis and vertical axis. A horizontal axis machine has its blades rotating on an axis parallel to the ground as shown in Figure 1. A vertical axis machine has its blades rotating on an axis perpendicular to the ground as shown in Figure 2. Today, the vast majority of manufactured wind turbines are horizontal axis with two or three blades

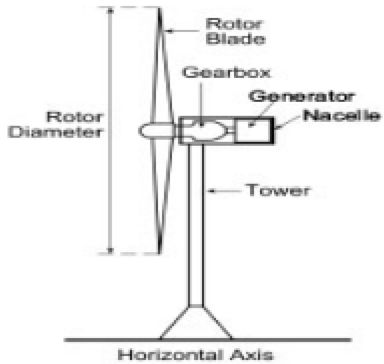

Figure.1 Horizontal axis wind turbine

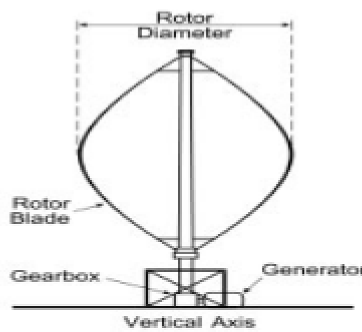

Figure.2 Vertical axis wind turbine

II. METHODOLOGY

At the present time and in the near future, generators for wind turbines will be synchronous generators, permanent magnet synchronous generators, and induction generators, including the squirrel cage type and wound rotor type. For small to medium power wind turbines, permanent magnet generators and squirrel cage induction generators are often used because of their reliability and cost advantages. Induction generators, permanent magnet synchronous generators and wound field synchronous generators are currently used in various high power wind turbines. Interconnection apparatuses are devices to achieve power control, soft start and interconnection functions. Very often, power electronic converters are used as such devices. Most modern turbine inverters are forced commutated PWM inverters to provide a fixed voltage and fixed frequency output with a high power quality. Both voltage source voltage controlled inverters and voltage source current controlled inverters have been applied in wind turbines. For certain high power wind turbines, effective power control can be achieved with double PWM (pulse width modulation) converters which provide a bi-directional power flow between the turbine generator and the utility grid. In order to analyze wind generation compatibility in power systems four factors may be taken into account:

- Electrical power system characteristics (GRID)
- Wind turbine technology (WIND FARM)
- Grid connection requirements
- Simulation tools

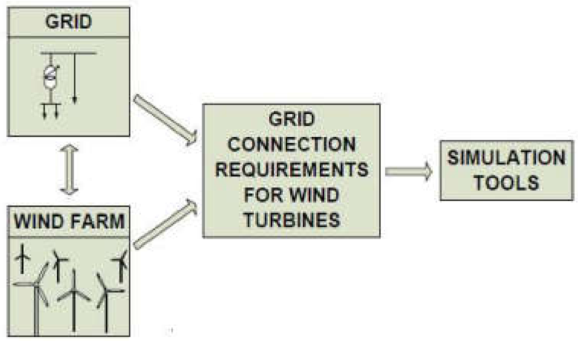

Figure.3 Evaluation Methodology

III. SYSTEM MODELLING

The first step is to state the problem and to define a set of parameters to be analyzed giving the grid connection requirements. After that the simulation tool suitable for analyzing the stated problem and to give the requested results must be chosen. After choosing the convenient simulation software modelling of the wind turbine and power grid components should be carried out.

Wind farms consist of many relatively small generation units. Two different models could be applied to the wind farm modelling: Separated modelling of all small generation units or aggregation of these many generators to one representative wind farm model.

Wind turbines use two different models: static models and dynamic models. Static models are needed to analyze all types of steady state analysis. Usually, these models are simple and easy to create. Dynamic models are needed for various types of analysis related to system dynamics, control analysis, optimization etc. Two different types of dynamic models are used: functional and mathematical physical models. The difference between them is that the latter one includes a detailed power electronics model.

To analyze variable speed wind turbines, the following points should be considered.

- Power electronic converters and controls may be aggregated along with the generators electrical part.

- Generator inertia, aerodynamics and pitch controllers should be modelled individually.

IV. CONCLUSION

Since the penetration of wind power generation is growing system operators have an increasing interest in analyzing the impact of wind power on the connected power system. For this reason grid connection requirements are established. Integration of large scale wind power into power systems present many new challenges. This paper presents the impacts of wind power on power quality, the gird requirements for integration of wind turbines, and discusses the potential operation and control methods to meet the challenges.

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