VOLTAGE FLUCTUATION OF POWERSYSTEM CONSISTING WIND FARM

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DEDICATION

In the name of Allah, Most Gracious, Most Merciful

The results of this study are firstly dedicated to my dear parents.
To my father who supported me not just financially but also spiritually whenever I felt any deficiency in my life.

To my mother who has been as a source of warmth and affection during my whole life, energizing me upon I feel down and making me ready for continuing the way.

To my dear brother (Jaberjoon) and my dear sister (Faezeh) whom I have missed enormously.

The last but not the least important persons to which I intend to dedicate the results are my precious friends back in my country and here in this greenland.
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ABSTRACT

This study is concerned with developing models of pitch regulated fixed speed (PRFS) type of wind turbine generators (WTG) used as distributed generation (DG) sources and demonstrating its application for steady state analysis. The model for this class of WTG developed here facilitates the computation of point of common coupling (PCC) voltages for a specified wind speed. The proposed model has been used to study the impact of WTG integrating in power system by different number of WTG on terminal voltage variation. In addition, the fluctuation of voltage has been investigated in different bus bars of power network by increasing the number of WT according to different wind speed samples. The application of the proposed models for the load flow analysis of radial systems having WTG has been demonstrated. The load flow method that has been used in this paper is balance radial load flow based on forward-backward method. Simulation studies have been carried out on a 33 bus IEEE radial distribution system having WTG sources to illustrate the application of the proposed models which is developed by using Matlab.

ABSTRAK

Kajian ini berkaitan tentang pembangunan model penyelarasan tetap halaju nada (PRFS), sejenis penjana turbin angin (WTG) yang digunakan sebagai sumber generasi pengagihan (DG) dan seterusnya aplikasi untuk analisis keadaan malar ditunjukkan. Model WTG yang dibangunkan ini membantu dalam pengiraan tenaga titik pasangan selari (PCC) untuk halaju angin. Model yang dicadangkan ini telah digunakan untuk mengkaji kesan WTG yang diintegrasikan dalam sistem kuasa bagi beberapa bilangan WTG yang berlainan dan di pelbagai terminal kuasa. Selain itu, perubahan kuasa juga dikaji di pelbagai tahap kuasa dengan meningkatkan bilangan WTG mengikut kesesuaian sampel kelajuan angin. Aplikasi untuk model yang dicadangkan dalam analisis pergerakan barangan dalam sistem yang mempunyai WTG turut ditunjukkan. Kaedah pergerakan barangan yang digunakan dalam kajian ini adalah pergerakan barangan seimbang bersandarkan kaedah depan-belakang. Satu kajian simulasi turut dijalankan pada 33 sistem pengagihan bas IEEE yang mempunyai sumber WTG untuk menggambarkan aplikasi model yang dicadangkan yang dibangunkan menggunakan Matlab.

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LIST OF ABBREVIATIONS

WT - Wind Turbine

PRFS - Pitch Regulated Fixed Speed

PCC - Point of Common Coupling

WTG - Wind Turbine Generator

WTGU - Wind Turbine Generating Units

DFIG - Doubly Feed Induction Generator

IEEE - The Institute of Electrical and Electronics Engineers

GFEC - Generator with Front End Converter

DG - Distributed Generation

IEA - International Energy Agency

LIST OF SYMBOLS

A - The rotor area

p - The density of air

v - The wind speed

Cp - The power coefficient

R1 - Stator Resistance

R2 - Rotor Resistance

Xl1 - Stator Leakage Reactance

Xl2 - Rotor Leakage Reactance

Xm - Magnetizing Reactance

I1 - Stator Current Weighting factors

I2 - Rotor Current

Im - Magnetizing Current

CHAPTER 1

INTRODUCTION

1.1 Introduction

Wind energy plays an important role in the growth of renewable resource exploitation both for plant number and installed power. The development of wind power generation is very fast in recent years because of its great advantages in environment protection and fuel costs. Among their advantages are the large number of potential sites for erection and the rapidly evolving technology with many suppliers offering from the individual turbine set to even turnkey projects. On the other hand, wind energy projects entail high initial capital costs and, in operation, a lack of controllability on the discontinuous or intermittent resource. However, because the random variation of wind power, the generation output of a wind power plant is neither continuous nor stable, so that it is considered as an unreliable power source to the power system.

In spite of these disadvantages, their incorporation is growing steadily, a fact that is making the utilities evaluate the various influencing aspects of wind power generation onto power systems. Throughout the world there are large scarcely populated areas with good wind power potential where the existing grids are small or weak, due to the small population. One of the main problems concerned with wind power is the voltage fluctuations. Several factors contribute to the voltage fluctuations in the terminals of a wind source to the turbine generator [1].

The aerodynamic phenomena, i.e., wind turbulence, tower shadow, etc.; the short-circuit power at the connection points; the number of turbines and the type of control. Besides, wind turbines may also cause voltage fluctuations in the grid if there are relatively large current variations during the connection and disconnection of turbines. With these aspects in mind, it turns necessary to ponder the information stemming from models that simulate the steady state interaction between wind farms and the power systems they are connected to. Such models allow performing the necessary preliminary studies before connecting wind farms to the grid.

The purpose of this project is to show by means of simulations the voltage fluctuations caused by a wind farm in a power system. A model for steady state performance of wind farms is presented, which takes into account the steady state behavior of an individual wind turbine and the aggregation effect of a wind farm (i.e., the larger the wind farm, the smoother the output waveforms). In addition, thewind speed modeland thewind turbine model used are briefly presented. Validation of models and simulations of the interactions between the wind farm and the power system are carried out by using SimPowerSystems of SIMULINK/MATLAB.

1.2 Problem Statement

Because the random variation of wind power, the generation output of a wind power plant is neither continuous nor stable, so that it is considered as an unreliable power source to the power system.This can forces the utilities to assess its impact on the steady state performance of power system.One of the main problems concerned with wind power and grids is the voltage fluctuations. Voltage fluctuation means the regular variation of a voltage in its envelope or the continuous and rapid variation of its amplitude that can cause an important damages on electrical equipment.

1.3 Objectives of Study

The objectives of this project are listed as follows:

i. To analyze the effect of wind farm on voltage profile of power system network.

ii. To investigate voltage fluctuation of power system network due to different wind speed.

iii. To develop the interpretation of wind farm in load flow analysis.

1.4 Scopes of Study

The scopes of this project are:

i. Present a suitable simulation for steady state performance of wind farm and power system.

ii. Analysis of the voltage behaviour in power system due to different wind speed

iii. Analysis of the voltage fluctuation at bus bars of the wind farm and at loads caused by wind farm.

1.5 Organization of the Report

The first chapter is the introduction. This chapter provides readers a first glimpse at the basic aspects of the research undertaken, such as overview of effect of wind farm on power system from voltage fluctuation point of view.

Report followed by Chapter 2, which discuss about the literature review and reviews the previous works of voltage fluctuation of power system consisting wind farm and how they analysis these effects on power system.

In Chapter 3 the overall systemmethodology and steps thatmust be taken into consideration for voltage fluctuation of power system consisting wind farm.

The results and discussions will be discussed in Chapter 4.

The last chapter provides the conclusion of the study and recommended work for future improvements.

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