1-MSC:

Matching The Stand Alone Solar Photovoltaic Power Systems With The Electrical Loads

With the continuous decrease of photovoltaic cell cost, there is an increasing interest in PV systems applications. Electrical motors powered by solar cells array are one of PV important applications. They can be used as water–pumping systems for irrigation or water supply, where the motors derive volumetric or centrifugal pumps. Good matching of loads to solar cell generators is so important for optimum operation of the PV system and maximum utilization of solar energy. It is necessary to study the matching performance system powered by Solar Cells Array to make the investment more effective.

This thesis presents two comprehensive techniques associated each other to investigate the degree of solar cell utilization and quality of load matching for any system consists of a motor coupled with a mechanical load powered by solar cell array generator.

First Technique: Graphical Analysis Method, which presents group of models for different types of dc motors coupled with different kinds mechanical loads powered by SCA. Through specified factors act as comparison indices to determine the best load matches SCA. The method also analyzes the effect and importance of the battery storage in photovoltaic power system.

Second Technique: provides a comprehensive study of Graph Theoretic Modeling (GTM) methodology which is systematic, flexible to include any component and suitable for nonlinear systems. GTM offers a global approach to obtain system of equations solved numerically. The technique has been applied to different types of motors coupled with different types of mechanical loads powered by SCA. A comparison has been made between the above two techniques to determine the accuracy and the quality of the methodology.

The thesis investigates the contribution of SCA in AC loads through modeling induction motor using GTM technique and presents the induction motor as a stamp ready for PVPS.

2-PHD:

Operation of wind Turbines Farms with Utility Grid

Wind energy conversion has emerged as a viable alternative to meet the increased demand for energy resources in recent years. Wind farms interconnected to power system bring new challenges to power system operation. It is imperative to study the impact of wind power on utility grid operation.

This thesis investigates the impact of wind power on utility grid operation through studying significant operation issues, such as reactive power injection, power flow analysis, voltage stability assessment and contingency analysis.

In this thesis, a probabilistic voltage stability algorithm of WTGUs interconnected with the utility grid is developed via power flow analysis where these units are modeled by detecting the collapse point on the Q-V curves. In case of fixed speed wind turbines (FSWT), they can be considered as P-Q bus(es). While in case of variable speed wind turbines VSWT, they are modeled as P-V bus(es) and the reactive power generation inside the wind farm as a margin. The probabilistic nature of wind is considered by introducing the expected voltage stability margin as an index that combines both of the voltage stability and the wind distribution in one index. The proposed algorithms are implemented in Matlab environment and applied on a standard system, IEEE 26-bus system and an Egyptian practical utility grid wind farm, Zafarana wind farm that is connected to a bus in the Canal Electricity Zone (34 bus system).Voltage stability margin (VSM), and expected voltage stability margin (EVSM) are calculated at each wind speed. The accumulation of the EVSM over a specific period can be considered as the system voltage stability margin which is a single value that can be compared with the voltage stability margin of an all-conventional power system

3-PAPERS

Abstract

Steady state analysis of wind turbine generating units (WTGUs) interconnected with the grid is needed as the use of WTGU are getting more popular and many new systems are being planned. In this paper, probabilistic voltage stability algorithm of WTGUs interconnected with the utility grid is developed via power flow analysis where these units are modeled as P-Q bus(es) by

detecting the collapse point on the Q-V curves. The developed algorithm also facilitates the computation of both the real and reactive power output of the fixed speed pitch regulated wind turbine at a specific site, wind turbine characteristics, wind speed and terminal voltage. The probabilistic nature of wind is considered by introducing the expected voltage stability margin as an index that combines both of the voltage stability and the wind distribution in one index. The proposed algorithm is implemented and applied on the IEEE 26-bus, voltage stability margin (VSM), and expected voltage stability margin (EVSM) are calculated at each wind speed. The accumulation of the EVSM over a specific period, can be considered as the system voltage stability margin which is a single value that can be compared with the voltage stability margin of the all-conventional power system

. Abstract

Wind energy conversion has emerged as a viable alternative to meet the increased demand for energy resources in recent years. Wind farms interconnected to power system bring new challenges to power system operation. It is imperative to study the impact of variable speed wind turbine coupled to doubly fed induction generator DFIG on utility grid operation.

A mathematical model has been developed to evaluate the steady state performance of the variable speed wind energy conversion system with DFIG. In addition a steady state converter (rectifier-inverter) model as a function of firing angles of the rectifier and inverter is developed and used directly to calculate the influence of DFIG on power system operation through power flow solution. These units are modeled as P-V bus(es) to manage the reactive power generation inside the wind farm. The paper presents and validates a model of DFIG suitable for operation in steady state mode and not only able to support voltage by feeding reactive power but also to fulfill grid requirement. The proposed algorithm is implemented and applied to the IEEE 26-bus system and the number of the equivalent wind turbines generating units WTGU at each generating bus is demonstrated and injected as P-V bus(es). The impact of WTGUs on active and reactive power of own generating bus)es(and slack bus at different wind speeds is also investigated

ABSTRACT

– With the global trend towards deregulation in the power system industry, the volume and the complexity of the contingency analysis results in the daily operation and system studies have been increasing. This paper discusses the impact of wind turbine generating units (WTGUs) on power system voltage stability. A probabilistic voltage stability algorithm is developed via power flow analysis where these units are modeled as P-Q bus(es) by detecting the collapse point on the Q-V curves. The developed algorithm also facilitates the computation of both the real and reactive power output of the fixed speed pitch regulated wind turbine at a specific site, wind turbine characteristics, wind speed and terminal voltage. The probabilistic nature of wind is considered by introducing the expected voltage stability margin as an index that combines both of the voltage stability and the wind distribution in one index. The proposed algorithm is implemented and applied on the IEEE 26-bus, voltage stability margin (VSM), and expected voltage stability margin (EVSM) are calculated at each wind speed. The accumulation of the EVSM over a specific period can be considered as the system voltage stability margin which is a single value that can be compared with the voltage stability margin of the all-conventional power system. Finally a contingency analysis for wind power through severe outage cases relevant to conventional power system is investigated.

ABSTRACT

The wind turbines are classified according to their control strategy either fixed speed or variable speed. The most common control strategies are stall (based on the design of the blade), pitch (based on pitch angle of the blade) and active stall (which is a combination of both). Fixed speed wind turbines (FSWT) are generally coupled with the utility grid through squirrel cage induction generator (SCIG) via a capacitor bank. However, variable speed wind turbines (VSWT) are coupled with the grid through doubly fed induction generator (DFIG) via static converter in the rotor side or with synchronous generator. Zafarana wind farm which has already reached a capacity of 425MW is the largest installed wind farm in the Middle East and Africa.
Zafarana wind farm includes both fixed speed wind turbines (FSWT) coupled with the utility grid through squirrel cage induction generator (SCIG). Fixed speed wind turbines (FSWT) are generally coupled with the utility grid through squirrel cage induction generator (SCIG) via a capacitor bank (Nordex 600/43 and Vestas 660/47). However, variable speed wind turbines (VSWT) are coupled with the grid through doubly fed induction generator (DFIG) via a capacitor bank (Gamesa 850/52).
This paper introduces models of different types of WTGs used in Zafarana wind farm in terms of calculating the performance coefficient, active power curve, and reactive power curve. These models are verified with the actual data measured from the site.

Abstract

Steady state analysis of wind turbine generating units (WTGUs) interconnected with the grid is needed as the use of WTGU are getting more popular and many new systems are being planned. Installed wind turbines capacity has reached a level where wind turbines have to take

part in reactive power dispatch and act like a conventional power plant. In this paper, an algorithm of WTGUs with doubly fed induction generator interconnected with the utility grid is developed via power flow analysis where these units are modeled as P-V bus(es) to manage the reactive power generation inside the wind farm. The developed algorithm also facilitates the computation of both the real and reactive power output of the variable speed pitch regulated wind turbine coupled to Doubly Fed Induction Generator (DFIG). This DFIG is connected to the grid directly from the stator circuit and through ac-dc-ac converter in the rotor circuit. The proposed algorithm is tested on the IEEE 26-bus system and the number of the equivalent WTGU at each generating bus was demonstrated and injected as P-V bus(es). The impact of WTGUs on both active and reactive power of its own generating bus and slack bus at different wind speeds was investigated.