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Wind Energy Conversion System with DFIG and STATCOM for Optimized Integration of Wind Power into Transmission and Distribution System

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Abstract - The aim of this paper is to present modeling and simulation of wind turbine driven doubly-fed induction generator. There are two pulse width modulated voltage source converters are connected back to back between the rotor terminals and utility grid via common dc link. In this paper the performance of DFIG wind system during dynamic loading and in various fault conditions are analyzed at variable wind speed. The performance of DFIG wind system during dynamic loading and in various fault conditions are analyzed at variable wind speed. This project is a small step forward and gives the benefits of static synchronous compensator (STATCOM) for wind farm integration based on DFIG. To generate reference voltage for a static compensator (STATCOM) operating in voltage control mode. The proposed individual wind turbine using STATCOM of dynamic wind farm electric network, of a Power Flow Control of DFIG Generators for Wind Turbine Variable Speed using STATCOM is connected to the grid. The control capability of the wind farm that is a critical issue in paining and working of the wind system. The dc link capacitor to exchange the power with the three phase feeders, the power-quality issues by providing load balancing and voltage regulation on the load can be satisfied with the proposed method.

Keywords: Wind turbine, MATLAB, SIMULINK, STATCOM, Wind power, Transmission, Distribution system.

I. INTRODUCTION

Electric power generation in the mere future rely on renewable and environmental friendly energy sources such as wind, solar, hydropower, geothermal, hydrogen and biomass due to the existence of fossil fuels. Among these renewable resources, wind is considered to be cheapest and one of the major renewable resources [1]. A highly efficient performance and improvement of power can be achieved using variable speed wind generator in combination of advanced power electronics converter [2]. In India, the wind farms mostly employ fixed wind turbines and induction generators. But the impediments of such generators are low productivity and poor power quality which requires the variable speed wind turbine generators, for example, a doubly excited PMSG generator (DFIG) [3]-[5].

II. EXISTING SYSTEM

The steadiness of generator (PMIG) based turbines can be enhanced by a StatCom, which is outstanding and recorded in the loading for adjusted lattice voltage plunges. Under uneven framework voltage plunges, the negative arrangement voltages which cause substantial generator torque motions that decrease the lifetime of the drive prepare. In this paper, investigations on an FSIG-based wind farm in combination with a StatCom under unbalanced grid voltage fault are carried out by means of theory, simulations, and measurements [6].

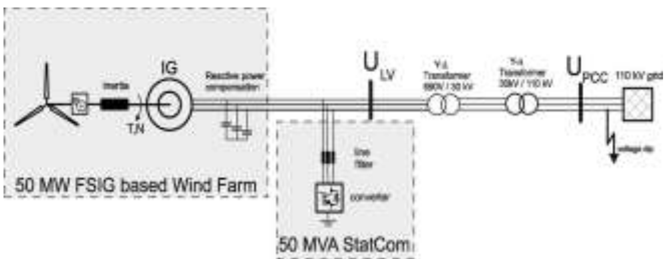

Figure-1: Existing System Design

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A StatCom control structure with the capability to between the positive and the negative co-ordinate sequence of the grid voltage is proposed [7]. The results clarify the effect of the positive- and the negative-sequence voltage compensation by a StatCom on the operation of the FSIG-based wind farm [8].

Modification

This paper presents a novel load-adaptive control strategy for stand-alone wind energy generation system using a permanent magnet synchronous generator (PMSG). Since there is no grid supply in a stand-alone system, the output voltage has to be controlled in the constant amplitude and frequency by the load-side PWM converter [9], [10]. To improve the operation performance under the nonlinear load and the unbalanced load, a PI based predictive current control technique is adopted in the inner loop current controller to improve the performance of transient response.

III. PROPOSED METHOD

The system of the wind turbine with DFIG and back-to back converter connected to the grid is shown in this configuration; the generator rotor operates at a variable speed to optimize the tip-speed ratio. Therefore the generator system operates in both a sub-synchronous and super-synchronous mode, normally between +/- 30% of synchronous speed. The rotor winding is fed through a power converter, typically based on two AC/DC/IGBT based linked voltage source converter.

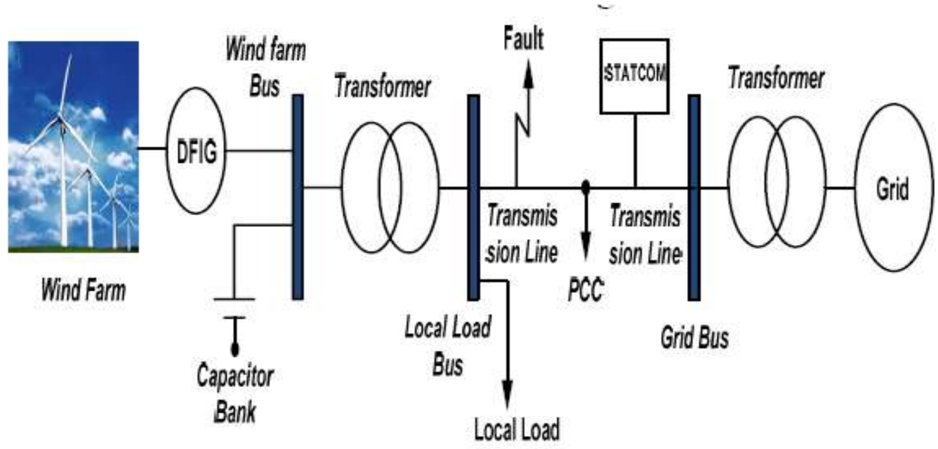

Figure-2: Proposed System Design

- Methods relying on wind speed;
- Methods relying on output power measurement and calculation; and
- Methods relying on characteristic power curve.

IV. SYSTEM SPECIFICATION

a) Hardware Required

- Wind mill
- ARM 7 LPC 2148
- H Bridge Inverter
- Transformer
- Pi control(fuzzy, pi, Nero fuzzy)

b) Software Required

- MATLAB 2013 v 10.1

c) Doubly Fed Induction Generator

The grid side converter itself compensates for the reactive power rather than providing an additional compensating device.

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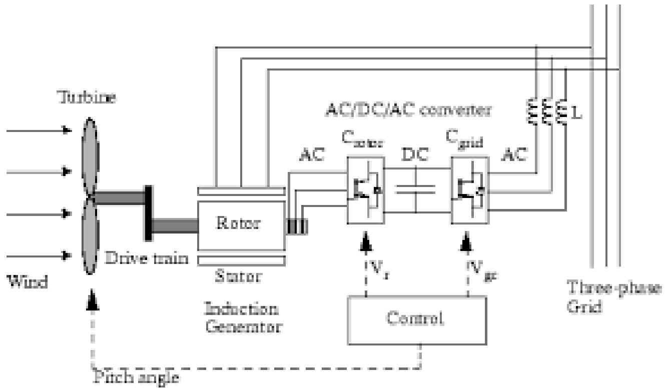

Figure-3: Grid Control Unit

d) Block Diagram

The grid-side converter controls the dc-link voltage and ensures the operation by making the reactive power drawn by the system from PI control technique. Additional power is also extracted from the rotor side. The rotor side converter is used for attaining maximum power extraction and to supply required reactive power to DFIG.

The DFIG consist of a 3 phase wound rotor and 3 phase wound stator.

As the rotor rotates the magnetic field produced due to the ac current and also rotates at a speed proportional to the frequency of the ac signal applied to the rotor windings.

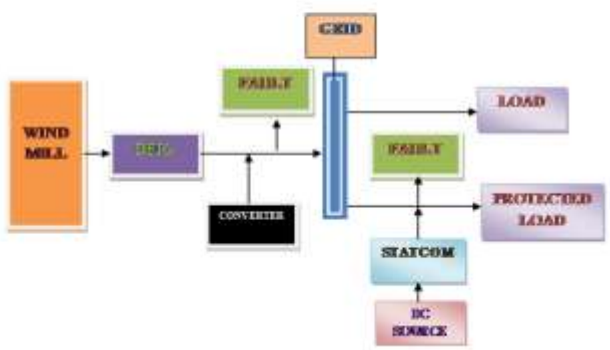

Figure-4: Block Diagram of Proposed System

e) PI Controller

PI controller is one type of close control loop feedback system. It is continuously detect an error signal as the difference between a measured process variable and a desired set point. PI controller use to minimize the error when supply the power. The Proportional and Integral values are denoted as P and I. Heuristically, these values can be interpreted in terms of time such as P depends on the present error and I depends on the accumulation of past errors.

f) Static Synchronous Compensator

A STATCOM is a controlled reactive power source device that is capable of generating and/ or absorbing reactive power in a power line.

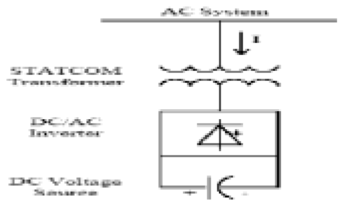

Figure-5: Static Synchronous Compensator

It provides the desired reactive power generation and absorption entirely by means of electronic processing of the voltage and current waveforms in a voltage source converter (VSC).

V. RESULT & OUTPUT

The simulation of the circuit is done using MATLAB Simulink and result waveforms are obtained as shown in figure-7(A,B)and figure-8 (A,B).

Advantages

- More Reliable
- High efficiency
- Low power loss,
- Better economical operation.

We use separate renewable source as a DC source so it reduce the distortions.

Applications

- Unbalanced loads
- Wind farms
- Wood chippers
- Welding operations
- Car crushers & shredders
- Industrial mills

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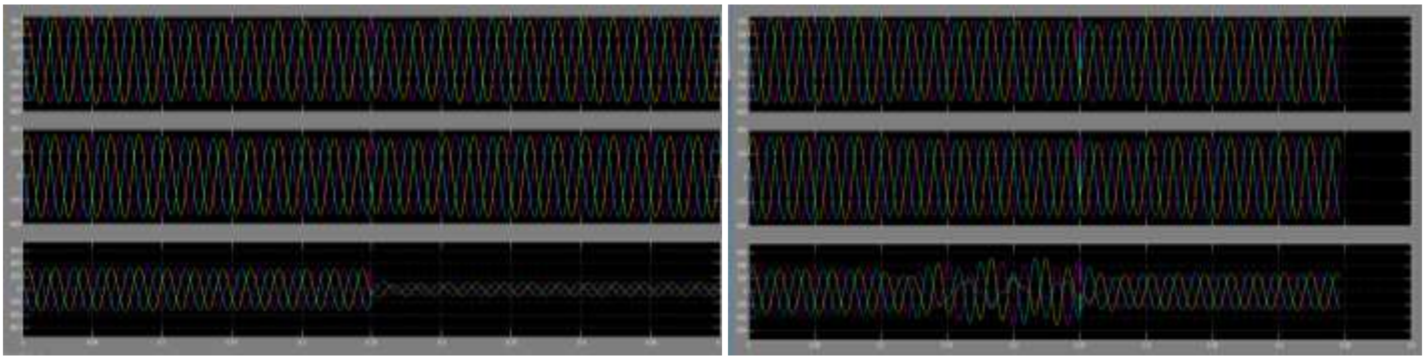
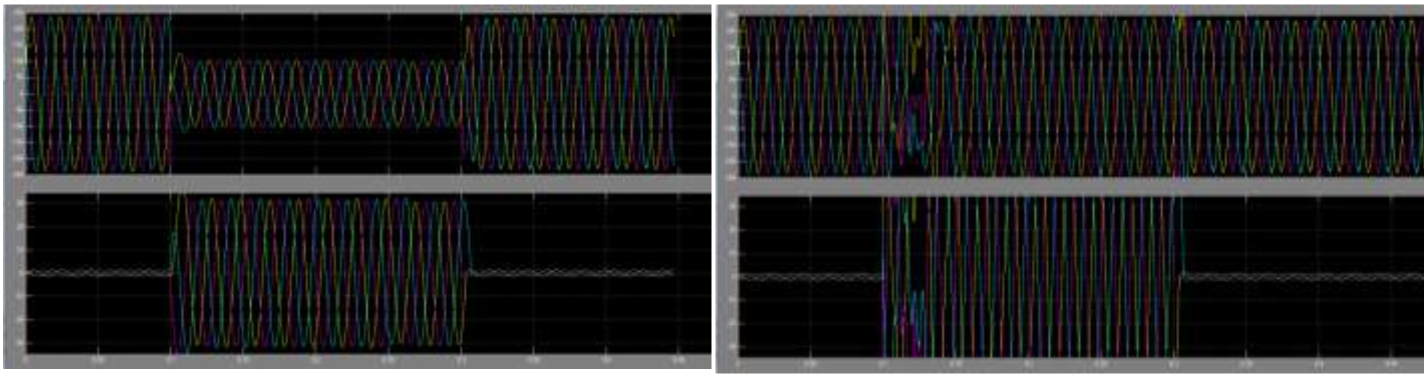


(A) **(B)**

Figure-7(A): Output of DFIG-1, (B): Output of DFIG-2



(A) **(B)**

Figure-8(A): Output of STATCOM-1, (B): Output of STATCOM-2

VI. CONCLUSION

This paper examined the STATCOM hysteresis control technique for harmonic cancelation with load tracking in a system where a wind turbine is present and it examined the work of the SVPWM operated DVR when connected to a critical load from the same system. It used a separate control for the STATCOM and the DVR interchanging their roles. This gives room to the subject of combining the two without having overlapping problems. This paper used as non-linear loads simple AC to DC rectifiers, another subject to be examined in the future is changing the non-linear load type.

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