

# Proceedings



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# Transient Performance Analysis of a DC Grid Interconnected Wind Turbine System

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<b>Abstract</b>	<b>Abstract:</b> Renewable energy sources being the future of power generation and wind energy being a prominent source has brought the necessity of its analysis under different loading scenario particularly when it is interconnected with a grid. For the past few years DC distribution system has gained popularity due to its several advantages. This paper presents a novel analysis on DC grid connected MPPT operated wind turbine system with the achievement of terminal voltage control for multiple load changes connected both with the Wind Turbine System (WTS) and with the DC grid. The proposed analysis demonstrates the achievement of the key objectives particularly terminal voltage regulation and load sharing analysis between WTS and DC grid for several load variations with the attainment of steady state within 0.3 sec of the applied changes. This study employs a straight forward classical PI controller-based speed control strategy for the turbine. This analysis demonstrates the direction and magnitude of the power supplied from and to the DC grid which is conducted on MATLAB Simulink platform and subsequently focused on MPPT by speed control, load end voltage control, and power transfer to the loads and grid within the context of variable loading environment, specifically focusing on the utilization of the DC grid demonstrates high accuracy of control even with a properly tuned classical PI controller.	
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**I. Introduction**  
Because of limited fossil fuel resources and their adverse effect on the environment, renewable energy resources have become the most promising alternative. As wind energy is a non-polluting and never-ending source of power, so wind energy is one of the potential alternative energy sources for the future [1]. Within wind speed limits particularly cut-in speed and cut-out speed the turbine is operated and beyond these limits, the turbine should not be operated as shown in Fig. 1, so that the mechanical limits of the generator and turbine is not crossed and they can be protected. For speed control of wind turbine for variable wind speed pitch angle control is employed [2], [3]. The typical pitch angle variation characteristics of a

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# Transient Performance Analysis of a DC Grid Interconnected Wind Turbine System

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**Abstract**— Renewable energy sources being the future of power generation and wind energy being a prominent source has brought the necessity of its analysis under different loading scenario particularly when it is interconnected with a grid. For the past few years DC distribution system has gained popularity due to its several advantages. This paper presents a novel analysis on DC grid connected MPPT operated wind turbine system with the achievement of terminal voltage control for multiple load changes connected both with the Wind Turbine System (WTS) and with the DC grid. The proposed analysis demonstrates the achievement of the key objectives particularly terminal voltage regulation and load sharing analysis between WTS and DC grid for several load variations with the attainment of steady state within 0.3 sec of the applied changes. This study employs a straight forward classical PI controller-based speed control strategy for the turbine. This analysis demonstrates the direction and magnitude of the power supplied from and to the DC grid which is conducted on MATLAB Simulink platform and subsequently focused on MPPT by speed control, load end voltage control, and power transfer to the loads and grid within the context of variable loading environment, specifically focusing on the utilization of the DC grid demonstrates high accuracy of control even with a properly tuned classical PI controller.

**Keywords**— DC Grid, Wind Turbine System (WTS), Maximum Power Point Tracking (MPPT), Proportional-Integral (PI) Controller.

## I. INTRODUCTION

Because of limited fossil fuel resources and their adverse effect on the environment, renewable energy resources have become the most promising alternative. As wind energy is a non-polluting and never-ending source of power, so wind energy is one of the potential alternative energy sources for the future [1]. Within wind speed limits particularly cut-in speed and cut-out speed the turbine is operated and beyond these limits, the turbine should not be operated as shown in Fig.1, so that the mechanical limits of the generator and turbine is not crossed and they can be protected. For speed control of wind turbine for variable wind speed pitch angle control is employed [2,3]. The typical pitch angle variation characteristics of a wind turbine is demonstrated in Fig.2. Pitch angle ( $\beta$ ) control method can be used for speed control of the turbine depending upon the wind speed and power produced. From Fig.2 it can be observed that the entire operating zone can be divided into four sub-regions between zero speed and cut-in speed. In this region  $\beta$  is varied to get the desired power output as well as protect the turbine.

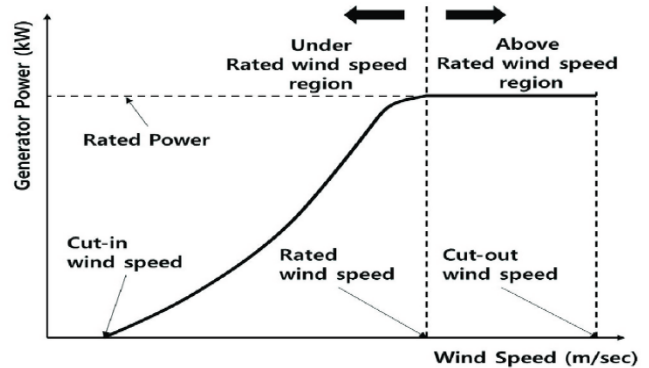


Fig.1 Power characteristics of a wind turbine

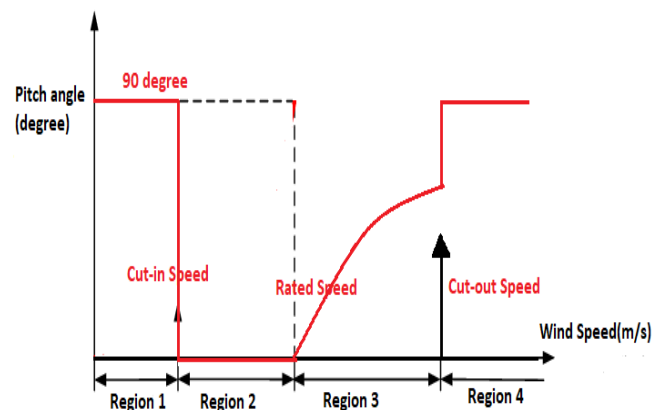


Fig.2 Typical pitch angle characteristics of a wind turbine

Because of gearless structure, higher efficiency and several other advantages we have considered direct-coupled Permanent Magnet Synchronous Generator (PMSG) [4,5]. Here we have used a lookup table-based speed control mechanism for MPPT operation of the wind turbine and an output terminal voltage controller using the simplest form of PI controller. This work mainly contributes the following:

- Design of an MPPT operated wind turbine system using optimal speed control.
- Output load voltage control of wind turbine system under variable loading conditions.
- Detailed transient analysis of the developed system connected with a DC grid for several load variations and have forecasted the power fed and drawn to and from the DC grid for these variations.