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Analysis Of Wind Power Generation Connected To The Grid Using Dfig

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ABSTRACT
Because of global warming, dangerous emissions, greenhouse effect, and ozone depletion, the usage of fossil fuels is being decreased these days. In recent years, renewable energy has risen to prominence as one as for the most important and promising the sources of energy generation, needing increased transmission capacity and system stability. The advancement of technology in the wind energy business has resulted in the wind turbines variable-speed generation development that has significant merits over turbines of fixed-speed . In the generation systems of wind energy , commonly employed are Permanent Magnet Synchronous Motor (PMSM) , Doubly fed induction generator (DFIG).

Keywords –DFIG, wind turbine modelling, ac to dc rectifiers and power electronic converters.

1. Introduction

Quadrature and direct components of the full-model, are used. Concerns about the environment have sparked a surge in interest in technology for generating renewable electrical energy around the world. Wind turbines are one technique to generate electricity from renewable sources. Wind energy power has recently been the focus of a lot of study and development [1]. Induction fed generators wind turbines are widely used in electrical grids with high wind penetration power, modifying the dynamics of the system [2]. This is due to their variable speed feature. This has piqued interest in developing adequate DFIG models for power system analysis. In recent years, the continued trend of rising wind power penetration has necessitated the introduction of new methods [3]. Grid standards are being changed to guarantee that contributions from wind turbines to frequency and voltage management, as well as the host unitary to a disturbance, are taken into account. One of the renewable sources of energy, wind power, plays a critical part in total power generation [4]. As a consequence, understanding the behaviour of wind energy systems in terms of dynamics is crucial. Many DFIG rotor voltage models have been proposed in response to the needs of the new grid code, in an acceptable reference frame [6].

2. Induction fed generators

On the rotor and stator are provided with 3 phase windings of wound rotor induction generators (WRIGs). Both the rotor and stator terminals can provide energy to them. In the generator mode, they are known as doubly fed induction generators (DFIG). EvenThe rotor circuit is supplied via slip rings and brushes through the power electronic converters should have the capability in both the directions of power handling for both motoring and generating operation modes to be possible.

2.1operating principle of DFIG

DFIG is the foundation for most high-power wind-energy conversion systems (WECSs). DFIG's stator windings are to the grids connected directly, while the windings of the rotor are to the grids connected via power electronic convertersreturn. The back-to-back converters have twin converters connected "next to each other," such as rotor side converter (RSC) and for the grid side converter (GSC). To keep the voltage changes in the dc-link voltage modest, for dc-link capacitor is put between two converters as energy storage. The DFIG's control is more difficult than that of a typical induction machine. For operating the DFIG, a power electronic converter controls the rotor current. AC/DC/AC power electronic converter and an IFG made up of a WRIG is used in wind turbines. A 3-phase, 50Hz grid is linked directly to the stator winding, while the rotor was fed through the AC/DC/AC converter at changing frequency through slip-rings, allowing DFIG to adapt to different wind speeds such as in Fig.1. Wind turbines, which run in a limited speed range of about 30-35 percent, are a typical application for DFIG. DFIG systems can be used in flywheel energy storage technologies, pumped storage power plants, as well as other applications. A machine-side adapter controls the dc-link voltage and ensures that the system has a power factor of one, while a grid-side converter controls the dc-link voltage and guarantees that perhaps the system has a power factor of one (i.e. zero reactive power). The DFIG can operate as a generator in neither sub-synchronous and super-synchronous modes thanks to a bidirectional converter inside the rotor circuit. Depending on the operational scenario, power is pumped into or out of the rotor (in super synchronous mode), and then it flows from the rotor to the grid via the converter. A PC rotor is used to create or absorb the power Pg in order to maintain proper dc voltage, as seen in Figure 1. The lossless AC/DC/AC converter, Pg equals Pr in steady-state, and the wind turbine's speed is controlled by the power Pr intercepted or provided by the PC rotor. For sub-synchronous speeds, the ac power supplied by the PC rotor has a positive phase-sequence, and for super-synchronous speeds, it has a negative phase-sequence. The product of the grid frequency and the significant value of the slip determines the frequency of this voltage. The PC rotor and grid can both generate and absorb reactive power, as well as control reactive power and voltage at the grid terminals. Figure 1 illustrates the DFIG System to Power Electronic converters.

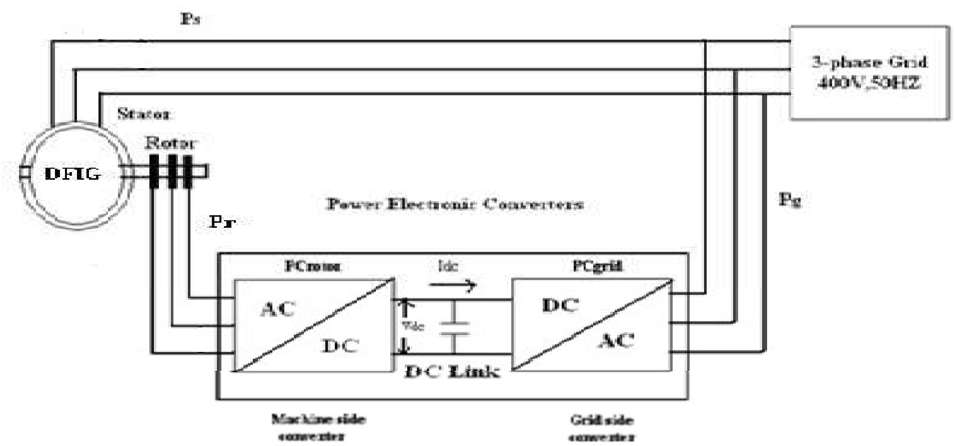

Fig 1wind doubly fed induction generator**.**

2.2characteristics of the DFIG

Wind, as a renewable resource, has numerous notable qualities, including the difficulty in predicting its direction and the fact that its speed fluctuates rapidly and arbitrarily. Converting wind energy to electricity is more challenging due to these qualities. Consequently negative value of the slip shows that machine is spinning faster than synchronously in the direction of the rotating field. Because the torque direction was reversed, and the machine should be powered by a mechanical source for offset the opposite torque (against the direction of the spinning field). The machine functions as a generator, supplying power to the source. When the machine rotates in the opposite direction as the rotating field and internal torque, it is said to be in reverse rotation. The machine should be driven by a mechanical power source to maintain the condition. Plugging is a method of running the induction machine that is similar to an electrical braking system. As shown in figure 2.

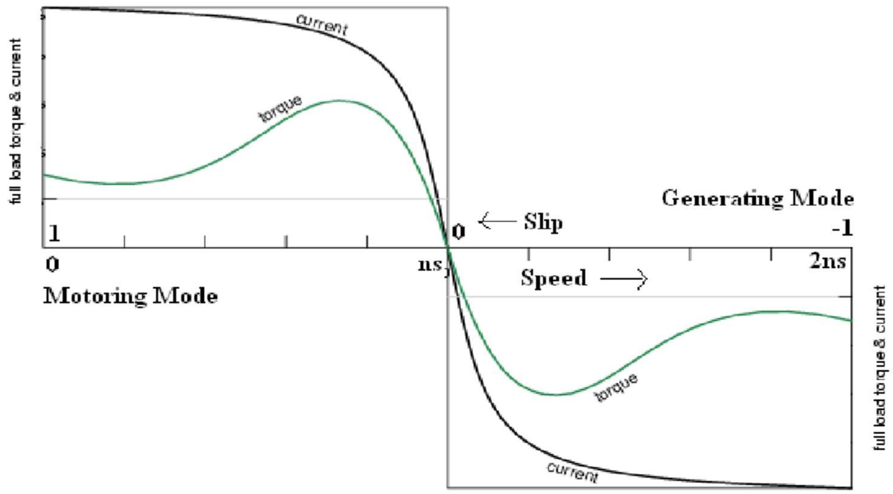

Fig 2.Torque speed characteristics.

3. Modelling of a wind turbine

Pitch-controlled rotor blades and a direct grid associated synchronous generator were utilised in the initial generation of wind turbines such as limit mechanical power during high wind speeds. As a result, for first modelling studies on this wind turbine idea were conducted. Directly grid associated asynchronous squirrel cage induction generator followed directly by the grid coupled synchronous generator. Pitch control or stall control can be used to minimize the power collected through the wind at high speeds [6]. There are numerous papers in the literature on modelling for wind turbine with a physically grid coupled squirrel cage induction generator, both are in combination with pitch control and mechanical power stall control, and squirrel cage induction generators with directly grid coupled are more commonly used in recent technology. As per the generated power is proportional for the wind speed cube, it is evident that any electricity-generating turbines should be located in locations with a annual wind speed high mean, therefore the resource of wind available is a consideration key in deciding where farms of wind should be built. As seen in figure. 3, the rotor wind turbine either a given rating was significantly larger than that of through geothermal power. From this wind turbine the wind speed is calculated and it is shown in figure 4.

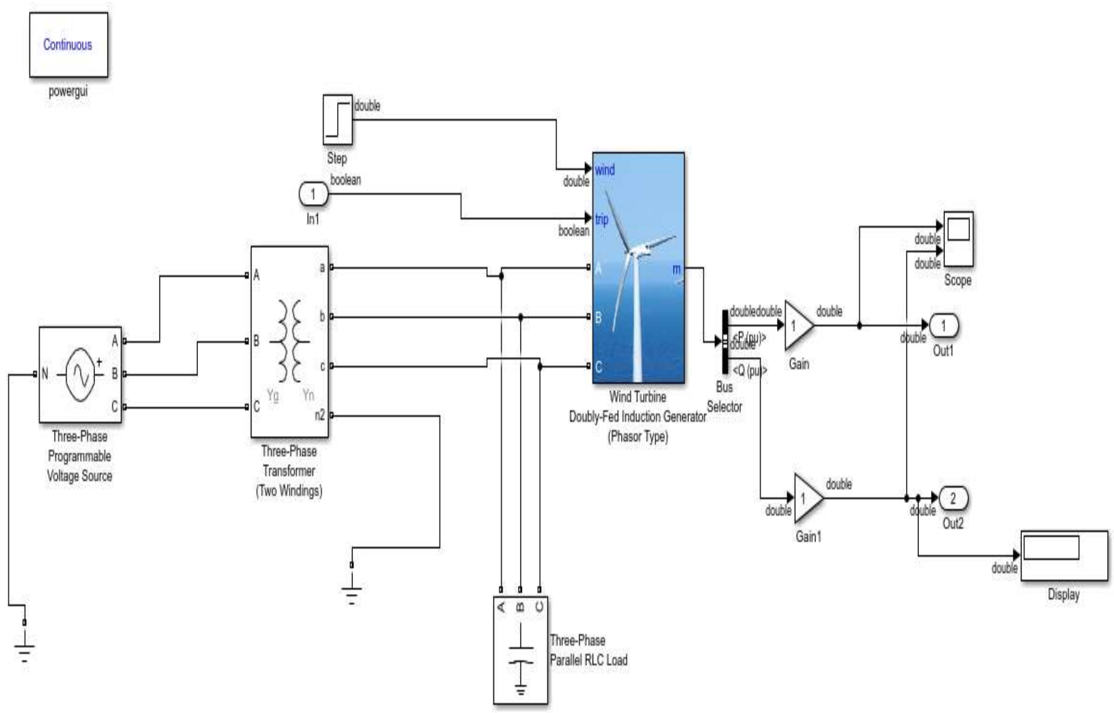

Fig 3.DFIG wind turbine output

Equation of the Rotor

The kinetic energy such as the wind going through the rotor as for the wind turbine is extracted.The development of Power by wind turbine was given by: P=1/2 CP 8 Vw4 A

Wind speed 12m/s &beta=5:

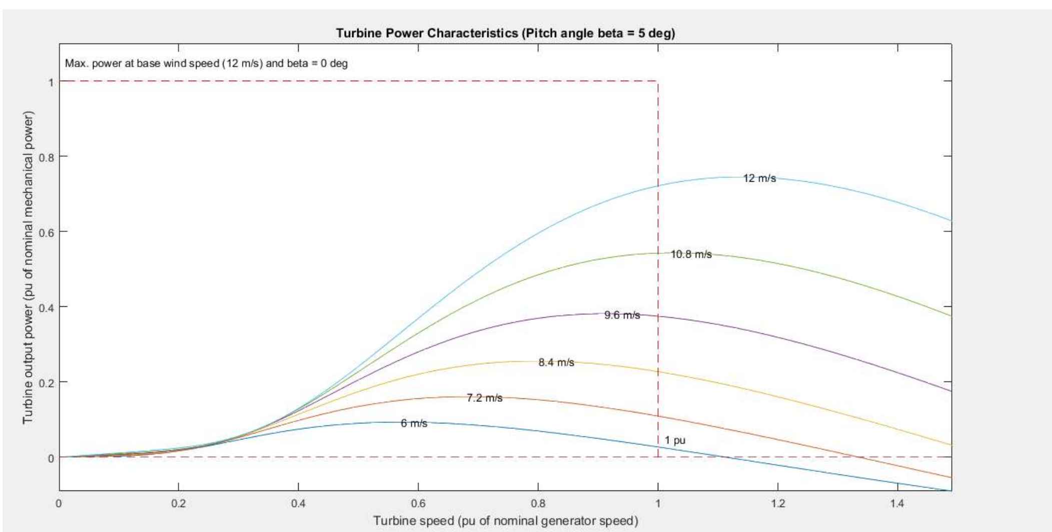

Fig 4. Turbine power characteristics.

4. AC/DC/AC CONVERTER

In modelling of DFIG, a commonly used approach is the simulation of converter based on projected controller response rather than real modelling of Power Electronics equipment. In actuality, the converters are considered to be perfect and the voltage of DC-link between them to be constant. As a consequence, based on the converter control, an adjustable source of voltage (current) can be provided in the model to replicate the converter rotor-side functioning. As illustrated in figure. 5, the kind and structure of a physical model is usually determined by analysing specific requirements such as steady-state, fault studies, and so on.

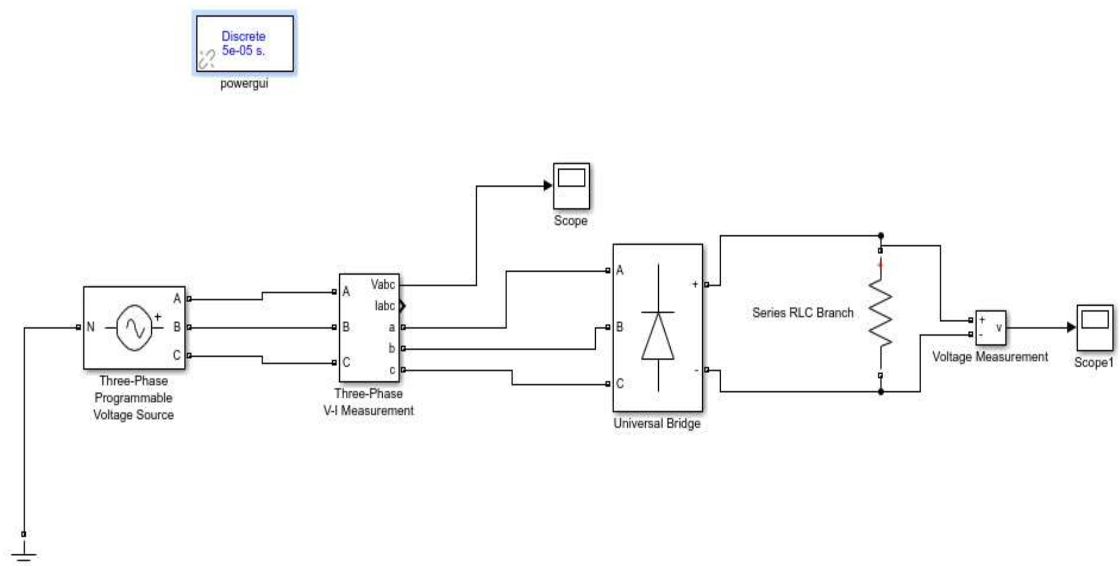

Fig 5.AC to DC rectifier.

5. SYSTEM FOR CONTROLLING CONVERTERS

The PWM back to back converter consists of 2 converters, one for the rotor and the other for the grid. Both converters' control has been described in this article. The grid-side actuator regulates the output power of the wind turbine as well as the recorded voltage at the terminals of the grid . Even follow a pre-determined characteristic of the power-speed, the power is adjusted known as tracking characteristic. For a air-gap flux is aligned for the rotor-side actuator on the spinning reference frame d-axis used for transformation of d-q. The total power losses (mechanical and electrical) are added to the actual electrical output power of the wind turbine measured at the grid terminals and compared to the reference power obtained from the tracking characteristic. To reduce the power error signal, a proportional-integral (PI) regulation is used. The reference rotor existing Iqr ref, which is pushed into the rotor by converter rotor, is the regulator's output. This current component is what generates the electromagnetic torque Tem. The reactive power generated as well as absorbed by the converter controls the voltage at grid terminals. Figure 6 depicts this.

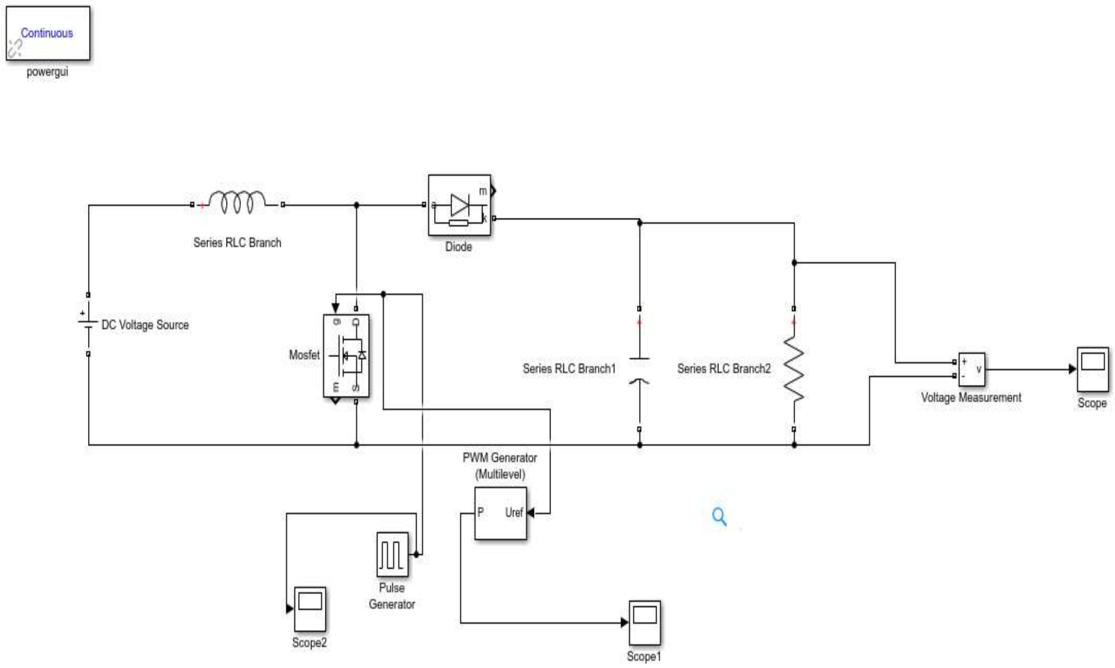

Fig 6.DC converter control system using PWM generator

6. CONVERTER CONTROLLING SYSTEM ON GRID

The grid side converter is often applied to alter the voltage such as the DC bus capacitor. As illustrated in figure 7, the revolving reference frame d-axis is applied for d-q transformation and is coordinated as per the sequential of positive voltage grid for controller grid-side.

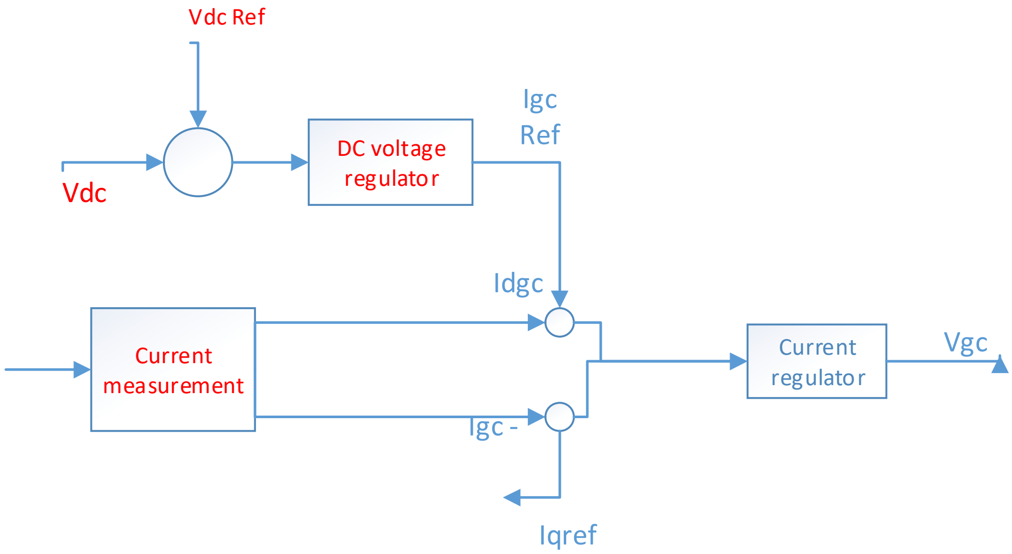

Fig 7. Grid control converter system.

7. Simulink diagrams

This is a Simulink schematic for a grid-connected DFIG with protection of wind turbine mechanisms for ground faults and single phase protection. The system is linked to a 110 KV three-phase voltage, as well as 8 MW wind farm (60.5 MW each), Pi-transmission line, step down transformers, and defect prevention. The figure of a wind-turbine is a phasor modelling that enables for extensive simulation times and transient stability testing. The system is observed for 50 seconds in this model. The figures are shown in the results

8. Results and Discussions

The wind turbine model system of DFIG is linked to the ac to dc rectifier an dc to dc converters with dc link provided system of converters is also named back to back converters. The ac to dc rectifier output is shown in figure 8. The output of dc ripples and rotor speed are shown in figure 9&10. And the output of ac grid wave form is shown in figure 11.

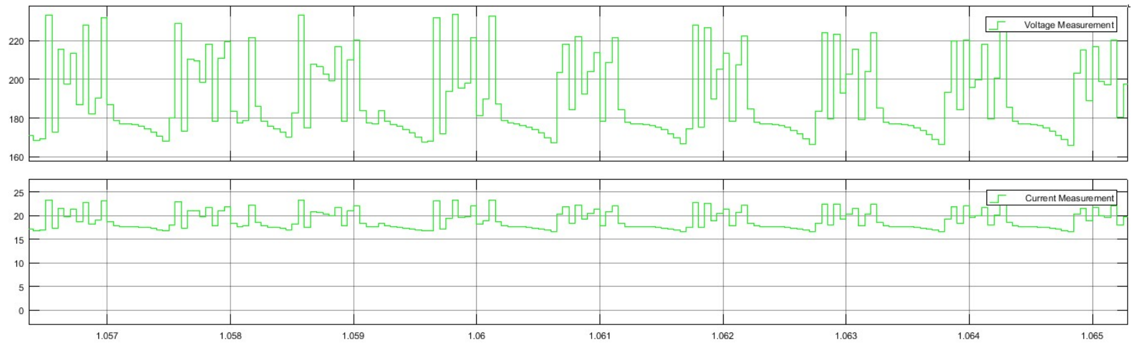

Fig 8.AC to DC rectifier output.

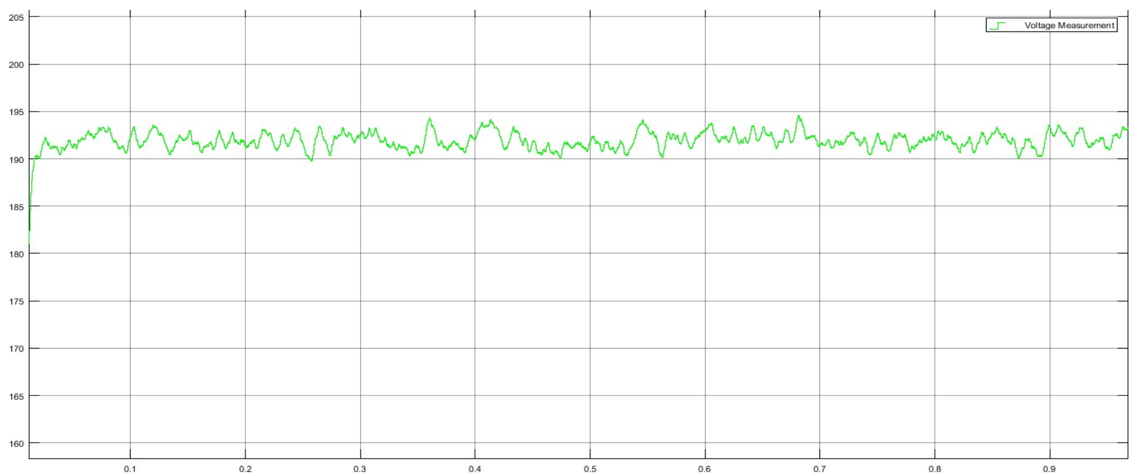

Fig 9. DC ripples output**.**

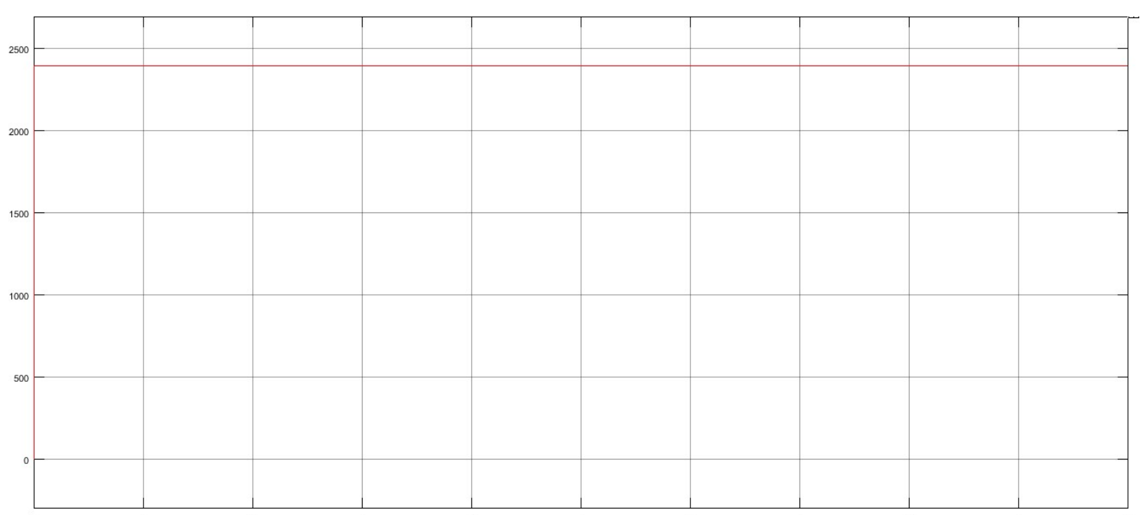

Fig 10. Rotor speed output

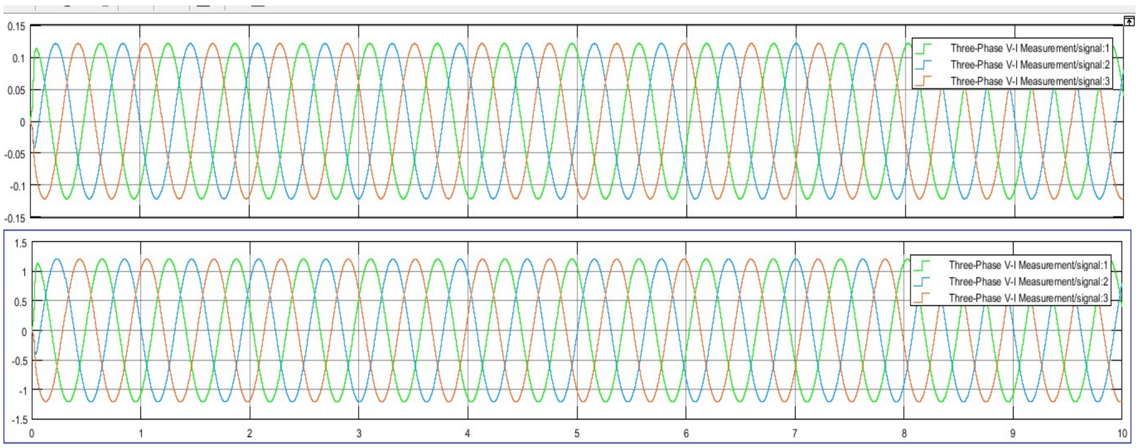

Fig 11. AC grid voltage and current output of wind

9. CONCLUSION

However, the DFIG system which is grid connected with greater control, is employed for maximum efficiency. The active and reactive power of the machine is controlled by the grid side converter (RSC), while the DC-link voltage is maintained by the grid side converter (GSC). Finally, we ran simulations of grid and wind turbine side phenomena and published the results. Faults may occur whenever the wind speed reduces to a minimal level or fluctuates often. During short circuit periods, the DFIG can make a significant contribution to grid voltage support. When connected to the grid and controlled properly, the DFIG proven to be a greaterstable and reliable technology.

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