MODEL WIND TURBINE USING WIND AS A RENEWABLE SOURCE OF ENERGY

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Abstract: This report discusses wind energy and its potential to be used in the future to meet current energy demand. A detailed description of wind turbines and wind generators focused on the connection of generators to the grid and the associated issues. The use of power electronics in circuits and their applications were also highlighted. Finally, voltage stability analysis was performed on different models of wind turbines to find the best way to troubleshoot and achieve optimal performance.

Index Terms - wind turbine, generator, converters, output

1. Introduction

A renewable energy source is an energy source that is not destroyed when the energy is used. Wind is the movement of air masses caused by the erratic heating of the earth's surface by the sun. As a result, these differences create forces that move air masses to equalize the temperature of the Earth, or, on a much smaller scale, between land and sea, or between mountains.Rising oil prices lead to overuse of sustainable energy sources. Among them, wind energy is attracting attention.Due to its high efficiency and low pollution, it is one of the most attractive developments in the area of sustainable energy supply. [1]. In any case, the energy produced by the Wind Power Conversion System (WECS) will change accordingly. Surprising variation in environmental weather and wind speed [2-3], WECS vitality generation, Labor costs for electrical installations considering store expansion and potential hazards The unwavering quality of the power supplies has been praised [4]. Power Glattice Admins need to anticipate change People in the Wind Control Age who program turns, guard perimeters, and supervise organizational tasks [4]. To decrease the holding limit and increase the wind Infiltration, an accurate measurement of wind speed is required [5]. In addition, wind strength prediction also plays an important role It's in the balance control part. Additionally, wind energy forecasts are used for routine programming. Commercialization of conventional power plants and commercial electricity [6]. Wind energy is one of the most attractive advances among sustainable energy sources due to its high efficiency and low pollution [1]. Be that as it may, the energy produced by a Wind Power Conversion System (WECS) varies with environmental weather and wind speed [2-3], and as storage devices are expanded, creating potential risks to the stable quality of power supply, unforeseen changes in WECS energy production can increase the operating costs of the electrical structure [4]. Grid managers must anticipate changes in wind control times to program tack storage limits and monitor planning tasks [4]. Accurate measurement of wind speed is required to reduce retention limits and increase wind intrusion [5]. In addition

2.CONSTRUCTION OF THE SYSTEM

A wind turbine is a rotating machine that converts the kinetic energy of the wind into mechanical energy. When mechanical energy is converted to electricity, it is called a wind generator, wind turbine, wind turbine generator (WPU), wind energy converter (WEC), or aeronautical generator. Wind turbines can be divided into two types he based on the axis of rotation of the turbine. Turbines rotating around a horizontal axis are more common. Vertical axis turbines are rarely used. In a horizontal axis wind turbine (HAWT), the main rotor shaft and generator are placed at the top of the tower and must face the wind. Most vehicles have a gearbox that converts the slow rotation of the rotor blades to a faster rotation suitable for driving a generator. Turbines are usually pointed downwind of towers because the towers behind them create turbulence. Turbine blades are stiffened to prevent them from being pushed into the tower in high winds. In addition, the rotor blades are positioned quite far from the front of the tower and partly tilted slightly upwards. Despite the turbulence problem, the windward machine was created because no additional mechanism is required to keep the machine in line with the wind, and in high winds the three rotor blades bend to reduce the swept area and therefore wind resistance. Most HAWTs are updraft machines, as periodic (that is, repetitive) turbulence can cause fatigue failure. Power control Wind turbines are designed to produce maximum power over a wide range of wind speeds. Wind turbines have three modes of operation.• Behavior when wind speed drops below nominal. • Operates at near nominal wind speed. • Behavior when nominal wind speed is exceeded. Power should be limited when the nominal wind speed is exceeded. There are various ways to achieve this. Stall works by increasing the angle at which the relative wind hits the rotor blades (angle of attack) and decreasing the induced drag (drag associated with lift). Stalling is simpler because it can be done passively (it increases automatically as wind speed increases), but normal drag increases due to the increased cross-sectional area of the blade facing the wind. Fully locked turbine blades have the flat side of the blade facing directly into the wind when stopped. A fixed speed HAWT inherently increases the angle of attack as the rotor blades speed up at higher wind speeds. Therefore, stalling the blades as the wind speed increases is a natural strategy. This technique was successfully used in many of his early HAWTs. However, it was observed that some of these blade sets tended to increase the audible noise level with the degree of blade pitch. Pitch control rolls work by reducing the angle of attack, reducing drag caused by rotor lift and reducing the cross-sectional area. A major problem in wind turbine design is that rapid acceleration caused by wind gusts can quickly stall or curl the blades. Fully wound turbine blades have the edge of the blade pointing upwind when at rest. Modern standard turbines tilt all blades in high winds. Pitch angle control is necessary because pitching must counteract the torque applied to the blade. Many turbines use 11 hydraulic systems. These systems are typically spring-loaded so that the rotor blades automatically rotate in the event of hydraulic failure. Other turbines use electric servo motors for each rotor blade. A small amount of battery is stored in case of power failure. minimized. However, since the wind direction varies quickly the turbine will not strictly follow the direction and will have a small yaw angle on average. The power output losses can simplified be approximated to fall with cos3 (yaw angle). Electrical braking Braking of a small wind turbine can also be done by dumping energy from the generator into a resistor bank, converting the kinetic energy of the turbine rotation into heat. This method is useful if the kinetic load on the generator is suddenly reduced or is too small to keep the turbine speed within its allowed limit. Cyclically braking causes the blades to slow down, which increases the stalling effect, reducing the efficiency of the blades. This way, the turbine's rotation can be kept at a safe speed in faster winds while maintaining (nominal) power output. This method is usually not applied on large grid-connected wind turbines. Mechanical braking A mechanical drum brake or disk brake is used to hold the turbine at rest for maintenance. Such brakes are usually applied only after blade furling and electromagnetic braking have reduced the 12 turbine speed, as the mechanical brakes would wear quickly if used to stop the turbine from full speed. There can also be a stick brake.

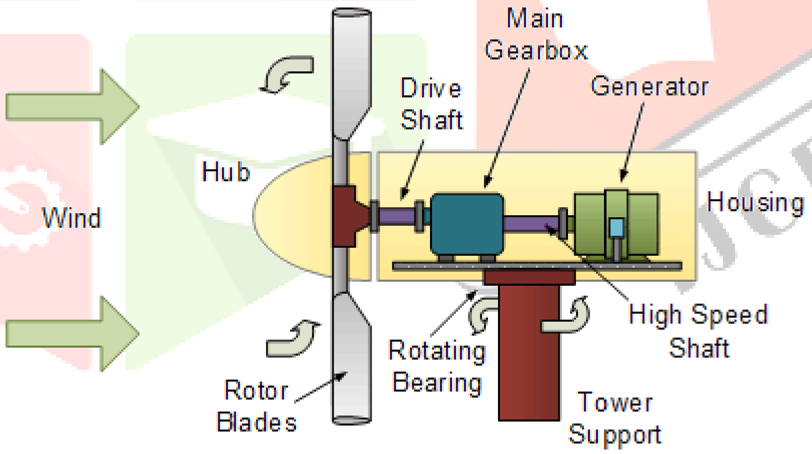


Fig.1 wind generator

GENERATOR

A generator is a device that converts mechanical energy into electrical energy. Wind generators are traditionally wind turbines. H. Propeller connected to generator. Connected to suitable electronics for connection to mains power. Generators can be broadly classified into two categories.a) Synchronous Generator b) Asynchronous Generator This classification is based on the operating speed of the generator. A synchronous generator runs at synchronous speed (1500 rpm for his 4-pole machine with a frequency of 50 Hz), while an asynchronous generator runs at a higher than synchronous speed. Synchronous Generator A synchronous generator is a doubly-fed machine that generates electricity based on the principle that the magnetic field around a conductor is varied, inducing a current in the conductor. A rotating magnet, usually called a rotor, rotates within a set of stationary conductors coiled around an iron core called a stator. While the rotor rotates due to mechanical input, the magnetic field crosses the conductor and produces an electric current.

WIND GENERATION SYSTEM DESCRIPTION USING PWM IGBT CONVERTERS

Voltage supply dual PWM converter wind energy system. Converter system Shows the voltage supply converter scheme used in this system. A vertical (or horizontal) wind turbine is connected to the shaft of a squirrel cage induction generator via a gear ratio 21 (not shown). The variable voltage, variable frequency current from the generator is rectified by a PWM IGBT (Insulated Gate Bipolar Transistor) rectifier. A rectifier also meets the excitation needs of the machine. The inverter topology is identical to the rectifier topology and feeds the generated electricity into the grid at 60 Hz. STATCOM A STATCOM (Static Synchronous Compensator) is a control device used in AC transmission networks. It is based on a power electronics voltage source converter, acting as a source or sink of AC reactive power in the power grid. It can also provide active AC power when connected to a power source. A STATCOM works by switching from a reactive load to a capacitive load to reconstruct the input voltage waveform. If disabled, it provides disabled AC power. If capacitive, it absorbs reactive power. This way it works as a source/sink

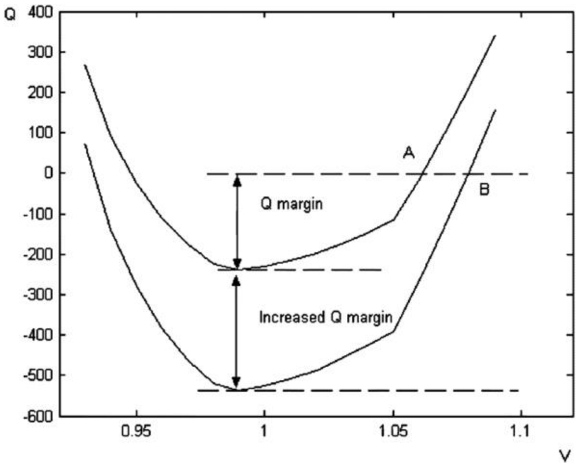
Requirements Wind Farm Connections to the Grid

If wind farms were set up solely to maximize energy harvest, they would have significant limitations in terms of:1. Power control and frequency response. 2. Power factor and voltage regulation 3. Transient fault response, voltage operating range These are the three main issues that new grid regulations for connecting wind farms will need to address. The most worrying problem facing wind farms is the voltage drop in the grid. Temporary fault effects can spread over a very large geographical area, and wind farm shutdowns in fault conditions can pose a significant threat to grid and supply security as large amounts of wind energy can be shut down simultaneously.Induction Generator Model The rotor of an induction generator is a wound rotor or squirrel cage rotor with squirrel cage windings that are not connected to an external voltage source. Figure 3 shows the steady-state equivalent circuit of an induction generator. fig 6.3 Steady-state equivalent circuit diagram of an induction generator 34 From the equivalent circuit diagram of an induction generator in Figure 3, the equations for active and reactive power are easily derived.

RESULTS AND DISCUSSION

P-V curve analysis of a wind farm with different generators. Wind farms based on different types of wind turbines are connected to the grid. When the active power output of the wind farm is low, the POI voltage is less affected, but when the wind force increases sharply, the voltage drops rapidly. Figure 7 shows the P-V curve of a wind farm as the active power output of the wind farm increases. 36 ' Figure 2,3,4 P-V curves of wind farms based on different wind turbine technologies. The steady-state voltage stability limit of induction generator-based wind farms with no-load compensation can be as low as 213 MW. Tensions will collapse when more than 213 MW of actual wind power is delivered to the POI. If a DFIG-based wind farm with constant power factor control controls the POI as a PQ bus with Q = 0 MW, the steady-state voltage stability limit increases significantly to 424 MW. If 350MW of real wind power is fed into the grid, the voltage stability margin is acceptable. Induction generator-based wind farms with full load compensation can increase the voltage stability limit, but it should be noted that it is not so obvious. Full load shunt capacitor compensation should not be fully deployed at low winds. Otherwise, the bus voltage will exceed the allowable voltage level as shown in curve (2). Practical operation of a wind farm with full load compensation requires the shunt capacitor to be turned on gradually as the active power output increases. Due to the shunt capacitor compensation, the voltage dip value for case (2) is 0.95 pu higher than 0.85 pu for case (1) or case (3). The reactive power loss in a shunt capacitor is proportional to V2 as the line voltage drops, so the capacitor can no longer deliver the rated reactive power. The reactive power capability of shunt capacitors is limited at low voltages and cannot radically improve the voltage stability of the local grid. 37 B. V-Q curve analysis of wind farms with different generators The V-Q curve is a powerful tool for analyzing the steady-state voltage stability limits and reactive power margins of the grid by describing the relationship between the bus voltage and the reactive power injected into the same node. Indicates the reactive power distance from the normal operating point to the voltage collapse point. In these studies, VWQ curves for different active power outputs of wind farms based on different types of wind turbines are shown in Figures 8 to 10. For an induction generator-based wind farm with no-load compensation, the reactive power margin is 13 MVar for a wind farm active power output of 200 MW. For a DFIG-based wind farm, if the wind farm has an active power output of 400 MW, the reactive power margin will be 12 MVar. DFIG-based wind turbines can provide reactive power to maintain a constant power factor across the wind farm and zero reactive power exchange within the POI, so the allowable actual injected wind power for case (3) is double that for case (1). This property of DFIG-based wind farms improves the voltage stability of local power grids that integrate wind energy. A key feature of large wind farms is the high demand for reactive power, which leads to grid voltage problems. The larger the wind farm, the more severe this effect can be. If the grid cannot cover the reactive power demand of the wind farm, the supply of wind energy to the grid should be restricted.

A.



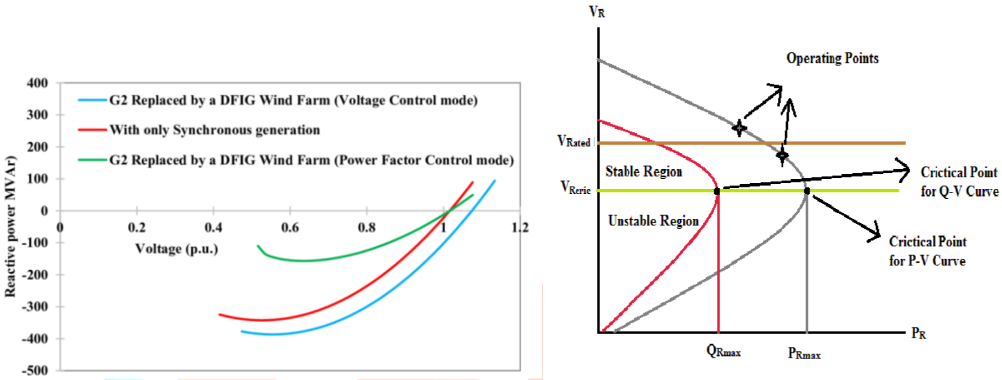


Fig 2.3.4 v.o characteristics

The following things can be concluded from the studies done above: a. Wind turbines equipped with simple induction generator are not provided with reactive power regulation capability. Voltage stability deterioration is mainly due to the large amount of reactive power absorbed by the wind turbine generators during the continuous operation and system contingencies. b. Wind turbines equipped with doubly fed induction generator (DFIG) controlled by the PWM converters are provided with reactive power regulation capability; can absorb or supply reactive power during normal operation. The adverse affect on local network voltage stability is mitigated so that more wind power installed capacity can be incorporated into the grid. c. The transient voltage stability characteristics of wind turbines with DFIG are better than wind turbines with induction generator because of the voltage control capability of the DFIG based wind turbines; The DFIG based wind turbines have a better voltage recovery performance than the IG based wind turbines with same rating.

CONCLUSIONS

The report explores the enormous potential of wind power, which, if harnessed appropriately, could help solve the global energy crisis. By studying wind turbines and their properties, we have learned how to properly design and use them for maximum performance. Power electronics circuits have greatly contributed to the concept of wind power generation. Without them, the concept would have been too expensive and unrealistic. The use of thyristors and converters not only simplifies operation, but also greatly improves efficiency. Voltage stability analysis shows that the doubly fed induction generator has better characteristics than the single induction generator. The report also highlighted the integration of wind farms into the grid and the associated problems, as well as possible solutions that can be applied to overcome these problems and achieve better performance.

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