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Stability Analysis and Fault Changes on Wind Turbine Effect in Multi Machine Power System

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Stability Analysis and Fault Changes on Wind Turbine Effect in Multi Machine Power System

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Abstract. This study presents stability analysis using a new approach to model the disturbances that occur in multi-machine systems connected with wind turbines. Consideration of stability and operability of conventional electric power systems planning and developing facing problems with the integration of installations in wind power plants (WPP) is needed because the current system is connected with renewable energy. This study highlighting the effects of WPP connected to a multi-engine 9 bus system from the effect of changes in disturbances occurring on several buses when operating. Disruption in multi-machine systems connected with wind turbines can affect system stability. The noise changes from bus to bus in the voltage drop effect on the system bus. The effect of wind turbine when a fault has a small moment of inertia can make the system unstable on the bus. The results of simulations carried out using ETAP to observe system stability have been carried out. The simulation results show that a system disruption that occurs in a multi engine system connected to the wind turbine does not result in a decrease in the bus near the fault then the stability decreases.

1. Introduction

Transmission models experience interference from various types from a balanced or unbalanced short circuit connected to generators and other equipment [1]. Disruption in multi machine systems is a problem of stability which leads to fluctuations in frequency stability and voltage on the power system connected to the wind turbine impact on multi machine systems [2]. However, when wind turbines emit power with insufficient capacity, when a fault occurs it can cause fluctuations in voltage and large frequencies. Many studies that discuss the interference with wind turbine connected systems are presented on the line [3, 4]. However, the problem is faced. Wind turbine technology that moves by wind speed is very dependent on natural conditions. In the supply and demand power system is demanded to always be balanced, because this affects the stability of the system. The wind turbine efficiency and DG impact on the load that has been studied by [5-7], and on [8] DG effect and placement are very influential on the system so it needs to be analyzed more deeply. In the power system there are two conditions, namely normal and abnormal. Normal conditions according to conditions within the prescribed limits. An abnormal state is when experiencing a change in load or interference. Disturbances in transmission can result in a decrease in voltage and frequency and oscillation in transient stability [9] In the study analyzing the disturbances that occur in several buses from 9 interconnected system buses in the wind turbine connected to a multi machine system. There is a disturbance point on some buses which results in changes in the condition of the bus system.

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2. Power System Model

The power system model used in this study is shown in Figure 1, interconnected on 9 buses. the system uses 3 generators each with a capacity of 8.5 MW, a voltage of 6.6 kV with a capacity of 10 MVA, cosphi 85%, a primary voltage step-up transformer 6.6 kV secondary voltage 20 kV 5 MVA capacity has been winded by wind turbines on the bus the type of aluminium is divided and distributed. The length of channel 1-2 is 1 km, while the conveyor 3-6 measures 0.5 km. There are 4 loads on buses 5.6 and 8 large capacity of 7 MVA. The wind turbine has been towed by a generator in the system. Wind turbine with a capacity of 20 MW and a grid frequency is 50 Hz. Two thermal power plants (SG1 and SG2), conventional power plants are hydropower (SG3), and one Turbine wind is on bus 5.

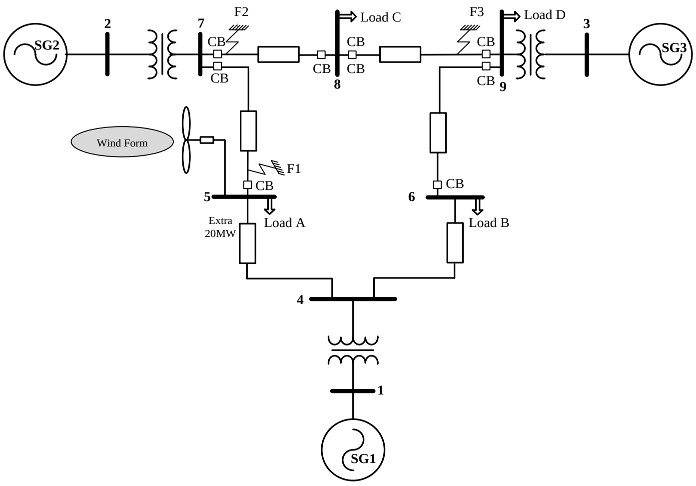

Figure 1. 9-bus test system with a wind farm [10]

3. Wind Turbine and Characteristic Model

The representation of the wind turbine model is shown in Figure 2 from ref [10]. On fig 3, shows from the MPPT Output without measuring wind speed, where it is noted that the maximum power captured can be expressed as a rotation speed cube (Pmppt= ω r3) [11] Characteristic model of wind turbine and MPPT of difference wind speed.

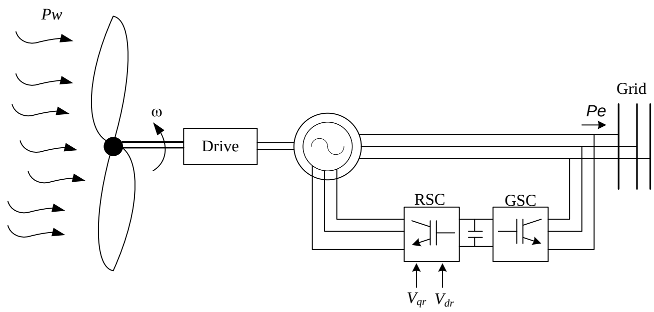

Figure 2. Wind turbine

Wind turbine output is obtained from wind speed. Significantly, the variation of wind turbine speed from the situation and conditions according to natural conditions (local area). Fluctuations in varying wind speeds affect the output of wind turbines.

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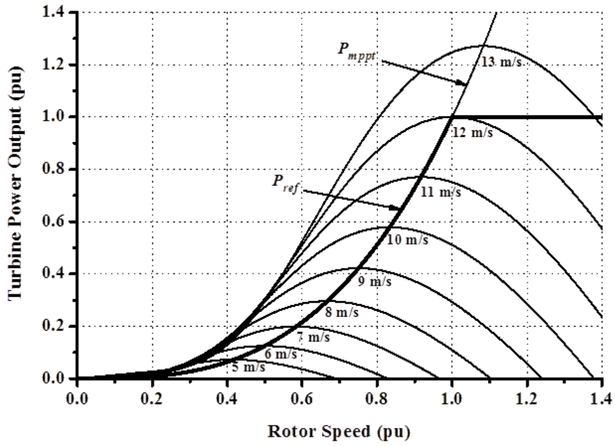

Figure 3. Characteristics of wind turbine and MPPT Curve

4. Simulation Results

In this section, shows the results of the simulation system of 9 buses connected with wind turbine and disturbances occur on buses 3, 4, and 7. Comparative analysis on the system is carried out in two scenarios. The first scenario of interference is done before the wind turbine is pulled. The scenario of both wind turbines is lost. Then an analysis of the stability and stress is carried out on each bus. In this system the voltage is 6.6 kV, the base capacity is 10MVA. 85% Cosphy. The basic capacity of bus bars 1,2 and 3 has a voltage of 6.6 kV. At 4–9 bus bar has a voltage of 20 kV. The primary voltage step up transformer is 6.6 kV. Secondary voltage is 20 kV, with a capacity of 10 MVA. Delivery of long conveyor 1, 2 aluminum is 1 km. while deliveries 3-6 have a length of 0.5 km. there are 4 loads divided on buses 5.6, 8 and 9, the size of each bus is 7 MVA. 20 MW wind turbine capacity. This is done to determine the stability and change in disturbed voltage in the system connected with wind turbine. This analysis uses ETAP, using the data in Table 1. The simulation has been performed on the personal computer Intel (R) core (TM) i5-3337U CPU @ 1.80 GHz installed memory (RAM) 4.00 GB. System type 64-bit.

4.1. Scenario #1. Before the Wind Turbine Enters

In Figure 4 shows the system before entering the wind turbine in scenario # 1 by presenting a 9 bus system, three generators on buses 1, 2 and 3, loads on buses 5, 6, 8 and 9. Short circuit on bus 3 is a bus generator so that changes in load flow have an impact on generators 1 and 2. Voltage surges in the bus type in Table 1.

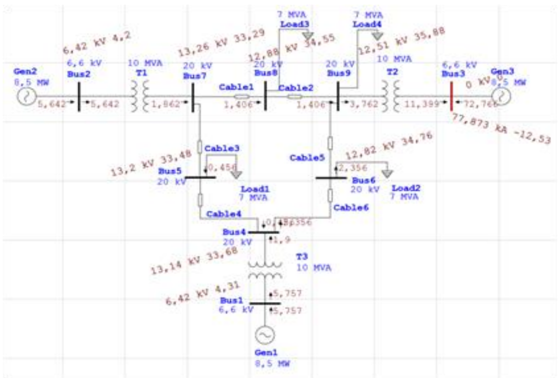

Figure 4. Fault in bus 3

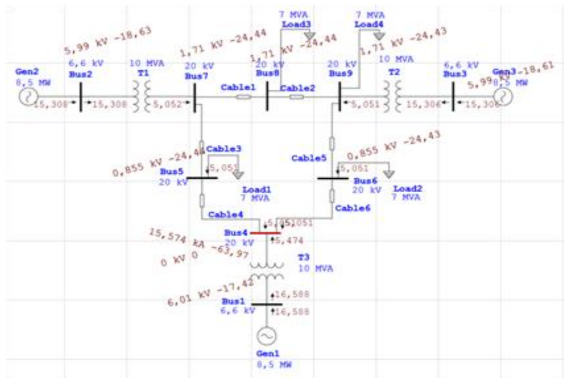

Figure 5. Fault in bus 4

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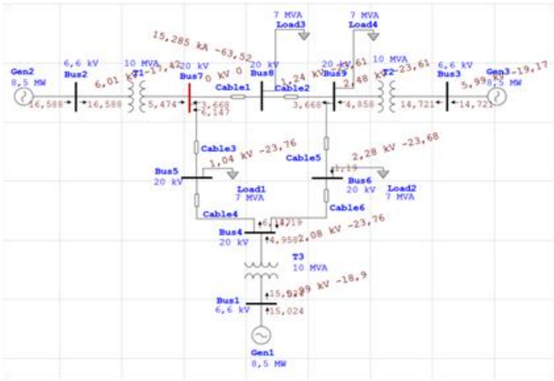

Figure 6. Fault in bus 7

Table 1. Table voltage on each bus when the fault is before the wind goes in

No. Bus	Bus voltage	kV, bus fault 3	kV, bus fault 4	kV, bus fault 7
1	6.6 kV	6.42 kV	6.01 kV	5.99 kV
2	6.6 kV	6.42 kV	5,99 kV	6.01 kV
3	6.6 kV	0 KA	5.99 kV	5.99 kV
4	20 kV	13.44 kV	0 kV	2.08 kV
5	20 kV	13.2 kV	0,855 kV	1.04 kV
6	20 kV	12.82 kV	0.855 kV	2.28 kV
7	20 kV	13.26 kV	1,71 kV	0 kV
8	20 kV	12.88 kV	1.71 kV	1.24 kV
9	20 kV	12.51 kV	1,71 kV	2.48 kV

4.2. Scenario #2. Wind Turbine Enters

The accuracy of the system model in this section has been validated using the system before the wind turbine enters the system. in the following figure shows the system model considered in this analysis. A wind turbine with a data capacity of 30 MW has been connected to the grid system in transformers and transmission tracks.

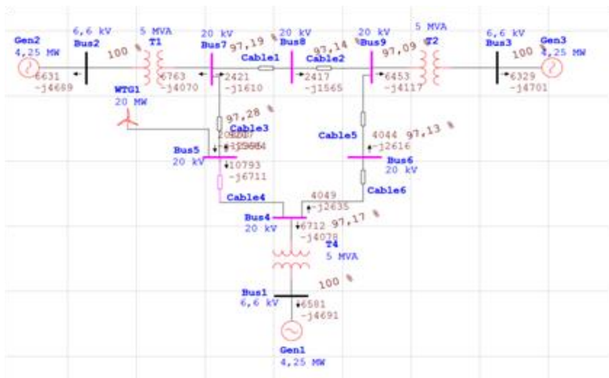

Figure 7. Fault in bus 3

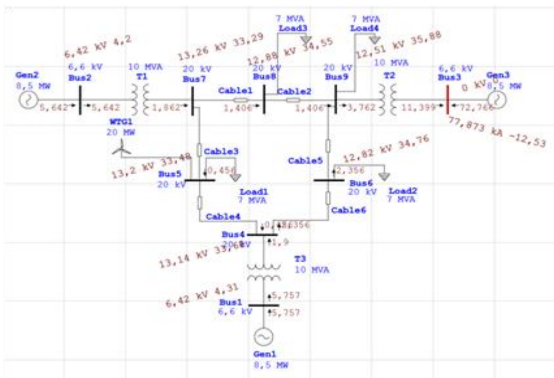

Figure 8. Fault in bus 3

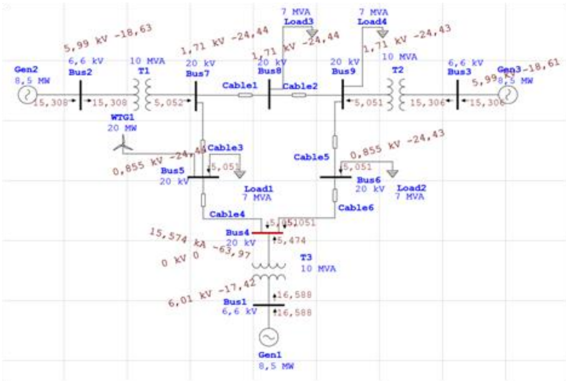

Figure 9. Fault in bus 4 with wind

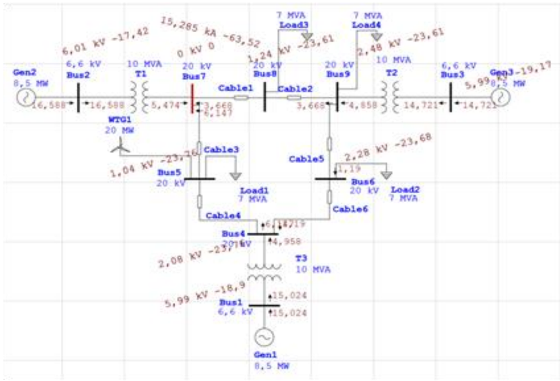

Figure 10. HS bus 7 with wind turbine

Table 2. Results The voltage table on each bus is faulted after wind is entered

No. Bus	Bus voltage	kV, bus fault 3	kV, bus fault 4	kV, bus fault 7
1	6.6 kV	6.42 kV	6.01 kV	5.99 kV
2	6.6 kV	6.42 kV	5,99 kV	6.01 kV
3	6.6 kV	0 KA	5.99 kV	5.99 kV
4	20 kV	13.14 kV	0 kV	2.08 kV
5	20 kV	13.2 kV	0,855 kV	1.04 kV
6	20 kV	12.82 kV	0.855 kV	2.28 kV
7	20 kV	13.26 kV	1,71 kV	0 kV
8	20 kV	12.88 kV	1.71 kV	1.24 kV
9	20 kV	12.51 kV	1,71 kV	2.48 kV

5. Conclusion

Effect of the wind turbine applied to the 9 bus system has been used measured using SVSI. The stability analysis is carried out on the simulation which has been carried out with the scheme occurring interference from several buses. System interruptions do not interfere with the stability of the interconnected system. the simulation results show that the response when the connection occurs occurs on bus 3 with a short circuit voltage of 5.99 kV, and bus 8 1.24 kV.

References

[1] Abhyankar, S. and Tushar. *Modeling of transmission line faults for transient stability analysis*. in *2017 North American Power Symposium (NAPS)*. 2017.

[2] Siswanto, A., et al., *Stability improvement of wind turbine penetrated using power system stabilizer (PSS) on South Sulawesi transmission system.* AIP Conference Proceedings, 2018. 1941(1): p. 020036.

[3] Tajdinian, M., A.R. Seifi, and M. Allahbakhshi, *Transient Stability of Power Grids Comprising Wind Turbines: New Formulation, Implementation, and Application in Real-Time Assessment.* IEEE Systems Journal, 2018: p. 1-12.

[4] Wang, L., et al., *Dual-Enhanced Sparse Decomposition for Wind Turbine Gearbox Fault Diagnosis.* IEEE Transactions on Instrumentation and Measurement, 2018: p. 1-12.

[5] Sainz, L., et al., *Effect of wind turbine converter control on wind power plant harmonic response and resonances.* IET Electric Power Applications, 2017. 11(2): p. 157-168.

[6] Yuli Asmi Rahman, A.S., and irwan Mahmudi, *Stability Issues in Presence Variable Distributed Generation Into Radial Distribution Network* International Conference on Industrial Electrical and Electronics (ICIEE) 2018.
[7] Yuli Asmi Rahman, e.a., *Distributed Generation's Integration Planning Involving Growht Load Model By Means of Genetic Algorithm.* Archivesof electrical Engineering 2018. 67 I(3): p. 667-682.
[8] Rahman, Y.A., et al., *Evaluating the effect placement capacitor and distributed photovoltaic generation for power system losses minimization in radial distribution system.* AIP Conference Proceedings, 2018. 1941(1): p. 020027.
[9] Gunadin, I.C., Z. Muslimin, and A. Siswanto. *Transient stability improvement using allocation power generation methods based on moment inertia*. in *2017 International Conference on Electrical Engineering and Informatics (ICELTICs)*. 2017.
[10] Bevrani, H., *Robust Power System Frequency Control.* Springer Cham Heidelberg New York Dordrecht London, 2014. Second Edition.
[11] Rosyadi, M., et al. *Fuzzy-PI controller design for PM wind generator to improve Fault Ride Through of wind farm*. in *2012 International Conference on Renewable Energy Research and Applications (ICRERA)*. 2012.