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Submission date: 19-Apr-2022 07:27PM (UTC-0700)

Submission ID: 1815056178

File name: Mustadir_Darusman_2018_J._Phys._Conf._Ser._1090_012034_2.pdf (1.19M)

Word count: 5201

Character count: 24749

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To cite this article: B Mustadir Darusman *et al* 2018 *J. Phys.: Conf. Ser.* **1090** 012034

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Small Signal Stability Analysis of Wind Turbine Penetration in Sulsebarbar Interconnection System

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Abstract. This paper present and explain the analysis of power flow and small-signal stability of the electrical system in the islands of South Sulawesi, East and West (Sulsebarbar) located in Indonesia. The research focused on the Eigen values analysis that used to investigate small-signal stability performance of the main electricity grid when the fault conditions with and without control equipment as well as the inclusion of wind turbines large scale on the system. Power Systems Analysis Toolbox (PSAT), which integrated in MATLAB is used to develop a network topology in Sulsebarbar. This study allowed us to determine the optimal location of the placement of Power System Stabilizer (PSS) to dampen the oscillation. The simulation result shows the placement of PSS on two generators can add system stability and help the system to resume operation at the balance point. Time domain simulation methods are used to see the frequency response of the rotor speed.

7 Introduction

The grow¹⁴ of electricity consumers lead to increase problems in the stability of the power system and become an important issue in the planning of electric power systems [1-4]. During the system under normal¹⁴ conditions, the balance between the needs of active⁴ and reactive power supply can be assured. The stability of the system will has a significant effect when all the isolated electricity networks interconnected as planned in the development of electricity networks [1-5].

Because of its³ large and complex system [6], the low frequency oscillation phenomenon needs more attention to the potential oscillation power problems that have a direct impact on the stability of the system [5-9]. The stability of the power system components which is related to the system in providing balance and improving the state during disturbances [7], one of the effects of these disorders is the electromechanical oscillation.

The electromechanical oscillation consists of two mode which are the local oscillation mode and inter-area oscillati⁹ mode [8]. This study focuses on the phenomenon of small-signal in the electrical network systems²² South Sulawesi, East and West (Sulsebarbar), one of the islands in eastern Indonesia. With small signal stability analysis, the performance of the pow²⁰ system in a minor disturbances state can be evaluated [10]. Small Signal Stability can be defined the system's ability to stay in synchronization when subjected to small perturbations [11]. The small disturbances phenomenon has frequency range between 0 to 2 Hz [5]. Whereas the local oscillation mode has



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typical frequency range of 1-2 Hz and the inter-area oscillation mode has a range of frequencies below 1 Hz [8].

Power System Analysis Toolbox (PSAT) software is used to analysis study of power system [12]. This toolbox capable of perform power flow studies [13], the stability of the small-signal and time domain simulation to see the response and rotor angular velocity. To provide damping during the placement of Power System Stabilizer (PSS) isolation is connected to the Automatic Voltage Regulator (AVR) become priority [7]. PSS placement is based on eigenvalue damping which obtained when simulation is done.

2. Research Methodology

These case studies are used as a test case to the electric grid interconnection system Sulsebar. Furthermore, the electrical system topology Sulsebar modeled and modified using a Power Systems Analysis Toolbox (PSAT), which has been integrated in Matlab Simulink®. This toolbox is open source software used to analyze and study the power system [14]. The toolbox can run the power flow, continuation power flow, optimal power flow, small-signal stability analysis and time domain simulation. All operations can be assessed by means of Graphical User Interfaces (GUI) and simulink which provides a variety of tools for network design.

2.1. Power System Modeling

All dynamic models of the system are available and have been documented in the manual PSAT. Include synchronous generator model, turbine governor and Automatic Voltage Regulator (AVR) model. Simple version of the synchronous generator contained in PSAT model s_{27} m, where the dynamic parameter of each of the synchronous generator as the input to d-axis and q-axis. Dynamic parameters are shown in Table 1 All mechanical damping and disregarded of the effect on the overall constellation generator. AVR models used is the model 3 and used for all generators but with different parameters. At the PSAT, Turbine Governor represent in two types of models, namely: models 1 and 3. Where the thermal power plant in the state and represented the first model (1) and the hydro plant model expressed and represented the third model (3). However, in this study, Model 3 [15] is used. In this model, some properties of the system regarded as inelastic penstock where the inertia of the water to be considered, and also the ideal turbine. For simplicity of analysis [18-21], static load models are also used [1]. As for wind turbine used doubly fed induction generator (DFIG).

2.2. Modeling of the Sulsebar Power Grid

Indonesia is an archipelagic country that has a complex electrical system between the island and other islands. Sulawesi islands comprising South Sulawesi, East and West (Sulsebar) used for this research study. Interconnection system Sulsebar strut by several generating units where the supply of Gas Power Generation and Sengkang Steam Power, Bakar and Poso Hydro, Jeneponto and Tello Steam is supply to the largest generation system interconnect Sulsebar [16]. Sulsebar interconnection system consists of 15 generators, 44 bus 47 lines and 34 load spread, whereas the voltage varies from 30, 70, 150 to 275 kV [17-20].

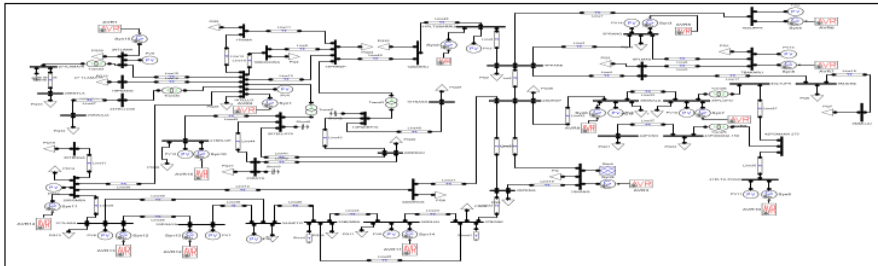


Figure 1. The Sulsebar Interconnection Power Grid Model Use PSAT

3. Case Study

The case studies in this research is to analyze the small signal before and after the inclusion of wind turbine large scale on Jeneponto bus at Sulsebarbar interconnection system as shown in Figure 1 Dynamic parameters and excitation of each generator is shown in Table 1 and Table 2 to see the response of the system using power flow studies, eigenvalue and time domain simulation. The first simulation model of the system under normal conditions, whereas system must demonstrate its stability. It is important before doing the next phase simulation.

After condition is stable by eigenvalue analysis, the second stage simulation is by giving disturbance to the system in the form of termination of the channel on bus of Parepare and bus of Barru. The first intervention given time is 1 second and the second intervening time is 200 second.

Table 1. Dynamic Parameter Sulsebarbar

No	Pembangkit	X'_d (pu)	X''_d (pu)	X'''_d (pu)	X'_q (pu)	X''_q (pu)	X'''_q (pu)	ra	xl
1	PLTA Bakaru	0,924	0,268	0,27	0,553	0,276	0,27	0	0,12
2	PLTA Teppo (Pinrang)	2,08	0,385	0,261	1,12	0,274	0,261	0	0,186
3	PLTD Suppa	2,08	0,385	0,261	1,12	0,267	0,261	0	0,186
4	PLTU Barru	2,363	0,199	0,204	2,182	0,395	0,204	0	0,107
5	PLTU Tello	1,182	0,0995	0,102	1,091	0,1975	0,102	0	0,107
6	PLTD Agrekko (Tello Lama)	2,363	0,199	0,204	2,182	0,395	0,204	0	0,107
7	PLTD Sgmnsa	2,08	0,385	0,261	1,12	0,337	0,261	0	0,186
8	PLTU Arena (Jeneponto)	2,08	0,385	0,261	1,12	0,485	0,261	0	0,186
9	PLTA Tangka manipi sinjai	1,924	0,268	0,27	1,553	0,256	0,27	0	0,12
10	PLTGU Sengkang	2,31	0,2	0,12	0,553	0,6	0,12	0	0,6
11	PLTD Malea (Torja)	2,08	0,385	0,261	1,12	0,337	0,261	0	0,186
12	PLTD Palopo	2,08	0,385	0,261	1,12	0,337	0,261	0	0,186
13	PLTA Bili-Bili	2,08	0,385	0,261	1,12	0,330	0,261	0	0,186
14	PLTA Poso	0,924	0,268	0,27	0,553	0,368	0,27	0	0,12
15	PLTD Tallasa	2,08	0,385	0,261	1,12	0,485	0,261	0	0,186

*Data source = PT PLN Persero. AP2B Sulsebarbar

Table 2. Data Excitation Sulsebarbar

No	Generator	KA (p.u)	TA	VAm _{max}	VAm _{in}
1	PLTA Bakaru	400	0,04	0,71	-0,71
2	PLTA Teppo (Pinrang)	1	0,02	1	-1
3	PLTD Tallasa	1	0,02	1	-1
4	PLTD Suppa	1	0,02	1	-1
5	PLTU Barru	1	0,02	1	-1
6	PLTU Tello	100	0,04	1	-1
7	PLTD Agrekko (T. Lama)	100	0,04	1	-1
8	PLTD Sgmnsa	10	0,02	18,3	-18,3
9	PLTU Arena (Jeneponto)	10	0,02	18,3	-18,3
10	PLTA POSO	400	0,04	0,71	-0,71
11	PLTA Tmatipi (sinjai)	4	0,02	5,99	-5,99
12	PLTGU Sengkang	300	0,04	1	-1
13	PLTD Malea (Toraja)	10	0,02	18,3	-18,3
14	PLTD Palopo	4	0,02	5,99	-5,99
15	PLTA Bili-Bili	4	0,02	5,99	-5,99

*Data source = PT PLN Persero. AP2B Sulsebrabar

The third simulation is the modeling system with the addition of PSS control the event of termination of channel. The simulation further analyzes the system when the inclusion of wind turbines on a jenepono bus with and without PSS control equipment.

PSS placement will be based on the critical eigenvalue or close to zero. There are 44 buses, 47 lines, 6 transformers, 15 generators and 34 loads will become the object of this research.

This study will use conventional thermal generators units, where for Turbine Governor (TG) used Model 1, while Hydroelectric unit used Model 3 TG and used to the whole system. As for wind turbine used model doubly fed induction generator (DFIG) with Nominal wind speed 15.00 (m/s).

4. Results and Discussions

In this paper, comparison between the system between with and without using the control damper and damper control is done. The simulation results were observed the deviation rotor angle (δ) or rotor angular velocity (ω) of each generating unit. Then, small signal stability analysis is used with the system. Figure 2 shows the PSAT Sulsebrabar eigenvalue models under normal conditions, dynamics condition without PSS and dynamics condition using the PSS.

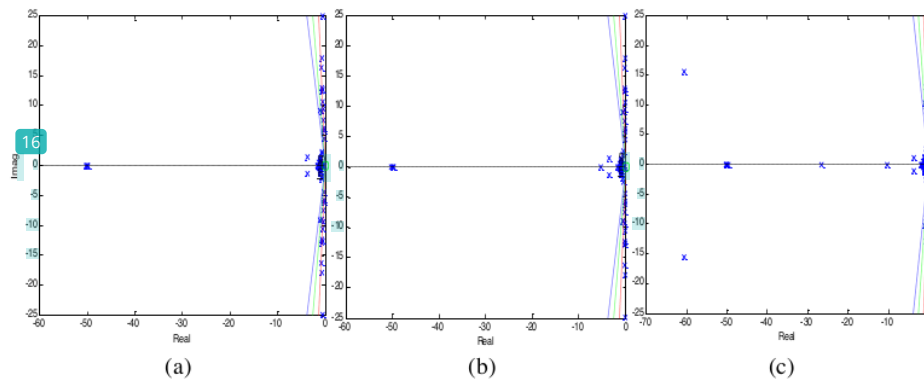


Figure 2. Eigenvalue use PSAT. (a) Normal conditions, (b) In the dynamical circumstances, (c) In the dynamical circumstances using PSS

Figure 2a shows the normal conditions on the electricity network of Sulsebrabar interconnection system. In this condition has not been given any input in the form of interference or load shedding. Figure 2b shows the dynamics system after being given the disruption of the termination of the transmission line between the buses 4 and 11 (bus Barru and Bus Parepare). As for Figure 2c shows the shift of eigenvalue after the addition of control given in the form of PSS. The placement of PSS is randomly based on critical or near-critical value of eigenvalue. From the results of the experiment placement of the maximum PSS is on the two generators in reducing oscillations of the system.

4.1. System Simulation before Entrance wind turbine.

For analysis purposes, the participation factor used to determine the bus and generator weakly damped and most affected by instability. From the analysis found that the generator 2, 6, 7, 12 and 13 represents the weakest bus with eigenvalue levels approaching critical value. There are 111 state and 31 pairs resulting complex to be initialized and observed.

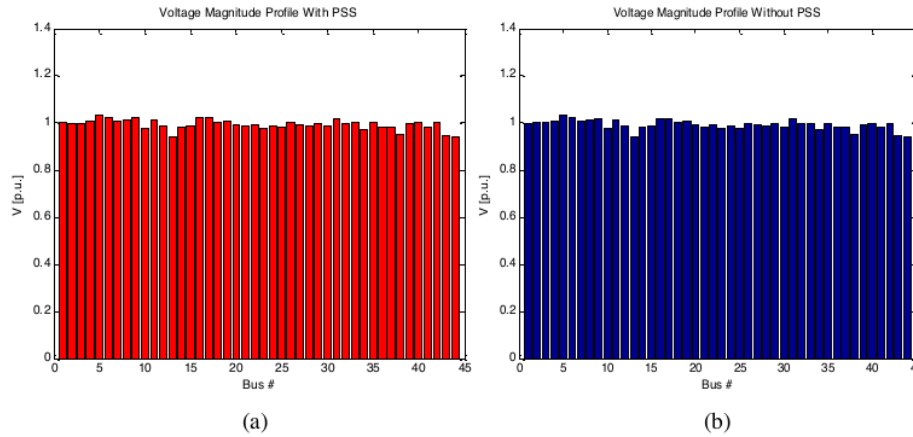


Figure 3. Voltage magnitude Profile. (a) Without installation of PSS, (b) With PSS installation

Figure 3a and Figure 3b shows the voltage profile of the whole bus is still in the voltage allowed range by the Energy Regulatory Commission from 0.95 to 1.05 p.u. Where in Figure 3a represents the voltage profile using with PSS and Figure 3b represent the voltage profile picture without the PSS.

Table 3. Improvement of Voltage Magnitude Before and After using PSS

Bus	Without PSS	With PSS	Voltage Improvement	Bus	Without PSS	With PSS	Voltage Improvement
10SUPPA	0.99802	0.99909	0.00106	30TBNGA	0.97440	0.97594	0.00154
11PLTUBARRU	0.99933	0.99560	-0.00373	31TLASA	0.98780	0.98989	0.00210
12BARRU	1.00003	0.99719	-0.00284	32MAROS	0.97647	0.97960	0.00313
13PNKEP	1.00813	1.00780	-0.00034	33PGA YA	0.99737	0.99946	0.00208
14PNKEP 70	1.03413	1.03436	0.00022	34JNPTO	0.99146	0.99356	0.00210
15TNASA	1.02598	1.02620	0.00022	35BK MBA	0.98821	0.98992	0.00172
16BOSOWA	1.00761	1.00749	-0.00012	36SNUAI	0.99488	0.99618	0.00130
17KIMA	1.01405	1.01429	0.00024	37BONE	0.98516	0.98711	0.00195
18TELLO	1.02315	1.02396	0.00081	38MKALE	1.01720	1.01803	0.00083
19PKANG	0.97703	0.97780	0.00077	39PLOPO	0.99821	0.99879	0.00057
1SKANG	1.01259	1.01505	0.00246	3SPENG	0.99685	0.99916	0.00231
20TELLO70	0.98763	0.98853	0.00090	40LTUPA	0.97298	0.97386	0.00088
21BRLOE	0.93965	0.94066	0.00101	41PLT A POSO	0.99821	0.99885	0.00064
22MNDAI	0.98359	0.98443	0.00083	42POMANA 275	0.98274	0.98345	0.00071
23DAYA	0.98687	0.98775	0.00087	43POMANA 150	0.98040	0.98110	0.00071
24TELLO30	1.02316	1.02397	0.00081	44POSO	0.95173	0.95241	0.00069
25BWAJA	1.02316	1.02397	0.00081	4PPARE	0.99417	0.99537	0.00121
26TLAMA	1.00021	1.00124	0.00103	5PRANG	0.99835	0.99924	0.00089
27TLAMA70	1.00981	1.01085	0.00104	6PLMAS	0.98156	0.98237	0.00081
28BNTLA	0.99311	0.99413	0.00102	7BAKARU	0.99872	0.99928	0.00056
29SCMSA	0.98608	0.98764	0.00156	8MJENE	0.94631	0.95709	0.01078
2SDRAP	0.99239	0.99469	0.00230	9MMUJU	0.94802	0.95880	0.01077

For improvement of voltage magnitude as seen in Table 3, there is a change before and after the installation of PSS. Where there improvement for each bus voltage. For example at a bus 10 (Suppa bus), an improvement of voltage from 0.99802 p.u becoming 0.99909 p.u or voltage changes 0.00106 p.u after the addition of PSS.

Table 4. Linear Value Analysis of The System Without PSS

Before Application of PSS						
Eig.#	Most associated states	Real part	Imaginary part	Frequency	Damping ratio	Mode oscillations
Eig As # 58	omega_Syn_2, delta_Syn_2	-0,0262	4,4241	0,7041	-0,0059	Inter Area
Eig As # 53	omega_Syn_6, delta_Syn_6	-0,0615	6,0832	0,9682	-0,0101	Inter Area
Eig As # 16	omega_Syn_7, delta_Syn_7	-0,0016	24,9226	3,9665	-0,00006	Lokal
Eig As # 41	delta_Syn_12, omega_Syn_12	-0,0084	12,6267	2,0096	-0,00067	Lokal
Eig As # 43	delta_Syn_13, omega_Syn_13	-0,0394	10,7185	1,7059	-0,0037	Lokal

Table 5. Linear Value Analysis of The System With PSS

After Application of PSS						
Eig.#	Most associated states	Real part	Imaginary part	Frequency	Damping ratio	Mode oscillations
Eig As # 60	delta_Syn_2, omega_Syn_2	-0,0269	4,4226	0,7039	-0,0061	Inter Area
Eig As # 56	delta_Syn_6, omega_Syn_6	-0,0767	6,1139	0,9731	-0,0125	Inter Area
Eig As # 18	omega_Syn_7, delta_Syn_7	-0,0017	24,9237	3,9667	-0,00007	Lokal
Eig As # 43	omega_Syn_12, delta_Syn_12	-0,0089	12,6211	2,0087	-0,00070	Lokal
Eig As # 48	omega_Syn_13, delta_Syn_13	-0,0586	10,7180	1,7058	-0,0055	Lokal

Table 4 and Table 5 shows participation factor of eigenvalue before and after the addition of PSS. From Table. 4. it can be seen that the value of damping ratio increased for the fifth generator. For the second generator damping ratio increased from -0.0059 to -0.0061. Also with the next generator the damping ratios will increase or will improve the eigenvalue. With the correct input parameters of the PSS, the real and imaginary parts of eigenvalue 59-60 improved from $-0.0262 \pm j4.4241$ become $-0.0269 \pm j4.4226$.

The next thing to observe is the rate speed of the rotor to return to a stability position after interference. From the simulation results using time domain on the PSAT, shows good damping occurs after the addition of PSS. Whereas the rotors speed dampen oscillations and back at the point of equilibrium faster than before using a PSS. This suggests that the placement of PSS and PSS proper tuning values can restore the stability of the system and reduce oscillation well in old or new balance point. Here is a graph of rotor speed (ω) on generators 2, 6, 7, 12 and 13 which are the weakest generators of the simulation results prior to the entry of wind turbines. The black graph is without the PSS and blue graph is using the PSS.

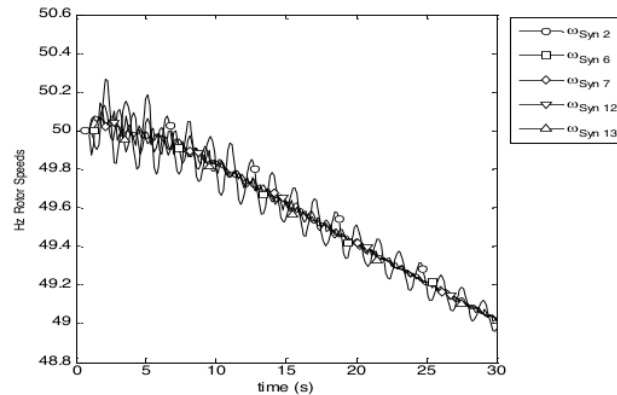


Figure 4. The Rotor Speed of The Generator (ω) during load release between Bus 4 and 11 without using PSS.

From the simulation results above indicate the difference graph generator rotor speed on the state of good dynamics with and without PSS control equipment. Figure 4 shows the rotor speed response to damp the oscillation and return to the equilibrium point more slowly in the appeal using PSS. For example, it can be seen in generator two, in which the rotor speed when its dynamic insulated and downhill. Isolation and degradation the speed at the start of the first second until the seconds to 30 and continued to decline to below the rate of 49.3 Hz. Free time to survive in the value of 49.8 Hz and 49.9 Hz climb back up to speed eventually decreasing.

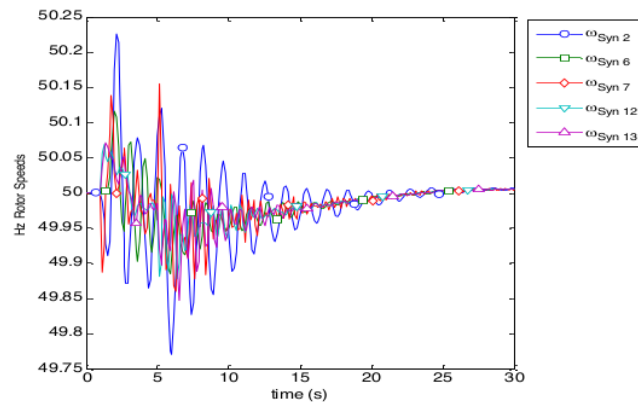


Figure 5. The rotor speed of the generator (ω) during load release between bus 4 and 11 with PSS control.

Figure 5 Indicates otherwise, where the fluctuations in the speed and isolation occurring in the five generators do not exceed the point 49.7 Hz at the lower boundary and 50.3 Hz at the upper limit. Slowly from the 7th to the 30th seconds the speed increases and the oscillation damping is good until it returns to its normal density. This shows the use of PSS control equipment in reducing the occurrence of better and faster oscillations than without the use of control equipment.

4.2. Simulation system after the entry of wind turbine.

The next observation is to insert wind turbines on the Jeneponto bus. The DFIG wind turbine model is used. Tables 6 and Tables 7 show the participation factor of the eigenvalues before and after the addition of PSS after the inclusion of wind turbines. It can be seen that the damping value of the ratio increases for the five generators. For generator six, the damping ratio increased from -0.005488 up to -0.005748. Likewise with the generator further increase or improve the eigenvalue after the addition of PSS. With correct input parameters of PSS, the real and imaginary parts of the eigenvalues of each generator are improved. In the two generators eg. from $-0.0426 \pm 5.0118i$ it has improved to $-0.0425 \pm 5.0189i$. Likewise with generators 6,7,12, and 13.

Table 6. Linear Value Analysis of The System Without PSS

Before Application of PSS						
Eig.#	Most associated states	Real part	Imaginary part	Frequency	Damping ratio	Mode oscillations
Eig As # 58	omega_Syn_2, delta_Syn_2	-0,0426	5,0118	0,7977	-0,008508	Inter Area
Eig As # 54	omega_Syn_6, delta_Syn_6	-0,0316	5,7527	0,9156	-0,005488	Inter Area
Eig As # 17	delta_Syn_7, omega_Syn_7	-0,0030	24,7455	3,9384	-0,000120	Lokal
Eig As # 40	omega_Syn_12, delta_Syn_12	-0,0052	12,5657	1,9999	-0,000413	Lokal
Eig As # 48	delta_Syn_13, omega_Syn_13	-0,0499	10,6240	1,6909	-0,004699	Lokal

Table 7. Linear Value Analysis of System with PSS

After Application of PSS						
Eig.#	Most associated states	Real part	Imaginary part	Frequency	Damping ratio	Mode oscillations
Eig As # 61	delta_Syn_2, omega_Syn_2	-0,0425	5,0189	0,7988	-0,008466	Inter Area
Eig As # 57	delta_Syn_6, omega_Syn_6	-0,0331	5,7546	0,9159	-0,005748	Inter Area
Eig As # 20	delta_Syn_7, omega_Syn_7	-0,0030	24,7376	3,9371	-0,000123	Lokal
Eig As # 42	delta_Syn_12, omega_Syn_12	-0,0053	12,5704	2,0006	-0,000421	Lokal
Eig As # 51	delta_Syn_13, omega_Syn_13	-0,0509	10,6175	1,6898	-0,004789	Lokal

For rotor speed, from the simulation results obtained that the entry of wind turbine in the interconnection system of Sulsebar very influential on the stability of the system. From Figure 6, it can be seen that the fifth rotor density of the generator fluctuates from the first second to the 30th seconds. At 25 seconds the rotor speed penetrates 50.03 Hz at the upper boundary and 49.97 in lower limit.

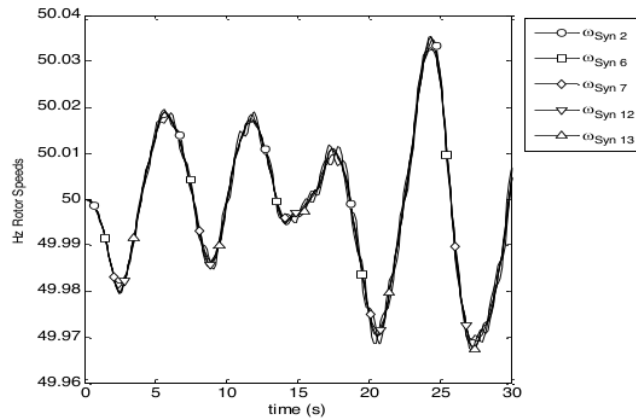


Figure 6. The rotor speed of the generator (ω) upon entry of wind turbines without PSS control

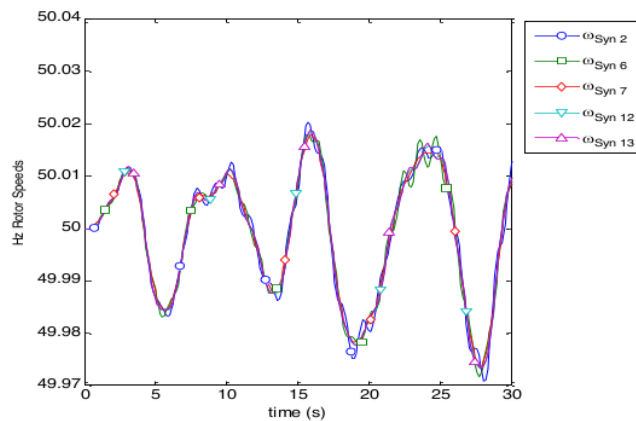


Figure 7. The rotor speed of generator (ω) upon entry of wind turbine with PSS control.

Meanwhile, with the addition of PSS control, the rotor speed on the five generators is relatively more stable in reducing the oscillations that occur. Figure 7 shows where the speed of the five generators is more stable. The rotor speed does not exceed 50.02 on the upper boundary and 49.97 at the lower limit and gradually returns to its normal density.

5. Conclusions

This paper explains the power flow and small-signal stability. Through the PSAT toolbox integrated on Matlab, multi-machine system of interconnected systems modeled Sulselabar. Conventional thermal generating units, where ¹³ for Turbine Governor (TG) used Model 1, while using the unit Hydroelectric Model 3 TG. For wind turbine using model doubly fed induction generator (DFIG).

Effective implementation and proper placement of the device PSS can cope with the dynamics of multi-machine network stability in the system and increase the critical eigenvalues as well, whether that the oscillation mode between areas and the local oscillation mode. Besides that the implementation of PSS can reduce and minimize overshoot oscillation frequency oscillation. Eigenvalues, voltage, frequency, and the factor observed with either participation in this study.

This research can provide a review for PT PLN electrical organizers to add control equipment on the system to prevent and dampen the occurrence of small signal oscillation in Sulsebar system. Further research can be developed by adding generators from other renewable resources, which will enter the Sulsebar electrical system. Optimization of PSS can also be used on systems with transient disturbances. In addition there are several methods that can be done to improve the stability of the system in Sulsebar, such as using control equipment STATCOM, UPFC, TCSC, SVC or equipment energy storage, SMEs (Superconducting Magnetic Energy Storage), CES (Capacitive Energy Storage) and BES (Battery Energy Storage) that can be researched.

References

- [1] Tristan Jr.G. M., 2016 Power Flow and Small Signal Stability Analysis on the Interconnected Philippine Power Grid, *Sciencedirect, Perspectives in Science*. Volume 8. sciencedirect, 2. 589–591. Web.
- [2] Pitono, Joko et al, 2013 Power Generation Optimization Based on Steady State Stability Using Particle Swarm Optimization (PSO) Limit, *International Review on Modelling and Simulations*, vol. 6, pp. 2–7.
- [3] Indar C.G, Soeprijanto, A., and Penangsang, O., 2012 Steady State Stability Assessment Using Extreme Learning Machine Based on Modal Analysis, *International Review of Electrical Engineering*, vol. xx, no. June.
- [4] Indar C.G, Muhammad.A., et al, 2012 Determination of Steady State Stability Margin Using Extreme Learning Machine 2 Research Method, *Wseas Transaction on Power System*, vol. 7, no. 3, pp. 91–103.
- [5] Salahi, Rim B E N et al, 2014 Small Signal Stability of The Tunisian Interconnected Power System, *IEEE*. N.p., Print.
- [6] Indar C.G, Soeprijanto, A., and Penangsang, O., 2010 Real Power Generation Scheduling to Improve Steady State Stability Limit in the Java-Bali 500 kV Interconnection Power System, vol. 4, no. 12, pp. 1771–1775.
- [7] Ali, I., Mehdi, K., and OP. M., 2011 Study of a major oscillations event in northeastern area of the Iranian power network, *Electric Power Systems Research*, vol. 81, no. 7, pp. 1292–1298.
- [8] Mondal, D., Abhijit, C., and Aparajita, S., 2014 in Power System Small Signal Stability Analysis and Control, 1st ed., *Academic Press*, p. 328.
- [9] Lin, Kyaw Myo., 2014 *Small Signal Stability Assessment of MEPE Test System in Free and Open Source Software*, vol. 8, no. 11, pp. 1707–1715,.
- [10] Motjaba, K., Mahdi, E., 1996 *Power-system small-signal stability and maximum loadability* 1996, vol. 21, no. 2.
- [11] Prabu, K., 1994 *Power System Stability and Control*, McGraw-Hill, Inc., pp. 699.
- [12] Federico, M., 2005 An Open Source Power System Analysis Toolbox, vol. 20, *IEEE Transaction On Power Systems*, pp. 1199–1206, Vol. 20, No. 3
- [13] Robert, W., Rakibuzzama, S., and N Mithulananthan, 2014 Expanding Power System Analysis Toolbox (PSAT) Functionalities for Better Result Interpretation, *Australasian Universities Power Engineering Conference*, 1–6. Print.
- [14] Federico, M., Luigi, V and Juan C, 2008 An Open Source Power System Virtual Laboratory : The PSAT Case and Experience, *IEEE Transactions on Education*, pp. 17–23, vol. 51, no.1
- [15] Yuwa, C., et al, 2012 Development and Implementation of a Nordic Grid Model for Power System Small-Signal and Transient Stability Studies in a Free and Open Source Software, *IEEE*,

- pp. 1–8.
- [16] Muhammad, D.J., and Yudhi, L. C., 2012 *Studi Aliran daya dan Hubung Singkat Sistem Interkoneksi 150 kV Sulawesi Selatan Dengan ETAP*, Skripsi, FT-Politeknik Negeri Ujung Pandang, MAKASSAR.
 - [17] Muhammad, B.N., and Ardiaty, A., 2016 Network Losses Reduction Due To New Hydro Power Plant Integration, in *ICITACEE*, no. 1, pp. 181–185.
 - [18] Muhammad, B.N., and Ardiaty, A., 2016 Network Losses-Based Economic Redispatch for Optimal Energy Pricing in a Congested Power System, in *Energy Procedia*, vol. 100, pp. 311–314.
 - [19] Ardiaty, A., and Muhammad, B., 2016 An Analytical Method for Optimal Capacitors Placement from the Inversed Reduced Jacobian Matrix, in *Energy Procedia*, vol. 100, pp. 307–310.
 - [20] Ardiaty, A., and Muhammad, B.N, 2016 Voltage Drop Simulation at Southern Sulawesi Power System Considering Composite Load Model, in *ICITACEE*, 2016, pp. 169–172.
 - [21] Muhammad, B.N., Ardiaty, A., Ramesh, C.B., 2014 Transmission management for congested power system : A review of concepts , technical challenges and development of a new methodology, *Renew. Sustain. Energy, Rev.*, vol. 38, pp. 572–580.

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