DAFTAR PUSTAKA

Aamir, A. *et al.* (2019) 'Impact of synchronous condenser on the dynamic behavior of LCC based UHVDC system hierarchically connected to AC system', *CSEE Journal of Power and Energy Systems*, 5(2), pp. 190–198. doi: 10.17775/cseejpes.2018.00420.

Alinejad-Beromi, Y., Sedighizadeh, M. and Sadighi, M. (2008) 'A particle swarm optimization for sitting and sizing of distributed generation in distribution network to improve voltage profile and reduce THD and losses', *Proceedings of the Universities Power Engineering Conference*. doi: 10.1109/UPEC.2008.4651544.

Bai, H. and Zhao, B. (2006) 'A survey on application of swarm intelligence computation to electric power system', *Proceedings of the World Congress on Intelligent Control and Automation (WCICA)*, 2(60421002), pp. 7587–7591. doi: 10.1109/WCICA.2006.1713441.

Cui, T. *et al.* (2020) 'Optimal Allocation of Synchronous Condensers in an Actual Weak Received Power Grid with an UHVDC System', *Asia-Pacific Power and Energy Engineering Conference, APPEEC*, 2020-Septe, pp. 1–5. doi: 10.1109/APPEEC48164.2020.9220673.

Dai, F. *et al.* (2020) 'Characteristic Analysis and Parameter optimization of Synchronous Condensers', *Asia-Pacific Power and Energy Engineering Conference, APPEEC*, 2020-Septe, pp. 3–7. doi: 10.1109/APPEEC48164.2020.9220444.

Fogarty, James M., and R. M. L. (2011) 'Converting existing synchronous generators into synchronous condensers', *Power Engineering 115.10 (2011): 28-28*.

Fogarty, J. M. and Nold, R. A. (2017) 'Application of Synchronous Condensers in the Modern Power Grid'.

Glaninger-Katschnig, A. (2013) 'Contribution of synchronous condensers for the energy transition', *Elektrotechnik und Informationstechnik*, 130(1), pp. 28–32. doi: 10.1007/s00502-013-0119-3.

Hirase, Y. *et al.* (2018) 'A novel control approach for virtual synchronous generators to suppress frequency and voltage fluctuations in microgrids', *Applied Energy*. Elsevier Ltd, 210, pp. 699–710. doi: 10.1016/j.apenergy.2017.06.058.

Igbinovia, F. O. *et al.* (2019) 'Reputation of the Synchronous Condenser Technology in Modern Power Grid', *2018 International Conference on Power System Technology, POWERCON 2018 - Proceedings*, (201805280000151), pp. 2108–2115. doi: 10.1109/POWERCON.2018.8601540.

Jia, J. *et al.* (2019) 'Impact of VSC Control Strategies and Incorporation of Synchronous Condensers on Distance Protection Under Unbalanced Faults', *IEEE Transactions on Industrial Electronics*, 66(2), pp. 1108–1118. doi: 10.1109/TIE.2018.2835389.

Kansal, S., Kumar, V. and Tyagi, B. (2013) 'Optimal placement of different type of DG sources in distribution networks', *International Journal of Electrical Power and Energy Systems*. Elsevier Ltd, 53(1), pp. 752–760. doi: 10.1016/j.ijepes.2013.05.040.

Kementrian ESDM (2020) 'Aturan Jaringan Sistem Tenaga Listrik (Grid Code)', *Menteri Energi dan Sumber Daya Mineral Republik Indonesia*, (3), pp. 417–607.

Lee, K. Y. and Park, J. B. (2006) 'Application of particle swarm optimization to economic dispatch problem: Advantages and disadvantages', *2006 IEEE PES Power Systems Conference and Exposition, PSCE 2006 - Proceedings*, pp. 188–192. doi: 10.1109/PSCE.2006.296295.

Li, H. *et al.* (2021) 'Design of LQR Excitation Controller of Synchronous Condenser in HVDC System', *Journal of Physics: Conference Series*, 1884(1). doi: 10.1088/1742-6596/1884/1/012004.

Manditereza, P. T. (2020) 'Rocof Enhancement Using Synchronous Condensers in Systems Integrated with Renewable Energy Sources', *2020 IEEE PES/IAS PowerAfrica, PowerAfrica 2020*. doi: 10.1109/PowerAfrica49420.2020.9219957.

Marazzi, E. (2015) 'Short circuit power planning for renewable energy systems via synchronous condensers', (October), p. 134.

Marrazi, E., Yang, G. and Weinreich-Jensen, P. (2018) 'Allocation of synchronous condensers for restoration of system short-circuit power', *Journal of Modern Power Systems and Clean Energy*. Springer Berlin Heidelberg, 6(1), pp. 17–26. doi: 10.1007/s40565-017-0346-4.

Masood, N. Al *et al.* (2016) 'Post-retirement utilisation of synchronous generators to enhance security performances in a wind dominated power system', *IET Generation, Transmission and Distribution*, 10(13), pp. 3314–3321. doi: 10.1049/iet-gtd.2016.0267.

Min, F. *et al.* (2019) 'Analysis of the Influence of Installing Synchronous Condenser in HVDC Inverter Station to Receiving-End Grid', *2019 22nd International Conference on Electrical Machines and Systems, ICEMS 2019*. IEEE, pp. 0–4. doi: 10.1109/ICEMS.2019.8921939.

Nahid-Al-Masood *et al.* (2015) 'Frequency response and its enhancement using synchronous condensers in presence of high wind penetration', *IEEE Power and Energy Society General Meeting*, 2015-Septe. doi: 10.1109/PESGM.2015.7285801.

Nedd, M., Booth, C. and Bell, K. (2017) 'Potential solutions to the challenges of low inertia power systems with a case study concerning synchronous condensers', *2017 52nd International Universities Power Engineering Conference, UPEC 2017*, 2017-Janua, pp. 1–6. doi: 10.1109/UPEC.2017.8232001.

Nguyen, H. T. *et al.* (2019) 'Combination of synchronous condenser and synthetic inertia for frequency stability enhancement in low-inertia systems', *IEEE Transactions on Sustainable Energy*, 10(3), pp. 997–1005. doi: 10.1109/TSTE.2018.2856938.

Nielsen, M. S. (2015) 'Allocation of Synchronous Condensers for Low Inertia Systems', (July), p. 119.

Okwu, M. O. and Tartibu, L. K. (2021) 'Particle Swarm Optimization', *Studies in Computational Intelligence*, 927, pp. 5–13. doi: 10.1007/978-3-030-61111-8_2.

Park, J. B. *et al.* (2005) 'A particle swarm optimization for economic dispatch with nonsmooth cost functions', *IEEE Transactions on Power Systems*, 20(1), pp. 34–42. doi: 10.1109/TPWRS.2004.831275.

Pertl, M. *et al.* (2018) 'Transient stability improvement: a review and comparison of conventional and renewable-based techniques for preventive and emergency control', *Electrical Engineering*. Springer Berlin Heidelberg, 100(3), pp. 1701–1718. doi: 10.1007/s00202-017-0648-6.

PT. PLN (Persero) (2019) 'Rencana Usaha Penyediaan Tenaga Listrik PT PLN (Persero) 2019-2028', pp. 1–735.

PT. PLN (Persero) (2021) 'Evaluasi Operasi Tahunan (EOT) 2020', *Opsis UIKL Sulawesi*, pp. 1–247.

PT. PLN (Persero) UIKL Sulawesi (2022) 'Rencana Operasi Bulan Desember 2022', pp. 1–117.

Ri, R. *et al.* (2018) 'Study on Coordinated Control Strategy of Reactive Power Compensation Device in DC Converter Station with New-generation Synchronous Condensers', (201805280000383), pp. 2–7.

Richard, L. *et al.* (2020) 'Optimal Allocation of Synchronous Condensers in Wind Dominated Power Grids', *IEEE Access*. IEEE, 8, pp. 45400–45410. doi: 10.1109/ACCESS.2020.2977941.

Rusek, S. *et al.* (2015) 'Comparative Review of Reactive Power Compensation Technologies', *Int Sci Con*, pp. 0–4. Available at: http://findit.dtu.dk/en/catalog/2383679160.

Shi, X. *et al.* (2020) 'Optimized idling grid-connection strategy for synchronous condenser', *Turkish Journal of Electrical Engineering and Computer Sciences*, 28(5), pp. 2895–2909. doi: 10.3906/ELK-1907-139.

Stiger, A., Rivas, R. A. and Halonen, M. (2019) 'Synchronous Condensers Contribution to Inertia and Short Circuit Current in Cooperation with

STATCOM', *2019 IEEE PES GTD Grand International Conference and Exposition Asia, GTD Asia 2019*. IEEE, pp. 955–959. doi: 10.1109/GTDAsia.2019.8715893.

Sun, Y. *et al.* (2020) 'Improving Grid-Connection Reliability and Safety of Synchronous Condensers with Start-Up Process Optimization', *IEEE Access*, 8, pp. 153742–153755. doi: 10.1109/ACCESS.2020.3018182.

Surya, A. S. *et al.* (2020) 'Study of Synchronous Condenser Impact in Jawa-Madura-Bali System to Provide Ancillary Services', *ICITEE 2020 - Proceedings of the 12th International Conference on Information Technology and Electrical Engineering*, pp. 234–238. doi: 10.1109/ICITEE49829.2020.9271782.

Tabatabaei, N. M. *et al.* (2017) *Reactive power optimization using MATLAB and DIgSILENT*, *Power Systems*. doi: 10.1007/978-3-319-51118-4_11.

Ulbig, A., Borsche, T. S. and Andersson, G. (2014) *Impact of low rotational inertia on power system stability and operation*, *IFAC Proceedings Volumes (IFAC-PapersOnline)*. IFAC. doi: 10.3182/20140824-6-za-1003.02615.

Westinghouse, C. (1962) 'Instructions for Intallation, Operation and Maintenance for Geared Turbine AC Generator', in *Instructions for Intallation, Operation and Maintenance for Geared Turbine AC Generator*, pp. 1–50.

Xiao, F. *et al.* (2019) 'Research on the Over-voltage Suppression Strategy for HVDC with New-generation Synchronous Condensers', *2019 3rd IEEE Conference on Energy Internet and Energy System Integration: Ubiquitous Energy Network Connecting Everything, EI2 2019*. IEEE, pp. 2708–2713. doi: 10.1109/EI247390.2019.9062106.

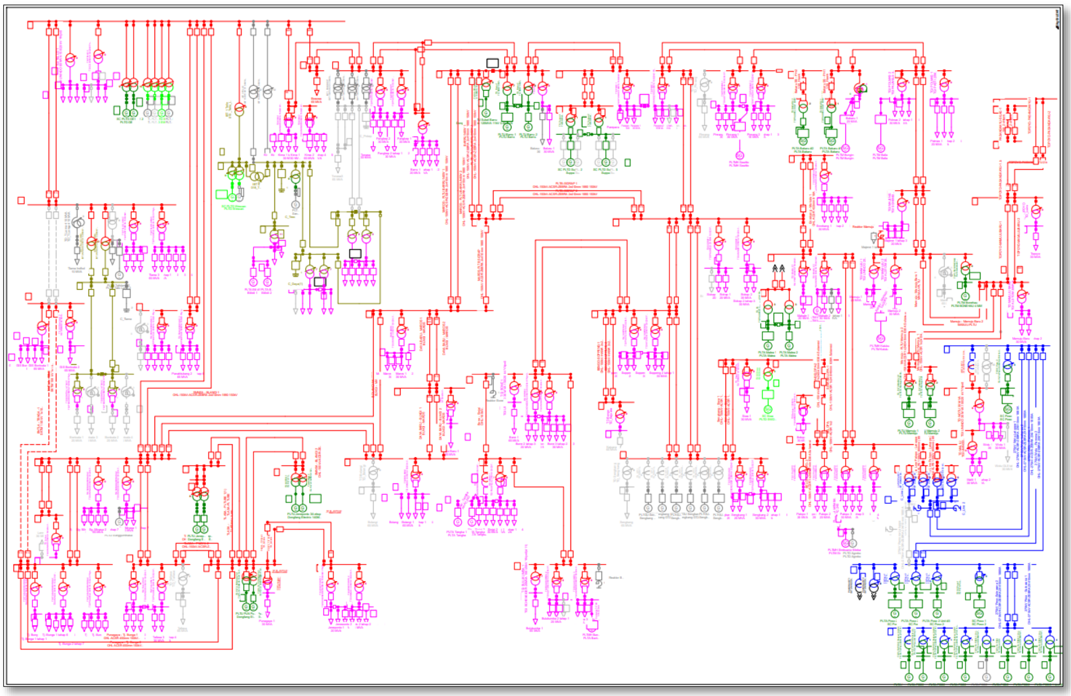
Xueyan, L. and Zheng, X. (2016) 'Swarm size and inertia weight selection of Particle Swarm Optimizer in system identification', *Proceedings of 2015 4th International Conference on Computer Science and Network Technology, ICCSNT 2015*, (Iccsnt), pp. 1554–1556. doi: 10.1109/ICCSNT.2015.7491026.

Yu, X. M., Xiong, X. Y. and Wu, Y. W. (2004) 'A PSO-based approach to optimal capacitor placement with harmonic distortion consideration', *Electric Power Systems Research*, 71(1), pp. 27–33. doi: 10.1016/j.epsr.2004.01.002.

Zhang, W. and Liu, Y. (2004) 'Reactive power optimization based on PSO in a practical power system', *2004 IEEE Power Engineering Society General Meeting*, 1(2), pp. 239–243. doi: 10.1109/pes.2004.1372792.

LAMPIRAN

Lampiran 1 Diagram satu garis sistem Sulbagsel



Lampiran 2 Nilai hasil aliran daya pada sistem Sulbagsel sebelum optimasi

		DIgSILENT PowerFactory 15.1.7	Project: Date: 4/15/2023

Load Flow Calculation — Total System Summary

AC Load Flow, balanced, positive sequence		Automatic Model Adaptation for Convergence	Yes
Automatic Tap Adjust of Transformers	No	Max. Acceptable Load Flow Error for	
Consider Reactive Power Limits	Yes	Nodes	1.00 kVA
		Model Equations	0.10 %

Total System Summary — Study Case: Study Case — Annex: / 1

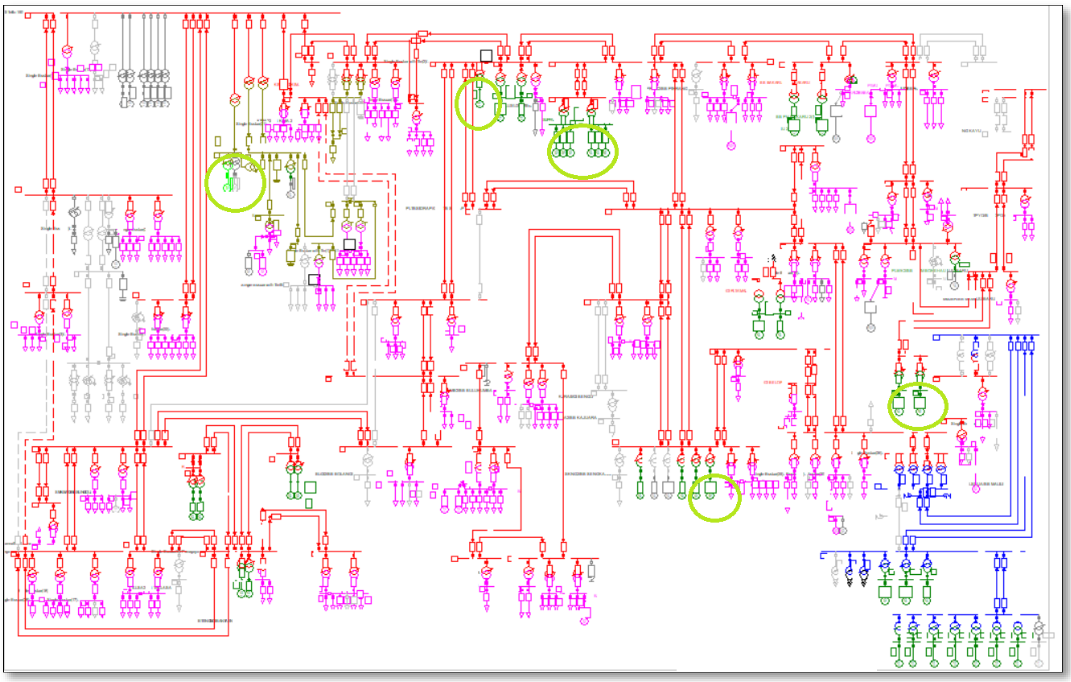
No. of Substations	290	No. of Busbars	320	No. of Terminals	5375	No. of Lines	214
No. of 2-w Trfs.	210	No. of 3-w Trfs.	8	No. of syn. Machines	57	No. of asyn.Machines	4
No. of Loads	295	No. of Shunts	12	No. of SVS	0		

Generation	=	1607.24 MW	203.82 Mvar	1620.11 MVA
External Infeed	=	0.00 MW	0.00 Mvar	0.00 MVA
Load P(U)	=	1556.14 MW	255.15 Mvar	1576.92 MVA
Load P(Un)	=	1575.90 MW	260.75 Mvar	1597.32 MVA
Load P(Un-U)	=	19.75 MW	5.60 Mvar	
Motor Load	=	0.00 MW	0.00 Mvar	0.00 MVA
Grid Losses	=	51.09 MW	-156.75 Mvar	
Line Charging	=		-471.62 Mvar	
Compensation ind.	=		125.26 Mvar	
Compensation cap.	=		-19.83 Mvar	
Installed Capacity	=	2123.14 MW		
Spinning Reserve	=	406.06 MW		

Total Power Factor:

Generation	=	0.99 [-]
Load/Motor	=	0.99 / 0.00 [-]

Lampiran 3 Lokasi penempatan SC di sistem transmisi Sulbagsel



Lampiran 4 Nilai hasil aliran daya sistem Sulbagsel setelah optimasi

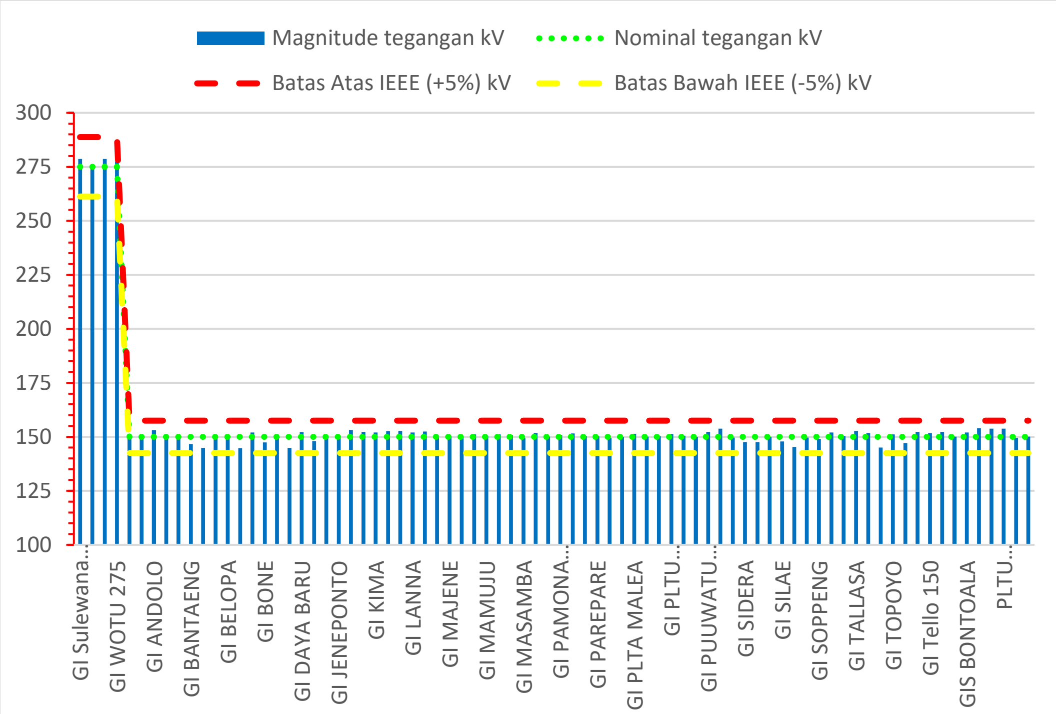
```
----------------------------------------------------------------------------------------------------------------
|                  |                                                              |  DIgSILENT   | Project:                  |
|                  |                                                              | PowerFactory |---------------------------
|                  |                                                              |    15.1.7    | Date:  4/16/2023          |
----------------------------------------------------------------------------------------------------------------
----------------------------------------------------------------------------------------------------------------
| Load Flow Calculation                                                                   Total System Summary |
----------------------------------------------------------------------------------------------------------------
|     AC Load Flow, balanced, positive sequence            |   Automatic Model Adaptation for Convergence      Yes      |
|     Automatic Tap Adjust of Transformers          No     |   Max. Acceptable Load Flow Error for                      |
|     Consider Reactive Power Limits                Yes    |      Nodes                                      1.00 kVA  |
|                                                          |      Model Equations                            0.10 %    |
----------------------------------------------------------------------------------------------------------------
----------------------------------------------------------------------------------------------------------------
| Total System Summary                          | Study Case: Study Case                  | Annex:           / 1  |
----------------------------------------------------------------------------------------------------------------
|                                                                                                              |
| No. of Substations     290       No. of Busbars       320       No. of Terminals      5375      No. of Lines          214  |
| No. of 2-w Trfs.       210       No. of 3-w Trfs.     8         No. of syn. Machines  66        No. of asyn.Machines  4    |
| No. of Loads           295       No. of Shunts        12        No. of SVS            0                                  |
|                                                                                                              |
| Generation             =    1602.94  MW         174.59  Mvar      1612.42  MVA                               |
| External Infeed        =       0.00  MW           0.00  Mvar         0.00  MVA                               |
| Load P(U)              =    1557.91  MW         255.48  Mvar      1578.72  MVA                               |
| Load P(Un)             =    1575.90  MW         260.75  Mvar      1597.32  MVA                               |
| Load P(Un-U)           =      17.98  MW           5.27  Mvar                                                 |
| Motor Load             =       0.00  MW          21.22  Mvar        21.22  MVA                               |
| Grid Losses            =      45.03  MW        -208.09  Mvar                                                 |
| Line Charging          =                       -472.33  Mvar                                                 |
| Compensation ind.      =                        125.90  Mvar                                                 |
| Compensation cap.      =                        -19.93  Mvar                                                 |
|                                                                                                              |
| Installed Capacity     =    2123.14  MW                                                                      |
| Spinning Reserve       =     410.35  MW                                                                      |
|                                                                                                              |
| Total Power Factor:                                                                                          |
|   Generation           =         0.99  [-]                                                                   |
|   Load/Motor           =  0.99 / 0.00  [-]                                                                   |
|--------------------------------------------------------------------------------------------------------------|
```

Lampiran 5 Nilai tegangan busbar sebelum optimasi

No	Nama bus	Nominal tegangan kV	Magnitude tegangan kV	Magnitude tegangan p.u.
1	GI Sulewana 275	275	278.7058	1.013476
2	GI LATUPPA 275	275	275.1194	1.000434
3	GI PAMONA 275	275	278.6913	1.013423
4	GI WOTU 275	275	277.492	1.009062
5	BB BAKARU 2	150	150.6137	1.004092
6	BB BAKARU 2(1)	150	150.6081	1.004054
7	GI ANDOLO	150	153.0783	1.020522
8	GI BAKARU	150	150.5721	1.003814
9	GI BALUSU	150	150.4903	1.003268
10	GI BANTAENG	150	146.6045	0.9773631
11	GI BANTAENG SWITCHING	150	144.9032	0.9660216
12	GI BARRU	150	150.4363	1.002908
13	GI BELOPA	150	149.8427	0.9989515
14	GI BNTAENG SMELTER	150	144.7869	0.9652463
15	GI BOLANGI	150	152.0602	1.013735
16	GI BONE	150	147.4538	0.9830253
17	GI BOSOWA	150	150.9459	1.006306
18	GI BULUKUMBA	150	144.8956	0.9659704
19	GI DAYA BARU	150	152.1541	1.014361
20	GI DONGGALA NEW	150	147.932	0.9862132
21	GI ENREKANG	150	149.8671	0.9991141
22	GI JENEPONTO	150	149.4778	0.9965187
23	GI KASIPUTE	150	153.1455	1.02097
24	GI KENDARI 150	150	152.2611	1.015074
25	GI KIMA	150	152.0333	1.013556
26	GI KOLAKA 150 KV	150	152.6301	1.017534
27	GI KOLAKA SMELTER	150	152.686	1.017907
28	GI LANNA	150	152.0308	1.013538
29	GI LASUSUA 150	150	152.4714	1.016476
30	GI Latuppa 150 kV	150	150.0764	1.000509
31	GI MAJENE	150	150.5557	1.003705
32	GI MAKALE	150	150.225	1.0015
33	GI MALILI 150	150	151.0766	1.007177
34	GI MAMUJU	150	150.5103	1.003402
35	GI MAMUJU BARU	150	151.1588	1.007725
36	GI MAROS	150	150.8005	1.005337
37	GI MASAMBA	150	149.2724	0.9951491
38	GI Moramo	150	151.8984	1.012656
39	GI PALOPO	150	150.0695	1.000463

No	Nama bus	Nominal tegangan	Magnitude tegangan	Magnitude tegangan
		kV	kV	p.u.
40	GI PAMONA 150	150	150.794	1.005293
41	GI PANAKKUKANG	150	151.5053	1.010035
42	GI PANGKEP 150KV	150	150.4426	1.00295
43	GI PAREPARE	150	150.2383	1.001588
44	GI PASANGKAYU	150	149.4186	0.9961237
45	GI PINRANG	150	149.909	0.9993932
46	GI PLTA MALEA	150	151.3517	1.009011
47	GI PLTB SDRAP	150	150.0629	1.00042
48	GI PLTU BARRU NEW	150	150.2908	1.001939
49	GI PLTU Mamuju	150	151.2549	1.008366
50	GI POLMAS	150	150.526	1.003507
51	GI POSO	150	149.9912	0.9999414
52	GI PUUWATU 150	150	152.3121	1.015414
53	GI Punagaya	150	153.7708	1.025139
54	GI SENGKANG	150	149.5662	0.997108
55	GI SIDERA	150	147.5349	0.9835663
56	GI SIDERA	150	147.5349	0.9835663
57	GI SIDRAP	150	149.9622	0.9997481
58	GI SILAE	150	147.8657	0.9857717
59	GI SINJAI	150	145.4073	0.9693818
60	GI SIWA	150	149.682	0.9978797
61	GI SOPPENG	150	148.9743	0.9931618
62	GI SUNGGUMINASA	150	152.0721	1.013814
63	GI SUPPA	150	150.4297	1.002865
64	GI TALLASA	150	152.7986	1.018657
65	GI TALLO LAMA 150	150	151.7295	1.01153
66	GI TANETE	150	145.0477	0.9669847
67	GI TOPOYO	150	151.0836	1.007224
68	GI Tallise 150 kV	150	147.0535	0.980357
69	GI Tanjung Bunga	150	152.3394	1.015596
70	GI Tello 150	150	151.7361	1.011574
71	GI UNAAHA 150 KV	150	152.3751	1.015834
72	GI WOTU 150	150	150.0095	1.000063
73	GIS BONTOALA	150	152.0294	1.013529
74	GIS PLTU JENEPONTO	150	153.8867	1.025911
75	PLTU JENEPONTO 1	150	153.8332	1.025555
76	PLTU JENEPONTO 2	150	153.8506	1.025671
77	WPP Jeneponto	150	149.4778	0.9965187
78	WPP Sidrap	150	150.0629	1.00042

Lampiran 6 Chart tegangan busbar sebelum optimasi



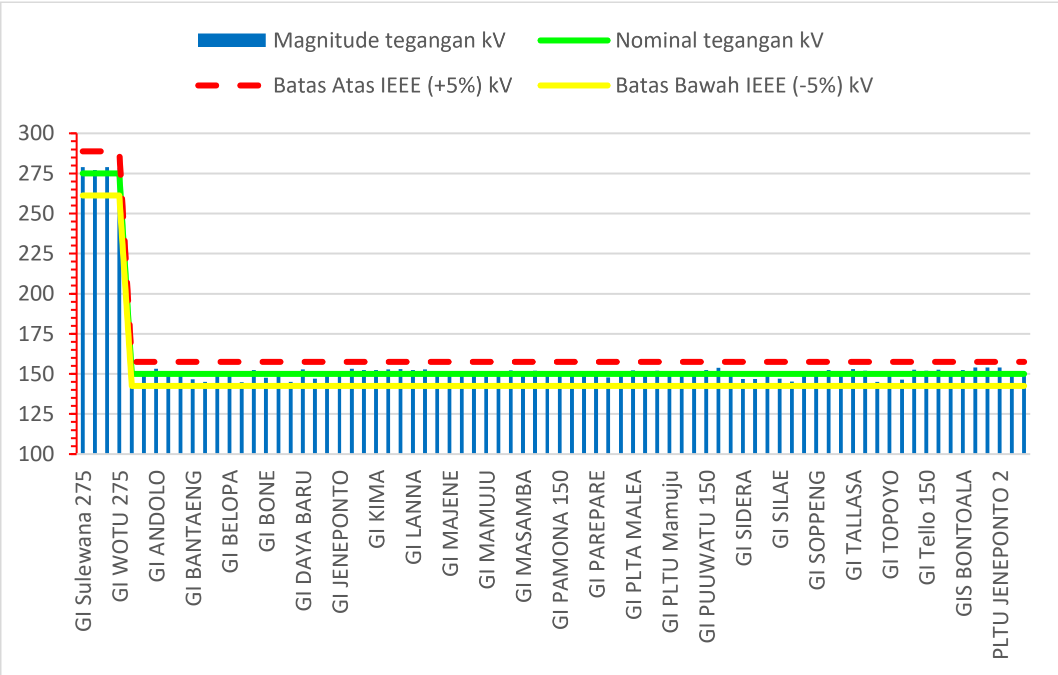
Lampiran 7 Nilai tegangan busbar setelah optimasi

No	Nama bus	Nominal tegangan kV	Magnitude tegangan kV	Magnitude tegangan p.u.
1	GI Sulewana 275	275	278.8626	1.014046
2	GI LATUPPA 275	275	277.0794	1.007561
3	GI PAMONA 275	275	278.8607	1.014039
4	GI WOTU 275	275	278.6279	1.013192
5	BB BAKARU 2	150	149.9383	0.9995886
6	BB BAKARU 2(1)	150	149.925	0.9994997
7	GI ANDOLO	150	153.1929	1.021286
8	GI BAKARU	150	149.8965	0.9993102
9	GI BALUSU	150	150.671	1.004473
10	GI BANTAENG	150	146.6872	0.9779149
11	GI BANTAENG SWITCHING	150	144.9953	0.9666353
12	GI BARRU	150	150.6928	1.004618
13	GI BELOPA	150	150.3706	1.00247
14	GI BNTAENG SMELTER	150	144.8789	0.9658595
15	GI BOLANGI	150	152.453	1.016354
16	GI BONE	150	147.5757	0.9838378
17	GI BOSOWA	150	151.2818	1.008545
18	GI BULUKUMBA	150	144.9952	0.9666348
19	GI DAYA BARU	150	152.8716	1.019144

No	Nama bus	Nominal tegangan	Magnitude tegangan	Magnitude tegangan
		kV	kV	p.u.
20	GI DONGGALA NEW	150	147.0543	0.9803621
21	GI ENREKANG	150	150.6421	1.00428
22	GI JENEPONTO	150	149.5662	0.9971077
23	GI KASIPUTE	150	153.2602	1.021735
24	GI KENDARI 150	150	152.3751	1.015834
25	GI KIMA	150	152.5133	1.016755
26	GI KOLAKA 150 KV	150	152.8731	1.019154
27	GI KOLAKA SMELTER	150	152.9882	1.019921
28	GI LANNA	150	152.3714	1.015809
29	GI LASUSUA 150	150	152.8311	1.018874
30	GI Latuppa 150 kV	150	150.723	1.00482
31	GI MAJENE	150	149.0951	0.9939671
32	GI MAKALE	150	151.0343	1.006895
33	GI MALILI 150	150	151.5541	1.010361
34	GI MAMUJU	150	148.1364	0.9875761
35	GI MAMUJU BARU	150	148.4329	0.9895526
36	GI MAROS	150	152.1477	1.014318
37	GI MASAMBA	150	149.7932	0.9986215
38	GI Moramo	150	151.9998	1.013332
39	GI PALOPO	150	150.7198	1.004799
40	GI PAMONA 150	150	150.8391	1.005594
41	GI PANAKKUKANG	150	151.8624	1.012416
42	GI PANGKEP 150KV	150	150.7629	1.005086
43	GI PAREPARE	150	150.2327	1.001551
44	GI PASANGKAYU	150	147.8303	0.9855353
45	GI PINRANG	150	149.715	0.9980999
46	GI PLTA MALEA	150	152.1566	1.014378
47	GI PLTB SDRAP	150	151.0433	1.006955
48	GI PLTU BARRU NEW	150	152.051	1.013673
49	GI PLTU Mamuju	150	148.4271	0.9895142
50	GI POLMAS	150	149.501	0.9966735
51	GI POSO	150	150.0258	1.000172
52	GI PUUWATU 150	150	152.4242	1.016161
53	GI Punagaya	150	153.8984	1.025989
54	GI SENGKANG	150	149.4225	0.9961498
55	GI SIDERA	150	146.9188	0.9794585
56	GI SIDERA	150	146.9188	0.9794585
57	GI SIDRAP	150	150.569	1.003793
58	GI SILAE	150	147.0134	0.9800891
59	GI SINJAI	150	145.2999	0.9686658

No	Nama bus	Nominal tegangan	Magnitude tegangan	Magnitude tegangan
		kV	kV	p.u.
60	GI SIWA	150	150.0115	1.000077
61	GI SOPPENG	150	149.1256	0.9941708
62	GI SUNGGUMINASA	150	152.4128	1.016085
63	GI SUPPA	150	150.0903	1.000602
64	GI TALLASA	150	153.0187	1.020125
65	GI TALLO LAMA 150	150	152.063	1.013753
66	GI TANETE	150	145.0366	0.966911
67	GI TOPOYO	150	148.676	0.9911736
68	GI Tallise 150 kV	150	146.4394	0.9762626
69	GI Tanjung Bunga	150	152.6432	1.017622
70	GI Tello 150	150	152.0937	1.013958
71	GI UNAAHA 150 KV	150	152.5417	1.016944
72	GI WOTU 150	150	150.5329	1.003553
73	GIS BONTOALA	150	152.3885	1.015923
74	GIS PLTU JENEPONTO	150	154.0074	1.026716
75	PLTU JENEPONTO 1	150	153.957	1.02638
76	PLTU JENEPONTO 2	150	153.9691	1.02646
77	WPP Jeneponto	150	149.5662	0.9971077
78	WPP Sidrap	150	151.0433	1.006955

Lampiran 8 Chart tegangan busbar setelah optimasi



Lampiran 9 Hasil Optimasi MATLAB dengan Algoritma PS

MATLAB Command Window Page 1

Iter	Func-count	f(x)	MeshSize	Method
0	1	5.10635e+07	1	
1	4	5.10163e+07	1	Successful Search
2	7	5.09694e+07	1	Successful Search
3	10	5.09228e+07	1	Successful Search
4	13	5.08765e+07	1	Successful Search
5	16	5.08305e+07	1	Successful Search
6	19	5.07848e+07	1	Successful Search
7	22	5.07395e+07	1	Successful Search
8	25	5.06945e+07	1	Successful Search
9	28	5.06497e+07	1	Successful Search
10	31	5.06053e+07	1	Successful Search
11	34	5.05612e+07	1	Successful Search
12	37	5.05174e+07	1	Successful Search
13	40	5.04739e+07	1	Successful Search
14	43	5.04307e+07	1	Successful Search
15	46	5.03877e+07	1	Successful Search
16	49	5.03451e+07	1	Successful Search
17	52	5.03028e+07	1	Successful Search
18	55	5.02609e+07	1	Successful Search
19	58	5.02192e+07	1	Successful Search
20	61	5.01778e+07	1	Successful Search
21	64	5.01367e+07	1	Successful Search
22	67	5.00959e+07	1	Successful Search
23	70	5.00554e+07	1	Successful Search
24	73	5.00153e+07	1	Successful Search
25	76	4.99754e+07	1	Successful Search
26	79	4.99358e+07	1	Successful Search
27	82	4.98966e+07	1	Successful Search
28	85	4.98576e+07	1	Successful Search
29	88	4.98189e+07	1	Successful Search
30	91	4.97806e+07	1	Successful Search

Iter	Func-count	f(x)	MeshSize	Method
31	94	4.97425e+07	1	Successful Search
32	97	4.97048e+07	1	Successful Search
33	100	4.96673e+07	1	Successful Search
34	103	4.96302e+07	1	Successful Search
35	106	4.95933e+07	1	Successful Search
36	109	4.95568e+07	1	Successful Search
37	112	4.95206e+07	1	Successful Search
38	115	4.94846e+07	1	Successful Search
39	118	4.9449e+07	1	Successful Search

40	121	4.94137e+07	1	Successful Search
41	124	4.93786e+07	1	Successful Search
42	127	4.93439e+07	1	Successful Search
43	130	4.93095e+07	1	Successful Search

MATLAB Command Window Page 2

44	133	4.92753e+07	1	Successful Search
45	136	4.92414e+07	1	Successful Search
46	139	4.92414e+07	1	Successful Search
47	142	4.92413e+07	1	Successful Search
48	145	4.92413e+07	1	Successful Search
49	148	4.92412e+07	1	Successful Search
50	151	4.92412e+07	1	Successful Search
51	154	4.92412e+07	1	Successful Search
52	157	4.92411e+07	1	Successful Search
53	160	4.92411e+07	1	Successful Search
54	163	4.9241e+07	1	Successful Search
55	166	4.9241e+07	1	Successful Search
56	170	4.91999e+07	1	Successful Search
57	174	4.9159e+07	1	Successful Search
58	178	4.91184e+07	1	Successful Search
59	182	4.90781e+07	1	Successful Search
60	186	4.9038e+07	1	Successful Search

Iter Func-count f(x) MeshSize Method

61	190	4.89982e+07	1	Successful Search
62	194	4.89586e+07	1	Successful Search
63	198	4.89193e+07	1	Successful Search
64	202	4.88803e+07	1	Successful Search
65	206	4.88415e+07	1	Successful Search
66	210	4.8803e+07	1	Successful Search
67	214	4.87647e+07	1	Successful Search
68	218	4.87267e+07	1	Successful Search
69	222	4.86889e+07	1	Successful Search
70	226	4.86515e+07	1	Successful Search
71	230	4.86143e+07	1	Successful Search
72	234	4.85773e+07	1	Successful Search
73	238	4.85406e+07	1	Successful Search
74	242	4.85042e+07	1	Successful Search
75	246	4.8468e+07	1	Successful Search
76	250	4.84321e+07	1	Successful Search
77	254	4.83965e+07	1	Successful Search
78	258	4.83612e+07	1	Successful Search
79	262	4.83261e+07	1	Successful Search
80	266	4.8291e+07	1	Successful Search
81	270	4.8256e+07	1	Successful Search

82	274	4.82213e+07	1	Successful Search
83	278	4.81869e+07	1	Successful Search
84	282	4.81528e+07	1	Successful Search
85	286	4.8119e+07	1	Successful Search
86	290	4.80852e+07	1	Successful Search
87	294	4.80518e+07	1	Successful Search
88	298	4.80186e+07	1	Successful Search
89	302	4.79858e+07	1	Successful Search
90	306	4.79532e+07	1	Successful Search

Iter	Func-count	f(x)	MeshSize	Method
91	310	4.79234e+07	1	Successful Search
92	314	4.78937e+07	1	Successful Search
93	318	4.78644e+07	1	Successful Search
94	322	4.78352e+07	1	Successful Search
95	326	4.78063e+07	1	Successful Search
96	330	4.77777e+07	1	Successful Search
97	334	4.77493e+07	1	Successful Search
98	338	4.77211e+07	1	Successful Search
99	342	4.76932e+07	1	Successful Search
100	346	4.76656e+07	1	Successful Search
101	350	4.76381e+07	1	Successful Search

```
Maximum number of iterations exceeded: increase options.MaxIterations.
-----------------------------------------------------------------
Losses Awal          = 51.0944 MW
Losses Optimal       = 47.6381 MW
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = |
|| Losses Reduction  = 3.4563 MW
                     = 3456275.00 W
|| Persentase        = 6.76%
=========================================================
Elapsed time is 2446.036811 seconds.
```

Lampiran 10 Hasil Optimasi MATLAB dengan Algoritma PSO

MATLAB Command Window Page 1

Iteration	f-count	Best f(x)	Mean f(x)	Stall Iterations
0	100	4.956e+07	5.515e+07	0
1	200	4.649e+07	5.242e+07	0
2	300	4.591e+07	4.934e+07	0
3	400	4.546e+07	4.728e+07	0
4	500	4.519e+07	4.633e+07	0
5	600	4.519e+07	4.576e+07	1
6	700	4.509e+07	4.545e+07	0
7	800	4.506e+07	4.529e+07	0
8	900	4.506e+07	4.518e+07	0
9	1000	4.506e+07	4.512e+07	1
10	1100	4.505e+07	4.51e+07	0
11	1200	4.505e+07	4.509e+07	0
12	1300	4.504e+07	4.508e+07	0
13	1400	4.504e+07	4.508e+07	0
14	1500	4.504e+07	4.506e+07	1
15	1600	4.504e+07	4.506e+07	0
16	1700	4.503e+07	4.506e+07	0
17	1800	4.503e+07	4.505e+07	1
18	1900	4.503e+07	4.505e+07	2
19	2000	4.503e+07	4.505e+07	3
20	2100	4.503e+07	4.504e+07	0
21	2200	4.503e+07	4.504e+07	0
22	2300	4.503e+07	4.504e+07	0
23	2400	4.503e+07	4.504e+07	1
24	2500	4.503e+07	4.504e+07	0
25	2600	4.503e+07	4.504e+07	0
26	2700	4.503e+07	4.504e+07	1
27	2800	4.503e+07	4.504e+07	2
28	2900	4.503e+07	4.504e+07	0
29	3000	4.503e+07	4.504e+07	0
30	3100	4.503e+07	4.503e+07	0
31	3200	4.503e+07	4.504e+07	0

Optimization ended: relative change in the objective value over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.

Losses Awal = 51.0944 MW
Losses Optimal = 45.0372 MW
= |
|| Losses Reduction = 6.0572 MW
= 6057225.00 W
|| Persentase = 11.85%
==
Elapsed time is 20041.514356 seconds.

Lampiran 11 Hasil Optimasi MATLAB dengan Algoritma PSPSO

MATLAB Command Window Page 1

Iteration	f-count	Best f(x)	Mean f(x)	Stall Iterations
0	100	4.962e+07	5.552e+07	0
1	200	4.776e+07	5.281e+07	0
2	300	4.683e+07	5.026e+07	0
3	400	4.579e+07	4.804e+07	0
4	500	4.564e+07	4.71e+07	0
5	600	4.553e+07	4.632e+07	0
6	700	4.538e+07	4.588e+07	0
7	800	4.52e+07	4.571e+07	0
8	900	4.514e+07	4.549e+07	0
9	1000	4.508e+07	4.532e+07	0
10	1100	4.505e+07	4.523e+07	0
11	1200	4.505e+07	4.518e+07	0
12	1300	4.505e+07	4.516e+07	0
13	1400	4.504e+07	4.513e+07	0
14	1500	4.504e+07	4.511e+07	1
15	1600	4.504e+07	4.509e+07	0
16	1700	4.504e+07	4.509e+07	0
17	1800	4.504e+07	4.508e+07	1
18	1900	4.504e+07	4.507e+07	0
19	2000	4.504e+07	4.508e+07	0
20	2100	4.504e+07	4.508e+07	1
21	2200	4.504e+07	4.507e+07	0
22	2300	4.504e+07	4.507e+07	0
23	2400	4.504e+07	4.507e+07	1
24	2500	4.503e+07	4.507e+07	0
25	2600	4.503e+07	4.506e+07	1
26	2700	4.503e+07	4.506e+07	0
27	2800	4.503e+07	4.506e+07	0
28	2900	4.503e+07	4.506e+07	0
29	3000	4.503e+07	4.506e+07	1
30	3100	4.503e+07	4.506e+07	0

Iteration	f-count	Best f(x)	Mean f(x)	Stall Iterations
31	3200	4.503e+07	4.505e+07	1
32	3300	4.503e+07	4.505e+07	0
33	3400	4.503e+07	4.505e+07	1
34	3500	4.503e+07	4.505e+07	0
35	3600	4.503e+07	4.505e+07	0
36	3700	4.503e+07	4.505e+07	1

Optimization ended: relative change in the objective value over the last OPTIONS.MaxStallIterations iterations is less than OPTIONS.FunctionTolerance.

Iter	Func-count	f(x)	MeshSize	Method
0	1	4.5029e+07	1	
1	25	4.50289e+07	1	Successful Search
2	49	4.50289e+07	1	Successful Search
3	73	4.50289e+07	1	Successful Search
4	99	4.50288e+07	1	Successful Search
5	125	4.50288e+07	1	Successful Search
6	151	4.50287e+07	1	Successful Search
7	177	4.50287e+07	1	Successful Search
8	203	4.50286e+07	1	Successful Search
9	289	4.50286e+07	0.5	Refine Mesh
10	389	4.50286e+07	0.25	Refine Mesh
11	497	4.50286e+07	0.125	Refine Mesh
12	543	4.50286e+07	0.125	Successful Search
13	544	4.50286e+07	0.125	Successful Search
14	660	4.50286e+07	0.0625	Refine Mesh
15	818	4.50286e+07	0.03125	Refine Mesh
16	821	4.50286e+07	0.03125	Successful Search
17	866	4.50286e+07	0.03125	Successful Search
18	1038	4.50286e+07	0.01562	Refine Mesh
19	1041	4.50286e+07	0.01562	Successful Search
20	1105	4.50286e+07	0.01562	Successful Search
21	1285	4.50286e+07	0.007812	Refine Mesh
22	1294	4.50286e+07	0.007812	Successful Search
23	1476	4.50286e+07	0.003906	Refine Mesh
24	1479	4.50286e+07	0.003906	Successful Search
25	1488	4.50285e+07	0.003906	Successful Search
26	1497	4.50285e+07	0.003906	Successful Search
27	1681	4.50285e+07	0.001953	Refine Mesh
28	1691	4.50285e+07	0.001953	Successful Search
29	1694	4.50285e+07	0.001953	Successful Search
30	1882	4.50285e+07	0.0009766	Refine Mesh

Iter	Func-count	f(x)	MeshSize	Method
31	1892	4.50285e+07	0.0009766	Successful Search
32	1895	4.50285e+07	0.0009766	Successful Search
33	2083	4.50285e+07	0.0004883	Refine Mesh
34	2093	4.50285e+07	0.0004883	Successful Search
35	2103	4.50285e+07	0.0004883	Successful Search
36	2293	4.50285e+07	0.0002441	Refine Mesh
37	2303	4.50285e+07	0.0002441	Successful Search
38	2495	4.50285e+07	0.0001221	Refine Mesh
39	2687	4.50285e+07	6.104e-05	Refine Mesh
40	2697	4.50285e+07	6.104e-05	Successful Search

Optimization terminated: change in X less than options. StepTolerance.

Losses Awal = 51.0944 MW
Losses Optimal = 45.0285 MW
= |
|| Losses Reduction = 6.0660 MW
= 6065955.00 W
|| Persentase = 11.87%
==
Elapsed time is 38924.101333 seconds.