

Supplementary Materials

Test Case 1: IEEE-14 Bus Standard

Table S1. load flow results GA, 14-bus, and 1 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	209.530	-12.621	209.530	-12.621	0	0	3.500	10.686	1.060
-0.078	18.299	27.134	39.999	39.834	21.700	12.700	2.230	9.207	1.045
-0.207	-94.200	6.011	0	25.011	94.200	19	2.128	8.969	1.010
-0.159	-47.800	3.899	0	0	47.800	-3.900	1.304	3.958	1.018
-0.136	-7.600	-1.599	0	0	7.600	1.600	0.722	2.205	1.020
-0.225	-11.200	12.848	0	20.348	11.200	7.500	0.478	1.221	1.070
-0.186	0	0	0	0	0	0	0.372	1.174	1.052
-0.154	20.848	23.307	0	23.307	-20.848	0	0	0.965	1.090
-0.221	-29.500	-16.600	0	0	29.500	16.600	0	0.815	1.037
-0.227	-8.999	-5.799	0	0	9	5.800	0	4.743	1.035
-0.228	-3.499	-1.800	0	0	3.500	1.800	0.086	0.181	1.049
-0.239	-6.099	-1.599	0	0	6.100	1.600	0.074	0.155	1.053
-0.239	-13.499	-5.799	0	0	13.500	5.800	0.220	0.434	1.047
-0.247	-14.900	-5	0	0	14.900	5	0	1.449	1.023
							0	1.448	
							0.014	0.039	
							0.127	0.271	
							0.035	0.082	
							0.008	0.007	
							0.073	0.148	

Table S2. load flow results PSO, 14-bus, and 1 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	209.529	-12.620	209.529	-12.620	0	0	3.500	10.686	1.060
-0.078	18.299	27.134	39.999	39.834	21.700	12.700	2.230	9.207	1.045
-0.207	-94.200	6.010	0	25.010	94.200	19	2.128	8.969	1.010
-0.159	-47.799	3.900	0	0	47.800	-3.900	1.304	3.958	1.018
-0.136	-7.599	-1.600	0	0	7.600	1.600	0.722	2.205	1.020
-0.225	-11.200	12.848	0	20.348	11.200	7.500	0.478	1.221	1.070
-0.186	0	0	0	0	0	0	0.372	1.174	1.052
-0.154	20.850	23.307	0	23.307	-20.850	0	0	0.965	1.090
-0.221	-29.500	-16.600	0	0	29.500	16.600	0	0.815	1.037
-0.227	-9	-5.799	0	0	9	5.800	0	4.743	1.035
-0.228	-3.500	-1.799	0	0	3.500	1.800	0.086	0.181	1.049
-0.239	-6.100	-1.599	0	0	6.100	1.600	0.074	0.155	1.053

-0.239	-13.499	-5.800	0	0	13.500	5.800	0.220	0.434	1.047
-0.247	-14.900	-4.999	0	0	14.900	5	0	1.449	1.023
							0	1.448	
							0.014	0.039	
							0.127	0.271	
							0.035	0.082	
							0.008	0.007	
							0.073	0.148	

Table S3. load flow results GRO, 14-bus, and 1 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	212.906	-13.074	212.906	-13.074	0	0	3.612	11.030	1.060
-0.079	18.299	28.127	39.999	40.827	21.700	12.700	2.306	9.520	1.045
-0.209	-94.200	6.303	0	25.303	94.200	19	2.157	9.090	1.010
-0.162	-47.799	3.900	0	0	47.800	-3.900	1.355	4.112	1.017
-0.139	-7.600	-1.599	0	0	7.600	1.600	0.749	2.288	1.019
-0.229	-11.200	12.997	0	20.497	11.200	7.500	0.464	1.184	1.070
-0.192	0	0	0	0	0	0	0.388	1.223	1.052
-0.165	17.771	23.405	0	23.405	-17.771	0	0	1.085	1.090
-0.226	-29.500	-16.600	0	0	29.500	16.600	0	0.880	1.036
-0.232	-8.999	-5.799	0	0	9	5.800	0	4.875	1.035
-0.232	-3.500	-1.799	0	0	3.500	1.800	0.089	0.187	1.048
-0.243	-6.099	-1.599	0	0	6.100	1.600	0.075	0.156	1.053
-0.243	-13.500	-5.800	0	0	13.500	5.800	0.224	0.441	1.047
-0.252	-14.900	-5	0	0	14.900	5	0	1.280	1.023
							0	1.376	
							0.013	0.035	
							0.121	0.259	
							0.035	0.083	
							0.008	0.008	
							0.075	0.154	

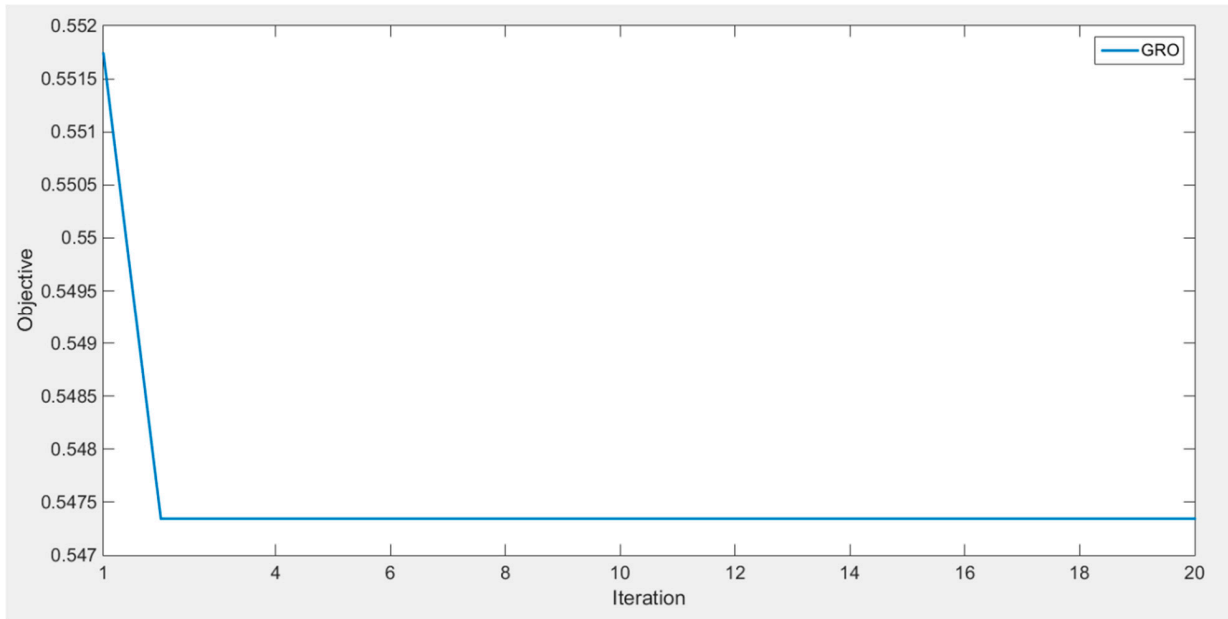


Figure S1. Algorithm Convergent GRO, 14-bus, and 1DG

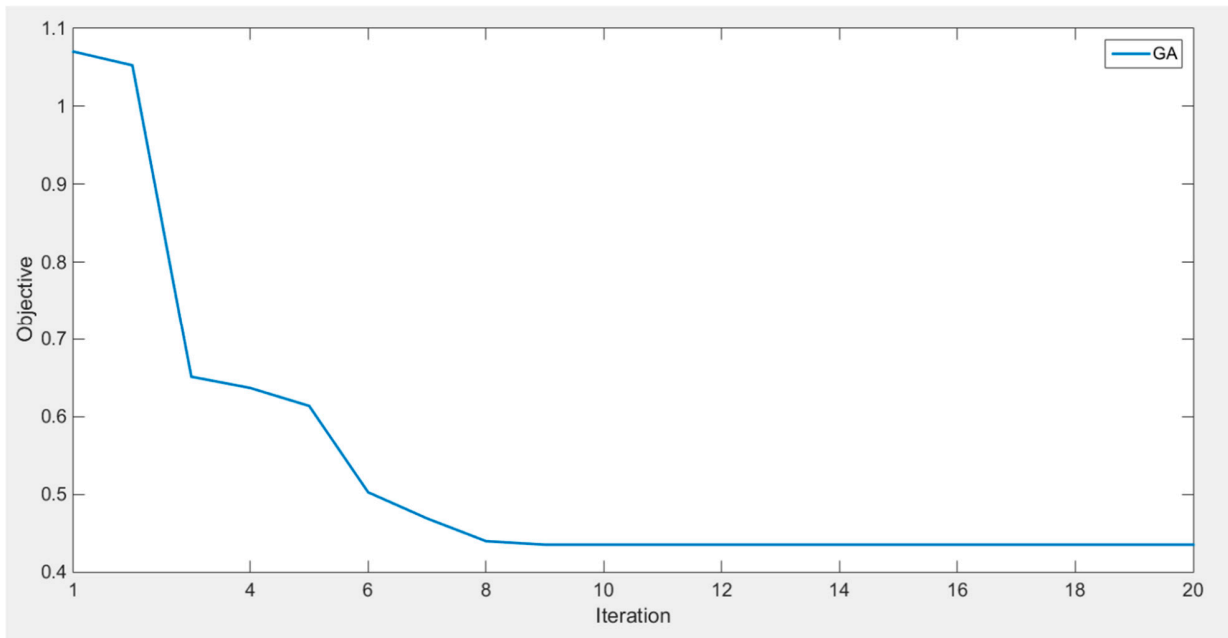


Figure S2. Algorithm Convergent GA, 14-bus, and 1DG

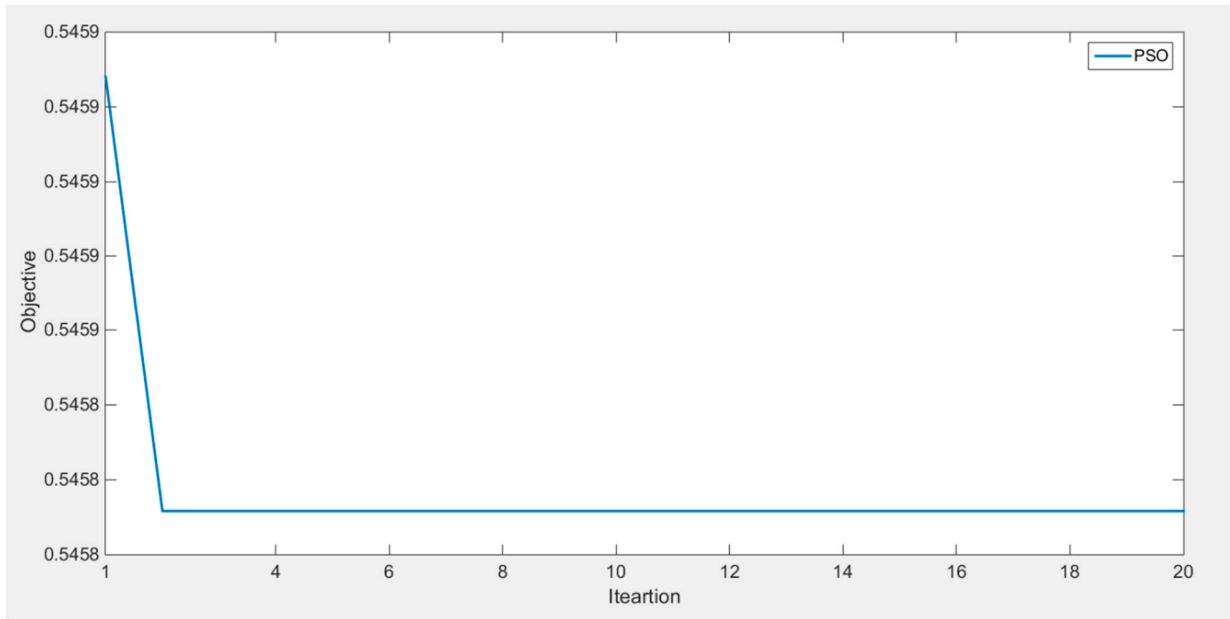


Figure S3. Algorithm Convergent PSO, 14-bus, and 1DG

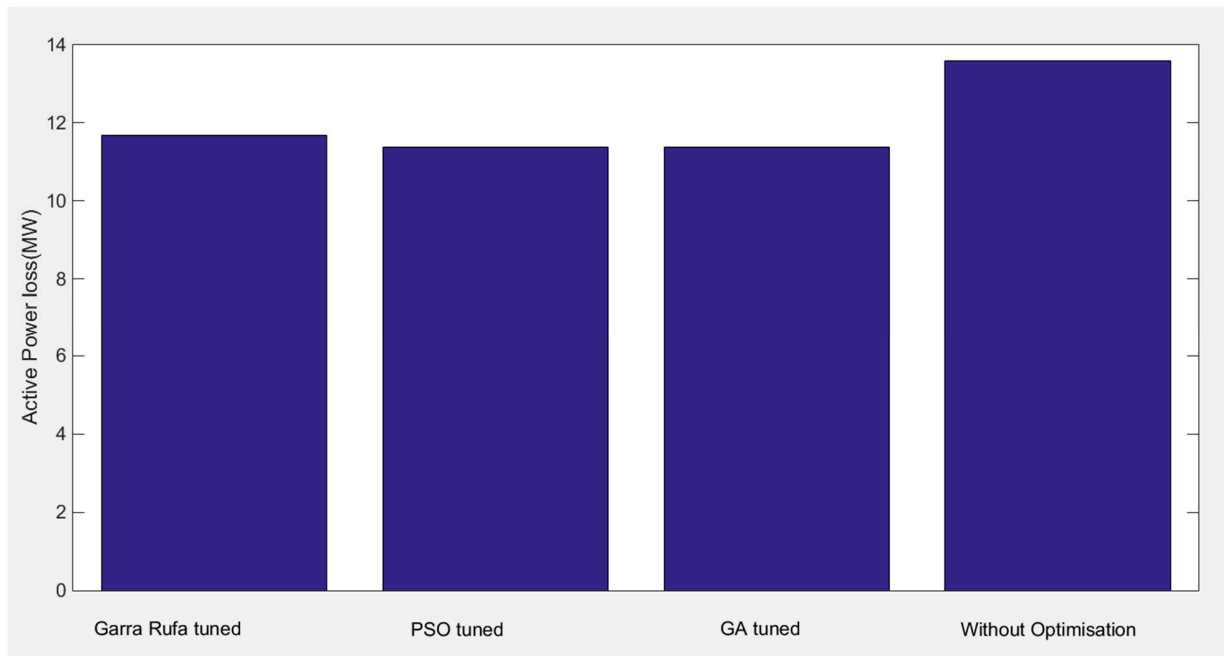


Figure S4. Active Power Losses 1DG and 14-bus

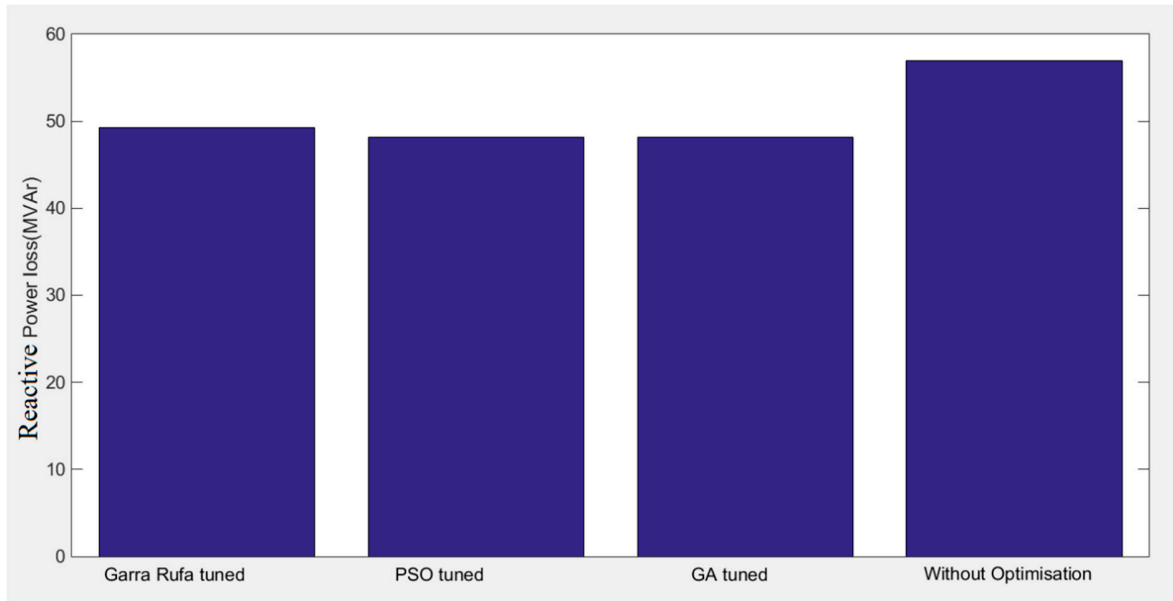


Figure S5. Reactive Power Losses 1DG and 14-bus

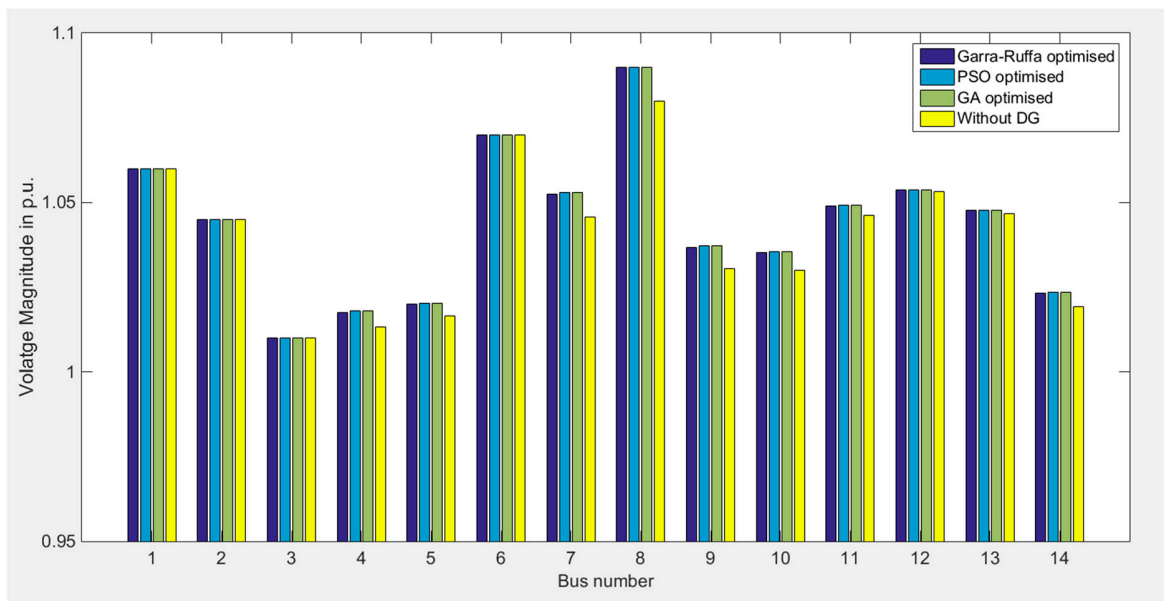


Figure S6. Voltage Profile 1DG and 14-bus

Table S4. load flow results GA, 14-bus, and 2 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	186.424	-7.870	186.424	-7.870	0	0	2.688	8.209	1.060
-0.068	18.300	22.507	40.00	35.207	21.700	12.700	1.870	7.723	1.045
-0.173	-73.362	-2.424	0	16.575	73.362	19	1.468	6.187	1.010
-0.144	-47.800	3.899	0	0	47.800	-3.900	1.155	3.504	1.018
-0.124	-7.599	-1.600	0	0	7.600	1.600	0.670	2.047	1.020
-0.212	-11.199	12.677	0	20.177	11.200	7.500	0.190	0.486	1.070
-0.171	20.707	0	0	0	-20.707	0	0.285	0.901	1.053
-0.171	0	22.723	0	22.723	0	0	0	0.989	1.090
-0.206	-29.499	-16.599	0	0	29.500	16.600	0	0.838	1.037
-0.212	-9.000	-5.800	0	0	9	5.800	0	4.655	1.035
-0.214	-3.500	-1.799	0	0	3.500	1.800	0.084	0.177	1.049
-0.226	-6.100	-1.600	0	0	6.100	1.600	0.074	0.154	1.053
-0.226	-13.499	-5.800	0	0	13.500	5.800	0.218	0.430	1.047
-0.233	-14.900	-5.00	0	0	14.900	5	0	0.765	1.023
							0	1.463	
							0.015	0.042	
							0.131	0.279	
							0.034	0.081	
							0.008	0.007	
							0.071	0.144	

Table S5. load flow results PSO, 14-bus, and 2 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	187.167	-7.977	187.167	-7.977	0	0	2.710	8.274	1.060
-0.068	18.300	22.720	40.000	35.420	21.700	12.700	1.886	7.786	1.045
-0.174	-73.350	-2.363	0	16.636	73.350	19	1.473	6.207	1.010
-0.144	-47.800	3.900	0	0	47.800	-3.900	1.165	3.537	1.018
-0.124	-7.599	-1.599	0	0	7.600	1.600	0.676	2.065	1.020
-0.213	-11.200	12.713	0	20.213	11.200	7.500	0.188	0.480	1.070
-0.173	20.010	0	0	0	-20.010	0	0.288	0.910	1.053
-0.173	0	22.775	0	22.775	0	0	0	1.015	1.090
-0.208	-29.499	-16.600	0	0	29.500	16.600	0	0.853	1.037
-0.214	-8.999	-5.799	0	0	9	5.800	0	4.684	1.035
-0.215	-3.500	-1.800	0	0	3.500	1.800	0.085	0.178	1.049
-0.227	-6.099	-1.600	0	0	6.100	1.600	0.074	0.154	1.053
-0.227	-13.500	-5.800	0	0	13.500	5.800	0.219	0.431	1.047
-0.234	-14.900	-4.999	0	0	14.900	5	0	0.769	1.023
							0	1.446	

							0.015	0.041	
							0.130	0.276	
							0.034	0.081	
							0.008	0.007	
							0.071	0.146	

Table S6. load flow results GRO, 14-bus, and 2 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	189.460	-8.565	189.460	-8.565	0	0	2.792	8.524	1.060
-0.069	18.300	23.000	40.000	35.700	21.700	12.700	1.912	7.892	1.045
-0.178	-76.818	-1.137	0	17.862	76.818	19	1.562	6.584	1.010
-0.146	-47.799	3.899	0	0	47.800	-3.900	1.168	3.544	1.018
-0.125	-7.600	-1.600	0	0	7.600	1.600	0.673	2.055	1.020
-0.213	-11.200	12.651	0	20.151	11.200	7.500	0.231	0.589	1.070
-0.172	21.432	0	0	0	-21.432	0	0.296	0.933	1.053
-0.172	0	22.684	0	22.684	0	0	0	0.961	1.090
-0.208	-29.500	-16.600	0	0	29.500	16.600	0	0.820	1.037
-0.213	-8.999	-5.799	0	0	9	5.800	0	4.638	1.035
-0.215	-3.500	-1.800	0	0	3.500	1.800	0.084	0.176	1.049
-0.227	-6.100	-1.600	0	0	6.100	1.600	0.073	0.153	1.053
-0.227	-13.499	-5.799	0	0	13.500	5.800	0.217	0.429	1.047
-0.234	-14.899	-4.999	0	0	14.900	5	0	0.762	1.023
							0	1.478	
							0.016	0.042	
							0.132	0.280	
							0.034	0.081	
							0.008	0.007	
							0.070	0.144	

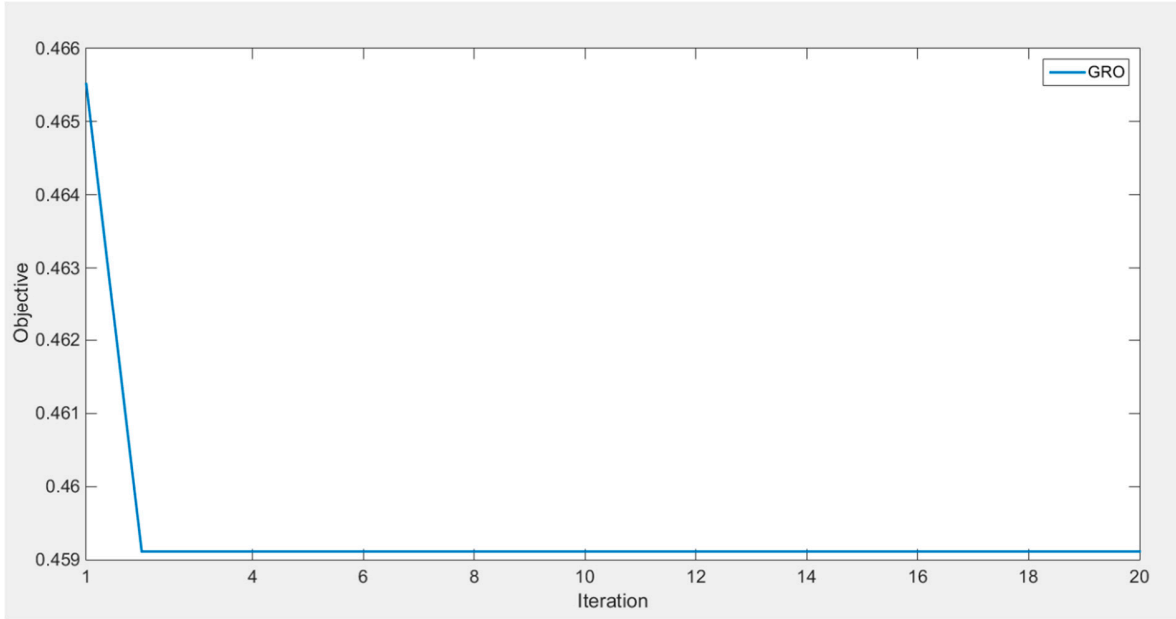


Figure S7. Algorithm Convergent GRO, 14-bus, and 2DG

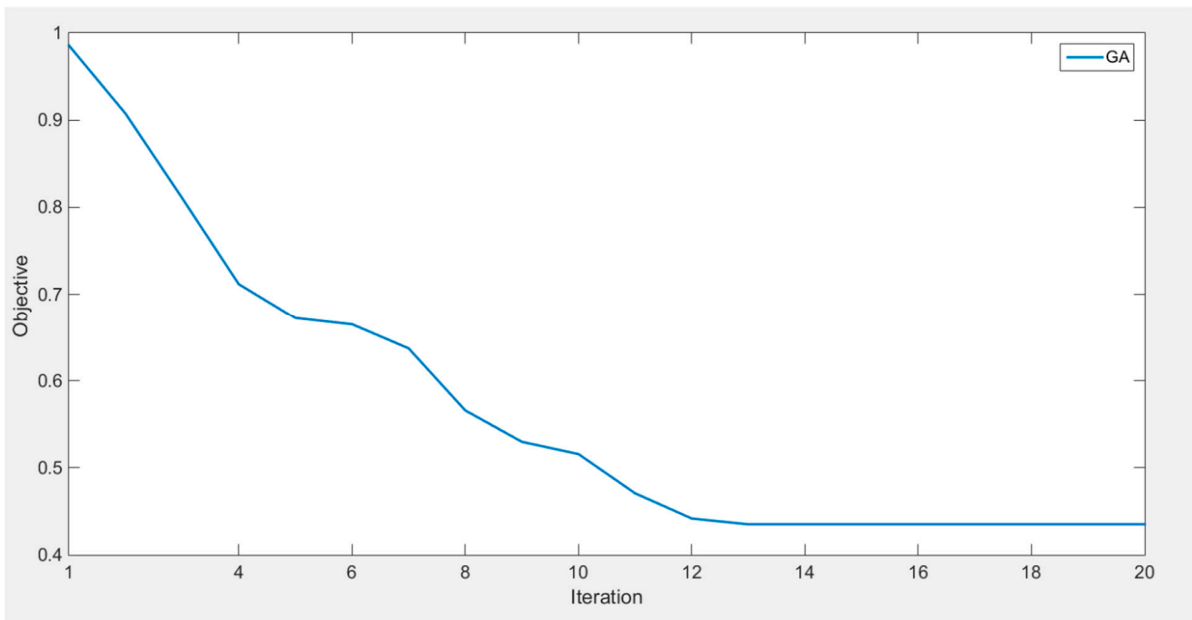


Figure S8. Algorithm Convergent GA, 14-bus, and 2DG

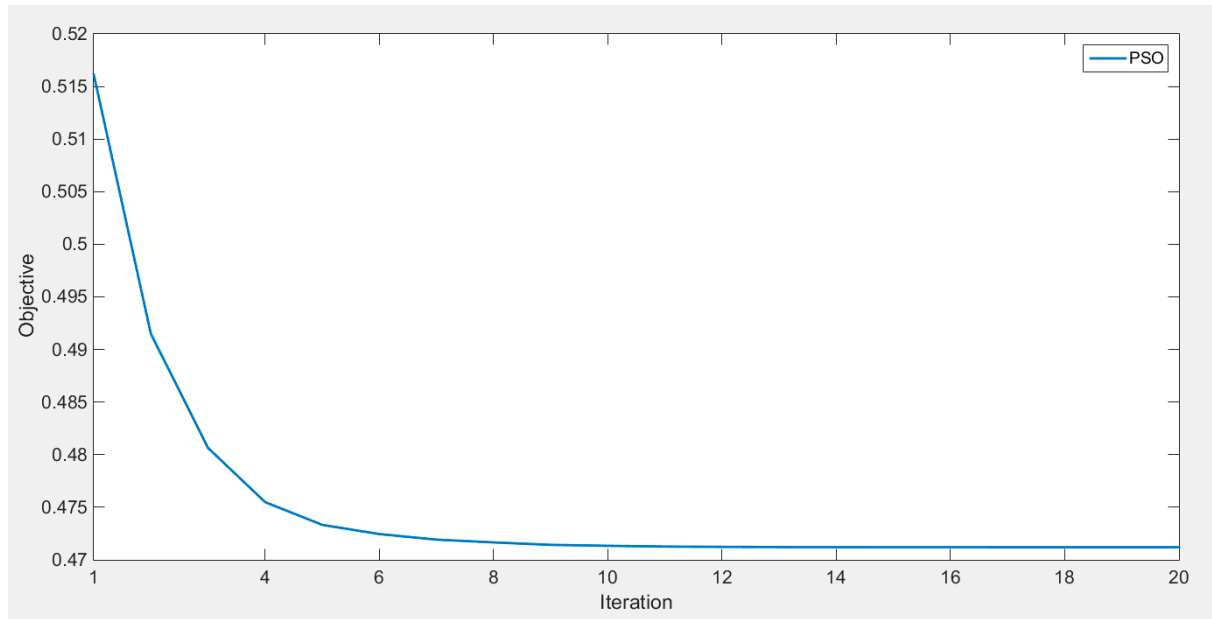


Figure S9. Algorithm Convergent PSO, 14-bus, and 2DG

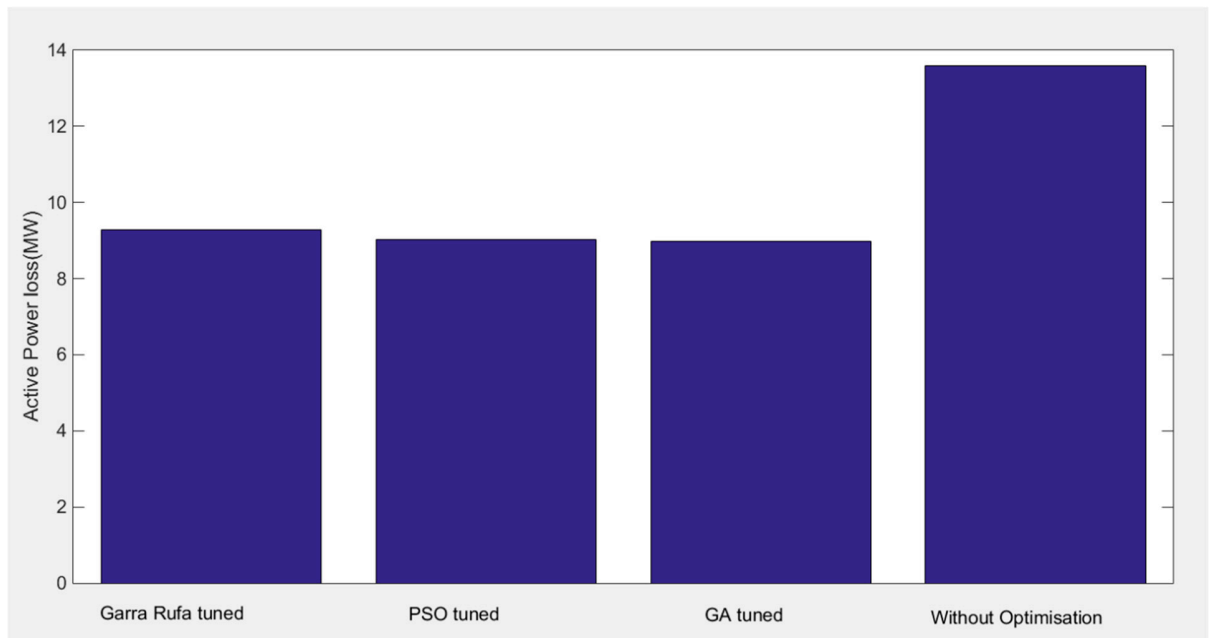


Figure S10. Active Power Losses 2DG and 14-bus

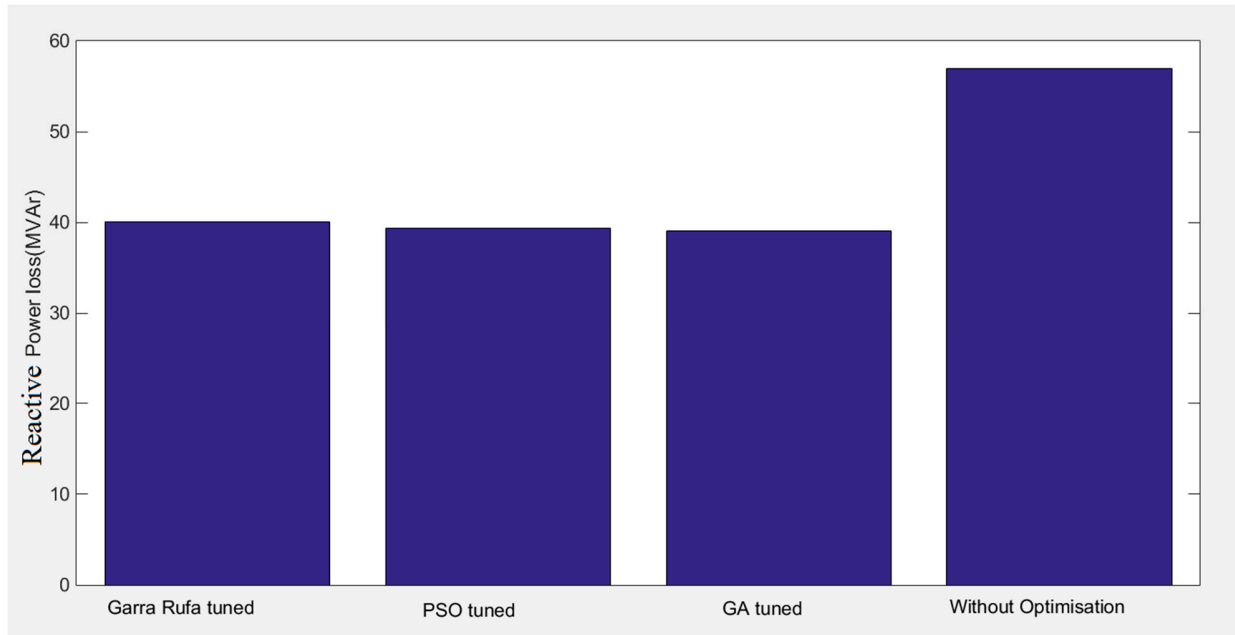


Figure S11. Reactive Power Losses 2DG and 14-bus

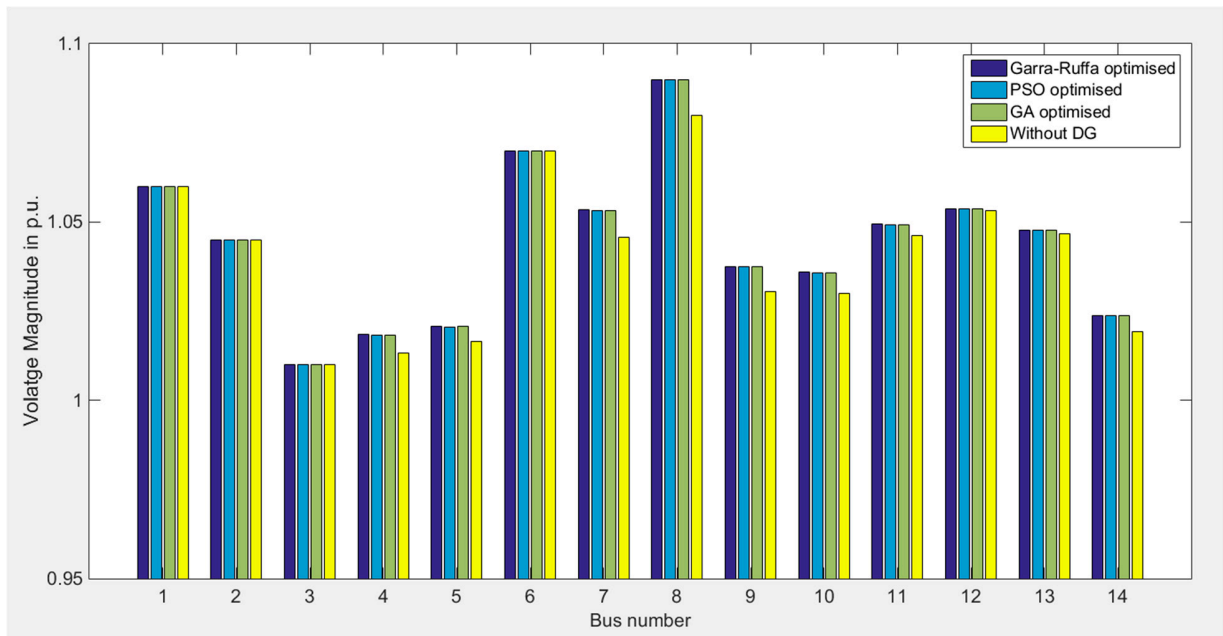


Figure S12. Voltage Profile 2DG and 14-bus

Table S7. load flow results GA, 14-bus, and 3 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	82.281	13.121	82.281	13.121	0	0	0.477	1.458	1.060
-0.025	69.089	-5.659	40.000	7.040	-29.089	12.700	0.486	2.009	1.045
-0.141	-94.200	3.658	0	22.658	94.200	19	1.738	7.325	1.010
-0.082	-47.800	3.899	0	0	47.800	-3.900	0.673	2.045	1.022
-0.058	-7.599	-1.599	0	0	7.600	1.600	0.245	0.749	1.028
-0.025	32.003	0.818	0	8.318	-32.003	7.500	0.730	1.865	1.070
-0.097	0	0	0	0	0	0	0.444	1.401	1.045
-0.097	0	20.941	0	20.941	0	0	0	0.375	1.080
-0.106	-29.500	-16.599	0	0	29.500	16.600	0	0.104	1.024
-0.096	-9.000	-5.800	0	0	9	5.800	0	1.228	1.023
-0.063	-3.500	-1.800	0	0	3.500	1.800	0.462	0.968	1.041
-0.025	-6.100	-1.600	0	0	6.1000	1.600	0.015	0.031	1.060
-0.013	35.829	-5.800	0	0	-35.829	5.800	0.062	0.123	1.066
-0.082	-14.900	-5	0	0	14.900	5	0	0.662	1.023
							0	0.474	
							0.036	0.096	
							0.084	0.178	
							0.281	0.658	
							0.052	0.047	
							0.810	1.650	

Table S8. load flow results PSO, 14-bus, and 3 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	72.975	15.126	72.975	15.126	0	0	0.387	1.182	1.060
-0.022	69.150	-7.129	39.999	5.570	-29.150	12.700	0.391	1.615	1.045
-0.135	-94.200	3.378	0	22.378	94.200	19	1.681	7.083	1.010
-0.075	-47.800	3.899	0	0	47.800	-3.900	0.593	1.800	1.023
-0.051	-7.600	-1.600	0	0	7.600	1.600	0.196	0.599	1.029
-0.005	39.650	0.156	0	7.656	-39.650	7.500	0.776	1.981	1.070
-0.087	0	0	0	0	0	0	0.450	1.420	1.045
-0.087	0	21.153	0	21.153	0	0	0	0.307	1.080
-0.093	-29.500	-16.600	0	0	29.500	16.600	0	0.062	1.023
-0.082	-9.000	-5.800	0	0	9	5.800	0	1.685	1.022
-0.046	-3.500	-1.799	0	0	3.500	1.800	0.527	1.104	1.040
-0.004	-6.100	-1.600	0	0	6.100	1.600	0.014	0.030	1.060
0.0075	37.350	-5.799	0	0	-37.350	5.800	0.062	0.123	1.066
-0.066	-14.900	-5	0	0	14.900	5	0	0.675	1.022

							0	0.479	
							0.048	0.128	
							0.111	0.237	
							0.329	0.772	
							0.052	0.047	
							0.901	1.835	

Table S9. load flow results GRO, 14-bus, and 3 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	91.660	10.843	91.660	10.843	0	0	0.600	1.834	1.060
-0.029	64.474	-3.293	39.999	9.406	-24.474	12.700	0.562	2.323	1.045
-0.146	-94.199	3.83	0	22.836	94.200	19	1.762	7.423	1.010
-0.088	-47.800	3.899	0	0	47.800	-3.900	0.707	2.145	1.022
-0.064	-7.599	-1.599	0	0	7.600	1.600	0.264	0.806	1.028
-0.037	30.725	1.084	0	8.584	-30.725	7.500	0.713	1.821	1.070
-0.105	0	0	0	0	0	0	0.449	1.416	1.045
-0.105	0	20.885	0	20.885	0	0	0	0.416	1.080
-0.114	-29.500	-16.600	0	0	29.500	16.600	0	0.131	1.024
-0.105	-9.000	-5.799	0	0	9	5.800	0	1.067	1.024
-0.073	-3.500	-1.800	0	0	3.500	1.800	0.437	0.915	1.041
-0.038	-6.099	-1.600	0	0	6.100	1.600	0.016	0.033	1.059
-0.026	32.454	-5.800	0	0	-32.454	5.800	0.048	0.094	1.065
-0.093	-14.900	-5.000	0	0	14.900	5	0	0.658	1.022
							0	0.478	
							0.031	0.084	
							0.067	0.144	
							0.262	0.614	
							0.042	0.038	
							0.748	1.524	

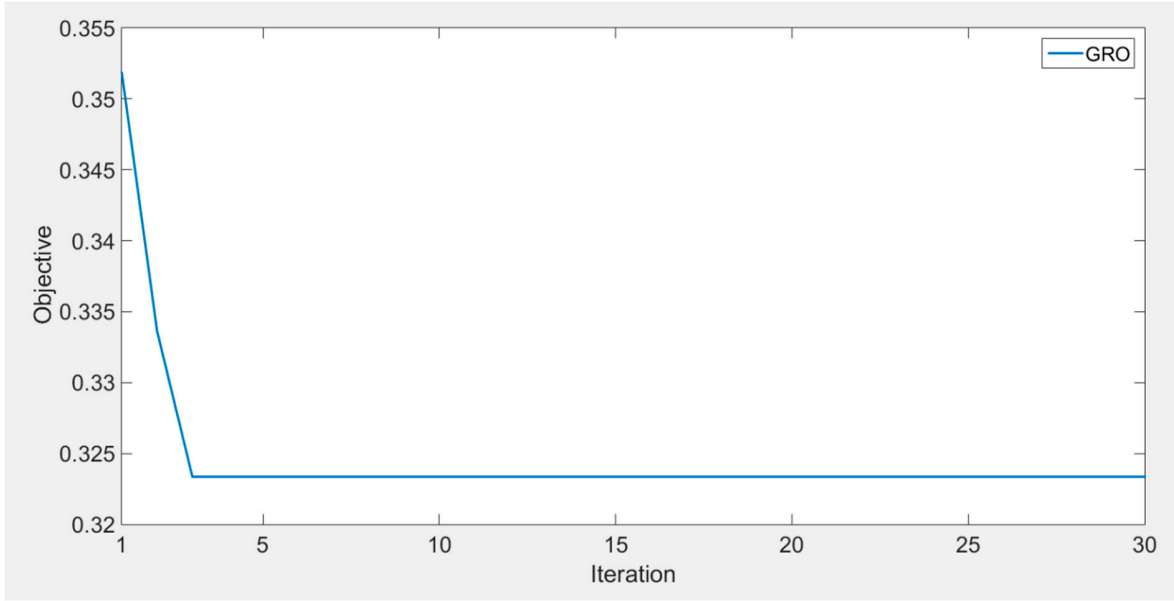


Figure S13. Algorithm Convergent GRO, 14-bus, and 3DG

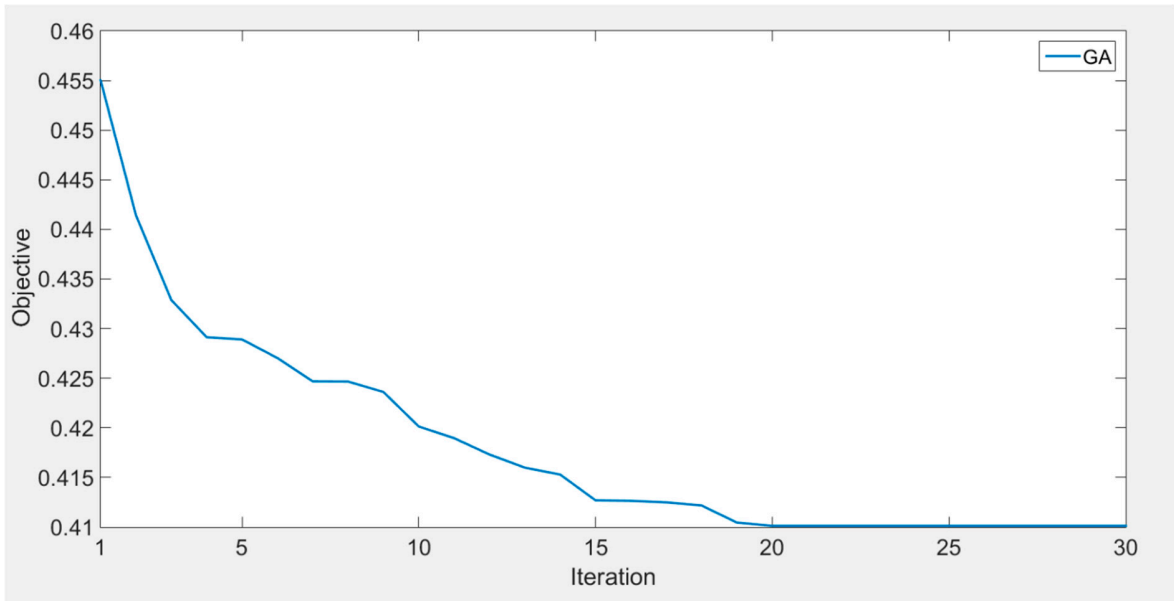


Figure S14. Algorithm Convergent GA, 14-bus, and 3DG

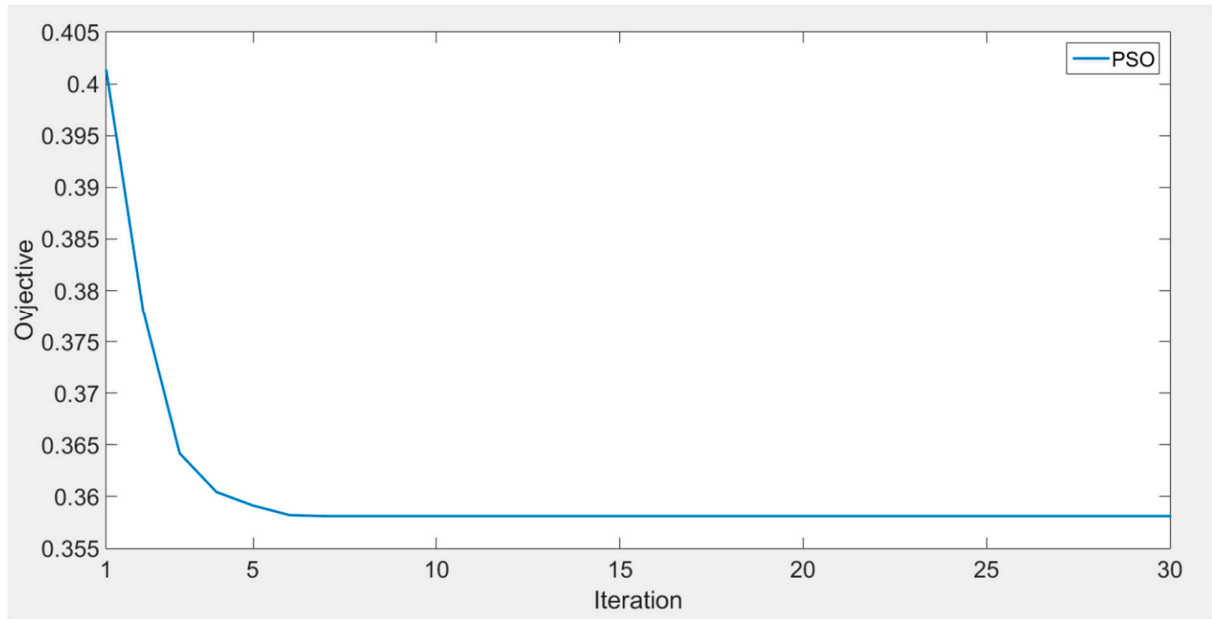


Figure S15. Algorithm Convergent PSO, 14-bus, and 3DG

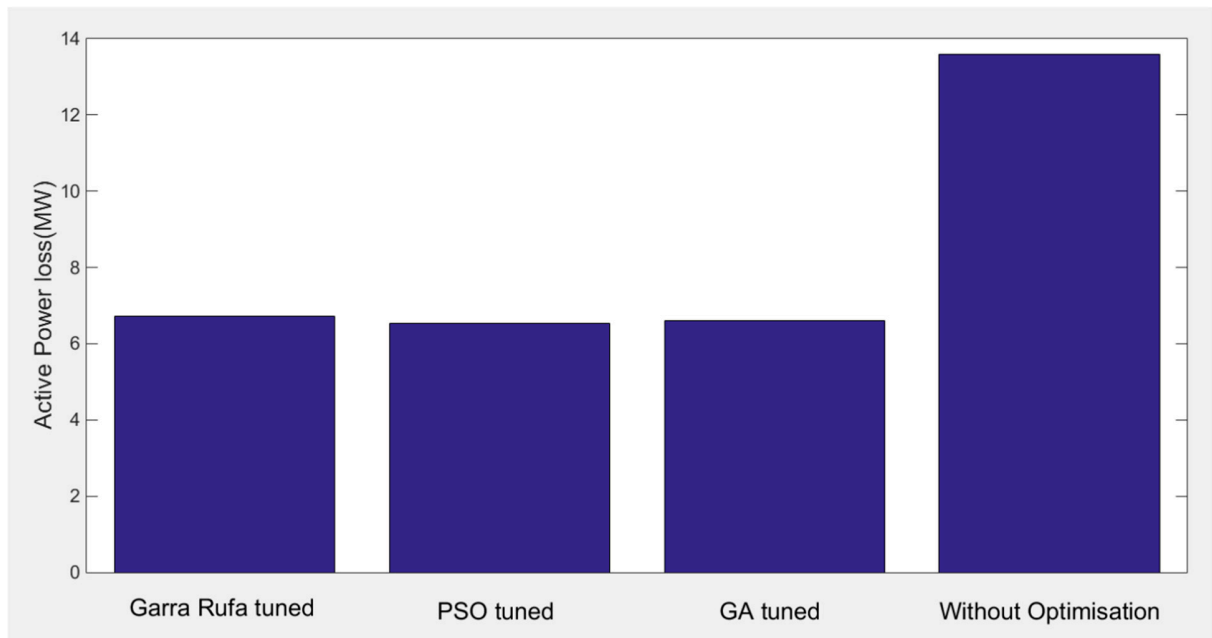


Figure S16. Active Power Losses 3DG and 14-bus

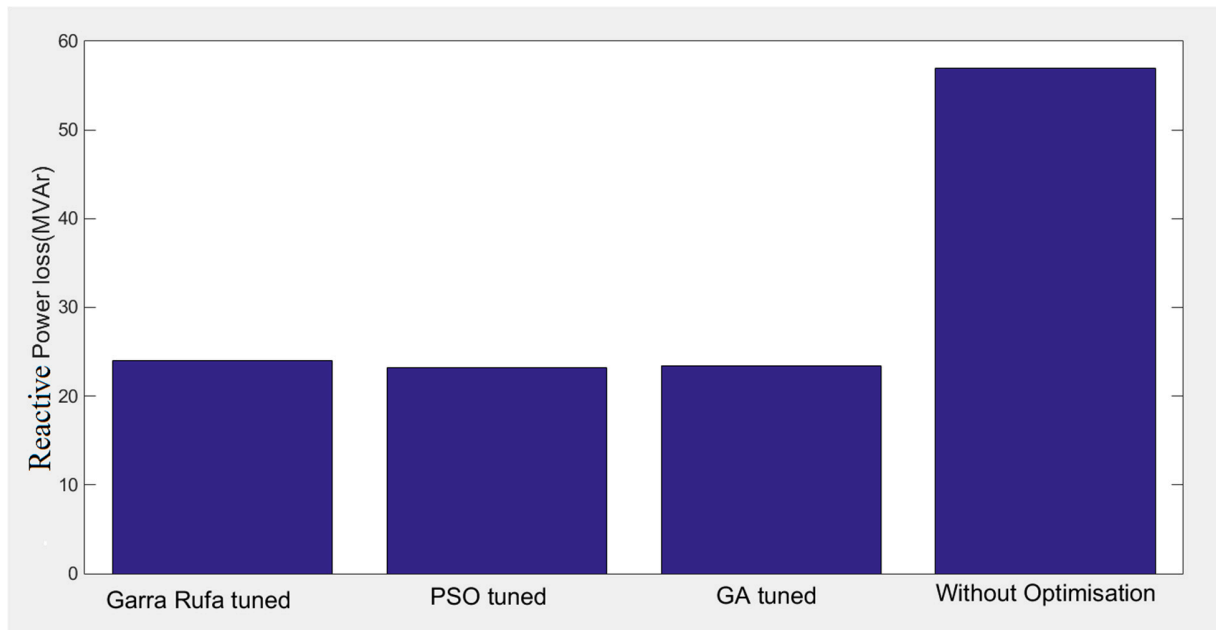


Figure S17. Reactive Power Losses 3DG and 14-bus

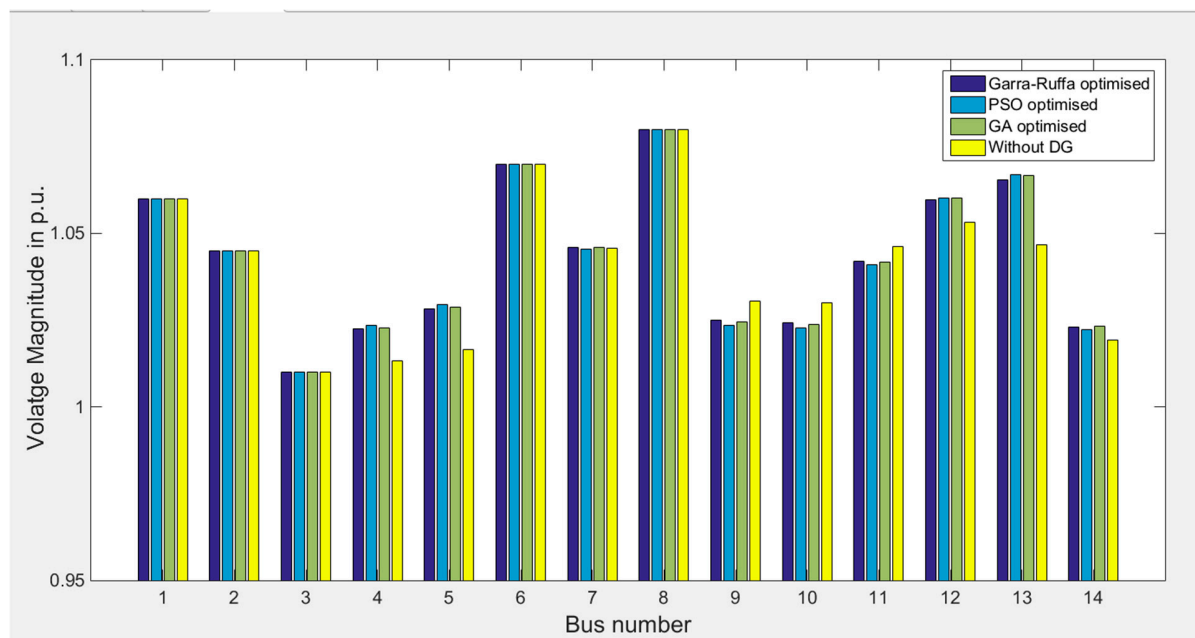


Figure S18. Voltage Profile 3DG and 14-bus

Table S10. load flow results GA, 14-bus, and 4 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	165.397	-4.563	165.397	-4.563	0	0	2.063	6.301	1.060
-0.059	39.149	13.176	40.000	25.876	0.850	12.700	1.538	6.349	1.045
-0.183	-94.200	4.365	0	23.365	94.200	19	1.996	8.411	1.010
-0.133	-47.799	3.900	0	0	47.800	-3.900	1.081	3.282	1.021
-0.112	-7.600	-1.599	0	0	7.600	1.600	0.587	1.793	1.023
-0.177	-11.200	9.901	0	17.401	11.200	7.500	0.548	1.399	1.070
-0.148	0	0	0	0	0	0	0.322	1.017	1.054
-0.116	20.777	22.302	0	22.302	-20.777	0	0	0.662	1.090
-0.177	-29.500	-16.600	0	0	29.500	16.600	0	0.432	1.038
-0.175	-9	-5.799	0	0	9	5.800	0	2.899	1.039
-0.160	17.325	-1.800	0	0	-17.325	1.800	0.086	0.180	1.059
-0.191	-6.100	-1.600	0	0	6.100	1.600	0.075	0.156	1.053
-0.191	-13.499	-5.799	0	0	13.500	5.800	0.223	0.440	1.047
-0.201	-14.900	-5.000	0	0	14.900	5	0	1.377	1.024
							0	1.050	
							0.001	0.004	
							0.117	0.250	
							0.124	0.291	
							0.008	0.007	
							0.072	0.148	

Table S11. load flow results PSO, 14-bus, and 4 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	182.258	-8.255	182.258	-8.255	0	0	2.611	7.973	1.060
-0.067	26.348	18.906	39.999	31.606	13.651	12.700	1.725	7.124	1.045
-0.192	-94.200	4.676	0	23.676	94.200	19	2.005	8.448	1.010
-0.141	-47.800	3.900	0	0	47.800	-3.900	1.094	3.320	1.020
-0.119	-7.599	-1.599	0	0	7.600	1.600	0.578	1.766	1.023
-0.186	-11.200	10.007	0	17.507	11.200	7.500	0.544	1.390	1.070
-0.160	0	0	0	0	0	0	0.352	1.111	1.054
-0.133	17.471	22.400	0	22.400	-17.471	0	0	0.739	1.090
-0.187	-29.500	-16.599	0	0	29.500	16.600	0	0.479	1.038
-0.185	-9.000	-5.800	0	0	9	5.800	0	3.013	1.039
-0.169	17.350	-1.800	0	0	-17.350	1.800	0.081	0.169	1.059
-0.200	-6.099	-1.599	0	0	6.100	1.600	0.075	0.157	1.053
-0.201	-13.500	-5.800	0	0	13.500	5.800	0.228	0.449	1.047
-0.211	-14.900	-5.000	0	0	14.900	5	0	1.196	1.024
							0	0.986	

							0.002	0.005	
							0.111	0.237	
							0.131	0.307	
							0.008	0.008	
							0.076	0.156	

Table S12. load flow results GRO, 14-bus, and 4 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	158.989	-3.971	158.989	-3.971	0	0	1.944	5.935	1.060
-0.057	35.434	12.093	39.999	24.793	4.565	12.700	1.367	5.646	1.045
-0.179	-94.200	3.820	0	22.820	94.200	19	1.923	8.104	1.010
-0.127	-47.800	3.899	0	0	47.800	-3.900	0.962	2.918	1.022
-0.105	-7.599	-1.600	0	0	7.600	1.600	0.489	1.494	1.024
-0.154	-11.200	8.548	0	16.048	11.200	7.500	0.593	1.514	1.070
-0.141	0	0	0	0	0	0	0.339	1.070	1.054
-0.120	13.558	21.928	0	21.928	-13.558	0	0	0.622	1.090
-0.162	-29.500	-16.600	0	0	29.500	16.600	0	0.287	1.038
-0.153	-9.000	-5.800	0	0	9	5.800	0	1.998	1.041
-0.123	34.521	-1.799	0	0	-34.521	1.800	0.225	0.472	1.067
-0.169	-6.100	-1.599	0	0	6.100	1.600	0.077	0.161	1.053
-0.170	-13.500	-5.800	0	0	13.500	5.800	0.236	0.465	1.047
-0.183	-14.899	-5	0	0	14.900	5	0	0.985	1.024
							0	0.684	
							0.034	0.091	
							0.097	0.208	
							0.319	0.748	
							0.009	0.008	
							0.083	0.170	

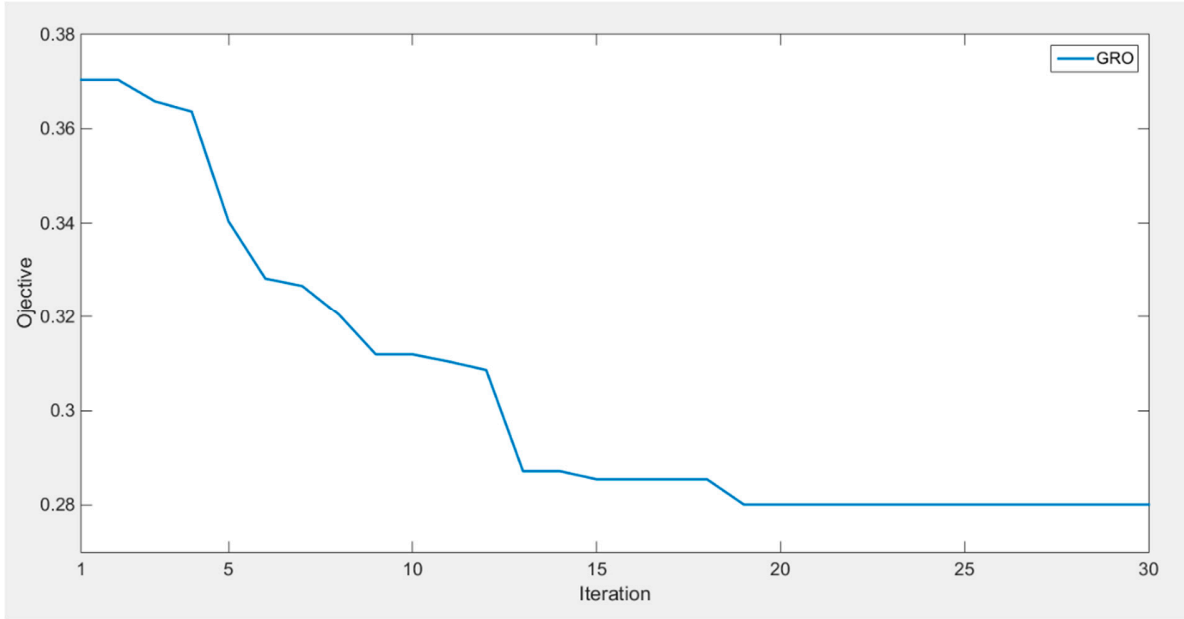


Figure S19. Algorithm Convergent GRO, 14-bus, and 4DG

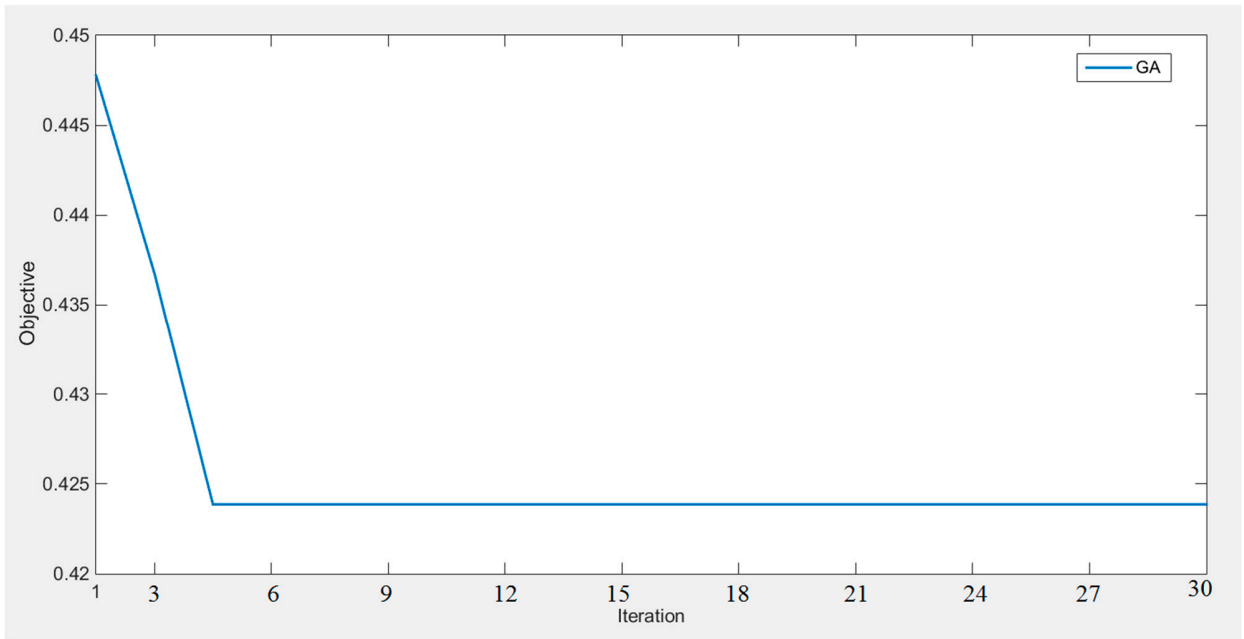


Figure S20. Algorithm Convergent GA, 14-bus, and 4DG

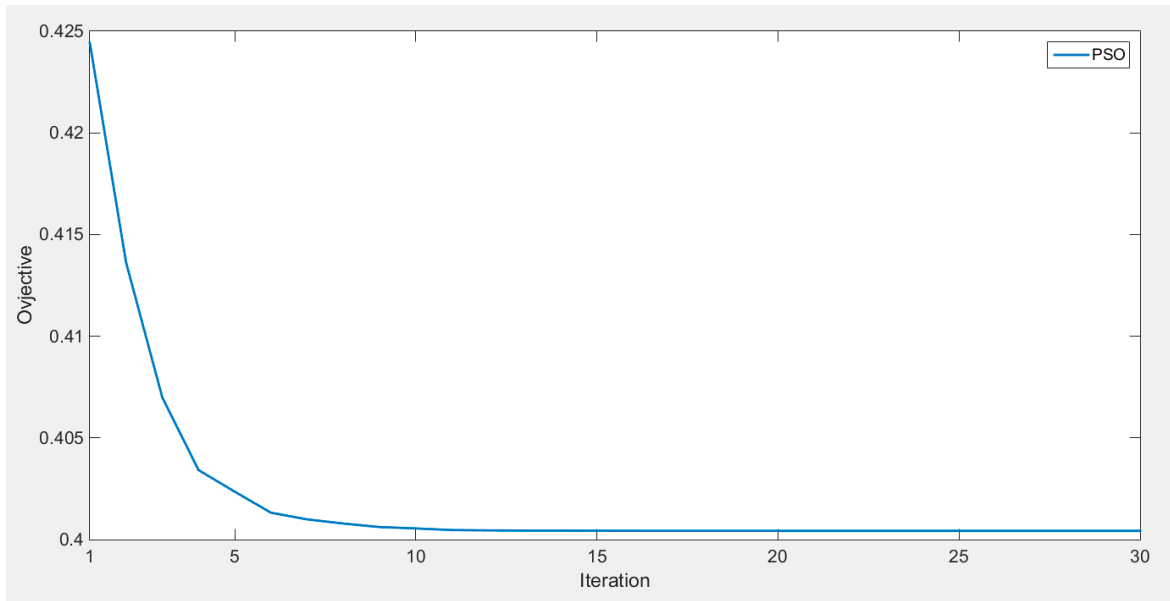


Figure S21. Algorithm Convergent PSO, 14-bus, and 4DG

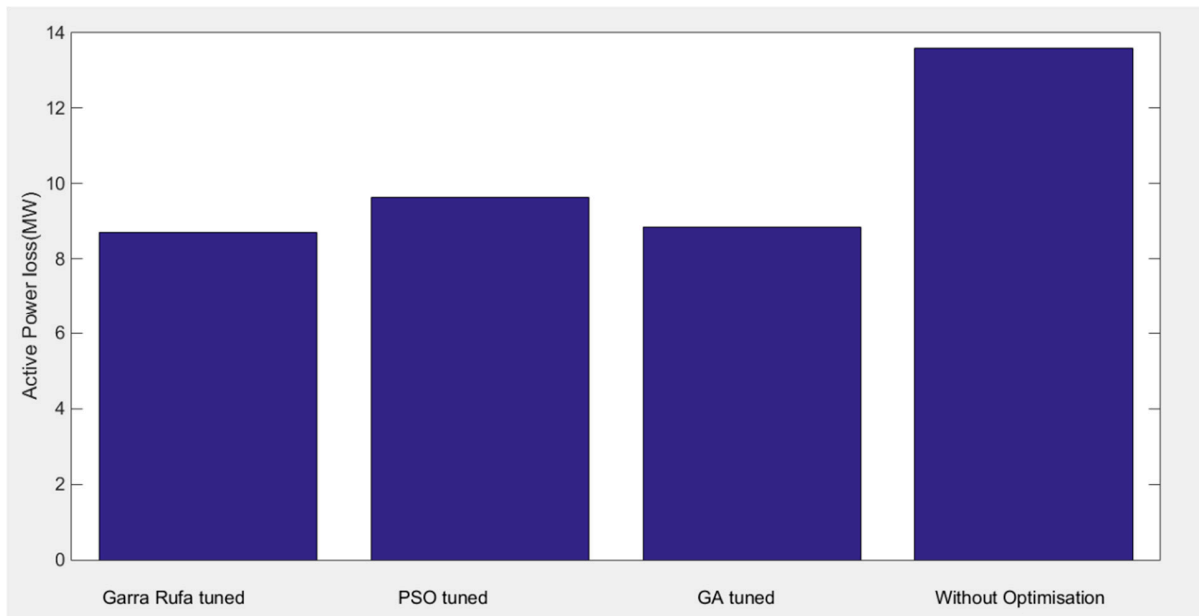


Figure S22. Active Power Losses 4DG and 14-bus

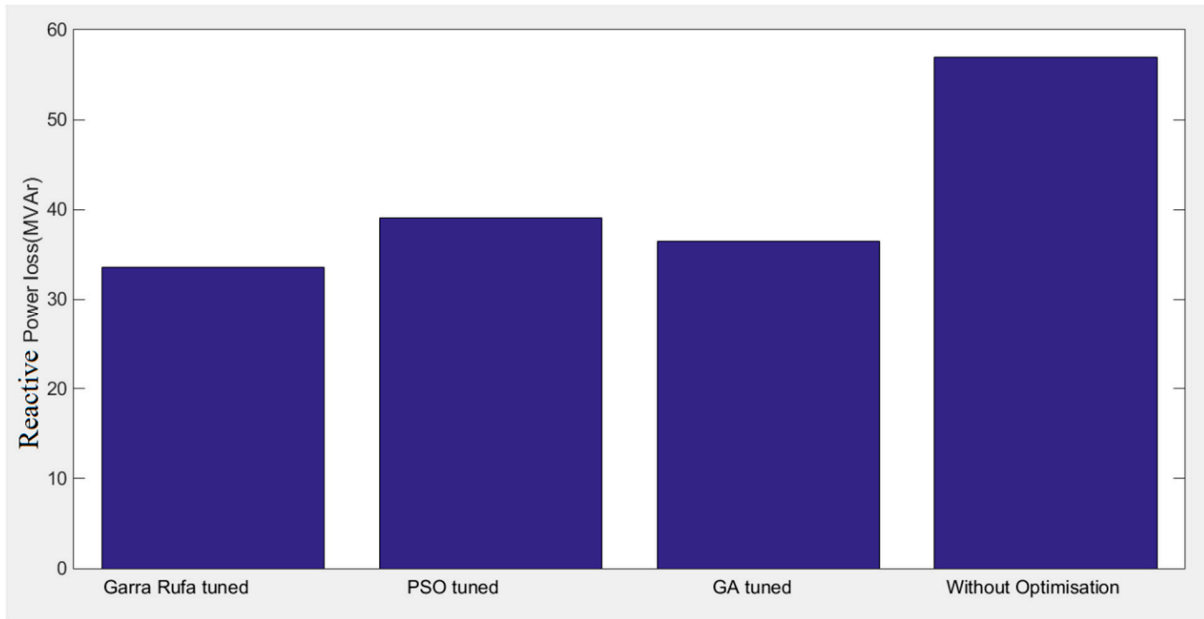


Figure S23. Reactive Power Losses 4DG and 14-bus

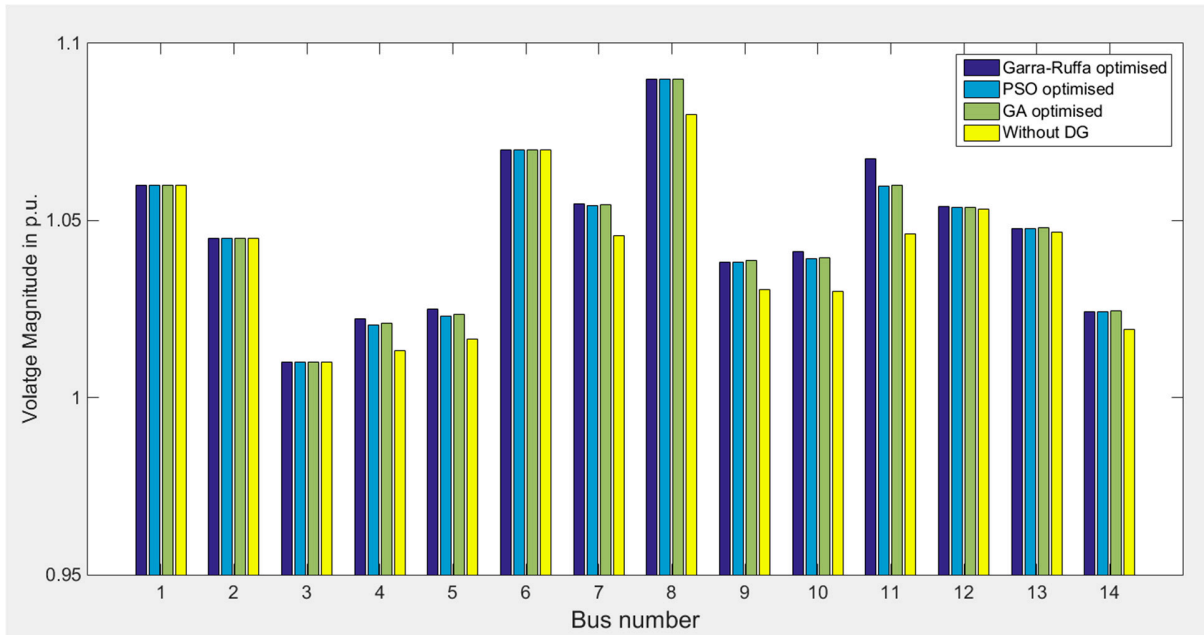


Figure S24. Voltage Profile 4DG and 14-bus

Table S13. load flow results GA, 14-bus, and 5 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	142.665	0.471	142.665	0.471	0	0	1.474	4.503	1.060
-0.049	39.135	9.030	39.999	21.730	0.864	12.700	1.237	5.108	1.045
-0.151	-73.371	-3.979	0	15.020	73.371	19	1.370	5.774	1.010
-0.119	-47.799	3.900	0	0	47.800	-3.900	0.962	2.920	1.021
-0.099	-7.599	-1.599	0	0	7.600	1.600	0.530	1.619	1.024
-0.156	-11.200	9.483	0	16.983	11.200	7.500	0.234	0.598	1.070
-0.143	0	0	0	0	0	0	0.274	0.865	1.055
-0.143	0	21.576	0	21.576	0	0	0	0.878	1.090
-0.156	-29.500	-16.600	0	0	29.500	16.600	0	0.337	1.039
-0.141	11.812	-5.799	0	0	-11.812	5.800	0	2.423	1.045
-0.133	17.254	-1.799	0	0	-17.254	1.800	0.135	0.282	1.062
-0.171	-6.099	-1.600	0	0	6.100	1.600	0.074	0.155	1.053
-0.171	-13.499	-5.799	0	0	13.500	5.800	0.222	0.438	1.048
-0.180	-14.899	-4.999	0	0	14.900	5	0	0.690	1.024
							0	0.392	
							0.109	0.289	
							0.118	0.252	
							0.071	0.168	
							0.008	0.007	
							0.071	0.144	

Table S14. load flow results PSO, 14-bus, and 5 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	158.089	-1.958	158.089	-1.958	0	0	1.808	5.520	1.060
-0.055	39.150	12.886	40.000	25.586	0.849	12.700	1.523	6.288	1.045
-0.160	-73.350	-2.933	0	16.066	73.350	19	1.464	6.168	1.010
-0.131	-47.799	3.900	0	0	47.800	-3.900	1.149	3.487	1.019
-0.111	-7.600	-1.600	0	0	7.600	1.600	0.658	2.010	1.022
-0.184	-11.199	11.125	0	18.625	11.200	7.500	0.191	0.487	1.070
-0.164	0	0	0	0	0	0	0.292	0.922	1.054
-0.164	0	22.171	0	22.171	0	0	0	1.170	1.090
-0.181	-29.500	-16.599	0	0	29.500	16.600	0	0.568	1.038
-0.172	11.211	-5.799	0	0	-11.211	5.800	0	3.491	1.042
-0.174	3.225	-1.799	0	0	-3.225	1.800	0.061	0.129	1.055
-0.198	-6.099	-1.599	0	0	6.100	1.600	0.074	0.154	1.053
-0.198	-13.500	-5.800	0	0	13.500	5.800	0.220	0.433	1.047
-0.207	-14.899	-4.999	0	0	14.900	5	0	0.728	1.024
							0	0.522	

							0.046	0.123	
							0.124	0.265	
							0.032	0.076	
							0.008	0.007	
							0.070	0.143	

Table S15. load flow results GRO, 14-bus, and 5 DG

Delta	Pi	qi	pg	Qg	pl	ql	PLs	Qls	V
0	125.926	4.823	125.926	4.823	0	0	1.086	3.318	1.060
-0.041	40.464	6.443	39.999	19.143	-0.464	12.700	1.074	4.436	1.045
-0.123	-55.113	-10.630	0	8.369	55.113	19	0.944	3.980	1.010
-0.108	-47.799	3.900	0	0	47.800	-3.900	0.899	2.727	1.020
-0.091	-7.600	-1.600	0	0	7.600	1.600	0.531	1.621	1.023
-0.154	-11.199	10.193	0	17.693	11.200	7.500	0.071	0.181	1.070
-0.135	0	0	0	0	0	0	0.206	0.652	1.055
-0.135	0	21.493	0	21.493	0	0	0	0.947	1.090
-0.149	-29.500	-16.600	0	0	29.500	16.600	0	0.388	1.039
-0.134	16.309	-5.800	0	0	-16.309	5.800	0	2.743	1.046
-0.136	8.551	-1.800	0	0	-8.551	1.800	0.095	0.199	1.059
-0.168	-6.099	-1.599	0	0	6.100	1.600	0.073	0.152	1.053
-0.168	-13.499	-5.800	0	0	13.500	5.800	0.213	0.420	1.048
-0.175	-14.900	-5	0	0	14.900	5	0	0.684	1.025
							0	0.408	
							0.098	0.261	
							0.134	0.285	
							0.035	0.083	
							0.008	0.007	
							0.064	0.132	

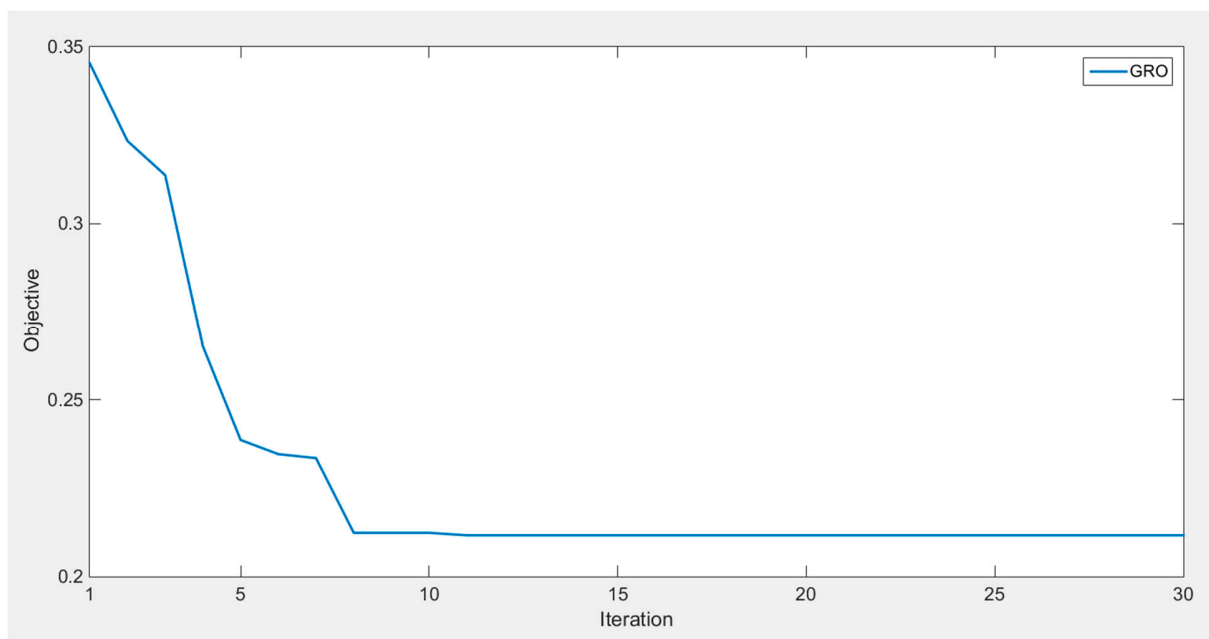


Figure S25. Algorithm Convergent GRO, 14-bus, and 5DG

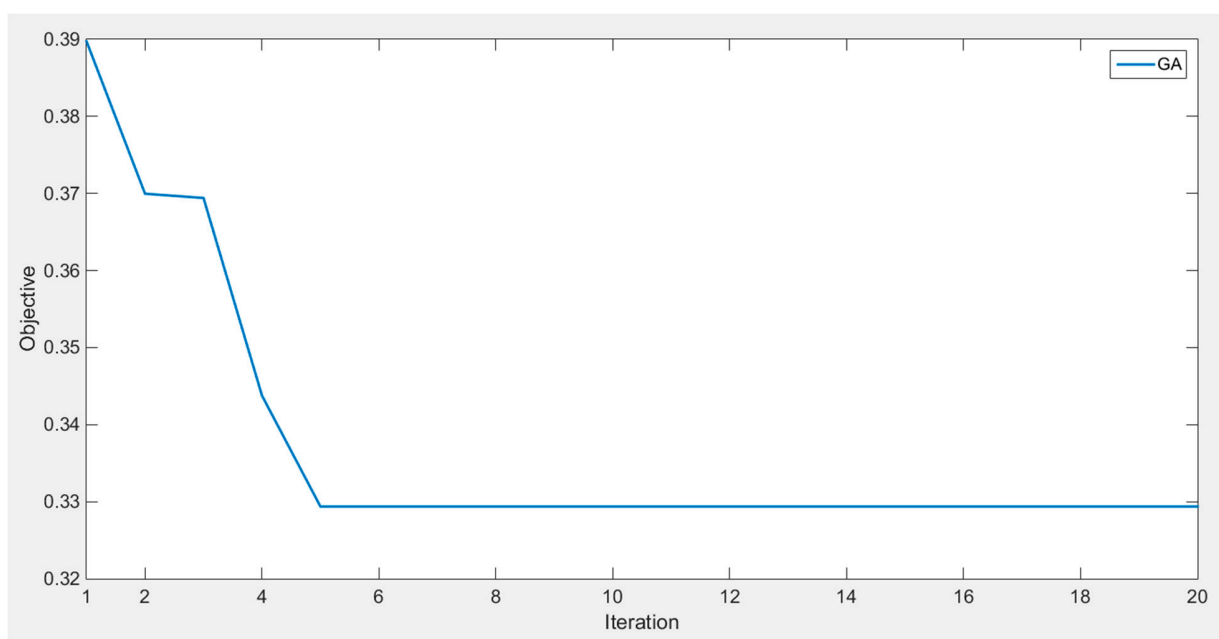


Figure S26. Algorithm Convergent GA, 14-bus, and 5DG

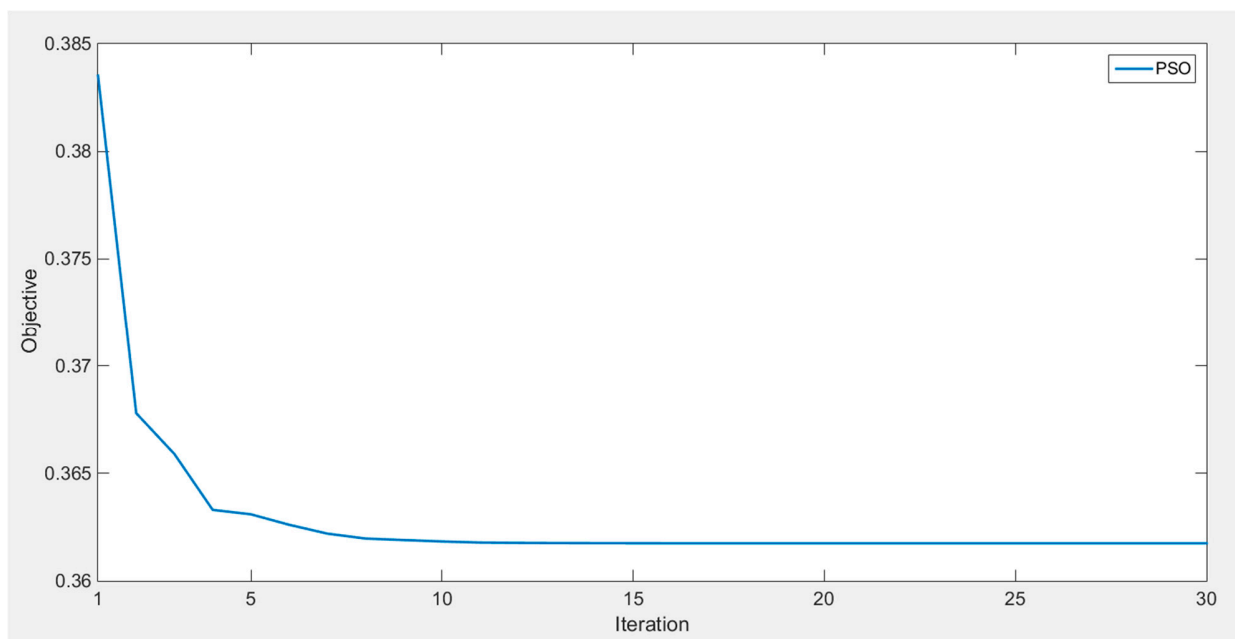


Figure S27. Algorithm Convergent PSO, 14-bus, and 5DG

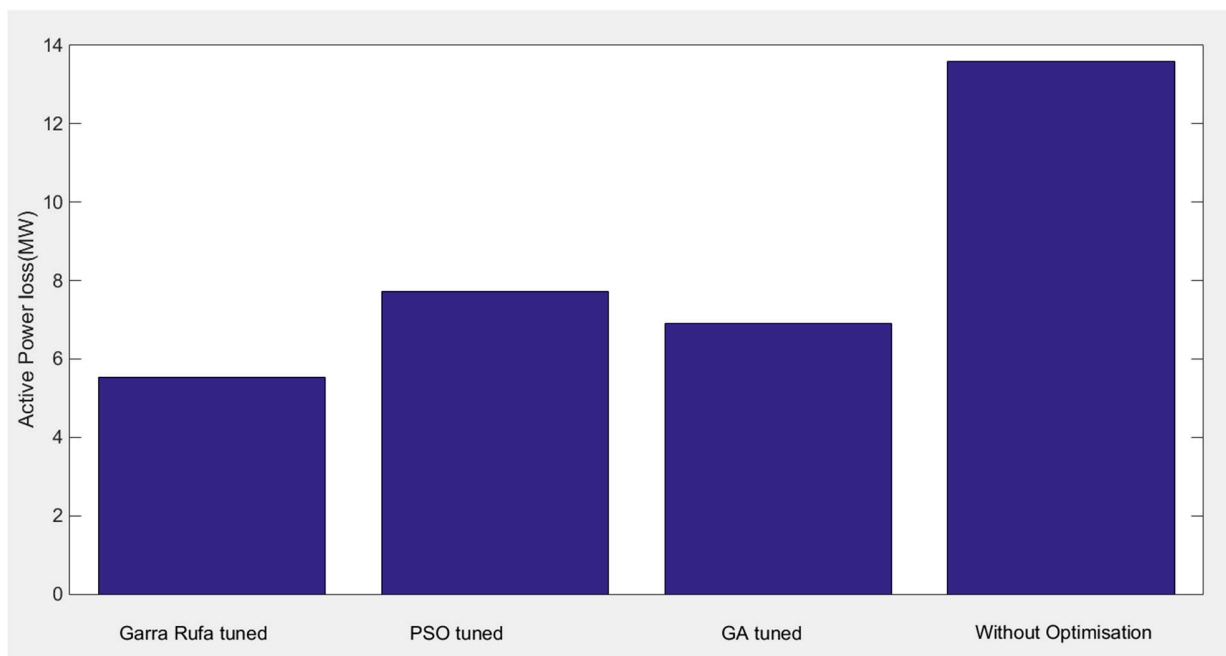


Figure S28. Active Power Losses 5DG and 14-bus

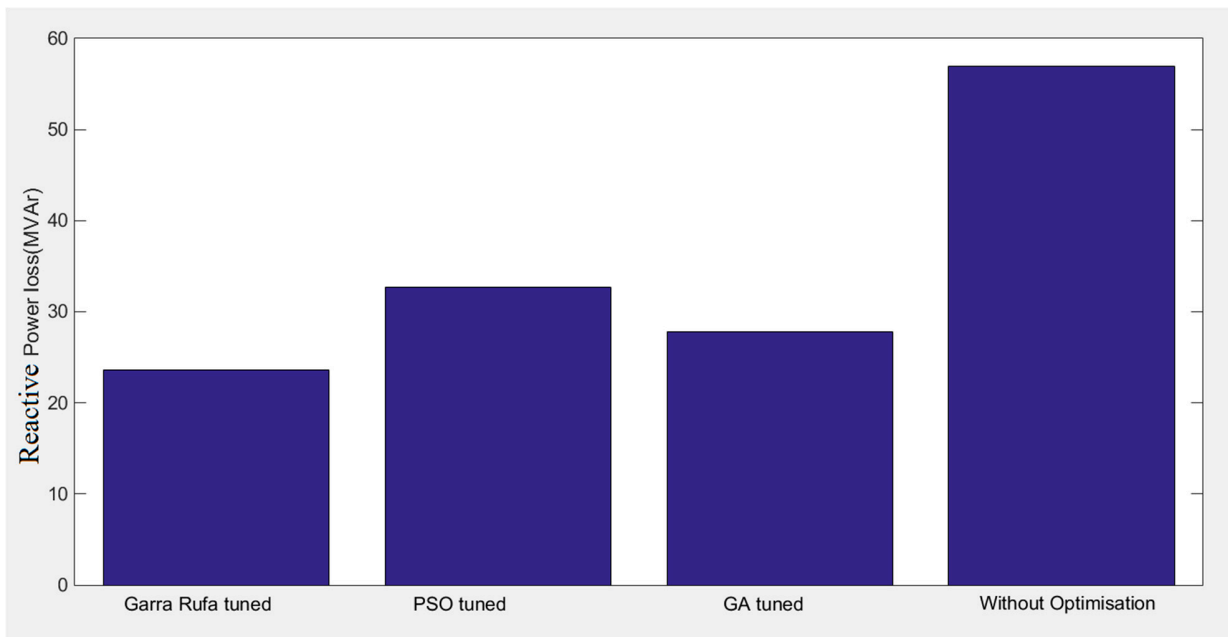


Figure S29. Reactive Power Losses 5DG and 14-bus

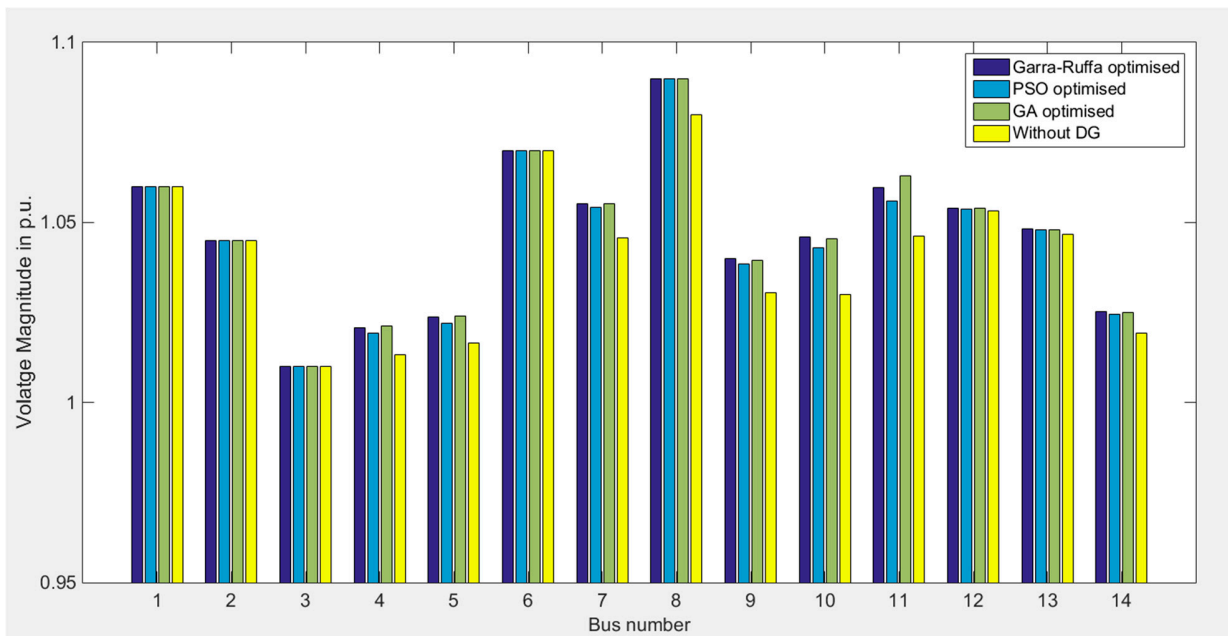


Figure S30. Voltage Profile 5DG and 14-bus

Table S16. load flow results without DG, 14-bus

Delta	Pi	qi	Pg	Qg	pl	ql	PLs	Qls	V
0	232.592	-15.233	232.592	-15.233	0	0	4.308	13.154	1.060
-0.087	18.300	35.227	40.000	47.927	21.700	12.700	2.772	11.445	1.045
-0.222	-94.200	8.758	0	27.758	94.200	19	2.333	9.829	1.010
-0.178	-47.799	3.899	0	0	47.800	-3.900	1.669	5.067	1.013
-0.152	-7.600	-1.599	0	0	7.600	1.6000	0.919	2.808	1.016
-0.252	-11.200	15.526	0	23.026	11.200	7.500	0.391	0.998	1.070
-0.231	0	0	0	0	0	0	0.479	1.511	1.045
-0.231	0	21.030	0	21.030	0	0	0	1.931	1.080
-0.258	-29.500	-16.600	0	0	29.500	16.600	0	1.292	1.030
-0.262	-9.000	-5.799	0	0	9	5.800	0	5.773	1.029
-0.259	-3.499	-1.799	0	0	3.500	1.800	0.122	0.256	1.046
-0.266	-6.100	-1.599	0	0	6.100	1.600	0.080	0.167	1.053
-0.267	-13.499	-5.799	0	0	13.500	5.800	0.251	0.495	1.046
-0.280	-14.900	-5	0	0	14.900	5	0	0.667	1.019
							0	0.957	
							0.006	0.016	
							0.089	0.190	
							0.051	0.120	
							0.011	0.009	
							0.105	0.214	

Test Case 2: IEEE-30 Bus Standard**Table S17. load flow results GA, 30-bus, and 1 DG**

Delta	Pi	Qi	Pg	Qg	pl	ql	PLs	Qls	V
0	187.301	-0.350	187.301	-0.350	0	0	2.139	6.407	1.060
-0.058	88.376	7.748	39.999	20.448	-48.376	12.700	2.312	8.452	1.043
-0.112	-2.400	-1.199	0	0	2.400	1.200	1.279	3.897	1.022
-0.137	-7.599	-1.599	0	0	7.600	1.600	0.631	1.813	1.013
-0.216	-94.199	16.907	0	35.907	94.200	19	3.082	12.949	1.010
-0.166	0	0	0	0	0	0	2.230	6.768	1.012
-0.196	-22.800	-10.900	0	0	22.800	10.900	0.543	1.890	1.003
-0.179	-29.999	0.433	0	30.433	30	30	0.131	0.332	1.010
-0.220	0	0	0	0	0	0	0.344	1.058	1.050
-0.248	-5.799	17.000	0	19.000	5.800	2	0.102	0.360	1.043
-0.220	0	16.212	0	16.212	0	0	0	2.238	1.082
-0.235	-11.199	-7.500	0	0	11.200	7.500	0	1.497	1.057
-0.235	0	10.170	0	10.170	0	0	0	0.466	1.071
-0.250	-6.200	-1.600	0	0	6.200	1.600	0	0.831	1.042

-0.251	-8.200	-2.499	0	0	8.200	2.500	0	5.087	1.038
-0.245	-3.500	-1.799	0	0	3.500	1.800	0	0.126	1.044
-0.251	-9.000	-5.799	0	0	9	5.800	0.072	0.150	1.038
-0.262	-3.200	-0.900	0	0	3.200	0.900	0.206	0.407	1.028
-0.265	-9.500	-3.400	0	0	9.500	3.400	0.055	0.117	1.025
-0.262	-2.200	-0.699	0	0	2.200	0.700	0.005	0.004	1.029
-0.257	-17.50	-11.200	0	0	17.500	11.200	0.012	0.029	1.029
-0.254	0	0	0	0	0	0	0.041	0.085	1.035
-0.257	-3.200	-1.600	0	0	3.200	1.600	0.005	0.011	1.029
-0.260	-8.700	-2.400	0	4.299	8.700	6.700	0.015	0.031	1.023
-0.253	0	0	0	0	0	0	0.077	0.172	1.020
-0.260	-3.500	-2.300	0	0	3.500	2.300	0.013	0.035	1.002
-0.244	0	0	0	0	0	0	0.152	0.327	1.026
-0.178	0	0	0	0	0	0	0.028	0.059	1.010
-0.266	-2.400	-0.899	0	0	2.400	0.900	0	0.0001	1.006
-0.281	-10.600	-1.899	0	0	10.600	1.900	0.023	0.047	0.995
							0.045	0.070	
							0.005	0.012	
							0.008	0.014	
							0.044	0.066	
							0.024	0.046	
							0	1.270	
							0.085	0.161	
							0.161	0.303	
							0.033	0.062	
							0.0002	0.0008	
							0.059	0.210	

Table S18. load flow results PSO, 30-bus, and 1 DG

Delta	Pi	Qi	Pg	Qg	Pl	Ql	PLs	Qls	V
0	196.686	-2.635	196.686	-2.635	0	0	2.451	7.340	1.060
-0.063	79.354	11.120	39.999	23.820	-39.354	12.700	2.408	8.801	1.043
-0.114	-2.400	-1.199	0	0	2.400	1.200	1.242	3.786	1.022
-0.140	-7.599	-1.599	0	0	7.600	1.600	0.658	1.890	1.013
-0.220	-94.200	16.911	0	35.911	94.200	19	3.064	12.874	1.010
-0.170	0	0	0	0	0	0	2.192	6.653	1.012
-0.199	-22.800	-10.900	0	0	22.800	10.900	0.555	1.932	1.003
-0.182	-29.999	0.456	0	30.456	30	30	0.135	0.342	1.010
-0.223	0	0	0	0	0	0	0.349	1.072	1.050
-0.251	-5.799	17.000	0	19.000	5.800	2	0.102	0.360	1.043
-0.223	0	16.218	0	16.218	0	0	0	2.235	1.082
-0.238	-11.199	-7.499	0	0	11.200	7.500	0	1.494	1.057

-0.238	0	10.178	0	10.178	0	0	0	0.467	1.071
-0.253	-6.200	-1.599	0	0	6.200	1.600	0	0.829	1.042
-0.255	-8.199	-2.500	0	0	8.200	2.500	0	5.099	1.038
-0.248	-3.500	-1.799	0	0	3.500	1.800	0	0.126	1.044
-0.254	-9.000	-5.799	0	0	9	5.800	0.072	0.150	1.038
-0.266	-3.200	-0.900	0	0	3.200	0.900	0.207	0.408	1.028
-0.269	-9.500	-3.400	0	0	9.500	3.400	0.056	0.117	1.025
-0.265	-2.199	-0.700	0	0	2.200	0.700	0.005	0.004	1.029
-0.260	-17.500	-11.200	0	0	17.500	11.200	0.012	0.029	1.029
-0.257	0	0	0	0	0	0	0.041	0.085	1.035
-0.260	-3.200	-1.600	0	0	3.200	1.600	0.005	0.011	1.029
-0.263	-8.699	-2.399	0	4.300	8.700	6.700	0.015	0.031	1.023
-0.257	0	0	0	0	0	0	0.076	0.171	1.020
-0.264	-3.500	-2.300	0	0	3.500	2.300	0.013	0.035	1.002
-0.248	0	0	0	0	0	0	0.151	0.327	1.026
-0.181	0	0	0	0	0	0	0.028	0.059	1.010
-0.269	-2.400	-0.899	0	0	2.400	0.900	0	0.0001	1.006
-0.284	-10.600	-1.899	0	0	10.600	1.900	0.023	0.047	0.995
							0.045	0.070	
							0.005	0.012	
							0.008	0.014	
							0.044	0.066	
							0.024	0.045	
							0	1.269	
							0.085	0.161	
							0.161	0.303	
							0.033	0.062	
							0.0002	0.0008	
							0.059	0.210	

Table S19. load flow results GRO, 30-bus, and 1 DG

Delta	Pi	Qi	Pg	Qg	Pl	Ql	PLs	QLs	V
0	213.830	-6.696	213.830	-6.696	0	0	3.078	9.217	1.060
-0.071	62.941	17.362	39.999	30.062	-22.941	12.700	2.587	9.457	1.043
-0.119	-2.400	-1.199	0	0	2.400	1.200	1.177	3.588	1.022
-0.146	-7.599	-1.599	0	0	7.600	1.600	0.708	2.035	1.013
-0.227	-94.200	16.922	0	35.922	94.200	19	3.032	12.738	1.010
-0.176	0	0	0	0	0	0	2.125	6.448	1.012
-0.206	-22.800	-10.899	0	0	22.800	10.900	0.577	2.010	1.003
-0.188	-29.999	0.505	0	30.505	30	30	0.142	0.359	1.010
-0.229	0	0	0	0	0	0	0.357	1.098	1.050
-0.257	-5.799	17.000	0	19.000	5.800	2	0.103	0.360	1.043

-0.229	0	16.230	0	16.230	0	0	0	2.229	1.082
-0.244	-11.199	-7.500	0	0	11.200	7.500	0	1.489	1.057
-0.244	0	10.193	0	10.193	0	0	0	0.468	1.071
-0.259	-6.200	-1.599	0	0	6.200	1.600	0	0.826	1.042
-0.261	-8.200	-2.499	0	0	8.200	2.500	-0	5.123	1.038
-0.254	-3.500	-1.799	0	0	3.500	1.800	0	0.126	1.044
-0.260	-8.999	-5.799	0	0	9	5.800	0.072	0.150	1.038
-0.272	-3.200	-0.899	0	0	3.200	0.900	0.208	0.410	1.028
-0.275	-9.500	-3.400	0	0	9.500	3.400	0.056	0.118	1.025
-0.271	-2.199	-0.699	0	0	2.200	0.700	0.005	0.004	1.029
-0.266	-17.500	-11.199	0	0	17.500	11.200	0.012	0.030	1.029
-0.263	0	0	0	0	0	0	0.042	0.085	1.035
-0.266	-3.199	-1.599	0	0	3.200	1.600	0.005	0.011	1.029
-0.270	-8.700	-2.400	0	4.299	8.700	6.700	0.015	0.031	1.023
-0.263	0	0	0	0	0	0	0.076	0.171	1.020
-0.270	-3.500	-2.300	0	0	3.500	2.300	0.013	0.035	1.002
-0.254	0	0	0	0	0	0	0.151	0.326	1.026
-0.187	0	0	0	0	0	0	0.028	0.059	1.010
-0.275	-2.400	-0.899	0	0	2.400	0.900	0	0.0001	1.006
-0.291	-10.600	-1.899	0	0	10.600	1.900	0.023	0.048	0.995
							0.045	0.070	
							0.005	0.012	
							0.008	0.014	
							0.044	0.066	
							0.023	0.045	
							0	1.267	
							0.085	0.161	
							0.161	0.303	
							0.033	0.062	
							0.0002	0.0008	
							0.059	0.210	

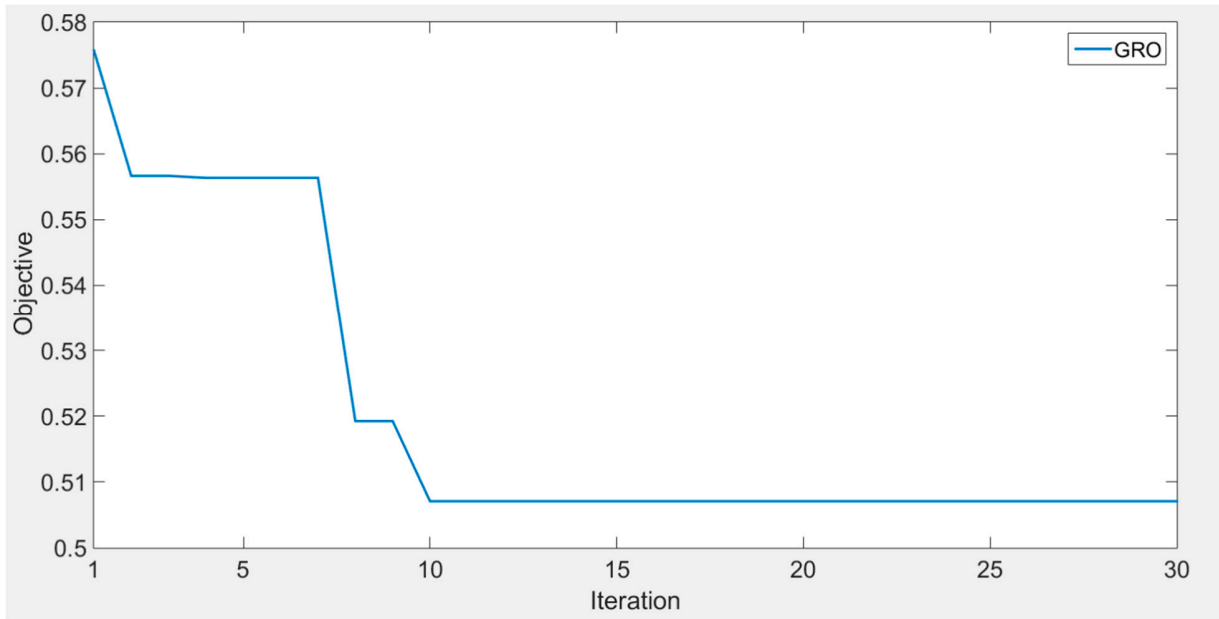


Figure S31. Algorithm Convergent GRO, 30-bus, and 1DG

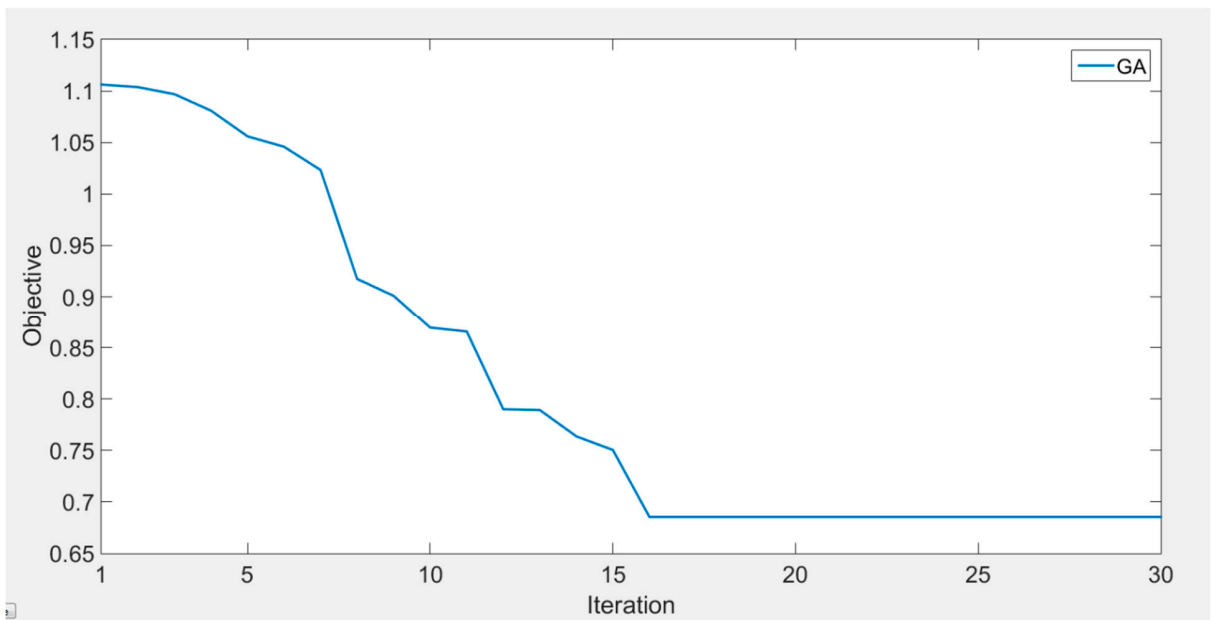


Figure S32. Algorithm Convergent GA, 30-bus, and 1DG

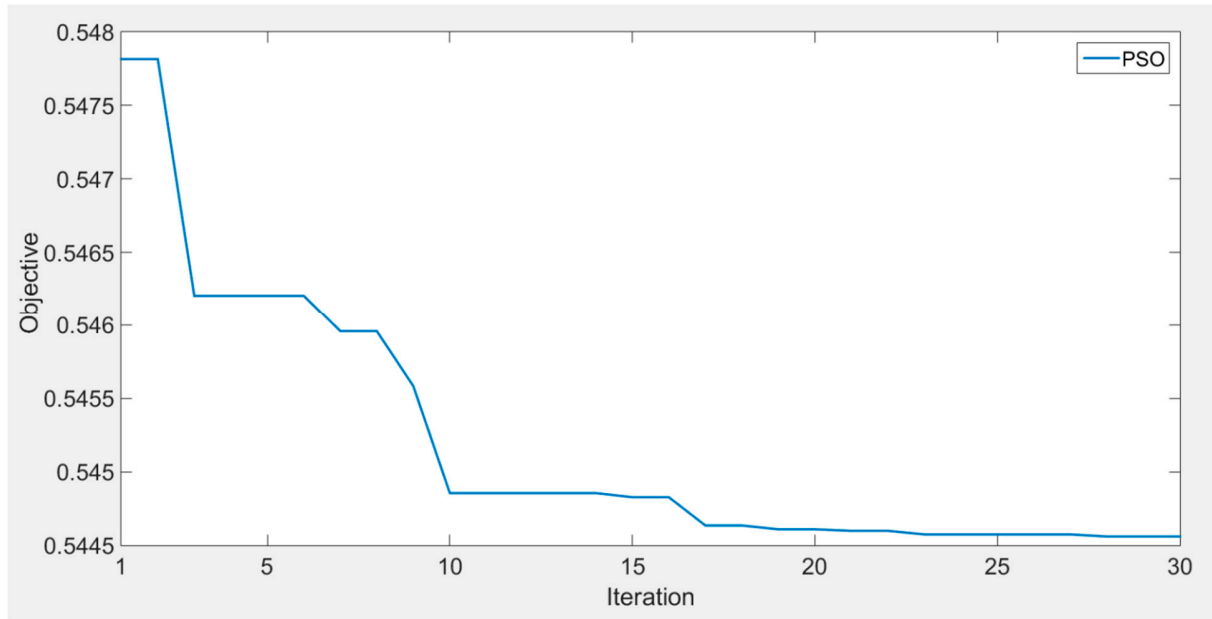


Figure S33. Algorithm Convergent PSO, 30-bus, and 1DG

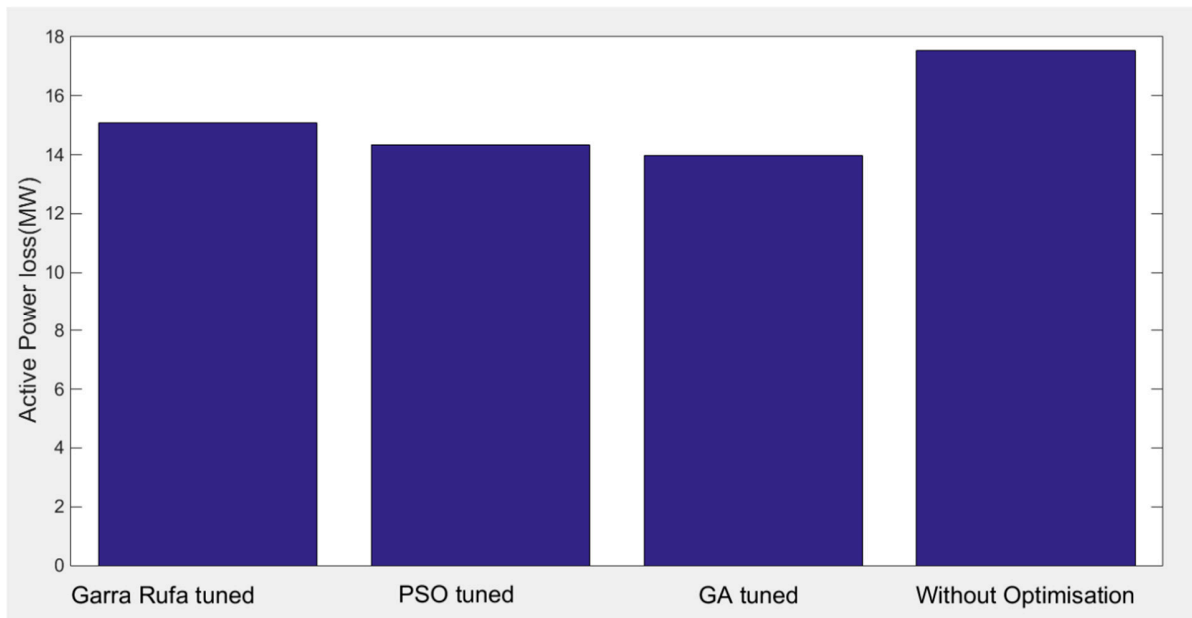


Figure S34. Active Power Losses 1DG and 30-bus

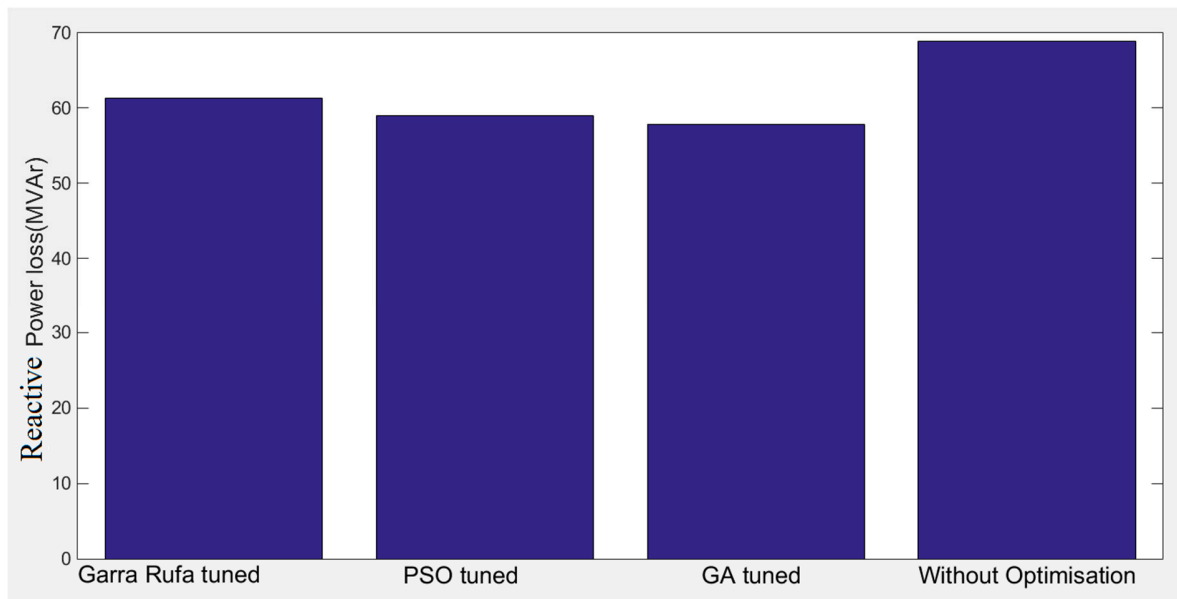


Figure S35. Reactive Power Losses 1DG and 30-bus

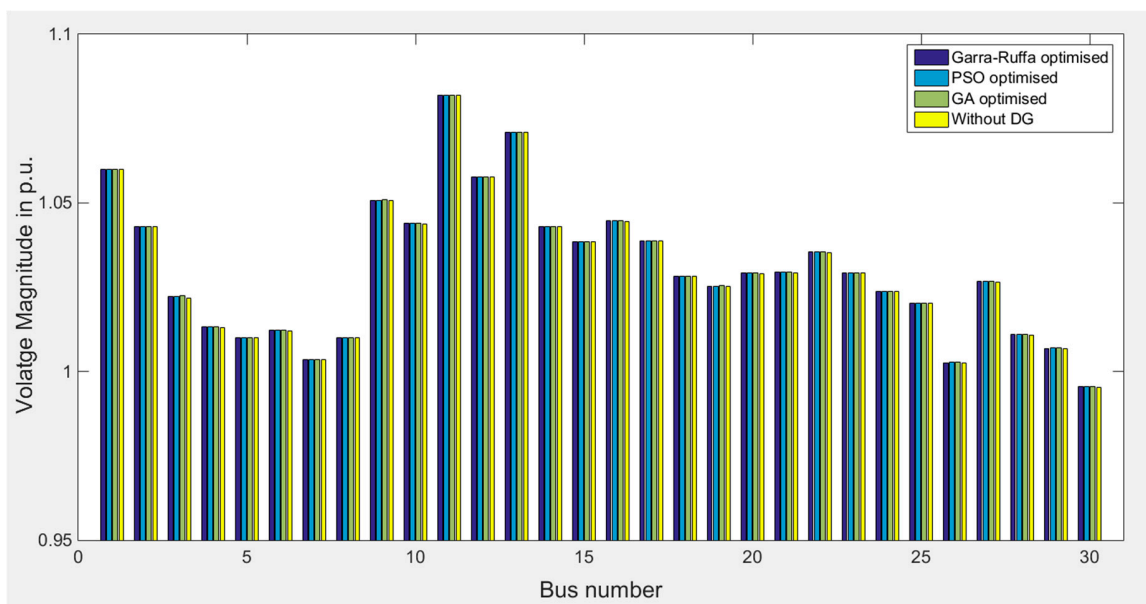


Figure S36. Voltage Profile 1DG and 30-bus

Table S20. load flow results GA, 30-bus, and 2 DG

Delta	Pi	qi	Pg	Qg	PI	QI	PLs	QIs	V
0	161.977	-0.984	161.977	-0.984	0	0	2.118	6.343	1.060
-0.058	18.300	14.023	40.000	26.723	21.700	12.700	1.051	3.842	1.043
-0.073	-2.400	-1.199	0	0	2.400	1.200	0.253	0.772	1.030
-0.090	-7.600	-1.599	0	0	7.600	1.600	0.279	0.802	1.023
-0.189	-94.199	14.071	0	33.071	94.200	19	2.187	9.190	1.010
-0.114	0	0	0	0	0	0	0.674	2.047	1.018
-0.154	-22.800	-10.90	0	0	22.800	10.900	0.418	1.456	1.007
-0.124	-29.999	-16.764	0	13.235	30	30	0.372	0.939	1.010
-0.119	0	0	0	0	0	0	0.627	1.928	1.054
-0.121	-5.800	17.000	0	19.000	5.800	2	0.108	0.381	1.046
-0.119	0	14.498	0	14.498	0	0	0	0.642	1.082
-0.090	-11.200	-7.499	0	0	11.200	7.500	0	0.154	1.064
-0.090	0	5.090	0	5.090	0	0	0	0.373	1.071
-0.049	33.975	-1.600	0	0	-33.975	1.600	0	0.062	1.085
-0.080	-8.200	-2.499	0	0	8.200	2.500	0	0.715	1.057
-0.108	-3.500	-1.799	0	0	3.500	1.800	0	0.031	1.049
-0.121	-9.000	-5.799	0	0	9	5.800	0.356	0.741	1.041
-0.039	49.519	-0.900	0	0	-49.519	0.900	0.050	0.100	1.073
-0.072	-9.500	-3.399	0	0	9.500	3.400	0.115	0.243	1.055
-0.085	-2.200	-0.699	0	0	2.200	0.700	0.457	0.413	1.051
-0.122	-17.50	-11.199	0	0	17.500	11.200	0.046	0.108	1.034
-0.129	0	0	0	0	0	0	0.381	0.777	1.038
-0.119	-3.200	-1.599	0	0	3.200	1.600	0.477	0.966	1.035
-0.139	-8.700	-2.399	0	4.300	8.700	6.700	0.118	0.236	1.026
-0.157	0	0	0	0	0	0	0.263	0.588	1.019
-0.164	-3.499	-2.299	0	0	3.500	2.300	0.008	0.021	1.001
-0.164	0	0	0	0	0	0	0.066	0.142	1.023
-0.122	0	0	0	0	0	0	0.034	0.072	1.015
-0.186	-2.399	-0.899	0	0	2.400	0.900	0.013	0.026	1.003
-0.201	-10.60	-1.900	0	0	10.600	1.900	0.433	0.875	0.992
							0.055	0.085	
							0.068	0.140	
							0.054	0.095	
							0.044	0.066	
							0.013	0.026	
							0	0.494	
							0.086	0.162	
							0.162	0.305	
							0.033	0.063	
							0.005	0.017	
							0.029	0.103	

Table S21. load flow results PSO, 30-bus, and 2 DG

Delta	Pi	Qi	Pg	Qg	pl	Ql	PLs	Qls	V
0	143.866	2.818	143.866	2.818	0	0	1.711	5.124	1.060
-0.051	18.299	11.264	39.999	23.964	21.700	12.700	0.794	2.904	1.043
-0.063	-2.400	-1.199	0	0	2.400	1.200	0.172	0.526	1.031
-0.076	-7.600	-1.599	0	0	7.600	1.600	0.209	0.600	1.024
-0.179	-94.200	13.811	0	32.811	94.200	19	2.062	8.663	1.010
-0.100	0	0	0	0	0	0	0.515	1.564	1.019
-0.141	-22.800	-10.899	0	0	22.800	10.900	0.385	1.340	1.007
-0.110	-29.999	-18.786	0	11.213	30	30	0.425	1.072	1.010
-0.095	0	0	0	0	0	0	0.680	2.090	1.053
-0.093	-5.800	17.000	0	19.000	5.800	2	0.112	0.395	1.045
-0.095	0	14.694	0	14.694	0	0	0	0.603	1.082
-0.058	-11.200	-7.499	0	0	11.200	7.500	0	0.135	1.064
-0.058	0	5.289	0	5.289	0	0	0	0.383	1.071
-0.007	41.185	-1.600	0	0	-41.185	1.600	0	0.074	1.090
-0.042	-8.200	-2.499	0	0	8.200	2.500	0	0.817	1.058
-0.077	-3.500	-1.799	0	0	3.500	1.800	0	0.034	1.048
-0.092	-9.000	-5.799	0	0	9	5.800	0.562	1.168	1.040
0.008	60.682	-0.900	0	0	-60.682	0.900	0.093	0.183	1.079
-0.030	-9.500	-3.399	0	0	9.500	3.400	0.128	0.270	1.058
-0.046	-2.200	-0.699	0	0	2.200	0.700	0.603	0.545	1.053
-0.092	-17.500	-11.200	0	0	17.500	11.200	0.054	0.126	1.034
-0.101	0	0	0	0	0	0	0.619	1.262	1.037
-0.089	-3.200	-1.599	0	0	3.200	1.600	0.663	1.341	1.035
-0.111	-8.700	-2.399	0	4.300	8.700	6.700	0.188	0.376	1.025
-0.134	0	0	0	0	0	0	0.437	0.977	1.017
-0.142	-3.499	-2.299	0	0	3.500	2.300	0.008	0.021	0.999
-0.144	0	0	0	0	0	0	0.061	0.132	1.021
-0.107	0	0	0	0	0	0	0.036	0.075	1.016
-0.166	-2.400	-0.899	0	0	2.400	0.900	0.018	0.038	1.001
-0.181	-10.599	-1.900	0	0	10.600	1.900	0.572	1.155	0.990
							0.057	0.089	
							0.089	0.183	
							0.083	0.146	
							0.044	0.066	
							0.024	0.046	
							0	0.392	
							0.086	0.163	
							0.162	0.306	
							0.033	0.063	
							0.006	0.021	
							0.025	0.090	

Table S22. load flow results GRO, 30-bus, and 2 DG

Delta	Pi	qi	Pg	Qg	PI	QI	PLs	QIs	V
0	153.912	0.627	153.912	0.627	0	0	1.933	5.791	1.060
-0.055	18.299	12.761	39.999	25.461	21.700	12.700	0.929	3.396	1.043
-0.068	-2.400	-1.199	0	0	2.400	1.200	0.212	0.648	1.031
-0.084	-7.600	-1.599	0	0	7.600	1.600	0.245	0.706	1.023
-0.185	-94.200	13.977	0	32.977	94.200	19	2.134	8.967	1.010
-0.108	0	0	0	0	0	0	0.605	1.836	1.018
-0.149	-22.800	-10.900	0	0	22.800	10.900	0.416	1.447	1.007
-0.118	-29.999	-17.509	0	12.490	30	30	0.394	0.994	1.010
-0.110	0	0	0	0	0	0	0.649	1.995	1.053
-0.111	-5.800	17.000	0	19.000	5.800	2	0.110	0.386	1.045
-0.110	0	14.755	0	14.755	0	0	0	0.605	1.082
-0.073	-11.200	-7.499	0	0	11.200	7.500	0	0.131	1.064
-0.073	0	4.767	0	4.767	0	0	0	0.386	1.071
-0.020	46.389	-1.600	0	0	-46.389	1.600	0	0.067	1.094
-0.063	-8.200	-2.499	0	0	8.200	2.500	0	0.758	1.057
-0.093	-3.500	-1.799	0	0	3.500	1.800	0	0.027	1.048
-0.109	-9.000	-5.799	0	0	9	5.800	0.636	1.322	1.040
-0.029	45.408	-0.900	0	0	3.200	0.900	0.055	0.108	1.070
-0.062	-9.500	-3.399	0	0	-39.108	3.400	0.141	0.296	1.053
-0.075	-2.200	-0.699	0	0	2.200	0.700	0.872	0.788	1.049
-0.110	-17.500	-11.199	0	0	17.500	11.200	0.062	0.145	1.033
-0.119	0	0	0	0	0	0	0.258	0.526	1.037
-0.107	-3.200	-1.599	0	0	3.200	1.600	0.464	0.938	1.034
-0.128	-8.700	-2.399	0	4.300	8.700	6.700	0.113	0.227	1.025
-0.148	0	0	0	0	0	0	0.252	0.564	1.018
-0.155	-3.499	-2.299	0	0	3.500	2.300	0.008	0.022	1.0004
-0.156	0	0	0	0	0	0	0.064	0.139	1.022
-0.116	0	0	0	0	0	0	0.034	0.070	1.015
-0.178	-2.400	-0.900	0	0	2.400	0.900	0.017	0.035	1.002
-0.193	-10.600	-1.900	0	0	10.600	1.900	0.521	1.053	0.991
							0.054	0.084	
							0.078	0.159	
							0.064	0.111	
							0.044	0.066	
							0.017	0.033	
							0	0.457	
							0.086	0.163	
							0.162	0.305	
							0.033	0.063	
							0.006	0.018	
							0.027	0.099	

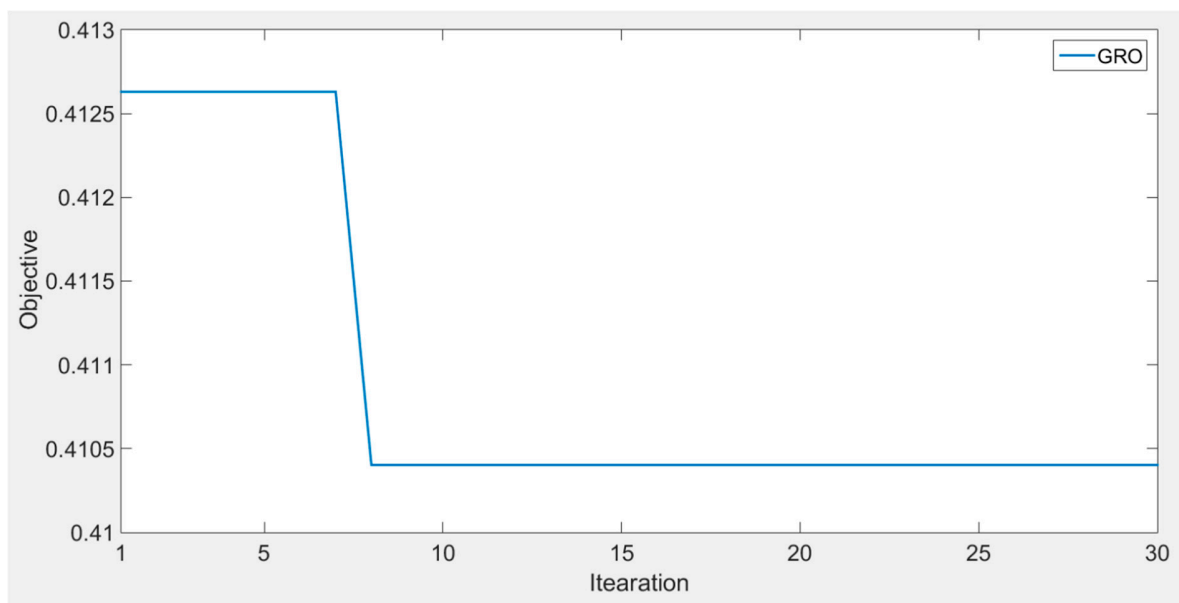


Figure S37. Algorithm Convergent GRO, 30-bus, and 2DG

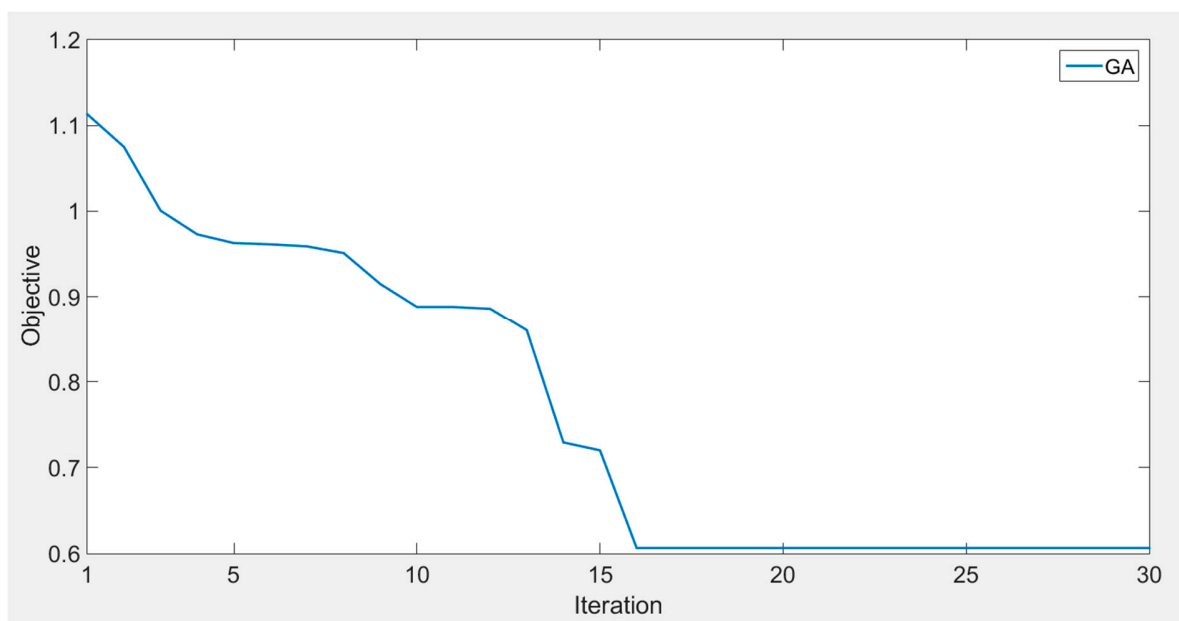


Figure S38. Algorithm Convergent GA, 30-bus, and 2DG

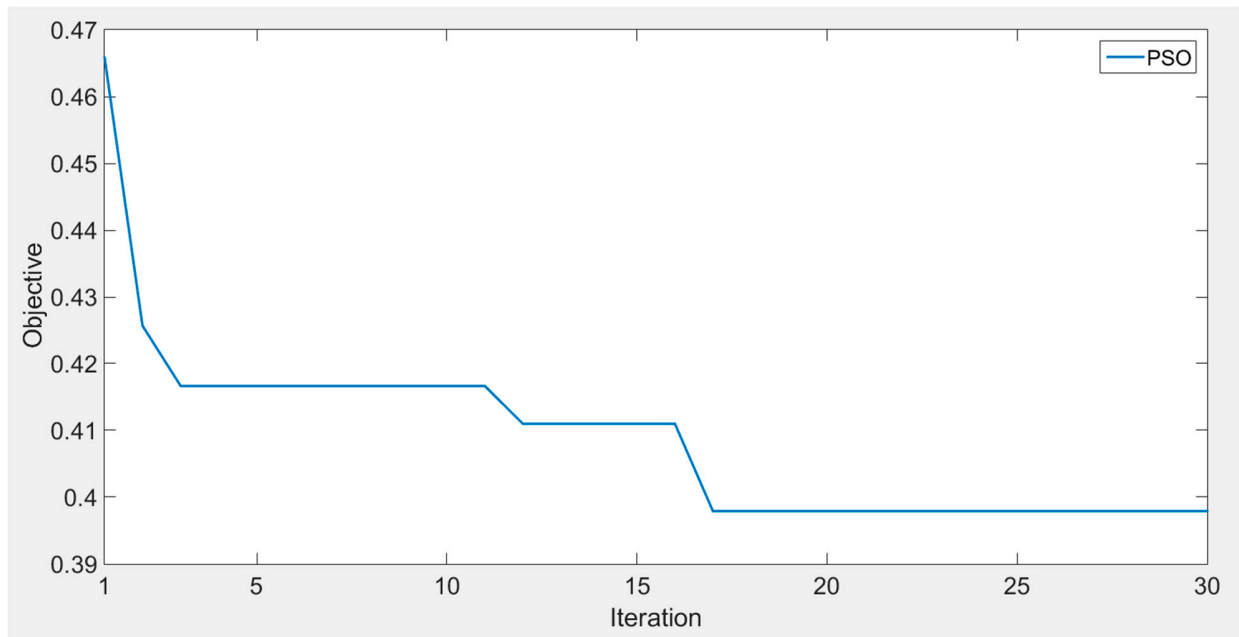


Figure S39. Algorithm Convergent PSO, 30-bus, and 2DG

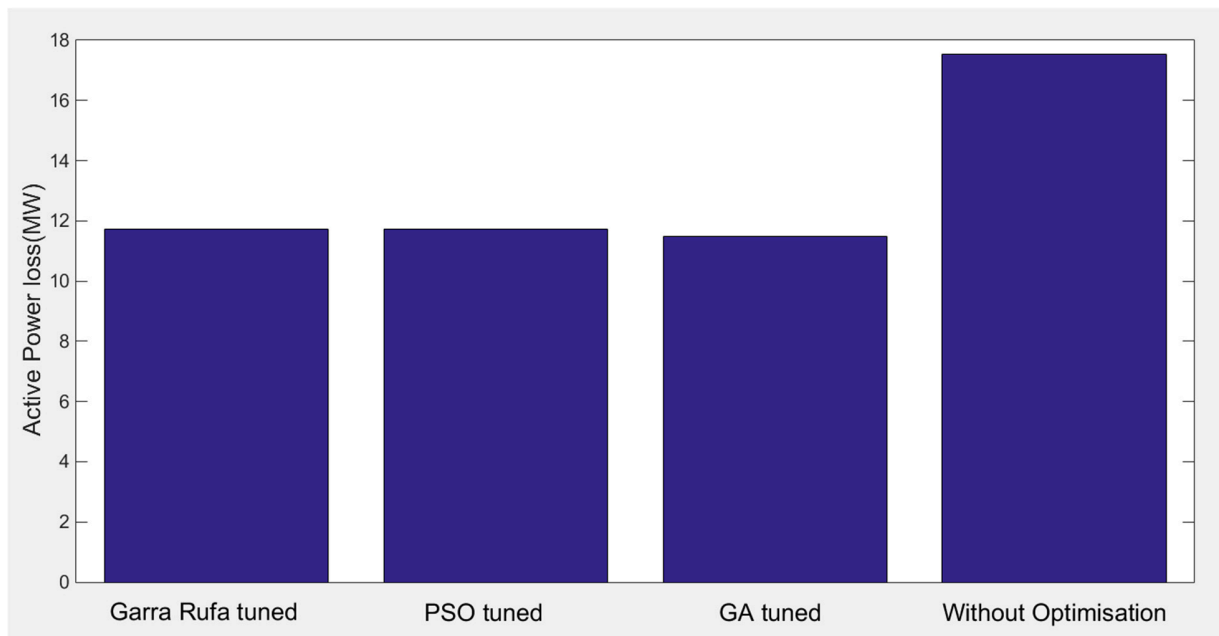


Figure S40. Active Power Losses 2DG and 30-bus

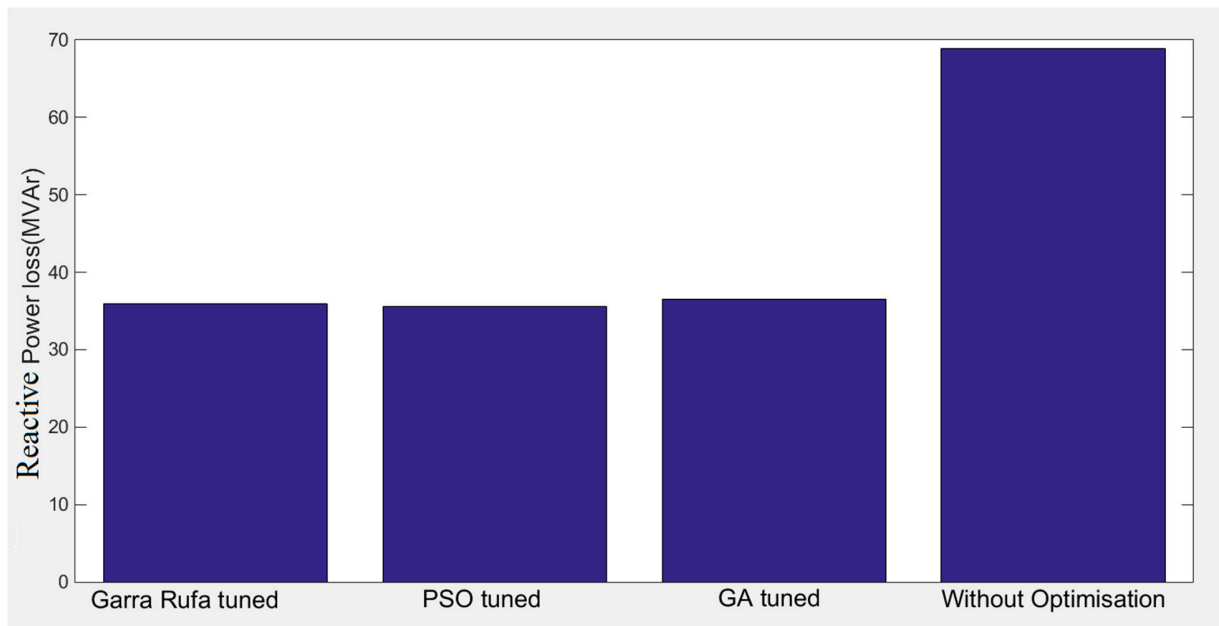


Figure S41. Reactive Power Losses 2DG and 30-bus

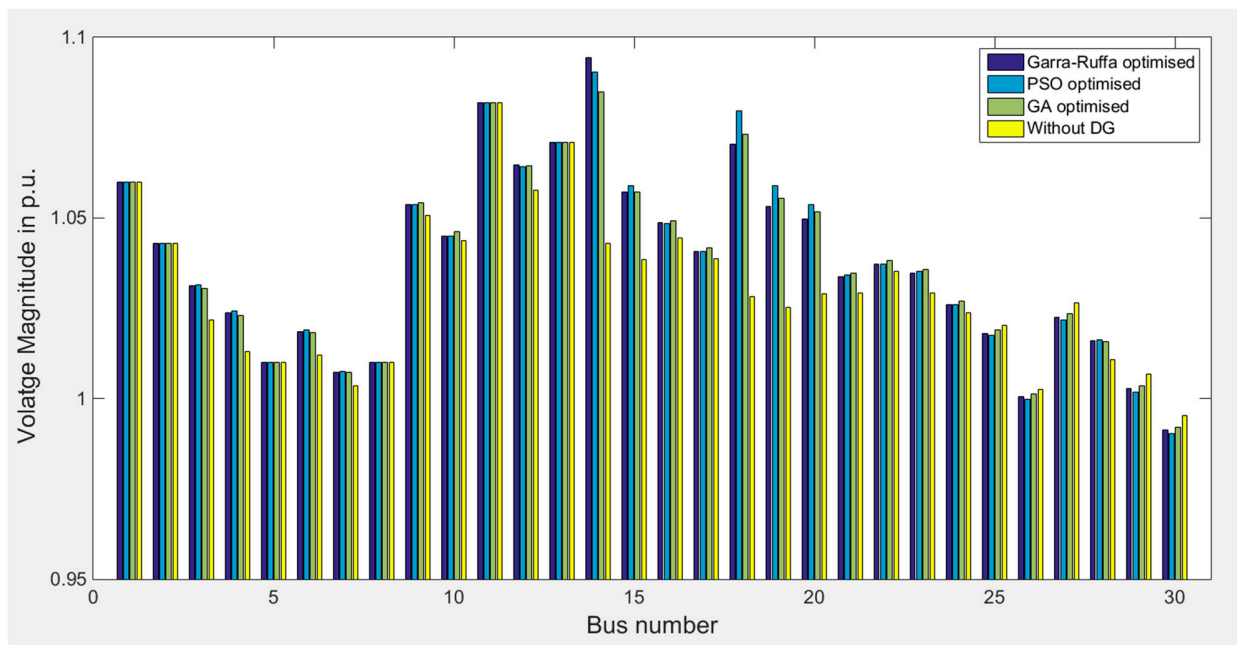


Figure S42. Voltage Profile 2DG and 30-bus

Table S23. load flow results GA, 30-bus, and 3 DG

Delta	Pi	qi	Pg	Qg	pl	Ql	PLs	Qls	V
0	104.158	14.125	104.158	14.125	0	0	0.918	2.751	1.060
-0.036	18.299	8.500	39.999	21.200	21.700	12.700	0.443	1.621	1.043
-0.042	-2.400	-1.199	0	0	2.400	1.200	0.112	0.342	1.030
-0.051	-7.600	-1.600	0	0	7.600	1.600	0.115	0.331	1.022
-0.151	-94.200	14.194	0	33.194	94.200	19	1.693	7.115	1.010
-0.058	0	0	0	0	0	0	0.178	0.542	1.019
-0.105	-22.800	-10.899	0	0	22.800	10.900	0.035	0.123	1.007
-0.041	37.387	-39.699	0	-9.699	-37.387	30	0.632	1.593	1.010
-0.064	0	0	0	0	0	0	0.867	2.662	1.058
-0.068	-5.800	16.999	0	18.999	5.800	2	0.226	0.791	1.054
-0.064	0	12.260	0	12.260	0	0	0	0.775	1.082
-0.085	-11.200	-7.499	0	0	11.200	7.500	0	0.250	1.059
-0.085	0	8.654	0	8.654	0	0	0	0.267	1.071
-0.095	-6.200	-1.600	0	0	6.200	1.600	0	0.026	1.045
-0.091	-8.200	-2.500	0	0	8.200	2.500	0	1.091	1.044
-0.061	-3.499	-1.799	0	0	3.500	1.800	0	0.091	1.059
-0.033	60.359	-5.800	0	0	-60.359	5.800	0.046	0.097	1.065
-0.095	-3.199	-0.899	0	0	3.200	0.900	0.089	0.176	1.035
-0.094	-9.499	-3.399	0	0	9.500	3.400	0.129	0.272	1.033
-0.088	-2.200	-0.699	0	0	2.200	0.700	0.004	0.003	1.038
-0.082	-17.500	-11.200	0	0	17.500	11.200	0.168	0.393	1.038
-0.077	0	0	0	0	0	0	0.015	0.030	1.045
-0.083	-3.199	-1.600	0	0	3.200	1.600	0.001	0.002	1.038
-0.086	-8.700	-2.400	0	4.299	8.700	6.700	0.030	0.061	1.033
-0.086	0	0	0	0	0	0	0.128	0.288	1.028
-0.093	-3.499	-2.299	0	0	3.500	2.300	0.590	1.540	1.011
-0.082	0	0	0	0	0	0	0.229	0.494	1.034
-0.058	0	0	0	0	0	0	0.041	0.086	1.018
-0.075	7.162	-0.900	0	0	-7.162	0.900	0.005	0.011	1.029
-0.102	-10.600	-1.899	0	0	10.600	1.900	0.019	0.040	1.012
							0.066	0.103	
							0.005	0.011	
							0.002	0.004	
							0.043	0.065	
							0.011	0.021	
							0	0.230	
							0.006	0.011	
							0.063	0.119	
							0.094	0.177	
							0.048	0.151	
							0.0006	0.002	

Table S24. load flow results PSO, 30-bus, and 3 DG

Delta	Pi	qi	Pg	Qg	Pl	ql	PLs	Qls	V
0	76.081	19.444	76.081	19.444	0	0	0.545	1.634	1.060
-0.026	18.299	-0.197	39.999	12.502	21.700	12.700	0.230	0.842	1.043
-0.027	-2.400	-1.200	0	0	2.400	1.200	0.048	0.148	1.034
-0.032	-7.600	-1.600	0	0	7.600	1.600	0.059	0.170	1.027
-0.133	-94.200	10.899	0	29.899	94.200	19	1.492	6.269	1.010
-0.035	0	0	0	0	0	0	0.061	0.187	1.026
-0.084	-22.800	-10.900	0	0	22.800	10.900	0.005	0.017	1.011
-0.021	28.858	-30.346	0	-0.346	-28.858	30	0.723	1.824	1.020
-0.033	0	0	0	0	0	0	0.971	2.983	1.060
-0.032	-5.800	17.000	0	19.000	5.800	2	0.153	0.538	1.055
-0.033	0	11.131	0	11.131	0	0	0	0.581	1.082
-0.056	-11.200	-7.500	0	0	11.200	7.500	0	0.157	1.059
-0.056	0	8.431	0	8.431	0	0	0	0.220	1.071
-0.064	-6.199	-1.599	0	0	6.200	1.600	0	0.027	1.045
-0.059	-8.199	-2.499	0	0	8.200	2.500	0	0.690	1.044
-0.028	-3.499	-1.800	0	0	3.500	1.800	0	0.086	1.060
0.002	61.849	-5.800	0	0	-61.850	5.800	0.042	0.088	1.066
-0.061	-3.199	-0.899	0	0	3.200	0.900	0.075	0.148	1.036
-0.059	-9.500	-3.400	0	0	9.500	3.400	0.167	0.351	1.034
-0.053	-2.199	-0.699	0	0	2.200	0.700	0.008	0.007	1.039
-0.044	-17.499	-11.199	0	0	17.500	11.200	0.208	0.485	1.039
-0.032	0	0	0	0	0	0	0.013	0.028	1.046
-0.045	-3.200	-1.600	0	0	3.200	1.600	0.002	0.004	1.039
-0.031	-8.699	-2.399	0	4.300	8.700	6.700	0.033	0.066	1.035
0.007	0	0	0	0	0	0	0.137	0.306	1.036
0.0008	-3.499	-2.299	0	0	3.500	2.300	0.585	1.525	1.018
0.036	0	0	0	0	0	0	0.195	0.421	1.045
-0.024	0	0	0	0	0	0	0.019	0.041	1.028
0.138	43.651	-0.900	0	0	-43.651	0.900	0.002	0.004	1.087
0.073	-10.599	-1.899	0	0	10.600	1.900	0.047	0.095	1.049
							0.031	0.048	
							0.029	0.059	
							0.223	0.389	
							0.042	0.064	
							0.194	0.371	
							0	1.138	
							1.350	2.551	
							0.104	0.195	
							0.571	1.079	
							0.013	0.041	
							0.050	0.180	

Table S25. load flow results GRO, 30-bus, and 3 DG

Delta	Pi	qi	Pg	Qg	pl	ql	PLs	QLs	V
0	53.896	26.009	53.896	26.009	0	0	0.335	1.006	1.060
-0.017	18.299	-0.840	39.999	11.859	21.700	12.700	0.141	0.518	1.043
-0.014	-2.399	-1.199	0	0	2.400	1.200	0.041	0.127	1.033
-0.016	-7.600	-1.599	0	0	7.600	1.600	0.038	0.111	1.027
-0.118	-94.200	11.551	0	30.551	94.200	19	1.343	5.646	1.010
-0.014	0	0	0	0	0	0	0.052	0.160	1.025
-0.065	-22.800	-10.900	0	0	22.800	10.900	0.007	0.026	1.011
0.014	71.799	-39.687	0	-9.687	-71.799	30	0.848	2.139	1.020
-0.017	0	0	0	0	0	0	1.074	3.299	1.061
-0.018	-5.799	17.00	0	19.000	5.800	2	0.555	1.944	1.057
-0.017	0	10.548	0	10.548	0	0	0	0.642	1.082
-0.041	-11.199	-7.499	0	0	11.200	7.500	0	0.196	1.061
-0.041	0	7.615	0	7.615	0	0	0	0.197	1.071
-0.050	-6.200	-1.600	0	0	6.200	1.600	0	0.016	1.047
-0.045	-8.200	-2.500	0	0	8.200	2.500	0	0.750	1.046
-0.014	-3.499	-1.800	0	0	3.500	1.800	0	0.070	1.062
0.0165	63.297	-5.800	0	0	-63.297	5.800	0.042	0.087	1.069
-0.048	-3.200	-0.900	0	0	3.200	0.900	0.072	0.143	1.038
-0.046	-9.499	-3.399	0	0	9.500	3.400	0.166	0.350	1.036
-0.040	-2.200	-0.700	0	0	2.200	0.700	0.006	0.005	1.041
-0.032	-17.499	-11.200	0	0	17.500	11.200	0.209	0.488	1.042
-0.024	0	0	0	0	0	0	0.012	0.025	1.049
-0.033	-3.199	-1.600	0	0	3.200	1.600	0.001	0.003	1.041
-0.030	-8.699	-2.399	0	4.300	8.700	6.700	0.033	0.067	1.038
-0.015	0	0	0	0	0	0	0.139	0.310	1.037
-0.022	-3.499	-2.299	0	0	3.500	2.300	0.615	1.606	1.020
-0.002	0	0	0	0	0	0	0.222	0.479	1.045
-0.007	0	0	0	0	0	0	0.027	0.056	1.026
0.037	19.723	-0.900	0	0	-19.723	0.900	0.005	0.010	1.058
-0.002	-10.600	-1.900	0	0	10.600	1.900	0.033	0.067	1.034
							0.043	0.066	
							0.003	0.007	
							0.031	0.054	
							0.042	0.064	
							0.052	0.099	
							0	0.104	
							0.191	0.361	
							0.009	0.018	
							0.214	0.404	
							0.080	0.251	
							0.019	0.069	

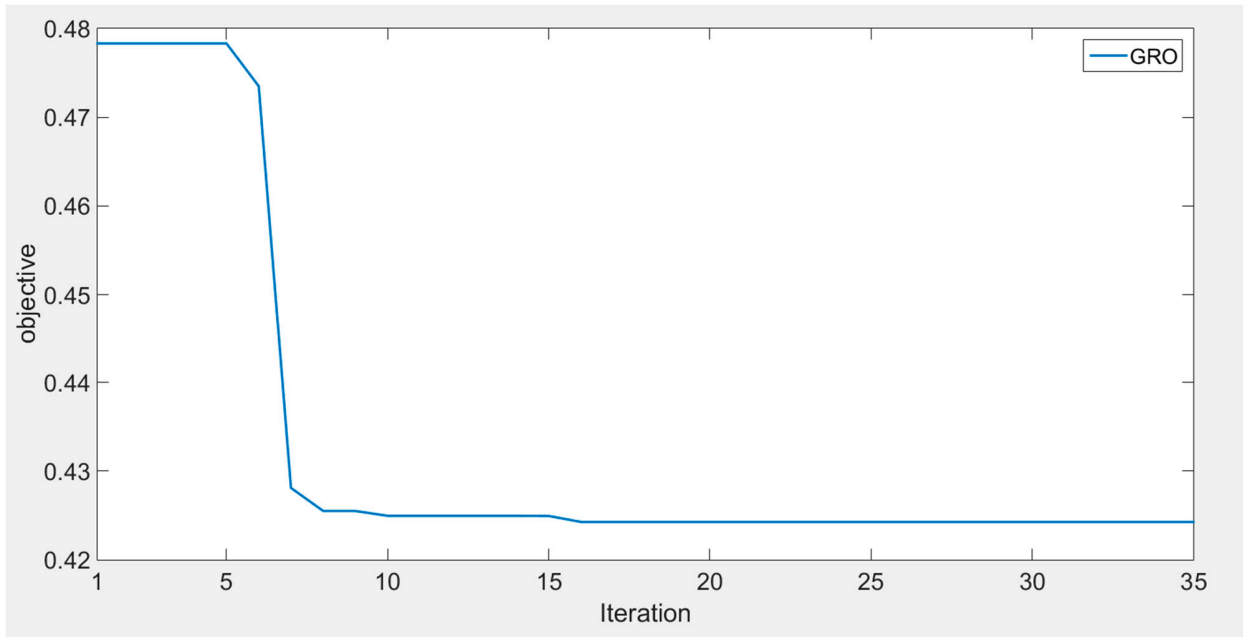


Figure S43. Algorithm Convergent GRO, 30-bus, and 3DG

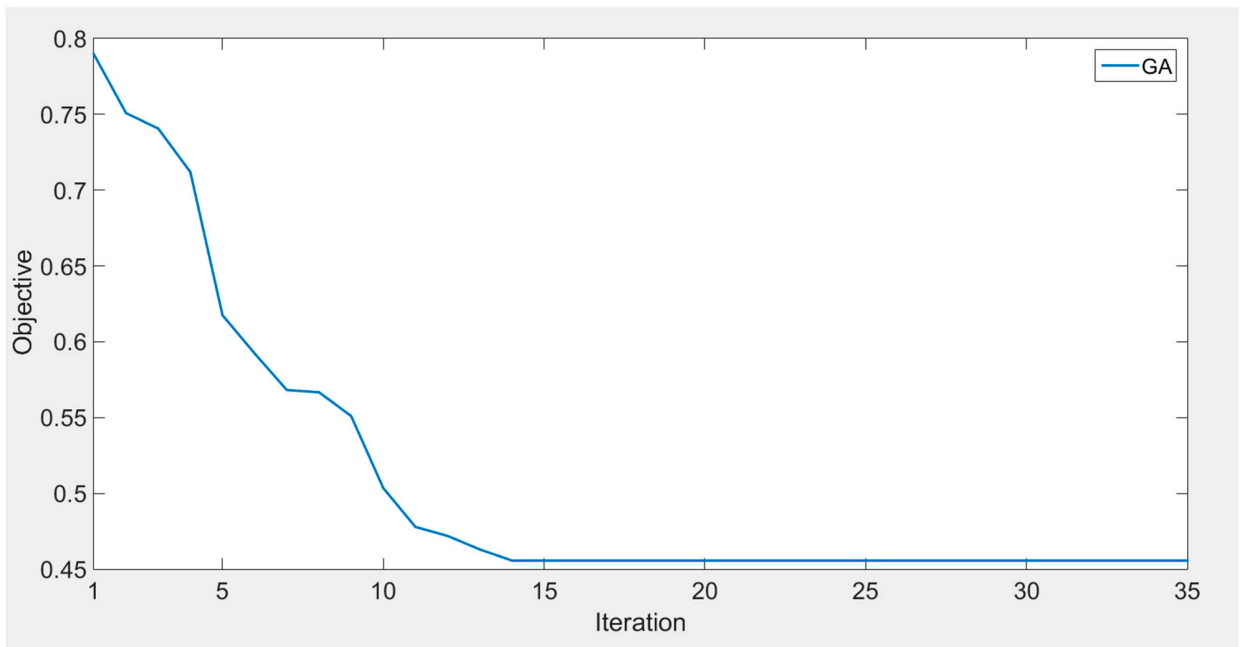


Figure S44. Algorithm Convergent GA, 30-bus, and 3DG

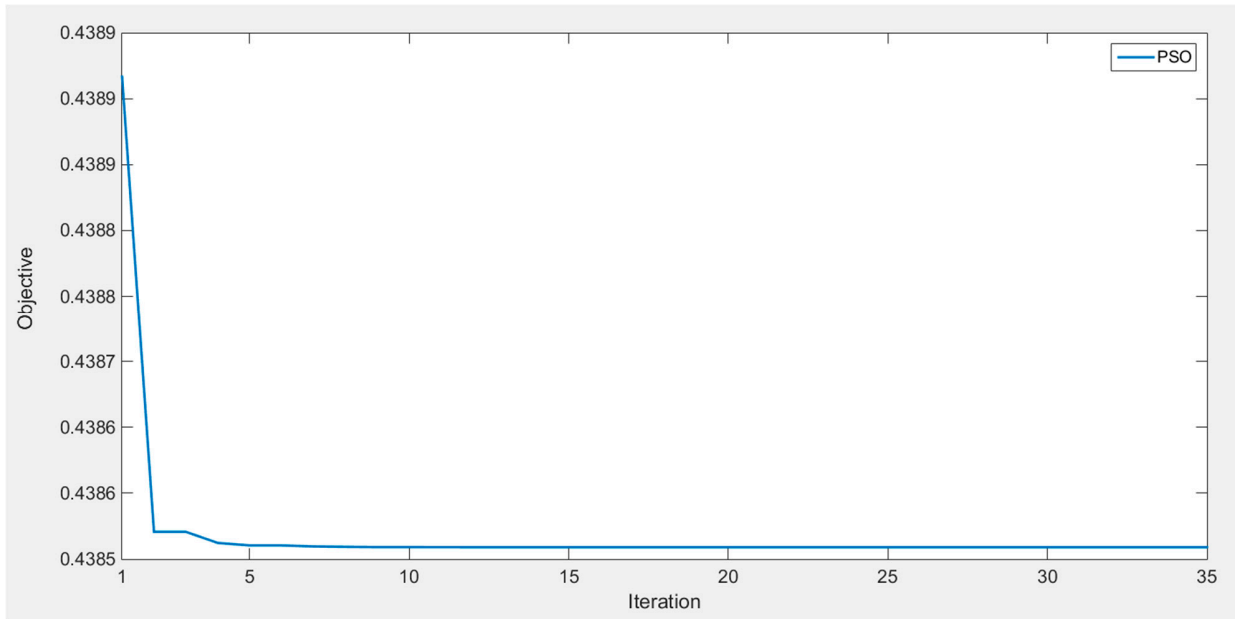


Figure S45. Algorithm Convergent PSO, 30-bus, and 3DG

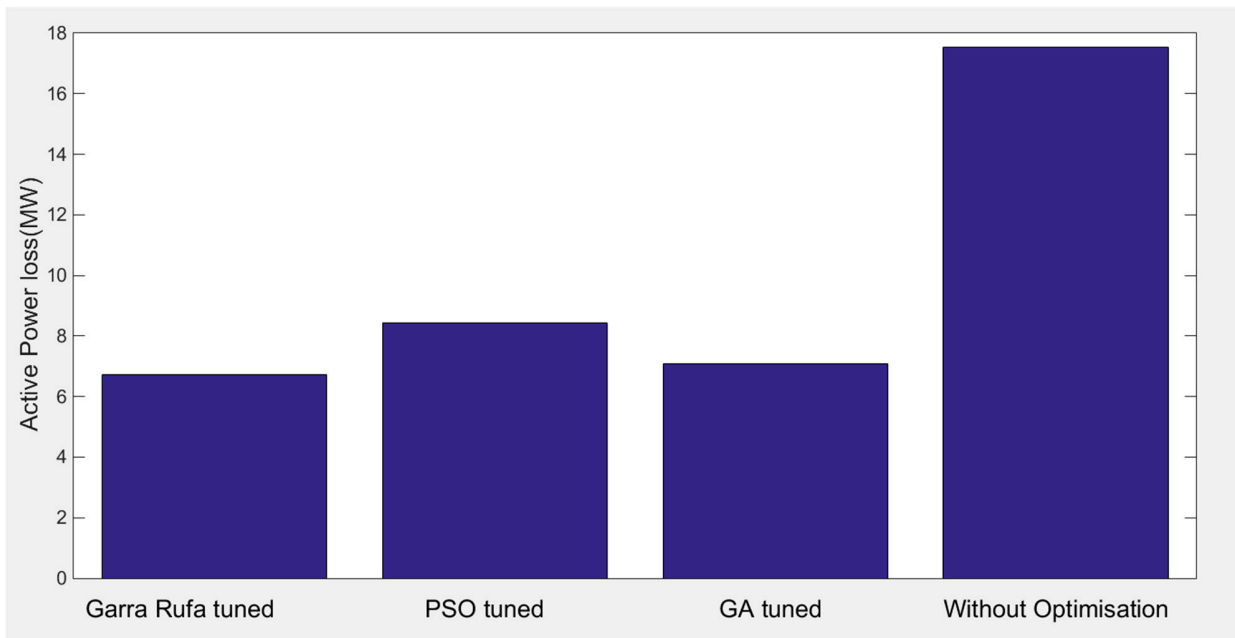


Figure S46. Active Power Losses 3DG and 30-bus

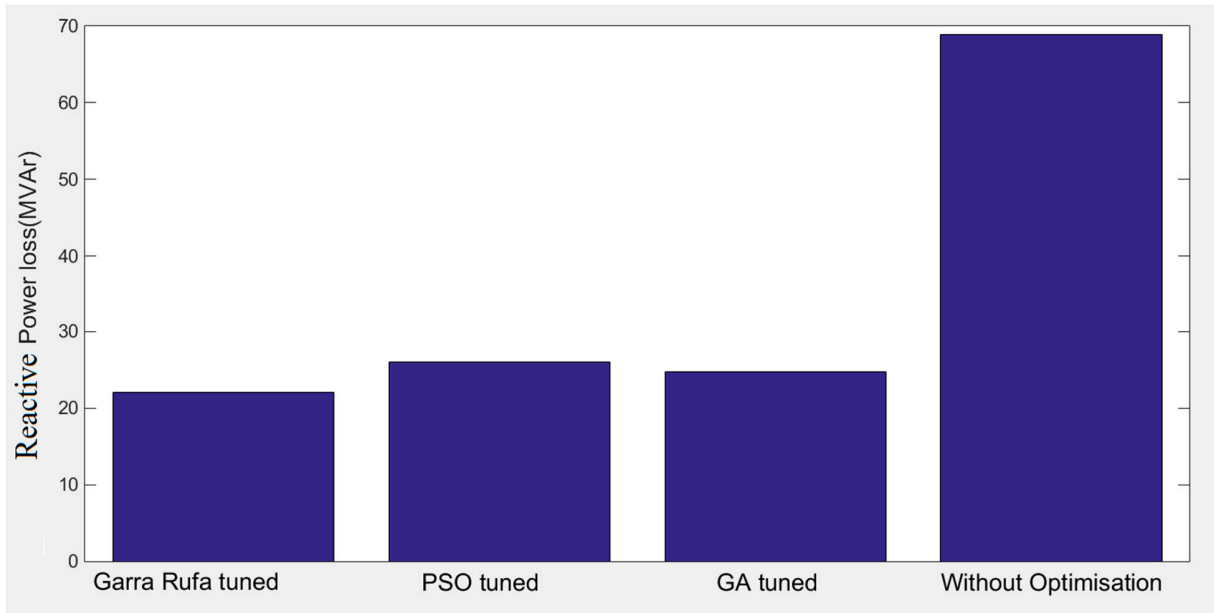


Figure S47. Reactive Power Losses 3DG and 30-bus

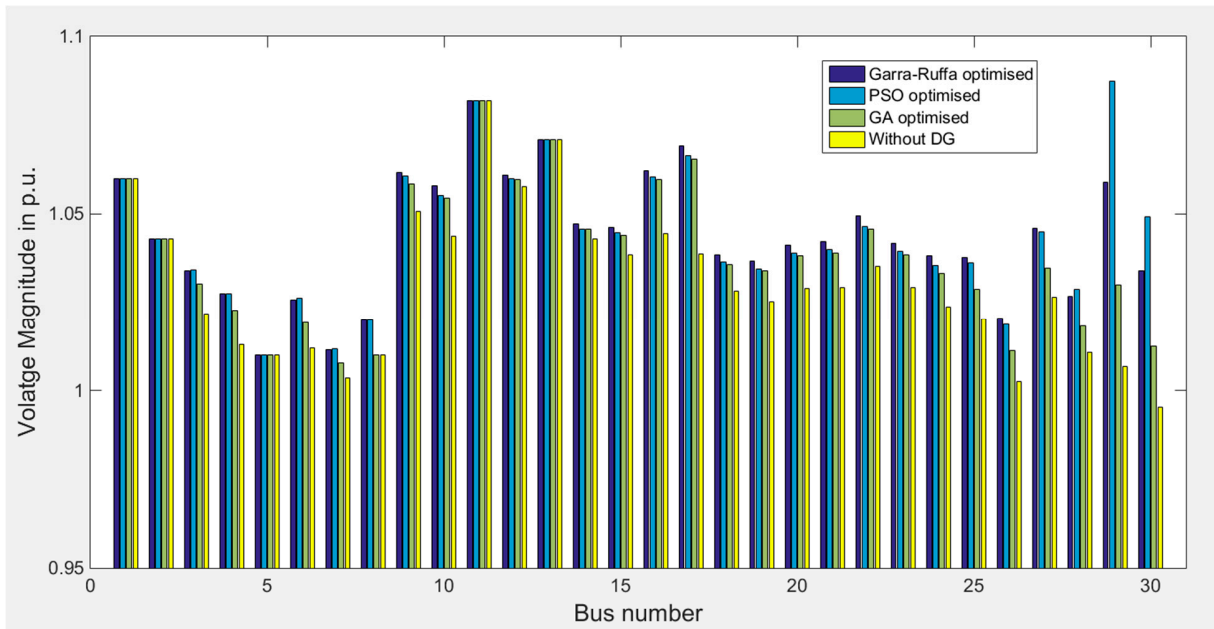


Figure S48. Voltage Profile 3DG and 30-bus

Table S26. load flow results GA, 30-bus, and 4 DG

Delta	Pi	qi	Pg	Qg	pl	ql	PLs	Qls	V
0	136.803	4.777	136.803	4.777	0	0	1.525	4.568	1.060
-0.048	18.300	9.344	40.000	22.044	21.700	12.700	0.746	2.728	1.043
-0.060	-2.400	-1.200	0	0	2.400	1.200	0.176	0.537	1.031
-0.073	-7.599	-1.599	0	0	7.600	1.600	0.196	0.562	1.024
-0.172	-94.200	12.918	0	31.918	94.200	19	1.957	8.225	1.010
-0.090	0	0	0	0	0	0	0.398	1.208	1.020
-0.133	-22.799	-10.899	0	0	22.800	10.900	0.195	0.680	1.008
-0.098	-29.999	-25.802	0	4.197	30	30	0.465	1.172	1.010
-0.077	0	0	0	0	0	0	0.725	2.226	1.060
-0.070	24.956	16.999	0	18.999	-24.956	2	0.116	0.406	1.057
-0.077	0	11.425	0	11.425	0	0	0	0.843	1.082
-0.089	-11.199	-7.499	0	0	11.200	7.500	0	0.322	1.060
-0.089	0	7.904	0	7.904	0	0	0	0.231	1.071
-0.092	-6.200	-1.599	0	0	6.200	1.600	0	0.056	1.048
-0.083	-8.199	-2.500	0	0	8.200	2.500	0	0.677	1.052
-0.076	-3.500	-1.799	0	0	3.500	1.800	0	0.076	1.056
-0.059	21.849	-5.799	0	0	-21.849	5.800	0.023	0.048	1.058
-0.051	27.639	-0.900	0	0	-27.639	0.900	0.038	0.075	1.061
-0.064	-9.500	-3.400	0	0	9.500	3.400	0.040	0.085	1.052
-0.067	-2.199	-0.699	0	0	2.200	0.700	0.028	0.025	1.052
-0.081	-17.500	-11.199	0	0	17.500	11.200	0.061	0.143	1.042
-0.077	0	0	0	0	0	0	0.224	0.456	1.048
-0.082	-3.200	-1.600	0	0	3.200	1.600	0.090	0.182	1.042
-0.085	-8.700	-2.399	0	4.300	8.700	6.700	0.003	0.007	1.036
-0.081	0	0	0	0	0	0	0.006	0.014	1.032
-0.088	-3.500	-2.300	0	0	3.500	2.300	0.052	0.136	1.014
-0.074	0	0	0	0	0	0	0.172	0.371	1.038
-0.091	0	0	0	0	0	0	0.033	0.068	1.021
-0.034	19.615	-0.900	0	0	-19.615	0.900	0.001	0.002	1.051
-0.074	-10.600	-1.899	0	0	10.600	1.900	0.017	0.036	1.026
							0.052	0.081	
							0.006	0.013	
							0.004	0.008	
							0.043	0.064	
							0.016	0.031	
							0	0.152	
							0.191	0.361	
							0.009	0.018	
							0.216	0.408	
							0.026	0.082	
							0	0.000	

Table S27. load flow results PSO, 30-bus, and 4 DG

Delta	Pi	qi	Pg	Qg	PI	QI	PLs	QIs	V
0	132.46	5.847	132.465	5.847	0	0	1.436	4.301	1.060
-0.047	18.300	8.848	40.000	21.548	21.700	12.700	0.697	2.550	1.043
-0.058	-2.400	-1.199	0	0	2.400	1.200	0.163	0.498	1.031
-0.070	-7.599	-1.599	0	0	7.600	1.600	0.182	0.524	1.024
-0.169	-94.200	12.898	0	31.898	94.200	19	1.923	8.080	1.010
-0.086	0	0	0	0	0	0	0.362	1.098	1.021
-0.129	-22.800	-10.900	0	0	22.800	10.900	0.173	0.602	1.008
-0.094	-30.000	-26.479	0	3.520	30	30	0.482	1.216	1.010
-0.074	0	0	0	0	0	0	0.741	2.277	1.059
-0.068	20.687	16.999	0	18.999	-20.687	2	0.112	0.394	1.055
-0.074	0	11.686	0	11.686	0	0	0	0.802	1.082
-0.087	-11.200	-7.500	0	0	11.200	7.500	0	0.290	1.060
-0.087	0	8.126	0	8.126	0	0	0	0.242	1.071
-0.090	-6.199	-1.599	0	0	6.200	1.600	0	0.051	1.048
-0.080	-8.200	-2.500	0	0	8.200	2.500	0	0.671	1.051
-0.074	-3.500	-1.799	0	0	3.500	1.800	0	0.080	1.055
-0.057	21.850	-5.800	0	0	-21.850	5.800	0.023	0.049	1.057
-0.048	27.650	-0.899	0	0	-27.650	0.900	0.040	0.079	1.060
-0.062	-9.500	-3.400	0	0	9.500	3.400	0.039	0.083	1.051
-0.064	-2.200	-0.700	0	0	2.200	0.700	0.028	0.025	1.051
-0.078	-17.499	-11.199	0	0	17.500	11.200	0.059	0.139	1.041
-0.073	0	0	0	0	0	0	0.220	0.449	1.047
-0.079	-3.199	-1.599	0	0	3.200	1.600	0.092	0.187	1.041
-0.077	-8.700	-2.399	0	4.300	8.700	6.700	0.004	0.008	1.036
-0.062	0	0	0	0	0	0	0.006	0.014	1.033
-0.069	-3.499	-2.299	0	0	3.500	2.300	0.053	0.140	1.015
-0.048	0	0	0	0	0	0	0.158	0.340	1.039
-0.084	0	0	0	0	0	0	0.024	0.050	1.021
0.014	28.450	-0.900	0	0	-28.4500	0.900	0.000	0.001	1.064
-0.034	-10.600	-1.899	0	0	10.600	1.900	0.019	0.038	1.034
							0.038	0.059	
							0.004	0.009	
							0.034	0.060	
							0.043	0.064	
							0.049	0.094	
							0	0.444	
							0.502	0.948	
							0.016	0.030	
							0.329	0.623	
							0.034	0.107	
							0.002	0.008	

Table S28. load flow results GRO, 30-bus, and 4 DG

Delta	Pi	qi	Pg	Qg	pl	ql	PLs	Qls	V
0	75.395	19.666	75.395	19.666	0	0	0.562	1.683	1.060
-0.026	18.299	1.604	39.999	14.304	21.700	12.700	0.208	0.761	1.043
-0.024	-2.400	-1.200	0	0	2.400	1.200	0.043	0.131	1.033
-0.029	-7.600	-1.599	0	0	7.600	1.600	0.054	0.155	1.027
-0.135	-94.199	12.097	0	31.097	94.200	19	1.543	6.483	1.010
-0.038	0	0	0	0	0	0	0.087	0.266	1.023
-0.087	-22.800	-10.900	0	0	22.800	10.900	0.066	0.230	1.010
-0.045	-30	-33.824	0	-3.824	30	30	0.703	1.772	1.010
0.014	0	0	0	0	0	0	0.945	2.903	1.062
0.042	60.711	17.000	0	19.000	-60.711	2	0.146	0.514	1.061
0.014	0	10.155	0	10.155	0	0	0	2.263	1.082
-0.006	-11.200	-7.499	0	0	11.200	7.500	0	1.599	1.058
-0.006	0	9.923	0	9.923	0	0	0	0.183	1.071
-0.005	-6.200	-1.600	0	0	6.200	1.600	0	0.797	1.046
0.008	-8.200	-2.499	0	0	8.200	2.500	0	0.638	1.051
0.027	-3.500	-1.799	0	0	3.500	1.800	0	0.120	1.060
0.063	47.195	-5.800	0	0	-47.195	5.800	0.022	0.046	1.068
0.041	22.688	-0.900	0	0	-22.688	0.900	0.088	0.173	1.059
0.034	-9.500	-3.399	0	0	9.500	3.400	0.247	0.521	1.052
0.035	-2.200	-0.699	0	0	2.200	0.700	0.056	0.051	1.053
0.025	-17.500	-11.200	0	0	17.500	11.200	0.293	0.684	1.045
0.031	0	0	0	0	0	0	0.238	0.485	1.052
0.023	-3.199	-1.599	0	0	3.200	1.600	0.032	0.066	1.045
0.018	-8.700	-2.399	0	4.300	8.700	6.700	0.002	0.004	1.038
0.009	0	0	0	0	0	0	0.020	0.044	1.030
0.002	-3.500	-2.299	0	0	3.500	2.300	0.214	0.558	1.013
0.008	0	0	0	0	0	0	0.284	0.612	1.034
-0.035	0	0	0	0	0	0	0.059	0.123	1.023
0.060	23.817	-0.900	0	0	-23.817	0.900	0.014	0.028	1.053
0.015	-10.600	-1.899	0	0	10.600	1.900	0.055	0.111	1.025
							0.094	0.147	
							0.010	0.020	
							0.018	0.031	
							0.043	0.064	
							0.003	0.006	
							0	0.570	
							0.323	0.611	
							0.008	0.016	
							0.269	0.509	
							0.041	0.129	
							0.005	0.019	

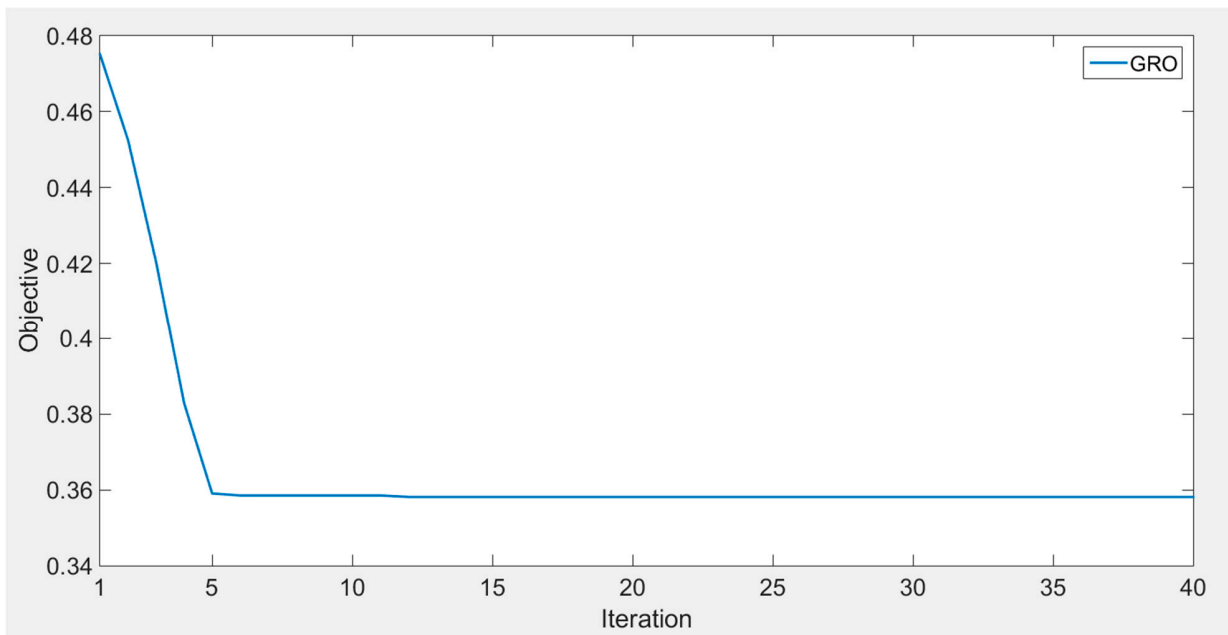


Figure S49. Algorithm Convergent GRO, 30-bus, and 4DG

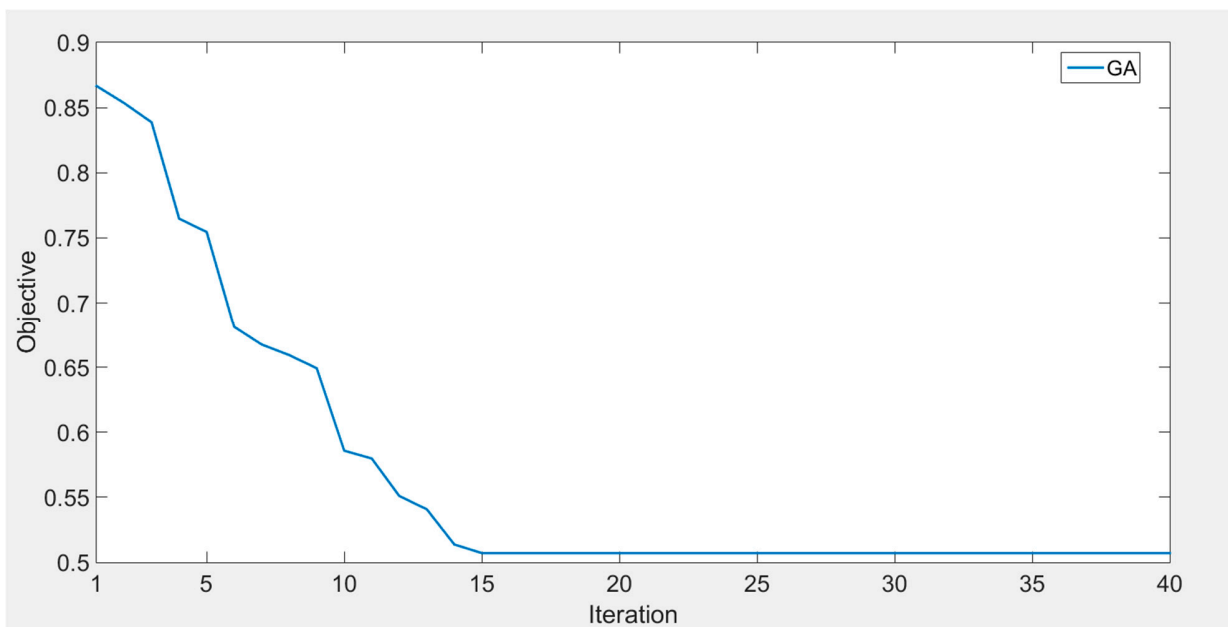


Figure S50. Algorithm Convergent GA, 30-bus, and 4DG

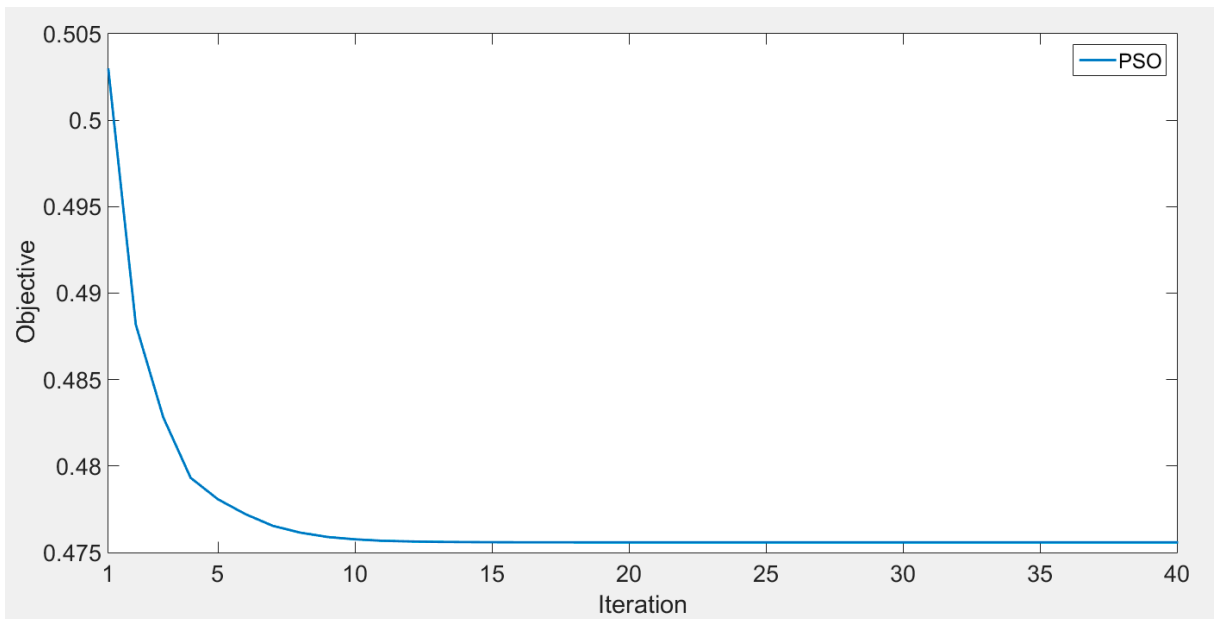


Figure S51. Algorithm Convergent PSO, 30-bus, and 4DG

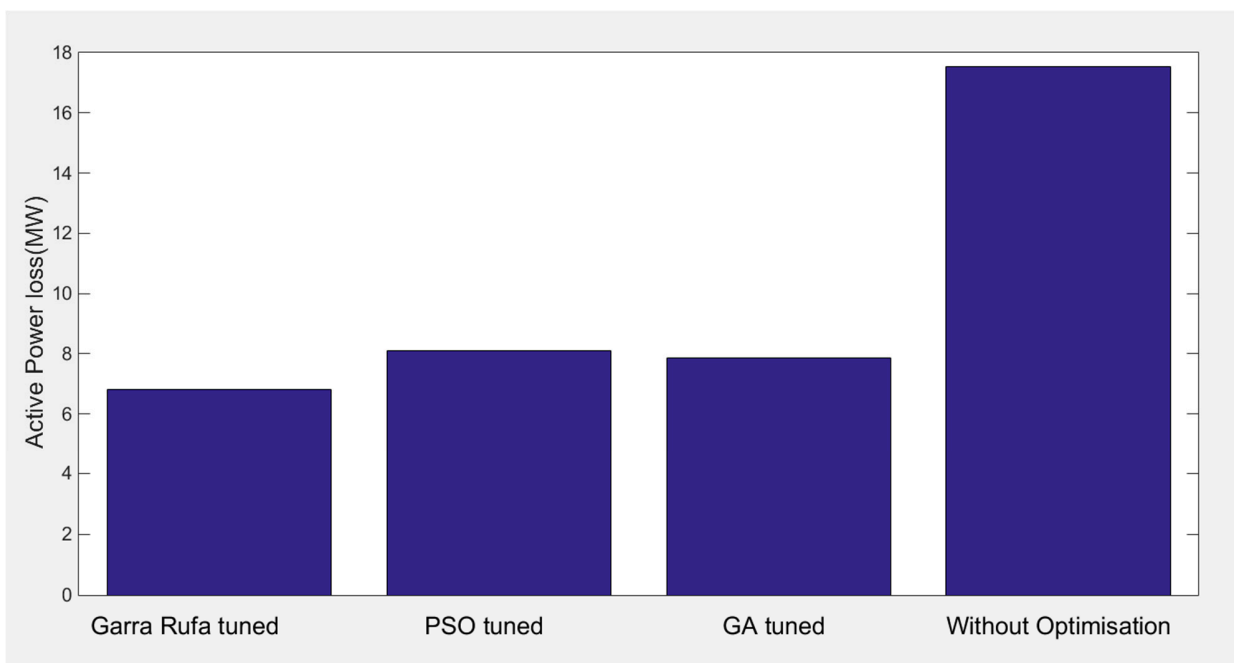


Figure S52. Active Power Losses 4DG and 30-bus

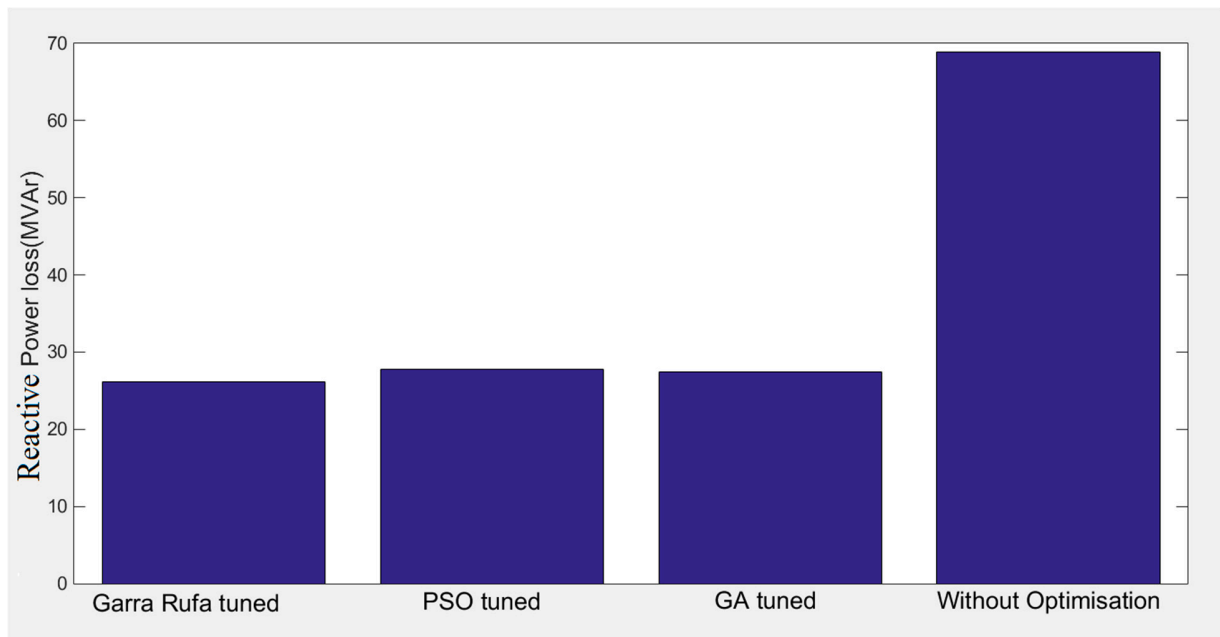


Figure S53. Reactive Power Losses 4DG and 30-bus

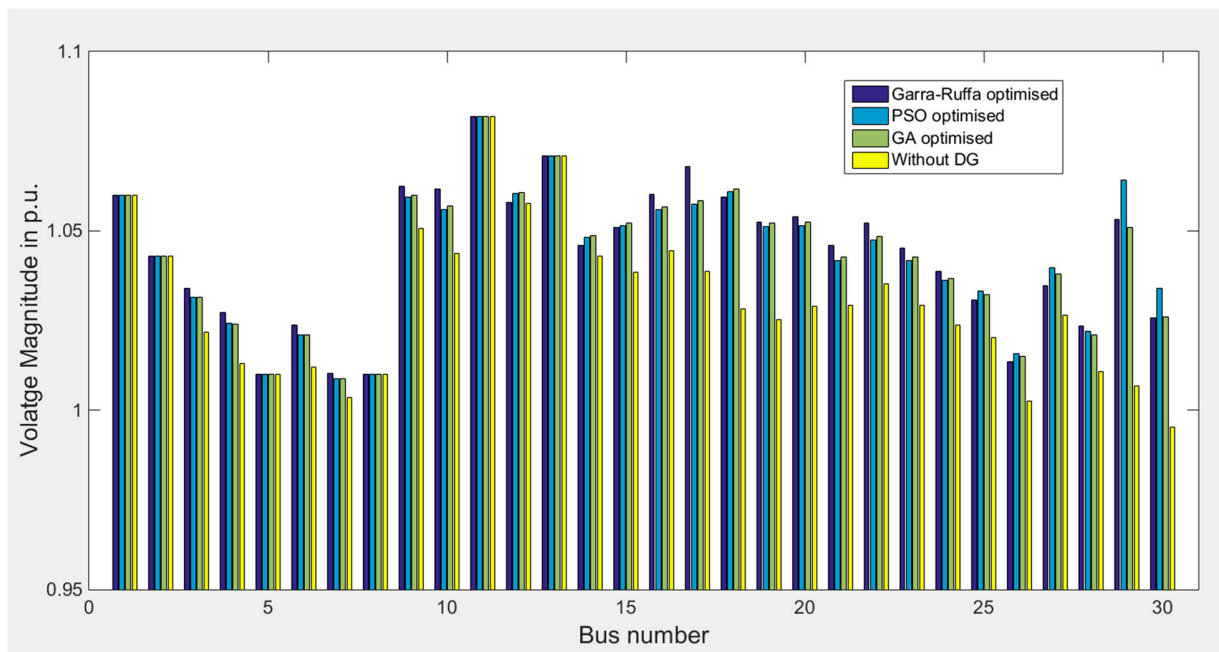


Figure S54. Voltage Profile 4DG and 30-bus

Table S29. load flow results GA, 30-bus, and 5 DG

Delta	Pi	qi	Pg	Qg	Pl	Ql	PLs	Qls	V
0	51.183	26.583	51.183	26.583	0	0	0.301	0.903	1.060
-0.016	18.300	-1.981	40.000	10.718	21.700	12.700	0.141	0.516	1.043
-0.015	-2.400	-1.199	0	0	2.400	1.200	0.039	0.119	1.034
-0.017	-7.599	-1.600	0	0	7.600	1.600	0.038	0.110	1.027
-0.099	-94.199	5.756	0	24.756	94.200	19	0.952	4.003	1.010
-0.020	0	0	0	0	0	0	0.063	0.193	1.024
-0.038	28.019	-10.900	0	0	-28.019	10.900	0.014	0.051	1.019
-0.025	-30.000	-35.567	0	-5.567	30	30	1.161	2.928	1.010
-0.003	0	0	0	0	0	0	0.126	0.388	1.057
-0.035	-5.800	17.000	0	19.000	5.800	2	0.139	0.487	1.052
0.073	42.210	14.442	0	14.442	-42.210	0	0	0.705	1.082
-0.013	35.261	-7.499	0	0	-35.261	7.500	0	0.191	1.066
-0.013	0	3.233	0	3.233	0	0	0	3.536	1.071
-0.027	-6.199	-1.600	0	0	6.200	1.600	0	1.098	1.053
-0.029	-8.200	-2.500	0	0	8.200	2.500	0	0.640	1.049
-0.027	-3.500	-1.799	0	0	3.500	1.800	0	0.0127	1.053
-0.036	-9.000	-5.800	0	0	9	5.800	0.065	0.135	1.047
-0.029	7.604	-0.899	0	0	-7.604	0.900	0.176	0.347	1.045
-0.038	-9.499	-3.399	0	0	9.500	3.400	0.079	0.166	1.039
-0.039	-2.200	-0.700	0	0	2.200	0.700	0.003	0.002	1.041
-0.043	-17.499	-11.199	0	0	17.500	11.200	0.025	0.059	1.038
-0.043	0	0	0	0	0	0	0.003	0.006	1.044
-0.043	-3.200	-1.600	0	0	3.200	1.600	0.041	0.084	1.038
-0.053	-8.700	-2.400	0	4.299	8.700	6.700	0.002	0.005	1.032
-0.060	0	0	0	0	0	0	0.020	0.045	1.029
-0.067	-3.500	-2.300	0	0	3.500	2.300	0.010	0.026	1.011
-0.060	0	0	0	0	0	0	0.128	0.277	1.035
-0.008	46.125	0	0	0	-46.125	0	0.035	0.073	1.025
-0.081	-2.400	-0.900	0	0	2.400	0.900	0.0001	0.0002	1.016
-0.096	-10.600	-1.899	0	0	10.600	1.900	0.067	0.135	1.004
							0.056	0.087	
							0.020	0.041	
							0.009	0.016	
							0.043	0.065	
							0.008	0.016	
							0	0.790	
							0.084	0.158	
							0.158	0.297	
							0.032	0.061	
							0.080	0.253	
							0.072	0.257	

Table S30. load flow results PSO, 30-bus, and 5 DG

Delta	Pi	qi	pg	Qg	Pl	ql	PLs	Qls	V
0	68.671	22.375	68.671	22.375	0	0	0.436	1.306	1.060
-0.022	18.300	0.095	40.000	12.795	21.700	12.700	0.228	0.834	1.043
-0.026	-2.400	-1.200	0	0	2.400	1.200	0.062	0.190	1.033
-0.031	-7.599	-1.599	0	0	7.600	1.600	0.059	0.170	1.026
-0.109	-94.200	5.996	0	24.996	94.200	19	1.037	4.358	1.010
-0.033	0	0	0	0	0	0	0.087	0.264	1.023
-0.050	26.356	-10.899	0	0	-26.356	10.900	0.008	0.029	1.018
-0.038	-29.999	-34.375	0	-4.375	30	30	1.068	2.693	1.010
-0.027	0	0	0	0	0	0	0.121	0.372	1.059
-0.053	-5.799	17.000	0	19.000	5.800	2	0.128	0.449	1.055
0.028	30.601	12.649	0	12.649	-30.601	0	0	0.651	1.082
-0.054	-3.580	-7.499	0	0	3.580	7.500	0	0.269	1.063
-0.054	0	5.770	0	5.770	0	0	0	1.948	1.071
-0.058	-6.199	-1.599	0	0	6.200	1.600	0	0.739	1.051
-0.050	-8.200	-2.499	0	0	8.200	2.500	0	0.838	1.055
-0.059	-3.500	-1.800	0	0	3.500	1.800	0	0.040	1.053
-0.059	-9.000	-5.799	0	0	9	5.800	0.023	0.048	1.049
-0.011	38.102	-0.900	0	0	-38.102	0.900	0.028	0.055	1.068
-0.031	-9.500	-3.399	0	0	9.500	3.400	0.025	0.052	1.056
-0.038	-2.199	-0.699	0	0	2.200	0.700	0.021	0.019	1.054
-0.061	-17.500	-11.200	0	0	17.500	11.200	0.002	0.005	1.042
-0.061	0	0	0	0	0	0	0.353	0.720	1.047
-0.061	-3.199	-1.599	0	0	3.200	1.600	0.199	0.402	1.042
-0.070	-8.699	-2.399	0	4.300	8.700	6.700	0.027	0.054	1.036
-0.075	0	0	0	0	0	0	0.048	0.108	1.031
-0.082	-3.499	-2.299	0	0	3.500	2.300	0.025	0.066	1.014
-0.073	0	0	0	0	0	0	0.126	0.273	1.038
-0.019	50.850	0	0	0	-50.850	0	0.033	0.070	1.026
-0.094	-2.400	-0.900	0	0	2.400	0.900	0	0.0001	1.018
-0.109	-10.600	-1.900	0	0	10.600	1.900	0.059	0.120	1.007
							0.053	0.083	
							0.017	0.034	
							0.005	0.009	
							0.043	0.064	
							0.007	0.014	
							0	0.858	
							0.083	0.158	
							0.157	0.296	
							0.032	0.061	
							0.090	0.285	
							0.096	0.343	

Table S31. load flow results GRO, 30-bus, and 5 DG

Delta	Pi	qi	Pg	Qg	pl	Ql	PLs	Qls	V
0	51.051	28.160	51.051	28.160	0	0	0.266	0.799	1.060
-0.014	18.300	-1.793	40.000	10.906	21.700	12.700	0.187	0.686	1.043
-0.020	-2.399	-1.199	0	0	2.400	1.200	0.070	0.213	1.032
-0.023	-7.600	-1.599	0	0	7.600	1.600	0.050	0.144	1.025
-0.078	-94.199	0.856	0	19.856	94.200	19	0.618	2.597	1.010
-0.020	0	0	0	0	0	0	0.071	0.216	1.023
-0.008	75.668	-10.899	0	0	-75.668	10.900	0.007	0.026	1.026
-0.026	-30.000	-33.743	0	-3.743	30	30	1.592	4.015	1.010
-0.016	0	0	0	0	0	0	0.063	0.194	1.058
-0.060	-5.800	16.999	0	18.999	5.800	2	0.139	0.488	1.054
0.070	47.781	14.520	0	14.520	-47.781	0	0	0.595	1.082
-0.069	-3.751	-7.499	0	0	3.751	7.500	0	0.497	1.062
-0.069	0	6.777	0	6.777	0	0	0	4.430	1.071
-0.079	-6.199	-1.599	0	0	6.200	1.600	0	2.030	1.048
-0.075	-8.200	-2.500	0	0	8.200	2.500	0	1.532	1.047
-0.070	-3.500	-1.800	0	0	3.500	1.800	0	0.056	1.052
-0.067	-9.000	-5.800	0	0	9	5.800	0.044	0.092	1.048
-0.072	4.356	-0.900	0	0	-4.356	0.900	0.080	0.158	1.043
-0.076	-9.499	-3.399	0	0	9.500	3.400	0.019	0.041	1.038
-0.073	-2.200	-0.700	0	0	2.200	0.700	0.003	0.003	1.042
-0.072	-17.500	-11.199	0	0	17.500	11.200	0.004	0.010	1.039
-0.068	0	0	0	0	0	0	0.005	0.011	1.046
-0.073	-3.200	-1.600	0	0	3.200	1.600	0.009	0.019	1.039
-0.077	-8.700	-2.399	0	4.300	8.700	6.700	0.011	0.022	1.034
-0.077	0	0	0	0	0	0	0.059	0.133	1.031
-0.085	-3.500	-2.300	0	0	3.500	2.300	0.033	0.086	1.013
-0.073	0	0	0	0	0	0	0.190	0.410	1.037
-0.014	35.144	0	0	0	-35.144	0	0.037	0.076	1.024
-0.094	-2.399	-0.899	0	0	2.400	0.900	0.002	0.005	1.018
-0.109	-10.600	-1.900	0	0	10.600	1.900	0.012	0.025	1.006
							0.058	0.091	
							0.006	0.013	
							0.001	0.002	
							0.043	0.064	
							0.012	0.023	
							0	1.015	
							0.083	0.158	
							0.157	0.296	
							0.032	0.061	
							0.052	0.165	
							0.019	0.068	

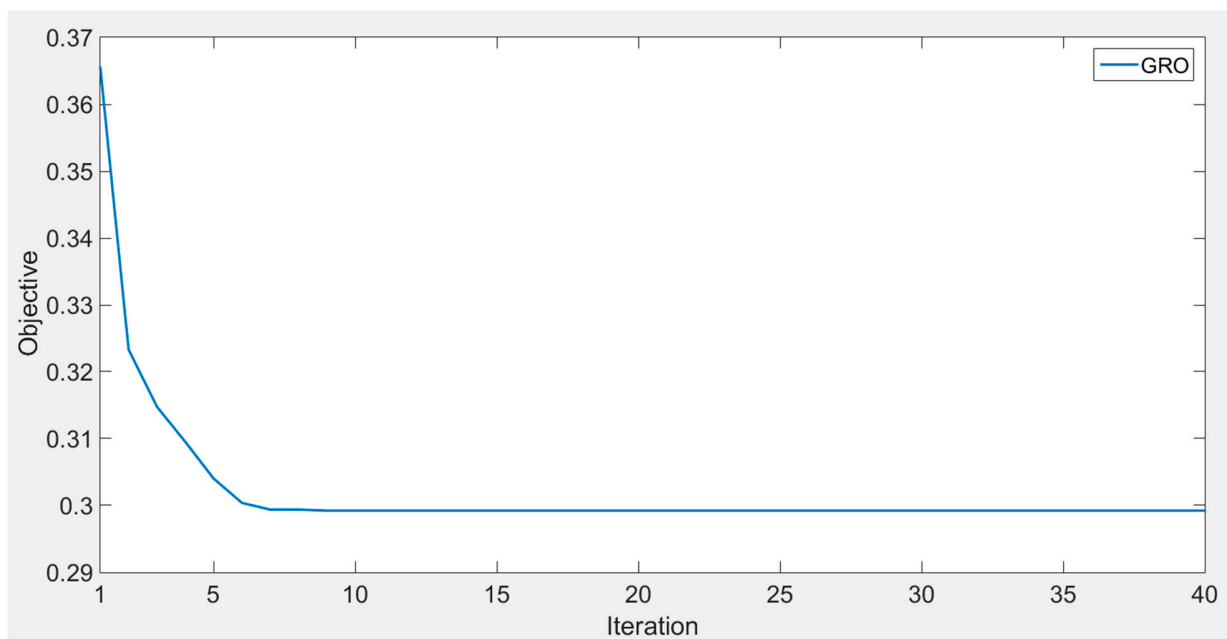


Figure S55. Algorithm Convergent GRO, 30-bus, and 5DG

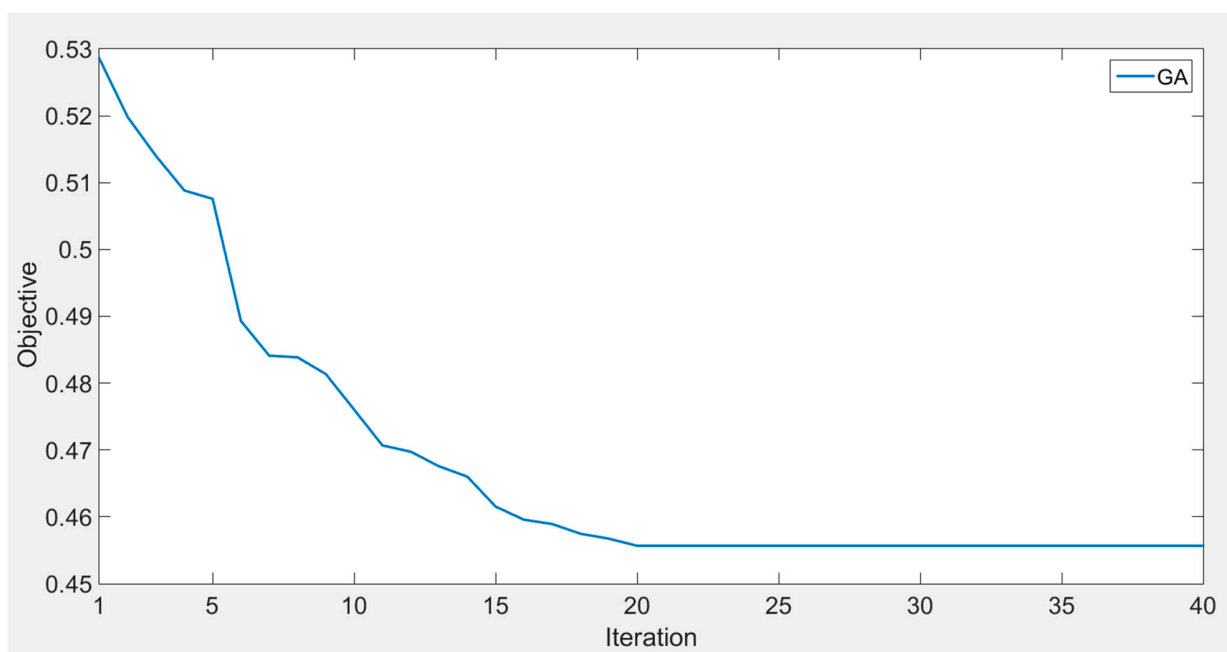


Figure S56. Algorithm Convergent GA, 30-bus, and 5DG

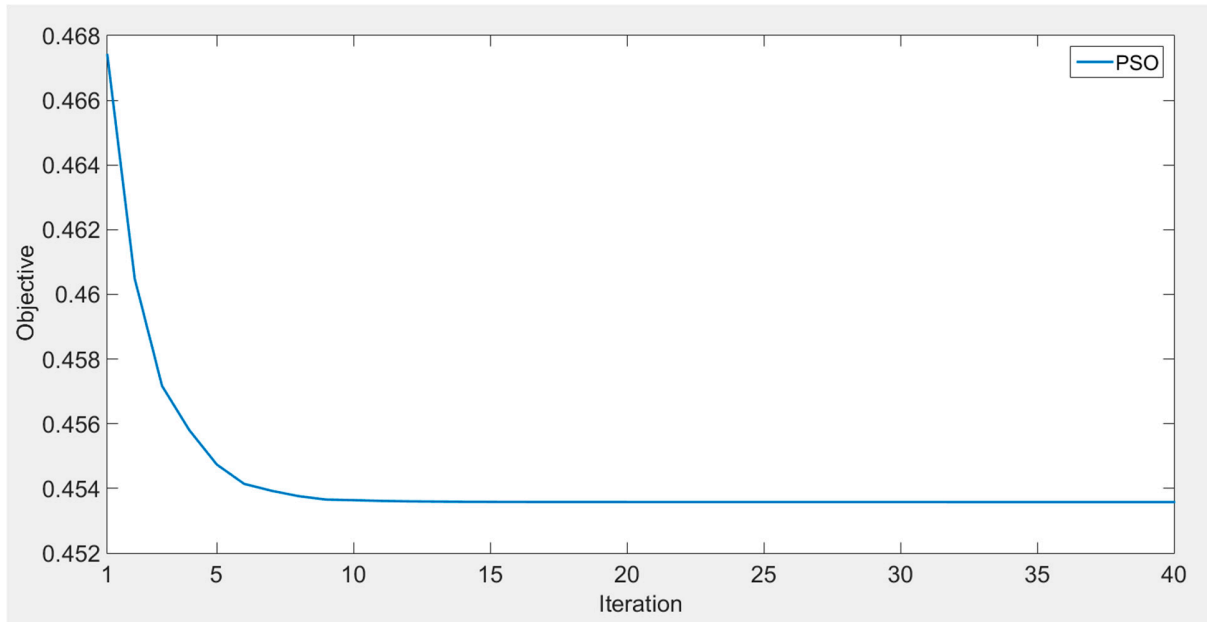


Figure S57. Algorithm Convergent PSO, 30-bus, and 5DG

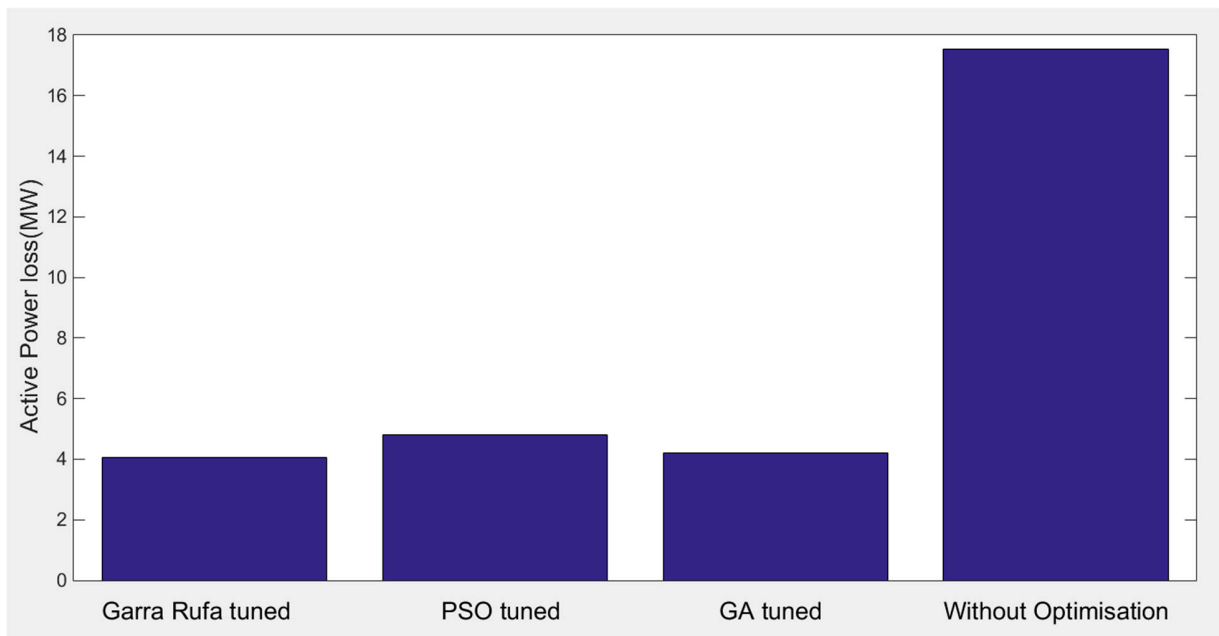


Figure S58. Active Power Losses 5DG and 30-bus

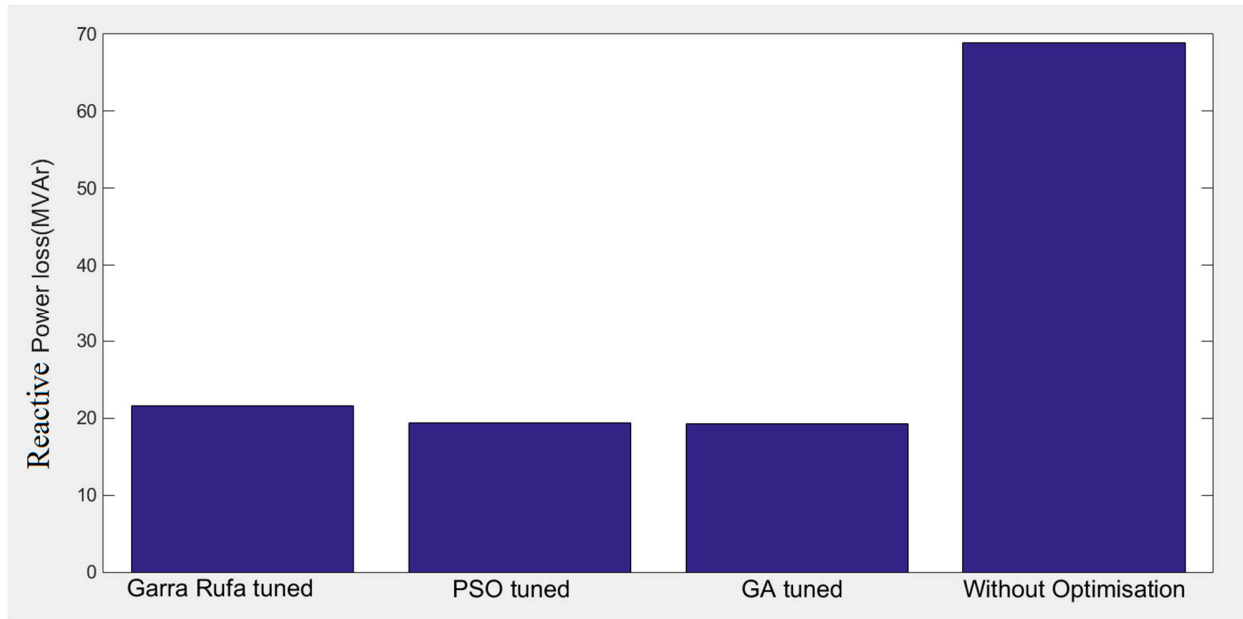


Figure S59. Reactive Power Losses 5DG and 30-bus

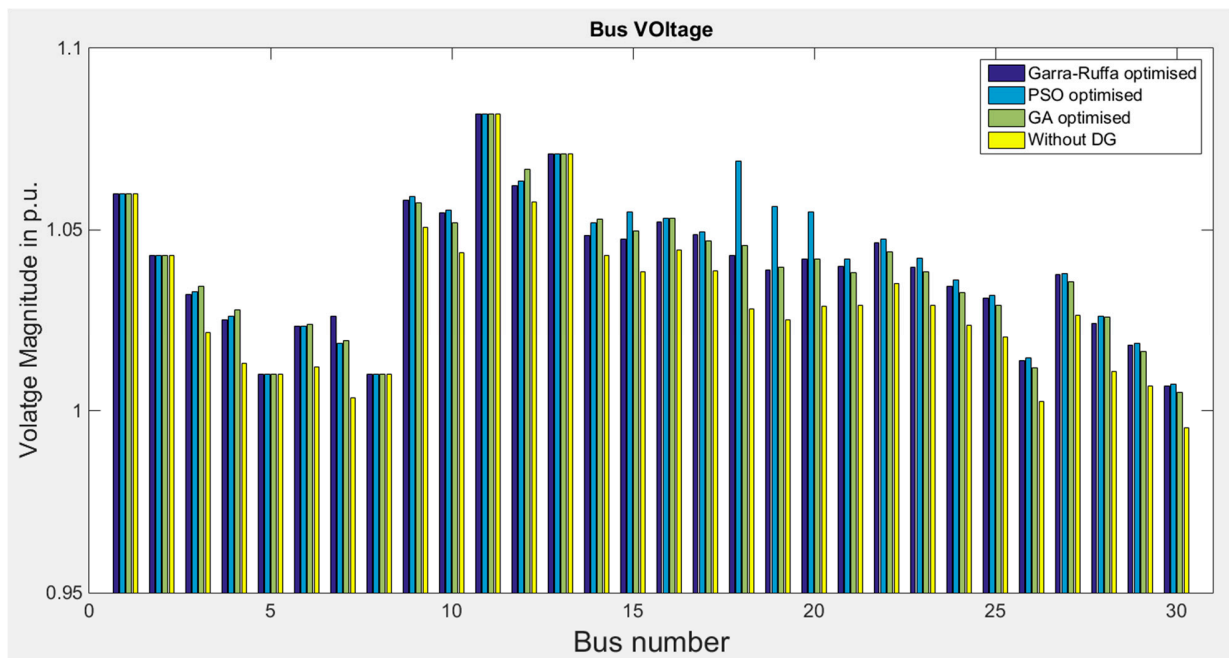


Figure S60. Voltage Profile 5DG and 30-bus

Table S32. load flow results without DG, 30-bus

Delta	Pi	Qi	Pg	Qg	PI	QI	PLs	QIs	V
0	260.927	-17.118	260.927	-17.118	0	0	5.178	15.509	1.060
-0.093	18.299	35.065	39.999	47.765	21.700	12.700	3.115	11.387	1.0430
-0.131	-2.400	-1.199	0	0	2.400	1.200	1.011	3.080	1.022
-0.162	-7.599	-1.599	0	0	7.600	1.600	0.857	2.462	1.013
-0.247	-94.200	16.965	0	35.965	94.200	19	2.945	12.374	1.010
-0.193	0	0	0	0	0	0	1.946	5.906	1.012
-0.224	-22.800	-10.900	0	0	22.800	10.900	0.641	2.231	1.000
-0.206	-29.999	0.691	0	30.691	30	30	0.162	0.409	1.010
-0.246	0	0	0	0	0	0	0.380	1.169	1.051
-0.274	-5.800	17.00	0	19.00	5.800	2	0.103	0.360	1.044
-0.246	0	16.269	0	16.269	0	0	0	2.213	1.082
-0.260	-11.199	-7.499	0	0	11.200	7.500	0	1.474	1.058
-0.260	0	10.247	0	10.247	0	0	0	0.470	1.071
-0.276	-6.200	-1.599	0	0	6.200	1.600	0	0.819	1.043
-0.277	-8.200	-2.499	0	0	8.200	2.500	0	5.188	1.038
-0.271	-3.500	-1.799	0	0	3.500	1.800	0	0.128	1.046
-0.277	-8.999	-5.799	0	0	9	5.800	0.073	0.151	1.039
-0.288	-3.200	-0.900	0	0	3.200	0.900	0.210	0.415	1.028
-0.291	-9.500	-3.400	0	0	9.500	3.400	0.057	0.121	1.025
-0.288	-2.199	-0.699	0	0	2.200	0.700	0.005	0.004	1.029
-0.283	-17.499	-11.199	0	0	17.500	11.200	0.013	0.031	1.029
-0.280	0	0	0	0	0	0	0.042	0.086	1.035
-0.283	-3.200	-1.600	0	0	3.200	1.600	0.006	0.012	1.029
-0.286	-8.700	-2.400	0	4.299	8.700	6.700	0.015	0.031	1.024
-0.280	0	0	0	0	0	0	0.076	0.169	1.020
-0.287	-3.500	-2.299	0	0	3.500	2.300	0.013	0.034	1.003
-0.271	0	0	0	0	0	0	0.151	0.325	1.027
-0.204	0	0	0	0	0	0	0.028	0.059	1.011
-0.292	-2.400	-0.899	0	0	2.400	0.900	0	0.0001	1.007
-0.308	-10.600	-1.899	0	0	10.600	1.900	0.024	0.049	0.995
							0.045	0.070	
							0.006	0.012	
							0.007	0.013	
							0.044	0.066	
							0.023	0.044	
							0	1.261	
							0.085	0.161	
							0.161	0.303	
							0.033	0.062	
							0.0002	0.0008	
							0.059	0.209	