5.3 CEED Solution :

Table 5.3.1.CEED solution of six-generator system.

	Load (MW)						
	500	600	700	800	900	1000	1100
Unit 1 (MW)	27.0761	37.1510	47.7319	58.7850	69.4172	80.7886	92.2725
Unit 2 (MW)	12.7469	25.4110	38.9012	52.9280	66.2622	80.5036	94.8011
Unit 3 (MW)	87.5175	103.27	118.9937	134.5476	150.128	165.4889	180.7754
Unit 4 (MW)	90.0724	105.0619	119.9757	134.7719	149.6309	164.3189	178.9645
Unit 5 (MW)	144.0005	166.9180	189.138	211.0186	233.4694	255.2878	277.1023
Unit 6 (MW)	138.5864	162.1952	185.2593	207.9487	231.0922	253.612	276.0841
Fuel cost ($/h)	27,085	31,620	36,305	41,142	46,111	51,248	56,536
Emission output (kg/h)	261	338	433	546	678	827	994

Table 5.3.2 CEED solution of eleven-generator system.

	Load (MW)						
	1000	1250	1500	1750	2000	2250	2500
Unit 1 (MW)	96.3722	108.7266	119.1675	126.1782	134.1285	40.9601	147.5659
Unit 2 (MW)	54.4709	66.1264	76.4648	84.3814	92.6630	99.9876	106.9765
Unit 3 (MW)	34.3775	51.2440	67.2675	81.5767	95.5855	108.5646	120.9388
Unit 4 (MW)	82.7644	102.7733	123.3978	145.218	166.8914	189.094	211.5236
Unit 5 (MW)	56.1714	74.154	92.4080	111.222	130.175	149.4965	169.0596
Unit 6 (MW)	85.2626	104.4727	124.2404	145.0236	165.5296	186.374	207.2804
Unit 7 (MW)	59.7574	77.0323	94.5844	112.6598	130.6829	148.9247	167.2576
Unit 8 (MW)	147.1684	182.6859	218.8348	256.0525	292.9103	330.0551	367.1877
Unit 9 (MW)	131.2123	161.8806	193.1217	225.3833	257.3779	289.6968	322.0772
Unit 10 (MW)	126.7146	163.4975	200.8392	239.3183	277.7522	316.6919	355.8675
Unit 11 (MW)	125.728	157.4066	189.6738	222.986	256.3037	290.1545	324.2652
Fuel cost ($/h)	8,465.1	9,080.6	9,713.4	10,359	11,021	11,707	12,406
Emission output(kg/h)	205.1	339.6	538.1	807	1135	1536	2001

5.4. Comparison of fuel cost and emission output for six-generator system

Table 5.4.1 Fuel cost ($/h):

	Load (MW)						
Method	500	600	700	800	900	1000	1100
γ-iteration	27,092.5	31,628.7	36,314.0	41,148.4	46,131.8	51,264.6	56,546.4
Recursive	27,092.5	31,628.6	36,313.9	41,148.3	46,131.8	51,264.5	56,546.2
PSO	27,097.5	31,634.9	36,314.2	41,160.3	46,160.6	51,269.6	56,556.7
DE	27,098.1	31,629.2	36,314.0	41,152.6	46,152.6	51,264.6	56,546.6
Simplified recursive	27,092.5	31,628.6	36,313.9	41,148.3	46,131.8	51,264.6	56,546.2
Proposed method	27,085	31,620	36,305	41,142	46,111	51,248	56,536

Table 5.4.2 Emission output (kg/h):

γ-iteration	261.635	338.993	434.380	547.797	679.241	828.720	996.224
Recursive	261.634	338.992	434.380	547.796	679.241	828.715	996.218
PSO	262.225	339.820	434.605	547.844	679.724	828.863	996.672
DE	261.859	339.065	434.453	547.802	679.283	828.715	996.222
Simplified recursive	261.634	338.992	434.380	547.796	679.241	828.715	996.218
Proposed method	261	338	433	546	678	827	994

5.5 Comparison of fuel cost and emission output for eleven-generator system

Table 5.5.1.Fuel cost ($/h):

	Load (MW)						
Method	1000	1250	1500	1750	2000	2250	2500
γ-iteration	8502.30	9108.38	9733.54	10,377.78	11,041.08	11,723.47	12,424.94
Recursive	8502.29	9108.38	9733.54	10,377.77	11,041.08	11,723.47	12,424.94
PSO	8508.24	9114.42	9737.33	10,380.82	11,041.09	11,725.68	12,428.63
DE	8505.81	9117.63	9736.22	10,377.86	11,041.08	11,723.54	12,425.06
Simplified recursive	8502.29	9108.38	9733.54	10,377.77	11,041.08	11,723.47	12,424.94
Proposed method	8456.1	9080.6	9713.4	10,359.01	11,021	11,707	12,406

Table.5.5.2.Emission output (kg/h)

γ-iteration	205.205	339.870	540.545	807.220	1,139.912	1,538.600	2,003.301
Recursive	205.204	339.870	540.544	807.220	1,139.911	1,538.600	2,003.300
PSO	208.012	345.669	545.347	812.263	1,142.182	1,540.465	2,003.720
DE	205.206	339.935	544.298	807.236	1,139.911	1,538.659	2,003.350
Simplified recursive	205.204	339.870	540.544	807.220	1,139.911	1,538.600	2,003.300
Proposed method	205.10	339.6	538.10	807	1,135	1,536	2,001

Table-5.4.presents the results of γ -iteration method , recursive method (RM), particle swarm optimization(PSO), Simplified recursive, differential evolution (DE), simplified recursive method (SRM) and proposed method; when the load demands are varies from 500 - 1100 MW for six generator system. The PSO produced the highest cost and emission and the obtained operation cost and emission output by RM, γ -iteration method are smaller than the DE respectively. For varying 500 – 1100 MW of load demands, the operation costs and emissions of all methods are higher than the operation costs and emission output of the proposed method. In order to demonstrate the efficiency and the robustness of the proposed genetic algorithm, same approach is used for eleven generator system. The results of the proposed and other five methods are shown in Table-5.5. For varying 1000 - 2500 MW of load demands, the operation costs and emission output of all methods are higher than the operation costs and emission output of the proposed method. It is obvious that the proposed method produced the better solution than the compared methods for six-generator and eleven-generator systems.

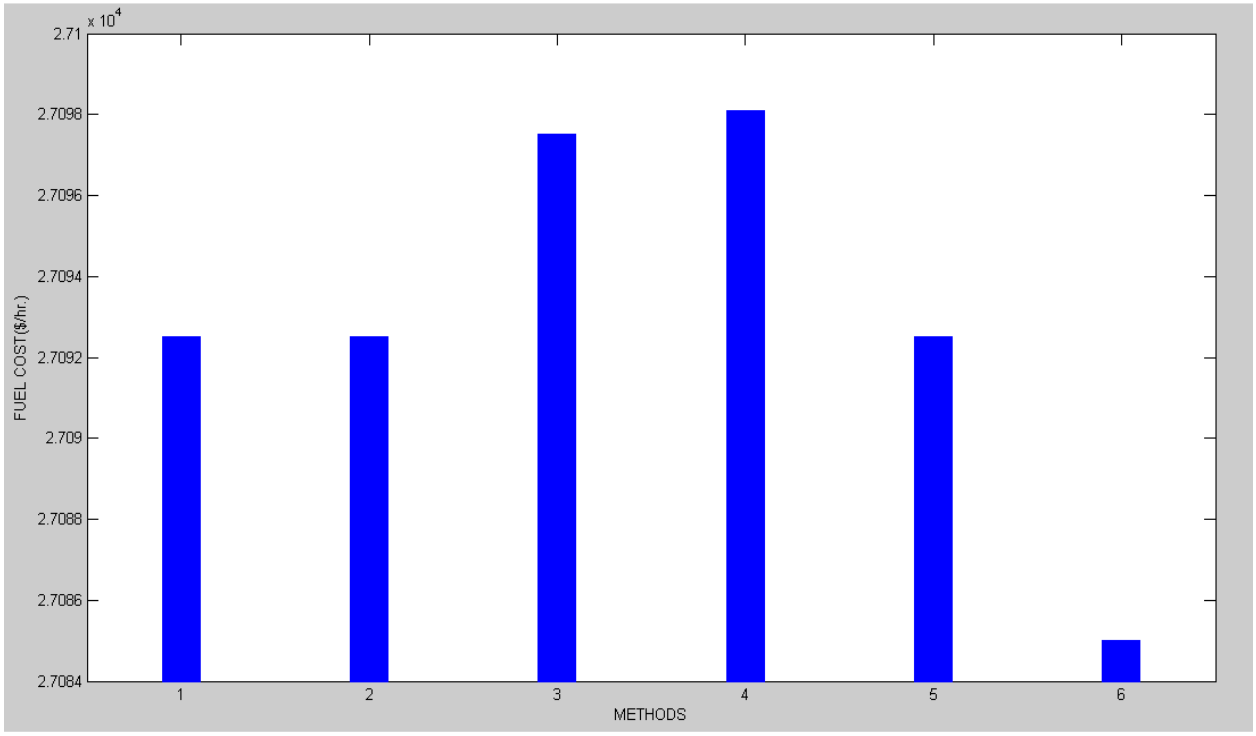
Output of methods, shown in table-5 and table-6 are compared in graphical form.

Graphical representation:

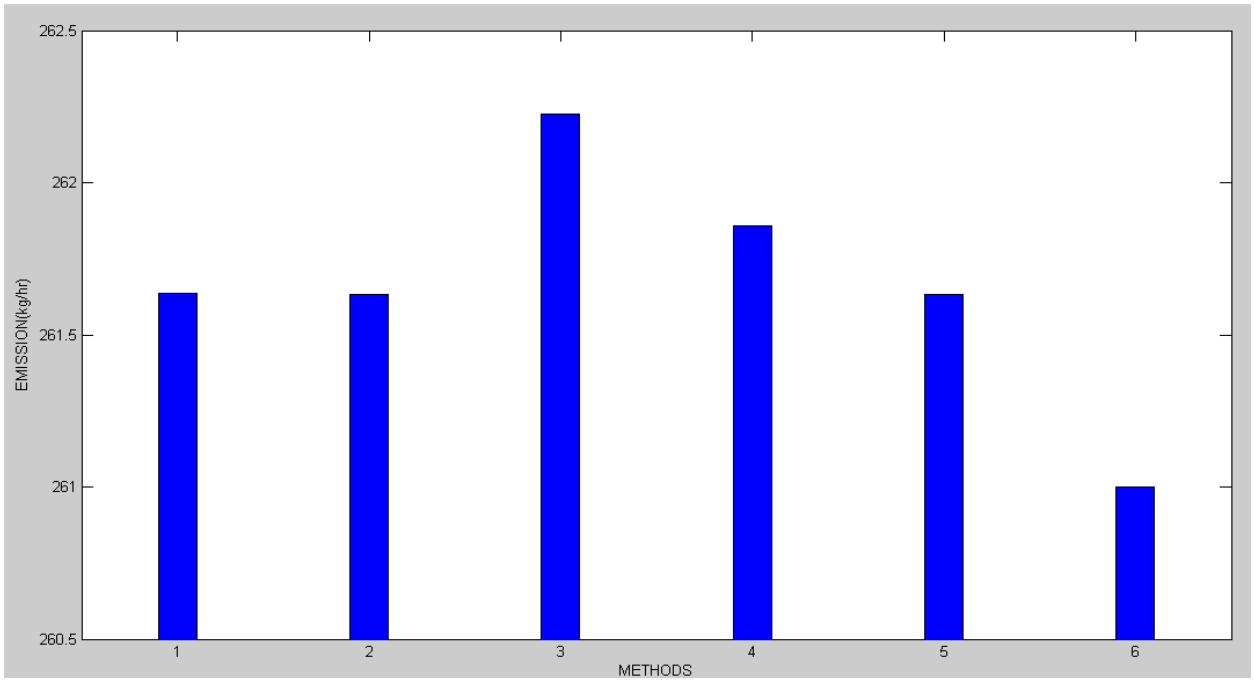
Graphs are plotted for six generator and eleven generator system for different loads. In the graphs shown below x-axis represent the methods used. Where, Method 1- γ-iteration, Method 2- Recursive , Method 3- PSO, Method 4- DE ,Method 5- Simplified recursive , Method 6- Proposed method. And y-axis represents fuel cost($/hr)/emission output(kg/hr).

Graphs for six generator system :

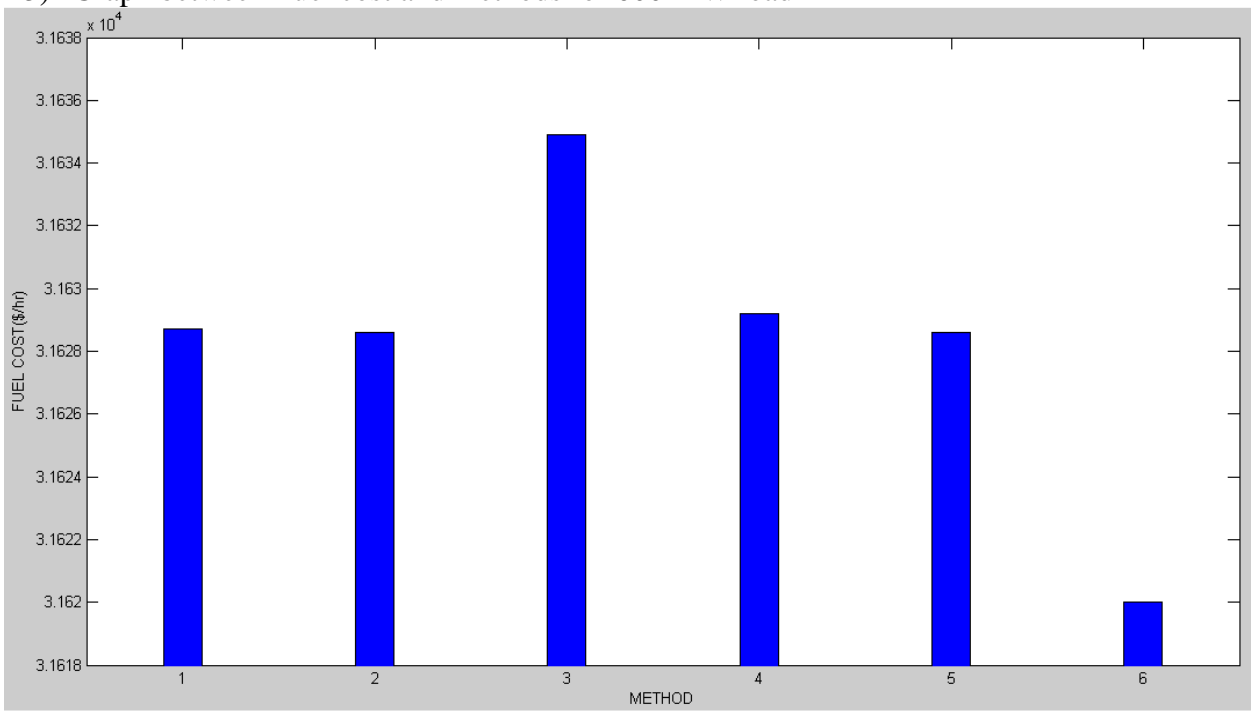
1) Graph between fuel cost and methods for 500 MW load



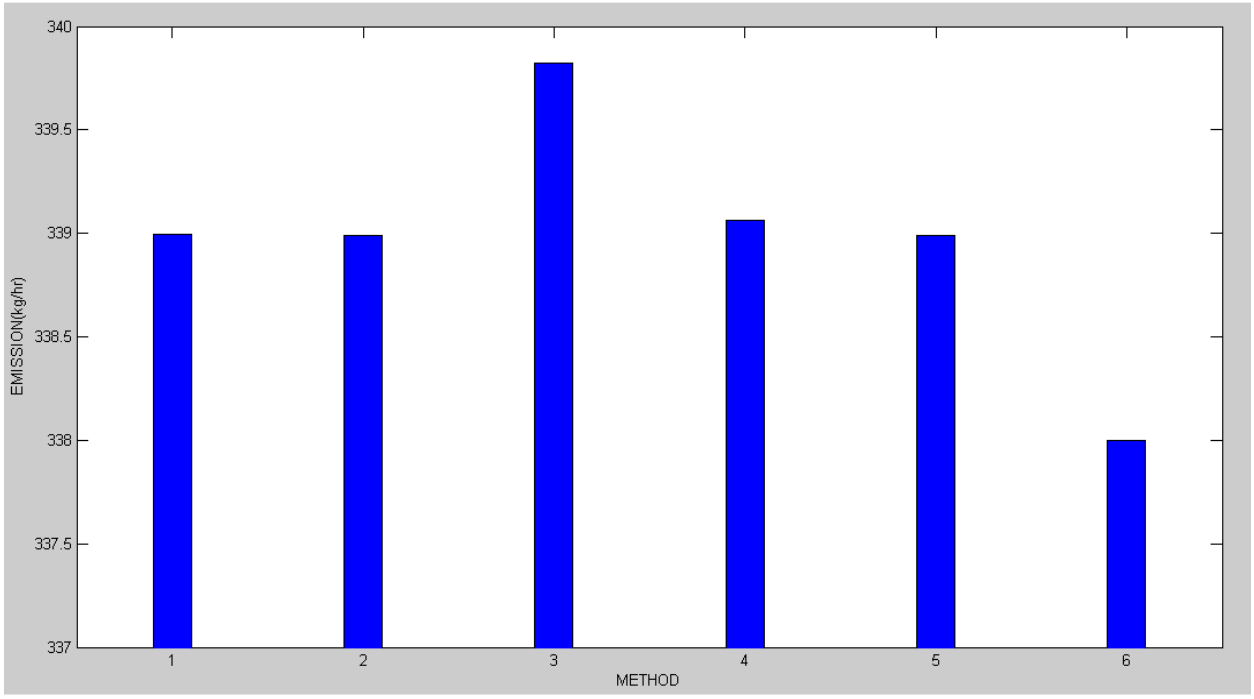
2) Graph between emission output and methods for 500 MW load



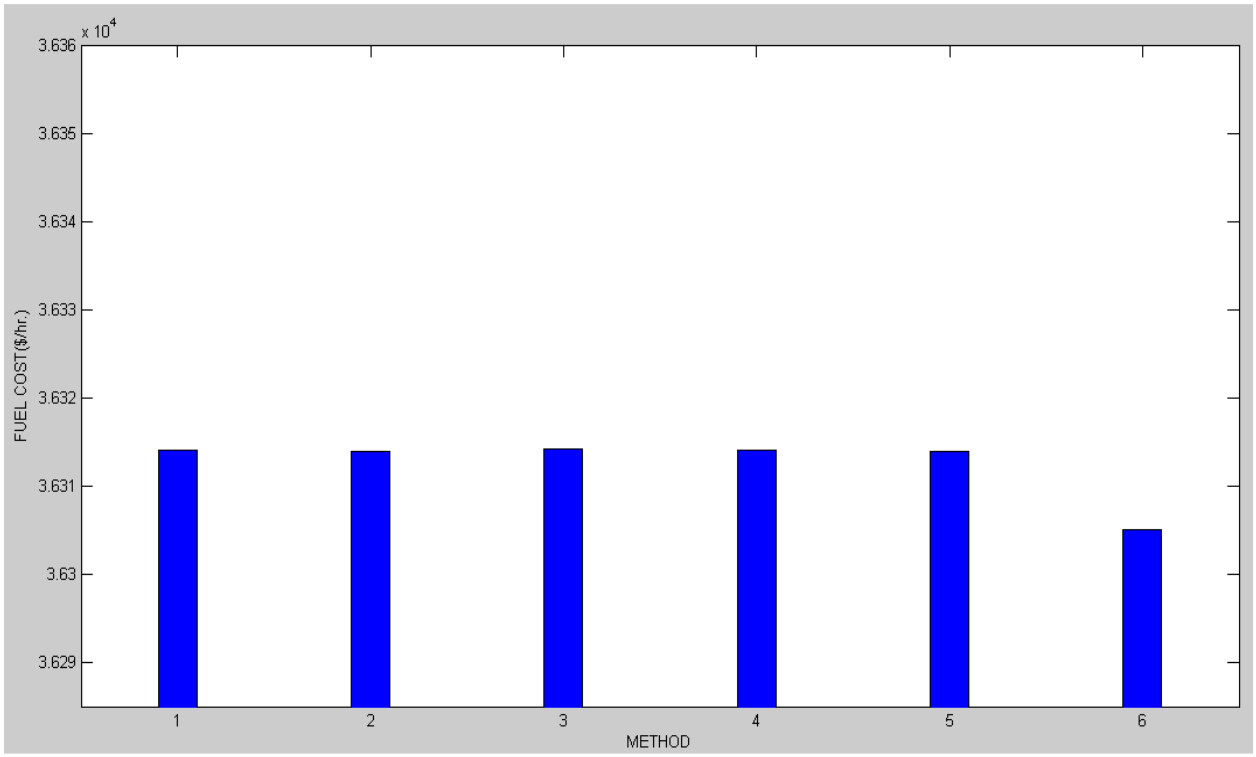
3) Graph between fuel cost and methods for 600 MW load



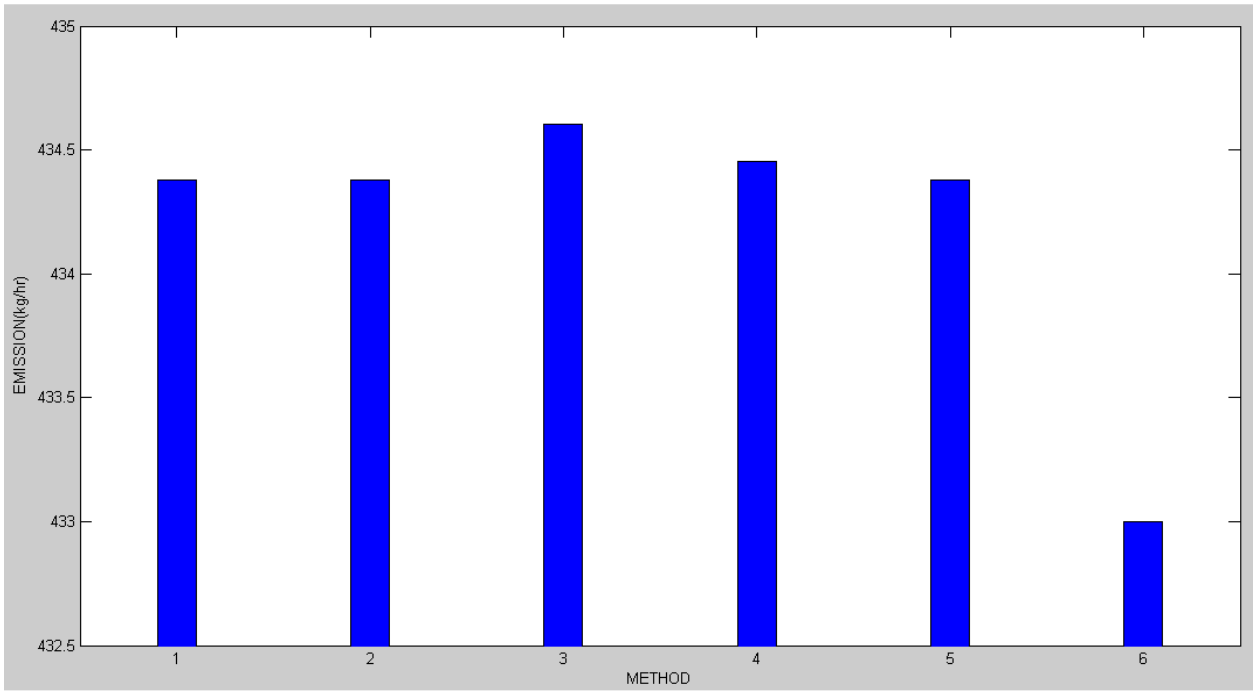
4) Graph between emission output and methods for 600 MW load



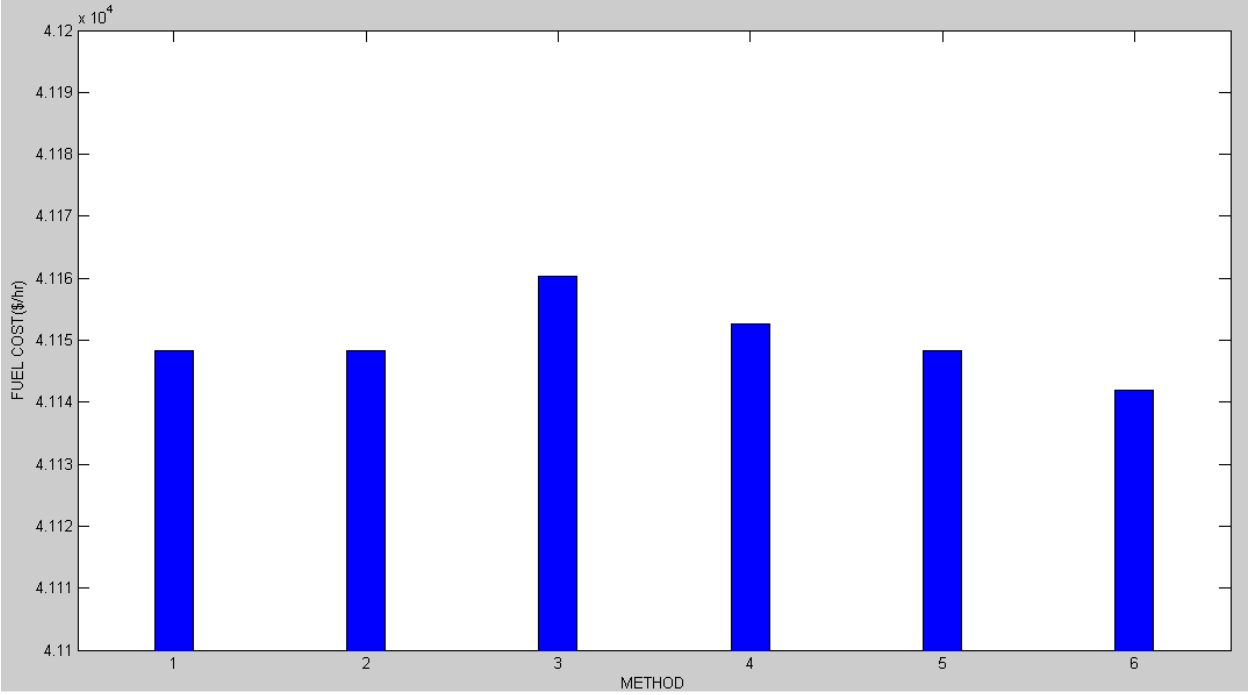
5) Graph between fuel cost and methods for 700 MW load



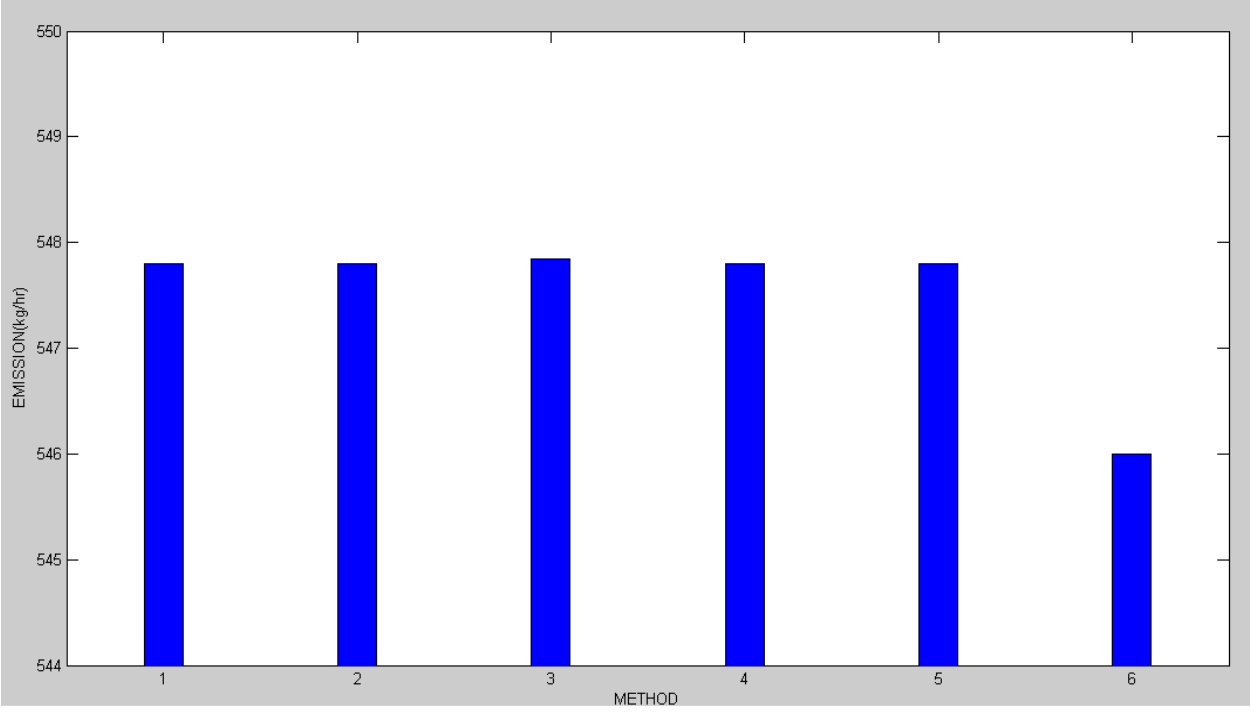
6) Graph between emission output and methods for 700 MW load



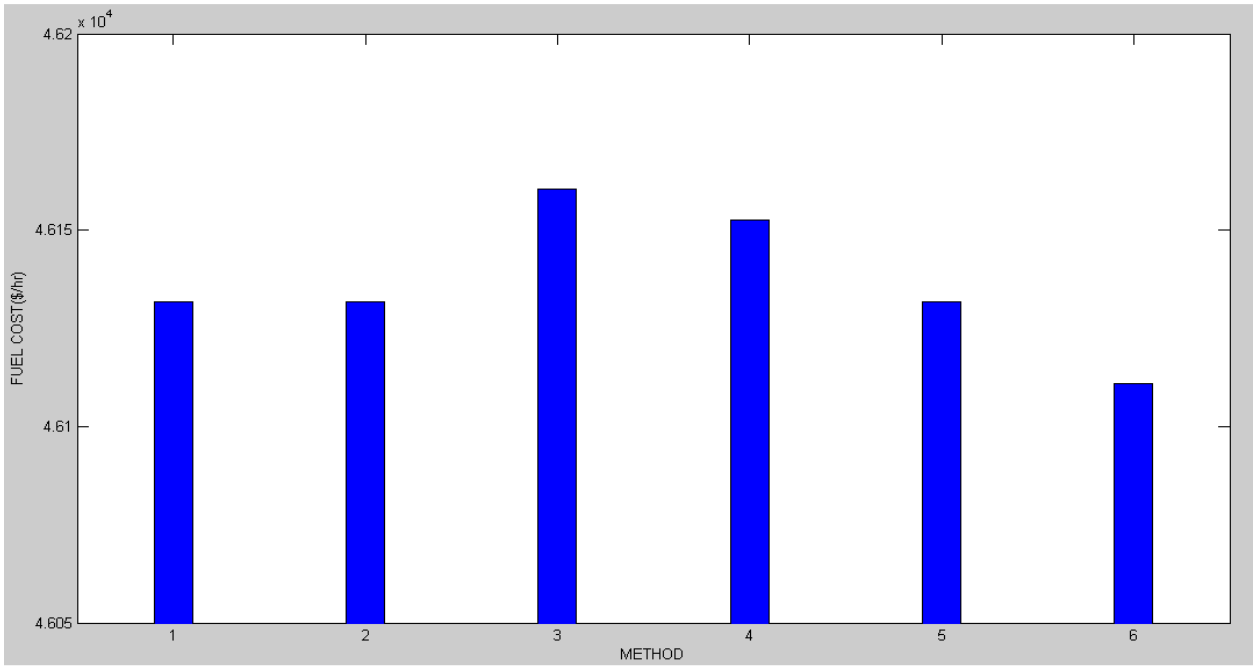
7) Graph between fuel cost and methods for 800MW load



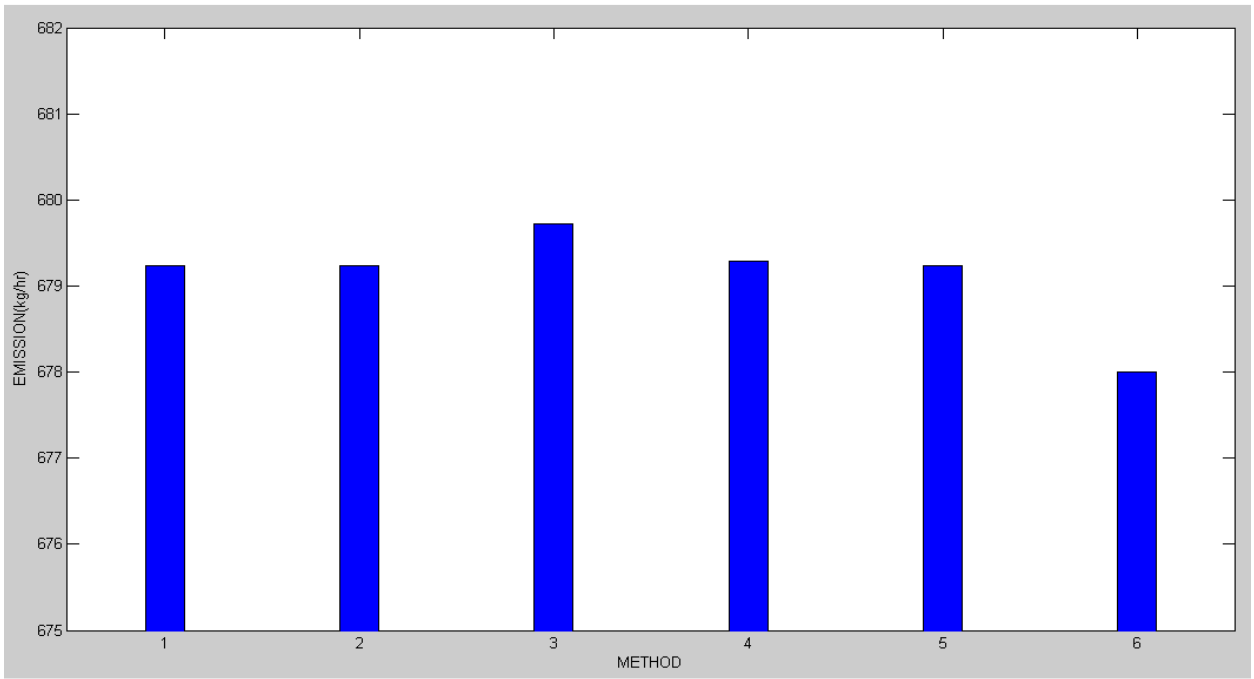
8) Graph between emission output and methods for 800 MW load



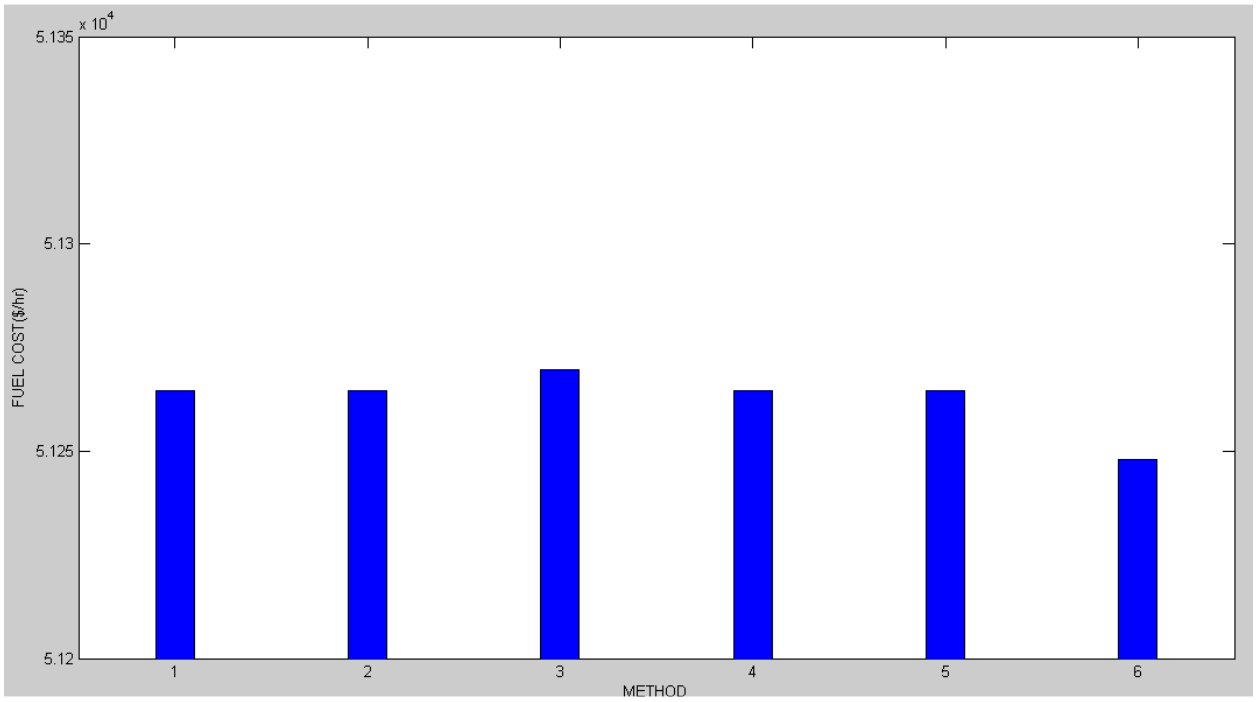
9) Graph between fuel cost and methods for 900 MW load



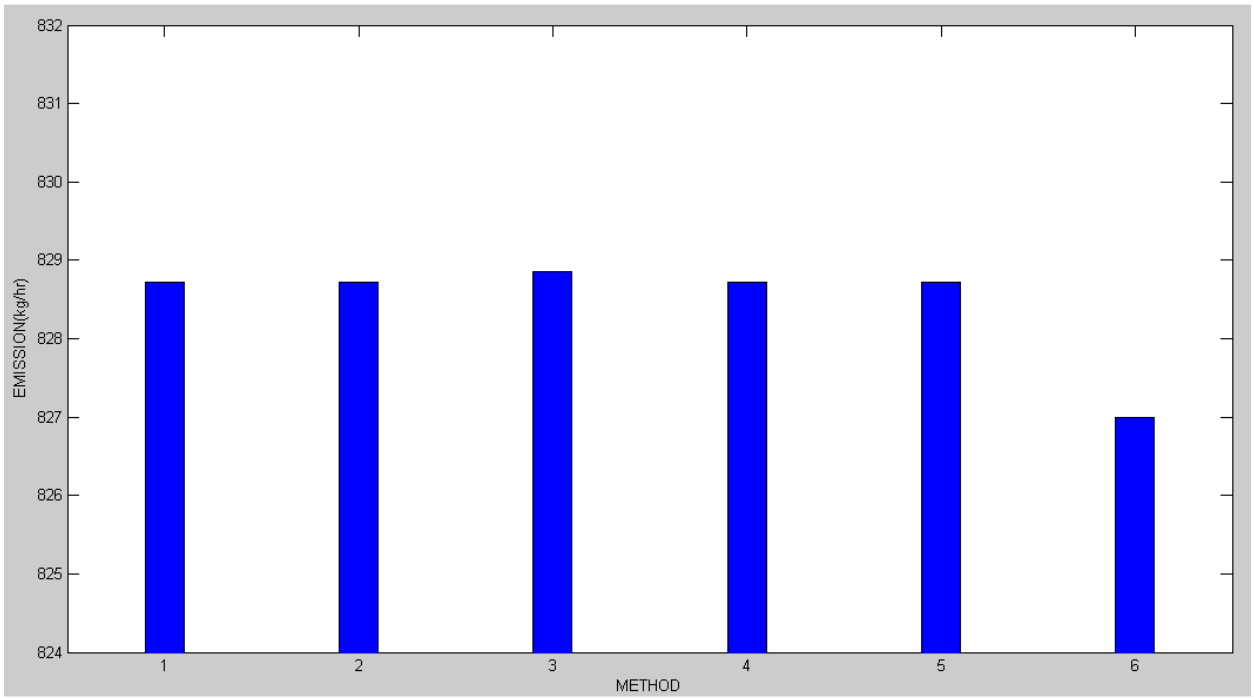
10) Graph between emission output and methods for 900 MW load



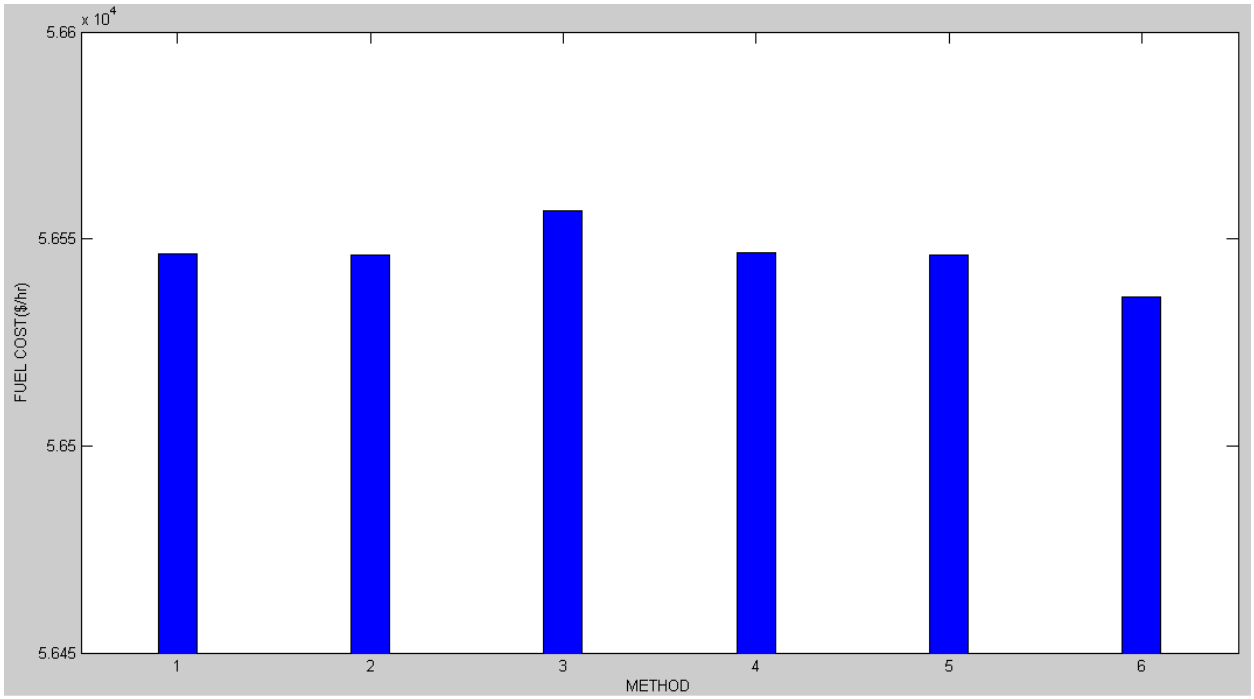
11) Graph between fuel cost and methods for 1000MW load



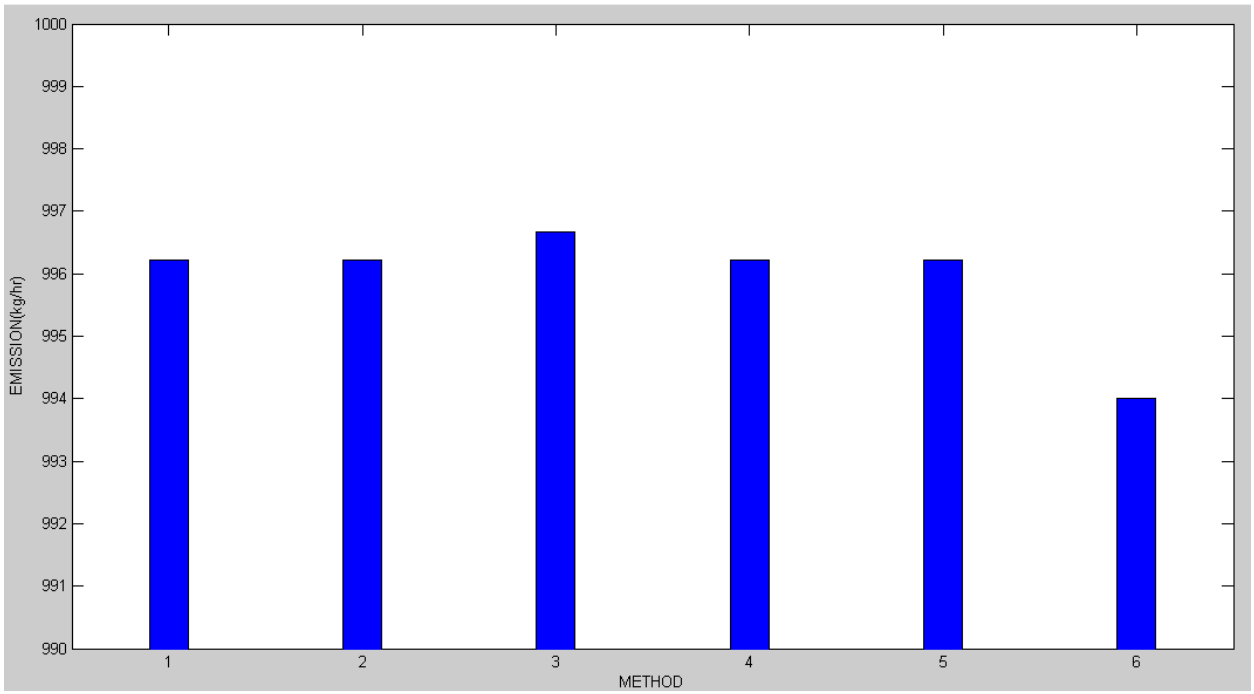
12) Graph between emission output and methods for 1000 MW load



13) Graph between fuel cost and methods for 1100 MW load

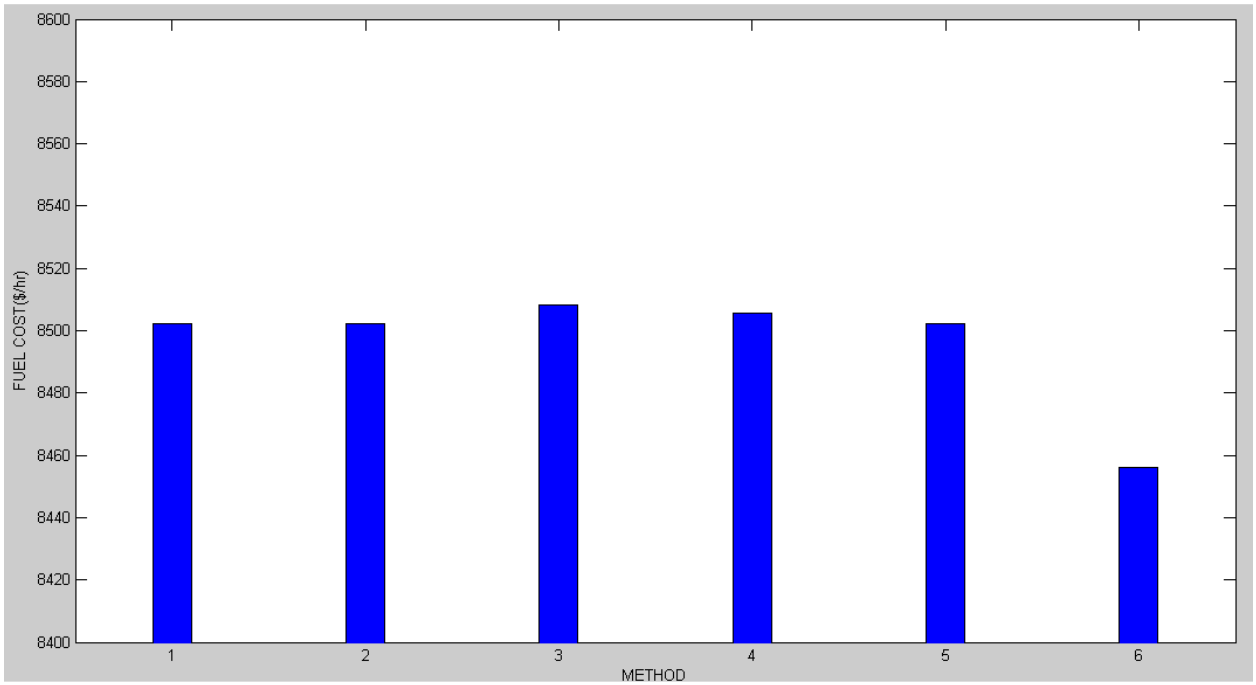


14) Graph between emission output and methods for 1100 MW load

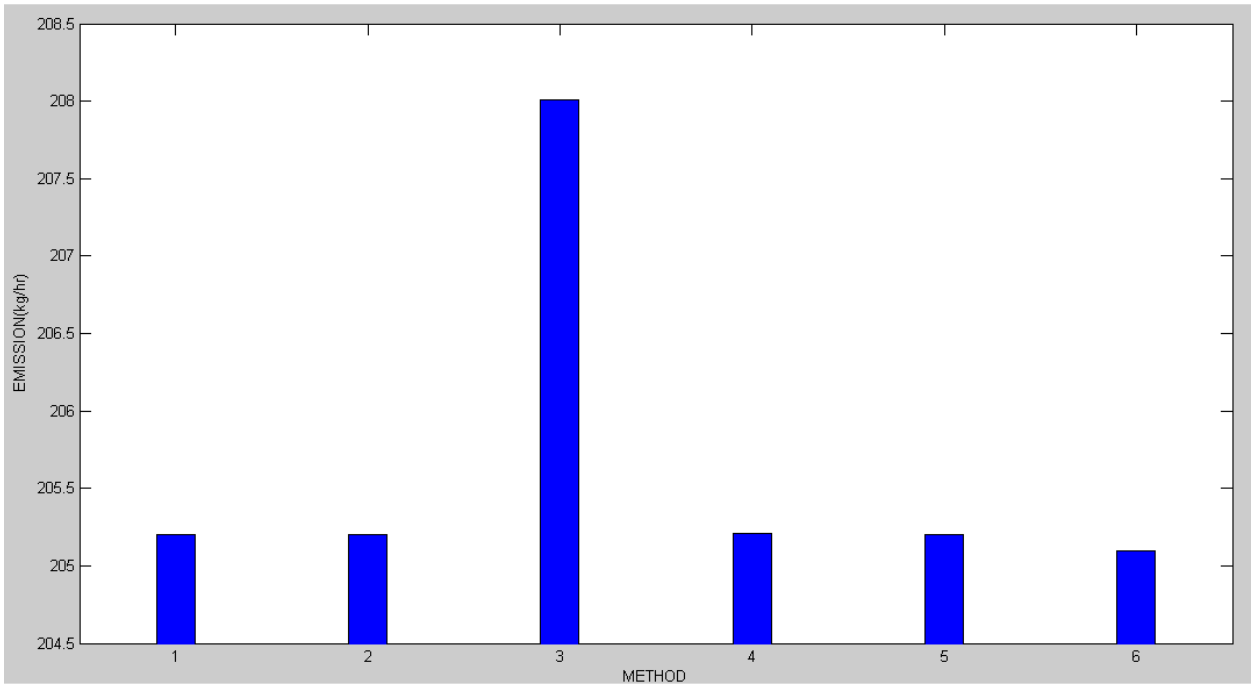


Graphs for eleven generator system:

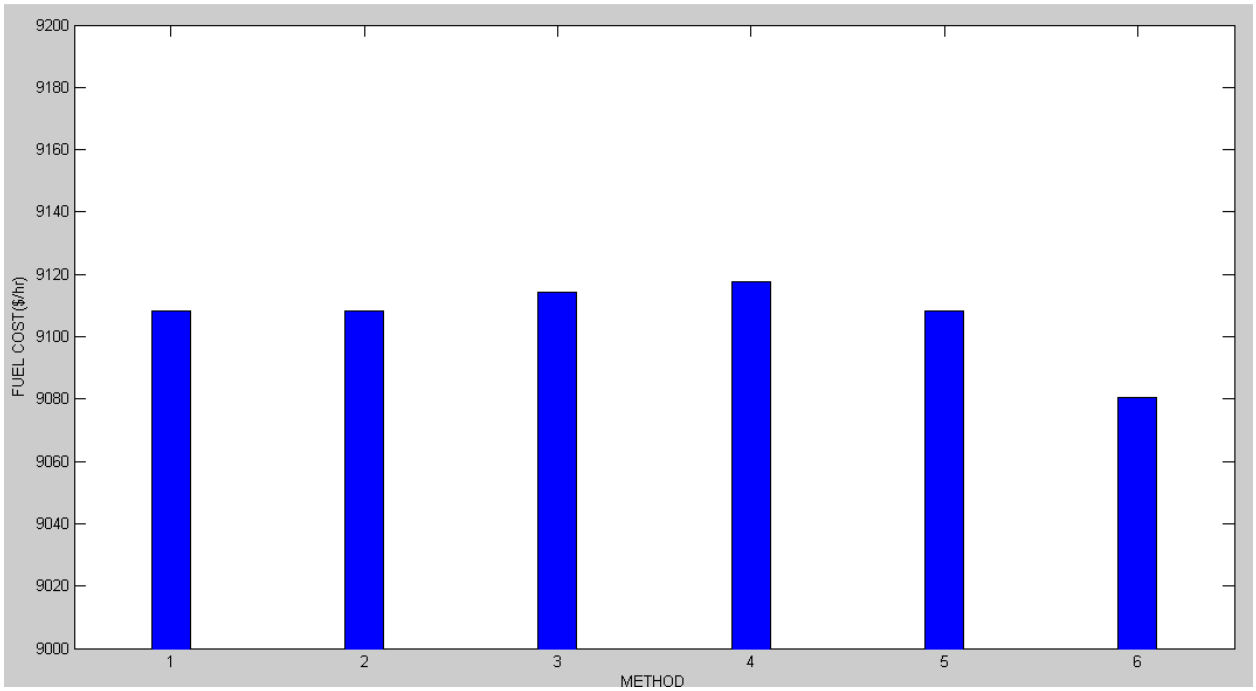
1) Graph between fuel cost and methods for 1000MW load



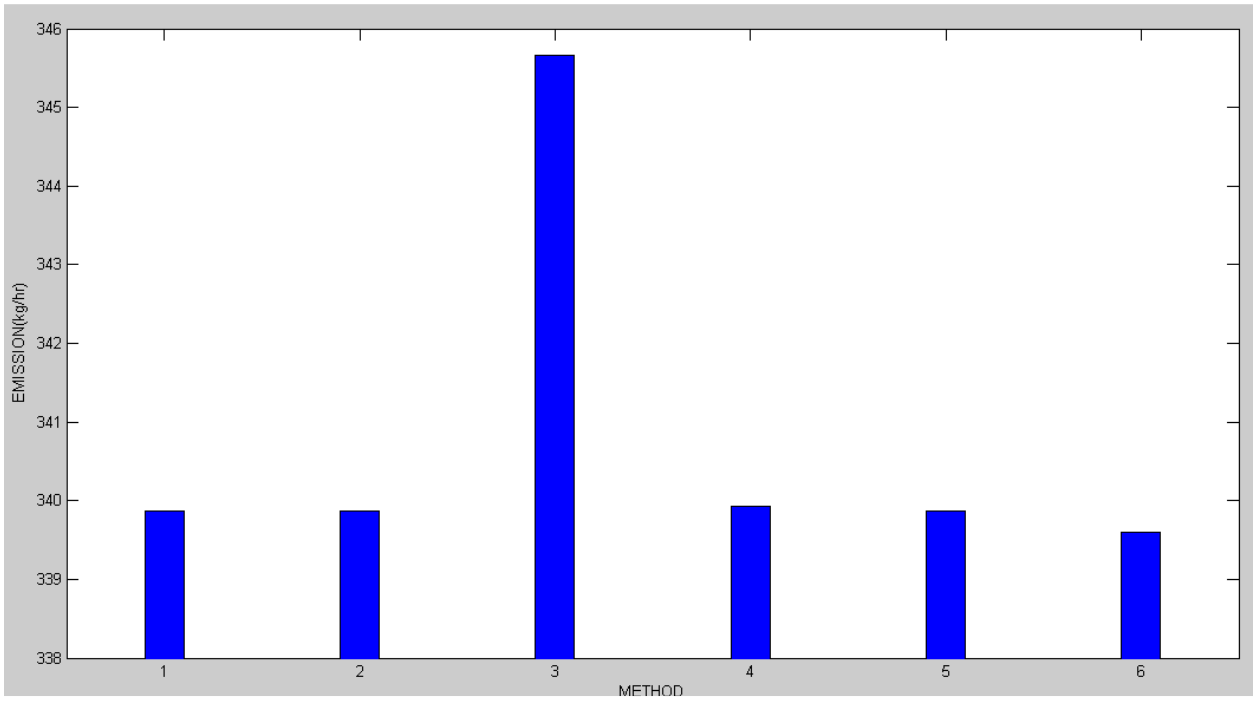
2) Graph between emission output and methods for 1000 MW load



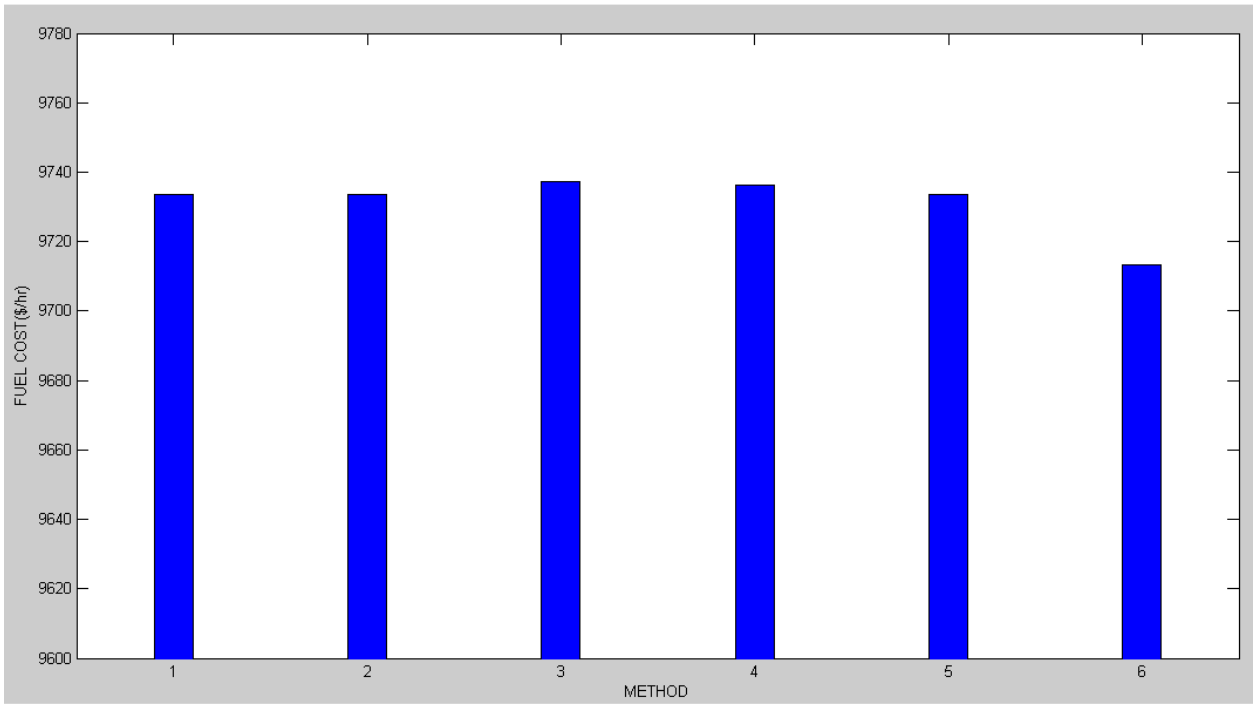
3) Graph between fuel cost and methods for 1250 MW load



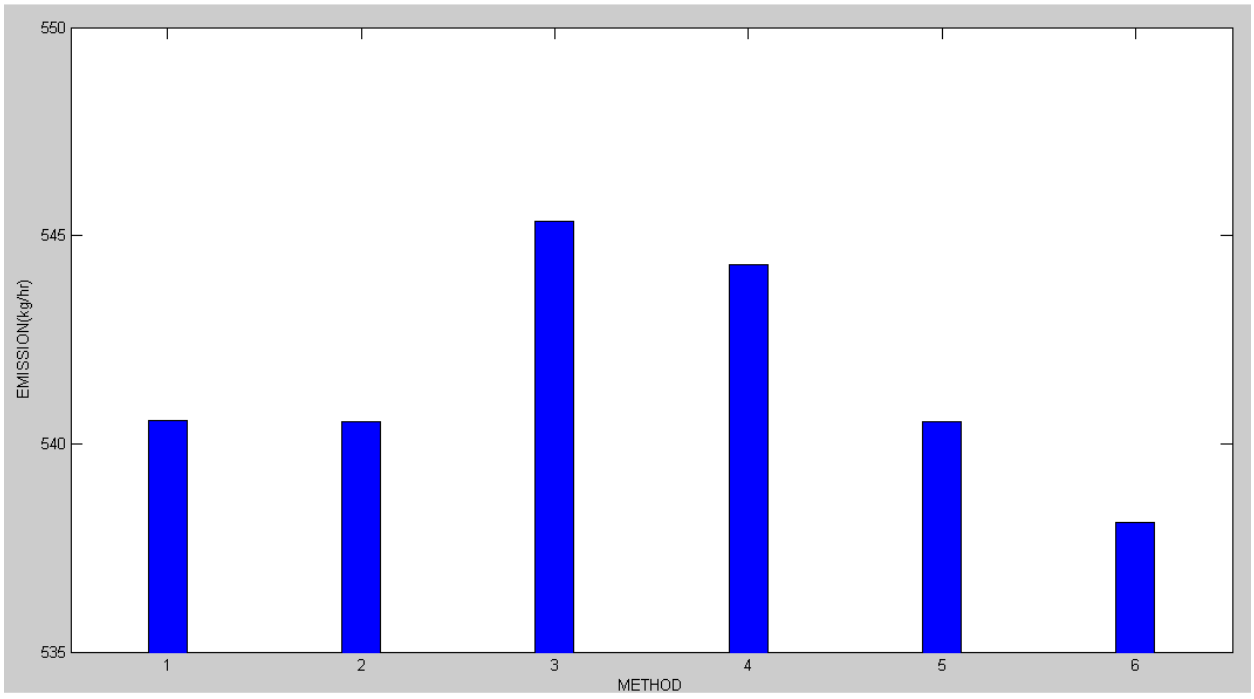
4) Graph between emission output and methods for 1250 MW load



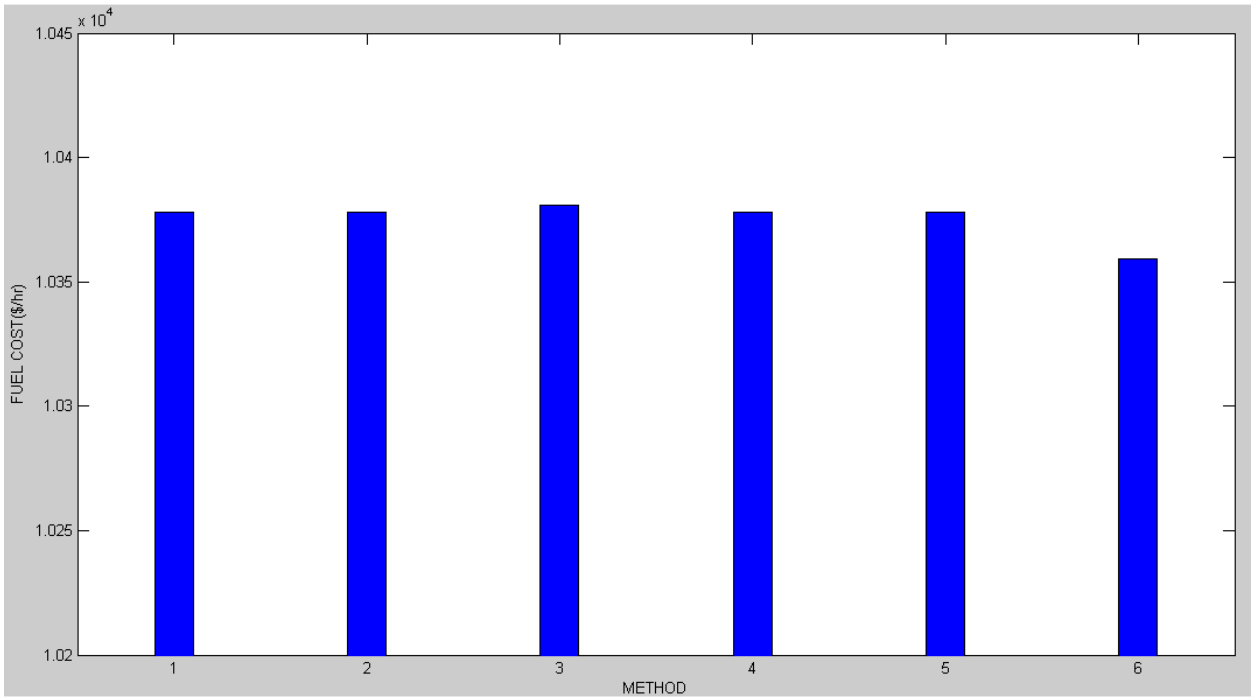
5) Graph between fuel cost and methods for 1500 MW load



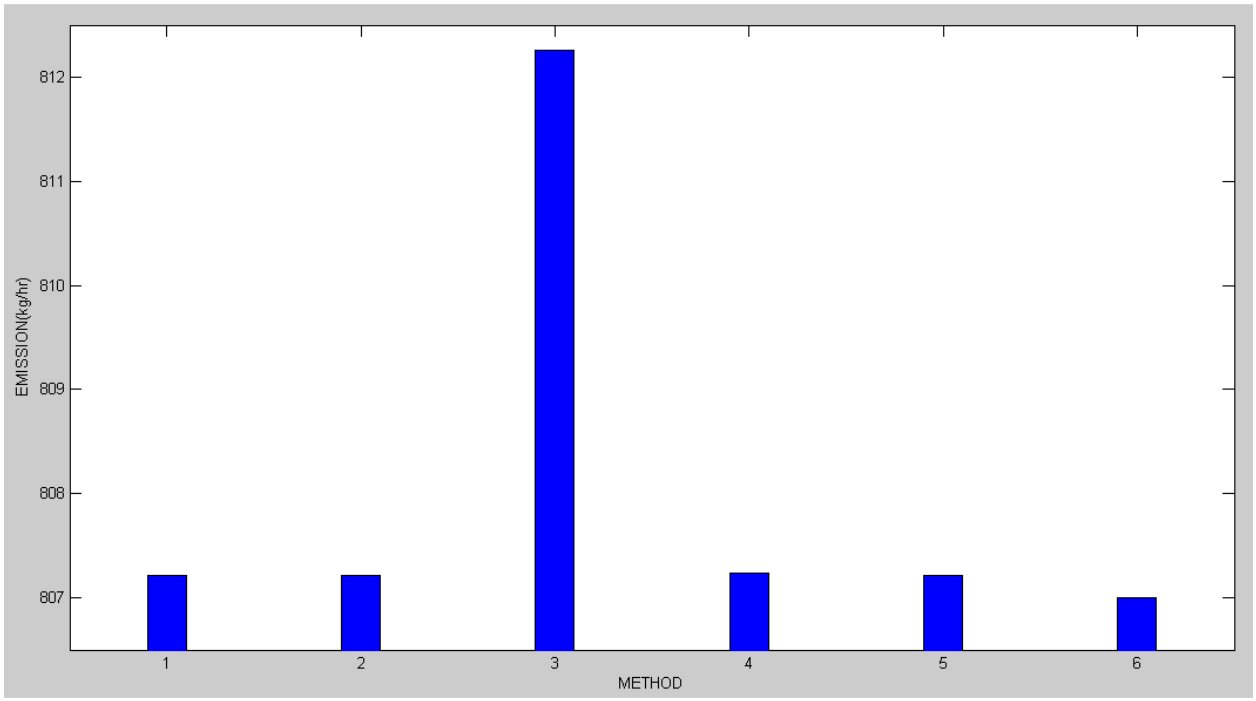
6) Graph between emission output and methods for 1500 MW load



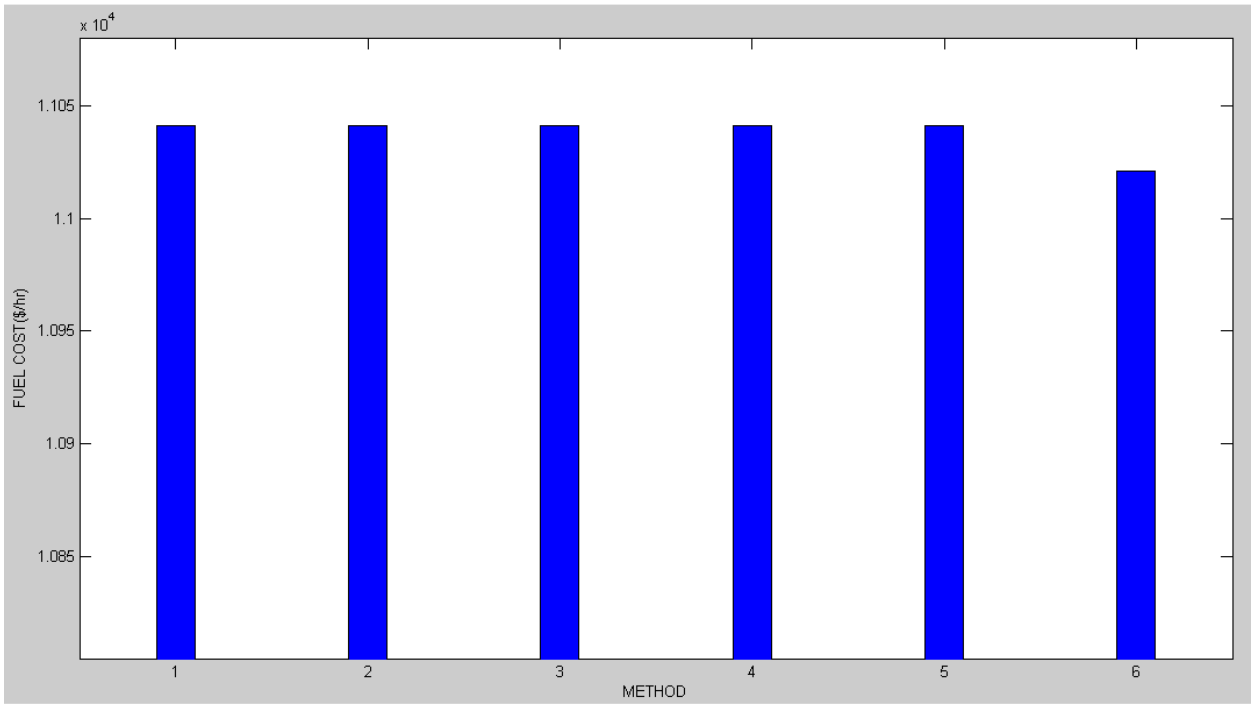
7) Graph between fuel cost and methods for 1750 MW load



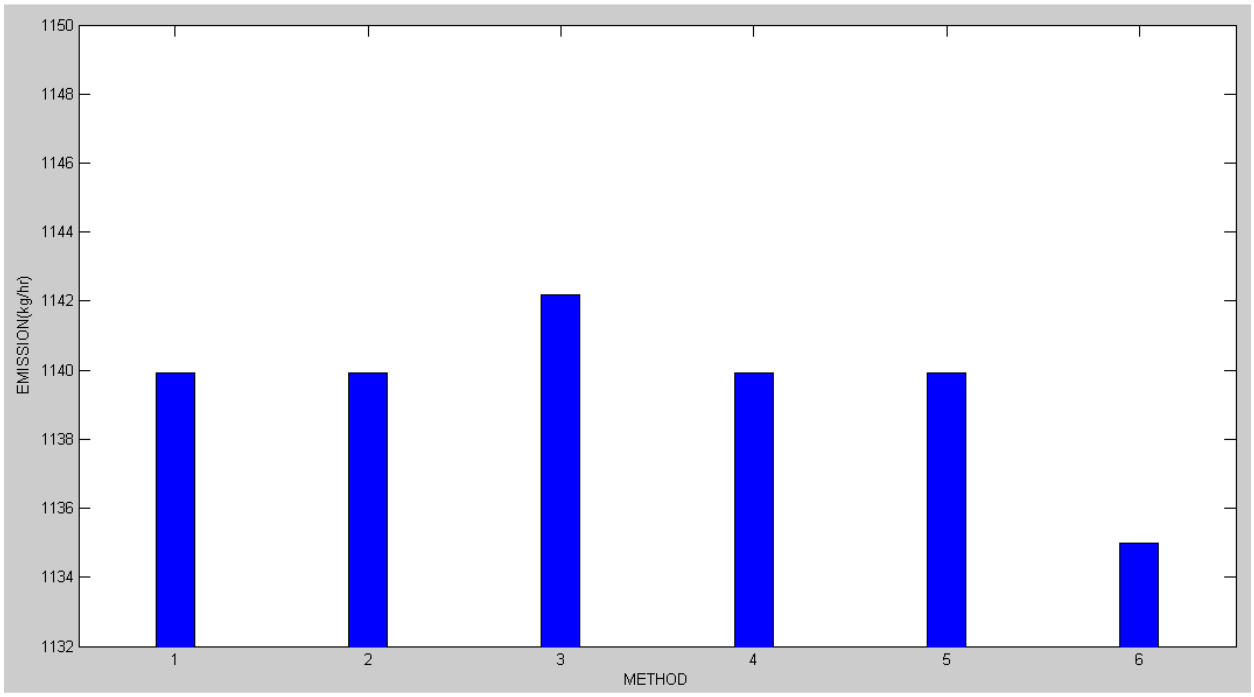
8) Graph between emission output and methods for 1750 MW load



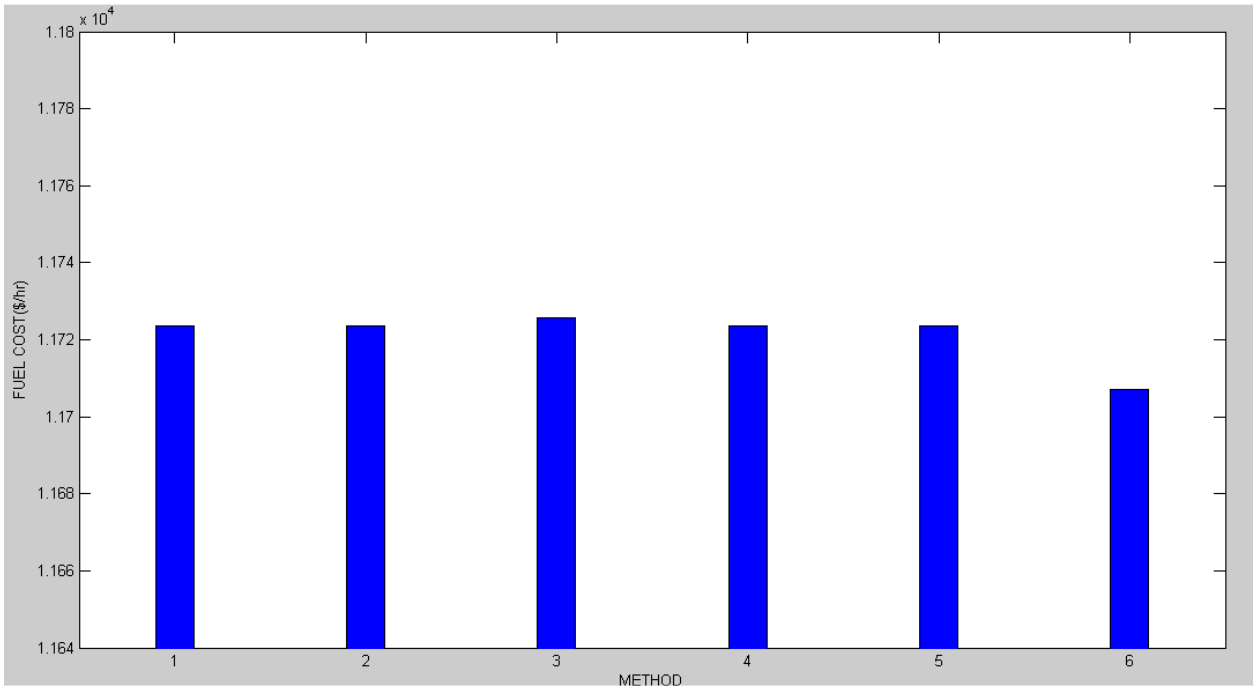
9) Graph between fuel cost and methods for 2000MW load



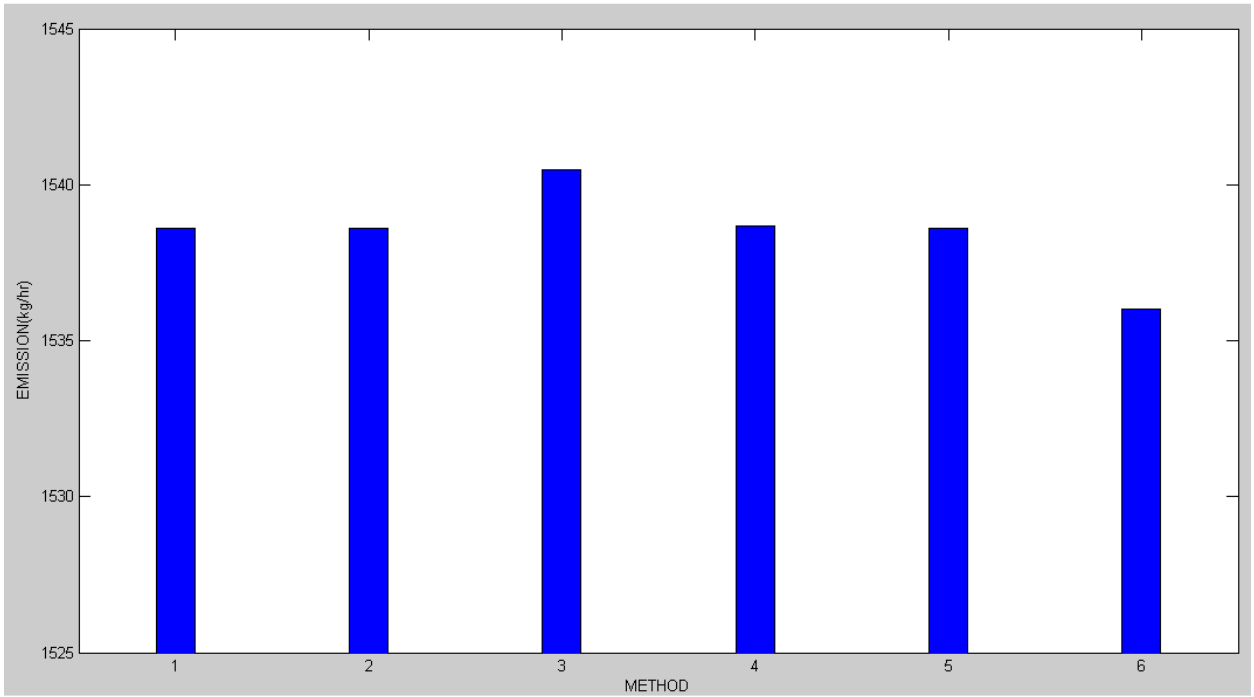
10) Graph between emission output and methods for 2000 MW load



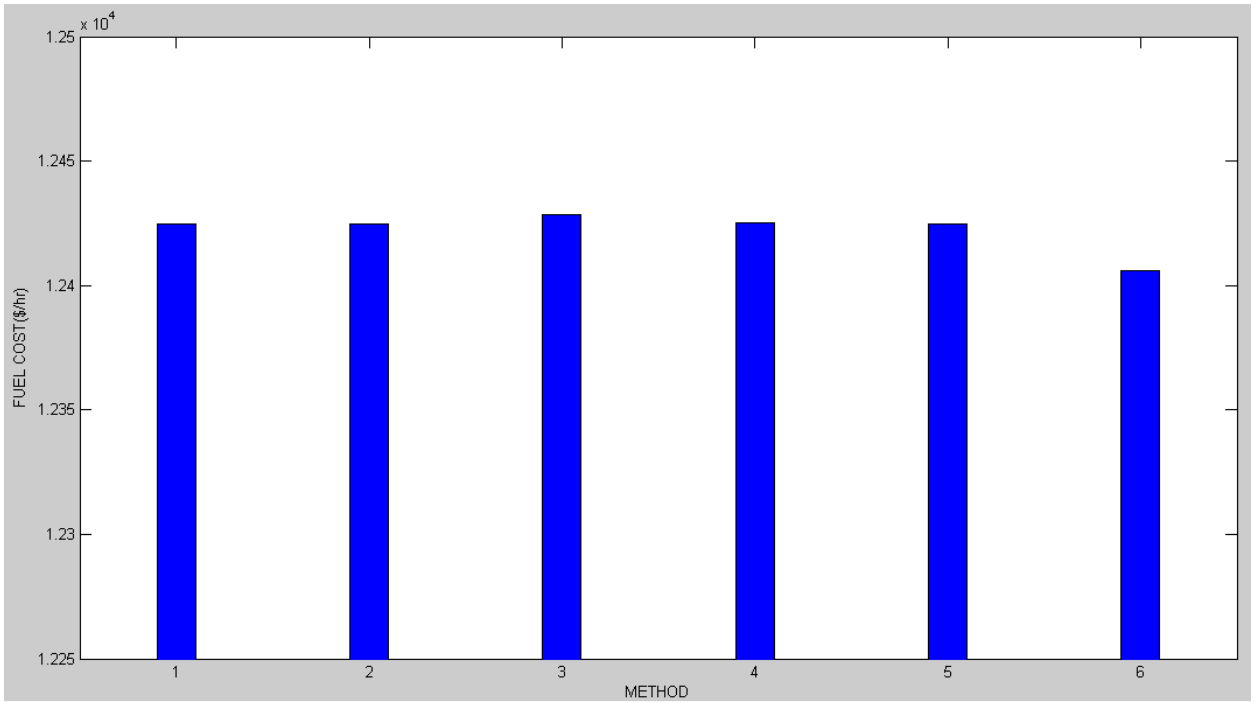
11) Graph between fuel cost and methods for 2250MW load



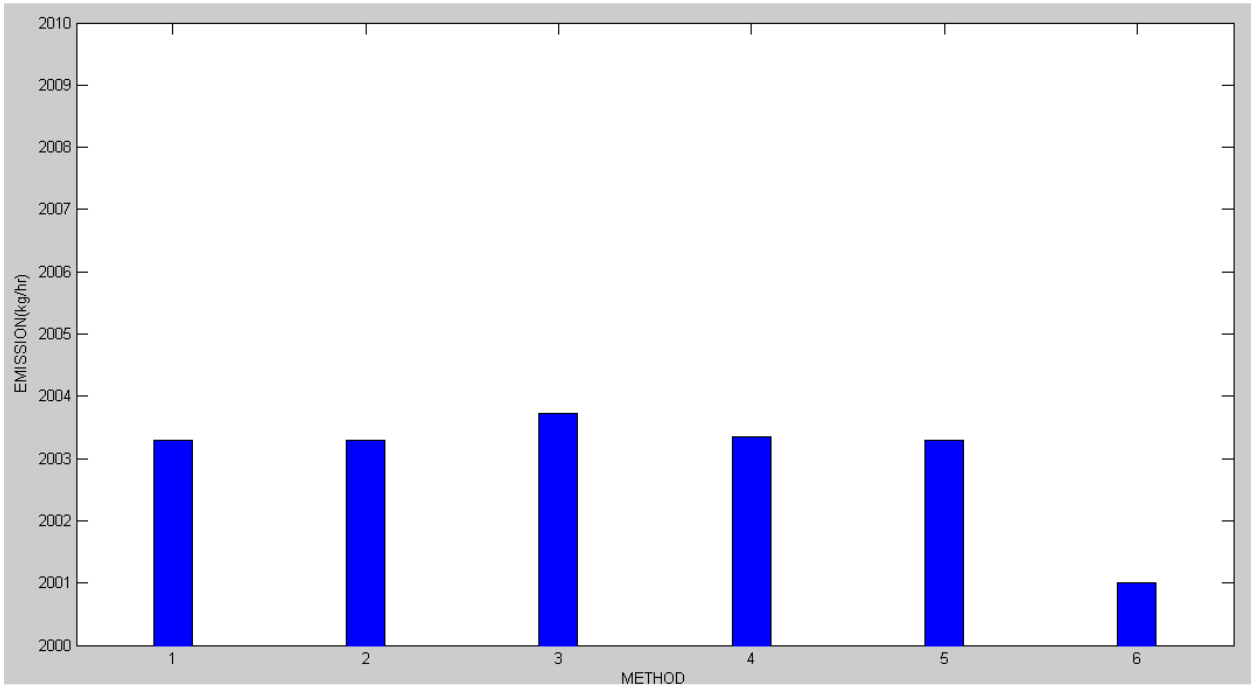
12) Graph between emission output and methods for 2250 MW load



13) Graph between fuel cost and methods for 2500 MW load



14) Graph between emission output and methods for 2500 MW load



Chapter-6

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

In this work, combined economic emission dispatch problem (CEED) problem has been formulated using price penalty factor and solving the problem using GA toolbox of MATLAB R2008b.

The focus of this thesis work is on simultaneously minimization of two objectives of power system, cost of generation and emission output using price penalty factor. The proposed method has been tested on six- generators and eleven generators economic emission load dispatch problems. Test results have shown that the proposed genetic algorithm can provide better solutions than particle swarm optimization, differential evolution, γ-iteration, recursive, and simplified recursive methods. The non-inferior set for six generator systems and eleven generator system obtained by parametrically varying weights attached to the objective. CEED problem has been solved by OPTIM TOOL of MATLAB and optimized value of fuel cost and emission output is obtained with minimum computational effort.

6.2 Scope for Future work

In addition to cost of generation, pollution and the other objectives viz. system transmission loss, security, reliability, reactive power dispatch can also be considered and the problem can be solved by using proposed method. If three objectives are considered then the results are analysed with the help of 3D representation of the objectives.

The proposed method in future should be applied in complex unit commitment problems and dynamic CEED problems, in the search of better quality results. Minimum computational time, simplicity and its capabilities of handling a wide class of optimization problems are key advantages of this powerful heuristic technique.

Beside of this proposed method, other methods like NISE method, Surrogate method can be applied along with Genetic Algorithm to explore innovative results.

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