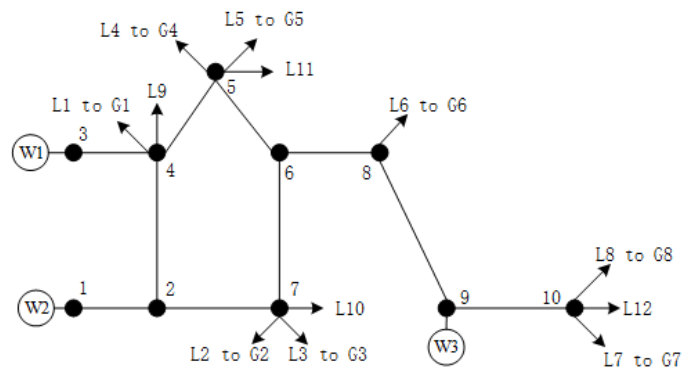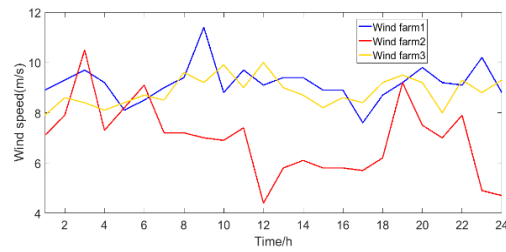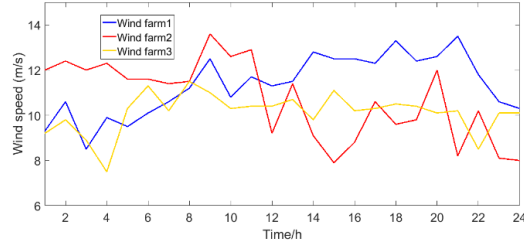(a) a modified IEEE 118-bus electricity network

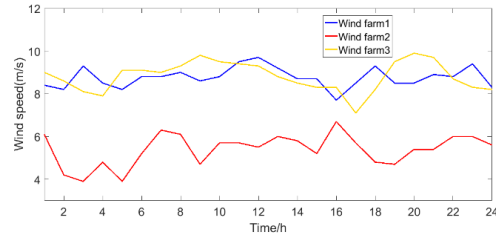(b) a 10-node natural gas network

Fig. A1 Topology of Simulation System

(a) normal wind speed period

(b) high wind speed period

(c) low wind speed period

Fig. A2 The forecasting wind speed of different periods

TABLE A1

PARAMETERS OF MID- AND LONG-TERM TRANSACTIONS FOR BIDDING UNITS

unit	E^{trade} /(MW·h)	E^o_{x-1} /(MW·h)	E^{max}_x /(MW·h)	E^{min}_x /(MW·h)	l^o_{x-1} /%	unit	E^{trade} /(MW·h)	E^o_{x-1} /(MW·h)	E^{max}_x /(MW·h)	E^{min}_x /(MW·h)	l^o_{x-1} /%
14	57200	34387	2400	100	60.12	37	57200	35552	2400	0	62.15
16	57200	33663	2400	800	58.85	40	114400	70417	4800	0	61.55
19	57200	34097	2400	400	59.61	43	171600	95204	7200	7200	55.48
21	143000	85655	6000	600	59.90	45	171600	101023	7200	2500	58.87
22	57200	32311	2400	2000	56.49	47	57200	35351	2400	0	61.80
24	114400	68051	4800	900	59.49	48	57200	34771	2400	0	60.79
27	240240	147745	10080	0	61.50	50	28600	17162	1200	100	60.01
28	240240	151351	8000	0	63.00	51	57200	34820	2400	0	60.87
30	45760	27908	1920	0	60.99	54	28600	17806	1200	0	62.26
35	57200	35454	2400	0	61.98						
Variance of contract completion progress											3.5278

TABLE A2

COEFFICIENT OF CO_2 EMISSION

unit	a	b	c	unit	a	b	c
1	70.0288	10.1083	0.0105	28	244.0042	11.4073	0.00264
2	140.0576	9.1083	0.0053	29	200.3179	10.0031	0.00343
3	112.3179	10.8416	0.00876	30	323.5475	8.8616	0.00199
4	189.6272	9.3016	0.00267	31	70.0288	13.1083	0.01059

unit				unit			
5	130.0021	8.6121	0.00505	32	140.0576	13.1083	0.0053
6	260.0042	9.6121	0.00253	33	112.3179	10.8416	0.00876
7	34.3891	10.542	0.02533	34	189.6272	9.3016	0.00267
8	68.7782	9.542	0.01266	35	70.0288	13.1083	0.01059
9	61.298	14.3272	0.01359	36	140.0576	13.1083	0.0053
10	134.1259	13.5073	0.00962	37	112.3179	10.8416	0.00876
11	70.0288	13.1083	0.01059	38	189.6272	9.3016	0.00267
12	140.0576	13.10830	0.0053	39	70.0288	13.1083	0.01059
13	112.3179	10.8416	0.00876	40	140.0576	13.1083	0.0053
14	189.6272	9.3016	0.00267	41	112.3179	10.8416	0.00876
15	130.0021	10.6121	0.00505	42	189.6272	9.3016	0.00267
16	260.0042	10.6121	0.00253	43	58.131	14.4921	0.01736
17	190.176	9.8416	0.00278	44	116.262	14.4921	0.00866
18	406.9102	7.5121	0.00143	45	72.6481	12.5752	0.01328
19	58.131	14.4921	0.01736	46	129.7552	11.28	0.00588
20	116.262	14.4921	0.00866	47	58.131	14.4921	0.01736
21	72.6481	12.5752	0.01328	48	116.262	14.4921	0.00866
22	129.75520	11.0800	0.00588	49	72.6481	12.5752	0.01328
23	55.5959	13.7154	0.01288	50	129.7552	11.28	0.00588
24	111.1918	13.7154	0.00644	51	122.0021	11.4073	0.00528
25	98.6485	11.9637	0.00823	52	244.0042	11.4073	0.00264
26	184.3879	10.7367	0.00473	53	200.3179	10.0031	0.00343
27	122.0021	11.4073	0.00528	54	323.5475	8.8616	0.00199

TABLE A3

COEFFICIENT OF SO_2 EMISSION

unit	a	b	c	unit	a	b	c
1	0	0	0	28	12.832	1.66783	0.002118088
2	0	0	0	29	1.356	2.5775	0.002175
3	0	0	0	30	14.866	3.094155	0.009184549
4	0	0	0	31	6.334	5.2487640	0.01393258
5	0	0	0	32	4.7505	3.936573	0.01044944
6	0	0	0	33	2.6925	5.654519	0.004245283
7	0	0	0	34	1.5225	2.673	0.00192
8	0	0	0	35	1.5225	2.673	0.00192
9	11.0845	9.185337	0.02438202	36	1.0170	1.9331250	0.001631250
10	11.0845	9.185337	0.02438202	37	0	0	0
11	2.373	4.510625	0.00380625	38	0	0	0
12	11.536	3.766	0.00105	39	0	0	0
13	0	0	0	40	0	0	0
14	0	0	0	41	0	0	0
15	9.501	7.873146	0.02089888	42	0	0	0

16	3.045	5.346	0.00384	43	0	0	0
17	9.501	7.873146	0.02089888	44	0	0	0
18	9.501	7.873146	0.02089888	45	0	0	0
19	0	0	0	46	0	0	0
20	0	0	0	47	0	0	0
21	7	3.082474	0.000600343	48	0	0	0
22	2.5375	4.455	0.0032	49	0	0	0
23	2.5375	4.455	0.0032	50	0	0	0
24	9.75	3.3225	0.0011	51	0	0	0
25	0	0	0	52	0	0	0
26	0	0	0	53	0	0	0
27	0	0	0	54	0	0	0

TABLE A4

COEFFICIENT OF NO_x EMISSION

unit	a	b	c	unit	a	b	c
1	0	0	0	28	5.1328	0.667131	0.000847
2	0	0	0	29	0.542	1.03	0.00087
3	0	0	0	30	5.9464	1.2376	0.00367
4	0	0	0	31	2.5336	2.0995	0.00557
5	0	0	0	32	1.9002	1.57462900000000	0.004179
6	0	0	0	33	1.077	2.2618	0.001698
7	0	0	0	34	0.609	1.069	0.000768
8	0	0	0	35	0.609	1.0692	0.000768
9	4.4338	3.674135	0.009752809	36	0.4068	0.77325	0.000652
10	4.4338	3.674135	0.009752809	37	0	0	0
11	0.9492	1.80425	0.0015225	38	0	0	0
12	4.61440	1.5064	0.00042	39	0	0	0
13	0	0	0	40	0	0	0
14	0	0	0	41	0	0	0
15	3.8004	3.149258	0.00835955	42	0	0	0
16	1.218	2.1384	0.001536	43	0	0	0
17	3.8004	3.149258	0.00835955	44	0	0	0
18	3.8004	3.149258	0.00835955	45	0	0	0
19	0	0	0	46	0	0	0
20	0	0	0	47	0	0	0
21	2.80	1.23299	0.00024	48	0	0	0
22	1.015	1.7820	0.00128	49	0	0	0
23	1.015	1.782	0.00128	50	0	0	0
24	3.90	1.329	0.00044	51	0	0	0
25	0	0	0	52	0	0	0

unit				unit			
26	0	0	0	53	0	0	0
27	0	0	0	54	0	0	0

TABLE A5

COSTS AND POLLUTED GAS EMISSION DURING STARTUP AND SHUTDOWN

unit	costs/$		Polluted gas emission/lbs		unit	costs/$		Polluted gas emission/lbs	
	Start-up	Shut-down	Start-up	Shut-down		Start-up	Shut-down	Start-up	Shut-down
1	736.5971	368.2986	736.5971	368.2986	28	2810.849	1405.425	2810.849	1405.425
2	750.7142	375.3571	750.7142	375.3571	29	1404.28	702.14	1404.28	702.14
3	656.13	328.065	656.13	328.065	30	863.5083	431.7542	863.5083	431.7542
4	7939.77	3969.885	7939.77	3969.885	31	1192.883	596.4417	1192.883	596.4417
5	1640.081	820.0404	1640.081	820.0404	32	1192.883	596.4417	1192.883	596.4417
6	672.8696	336.4348	672.8696	336.4348	33	1174.325	587.1627	1174.325	587.1627
7	676.2979	338.149	676.2979	338.149	34	933.15	466.575	933.15	466.575
8	565.9632	282.9816	565.9632	282.9816	35	933.15	466.575	933.15	466.575
9	1192.883	596.4417	1192.883	596.4417	36	7782.68	3891.34	7782.68	3891.34
10	1404.28	702.14	1404.28	702.14	37	933.15	466.575	933.15	466.575
11	1138.96	569.48	1138.96	569.48	38	1192.883	596.4417	1192.883	596.4417
12	1192.883	596.4417	1192.883	596.4417	39	5348.16	2674.08	5348.16	2674.08
13	1192.883	596.4417	1192.883	596.4417	40	6901.78	3450.89	6901.78	3450.89
14	933.15	466.575	933.15	466.575	41	1174.325	587.1627	1174.325	587.1627
15	1192.883	596.4417	1192.883	596.4417	42	1111.005	555.5024	1111.005	555.5024
16	933.15	466.575	933.15	466.575	43	1404.28	702.14	1404.28	702.14
17	1192.883	596.4417	1192.883	596.4417	44	1404.28	702.14	1404.28	702.14
18	1192.883	596.4417	1192.883	596.4417	45	1555.993	777.9963	1555.993	777.9963
19	1106.087	553.0434	1106.087	553.0434	46	1174.325	587.1627	1174.325	587.1627
20	1285.003	642.5017	1285.003	642.5017	47	933.15	466.575	933.15	466.575
21	1285.003	642.5017	1285.003	642.5017	48	933.15	466.575	933.15	466.575
22	933.15	466.575	933.15	466.575	49	1174.325	587.1627	1174.325	587.1627
23	933.15	466.575	933.15	466.575	50	1111.005	555.5024	1111.005	555.5024
24	1412	706	1412	706	51	933.15	466.575	933.15	466.575
25	1412	706	1412	706	52	933.15	466.575	933.15	466.575
26	933.15	466.575	933.15	466.575	53	933.15	466.575	933.15	466.575
27	2810.849	1405.425	2810.849	1405.425	54	1111.005	555.5024	1111.005	555.5024

TABLE A6

UPWARD AND DOWNWARD SPINNING RESERVE CAPACITY PRICE

unit	price/$		unit	price/$		unit	price/$		unit	price/$	
	up	down		up	down		up	down		up	down
1	1.65	1.65	15	2.62	2.62	29	1.29	1.29	43	1.29	1.29
2	1.65	1.65	16	1.78	1.78	30	1.55	1.55	44	1.29	1.29

3	1.43	1.43	17	2.62	2.62	31	2.62	2.62	45	1.29	1.29
4	1.35	1.35	18	2.62	2.62	32	2.62	2.62	46	3.77	3.77
5	1.31	1.31	19	1.78	1.78	33	3.77	3.77	47	1.78	1.78
6	1.31	1.31	20	1.23	1.23	34	1.78	1.78	48	1.78	1.78
7	1.08	1.08	21	1.23	1.23	35	1.78	1.78	49	3.77	3.77
8	0.93	0.93	22	1.78	1.78	36	1.29	1.29	50	2.29	2.29
9	2.62	2.62	23	1.78	1.78	37	1.78	1.78	51	1.78	1.78
10	1.29	1.29	24	1.33	1.33	38	2.62	2.62	52	1.78	1.78
11	1.08	1.08	25	1.33	1.33	39	1.08	1.08	53	1.78	1.78
12	2.62	2.62	26	1.78	1.78	40	1.29	1.29	54	2.29	2.29
13	2.62	2.62	27	0.83	0.83	41	3.77	3.77			
14	1.78	1.78	28	0.83	0.83	42	2.29	2.29			

TABLE A7

NODE GAS PRESSURE OF GAS NETWORK

node	Minimum pressure/Psig	Maximum pressure /Psig
1	280	370
2	250	330
3	280	370
4	230	310
5	200	260
6	210	290
7	240	270
8	250	330
9	280	370
10	210	320

TABLE A8

OTHER PARAMETERS

M	P_w^{rate} (w=1,2,3)	CPLEX Solver Parameters
1000	200MW	Gap=0.01%, Solution termination time t=500s