Two IEGSs Used for Case Studies in Manuscript entitled “Two-stage Convexification Based Optimal Electricity-Gas Flow”

The network data of the IEEE 39-bus system and IEEE 118-bus system used in this paper can be obtained from MATPOWER (Available: https://matpower.dyson.cornell.edu/). Here, we provide the data of flexible electricity loads used in our paper and the detailed data of the 20-node, 90-noda gas systems.

1. The IEGS with the IEEE 39-bus system and a 20-node gas system

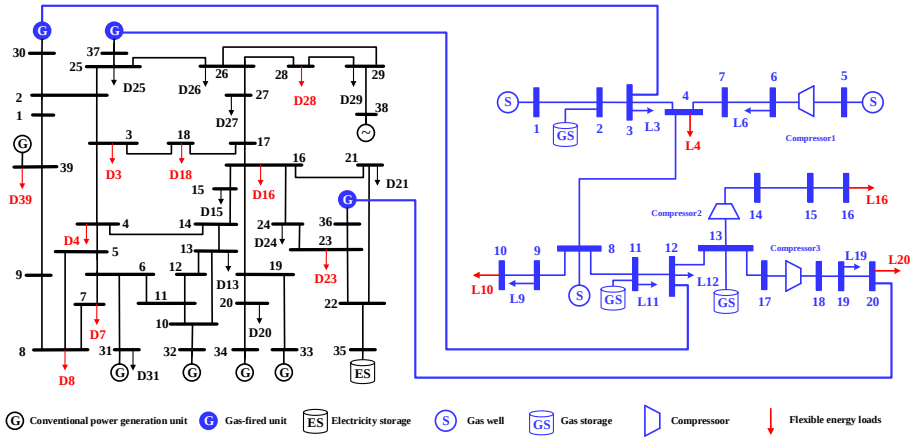

Fig.1. The topology of the IEGS with the IEEE 39-bus system and a 20-node gas system

Table 1. Parameters of flexible electricity loads in the IEEE 39-bus system

Number	Bus	Electricity load(MW)	Alpha	Beta
1	3	322	0.04	16.3
2	4	500	0.054	32.51
3	7	233.8	0.063	17.92
4	8	522	0.023	14.43
5	16	329.4	0.061	24.11
6	18	158	0.076	14.56
7	23	247.5	0.068	20.49
8	28	206	0.075	18.54
9	39	1104	0.027	29.81

Table 2. Parameters of nodes in the 20-node gas system

Node	Gas load(kcf)	Pressure maximum(Psig)	Pressure minimum(Psig)
1	0	380	365
2	0	375	360
3	1000	365	345
4	5000	350	325
5	0	305	285
6	3500	360	340
7	0	350	330
8	0	340	320
9	2000	330	310
10	3500	325	305

11	3000	290	270
12	2000	210	190
13	0	180	160
14	0	210	190
15	0	200	180
16	3000	190	170
17	0	145	130
18	0	175	155
19	1500	135	125
20	1000	110	100

Table 3. Parameters of flexible gas loads in the 20-node gas system

Node.No	Gas load(kcf)	Alpha	Beta
4	5000	0.0021	8.41
10	3500	0.0034	14.49
16	3000	0.0026	9.31
20	1000	0.0043	5.19

Table 4. Parameters of pipelines in the 20-node gas system

Number	fbus	tbus	*C*(kcf/Psig)	Capacity (kcf)
1	1	2	115	10000
2	2	3	112.5	10000
3	3	4	65.1	9500
4	4	8	63.4	8000
6	6	7	66.1	8000
7	7	4	60	5000
8	8	11	61.3	11000
9	8	9	65	6000
10	9	10	61.5	5000
11	11	12	60	12000
12	12	13	62.5	8000
14	13	17	67.5	8000
15	14	15	61	5000
16	15	16	59.1	5000
18	18	19	69	8000
19	19	20	67	6000

Table 5. Parameters of gas sources in the 20-node gas system

Gas sources	Node	Max(kcf)	Min(kcf)	Price($/kcf)
S1	1	8000	1000	2
S2	5	8000	1000	2.1
S3	8	12000	2000	2.4

Table 6. Parameters of gas storages in the 20-node gas system

Gas storages	Node	Capacity (kcf)	Cost coefficients
GS1	2	5000	0.0010
GS2	11	5000	0.0013
GS3	13	4000	0.0011

Table 7. Parameters of compressors in the 20-node gas system

Compressor	Inlet node	Outlet node	Minimum of ratio	Maximum of ratio	Maximum of transported gas flow/kcf	Z_C	B_C	α_C	β_C	γ_C
Compressor 1	5	6	1.2	1.8	8000	0.234	227.0	0	0.003	0
Compressor 2	13	14	1.2	1.8	5000	0.234	224.2	0	0.002	0
Compressor 3	17	18	1.2	1.8	8000	0.235	228.0	0	0.003	0

Table 8. Parameters of gas-fired units in the 20-node gas system

Number	Bus at the power system	Node at the gas system	Conversion coefficient (kcf/MW)
1	30	2	6.329
2	37	12	6.803
3	36	20	6.897

2. The IEGS with the IEEE 118-bus system and a 90-node gas system

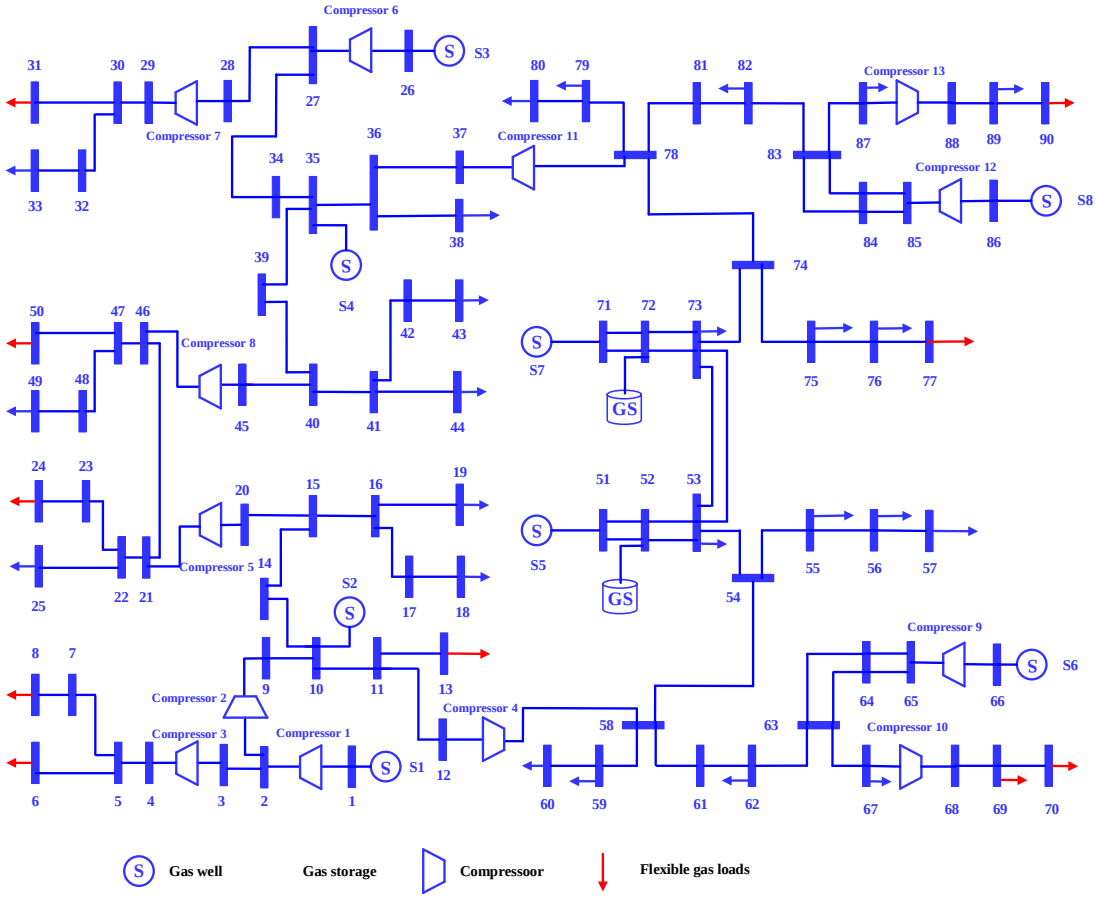

Fig.2. The topology of the 90-node gas system

Table 9. Parameters of flexible electricity loads in the IEEE 118-bus system

Number	Bus	Electricity load(MW)	Alpha	Beta
1	1	51	0.030	30.00
2	2	20	0.020	25.00
3	15	90	0.010	30.00
4	18	60	0.020	26.00
5	39	27	0.020	22.00
6	40	66	0.040	30.00
7	41	37	0.050	20.00
8	42	96	0.040	30.00
9	45	53	0.020	26.00
10	49	87	0.030	28.00
11	54	113	0.015	32.00
12	60	78	0.025	36.00

13	66	39	0.055	20.00
14	78	71	0.045	32.00
15	79	39	0.030	38.00
16	118	33	0.030	22.00

Table 10. Parameters of nodes in the 90-node gas system

Node. No	Gas load(kcf)	Pressure maximum(Psig)	Pressure minimum(Psig)	Node. No	Gas load(kcf)	Pressure maximum(Psig)	Pressure minimum(Psig)
1	0	250	230	46	0	290	270
2	0	295	275	47	0	345	325
3	0	260	240	48	2000	330	310
4	0	310	290	49	0	330	310
5	2500	280	260	50	2000	330	310
6	1000	280	260	51	1000	330	310
7	0	280	260	52	0	385	365
8	1000	275	255	53	0	385	365
9	0	355	335	54	2000	380	360
10	0	350	330	55	0	380	360
11	0	330	310	56	1000	375	355
12	0	320	300	57	1000	375	355
13	2000	330	310	58	800	375	355
14	0	310	290	59	0	380	360
15	0	290	270	60	500	380	360
16	0	270	250	61	1000	380	360
17	0	250	230	62	0	380	360
18	2500	245	225	63	500	380	360
19	2000	265	245	64	0	380	360
20	0	285	265	65	0	380	260
21	0	340	320	66	0	400	380
22	2000	310	290	67	0	340	320
23	0	310	290	68	1500	355	335
24	2000	310	290	69	0	420	400
25	2000	310	290	70	1200	415	395
26	0	315	295	71	1000	415	395
27	0	375	355	72	0	390	370
28	0	350	330	73	0	385	365
29	0	415	395	74	2000	375	355

30	2500	390	370	75	0	340	320
31	500	390	370	76	1000	335	315
32	0	375	355	77	1000	330	310
33	3500	365	345	78	800	330	310
34	0	375	355	79	0	325	305
35	0	375	355	80	1000	320	300
36	0	380	360	81	1000	315	295
37	0	385	365	82	0	325	305
38	2000	375	355	83	0	420	120
39	0	355	335	84	0	420	120
40	0	330	310	85	0	420	120
41	0	310	290	86	0	420	120
42	0	305	285	87	1500	420	120
43	2000	300	280	88	0	420	120
44	2500	300	280	89	1200	420	120
45	0	250	230	90	1000	420	120

Table 11. Parameters of pipelines in the 90-node gas system

Number	fbus	tbus	*C*(kcf/Psig)	Capacity (kcf)	Number	fbus	tbus	*C*(kcf/Psig)	Capacity (kcf)
1	2	3	50	10000	46	51	52	58	10000
2	4	5	55	10000	47	51	52	58	10000
3	5	6	40	10000	48	52	53	52	10000
4	5	7	45	10000	49	52	53	52	10000
5	7	8	40	10000	50	54	53	62	10000
6	9	10	40	10000	51	54	55	56	10000
7	10	11	40	10000	52	55	56	53	10000
8	11	12	36	10000	53	56	57	47	10000
9	11	13	40	10000	54	58	54	56	10000
10	10	14	55	10000	55	58	59	54	10000
11	14	15	40	10000	56	59	60	45	10000
12	14	15	40	10000	57	61	58	67	10000
13	15	16	55	10000	58	62	61	62	10000
14	16	17	40	10000	59	63	62	63	10000
15	17	18	55	10000	60	64	63	56	10000

16	16	19	45	10000	61	64	63	56	10000
17	15	20	40	10000	62	65	64	40	10000
18	46	21	55	10000	63	65	64	40	10000
19	21	22	45	10000	64	63	67	35	10000
20	22	23	40	10000	65	68	69	55	10000
21	23	24	38	10000	66	69	70	58	10000
22	22	25	42	10000	67	71	72	55	10000
23	27	28	58	10000	68	71	72	55	10000
24	27	34	56	10000	69	72	73	54	10000
25	29	30	53	10000	70	72	73	58	10000
26	30	31	43	10000	71	73	74	52	10000
27	30	32	46	10000	72	53	73	55	10000
28	32	33	52	10000	73	74	75	55	10000
29	34	35	40	10000	74	75	76	52	10000
30	36	35	56	10000	75	76	77	53	10000
31	37	36	62	10000	76	74	78	58	10000
32	36	38	58	10000	77	78	79	52	10000
33	35	39	52	10000	78	79	80	55	10000
34	35	39	52	10000	79	81	78	56	10000
35	39	40	48	10000	80	82	81	55	10000
36	39	40	48	10000	81	83	82	54	10000
37	40	41	45	10000	82	84	83	45	10000
38	41	42	44	10000	83	84	83	45	10000
39	42	43	39	10000	84	85	84	35	10000
40	41	44	46	10000	85	85	84	35	10000
41	40	45	54	10000	86	83	87	45	10000
42	46	47	60	10000	87	88	89	30	10000
43	47	48	51	10000	88	89	90	30	10000
44	48	49	46	10000	89	58	54	25	10000
45	47	50	55	10000	90	58	54	25	10000

Table 12. Parameters of gas sources in the 90-node gas system

Sources	Node	Max(kcf)	Min(kcf)	Price($/kcf)
S1	1	15000	1000	2.25
S2	10	10000	1500	2.00
S3	26	9000	1000	2.08
S4	35	9000	1500	2.28
S5	51	4000	1000	2.38
S6	66	7500	1500	2.00
S7	71	7000	1000	2.10
S8	86	7500	1500	2.05

Table 13. Parameters of gas storages in the 90-node gas system

Gas storages	Node	Capacity (kcf)	Cost coefficients
GS1	52	1000	0.0015
GS2	72	500	0.0018

Table 14. Parameters of compressors in the 90-node gas system

Compressors	Inlet node	Outlet node	Minimum of ratio	Maximum of ratio	Maximum of transported gas flow/kcf	Z_C	B_C	α_C	β_C	γ_C
Compressor 1	1	2	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 2	2	9	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 3	3	4	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 4	12	58	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 5	20	21	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 6	26	27	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 7	28	29	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 8	45	46	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 9	66	65	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 10	67	68	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 11	78	37	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 12	86	85	1.2	1.8	12000	0.238	228	0	0.002	0
Compressor 13	87	88	1.2	1.8	12000	0.238	228	0	0.002	0

Table 15. Parameters of gas-fired units in the 20-node gas system

Number	Bus at the power system	Node at the gas system	Conversion coefficient (kcf/MW)
1	30	2	5.064
2	37	12	5.440
3	36	20	5.520
4	1	90	5.064
5	12	80	5.440
6	25	33	5.520
7	26	49	5.064
8	49	24	5.440
9	59	25	5.520
10	65	5	5.064