Base Data for "A Data-driven Distributionally Robust Operation Model for Urban Integrated Energy System"

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***Abstract*—This material presents some base data for the paper "A Data-driven Distributionally Robust Operation Model for Urban Integrated Energy System".**

The penalty price of wind power curtailed is \$1/kWh. The electricity price is obtained from [1]. We assume that 1 kilo-cubic feet of natural gas can generate 1 MBtu of heat energy [2], and the price of natural gas is 5\$/MBtu (i.e., \$5/kcf). The modified 6-node natural gas system from [2] is given in Fig. 1, which has five pipelines, two GSs, two GSSs and one GB. The forecasted values of WTG output and electricity load are depicted in Fig. 2, and the data of heat load and gas load are shown in Fig. 3. The detailed parameters for GT, P2G, EB, GB, ESS and GSS are listed in Tables I–VII.

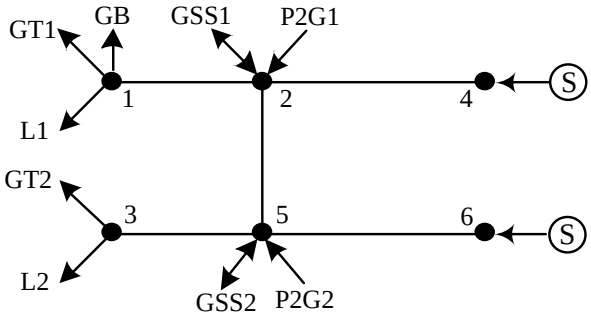

Fig. 1 The 6-node natural gas system.

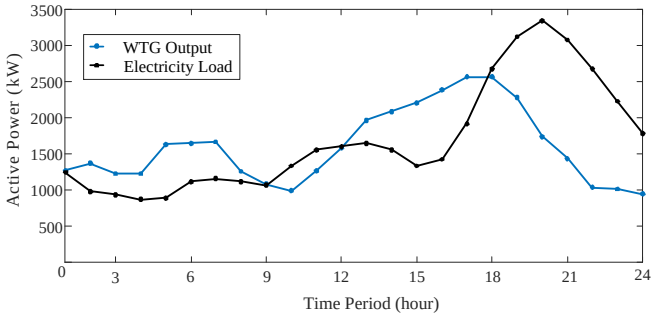

Fig. 2 Daily curves of WTG output and electricity load.

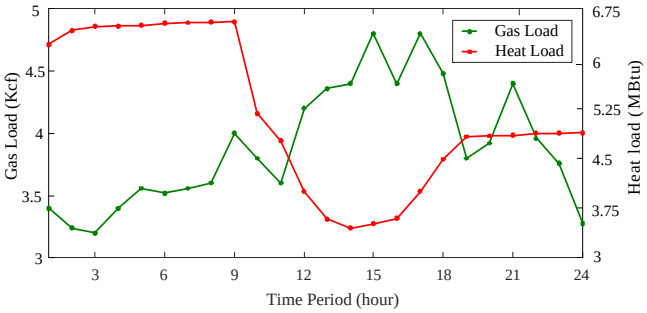

Fig. 3 Daily curves of gas load and heat load.

APPENDIX A

TABLE I
PARAMETERS OF GTS

Types	Lower (kW)	Upper (kW)	Conversion efficiency	Ramp (kW/h)
GT1	300	800	0.4	300
GT2	100	600	0.45	100

TABLE II
COST DATA OF GTS

Types	a (MBtu/kW^{2}h)	b (MBtu/kWh)	c (MBtu)	Start-up cost (\$)	Shut-down cost (\$)
GT1	0.00016	0.67	58.81	100	90
GT2	0.00018	0.85	31.67	80	60

TABLE III
PARAMETERS OF P2GS

Types	Lower (kW)	Upper (kW)	Conversion efficiency
P2G1	0	500	0.8
P2G2	0	600	0.8

TABLE IV
PARAMETERS OF EBS

Types	Lower (kW)	Upper (kW)	Conversion efficiency
EB1	0	600	0.98
EB2	0	400	0.95

TABLE V
PARAMETERS OF GBS

Types	Lower (MBtu)	Upper (MBtu)	Conversion efficiency
GB1	0	1.4	0.9

GB2	0	2	0.9

TABLE VI
PARAMETERS OF ESS

Types	$E_i^{\mathrm{ESS,min}}$ (kW)	$E_i^{\mathrm{ESS,max}}$ (kW))	$P_i^{\mathrm{ESS,max}}$ (kW/h)	$\alpha_{\mathrm{c}}^{\mathrm{ESS}}$	$\alpha_{\mathrm{d}}^{\mathrm{ESS}}$
ESS1	100	1000	250	0.9	1.1
ESS2	50	1000	200	0.9	1.1

TABLE VII
PARAMETERS OF GSS

Types	$E_i^{\mathrm{GSS,min}}$ (Kcf)	$E_i^{\mathrm{GSS,max}}$ (Kcf))	$G_i^{\mathrm{GSS,max}}$ (Kcf/h)	$\alpha_{\mathrm{c}}^{\mathrm{GSS}}$	$\alpha_{\mathrm{d}}^{\mathrm{GSS}}$
GSS1	0.1	4	1	0.9	1.11
GSS2	0.05	3	1	0.9	1.11

REFERENCES

[1] H. Gao, J. Liu, and L. Wang, " Robust coordinated optimization of active and reactive power in active distribution systems," *IEEE Trans. Smart Grid*., vol. 9, no. 5, pp. 4436-4447, Sept 2018.

[2] C. Liu, Shahidehpour M, Y. Fu et al., "Security-constrained unit commitment with natural gas transmission constraints," *IEEE Trans. Power Syst*., vol. 24, no. 3, pp. 1523-1536, August 2009.