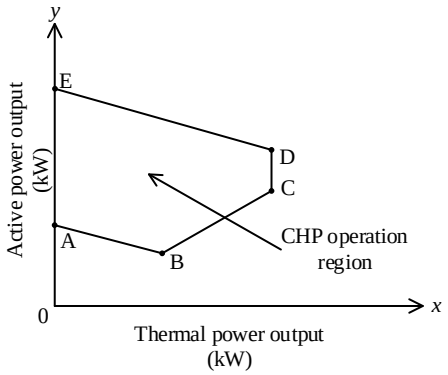

CHP operation region diagram

Data for Beijing South Station

Time (h)	Winter outdoor temperatures (℃)	Summer outdoor temperatures (℃)	Winter solar radiation (W/m^2)	Summer solar radiation (W/m^2)	Uncontrollable load coefficient	Nodal electricity price (¥/kWh)
0.0	-7.26	23.22	0	0	0.70	0.645
0.5	-7.46	23.03	0	0	0.70	0.609
1.0	-7.61	22.90	0	0	0.70	0.609
1.5	-7.76	22.77	0	0	0.70	0.609
2.0	-7.79	22.75	0	0	0.70	0.609
2.5	-7.82	22.72	0	0	0.70	0.609
3.0	-8.00	22.56	0	0	0.70	0.609
3.5	-8.17	22.40	0	0	0.70	0.609
4.0	-8.06	22.51	0	10	0.70	0.609
4.5	-7.94	22.61	0	21	0.70	0.609
5.0	-7.94	22.61	0	68	0.85	0.645
5.5	-7.94	22.61	0	115	0.85	0.645
6.0	-8.24	22.35	0	199	0.85	0.681
6.5	-8.53	22.09	0	282	0.85	0.681
7.0	-8.47	22.14	55	382	0.90	0.681
7.5	-8.41	22.19	110	482	0.90	0.681
8.0	-8.35	22.25	223	575	0.90	0.717
8.5	-8.29	22.30	337	667	1.00	0.717
9.0	-7.08	23.38	446	742	1.00	0.788
9.5	-5.86	24.45	556	818	1.00	0.788
10.0	-4.80	25.40	638	885	1.00	0.860
10.5	-3.73	26.34	720	951	1.00	0.860
11.0	-2.96	27.02	752	975	1.00	0.860
11.5	-2.19	27.70	785	999	1.00	0.788
12.0	-1.51	28.31	765	1001	1.00	0.788
12.5	-0.83	28.91	746	1003	1.00	0.681

13.0	-0.39	29.30	683	983	1.00	0.681
13.5	0.06	29.69	620	963	1.00	0.681
14.0	0.45	30.03	520	874	1.00	0.717
14.5	0.83	30.37	420	785	1.00	0.717
15.0	1.28	30.77	253	674	1.00	0.860
15.5	1.72	31.16	85	563	1.00	0.860
16.0	1.57	31.03	51	458	1.00	0.860
16.5	1.42	30.90	16	353	1.00	0.860
17.0	1.16	30.67	8	256	1.00	0.860
17.5	0.89	30.43	0	160	1.00	0.752
18.0	0.33	29.93	0	97	1.00	0.717
18.5	-0.24	29.43	0	34	1.00	0.717
19.0	-2.55	27.39	0	17	1.00	0.717
19.5	-4.86	25.34	0	0	1.00	0.717
20.0	-5.36	24.90	0	0	1.00	0.681
20.5	-5.86	24.45	0	0	1.00	0.681
21.0	-6.22	24.14	0	0	1.00	0.681
21.5	-6.57	23.82	0	0	0.90	0.681
22.0	-6.75	23.67	0	0	0.90	0.681
22.5	-6.93	23.51	0	0	0.90	0.645
23.0	-6.99	23.46	0	0	0.80	0.645
23.5	-7.05	23.40	0	0	0.80	0.645

Station length (m)	**Station width (m)**	**Station height (m)**	**Winter maximum indoor temperature (℃)**	**Winter minimum indoor temperature (℃)**	**Summer maximum indoor temperature (℃)**	**Summer minimum indoor temperature (℃)**
500	300	20	20	16	27	23
Heat transfer coefficient ($W/(m^2 \cdot ℃)$)	**Winter solar radiation coefficient (%)**	**Summer solar radiation coefficient (%)**	**average specific heat capacity ($kJ/(m^3 \cdot ℃)$)**	**Winter initial temperature (℃)**	**Summer initial temperature (℃)**	**-**
1.7566	1	3	1.29	16	24	-

CHP Parameters							
No.	**Capacity (kVA)**	**Maximum reactive power output (kVar)**	**Minimum reactive power output (kVar)**	**Electricity cost (¥/kWh)**	**Heating cost (¥/kWh)**	**Ramping rate (kW/h)**	**A(y)**

1	2000	1200	240	0.7	0.45	180	360
2	2000	1200	240	0.75	0.5	180	360
No.	**B(x)**	**B(y)**	**C(y)**	**D(x)**	**D(y)**	**E(x)**	**E(y)**
1	600	200	700	1500	900	0	1800
2	600	200	700	1500	900	0	1800

HP parameters

No.	Maximum thermal power output (kW)	Minimum thermal power output (kW)	Power factor	Efficiency coefficient *a*	Efficiency coefficient *b*
1	2000	400	0.85	3.126	6.27
2	4000	800	0.85	3.126	6.27

PV parameters

No.	Installed power (kW)	Power factor	Rated solar radiation (kW/m2)
1	2000	0.95	750

CAC parameters

No.	Maximum refrigerating power (kW)	Minimum refrigerating power (kW)	Power factor	Refrigerating efficiency
1	3000	300	0.85	0.9
2	4000	400	0.85	0.92

Transformers parameters

No.	Type	Capacity (kVA)
1	Distribution transformer	2000
2	Distribution transformer	2000
3	Main transformer	30000
4	Upstream traction transformer	10000
5	Downstream traction transformer	10000

Station-side ESS parameters

No.	Capacity (kWh)	Charging efficiency	Discharging efficiency	Maximum SOC	Minimum SOC	Initial SOC	Charging/ Discharging power (kW)
1	1000	0.98	0.98	1	0.05	0.2	100

Load information

Total load (kW)	Uncontrollable load ratio (%)	Uncontrollable load power factor	SL ratio (%)	Maximum SL power demand (kW)	Minimum SL power demand (kW)	SL power factor
4348	90	0.9	10	700	100	0.85

Data for Langfang Station

Time (h)	Winter outdoor temperatures (℃)	Summer outdoor temperatures (℃)	Winter solar radiation (W/m^2)	Summer solar radiation (W/m^2)	Uncontrollable load coefficient	Nodal electricity price (¥/kWh)
0.0	-7.78	23.33	0	0	0.70	0.700
0.5	-7.92	23.20	0	0	0.70	0.661
1.0	-7.85	23.27	0	0	0.70	0.661
1.5	-7.78	23.33	0	0	0.70	0.661
2.0	-8.18	22.99	0	0	0.70	0.661
2.5	-8.57	22.64	0	0	0.70	0.661
3.0	-8.65	22.58	0	0	0.70	0.661
3.5	-8.72	22.52	0	0	0.70	0.661
4.0	-8.94	22.34	0	10	0.70	0.661
4.5	-9.15	22.15	0	20	0.70	0.661
5.0	-9.26	22.06	0	67	0.85	0.700
5.5	-9.37	21.96	0	113	0.85	0.700
6.0	-9.34	21.99	0	192	0.85	0.739
6.5	-9.30	22.02	0	270	0.85	0.739
7.0	-9.19	22.12	53	367	0.90	0.739
7.5	-9.08	22.21	106	463	0.90	0.739
8.0	-9.12	22.18	214	550	0.90	0.778
8.5	-9.15	22.15	322	638	1.00	0.778
9.0	-8.47	22.74	426	709	1.00	0.855
9.5	-7.78	23.33	531	781	1.00	0.855
10.0	-6.33	24.57	620	859	1.00	0.933
10.5	-4.88	25.81	709	937	1.00	0.933
11.0	-4.09	26.50	736	954	1.00	0.933
11.5	-3.29	27.18	764	972	1.00	0.855
12.0	-2.39	27.96	744	973	1.00	0.855
12.5	-1.48	28.74	725	975	1.00	0.739
13.0	-0.62	29.49	659	948	1.00	0.739
13.5	0.25	30.23	592	920	1.00	0.739
14.0	0.72	30.63	503	847	1.00	0.778
14.5	1.19	31.03	413	773	1.00	0.778
15.0	1.45	31.25	248	661	1.00	0.933
15.5	1.70	31.47	83	549	1.00	0.933
16.0	1.52	31.32	50	444	1.00	0.933
16.5	1.34	31.16	16	340	1.00	0.933
17.0	0.91	30.79	8	248	1.00	0.933
17.5	0.47	30.41	0	155	1.00	0.816
18.0	-1.20	28.98	0	94	1.00	0.778
18.5	-2.86	27.55	0	33	1.00	0.778

19.0	-3.91	26.65	0	17	1.00	0.778
19.5	-4.96	25.75	0	0	1.00	0.778
20.0	-5.50	25.29	0	0	1.00	0.739
20.5	-6.04	24.82	0	0	1.00	0.739
21.0	-6.37	24.54	0	0	1.00	0.739
21.5	-6.69	24.26	0	0	0.90	0.739
22.0	-6.91	24.08	0	0	0.90	0.739
22.5	-7.13	23.89	0	0	0.90	0.700
23.0	-7.38	23.67	0	0	0.80	0.700
23.5	-7.63	23.45	0	0	0.80	0.700

Station length (m)	**Station width (m)**	**Station height (m)**	**Winter maximum indoor temperature (℃)**	**Winter minimum indoor temperature (℃)**	**Summer maximum indoor temperature (℃)**	**Summer minimum indoor temperature (℃)**
100	50	10	20	16	26	23
Heat transfer coefficient (W/(m^2·℃))	**Winter solar radiation coefficient (%)**	**Summer solar radiation coefficient (%)**	**average specific heat capacity (kJ/(m^3·℃))**	**Winter initial temperature (℃)**	**Summer initial temperature (℃)**	**-**
1.7566	1	5	1.29	16	24	-

CHP Parameters							
No.	**Capacity (kVA)**	**Maximum reactive power output (kVar)**	**Minimum reactive power output (kVar)**	**Electricity cost (¥/kWh)**	**Heating cost (¥/kWh)**	**Ramping rate (kW/h)**	**A(y)**
1	1000	600	120	0.7	0.45	90	180
No.	**B(x)**	**B(y)**	**C(y)**	**D(x)**	**D(y)**	**E(x)**	**E(y)**
1	300	100	350	750	450	0	900

HP parameters					
No.	**Maximum thermal power output (kW)**	**Minimum thermal power output (kW)**	**Power factor**	**Efficiency coefficient *a***	**Efficiency coefficient *b***
1	200	100	0.85	3.1260	6.27

PV parameters			
No.	**Installed power (kW)**	**Power factor**	**Rated solar radiation (kW/m2)**
1	600	0.95	750

CAC parameters				
No.	**Maximum refrigerating power (kW)**	**Minimum refrigerating power (kW)**	**Power factor**	**Refrigerating efficiency**
1	750	75	0.85	0.88

Transformers parameters		
No.	**Type**	**Capacity (kVA)**
1	Distribution transformer	2000
2	Main transformer	30000
3	Upstream traction transformer	15000
4	Downstream traction transformer	15000

Station-side ESS parameters							
No.	**Capacity (kWh)**	**Charging efficiency**	**Discharging efficiency**	**Maximum SOC**	**Minimum SOC**	**Initial SOC**	**Charging/ Discharging power (kW)**
1	300	0.98	0.98	1	0.05	0.2	30

Load information						
Total load (kW)	**Uncontrollable load ratio (%)**	**Uncontrollable load power factor**	**SL ratio (%)**	**Maximum SL power demand (kW)**	**Minimum SL power demand (kW)**	**SL power factor**
1740	90	0.9	10	200	30	0.85

Data for Tianjin South Station

Time (h)	Winter outdoor temperatures (℃)	Summer outdoor temperatures (℃)	Winter solar radiation (W/m^2)	Summer solar radiation (W/m^2)	Uncontrollable load coefficient	Nodal electricity price (¥/kWh)
0.0	-6.89	23.77	0	0	0.70	0.867
0.5	-7.08	23.60	0	0	0.70	0.819
1.0	-7.43	23.30	0	0	0.70	0.819
1.5	-7.78	23.00	0	0	0.70	0.819
2.0	-7.82	22.97	0	0	0.70	0.819
2.5	-7.85	22.93	0	0	0.70	0.819
3.0	-7.58	23.17	0	0	0.70	0.819
3.5	-7.31	23.40	0	0	0.70	0.819
4.0	-7.55	23.20	0	10	0.70	0.819
4.5	-7.78	23.00	0	20	0.70	0.819
5.0	-7.90	22.90	0	64	0.85	0.867
5.5	-8.01	22.80	0	108	0.85	0.867
6.0	-7.97	22.84	0	186	0.85	0.916
6.5	-7.93	22.87	0	264	0.85	0.916
7.0	-7.66	23.10	52	361	0.90	0.916
7.5	-7.39	23.33	105	458	0.90	0.916
8.0	-7.16	23.53	215	552	0.90	0.964
8.5	-6.92	23.73	326	646	1.00	0.964
9.0	-6.69	23.93	432	709	1.00	1.060
9.5	-6.46	24.13	538	772	1.00	1.060
10.0	-5.61	24.86	606	839	1.00	1.156
10.5	-4.75	25.59	674	907	1.00	1.156
11.0	-3.59	26.59	717	922	1.00	1.156
11.5	-2.43	27.59	760	938	1.00	1.060
12.0	-1.85	28.09	741	950	1.00	1.060
12.5	-1.26	28.59	722	963	1.00	0.916
13.0	-0.57	29.19	655	934	1.00	0.916
13.5	0.13	29.78	588	905	1.00	0.916
14.0	0.71	30.28	496	826	1.00	0.964
14.5	1.29	30.78	404	746	1.00	0.964
15.0	1.53	30.98	242	643	1.00	1.156
15.5	1.76	31.18	80	539	1.00	1.156
16.0	1.49	30.95	48	440	1.00	1.156
16.5	1.22	30.71	16	340	1.00	1.156
17.0	0.83	30.38	8	248	1.00	1.156
17.5	0.44	30.05	0	155	1.00	1.011
18.0	-0.61	29.15	0	94	1.00	0.964
18.5	-1.65	28.25	0	33	1.00	0.964

19.0	-2.27	27.72	0	16	1.00	0.964
19.5	-2.89	27.19	0	0	1.00	0.964
20.0	-3.17	26.96	0	0	1.00	0.916
20.5	-3.44	26.72	0	0	1.00	0.916
21.0	-4.25	26.03	0	0	1.00	0.916
21.5	-5.06	25.33	0	0	0.90	0.916
22.0	-5.57	24.90	0	0	0.90	0.916
22.5	-6.07	24.46	0	0	0.90	0.867
23.0	-6.38	24.20	0	0	0.80	0.867
23.5	-6.69	23.93	0	0	0.80	0.867

Station length (m)	**Station width (m)**	**Station height (m)**	**Winter maximum indoor temperature (℃)**	**Winter minimum indoor temperature (℃)**	**Summer maximum indoor temperature (℃)**	**Summer minimum indoor temperature (℃)**
160	80	10	20	16	27	23
Heat transfer coefficient (W/(m^2·℃))	**Winter solar radiation coefficient (%)**	**Summer solar radiation coefficient (%)**	**average specific heat capacity (kJ/(m^3·℃))**	**Winter initial temperature (℃)**	**Summer initial temperature (℃)**	**-**
1.7566	1	5	1.29	16	24	-

CHP Parameters							
No.	**Capacity (kVA)**	**Maximum reactive power output (kVar)**	**Minimum reactive power output (kVar)**	**Electricity cost (¥/kWh)**	**Heating cost (¥/kWh)**	**Ramping rate (kW/h)**	**A(y)**
1	800	480	96	0.7	0.45	72	144
No.	**B(x)**	**B(y)**	**C(y)**	**D(x)**	**D(y)**	**E(x)**	**E(y)**
1	240	80	240	600	360	0	720

HP parameters					
No.	**Maximum thermal power output (kW)**	**Minimum thermal power output (kW)**	**Power factor**	**Efficiency coefficient *a***	**Efficiency coefficient *b***
1	600	60	0.85	3.126	6.27

PV parameters			
No.	**Installed power (kW)**	**Power factor**	**Rated solar radiation (kW/m2)**
1	800	0.95	750

CAC parameters				
No.	**Maximum refrigerating power (kW)**	**Minimum refrigerating power (kW)**	**Power factor**	**Refrigerating efficiency**
1	1000	100	0.85	0.85

Transformers parameters		
No.	**Type**	**Capacity (kVA)**
1	Distribution transformer	2000
2	Main transformer	30000
3	Upstream traction transformer	15000
4	Downstream traction transformer	15000

Station-side ESS parameters							
No.	**Capacity (kWh)**	**Charging efficiency**	**Discharging efficiency**	**Maximum SOC**	**Minimum SOC**	**Initial SOC**	**Charging/ Discharging power (kW)**
1	200	0.98	0.98	1	0.05	0.2	20

Load information						
Total load (kW)	**Uncontrollable load ratio (%)**	**Uncontrollable load power factor**	**SL ratio (%)**	**Maximum SL power demand (kW)**	**Minimum SL power demand (kW)**	**SL power factor**
1050	90	0.9	10	150	15	0.85

Data for Cangzhou West Station

Time (h)	Winter outdoor temperatures (℃)	Summer outdoor temperatures (℃)	Winter solar radiation (W/m^2)	Summer solar radiation (W/m^2)	Uncontrollable load coefficient	Nodal electricity price (¥/kWh)
0.0	-5.51	23.60	0	0	0.70	0.569
0.5	-5.85	23.28	0	0	0.70	0.537
1.0	-5.92	23.22	0	0	0.70	0.537
1.5	-5.98	23.16	0	0	0.70	0.537
2.0	-6.33	22.85	0	0	0.70	0.537
2.5	-6.67	22.53	0	0	0.70	0.537
3.0	-7.14	22.10	0	0	0.70	0.537
3.5	-7.61	21.67	0	0	0.70	0.537
4.0	-6.92	22.30	0	9	0.70	0.537
4.5	-6.23	22.93	0	19	0.70	0.537
5.0	-6.83	22.39	0	62	0.85	0.569
5.5	-7.42	21.84	0	105	0.85	0.569
6.0	-6.67	22.53	0	183	0.85	0.601
6.5	-5.91	23.22	0	261	0.85	0.601
7.0	-5.69	23.42	50	352	0.90	0.601
7.5	-5.47	23.62	101	443	0.90	0.601
8.0	-5.29	23.80	204	527	0.90	0.633
8.5	-5.10	23.97	308	610	1.00	0.633
9.0	-5.04	24.03	413	686	1.00	0.695
9.5	-4.97	24.08	519	763	1.00	0.695
10.0	-4.69	24.34	592	821	1.00	0.759
10.5	-4.40	24.60	665	878	1.00	0.759
11.0	-3.43	25.49	694	900	1.00	0.759
11.5	-2.46	26.38	724	921	1.00	0.695
12.0	-1.52	27.25	711	930	1.00	0.695
12.5	-0.57	28.11	699	939	1.00	0.601
13.0	0.12	28.74	632	909	1.00	0.601
13.5	0.81	29.37	565	878	1.00	0.601
14.0	1.32	29.83	478	804	1.00	0.633
14.5	1.82	30.29	391	731	1.00	0.633
15.0	2.07	30.52	235	627	1.00	0.759
15.5	2.32	30.75	79	524	1.00	0.759
16.0	2.23	30.67	47	423	1.00	0.759
16.5	2.13	30.58	15	323	1.00	0.759
17.0	1.66	30.15	8	235	1.00	0.759
17.5	1.19	29.72	0	148	1.00	0.663
18.0	0.37	28.97	0	89	1.00	0.633
18.5	-0.45	28.22	0	31	1.00	0.633

19.0	-1.02	27.71	0	16	1.00	0.633
19.5	-1.58	27.19	0	0	1.00	0.633
20.0	-2.15	26.67	0	0	1.00	0.601
20.5	-2.71	26.15	0	0	1.00	0.601
21.0	-3.43	25.49	0	0	1.00	0.601
21.5	-4.15	24.83	0	0	0.90	0.601
22.0	-4.56	24.46	0	0	0.90	0.601
22.5	-4.97	24.08	0	0	0.90	0.569
23.0	-5.07	24.00	0	0	0.80	0.569
23.5	-5.16	23.91	0	0	0.80	0.569

Station length (m)	**Station width (m)**	**Station height (m)**	**Winter maximum indoor temperature (℃)**	**Winter minimum indoor temperature (℃)**	**Summer maximum indoor temperature (℃)**	**Summer minimum indoor temperature (℃)**
100	60	15	20	16	27	23
Heat transfer coefficient (W/(m^2·℃))	**Winter solar radiation coefficient (%)**	**Summer solar radiation coefficient (%)**	**average specific heat capacity (kJ/(m^3·℃))**	**Winter initial temperature (℃)**	**Summer initial temperature (℃)**	**-**
1.7566	1	5	1.29	16	24	-

CHP Parameters							
No.	**Capacity (kVA)**	**Maximum reactive power output (kVar)**	**Minimum reactive power output (kVar)**	**Electricity cost (¥/kWh)**	**Heating cost (¥/kWh)**	**Ramping rate (kW/h)**	**A(y)**
1	1000	600	120	0.7	0.45	90	180
No.	**B(x)**	**B(y)**	**C(y)**	**D(x)**	**D(y)**	**E(x)**	**E(y)**
1	300	100	350	750	450	0	900

HP parameters					
No.	**Maximum thermal power output (kW)**	**Minimum thermal power output (kW)**	**Power factor**	**Efficiency coefficient *a***	**Efficiency coefficient *b***
1	500	80	0.85	3.1260	6.27

PV parameters			
No.	**Installed power (kW)**	**Power factor**	**Rated solar radiation (kW/m2)**
1	800	0.95	750

CAC parameters				
No.	**Maximum refrigerating power (kW)**	**Minimum refrigerating power (kW)**	**Power factor**	**Refrigerating efficiency**
1	1200	120	0.85	0.88

Transformers parameters		
No.	**Type**	**Capacity (kVA)**
1	Distribution transformer	2000
2	Main transformer	30000
3	Upstream traction transformer	15000
4	Downstream traction transformer	15000

Station-side ESS parameters							
No.	**Capacity (kWh)**	**Charging efficiency**	**Discharging efficiency**	**Maximum SOC**	**Minimum SOC**	**Initial SOC**	**Charging/ Discharging power (kW)**
1	500	0.98	0.98	1	0.05	0.2	50

Load information						
Total load (kW)	**Uncontrollable load ratio (%)**	**Uncontrollable load power factor**	**SL ratio (%)**	**Maximum SL power demand (kW)**	**Minimum SL power demand (kW)**	**SL power factor**
2750	90	0.9	10	700	100	0.85

Data for Dezhou East Station

Time (h)	Winter outdoor temperatures (℃)	Summer outdoor temperatures (℃)	Winter solar radiation (W/m^2)	Summer solar radiation (W/m^2)	Uncontrollable load coefficient	Nodal electricity price (¥/kWh)
0.0	-6.47	23.12	0	0	0.70	0.677
0.5	-6.24	23.33	0	0	0.70	0.640
1.0	-6.02	23.54	0	0	0.70	0.640
1.5	-5.79	23.75	0	0	0.70	0.640
2.0	-5.72	23.82	0	0	0.70	0.640
2.5	-5.64	23.89	0	0	0.70	0.640
3.0	-5.57	23.96	0	0	0.70	0.640
3.5	-5.49	24.03	0	0	0.70	0.640
4.0	-5.57	23.96	0	9	0.70	0.640
4.5	-5.64	23.89	0	18	0.70	0.640
5.0	-5.72	23.82	0	62	0.85	0.677
5.5	-5.79	23.75	0	105	0.85	0.677
6.0	-5.87	23.68	0	178	0.85	0.715
6.5	-5.94	23.61	0	252	0.85	0.715
7.0	-5.79	23.75	50	343	0.90	0.715
7.5	-5.64	23.89	99	435	0.90	0.715
8.0	-6.02	23.54	199	513	0.90	0.753
8.5	-6.40	23.18	299	591	1.00	0.753
9.0	-6.25	23.33	400	665	1.00	0.828
9.5	-6.09	23.47	502	739	1.00	0.828
10.0	-4.65	24.82	572	793	1.00	0.903
10.5	-3.21	26.16	641	847	1.00	0.903
11.0	-2.30	27.01	676	876	1.00	0.903
11.5	-1.39	27.86	711	905	1.00	0.828
12.0	-0.56	28.64	694	908	1.00	0.828
12.5	0.28	29.42	677	910	1.00	0.715
13.0	0.96	30.06	620	893	1.00	0.715
13.5	1.64	30.69	564	876	1.00	0.715
14.0	2.02	31.05	470	791	1.00	0.753
14.5	2.40	31.40	377	705	1.00	0.753
15.0	2.63	31.62	226	601	1.00	0.903
15.5	2.86	31.83	76	497	1.00	0.903
16.0	2.94	31.90	45	405	1.00	0.903
16.5	3.01	31.97	15	313	1.00	0.903
17.0	2.67	31.65	7	230	1.00	0.903
17.5	2.33	31.33	0	147	1.00	0.790
18.0	1.38	30.45	0	89	1.00	0.753
18.5	0.43	29.56	0	31	1.00	0.753

19.0	-0.33	28.85	0	15	1.00	0.753
19.5	-1.09	28.14	0	0	1.00	0.753
20.0	-2.08	27.22	0	0	1.00	0.715
20.5	-3.06	26.30	0	0	1.00	0.715
21.0	-3.93	25.49	0	0	1.00	0.715
21.5	-4.80	24.67	0	0	0.90	0.715
22.0	-5.60	23.93	0	0	0.90	0.715
22.5	-6.40	23.18	0	0	0.90	0.677
23.0	-6.55	23.04	0	0	0.80	0.677
23.5	-6.70	22.90	0	0	0.80	0.677

Station length (m)	**Station width (m)**	**Station height (m)**	**Winter maximum indoor temperature (℃)**	**Winter minimum indoor temperature (℃)**	**Summer maximum indoor temperature (℃)**	**Summer minimum indoor temperature (℃)**
200	50	10	20	16	27	23
Heat transfer coefficient (W/(m^2·℃))	**Winter solar radiation coefficient (%)**	**Summer solar radiation coefficient (%)**	**average specific heat capacity (kJ/(m^3·℃))**	**Winter initial temperature (℃)**	**Summer initial temperature (℃)**	**-**
1.7566	1	3	1.29	16	24	-

CHP Parameters							
No.	**Capacity (kVA)**	**Maximum reactive power output (kVar)**	**Minimum reactive power output (kVar)**	**Electricity cost (¥/kWh)**	**Heating cost (¥/kWh)**	**Ramping rate (kW/h)**	**A(y)**
1	1500	900	180	0.7	0.45	135	270
No.	**B(x)**	**B(y)**	**C(y)**	**D(x)**	**D(y)**	**E(x)**	**E(y)**
1	450	150	525	1125	675	0	1350

HP parameters					
No.	**Maximum thermal power output (kW)**	**Minimum thermal power output (kW)**	**Power factor**	**Efficiency coefficient *a***	**Efficiency coefficient *b***
1	600	120	0.85	3.1260	6.27

PV parameters			
No.	**Installed power (kW)**	**Power factor**	**Rated solar radiation (kW/m2)**
1	1000	0.95	750

CAC parameters				
No.	**Maximum refrigerating power (kW)**	**Minimum refrigerating power (kW)**	**Power factor**	**Refrigerating efficiency**
1	900	90	0.85	0.85

Transformers parameters		
No.	**Type**	**Capacity (kVA)**
1	Distribution transformer	2000
2	Distribution transformer	2000
3	Main transformer	30000
4	Upstream traction transformer	15000
5	Downstream traction transformer	15000

Station-side ESS parameters							
No.	**Capacity (kWh)**	**Charging efficiency**	**Discharging efficiency**	**Maximum SOC**	**Minimum SOC**	**Initial SOC**	**Charging/ Discharging power (kW)**
1	600	0.98	0.98	1	0.05	0.2	60

Load information						
Total load (kW)	**Uncontrollable load ratio (%)**	**Uncontrollable load power factor**	**SL ratio (%)**	**Maximum SL power demand (kW)**	**Minimum SL power demand (kW)**	**SL power factor**
1850	90	0.9	10	700	100	0.85

Data for Jinan West Station

Time (h)	Winter outdoor temperatures (℃)	Summer outdoor temperatures (℃)	Winter solar radiation (W/m^2)	Summer solar radiation (W/m^2)	Uncontrollable load coefficient	Nodal electricity price (¥/kWh)
0.0	-0.54	26.55	0	0	0.70	0.688
0.5	-0.71	26.36	0	0	0.70	0.649
1.0	-0.76	26.32	0	0	0.70	0.649
1.5	-0.80	26.27	0	0	0.70	0.649
2.0	-1.29	25.77	0	0	0.70	0.649
2.5	-1.77	25.26	0	0	0.70	0.649
3.0	-1.86	25.17	0	0	0.70	0.649
3.5	-1.95	25.08	0	0	0.70	0.649
4.0	-2.26	24.76	0	9	0.70	0.649
4.5	-2.57	24.43	0	18	0.70	0.649
5.0	-3.06	23.93	0	60	0.85	0.688
5.5	-3.54	23.42	0	102	0.85	0.688
6.0	-3.85	23.10	0	171	0.85	0.726
6.5	-4.16	22.78	0	241	0.85	0.726
7.0	-4.34	22.60	48	329	0.90	0.726
7.5	-4.51	22.41	95	418	0.90	0.726
8.0	-4.20	22.73	192	496	0.90	0.764
8.5	-3.89	23.05	290	574	1.00	0.764
9.0	-2.92	24.07	390	648	1.00	0.840
9.5	-1.95	25.08	490	721	1.00	0.840
10.0	-0.10	27.01	557	773	1.00	0.917
10.5	1.76	28.94	625	825	1.00	0.917
11.0	2.29	29.49	660	855	1.00	0.917
11.5	2.82	30.04	696	885	1.00	0.840
12.0	3.13	30.36	668	873	1.00	0.840
12.5	3.44	30.68	640	860	1.00	0.726
13.0	3.53	30.78	586	844	1.00	0.726
13.5	3.61	30.87	533	829	1.00	0.726
14.0	3.70	30.96	446	750	1.00	0.764
14.5	3.79	31.05	359	672	1.00	0.764
15.0	3.66	30.91	216	577	1.00	0.917
15.5	3.53	30.77	73	482	1.00	0.917
16.0	3.27	30.50	44	397	1.00	0.917
16.5	3.00	30.22	15	312	1.00	0.917
17.0	2.29	29.49	7	226	1.00	0.917
17.5	1.58	28.75	0	140	1.00	0.802
18.0	0.74	27.88	0	85	1.00	0.764
18.5	-0.10	27.01	0	30	1.00	0.764

19.0	0.04	27.15	0	15	1.00	0.764
19.5	0.17	27.28	0	0	1.00	0.764
20.0	-0.41	26.69	0	0	1.00	0.726
20.5	-0.98	26.09	0	0	1.00	0.726
21.0	-0.98	26.09	0	0	1.00	0.726
21.5	-0.98	26.09	0	0	0.90	0.726
22.0	-0.85	26.23	0	0	0.90	0.726
22.5	-0.71	26.36	0	0	0.90	0.688
23.0	-0.54	26.55	0	0	0.80	0.688
23.5	-0.36	26.73	0	0	0.80	0.688

Station length (m)	**Station width (m)**	**Station height (m)**	**Winter maximum indoor temperature (℃)**	**Winter minimum indoor temperature (℃)**	**Summer maximum indoor temperature (℃)**	**Summer minimum indoor temperature (℃)**
500	100	20	20	16	27	23
Heat transfer coefficient (W/(m^2·℃))	**Winter solar radiation coefficient (%)**	**Summer solar radiation coefficient (%)**	**average specific heat capacity (kJ/(m^3·℃))**	**Winter initial temperature (℃)**	**Summer initial temperature (℃)**	**-**
1.7566	1	3	1.29	16	24	-

CHP Parameters							
No.	**Capacity (kVA)**	**Maximum reactive power output (kVar)**	**Minimum reactive power output (kVar)**	**Electricity cost (¥/kWh)**	**Heating cost (¥/kWh)**	**Ramping rate (kW/h)**	**A(y)**
1	2000	1200	240	0.7	0.45	180	360
2	1000	600	120	0.75	0.5	90	180
No.	**B(x)**	**B(y)**	**C(y)**	**D(x)**	**D(y)**	**E(x)**	**E(y)**
1	600	200	700	1500	900	0	1800
2	300	100	350	750	450	0	900

HP parameters					
No.	**Maximum thermal power output (kW)**	**Minimum thermal power output (kW)**	**Power factor**	**Efficiency coefficient *a***	**Efficiency coefficient *b***
1	1000	400	0.85	3.1260	6.27
2	500	400	0.85	3.1260	6.27
PV parameters					

No.	Installed power (kW)	Power factor	Rated solar radiation (kW/m2)
1	1800	0.95	750

CAC parameters

No.	Maximum refrigerating power (kW)	Minimum refrigerating power (kW)	Power factor	Refrigerating efficiency
1	3000	300	0.85	0.90
2	2000	200	0.85	0.88

Transformers parameters

No.	Type	Capacity (kVA)
1	Distribution transformer	2000
2	Distribution transformer	2000
3	Main transformer	30000
4	Upstream traction transformer	15000
5	Downstream traction transformer	15000

Station-side ESS parameters

No.	Capacity (kWh)	Charging efficiency	Discharging efficiency	Maximum SOC	Minimum SOC	Initial SOC	Charging/ Discharging power (kW)
1	800	0.98	0.98	1	0.05	0.2	80

Load information

Total load (kW)	Uncontrollable load ratio (%)	Uncontrollable load power factor	SL ratio (%)	Maximum SL power demand (kW)	Minimum SL power demand (kW)	SL power factor
3250	90	0.9	10	700	100	0.85

Data for traction grid

No.	Station ID	Node in TG
1	Beijing South	1
2	Langfang	2
3	Tianjin South	3
4	Cangzhou West	4
5	Dezhou East	5
6	Jinan West	6

No.	Track length (km)	From Node	To Node
1	60	1	2
2	62	2	3
3	88	3	4
4	104	4	5
5	92	5	6

Resistance (Ω/km)	Reactance (Ω/km)	Maximum power of line (kW)	Maximum voltage (kV)	Minimum voltage (kV)	Rated voltage (kV)	Train power factor
0.138	0.369	9000	27.5	22.5	25	0.96

Time (h)	Price (¥/kWh)	Time (h)	Price (¥/kWh)	Time (h)	Price (¥/kWh)	Time (h)	Price (¥/kWh)
0.0	0.764	6.0	0.806	12.0	0.933	18.0	0.849
0.5	0.721	6.5	0.806	12.5	0.806	18.5	0.849
1.0	0.721	7.0	0.806	13.0	0.806	19.0	0.849
1.5	0.721	7.5	0.806	13.5	0.806	19.5	0.849
2.0	0.721	8.0	0.849	14.0	0.849	20.0	0.806
2.5	0.721	8.5	0.849	14.5	0.849	20.5	0.806
3.0	0.721	9.0	0.933	15.0	1.018	21.0	0.806
3.5	0.721	9.5	0.933	15.5	1.018	21.5	0.806
4.0	0.721	10.0	1.018	16.0	1.018	22.0	0.806
4.5	0.721	10.5	1.018	16.5	1.018	22.5	0.764
5.0	0.764	11.0	1.018	17.0	1.018	23.0	0.764
5.5	0.764	11.5	0.933	17.5	0.890	23.5	0.764

On-board ESS capacity (kWh)	Charging/Discharging power (kW)	Charing efficiency	Discharing efficiency	Minimum SOC	Maximum SOC	Initial SOC
500	200	0.98	0.98	0.5	1	0.8

Train timetable																								
No.	Station																							
	BJS				LF				TJS				CZW				DZE				JNW			
	Arrival time		Departure time		Arrival time		Departure time		Arrival time		Departure time		Arrival time		Departure time		Arrival time		Departure time		Arrival time		Departure time	
	h	min	h	min	h	min	h	min	h	min	h	min	h	min	h	min	h	min	h	min	h	min	h	min
GU1			08	00																	09	22		
GU2			09	12									10	04	10	06					10	52		
GU3			10	00																	11	12		
GU4			11	10					11	44	11	46					12	30	12	32	12	56		
GU5			12	30	12	52	12	54	13	12	13	14									14	16		
GU6			13	00					13	30	13	34									14	30		
GU7			14	40	15	00	15	04	15	24	15	32	15	54	15	56					16	42		
GU8			15	50					16	24	16	30	16	54	16	56	17	20	17	22	17	48		
GU9			16	46									17	36	17	46	18	12	18	16	18	40		
GU10			17	46	18	10	18	26	18	44	18	46	19	08	19	10					19	56		
GU11			18	40					19	14	19	16	19	38	19	54	20	22	20	24	20	48		
GU12			19	56	20	16	20	18	20	36	20	38	21	00	21	08	21	34	21	36	22	00		
GU13			20	10					20	44	20	46					21	30	21	32	21	56		
GU14			21	00	21	20	21	22	21	42	21	44					22	28	22	30	22	54		
GD1	10	18			09	54	09	56					09	18	09	20	08	48	08	52			08	24
GD2	11	18							10	42	10	44					09	48	09	58			09	24
GD3	12	34											11	30	11	42							10	44
GD4	13	38											12	36	12	44							11	50
GD5	14	18											13	24	13	26							12	38

GD6	15	44			15	18	15	22					14	34	14	42							13	50
GD7	16	34			16	08	16	12	15	36	15	50	15	08	15	14							14	22
GD8	17	44							17	04	17	10	16	36	16	42	16	08	16	10			15	44
GD9	18	32							17	50	18	00	17	24	17	26	16	56	16	58			16	32
GD10	18	54															17	36	17	38			17	12
GD11	20	30			20	06	20	08									19	08	19	10			18	44
GD12	21	48							21	12	21	14	20	44	20	50							19	56
GD13	21	36																					20	10
GD14	23	30											22	28	22	38							21	42