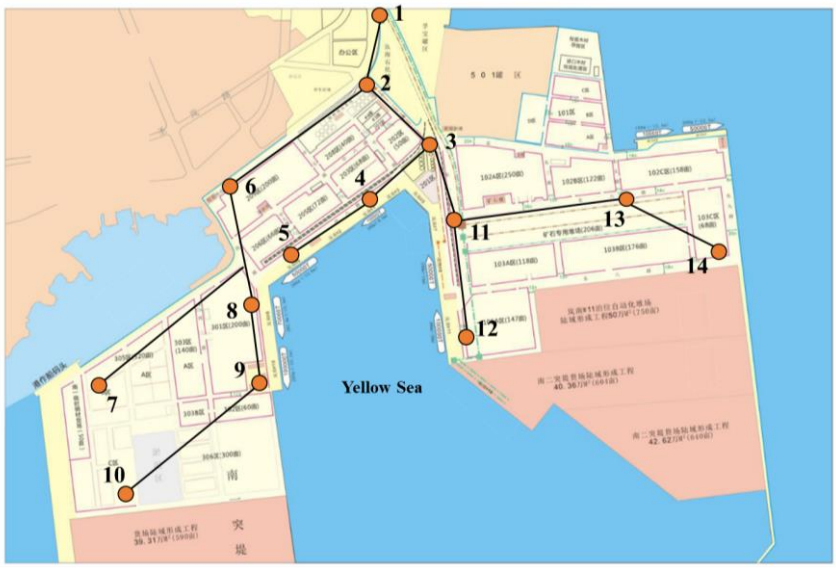
This file is the data of the article:

Y. Huang, W. Huang, T. Huang et al., “Multi-Objective Multistage Distributionally Robust Flexibility Enhancement for Seaport Logistic-Energy Coordination,” IEEE Transactions on Transportation Electrification, doi: 10.1109/TTE.2024.3394675.

1、System Topology



Connection between electrical node and equipment

Electrical Node	Berths	QCs	BSS	Wind Turbine (WT) Units
2	—	—	1	
3	—	—	—	WT1 (5MW)
4	4	7,8	—	—
5	3	5,6		—
6	—	—	—	WT2 (5MW)
8	2	3,4	—	—
9	1	1,2	—	—
11	5	9,10	—	WT3 (5MW)
12	6	11,12	—	—

2、System Data

Property	Value
Number of available berths	6
Number of AESs	8
Number of available QCs	12
Number of batteries	30
Number of AGVs	20
Number of WT units	3

AES Parameters		
Property	Symbol	Value
AES arrival time (hour)	t_s^a	[1, 2, 4, 5, 6, 9, 10, 13]
AES latest departure time (hour)	$t_s^{d,\max}$	[11, 14, 15, 17, 19, 23, 20, 24]
AES service load (MW)	P_s^{SL}	[3.0, 3.5, 3.0, 2.5, 4.0, 3.5, 2.5, 4.0]
Maximum/Minimum power of AES auxiliary generator (MW)	$P_s^{AG,\max/\min}$	Maximum [6, 7, 6, 5, 8, 7, 5, 8] Minimum [0.6, 0.7, 0.6, 0.5, 0.8, 0.7, 0.5, 0.8]
Generation coefficients of AES auxiliary generator ($/MW^2, $/MW, $)	$\beta_{s,2}^{AES}$, $\beta_{s,1}^{AES}$, $\beta_{s,0}^{AES}$	$\beta_{s,2}^{AES}$ [6.615, 6.615, 6.615, 7.497, 7.056, 7.056, 6.615, 6.615] $\beta_{s,1}^{AES}$ [85.995, 83.349, 79.380, 84.672, 85.995, 92.610, 92.610, 89.964] $\beta_{s,0}^{AES}$ [58.810, 66.150, 69.825, 66.150, 69.825, 51.450, 55.125, 73.510]
Degradation cost coefficient of onboard ESS($/MWh)	d_s^{AES}	[50, 50, 50, 50, 50, 50, 50, 50, 50, 50]
Maximum charging/discharging power of ESS on AES (MW)	$P_s^{AES,ch/dis,\max}$	Charging [4.50, 5.25, 4.50, 3.75, 6.00, 5.25, 3.75, 6.00] Discharging [4.50, 5.25, 4.50, 3.75, 6.00, 5.25, 3.75, 6.00]
Minimum charging/discharging power of ESS on AES (MW)	$P_s^{AES,ch/dis,\min}$	Charging [0, 0, 0, 0, 0, 0, 0, 0] Discharging [0, 0, 0, 0, 0, 0, 0, 0]
Maximum/minimum energy level of ESS on AES (MWh)	$E_s^{AES,\max,\min}$	Maximum [8.10, 9.45, 8.10, 6.75, 10.80, 9.45, 6.75, 10.80] Minimum [0.90, 1.05, 0.90, 0.75, 1.20, 1.05, 0.75, 1.20]
Maximum power of G2S and S2G (MW)	$P_s^{G2S/S2G,\max}$	G2S [30, 30, 30, 30, 30, 30, 30, 30] S2G [30, 30, 30, 30, 30, 30, 30, 30]
Minimum power of G2S and S2G (MW)	$P_s^{G2S/S2G,\min}$	G2S [0, 0, 0, 0, 0, 0, 0, 0] S2G [0, 0, 0, 0, 0, 0, 0, 0]
Initial energy level of ESS on AES (MWh)	$E_{s,0}^{AES}$	[0.90, 1.05, 0.90, 0.75, 1.20, 1.05, 0.75, 1.20]
Charging/discharging efficiency of ESS on AES	$\eta_s^{AES,ch/dis}$	Charging [0.95, 0.95, 0.95, 0.95, 0.95, 0.95, 0.95, 0.95] Discharging [0.95, 0.95, 0.95, 0.95, 0.95, 0.95, 0.95, 0.95]

Maximum/minimum number of QCs that can be assigned for AES	$Q_s^{\max/\min}$	Maximum [5, 5, 5, 4, 4, 5, 5, 5] Minimum [1, 1, 1, 1, 1, 1, 1, 1]
Number of cargoes on AES (TEU)	TEU_s^{Req}	[650, 760, 650, 550, 580, 770, 640, 950]

QC Parameters (All QC are considered homogeneous)		
Property	Symbol	Value
Maximum cargo handling efficiency of QC (TEU/hour)	η_q^{QC}	50
Duration of lifting up/down in one cargo handling cycle (hour)	Δt_q^{up} , Δt_q^{down}	Lifting up 0.00833 Lifting down 0.00833
Power demand when lifting up (MW)	$P_q^{QC,up}$	1.2
Maximum regenerated power when lifting down (MW)	$P_q^{QC,down}$	0.6
Maximum charging/discharging power of ESS on QC (MW)	$P_q^{QC,ch/dis,\max}$	Charging 1 Discharging 1
Minimum charging/discharging power of ESS on QC (MW)	$P_q^{QC,ch/dis,\min}$	Charging 0 Discharging 0
Maximum/minimum energy level of ESS on QC (MWh)	$E_q^{QC,\max/\min}$	Maximum 1.8 Minimum 0.2
Initial energy level of ESS on QC (MWh)	$E_{q,0}^{QC}$	1.8
Charging/discharging efficiency of ESS on QC	$\eta_q^{QC,ch/dis}$	0.95
Degradation cost coefficient of ESS($/MWh)	d_q^{QC}	50

AGV and BSS Parameters (All AGVs and batteries are considered homogeneous)		
Property	Symbol	Value
Maximum transport efficiency of AGV when working/swapping battery (TEU/hour)	$\eta_v^{AGV,work/swap,\max}$	Working 25 Swapping battery 20
Maximum/minimum energy level of battery (MWh)	$E_n^{BT,\max/\min}$	Maximum 0.1672 Minimum 0.0088
Maximum charging/discharging power	$P_n^{BT,ch/dis,\max}$	Charging 0.45 Discharging 0.45

of battery (MW)		
Minimum charging/discharging power of battery (MW)	$P_n^{BT,ch/dis,\min}$	Charging 0 Discharging 0
Degradation cost coefficient of battery ($/MWh)	d_n^{BT}	50
Coefficient to represent the time loss caused by swapping battery	α^{swap}	0.8
Initial energy level of battery (MWh)	$E_{n,0}^{BT}$	0.1672
Threshold on energy level of battery for swap-in/out (MWh)	$\underline{E}_n^{BT,swapin}$, $\overline{E}_n^{BT,swapout}$	$\underline{E}_n^{BT,swapin}$ 0.1408 $\overline{E}_n^{BT,swapout}$ 0.0352
Charing/discharging efficiency of battery	$\eta_n^{BT,ch/dis}$	Charging 0.95 Discharging 0.95
Energy consumption of battery on AGV in one cargo transport cycle (MWh)	ΔE_v^{AGV}	0.0012672

SPDN Parameters		
Property	Symbol	Value
Constant active and reactive power loads (MW, MVar)	$P_{j,t}^{load}$, $Q_{j,t}^{load}$	All nodes are assumed to have the same loads; Active power load at 24 hours [1.38, 1.31, 1.86, 1.30, 1.81, 1.53, 2.51, 2.95, 3.11, 1.85, 3.07, 3.03854489566510, 3.28, 2.97, 2.60, 2.28, 2.31, 2.54, 2.40, 1.69, 2.10, 1.97, 2.90, 2.06] Reactive power load at 24 hours [1.25, 1.34, 1.34, 1.35, 1.36, 1.39, 1.56, 1.65, 1.62, 1.60, 1.87, 1.87, 1.86, 1.85, 1.86, 1.64, 1.48, 1.41, 1.46, 1.35, 1.39, 1.62, 1.62, 1.42]
Maximum/minimum voltage magnitude (p.u.)	$U_j^{\max}$, $U_j^{\min}$	Maximum 1.05 Minimum 0.95
Forecast renewable energy output (MW)	$P_{m,t}^{RES,f}$	Every WT unit has the same forecast output; The forecast output of one WT unit at 24 hours [2.20, 3.51, 3.80, 4.10, 4.20, 4.20, 5.00, 5.00, 3.90, 3.20, 5.00, 4.60, 4.20, 4.00, 3.90, 1.60, 0.20, 0.40, 0.50, 0.25, 0.30, 2.80, 4.10, 2.60]
Day-ahead electricity purchase price ($/MWh)	$c_t^{grid,DA}$	[117.5, 59.0, 43.5, 36.0, 43.0, 131.5, 142.5, 152.0, 164.0, 148.5, 144.5, 137.5, 139.0, 137.0, 136.0, 140.5, 148.5, 147.5, 137.5, 132.0, 126.0, 124.0, 121.5, 33.5]

Intra-day electricity adjustment price ($/MWh)	$c_t^{grid,ID,+}$, $c_t^{grid,ID,-}$	Upward [127.5, 126.0, 79.5, 47.5, 64.5, 145.5, 147.5, 171.0, 185.5, 160.5, 170.5, 148.0, 149.5, 152.0, 158.0, 163.5, 160.5, 161.5, 147.0, 147.5, 152.5, 143.0, 142.5, 35.0] Downward [127.5, 126.0, 79.5, 47.5, 64.5, 145.5, 147.5, 171.0, 185.5, 160.5, 170.5, 148.0, 149.5, 152.0, 158.0, 163.5, 160.5, 161.5, 147.0, 147.5, 152.5, 143.0, 142.5, 35.0]