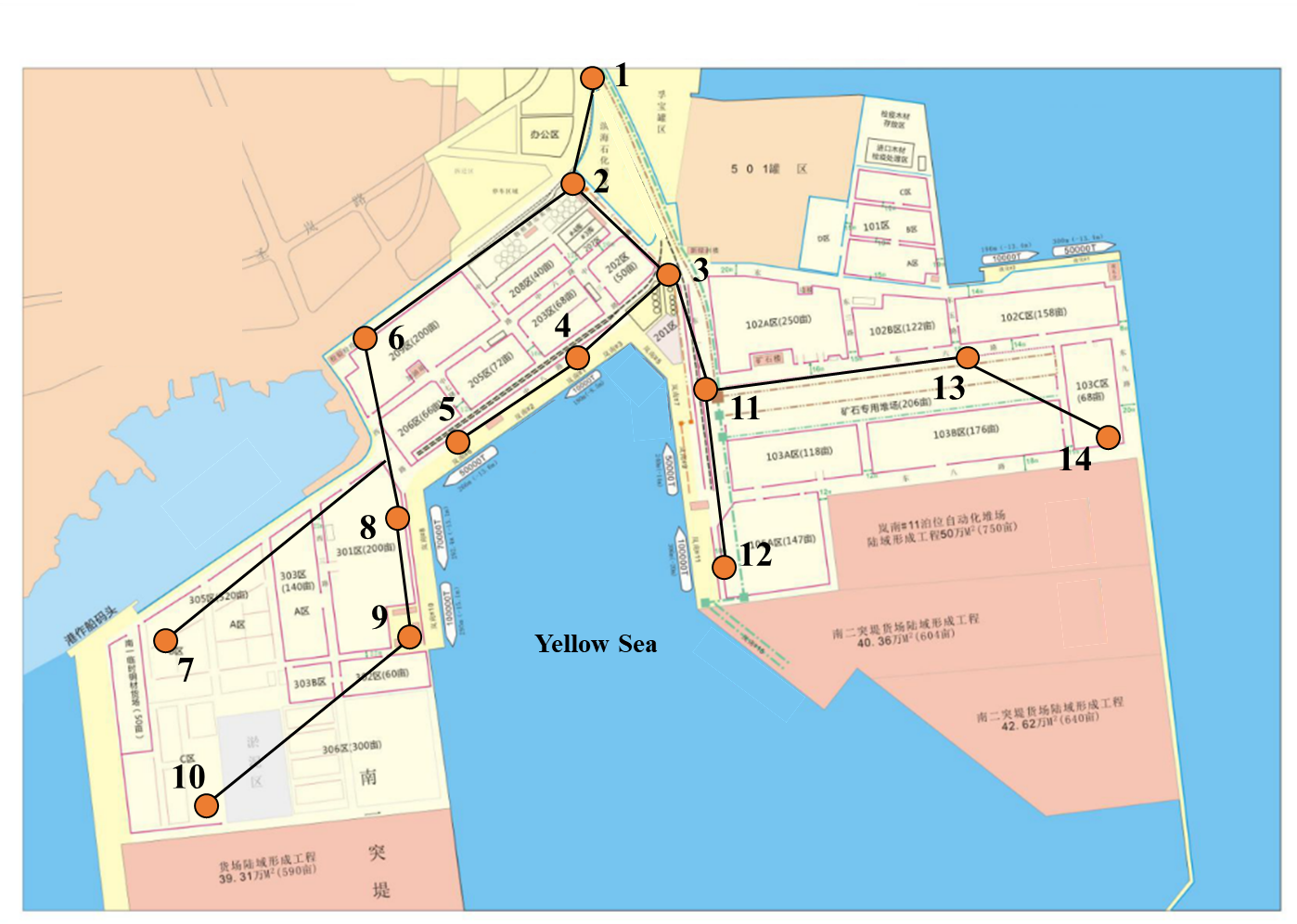
1、System topology



Connection between electrical node and equipment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Electrical Node | Berths | QCs | BSS | Wind Turbine 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) |  | [1, 2, 4, 5, 6, 9, 10, 13] |
| AES latest departure time (hour) |  | [10, 12, 11, 12, 13, 14, 10, 11] |
| AES service load (MW) |  | [3, 3.5, 3, 2.5, 4, 3.5, 2.5, 4, 3.5, 2] |
| Maximum/ Minimum power of AES auxiliary generator (MW) |  | Maximum [6, 7, 6, 5, 8, 7, 5, 8, 7, 4]  Minimum [0.6, 0.7, 0.6, 0.5, 0.8, 0.7, 0.5, 0.8, 0.7, 0.4] |
| Generation coefficients of AES auxiliary generator | , , | [2.25, 2.25, 2.25, 2.55, 2.4, 2.4, 2.25, 2.25, 2.4, 2.4]  [29.25, 28.35, 27, 28.8, 29.25, 31.5, 31.5, 30.6, 30.75, 31.75]  [20, 22.5, 23.75, 22.5, 23.75, 17.5, 18.75, 25, 25, 22.5] |
| Maximum charging/discharging power of ESS on AES (MW) |  | Charging [4.5, 5.25, 4.5, 3.75, 6, 5.25, 3.75, 6, 5.25, 3]  Discharging [4.5, 5.25, 4.5, 3.75, 6, 5.25, 3.75, 6, 5.25, 3] |
| Minimum charging/discharging power of ESS on AES (MW) |  | Charging [0, 0, 0, 0, 0, 0, 0, 0]  Discharging [0, 0, 0, 0, 0, 0, 0, 0] |
| Maximum/minimum energy limit of ESS on AES (MWh) |  | Maximum [8.1, 9.45, 8.1, 6.75, 10.8, 9.45, 6.75, 10.8, 9.45, 5.4]  Minimum [0.9, 1.05, 0.9, 0.75, 1.2, 1.05, 0.75, 1.2, 1.05, 0.6] |
| Maximum power of G2B and B2G (MW) |  | G2B [15, 15, 15, 15, 15, 15, 15, 15]  B2G [15, 15, 15, 15, 15, 15, 15, 15] |
| Minimum power of G2B and B2G (MW) |  | G2B [0, 0, 0, 0, 0, 0, 0, 0]  B2G [0, 0, 0, 0, 0, 0, 0, 0] |
| Initial energy level of ESS on AES (MWh) |  | [0.9, 1.05, 0.9, 0.75, 1.2, 1.05, 0.75, 1.2, 1.05, 0.6] |
| Charging/discharging efficiency of ESS on AES |  | 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 |  | Maximum [5, 5, 5, 4, 4, 5, 5, 5, 4, 4]  Minimum [1, 1, 1, 1, 1, 1, 1, 1, 1, 1] |
| Number of cargoes on AES |  | [650, 760, 650, 550, 580, 770, 640, 950] |

|  |  |  |
| --- | --- | --- |
| QC Parameters (All QC are considered homogeneous) | | |
| Property | Symbol | Value |
| Maximum cargo handling efficiency of QC |  | 50 |
| Duration of lifting up/down in one cargo handling cycle (hour) | , | Lifting up 0.00833  Lifting down 0.00833 |
| Power demand when lifting up (MW) |  | 1.2 |
| Maximum regenerated power when lifting down (MW) |  | 0.6 |
| Maximum charging/discharging power of ESS on QC (MW) |  | Charging 1  Discharging 1 |
| Minimum charging/discharging power of ESS on QC (MW) |  | Charging 0  Discharging 0 |
| Maximum/minimum energy limit of ESS on QC (MWh) |  | Maximum 1.8  Minimum 0.2 |
| Initial energy level of ESS on QC (MWh) |  | 1.8 |
| Charging/discharging efficiency of ESS on QC |  | 0.95 |

|  |  |  |
| --- | --- | --- |
| AGV and BSS Parameters (All AGVs and batteries are considered homogeneous) | | |
| Property | Symbol | Value |
| Maximum transport efficiency of AGV when working/swapping battery |  | Working 25  Swapping battery 20 |
| Maximum/minimum energy level of battery (MWh) |  | Maximum 0.1672  Minimum 0.0088 |
| Maximum charging/discharging power of battery (MW) |  | Charging 0.45  Discharging 0.45 |
| Minimum charging/discharging power of battery (MW) |  | Charging 0  Discharging 0 |
| Coefficient to present loss on charging/discharging efficiency when swapping battery |  | 0.8 |
| Initial energy level of battery (MWh) |  | 0.1672 |
| Limit on energy level of battery if being swapped-in/out (MWh) | , | 0.1408  0.0352 |
| Charing/discharging efficiency of battery |  | Charging 0.95  Discharging 0.95 |
| Energy consumption of battery on AGV in one cargo transport cycle (MWh) |  | 0.0012672 |

|  |  |  |
| --- | --- | --- |
| SPDN Parameters | | |
| Property | Symbol | Value |
| Constant active/reactive power loads (MW/MVar) | , | All nodes are assumed to have the same loads;  Active power load at 24 hours [1.77, 1.63, 1.91, 1.33, 1.78, 1.73, 1.77, 1.66, 1.39, 0.39, 3.93, 1.89, 3.70, 1.97, 2.55, 2.96, 2.18, 3.04, 2.25, 3.01, 1.11, 2.85, 2.20, 1.74]  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.) | , | Maximum 1.05  Minimum 0.9 |
| Forecast renewable generation (MW) |  | Every renewable energy unit has the same forecast output;  The forecast output of one renewable energy unit at 24 hours [2.2, 3.5, 3.8, 4.1, 4.2, 4.2, 5.0, 5.0, 3.9, 3.2, 5.0, 4.6, 4.2, 4.0, 3.9, 1.6, 0.2, 0.4, 0.5, 0.25, 0.3, 2.8, 4.1, 2.6] |
| Day-ahead electricity purchase price ($/MW) |  | [117.5, 59.0, 43.5, 36.0, 43.0, 131.5, 142.5, 152.0, 164.0, 148.5, 144.5, 137.5, 139.0, 137.0, 136.0, 140.5, 148.5, 147.5, 137.5, 132.0, 126.0, 124.0, 121.5, 33.5] |
| Intra-day electricity adjustment price ($/MWh) | , | Day-ahead [127.5, 126, 124.5, 37.5, 44.5, 135.5, 147.5, 171, 165.5, 160.5, 150.5, 175, 177.5, 186, 185, 183.5, 160.5, 161.5, 147, 147.5, 172.5 173, 162.5, 35]  Intra-day [127.5, 126 79.5, 47.5, 64.5, 145.5, 147.5, 171, 185.5, 160.5, 170.5, 148, 149.5, 152, 158, 163.5, 160.5, 161.5, 147, 147.5, 152.5 143, 142.5, 35] |