# Appendix

TABLE A1

Parameters of the power system

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | From bus | To bus | Reactance (p.u.) | Upper bound of power flow (MW) |
| L1 | 1 | 2 | 0.05917 | 110 |
| L2 | 1 | 5 | 0.22304 | 110 |
| L3 | 2 | 3 | 0.19797 | 110 |
| L4 | 2 | 4 | 0.17632 | 110 |
| L5 | 2 | 5 | 0.17388 | 110 |
| L6 | 3 | 4 | 0.17103 | 110 |
| L7 | 4 | 5 | 0.04211 | 110 |
| L8 | 4 | 7 | 0.20912 | 110 |
| L9 | 4 | 9 | 0.55618 | 110 |
| L10 | 5 | 6 | 0.25202 | 110 |
| L11 | 6 | 11 | 0.1989 | 110 |
| L12 | 6 | 12 | 0.25581 | 110 |
| L13 | 6 | 13 | 0.13027 | 110 |
| L14 | 7 | 8 | 0.17615 | 110 |
| L15 | 7 | 9 | 0.11001 | 110 |
| L16 | 9 | 10 | 0.0845 | 110 |
| L17 | 9 | 14 | 0.27038 | 110 |
| L18 | 10 | 11 | 0.19207 | 110 |
| L19 | 12 | 13 | 0.19988 | 110 |
| L20 | 13 | 14 | 0.34802 | 110 |

TABLE A2

Parameters of the natural gas system

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| No. | From bus | To bus | Diameter (mm) | Length (km) | Upper bound of gas flow (km3/h) |
| PI1 | 1 | 3 | 0.8 | 40 | 35 |
| PI2 | 2 | 4 | 0.8 | 40 | 35 |
| PI3 | 3 | 4 | 0.5 | 44 | 15 |
| PI4 | 3 | 5 | 0.7 | 50 | 30 |
| PI5 | 4 | 7 | 0.7 | 50 | 30 |
| PI6 | 6 | 9 | 0.7 | 50 | 30 |
| PI7 | 8 | 11 | 0.7 | 50 | 30 |
| PI8 | 10 | 13 | 0.6 | 40 | 20 |
| PI9 | 12 | 14 | 0.6 | 40 | 20 |
| PI10 | 13 | 14 | 0.5 | 46 | 15 |
| PI11 | 13 | 15 | 0.5 | 46 | 15 |
| PI12 | 14 | 15 | 0.5 | 46 | 15 |

TABLE A3

Bus data of the power system

|  |  |
| --- | --- |
| Bus | Load distribution (p.u.) |
| 1 | 0.0478 |
| 2 | 0.0955 |
| 3 | 0.0955 |
| 4 | 0.0796 |
| 5 | 0.0637 |
| 6 | 0.1115 |
| 7 | 0.0637 |
| 8 | 0.0414 |
| 9 | 0.0701 |
| 10 | 0.0414 |
| 11 | 0.0414 |
| 12 | 0.0574 |
| 13 | 0.0955 |
| 14 | 0.0955 |

TABLE A4

Node data of the natural gas system

|  |  |  |  |
| --- | --- | --- | --- |
| Node | Lower bound of nodal pressure (bar) | Upper bound of nodal pressure (bar) | Load distribution (p.u.) |
| 1 | 30 | 80 | 0 |
| 2 | 30 | 80 | 0 |
| 3 | 30 | 80 | 0.1203 |
| 4 | 30 | 80 | 0.0865 |
| 5 | 30 | 80 | 0.0865 |
| 6 | 25 | 77 | 0 |
| 7 | 25 | 77 | 0.0865 |
| 8 | 25 | 77 | 0 |
| 9 | 25 | 77 | 0.0752 |
| 10 | 25 | 77 | 0.1015 |
| 11 | 25 | 77 | 0.0752 |
| 12 | 25 | 77 | 0.1015 |
| 13 | 25 | 77 | 0.0902 |
| 14 | 25 | 77 | 0.0827 |
| 15 | 25 | 77 | 0.0939 |

TABLE A5

Parameters of CG

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Upper bound of output (MW) | Lower bound of output (MW) | Ramp up rate (MW/h) | Ramp down rate (MW/h) |
| CG1 | 130 | 15 | 26 | 26 |
| CG2 | 130 | 15 | 26 | 26 |
| CG3 | 120 | 15 | 24 | 24 |
| CG4 | 120 | 15 | 24 | 24 |

TABLE A6

Parameters of P2G

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| No. | Capacity (MW) | Upper bound of input hydrogen in HS (km3/h) | Upper bound of output hydrogen in HS (km3/h) | Upper bound of stored hydrogen in HS (km3) | Lower bound of stored hydrogen in HS (km3) |
| P2G1 | 100 | 20 | 20 | 120 | 40 |
| P2G2 | 100 | 20 | 20 | 120 | 40 |

TABLE A7

Parameters of GG

|  |  |
| --- | --- |
| No. | Capacity (MW) |
| GG1 | 100 |
| GG2 | 100 |

TABLE A8

Parameters of GW

|  |  |  |
| --- | --- | --- |
| No. | Upper bound of supplied gas (km3/h) | Lower bound of supplied gas (km3/h) |
| GW1 | 15 | 5 |
| GW2 | 15 | 5 |
| GW3 | 15 | 5 |
| GW4 | 15 | 5 |

TABLE A9

Parameters of GC

|  |  |  |
| --- | --- | --- |
| Upper bound of the compression ratio | Lower bound of the compression ratio | Gas consumption ratio |
| 1.5 | 1 | 0.03 |