In real-time dispatch model, to guarantee that enough regulation capacities are reserved, the system regulation-up/down capacity requirement of each dispatch interval is set to be 5% of the peak load in that interval. For simplicity, all generators submit the same bid for regulation-up/down services, and the ramping-up and the ramping-down capability of generators are the same. Suppose generator 1 must be the regulation generator.

The parameters of generators in the IEEE 30-bus system are summarized in Table A. 6 generators are contained in this case.

TABLE A

PARAMETERS OF GENERATORS IN THE IEEE 30-BUS SYSTEM

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Index | 1 | 2 | 3 | 4 | 5 | 6 |
| Energy bid ($/MWh) | 44 | 25 | 22 | 30 | 32 | 35 |
| Capacity bid ($/MWh) | 19.8 | 28.8 | 36 | 27 | 32.4 | 39.6 |
| Mileage bid ($/MW) | 2.9 | 2.5 | 4 | 3 | 3 | 3.5 |
| (MW) | 80 | 80 | 50 | 55 | 30 | 40 |
| (MW) | 10 | 10 | 10 | 10 | 10 | 10 |
| (MW/ min) | 48 | 48 | 30 | 33 | 18 | 24 |
| (MW) | 48 | 48 | 30 | 33 | 18 | 24 |

The parameters of generators in the IEEE 118-bus system are summarized in Table B. 54 generators are contained in this case. For simplicity, suppose generator 1 to generator 6 are possible regulation generators.

TABLE B

PARAMETERS OF GENERATORS IN THE IEEE 118-BUS SYSTEM

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Index | Energy bid ($/MWh) | Capacity bid ($/MWh) | Mileage bid ($/MW) | (MW) | (MW) | (MW/ min) | (MW) |
| 1 | 23 | 21.9 | 2.2 | 100 | 10 | 60 | 60 |
| 2 | 34 | 22.5 | 1.7 | 100 | 10 | 60 | 60 |
| 3 | 38 | 30.3 | 0.9 | 100 | 10 | 60 | 60 |
| 4 | 59 | 34.8 | 1.8 | 100 | 10 | 60 | 60 |
| 5 | 29 | 47 | 1.8 | 550 | 10 | 330 | 330 |
| 6 | 40 | 26.1 | 0.9 | 185 | 10 | 111 | 111 |
| 7 | 55 | 24.8 | 2.1 | 100 | 10 | 60 | 60 |
| 8 | 61 | 36.7 | 1.5 | 100 | 10 | 60 | 60 |
| 9 | 47 | 22.7 | 2.6 | 100 | 10 | 60 | 60 |
| 10 | 66 | 21 | 2.7 | 100 | 10 | 60 | 60 |
| 11 | 66 | 15.6 | 1.4 | 320 | 10 | 192 | 192 |
| 12 | 51 | 33.1 | 1.5 | 414 | 10 | 248.4 | 248.4 |
| 13 | 66 | 15.1 | 1 | 100 | 10 | 60 | 60 |
| 14 | 65 | 34.5 | 2.3 | 107 | 10 | 64.2 | 64.2 |
| 15 | 37 | 34.5 | 2.3 | 100 | 10 | 60 | 60 |
| 16 | 70 | 17.6 | 2.1 | 100 | 10 | 60 | 60 |
| 17 | 65 | 28.9 | 1.6 | 100 | 10 | 60 | 60 |
| 18 | 38 | 42 | 2.1 | 100 | 10 | 60 | 60 |
| 19 | 59 | 35 | 1.9 | 100 | 10 | 60 | 60 |
| 20 | 36 | 29.1 | 2.2 | 119 | 10 | 71.4 | 71.4 |
| 21 | 28 | 33.3 | 2.6 | 304 | 10 | 182.4 | 182.4 |
| 22 | 57 | 28.7 | 1.5 | 148 | 10 | 88.8 | 88.8 |
| 23 | 52 | 17.3 | 2 | 100 | 10 | 60 | 60 |
| 24 | 50 | 42.2 | 0.9 | 100 | 10 | 60 | 60 |
| 25 | 32 | 41.8 | 1.3 | 255 | 10 | 153 | 153 |
| 26 | 34 | 34.9 | 2.5 | 260 | 10 | 156 | 156 |
| 27 | 60 | 36.5 | 1.4 | 100 | 10 | 60 | 60 |
| 28 | 50 | 35.6 | 1 | 491 | 10 | 294.6 | 294.6 |
| 29 | 35 | 36.6 | 2.3 | 492 | 10 | 295.2 | 295.2 |
| 30 | 35 | 23.4 | 2.2 | 805.2 | 10 | 483.12 | 483.12 |
| 31 | 31 | 42.7 | 2.2 | 100 | 10 | 60 | 60 |
| 32 | 45 | 39.7 | 2.7 | 100 | 10 | 60 | 60 |
| 33 | 48 | 40.8 | 1.2 | 100 | 10 | 60 | 60 |
| 34 | 23 | 19.8 | 2.2 | 100 | 10 | 60 | 60 |
| 35 | 28 | 15.2 | 1.6 | 100 | 10 | 60 | 60 |
| 36 | 46 | 40.8 | 2.3 | 100 | 10 | 60 | 60 |
| 37 | 47 | 43.4 | 1.5 | 577 | 10 | 346.2 | 346.2 |
| 38 | 46 | 34.8 | 2.2 | 100 | 10 | 60 | 60 |
| 39 | 26 | 16.9 | 1.6 | 104 | 10 | 62.4 | 62.4 |
| 40 | 28 | 26.3 | 2.7 | 707 | 10 | 424.2 | 424.2 |
| 41 | 40 | 47.7 | 1.6 | 100 | 10 | 60 | 60 |
| 42 | 55 | 44.8 | 2.2 | 100 | 10 | 60 | 60 |
| 43 | 59 | 39 | 2.4 | 100 | 10 | 60 | 60 |
| 44 | 52 | 20.9 | 1.2 | 100 | 10 | 60 | 60 |
| 45 | 49 | 38.8 | 2.2 | 352 | 10 | 211.2 | 211.2 |
| 46 | 69 | 17.8 | 2.5 | 140 | 10 | 84 | 84 |
| 47 | 46 | 34.6 | 2.3 | 100 | 10 | 60 | 60 |
| 48 | 34 | 31.1 | 1.2 | 100 | 10 | 60 | 60 |
| 49 | 44 | 19.8 | 1.2 | 100 | 10 | 60 | 60 |
| 50 | 25 | 28.8 | 1 | 100 | 10 | 60 | 60 |
| 51 | 22 | 36 | 1.7 | 136 | 10 | 81.6 | 81.6 |
| 52 | 30 | 27 | 1.3 | 100 | 10 | 60 | 60 |
| 53 | 32 | 32.4 | 1.3 | 100 | 10 | 60 | 60 |
| 54 | 35 | 39.6 | 1.5 | 100 | 10 | 60 | 60 |

For privacy reasons, only part of the practical utility data is shown in Fig. 1. The load curves used in this paper can be obtained by linear transformation to match the generation capacity of the standard test cases.



Fig. 1. Net load curve