Power System Expansion Planning Considering the DSO’s Market Operations

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[[1]](#footnote-1) Appendix

Table A.I shows the existing bulk generating unit data. Table A.II shows the LDAs in the corresponding transmission buses. The data for candidate transmission lines, bulk generating units and distributed generating units are presented in Tables A.III, A.IV and A.V, respectively. In these tables, the required investment cost (IC) for candidate options are presented as annual IC. In Table A.III we assume candidate transmission lines are installed in parallel with existing lines (same right of way).

Table A.I

Existing Bulk generating unit data

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Bus Number | Type | Pmax (MW) | Pmin (MW) | Gen. Cost ($/MW) | Number of Units | FOR |
| 1 | oil | 20 | 5 | 74 | 2 | 0.1 |
| 1 | coal | 76 | 40 | 31 | 2 | 0.02 |
| 2 | oil | 20 | 5 | 74 | 2 | 0.1 |
| 2 | coal | 76 | 40 | 31 | 2 | 0.02 |
| 7 | oil | 100 | 10 | 85 | 3 | 0.04 |
| 13 | oil | 197 | 20 | 70 | 3 | 0.05 |
| 15 | oil | 12 | 4 | 75 | 5 | 0.02 |
| 15 | coal | 155 | 80 | 27 | 1 | 0.04 |
| 16 | coal | 155 | 80 | 27 | 1 | 0.04 |
| 18 | nuclear | 400 | 300 | 15 | 1 | 0.12 |
| 21 | nuclear | 400 | 300 | 15 | 1 | 0.12 |
| 22 | hydro | 50 | 10 | 7 | 6 | 0.01 |
| 23 | coal | 155 | 80 | 27 | 2 | 0.04 |
| 23 | coal | 350 | 180 | 25 | 1 | 0.08 |

Table A.II

LDAs’ peak load percentage

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| LDA1 | LDA2 | | LDA3 | | LDA4 | | LDA5 | | LDA6 | | LDA7 | | LDA8 | | LDA9 |
| 4 | 3 | | 6 | | 3 | | 2 | | 5 | | 4 | | 6 | | 6 |
| LDA10 | | LDA13 | | LDA14 | | LDA15 | | LDA16 | | LDA18 | | LDA19 | | LDA21 | |
| 7 | | 9 | | 7 | | 11 | | 4 | | 12 | | 6 | | 4 | |

Table A.III

Existing and candidate line data

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Existing Line | Candidate Line | from | to | Capacity (MW) | X  (p.u) | Existing line FOR | Candidate line FOR | Annual IC  ($/MW) |
| 1 | L1 | 1 | 2 | 80 | 0.014 | 0.005 | 0.008 | 1404 |
| 2 | L2 | 1 | 3 | 80 | 0.211 | 0.007 | 0.002 | 1013 |
| 3 | L3 | 1 | 5 | 80 | 0.085 | 0.004 | 0.001 | 405 |
| 4 | L4 | 2 | 4 | 40 | 0.127 | 0.005 | 0.002 | 608 |
| 5 | L5 | 2 | 6 | 40 | 0.192 | 0.006 | 0.007 | 918 |
| 6 | L6 | 3 | 9 | 40 | 0.119 | 0.005 | 0.001 | 567 |
| 7 | L7 | 3 | 24 | 320 | 0.084 | 0.020 | 0.006 | 1350 |
| 8 | L8 | 4 | 9 | 80 | 0.104 | 0.005 | 0.001 | 500 |
| 9 | L9 | 5 | 10 | 40 | 0.088 | 0.004 | 0.001 | 432 |
| 10 | L10 | 6 | 10 | 120 | 0.061 | 0.015 | 0.005 | 297 |
| 11 | L11 | 7 | 8 | 200 | 0.061 | 0.004 | 0.001 | 297 |
| 12 | L12 | 8 | 9 | 166 | 0.165 | 0.006 | 0.002 | 797 |
| 13 | L13 | 8 | 10 | 160 | 0.165 | 0.006 | 0.01 | 797 |
| 14 | L14 | 9 | 11 | 160 | 0.084 | 0.020 | 0.006 | 1350 |
| 15 | L15 | 9 | 12 | 200 | 0.084 | 0.020 | 0.006 | 1350 |
| 16 | L16 | 10 | 11 | 240 | 0.084 | 0.020 | 0.006 | 1350 |
| 17 | L17 | 10 | 12 | 240 | 0.084 | 0.020 | 0.01 | 1350 |
| 18 | L18 | 11 | 13 | 320 | 0.048 | 0.006 | 0.002 | 608 |
| 19 | L19 | 11 | 14 | 240 | 0.042 | 0.006 | 0.002 | 540 |
| 20 | L20 | 12 | 13 | 240 | 0.048 | 0.006 | 0.002 | 608 |
| 21 | L21 | 12 | 23 | 280 | 0.097 | 0.007 | 0.002 | 1242 |
| 22 | L22 | 13 | 23 | 280 | 0.087 | 0.007 | 0.002 | 1107 |
| 23 | L23 | 14 | 16 | 400 | 0.059 | 0.005 | 0.002 | 500 |
| 24 | L24 | 15 | 16 | 160 | 0.017 | 0.005 | 0.008 | 216 |
| 25 | L25 | 15 | 21 | 240 | 0.049 | 0.006 | 0.002 | 635 |
| 26 | L26 | 15 | 21 | 240 | 0.049 | 0.006 | 0.002 | 635 |
| 27 | L27 | 15 | 24 | 280 | 0.052 | 0.006 | 0.002 | 662 |
| 28 | L28 | 16 | 17 | 400 | 0.026 | 0.005 | 0.008 | 338 |
| 29 | L29 | 16 | 19 | 320 | 0.023 | 0.005 | 0.001 | 297 |
| 30 | L30 | 17 | 18 | 240 | 0.014 | 0.005 | 0.001 | 189 |
| 31 | L31 | 17 | 22 | 160 | 0.105 | 0.008 | 0.002 | 1350 |
| 32 | L32 | 18 | 21 | 80 | 0.026 | 0.005 | 0.02 | 338 |
| 33 | L33 | 18 | 21 | 80 | 0.026 | 0.005 | 0.002 | 338 |
| 34 | L34 | 19 | 20 | 160 | 0.040 | 0.005 | 0.002 | 513 |
| 35 | L35 | 19 | 20 | 160 | 0.040 | 0.005 | 0.002 | 513 |
| 36 | L36 | 20 | 23 | 120 | 0.022 | 0.005 | 0.001 | 284 |
| 37 | L37 | 20 | 23 | 120 | 0.022 | 0.005 | 0.001 | 284 |
| 38 | L38 | 21 | 22 | 200 | 0.068 | 0.006 | 0.002 | 864 |

Table A.IV

Candidate bulk generator data

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | Bus | Capacity  (MW) | Number of  Units | FOR | O&MC  ($/MWh) | Annual IC  ($/MW) |
| C1 | 1 | 76 | 2 | 0.01 | 24 | 53360 |
| C2 | 2 | 76 | 2 | 0.01 | 24 | 53360 |
| NG1 | 7 | 50 | 2 | 0.02 | 5.5 | 43700 |
| O2 | 13 | 197 | 2 | 0.03 | 52 | 43355 |
| C3 | 15 | 155 | 2 | 0.015 | 21 | 56695 |
| C4 | 16 | 155 | 2 | 0.015 | 21 | 56695 |
| NG2 | 18 | 100 | 2 | 0.02 | 6 | 26450 |
| N1 | 21 | 400 | 1 | 0.05 | 12 | 66700 |
| C5 | 22 | 155 | 2 | 0.02 | 21 | 56695 |
| C6 | 23 | 350 | 2 | 0.03 | 19 | 56695 |
| H1 | 24 | 50 | 1 | 0.005 | 12 | 66700 |

Table A.V

Candidate DG data

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | Bus | Capacity  (MW) | Number of  Units | FOR | O&MC  ($/MWh) | Annual IC  ($/MW) |
| G1 | 1 | 10 | 4 | 0.008 | 1 | 115000 |
| G2 | 2 | 10 | 2 | 0.008 | 1 | 115000 |
| G3 | 3 | 20 | 6 | 0.012 | 6.5 | 49450 |
| G4 | 4 | 10 | 4 | 0.008 | 1 | 115000 |
| G5 | 5 | 10 | 5 | 0.008 | 1 | 115000 |
| G6 | 6 | 15 | 3 | 0.01 | 1.6 | 87400 |
| G7 | 7 | 15 | 5 | 0.01 | 1.6 | 87400 |
| G8 | 8 | 20 | 6 | 0.012 | 6.5 | 49450 |
| G9 | 9 | 20 | 4 | 0.012 | 6.5 | 49450 |
| G10 | 10 | 20 | 6 | 0.012 | 6.5 | 49450 |
| G13 | 13 | 30 | 6 | 0.015 | 11 | 32200 |
| G14 | 14 | 20 | 5 | 0.012 | 6.5 | 49450 |
| G15 | 15 | 30 | 6 | 0.015 | 11 | 32200 |
| G16 | 16 | 10 | 6 | 0.008 | 1 | 115000 |
| G18 | 18 | 30 | 6 | 0.015 | 11 | 32200 |
| G19 | 19 | 20 | 2 | 0.012 | 6.5 | 49450 |
| G20 | 20 | 15 | 5 | 0.01 | 1.6 | 87400 |

1. [↑](#footnote-ref-1)