Supplemental File for

Aggregate Flexibility of Regional Power Grids for Non-iterative Coordinated Dispatch of the Interconnected Systems

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# Parameters of IEEE 118 Test case

TABLE

Configuration of the IEEE 118 System

|  |  |
| --- | --- |
| Item | Number |
| Bus | 118 |
| Branch | 186 |
| Thermal power generator | 32 |
| PV stations | 23 |
| Wind farms | 18 |
| Tie-lines | 2 (AC@Bus17, DC@Bus31) |

# Parameters of 5-Region Interconnected Power Grid

TABLE

Configuration of Generation Units in Five Regional Power Grids

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | Case name | Thermal power generators | PV stations | Wind farms |
| R1 | case39 | 10 | 10 | 6 |
| R2 | case118 | 32 | 12 | 11 |
| R3 | case89pegase | 24 | 10 | 8 |
| R4 | case39 | 10 | 6 | 10 |
| R5 | case89pegase | 24 | 8 | 10 |

TABLE

Tie-Lines of 5-Region Interconnected Power Grids

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From RPG | From bus | To RPG | To bus | Type |
| R1 | 30 | R2 | 25 | DC |
| 33 | 28 | DC |
| 35 | 75 | DC |
| 37 | 81 | DC |
| R1 | 31 | R3 | 913 | AC |
| 34 | 2107 | AC |
| 38 | 2267 | AC |
| R2 | 82 | R3 | 5097 | DC |
| 108 | 6233 | DC |
| R2 | 16 | R4 | 30 | AC |
| 80 | 32 | AC |
| 100 | 33 | AC |
| R3 | 3659 | R5 | 6798 | AC |
| 4586 | 7960 | AC |
| 6798 | 8605 | DC |
| 7279 | 9239 | DC |
| R4 | 35 | R5 | 2107 | AC |
| 34 | 3659 | AC |
| 36 | 4586 | AC |
| 38 | 6233 | AC |

# Solution Method of the Min-Max Problem

To solve the Stackelberg game min-max problem in (23), the internal variables are eliminated via duality and (23) is transformed into a minimization problem:

  (A.1)

where  and  are the dual variables associated with the equality (23d) and inequality constraints (23e), respectively.

The problem in (A.1) is a bilinear programming problem with a bilinear term  in the objective function, which poses challenges for direct solution with commonly used solvers. According to the propriety of dual variables, violation of the equality constraints (23d) will lead to the objective function an infinity value . Therefore, the optimal value of each element in vector  is the 3 possible values of 0,  and . To facilitate computation, we discretize each element in the unbounded vector variable  to three specific values, , 0, and , where  is a sufficient large positive constant. By introducing two discrete variables,  and ,  can be expressed as follows:

  (A.2)

where . Subsequently, the bilinear term  can be reformulated as products between binary and continuous variables, which can then be transformed into a mixed-integer linear programming problem or directly solved using off-the-shelf solvers, such as Gurobi.