Mixed Integer Linear Programming (MILP) Problem Formulation (Problem 3)

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1 Problem statement

Design an economic dispatch model to serve a load. Load data for a week is given in accompanying excel file. Assume 3 generators as follows:

1. Solar 30MW
2. Coal plant 50MW
3. Natural gas plant 30MW

They should get dispatched according to priority mentioned. Express outputs in area charts and write data to excel

2 Variables and parameters

1. t: time instance
2. C_C^t: Generation cost of coal plant
3. C_g^t: Generation cost of natural gas plant
4. C_s^t: Generation cost of solar plant
5. Q_{in}^t: Rate of charging
6. Q_{out}^t: Rate of discharging

7. $Q_{in,out}^{max}$: Maximum rate of charging and discharging (assumed to be equal)

8. Q_{Bd}^{t}: Binary variable indicating discharging at time t

9. Q_{Bc}^{t}: Binary variable indicating charging at time t

10. z^t: State of charge available at time t

11. η: Charging/discharging efficiency

12. T_{max}: Maximum time

13. P_c, P_g, P_s: Power generated by coal plant, natural gas plant, and solar power plant

14. $C_{c,op}^{t}, C_{g,op}^{t}$: Operating costs of coal and natural gas plant

15. $b_{c,g}^{t}$: Binary indicators of availability of generation from coal and natural gas plants

16. P_{load}: Load demand

3 MILP formulation of problem 3

Problem 3 can be mathematically expressed in the MILP form as follows:

$$\min \sum_{t \in T}^{T_{max}} C_c^t P_c^t + C_g^t P_g^t + C_s^t P_s^t + C_{g,op}^t b_g^t + C_{c,op}^t b_c^t \tag{1}$$

$$\text{Subject to}: Q_{out}^t \leq Q_{Bd}^t Q_{out}^{max} \tag{2}$$

$$Q_{in}^t \leq Q_{Bc}^t Q_{in}^{max} \tag{3}$$

$$z^t = z^{t-1} + \triangle t \sqrt{\eta} Q_{in}^{t-1} - \triangle t \frac{Q_{out}^{t-1}}{\sqrt{\eta}} \tag{4}$$

$$Q_{Bc}^t + Q_{Bd}^t \leq 1 \tag{5}$$

$$\sum_{t \in T}^{T_{max}} P_c^t + P_g^t + Q_{out}^t = P_{load} \tag{6}$$

Interested readers may refer to [1–4].

References

[1] Rami Ariss, Jérôme Buard, Marc Capelo, Berengere Duverneuil, Arthur Hatchuel, and May. Cost-optimization of battery sizing and operation. 2016.

[2] Erik Delarue and William D'haeseleer. A mixed integer linear programming model for solving the unit commitment problem: development and illustration. In *Proceedings of the Young Energy Engineers and Economists Seminar*, 2006.

[3] Ivo Nowak. *Relaxation and decomposition methods for mixed integer nonlinear programming*, volume 152. Springer Science & Business Media, 2005.

[4] Sylvain Quoilin, Konstantinos Kavvadias, Arnaud Mercier, Irene Pappone, and Andreas Zucker. Quantifying self-consumption linked to solar home battery systems: Statistical analysis and economic assessment. *Applied Energy*, 182:58–67, 2016.