Mixed Integer Linear Programming (MILP) Problem Formulation (Problem 2)

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1 Problem statement

Implement Solar/Storage hybrid model. Using the storage model created above, build a solar + storage hybrid model. Assume solar plant to be 5 MW. Assume battery size as above. The storage should strictly charge only from solar. Storage should discharge in the eve from 7 pm onwards every day. For solar simulation irradiance data can be obtained from pv watts (hourly data; you will need to convert it to 15 min frequency)

1. Solar output MW
2. SoC MWh
3. Charging Units
4. Discharging units
5. Time stamp

2 Variables and parameters

1. t: time instance
2. C_t: Electricity cost
3. Q_{in}^t: Rate of charging

4. Q_{out}^t: Rate of discharging
5. $Q_{in,out}^{max}$: Maximum rate of charging and discharging (assumed to be equal)
6. Q_{Bd}^t: Binary variable indicating discharging at time t
7. Q_{Bc}^t: Binary variable indicating charging at time t
8. z^t: State of charge available at time t
9. η: Charging/discharging efficiency
10. T_{max}: Maximum time
11. P_{load}: Load demand
12. P_{solar}: Solar output

3 MILP formulation of problem 2

Problem 2 can be mathematically expressed in the MILP form as follows:

$$\min \sum_{t \in T}^{T_{max}} C_t(P_{load}^t - Q_{out}^t - P_{solar}^t) \tag{1}$$

$$\text{Subject to : } Q_{out}^t \leq Q_{Bd}^t \min(Q_{out}^{max}, \max(0, P_{load}^t - P_{solar}^t)) \tag{2}$$

$$Q_{in}^t \leq Q_{Bc}^t \min(Q_{in}^{max}, \max(0, -P_{load}^t + P_{solar}^t)) \tag{3}$$

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

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

$$\sum_{t \in T}^{T_{max}} P_{load}^t + Q_{in}^t \geq 0 \tag{6}$$

Interested readers may refer to [1–3].

References

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

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

[3] 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.