Mixed Integer Linear Programming (MILP) Problem Formulation (Problem 1)

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1 Problem statement

Implement a Storage Battery model of $1MW/2MWh$ which charges in morning (assume any suitable time) and discharges in evening (assume any suitable time) every day for a year. Assume data frequency of simulation to be of 15 min. Consider parameters like charging efficiency ($\eta = 92\%$), discharge efficiency ($\eta = 92\%$). Assume data wherever necessary. Express data in suitable charts (plotly preferred). Also the model should write the data in excel/csv to review data manually Output data expected (35040 points each):

1. SoC MWh
2. Charging Units
3. Discharging units
4. 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

3 MILP formulation of problem 1

Problem 1 can be mathematically expressed in the MILP form as follows:

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

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

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

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

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

$$\tag{6}$$

Interested readers may refer to [1], and for the MILP techniques [2].

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 non-linear programming*, volume 152. Springer Science & Business Media, 2005.