Complement to Week 4's Material

Prof. Dr. Fabrizio Sossan (HES-SO Valais-Wallis)
fabrizio.sossan@hevs.ch

EPFL EE-466
Week 4

Slides compiled on: October 5, 2024

A note

The solution of Week 3's exercise (MATLAB) will be posted in Week 5 to give you some additional time to formulate the linear optimization problem autonomously.

This slidepack proposes some questions to self assess your understanding of Week 4's material and discussion.

Self-Assessment of Understanding

1. List the main components of a BESS and their main functionalities.
2. Recall the definition of (approximated) C-rate of a BESS (rated power over energy capacity) and calculate it for Californian BESS in discussed in the class and for the EPFL system.
3. What does the inverse value of the "C-rate" here above indicate?
4. What does the capability curve of a converter represent?
5. Why the linear optimization program of the battery scheduling problem with ToU tariffs (Exercise 3.1) might generate a solution where the battery power oscillates between two values (e.g., 0 and $\bar{P}$) as opposed to staying more constant?
6. The converter is also capable of injecting reactive power into the grid. Does the provision of reactive power affect the state of energy (assume that losses are negligible)? Why?
7. Take a look at the bonus matlab script that've included in Week 4 material in Moodle. It might help to clarify the notion of reactive (and active) power in relation with the one of instantaneous power.

Exercise 4.1

For Exercise 3.1, it was discussed in the class of Week 4 that adding to the cost function a term as the one in red here below

$$\text{Electricity cost} + \text{convexification term} = \Delta \sum_{t=0}^{T-1} p(t)B(t) + \alpha \sum_{t=0}^{T-1} B(t)^2 \tag{1}$$

(with α a small positive coefficient) would render the problem strictly convex (sufficient solution for having a global optimum and a global minimizer – provided that the solution of the problem exists), contributing to eliminating the power oscillations of the linear optimization-based scheduling problem.

In matrix form the cost function above can be written as:

$$p_{[0,T]}^{\top} B_{[0,T]} + B_{[0,T]}^{\top} \alpha \cdot 1_{T\times T} B_{[0,T]}$$

where $\alpha \cdot 1_{T\times T}$ is a diagonal matrix where all diagonal coefficients are α.

Such a problem can be solved with the Matlab function `quadprog`. Give it a try and see whether that helps to get rid of the power oscillations. Note that this modification impacts only the cost function of the problems; constraints aren't affected (so you can keep the same you've formulated already for Ex. 3.1).