ELEN0445-1 Microgrids

Assignment 4: Operational planning and sizing

Introduction

In this assignment, you will have to first use optimization to improve your results from assignment 3. With a given system and some load and production profiles, you'll be able to compare these results with the ones you obtained in the previous homework. Please note that here, the efficiency of the batteries and the diesel genset are considered constant.

In the second part, you will have to change the design of your energy system to optimize the sizes of the assets for several scenarios, first depending on grid tariffs. Then you will model the optimal design for an isolated system ("islanded microgrid").

Operational planning

In this first part, you will start by modeling a simple daily problem comparable to the case study of homework 3. Then you will add a grid connection, with different tariffs for grid sale, and compute your energy system costs for one whole year:

1. Solve the operational planning problem (in `OP_opt.py`) using a linear programming formulation. Here, the sizes of the devices are known, you just want to optimize the usage of each device to minimize OPEX.

2. Add a grid connection to the system and compute your **yearly** system costs (compare cases of net-metering, selling to the grid, or giving it away). Try to compare the results with and without the grid as well as the influence of the grid exchange tariffs.

Sizing

In the second part of this assignment, you are asked to size a home microgrid that will first be considered as a grid-connected system, then as a domestic islanded (isolated) microgrid.

The grid connection is single-phase and can be either 16A, 32A, or 64A, with a nominal voltage of 230V. You can invest in a genset with three sizes available. Battery packs where the energy capacity can be sized independently of the inverter power can also be purchased. Similarly, PV capacity can be sized independently of the PV inverter power.

If the given sets of devices are insufficient for your case, you can modify them (realistically). You can also modify some of the key parameters to discuss their impact on the results (e.g. the grid tariff, the fuel price, the investment prices, ...).

Since your role is now to size the microgrid, you should set the device sizes as variables. Moreover, the objective must be changed to take into account both CAPEX and OPEX. You should also include the data from your house (consumption, number of kilometers per year, maximum PV capacity according to *Sunny Design Web*).

In this part, to avoid losing too much time waiting for the solver, you should start by simulating one month before solving the whole year problem when you are sure that your code works.

1. Use the normalized load and power profile from `HW4.csv` to compute the optimal sizing for the three previous export tariffs.

2. Solve the same problem after removing the grid connection to isolate your house from the grid.

3. Remove the electric vehicle for all the previous cases. How does this affect your results?

4. Compare the previous results (grid-connected without the electric vehicle) with the sizing you did using *Sunny Design Web*. You should add some batteries to make the comparison more realistic but there should be no need to add a genset.

Bonus

1. Compute the CO2 emissions for the cases above.

2. Stay in islanded mode, now your goal is to minimize CO2 emissions and change the objective accordingly. Compute the cost of such a system.

3. Use another approach where you decide on the yearly CO2 budgets as a parameter. Implement this as a constraint in your model. Then compute the optimal cost associated with each of the values.

The assignment should again be carried out by groups of two students and submitted as a zip file on eCampus before 23:59, 3 days before the exam. The zip should contain a report describing your process, results, and analyses (maximum **9** pages) and your modified Python files. You will have to present your work on the exam day.

Few advices

- For the first part of the project, you can compare your results with those obtained in homework 3. Evaluate whether your current results are better or worse. Why?

- When connected to the grid, try to use some metrics such as self-consumption or self-sufficiency. These measures will help you assess your system's performance and efficiency.

- In the sizing part, don't forget to compare the installed capacities and the energy produced by the different units. Try to interpret the results.

- Generally speaking, you should always keep an eye on the prices obtained and try to interpret them.

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