Homework 4

In the lecture, we introduced an investment model. This model takes a certain renewable share as an input and determines the optimal generation portfolio to match the given share. The current implementation lacks an investment option into storage technologies such as batteries or pumped-hydro storages. When looking at the results, the curtailment of renewable energy increases significantly at higher renewable shares.

Task 1: Expand the model:
The goal of this task is to expand the model with the possibility to invest in storage technologies.

a) Implementing storages as an investment option, we need

- overnight costs in EUR/MW
- overnight costs in EUR/MWh
- efficiency in %
- lifetime in years

as properties of each storage technology. A CSV file is provided that contains values for pumped-hydro storages. Your task is to do a quick literature research and find two appropriate storage technologies with the corresponding cost parameters. Please state your source!

b) Add these two storage technologies to the CSV file. Write an input within the given greenfield.jl file. To calculate the annuity of an investment into storages use this equation:

$$OvernightCosts * \frac{(i+1)^{Lifetime}}{(i+1)^{Lifetime} - 1}$$

You will receive an annuity for the investment into power (EUR/MW) and energy (EUR/MWh). To avoid a double charge for an investment into storages, weight both costs only half in the objective function.

c) Run the model for shares of 70 %, 80 %, 90 %, and 100 %. Submit a plot from the given model and one plot after you successfully implemented storages. How does the investment into generation capacity change? What happens with the curtailment?

d) Create your own plot showing the investment into storage power and storage capacity. How much energy is stored during the course of the year? How much energy was lost due to storage efficiency?

Task 2: Load duration curve: In lecture 2 we talked briefly about load duration curves and how we can plot them in Julia. Your task is now to plot the different residual load duration curves.

a) Simply create a load duration curve in Julia with the given demand. Since the demand stays constant for all scenario, you can use this as a base for the following tasks.

b) The residual demand is calculated by subtracting the renewable feed-in from the demand for each hour. Afterwards you need to sort your calculated time series in a descending order. Do that one time without the implementation of storages for the shares of 70 %, 80 %, 90 %, 100 % and one time with the expanded model (where you implemented storages). Submit the plots and describe briefly what changes with higher shares and the implementation of storages.

Please send your results to riw@wip.tu-berlin.de by July 24, 2018.