

Lecture 8: Join capacity and dispatch optimization

DTU Course 46770: Integrated Energy Grids

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Problem 8.1. Optimize the capacity and dispatch of solar PV, onshore wind, and Open Cycle Gas Turbine (OCGT) generators to supply the inelastic electricity demand throughout one year. To do this, take the time series for the wind and solar capacity factors for Portugal in 2015 obtained from <https://zenodo.org/record/3253876#.XSiV0EdS810> and <https://zenodo.org/record/2613651#.X0kbhDVS-uV> (select the file 'pvoptimal.csv') and the electricity demand from <https://github.com/martavp/integrated-energy-grids/tree/main/integrated-energy-grids/Problems/data>.

Consider the annualized capital costs and marginal generation costs for the different technologies in the following table. The efficiency for the OCGT plant is 0.41.

Technology	Annualized capital costs (EUR/MW/a)	Marginal generation costs (EUR/MWh)
Onshore Wind	101,644	0
Solar PV	51,346	0
OCGT	47,718	64.7

Table 1: Costs assumptions.

- Calculate the total system cost, the optimal installed capacities, the annual generation per technology, and plot the hourly generation and demand during January.
- Calculate the revenues collected by every technology throughout the year and show that their sum is equal to their costs.

Problem 8.2. Use the model described in Problem 8.1 and add the possibility of installing battery storage. The annualized capital cost of the battery comprises 12,894 EUR/MWh/a for the energy capacity and 24,678 EUR/MW/a for the inverter. The inverter efficiency is 0.96 and the battery is assumed to have a fixed energy-to-power ratio of 2 hours. Assume also an existing Combined Cycled Gas Turbine (CCGT) unit with an electricity generation capacity of 6 GW and efficiency of 0.58. The annualized capital cost and marginal generation costs for the CCGT are respectively 104,788 EUR/MW/a and 46.8 EUR/MWh.

- Calculate the total system cost, the optimal installed capacities, the annual generation per technology, and plot the hourly generation and demand during January.
- How does the CCGT power plant recover its cost?
- How does the battery recover its cost?