Exercise - Stochastic programming

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Heat production planning

A small district heating company approaches you to get your help on optimizing their production. The company has three heat producing units $\mathcal{U}$ to fulfill the heat demand in the connected district heating network, namely one combined heat and power plant (CHP), a gas boiler (GB) and a wood chip boiler (WCB). The CHP plant is a back-pressure unit and produces heat and power simultaneously. For each produced MWh power ϕ MWh heat are produced. Each production unit has maximum production of heat Q_u^{Max}. The cost to produce one MWh heat for each unit is given by c_u.
Your task is to obtain the optimal production of all units for every hour $t \in T$ of the next day ($T = \{1, \ldots, 24\}$). As the CHP unit has the longest start up time and the electricity production should be sold on the day-ahead market, the production of the CHP unit has to be determined one day in advance. The GB and WCB are more flexible and can be started spontaneously. The goal is to obtain a cost minimal production schedule, while taking the income from the day-ahead electricity market into account.
The heat demand $d_{t,s}$ and electricity price $e_{t,s}$ are uncertain on the day before, but the company has a forecasting tool to obtain scenarios $s \in S$ for the next day.

Tasks

1. Formulate a general two-stage stochastic program to obtain the optimal production schedule. Hint: Split up the production units in two sets (one for combined heat and power units, one for heat-only units). You can change the notation of the parameters, if you need to (e.g. other indices).

2. Download `heat.jl` from DTUInside. Solve the model for the given input data using Julia JuMP.

3. Assume you can introduce a thermal storage with a capacity of K MWh heat to the system, which allows to store heat between hours (with losses). Adapt your stochastic program from Task 1 and solve it again for a storage size of 7 MWh. How does the solution change and why?