Optimization of energy production of a CHP plant with heat storage - Overview

Elnaz Abdollahi, Haichao Wang, Samuli Rinne, Risto Lahdelma

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This paper optimizes CHP production with heat storage in order to satisfy consumer's heat demand while selling the electricity on the market when the price is the highest.

A small analysis on the flexibility that heat storage offers in satisfying demand and decreasing overall acquisition costs has been performed. The analysis how heat storage capacity influences balancing between minimizing overall net acquisition costs and meeting consumer's demand has been performed here.

In Figure 1,2 and 3 we can see fuel consumption, power production, produced heat and heat demand when heat storage capacity is 0.

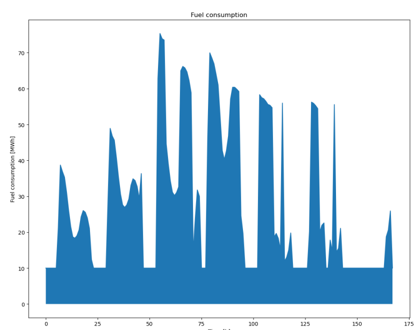

Figure 1: Fuel consumption when heat storage capacity is zero

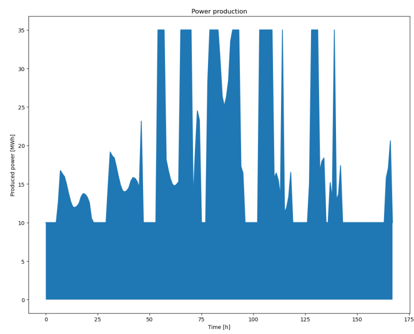

Figure 2: Power production when heat storage capacity is zero

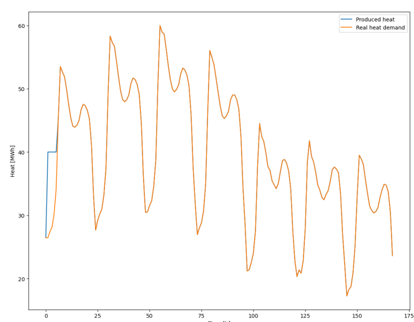

Figure 3: Produced heat when heat storage capacity is zero and heat demand

In Figure 4,5 and 6 we can see fuel consumption, power production, produced heat and heat demand when heat storage capacity is 200.

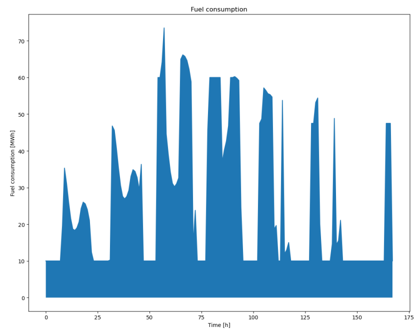

Figure 4: Fuel consumption when heat storage capacity is 200

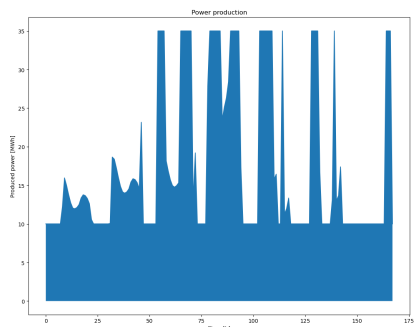

Figure 5: Power production when heat storage capacity is 200

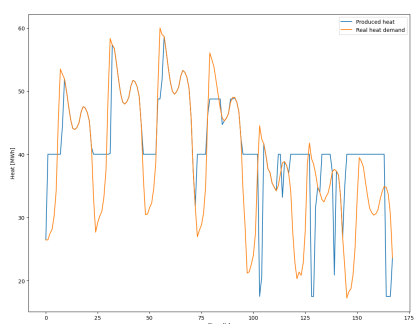

Figure 6: Produced heat when heat storage capacity is 200 and heat demand

In Figure 7 we can see dependence of net acquisition costs of heat storage capacity. By increasing heat storage capacity, the overall net acquisition costs are decreasing.

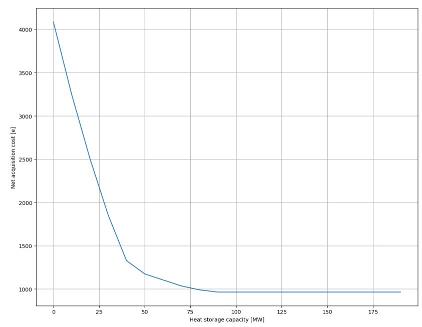

Figure 7: Net acquisition costs when changing heat storage capacity

In Figure 8 we can see dependence of mean squared error of heat demand and produced heat of heat storage capacity. By increasing heat storage capacity, the mean squared error is increasing.

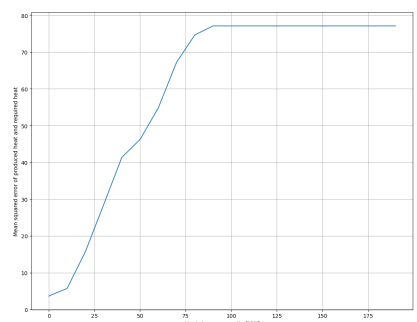

Figure 8: Mean squared error when changing heat storage capacity

Conclusion: It can be seen clearly that this model will sacrifice consumer's heat demand in order to reach minimal cost. It will exploit flexibility that heat storage capacity offers in order to minimize its objective function, not caring so much about its consumers demand constraint.

Question: Can we include thermal inertia of a heat grid in this model in order to make everything better? In order to minimize costs additionally, and in order to satisfy consumer's demand better? How can thermal inertia be included to obtain this goal?

Unclear things in implementation: The extreme points of the CHP plant in 3D feasible region graph, specifically extreme points for cost, are not clear what do they exactly represent. Is their unit e or MWh? I implemented as their unit is MWh. In objective function, the production cost - fuel price is calculated by multiplying 15e/MWh (fixed price of the fuel) and consumption fuel (MWh). The consumption (MWh) is assumed to be on the 3D plot. In paper, it is said that heat-to-power-ratio is assumed to be constant, but I don't understand that or where is it in the implementation.

Things that this paper is missing:
There is no ramping constraint, heat and power production of CHP drastically are changing values from one hour to other hour.
Heat demand doesn't seem to be satisfied all the time.
The heat demand is assumed to be given at a production side, not consumer side.
The optimization horizon is one week. The heat storage content at the end of optimization horizon is not considered at all. What if empty heat storage imposes additional, bigger costs in the next planning horizon? It probably does.
Thermal inertia missing here - buffer is a heat storage. It may be interesting to compare how much can we save from heat storage vs. thermal inertia.