Mixed-Integer Nonlinear Predictive Control for District Heating Networks

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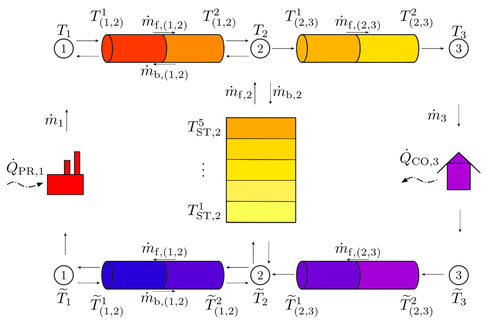
District Heating Network (DHN)

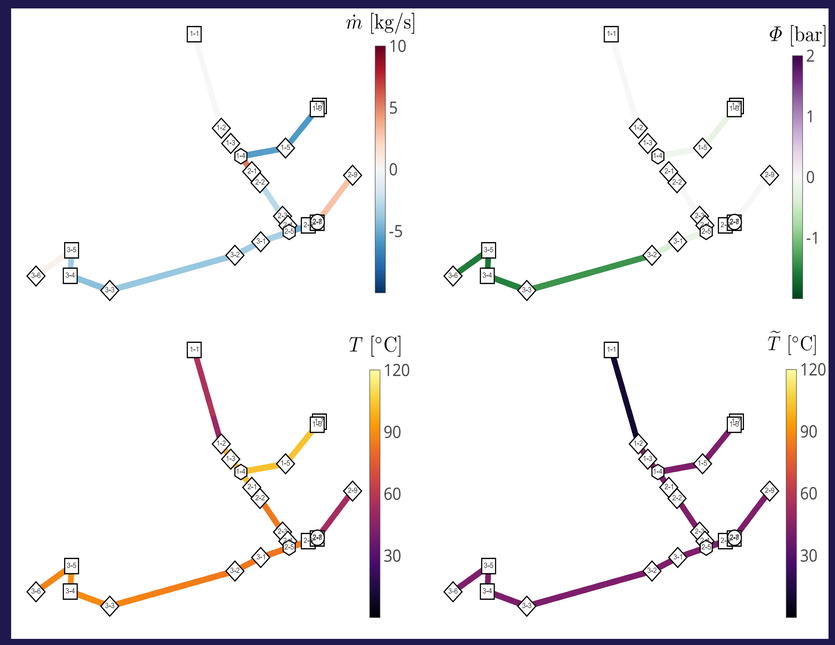
- Today: highly dependent on fossil fuels
- Reduce greenhouse gas emission by increasing the utilization of DHNs
- One of most cost expensive heating option

WOpS Project

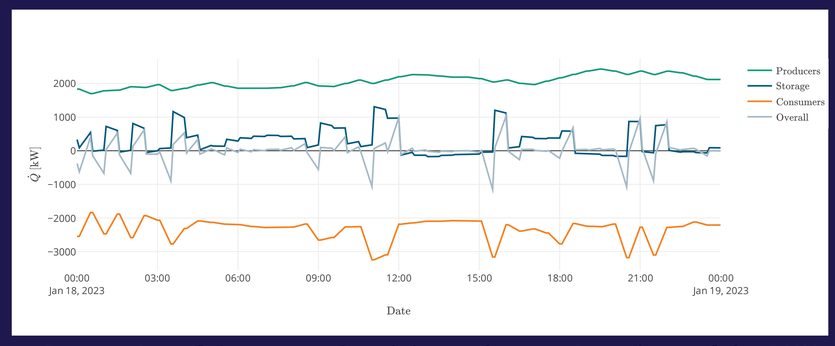
- Minimize the economic cost of heating
- Operating the producers automatically
- Accounting for technical limitations
- Use mathematical optimization



GPU-Powered optimization enables city-scale DHN Model Predictive Control



Optimal control solution of the DHN of Weil am Rhein at 12:00



Progression of the accumulated thermal power in and out of the DHN

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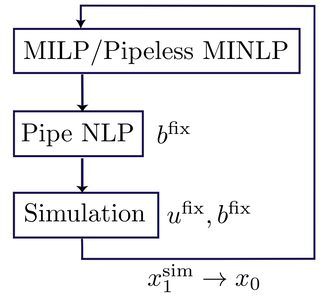
Optimal Control Problem (OCP)

- Nonlinear dynamics
- Complementarity constraints due to bidirectional flow
- Binary decision variables
- Model predictive control problem for minimizing iteratively the production heating cost

Compact Mixed-Integer Nonlinear Program

$$\begin{aligned} \min_{v,b} \quad & J(v,b;p) \\ \text{s.t.} \quad & 0 = G(v,b;p), \\ & 0 \le H(v,b;p), \\ & 0 \le C_1(v) \perp C_2(v) \ge 0, \\ & v \in \mathbb{R}^{n_v}, b \in \{0,1\}^{n_b}. \end{aligned}$$

- Complex for city-scale networks ⇒ Solving problem in multiple stages



Results

- Simplified Weil am Rhein DHN behaviour for the next 24 h
- Pipe NLP stage most time-consuming