Comparison of modelling approaches for operational optimization of district cooling networks

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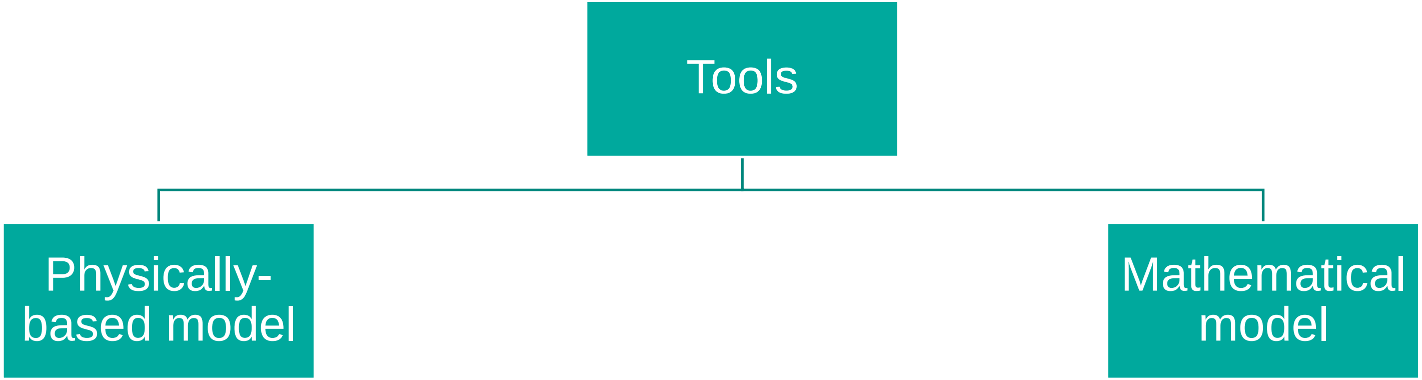
Purpose

Why include network in DCS (District Cooling System) model?

- Pumping costs: 30% of total cost
- Network based constraints:
  - Congestion
  - Maximum flow in the pipes
  - Opposite flow
- Large impact on dispatch and future investments
- Realism of results depends on network-based constraints
- **Comparison of two methods to model network in this study**
  - **<u>Conventionally used method vs Developed novel cost linking method</u>**

Tools studied for modeling the DCN



- Physically-based **simulation** in Modelica or Dymola
  - Pros: Dynamic thermo-hydraulic effects
  - Cons: Long simulation times

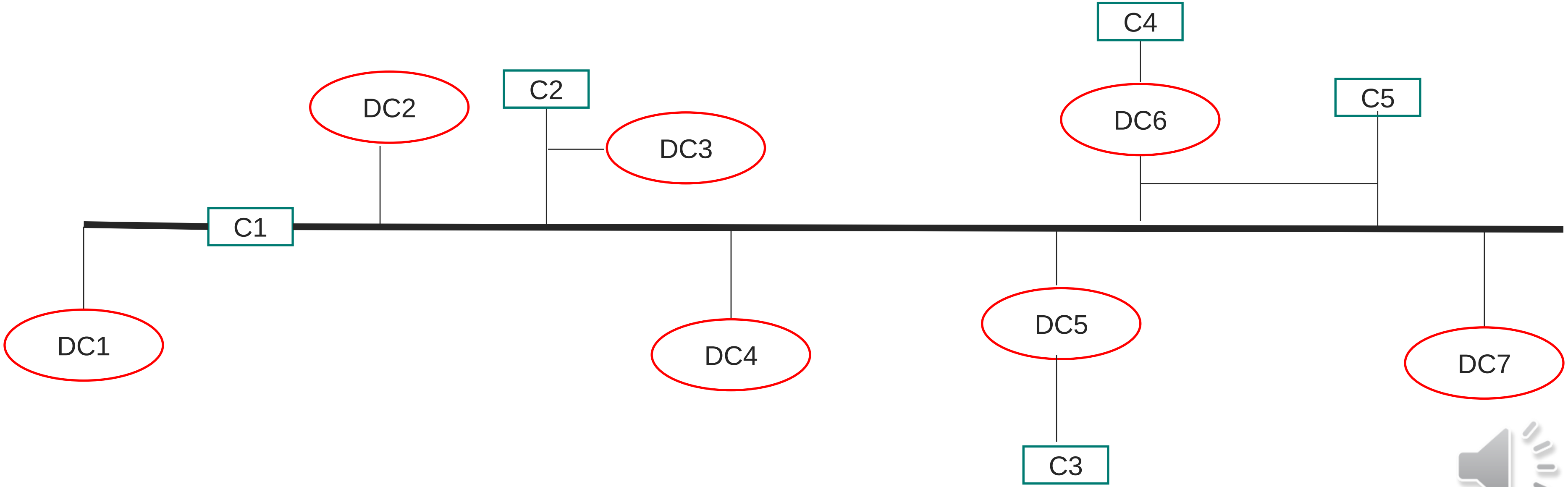
- Mathematical **optimization** model in GAMS
  - Pros: Optimal solution for larger models
  - Cons: No thermo-hydraulic effects

Case study: The District Cooling network

District cooling network in Gothenburg, Sweden

Level of aggregation and disaggregation

- Buildings grouped: demand clusters
- Network disaggregated into main and sub pipes
- Radial network



Different methods explored

Model of DC network

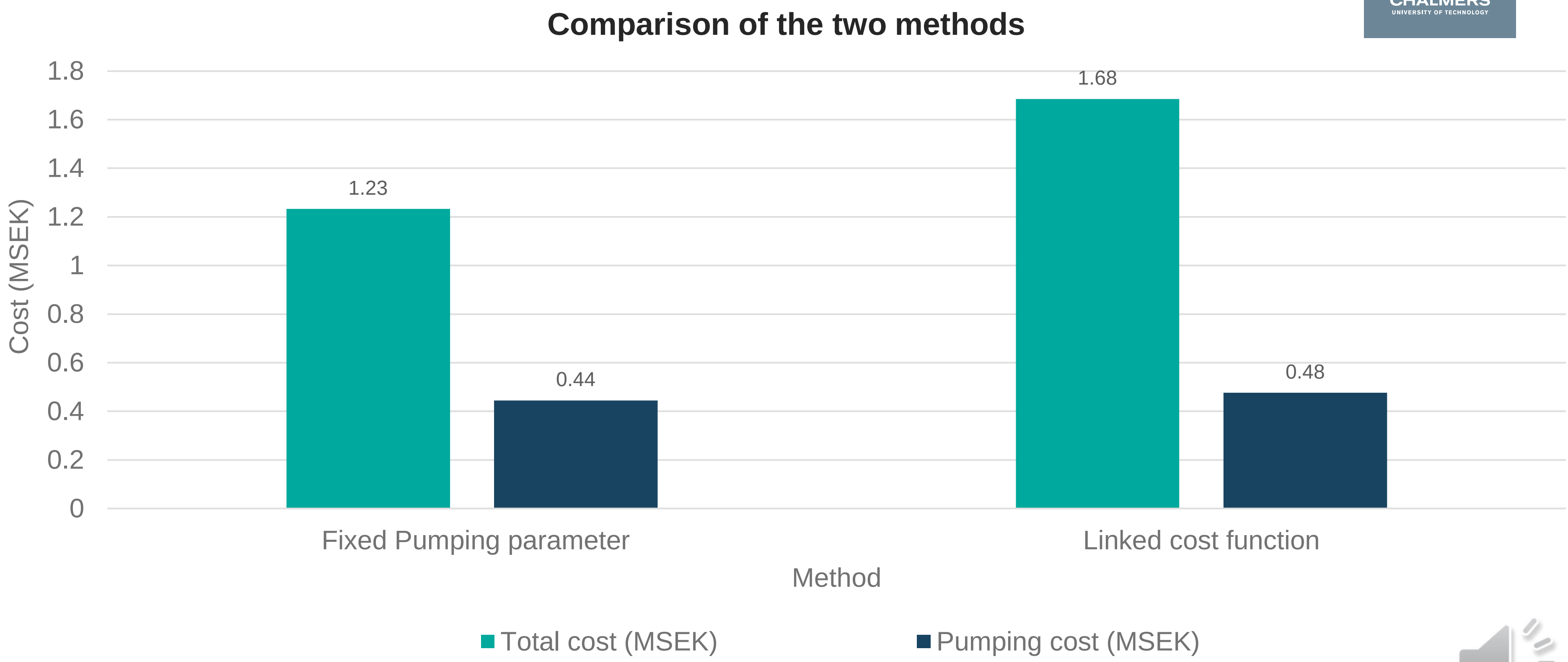
Method 1: Fixed pumping cost parameter

- Fixed additional O&M cost
- kW_p/MW_c
- From physically-based simulation model of the system

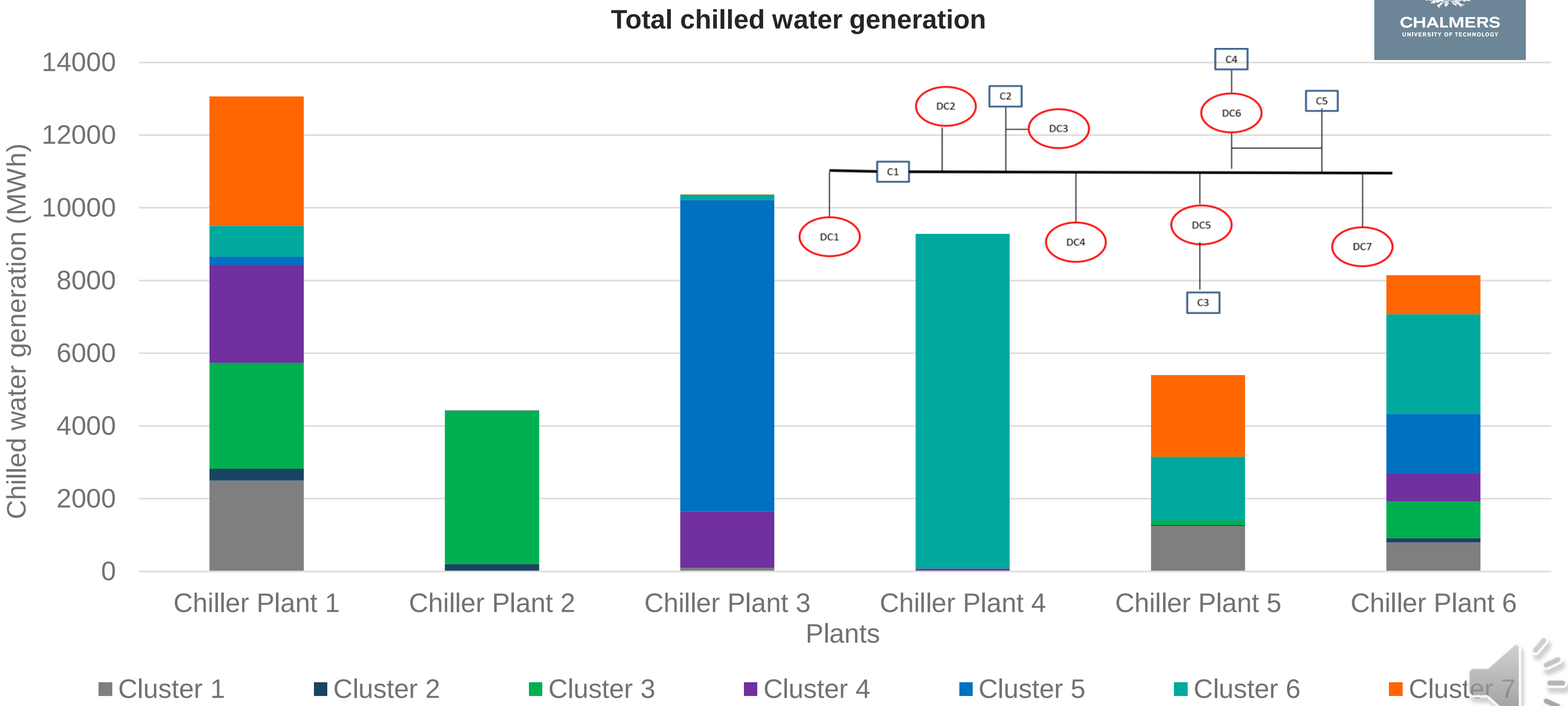
Method 2: Linked cost functions

- Pumping cost as function of chilled water flow
- Couple demand with chiller
- Pressure drop
- Fixed ΔT of 6.6°C
- Constraints:
  - Maximum flow in pipes
  - Opposite flow in pipes

Comparison of the results



Results: Linked cost functions



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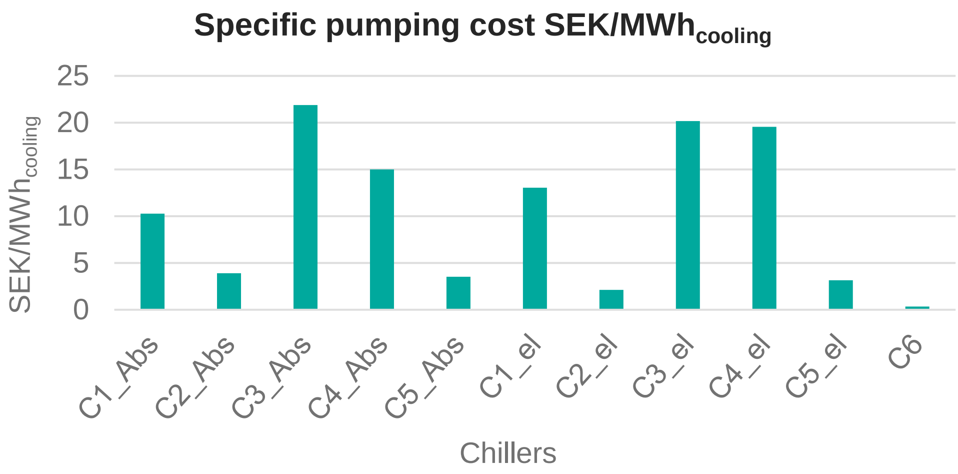
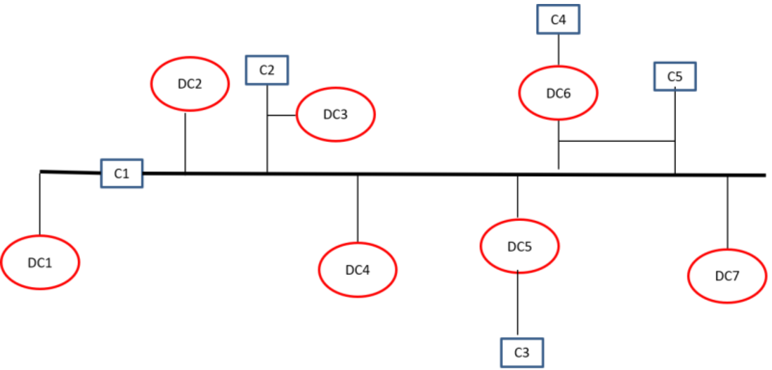
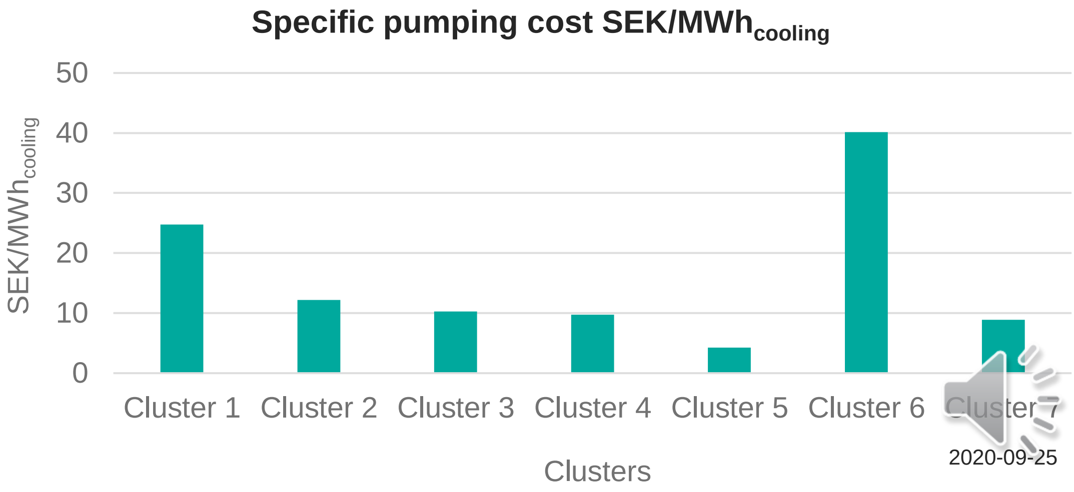
Results: Linked cost functions







Conclusions

The Linked Cost Functions Method:

- Provides detailed representation of pumping costs and network-based constraints
- Captures spatial aspects
- Enables detailed network and congestion analysis
- Enables analysis of future investment locations

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