3rd International Conference on Smart Energy Systems and 4th Generation District Heating
Copenhagen, 12-13 September 2017

Comparison of methods for thermal storage sizing in district heating networks

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4DH
4th Generation District Heating Technologies and Systems

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Heat Roadmap Europe 2050
A low-carbon heating and cooling strategy

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Background

Thermal storage technologies are a key component in the transition towards 100% renewable energy systems.

- ✓ Increase integration of renewable and industrial waste energy sources into district heating networks.
- ✓ Increase system flexibility through decoupling heat and electricity production/consumption.
- ✓ Increase system stability.

Background

Heat_portfolio

- **Objective**
  Development of technical basis for increasing the share of decentralised alternative heat sources, particularly industrial waste heat, heat pumps and solar thermal energy in district heating networks.
- **Period**
  From 03.2015 to 02.2018
- **Funds**
  Climate and Energy Funds
- **Programme**
  Energieforschungsprogramm 2014
- **FFG project number**
  848849

Goal

Comparison of thermal storage sizing methods:

Simulation methods

Engineering methods

Design rules from manufacturers

Mathematical methods

Assessment of consumers and producers profiles

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Comparison of thermal storage sizing methods:

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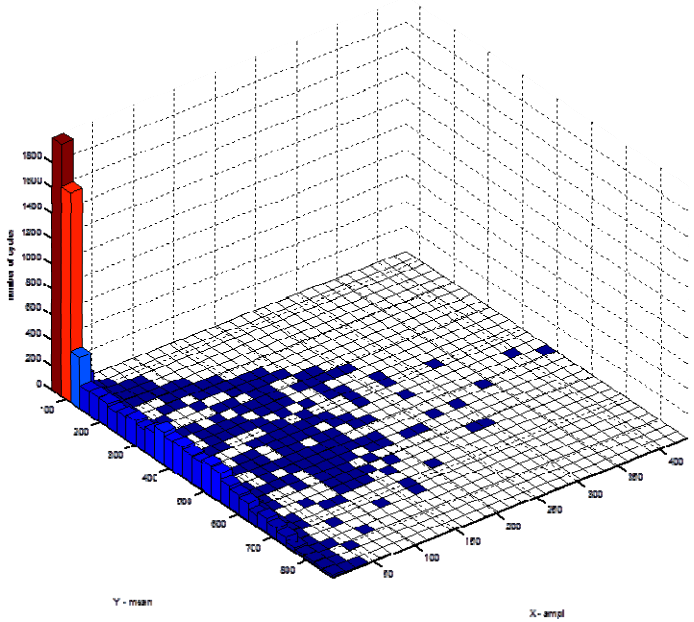
Assessment of consumers and producers profiles

Mathematical methods

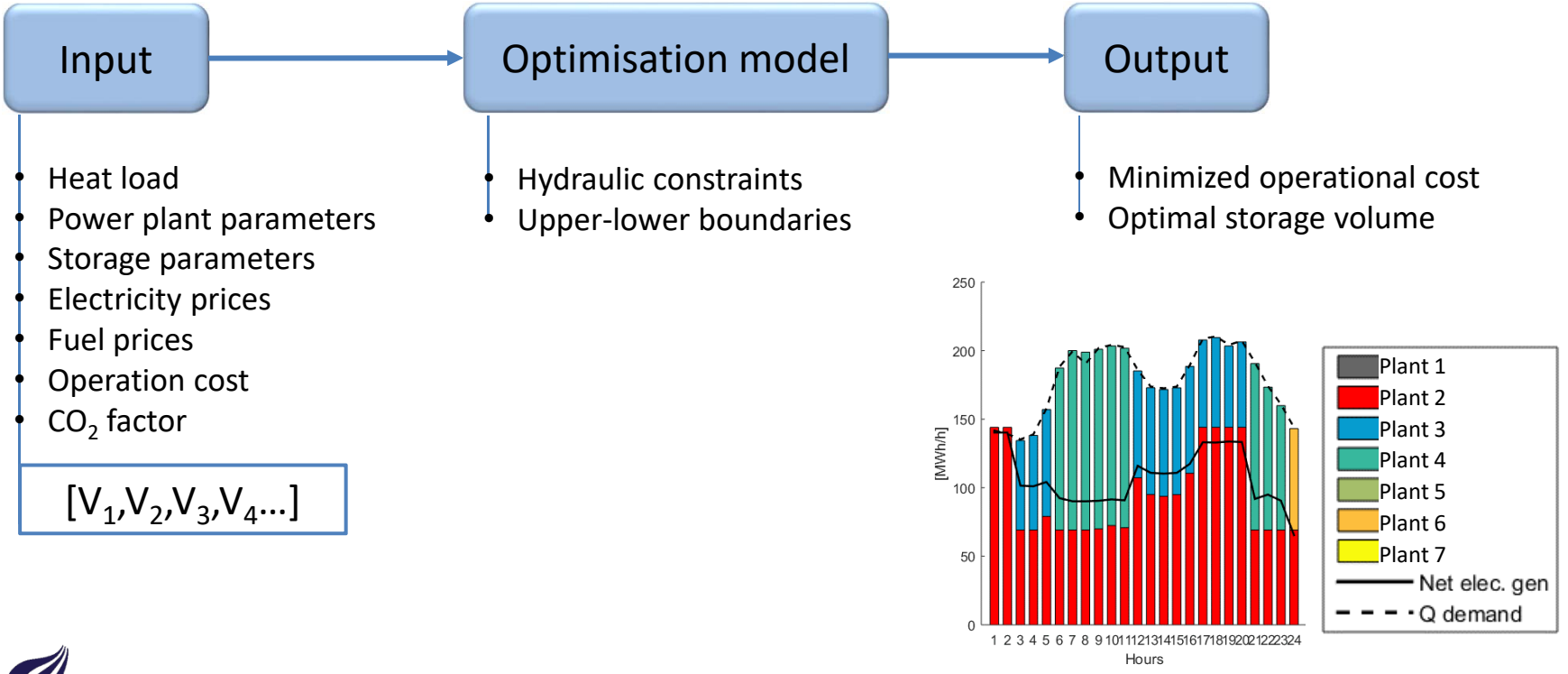
The following methodologies have been compared:

- **Rainflow counting algorithm** determines the number of cycles present in a heat load profile.
- **Fourier transformation** decomposes a function of time (a signal) into frequencies.
- **Minimum load boiler algorithm** considers the heat load profile below the minimum load.



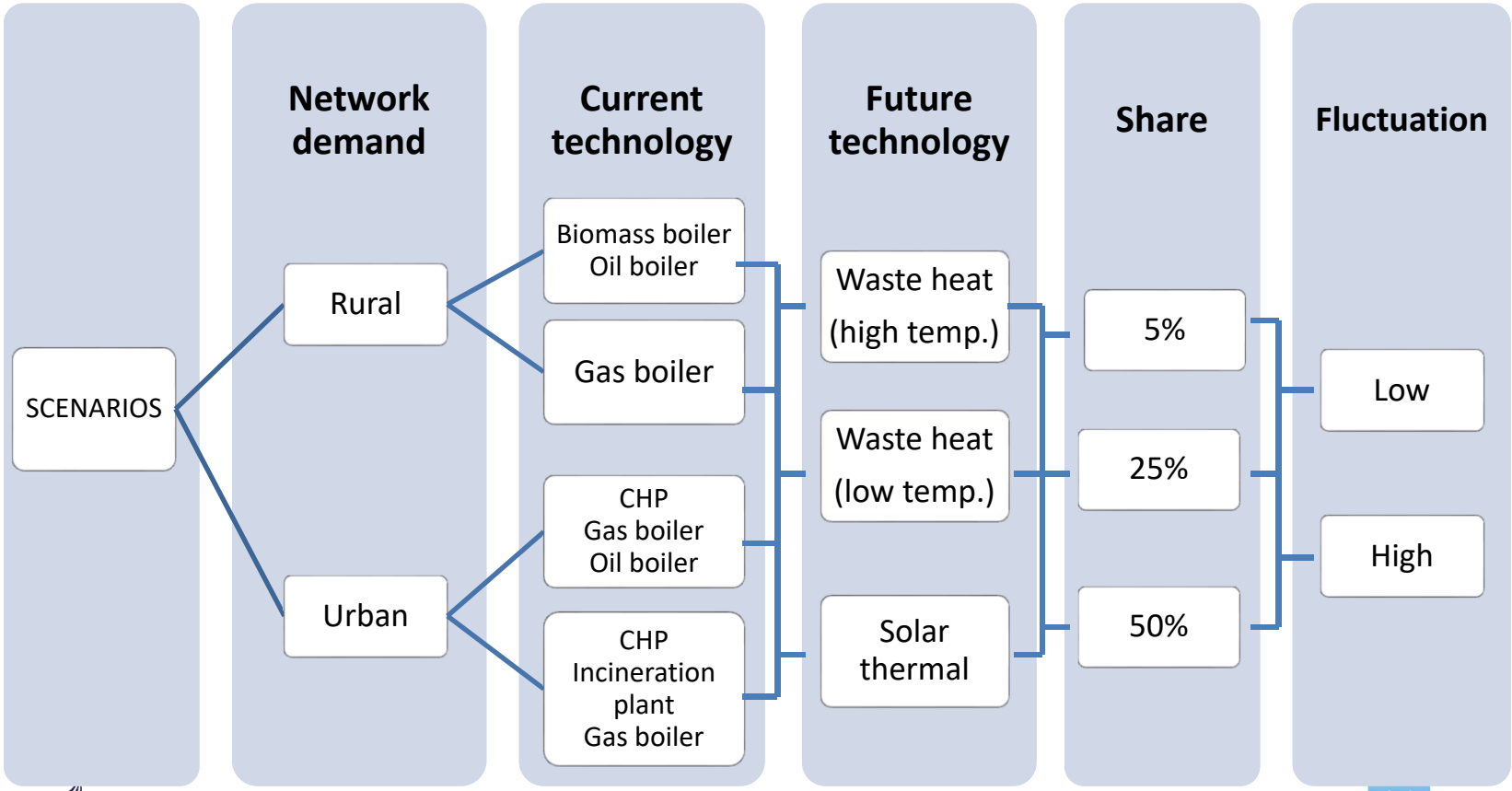
Simulation method

- Operation optimization model is developed.
- The model is based on the mixed integer linear programming (MILP) method.
- It provides the cost optimal storage volume and operation strategy.



Scenarios

A set of scenarios is developed based on representative Austrian district heating networks.



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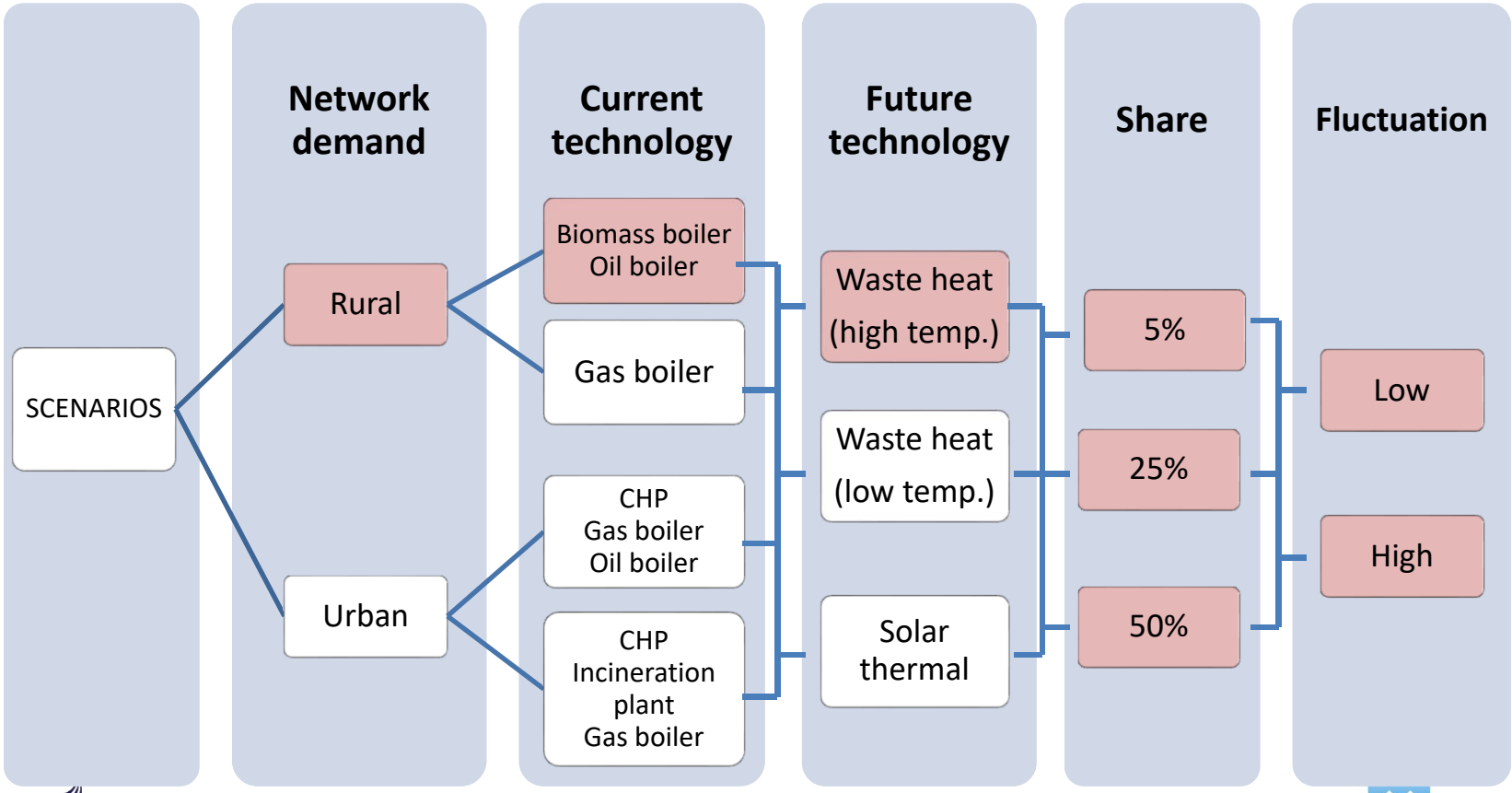
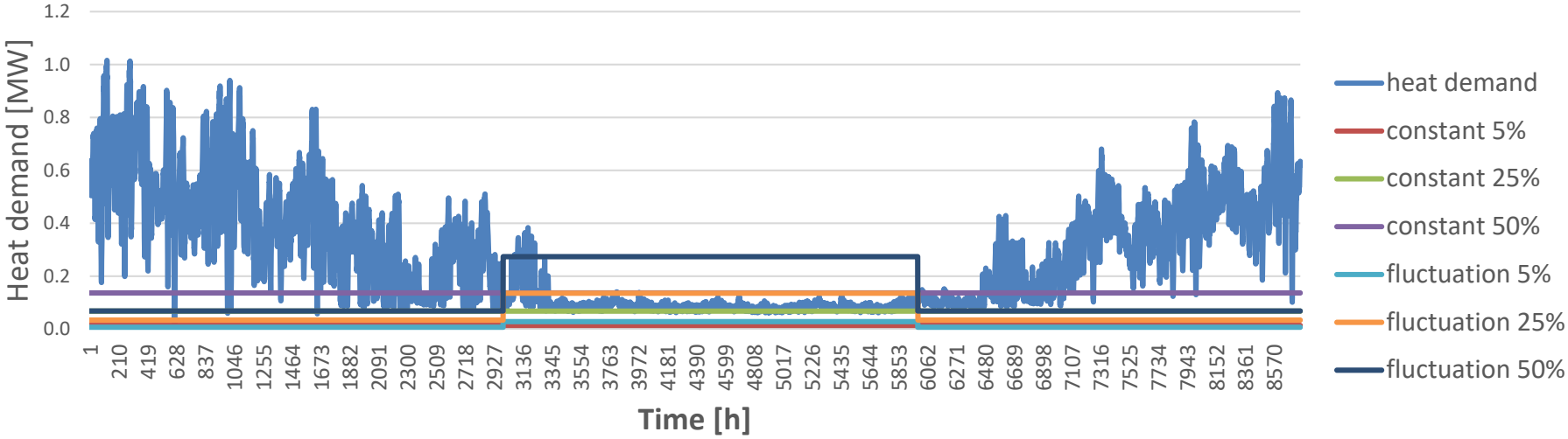
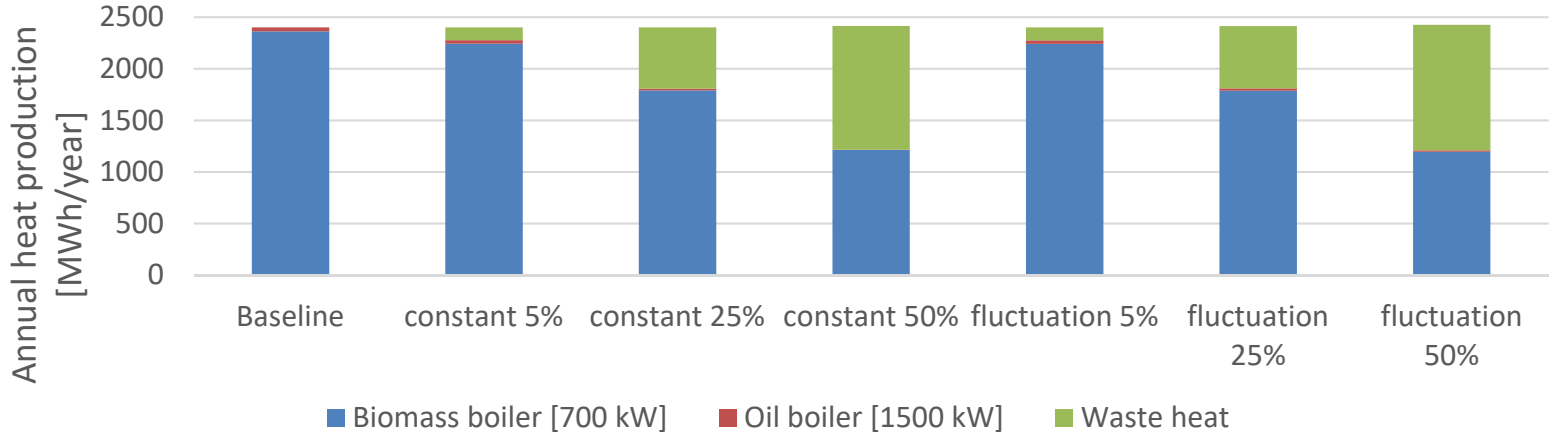


Scenarios – simulation results





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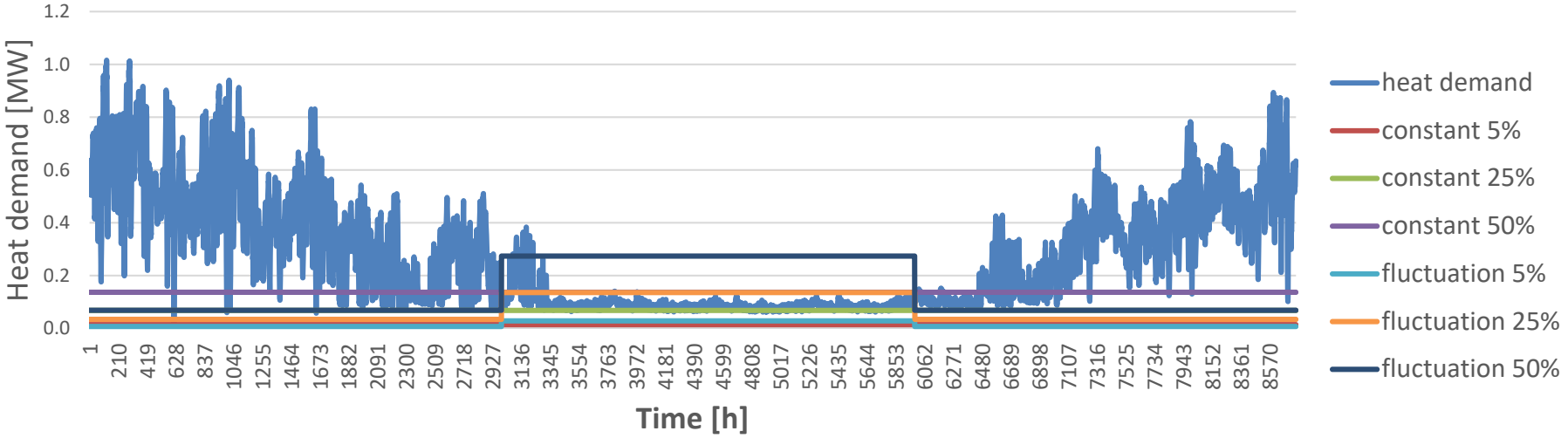
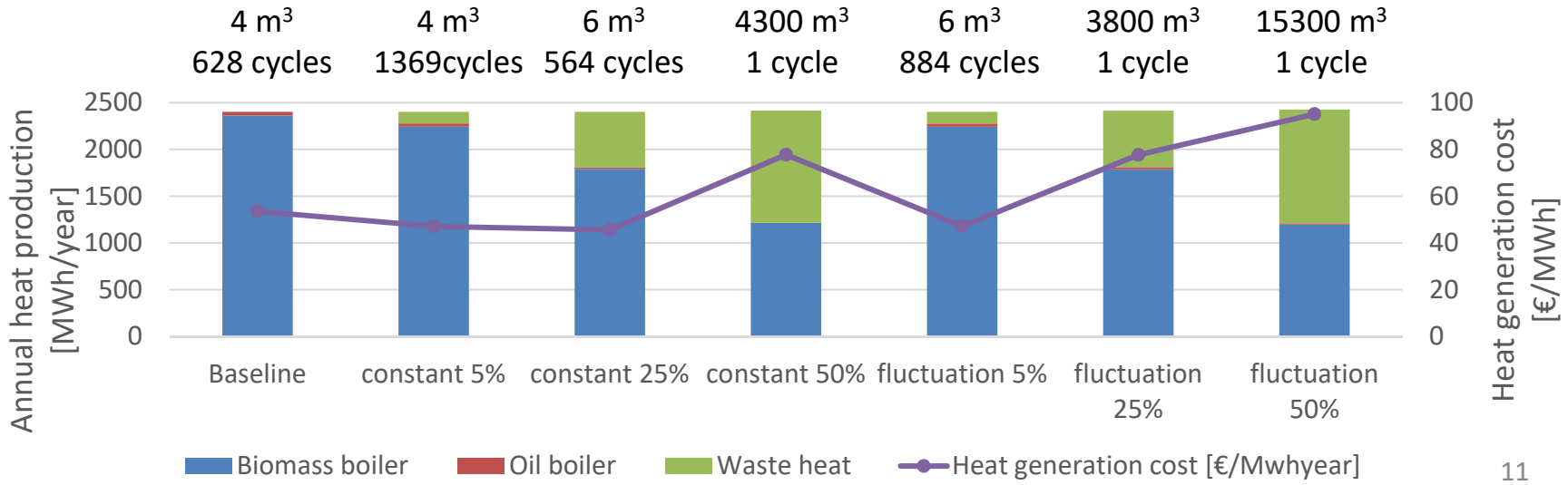
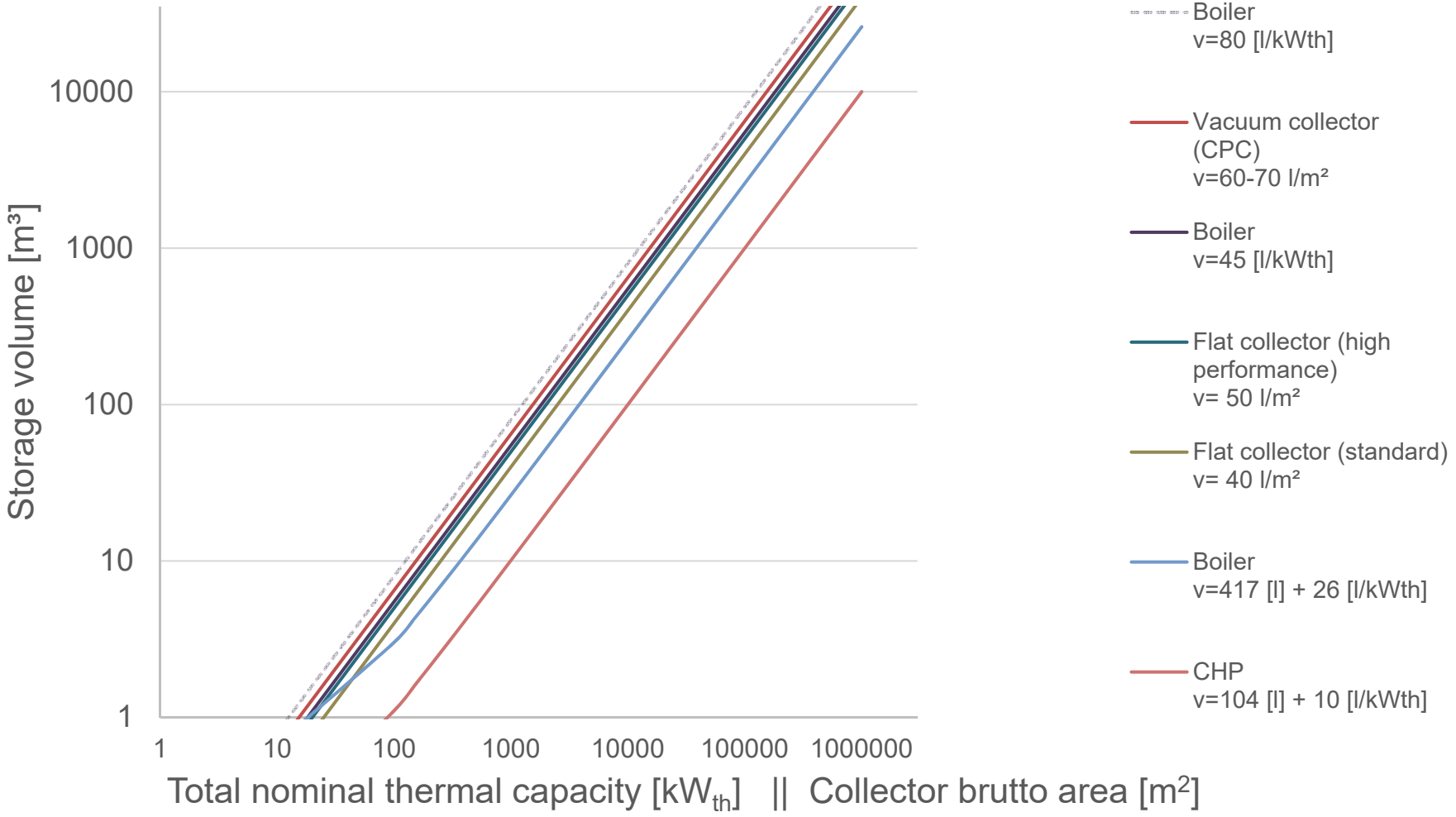


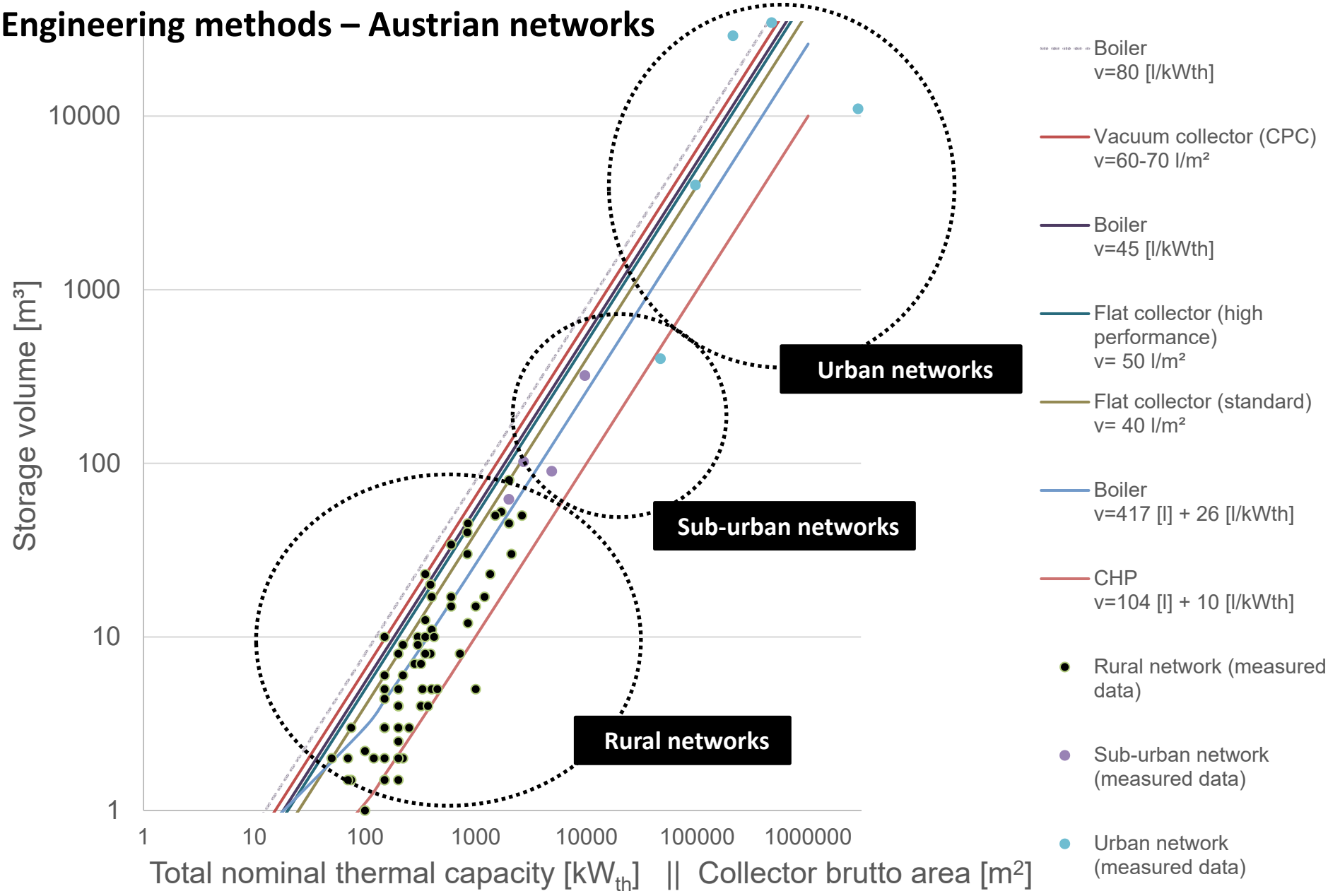


Engineering methods



Source: [Wolff, 2011] D. Wolff und K. Jagnow, „Überlegungen zu Einsatzgrenzen und zur Gestaltung einer zukünftigen Fern- und Nahwärmeversorgung," delta-q, Wolfenbüttel/Braunschweig, 2011.

Engineering methods – Austrian networks



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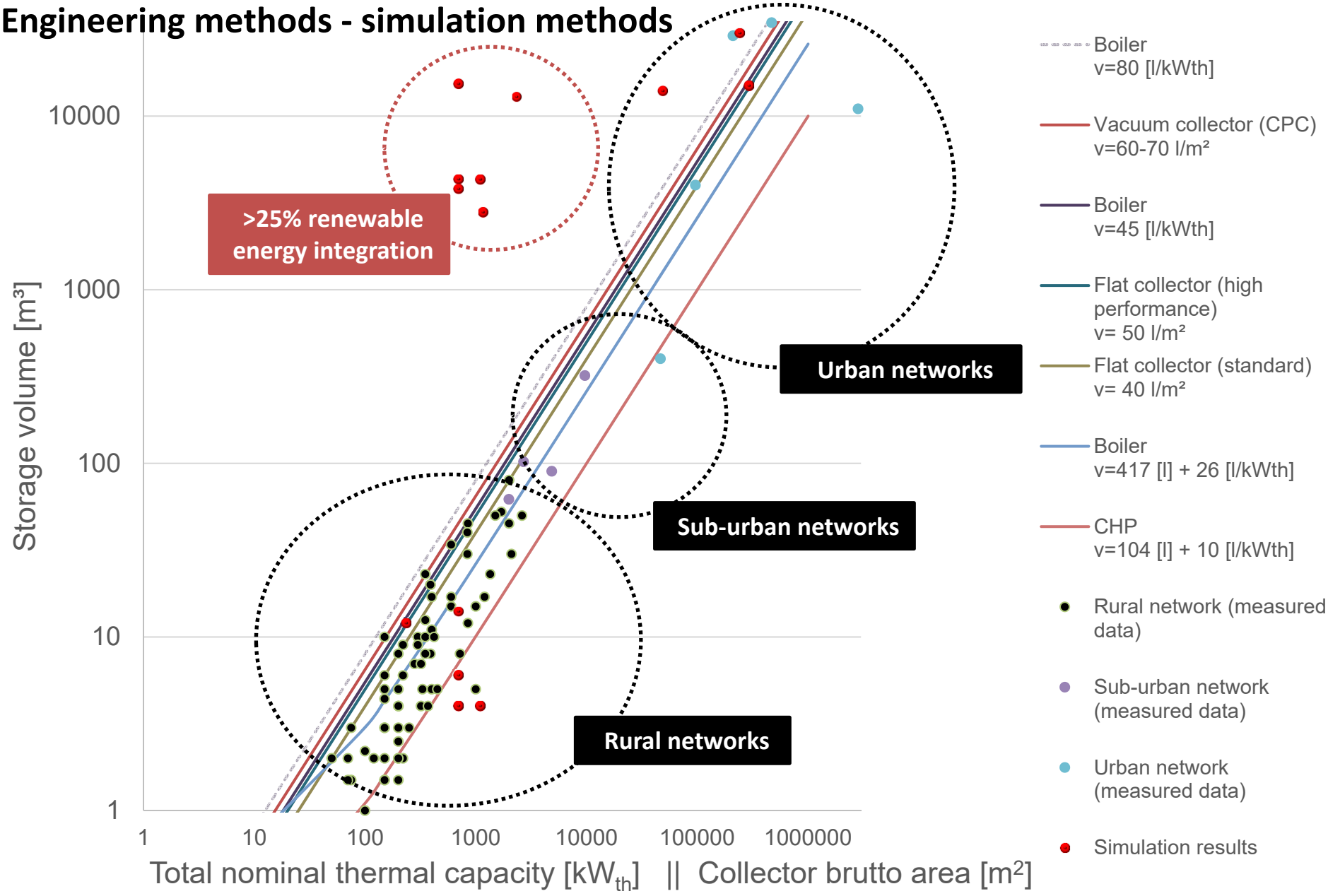
Engineering methods - simulation methods



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Conclusions

- Engineering methods
  - For baseline scenarios the calculated storage volumes are usually bigger compared to the results obtained from the simulation method.
  - Our study shows that V = 417[l] + 26 [l/kW] rule can be recommended for storage sizing in rural networks (peak storage 2-3 hours).
  - Not suitable for storage sizing in scenarios with high integration of future rewenable technologies.
- Simulation method
  - The results are validated with real scenarios and engineering methods.
  - Holistic analysis of the network: consumers, power plants and storages.
  - Further developments: yearly based optimisation would improve the behaviour of seasonal storages.

Thank you for your attention.

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