2nd International Conference on Smart Energy Systems and 4th Generation District Heating
Aalborg, 27-28 September 2016

Simple simulation method for a pit thermal energy storage system with a heat pump in a district heating system

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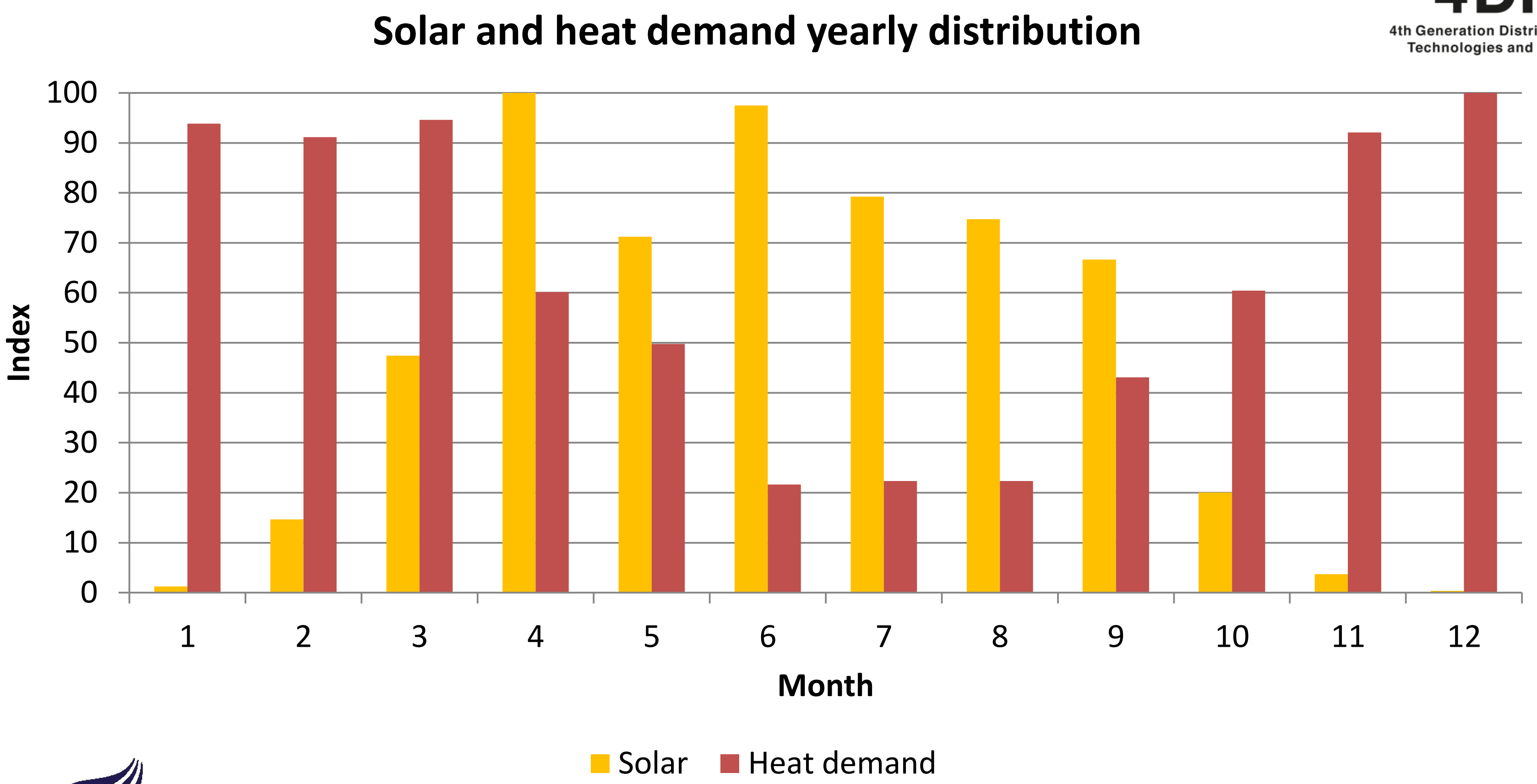
Technologies and Systems

Peter Sorknæs - AAU

The relevance of seasonal storage in district heating



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Based on simulation of Ringkøbing Fjernvarme using Danish Design Reference Year for temperature and solar radiation

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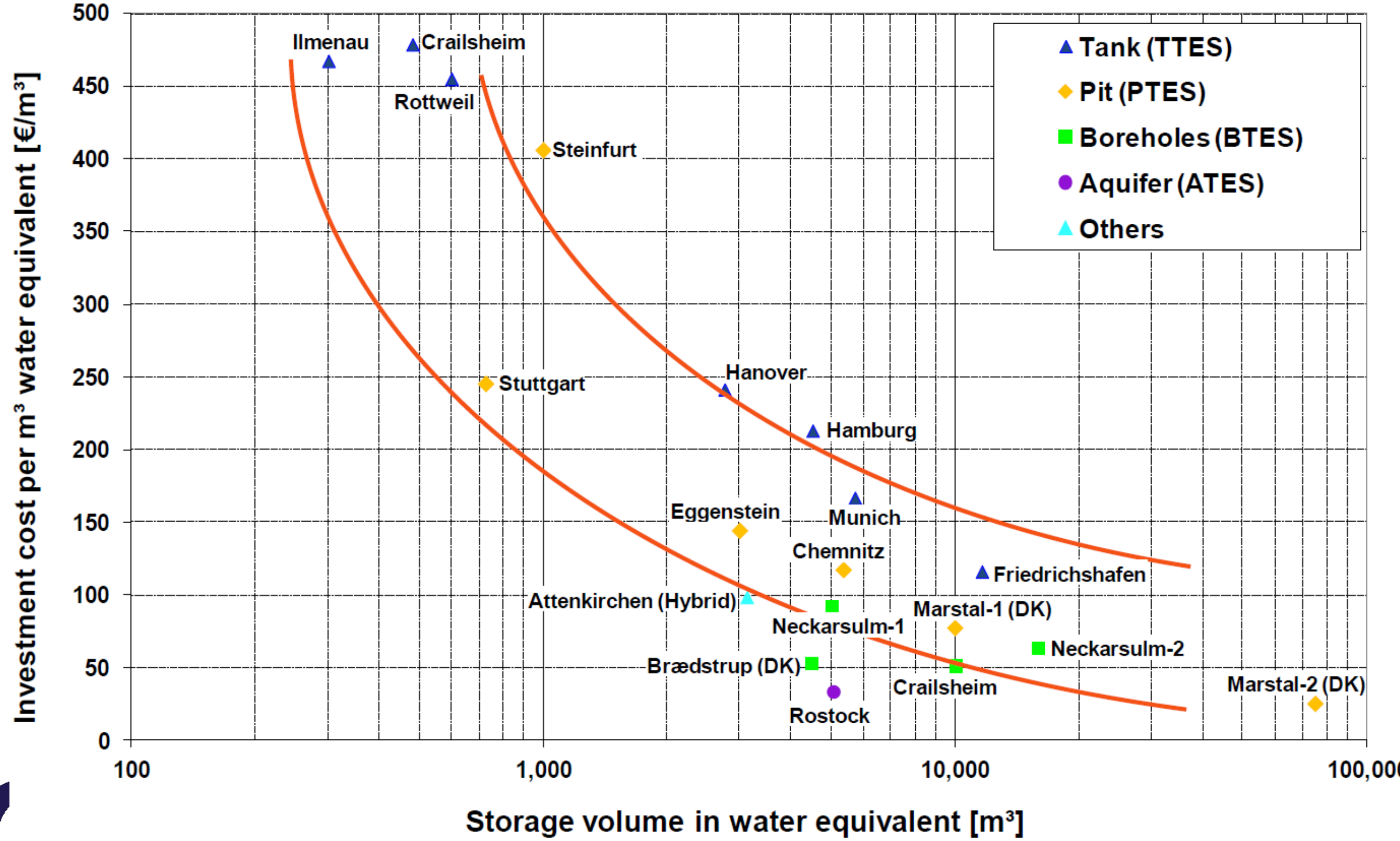
Investment cost for existing thermal energy storage systems



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Source: Large scale heat storage. T. Schmidt, D. Mangold, P.A. Sørensen and N. From. Conference paper from IRES 2011, Berlin

Methods for seasonal thermal energy storage

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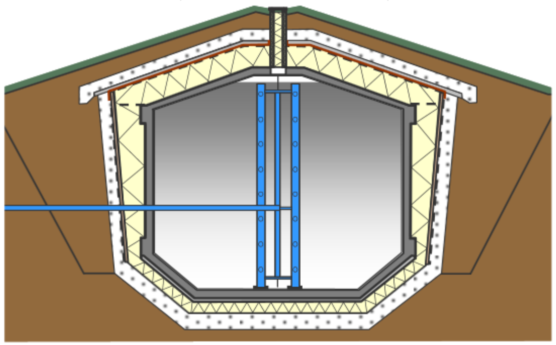
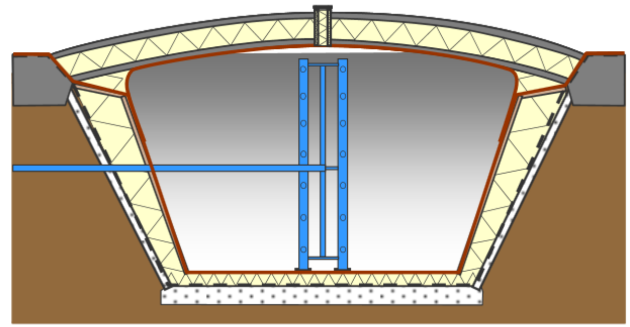
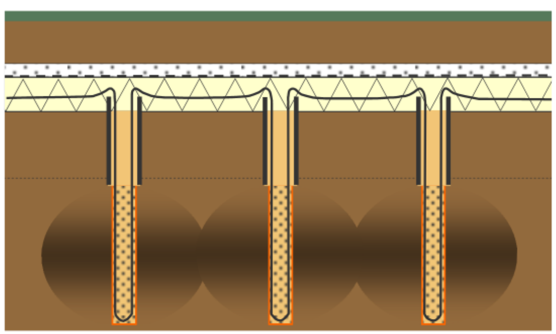
Tank thermal energy storage (TTES)
(60 to 80 kWh/m³)



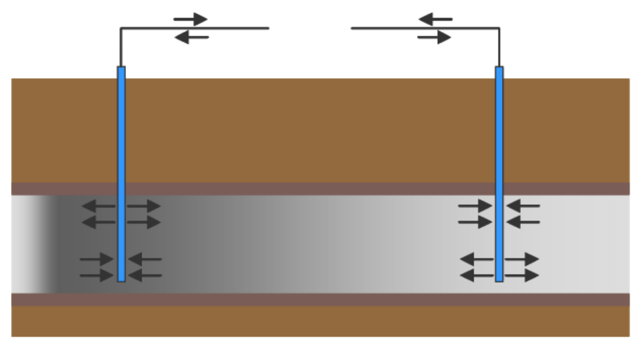
Pit thermal energy storage (PTES)
(60 to 80 kWh/m³)



Borehole thermal energy storage (BTES)
(15 to 30 kWh/m³)



Aquifer thermal energy storage (ATES)
(30 to 40 kWh/m³)



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Source: Mangold, D., & Schmidt, T. (n.d.). The next Generations of Seasonal Thermal Energy Storage in Germany.

Dronninglund Fjernvarme – PTES with absorption heat pump

- Start of operation: 2014
- Size: 60,000 m^3
- Capacity: 5,500 MWh
- Uses absorption heat pump to boost temperature when needed.

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Source: Jensen, M. V. (2014). Seasonal pit heat storages - Guidelines for materials & construction, from http://task45.iea-shc.org/fact-sheets

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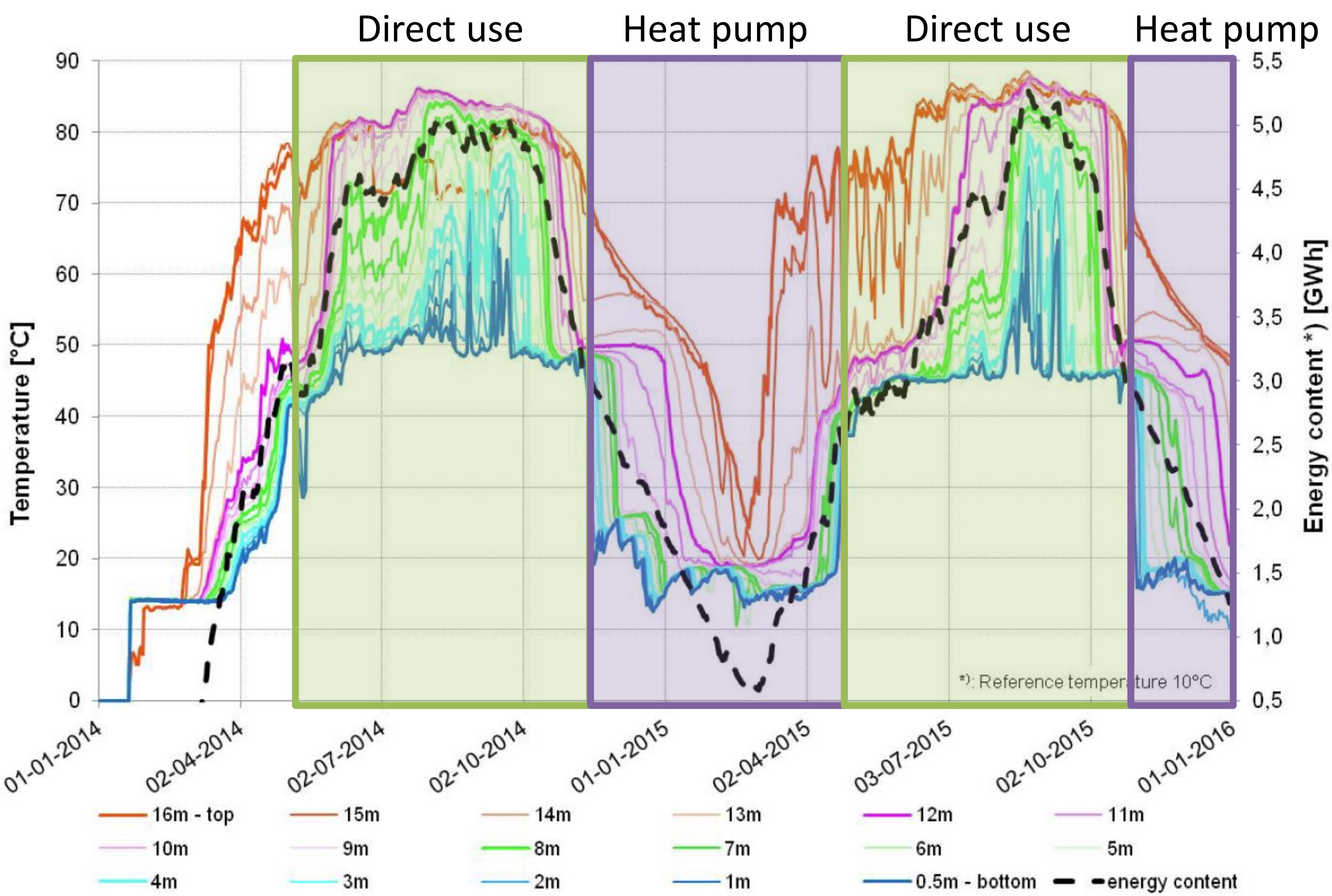
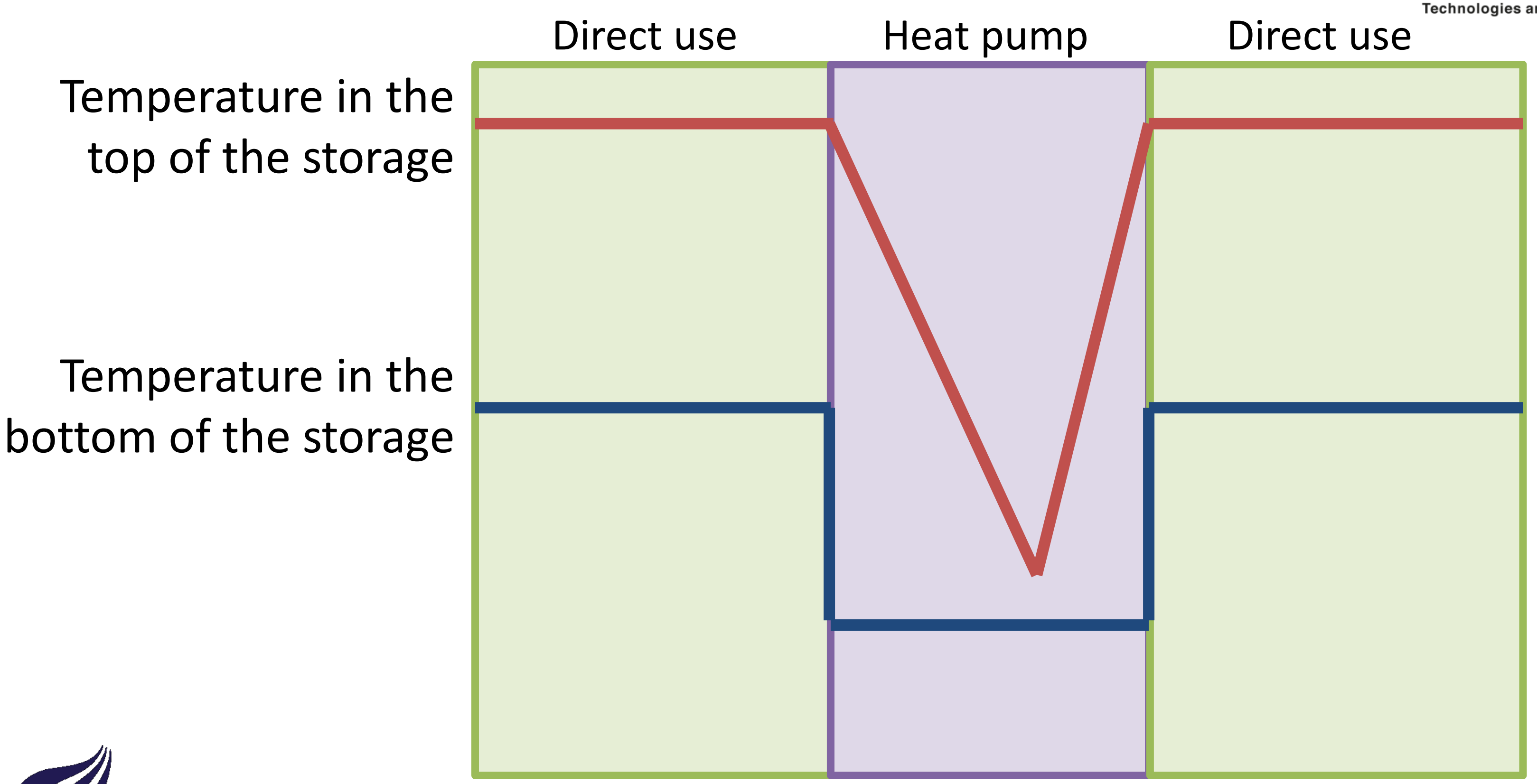
Dronninglund Fjernvarme – Operation data for the PTES

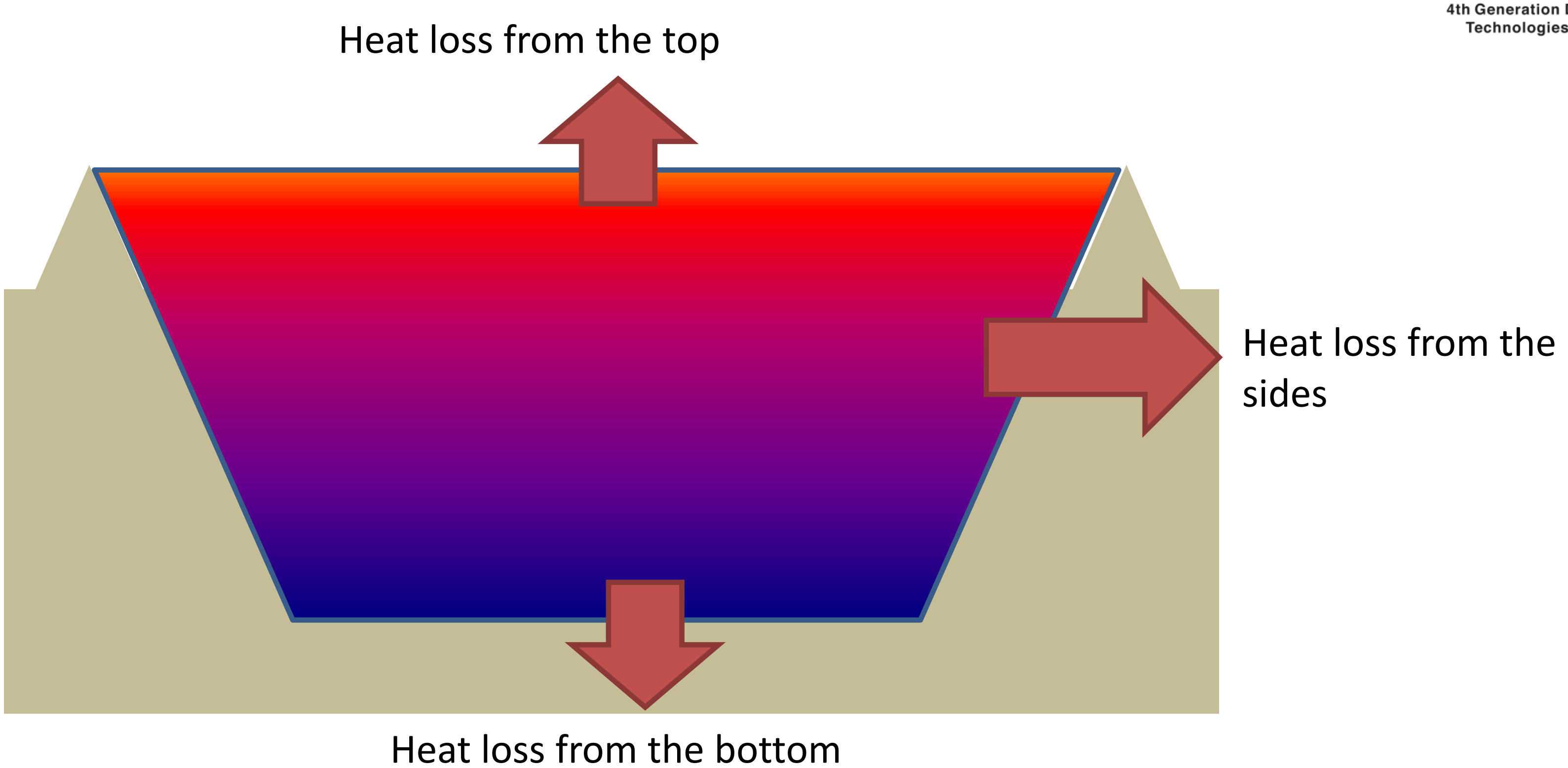


Source: Thomas Schmidt, Solites

Temperature principle for the simple method



Losses from a PTES



Overall principles for the simulation method

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- **The content of the storage is split into two parts:**
  1. **The content that can be used directly.**
  2. **The content that can only be used with a heat pump.**
     - **The temperature input for the heat pump is assumed to be depended on the percentage of storage content.**
- **Fixed output temperature from the storage system (ex heat pump).**

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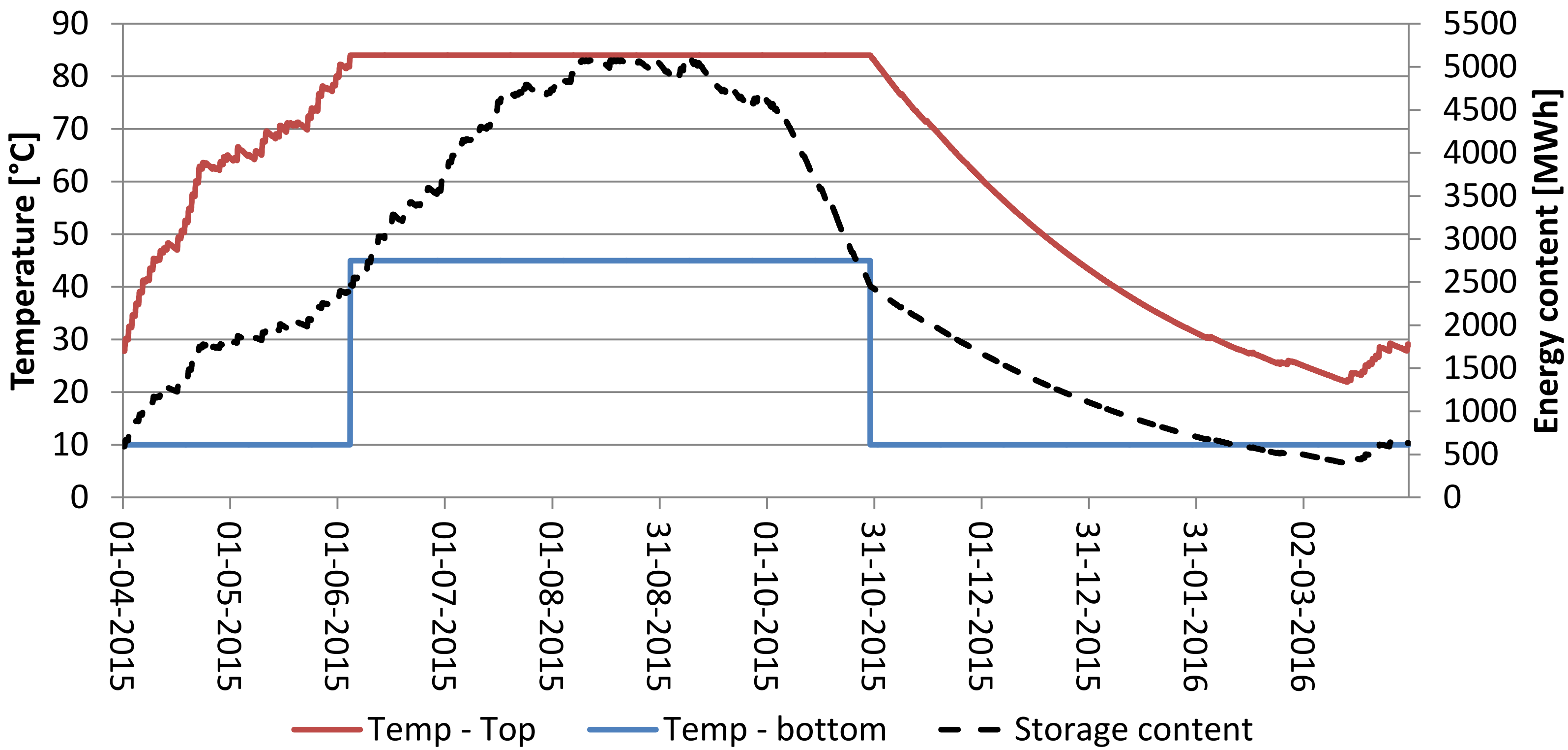
Example of simulation of one year (Preliminary results)



Data used for the simulation of Dronninglund Fjernvarme:

-Hourly solar production from www.solvarmedata.dk

-Hourly heat demand at Dronninglund Fjernvarme is estimated using CSFR2 temperature data