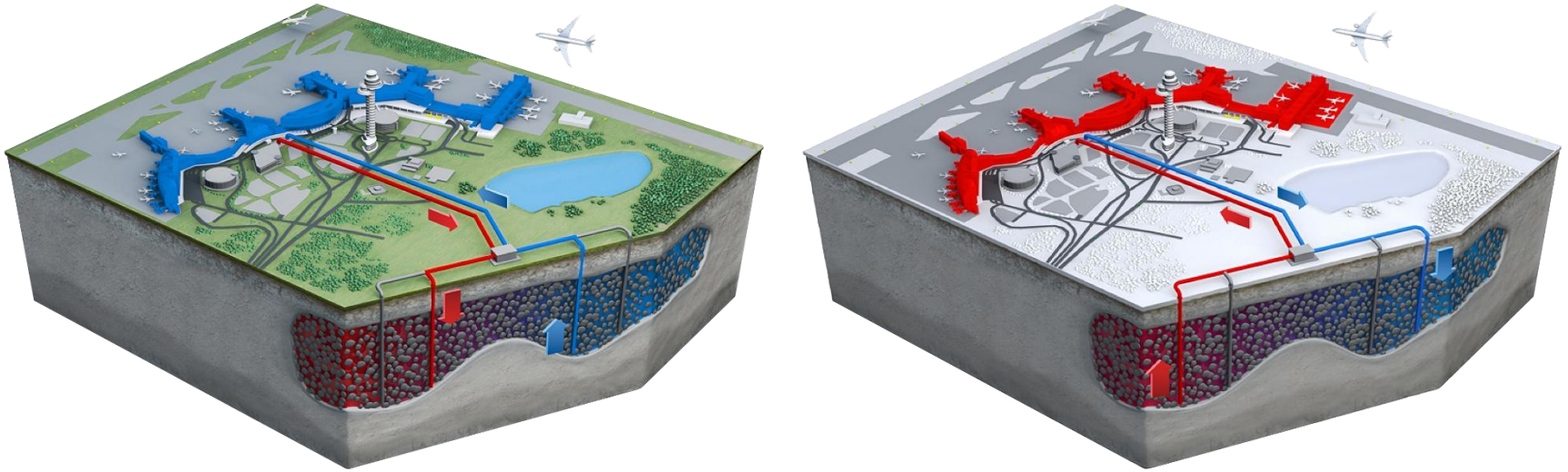
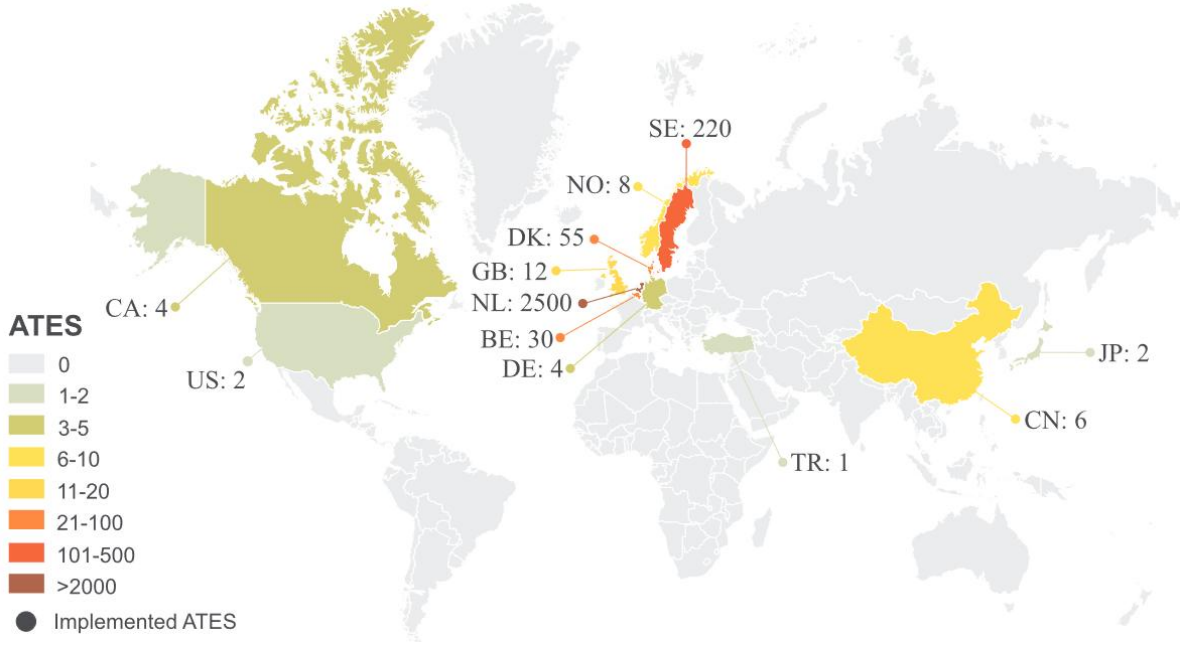
ATES: what do they cost?

Matthias Herrmann, Paul Fleuchaus, Michaël Verbiest, Bas Godschalk, Stig Niemi Sørensen, Philipp Blum

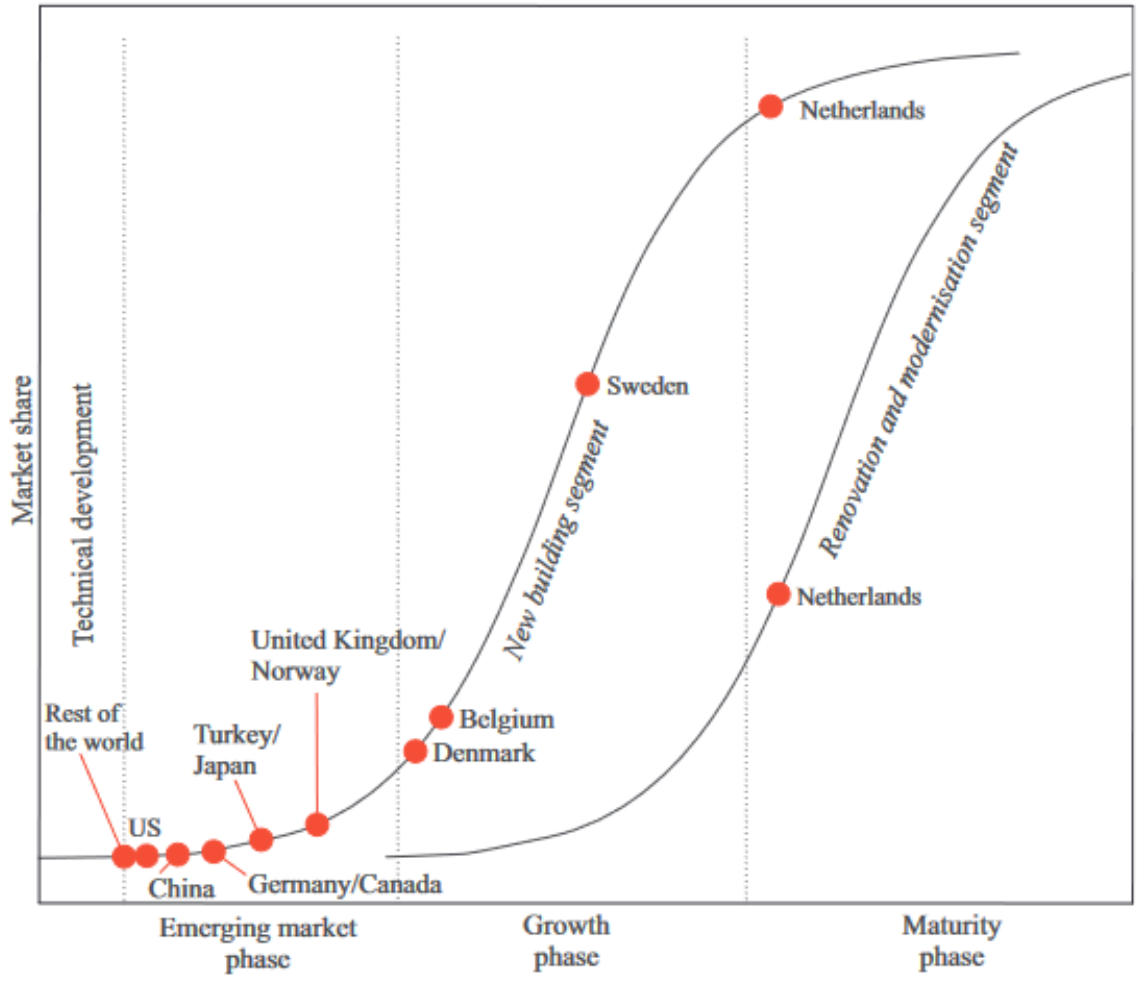


Arlanda airport (Stockholm)

Major markets for ATES
How important are capital costs for ATES markets?



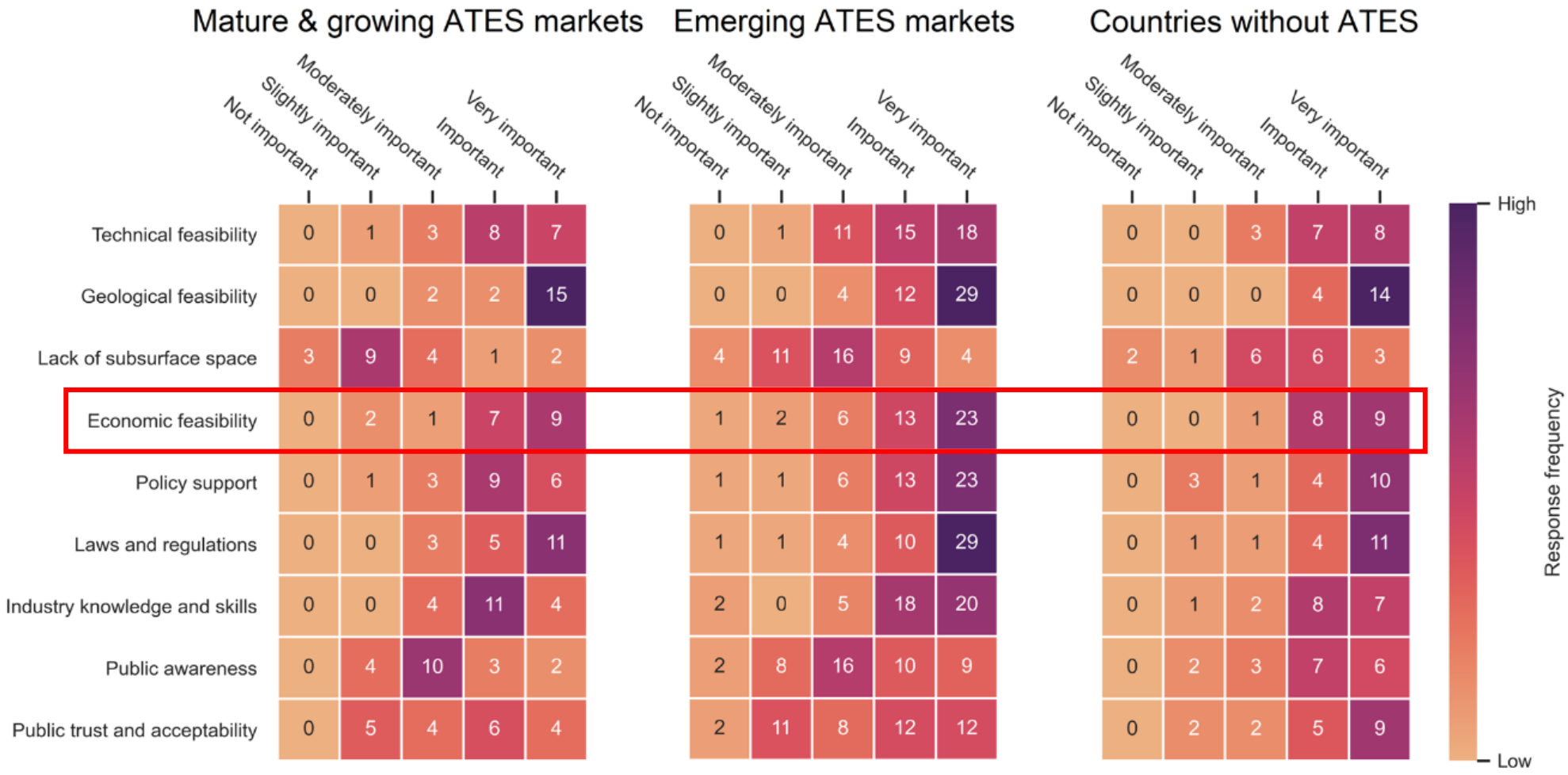
Fleuchaus et al. 2018



Fleuchaus et al. (2018)

- High capital costs are a market barrier, especially for growing markets

Capital costs of high importance for all markets



Stemmle et al. (2024)

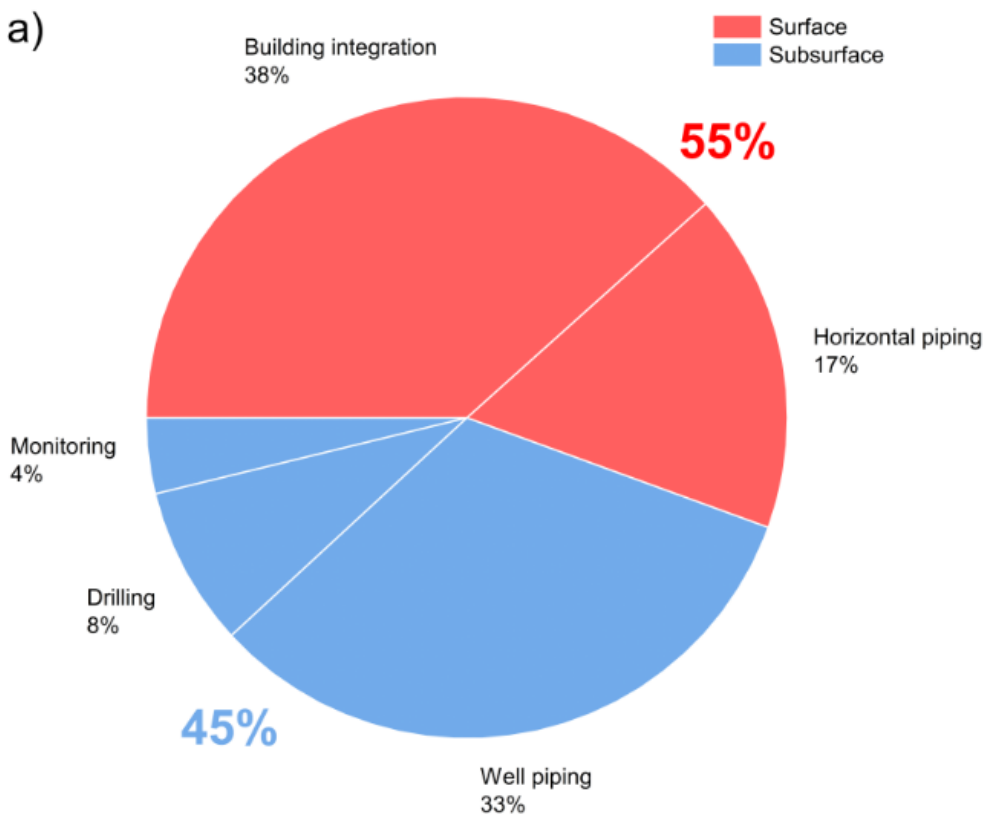
Data and partners

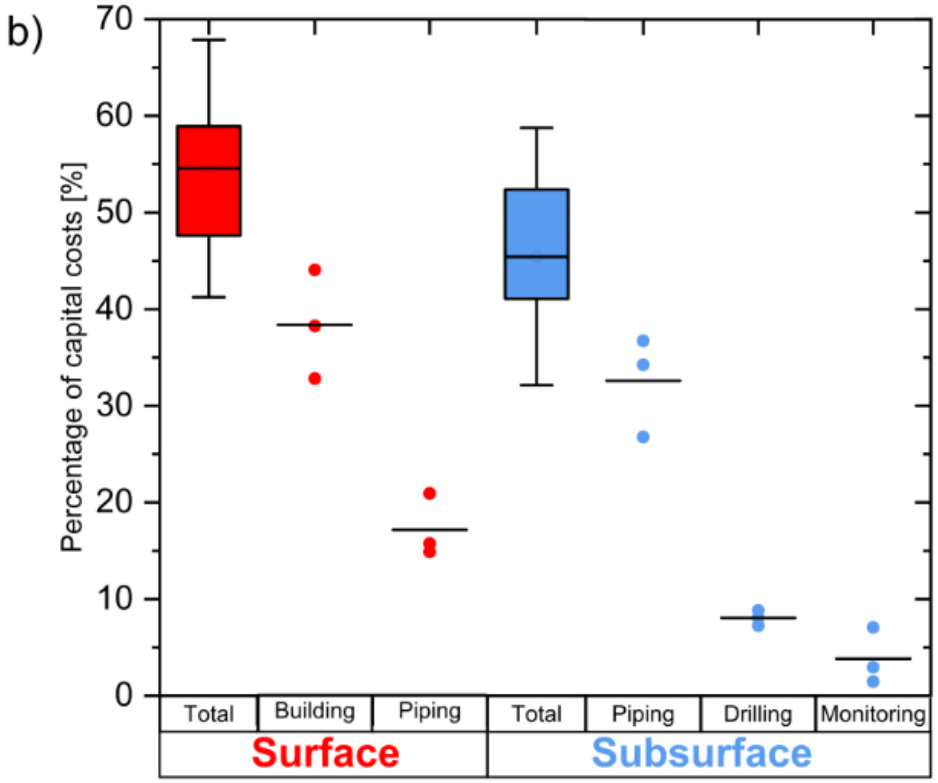
- Capital costs data from 7 different countries
  - Belgium: IFTech → **8 systems**
  - Netherlands: IF Technology → **102 Systems**
  - Denmark: Energy Machines → **5 Systems**
  - Germany: tewag – Technologie – Erdwärmeanlagen – Umweltschutz GmbH → **3 GWHP systems**
  - Sweden, Canada, Norway, Netherlands, Germany, Belgium, Denmark:
    19 ATES systems from literature

→ All data was corrected for inflation using the Harmonized Index of Consumer Prices (HICP), reference year was 2022.

Capital costs of ATES

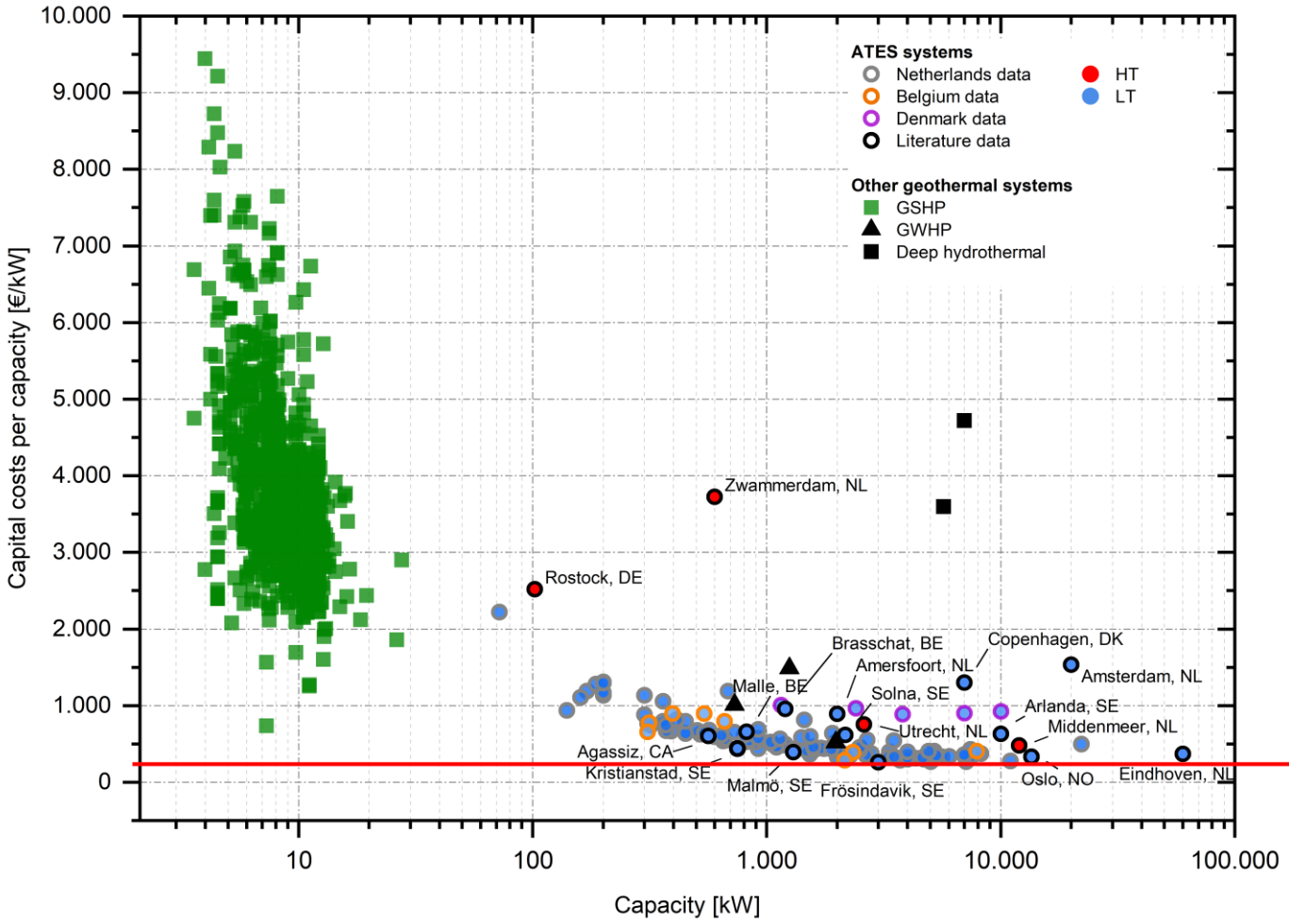
Drilling costs contribute to 8% of total capital costs





Herrmann et al. (RSER, in review)

Larger systems have lower capital costs per installed capacity

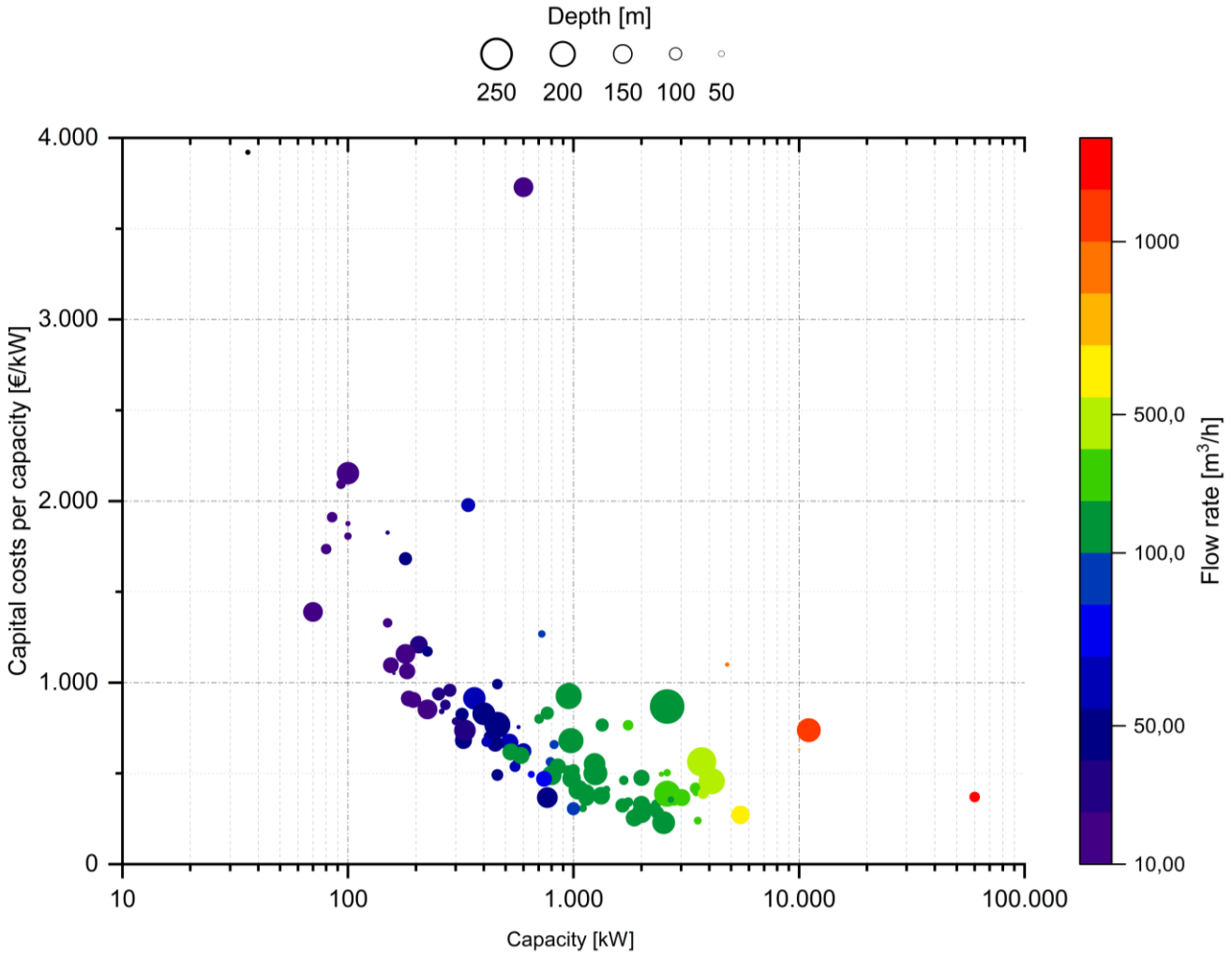


- Data converge to 300 €/kW at around 2 MW of installed capacity
- Range of 300 €/kW to 1.500 €/kW
- Heating and cooling capacity

300 €/kW

Herrmann et al. (RSER, in review)

Drilling depth does not strongly correlate with capital costs

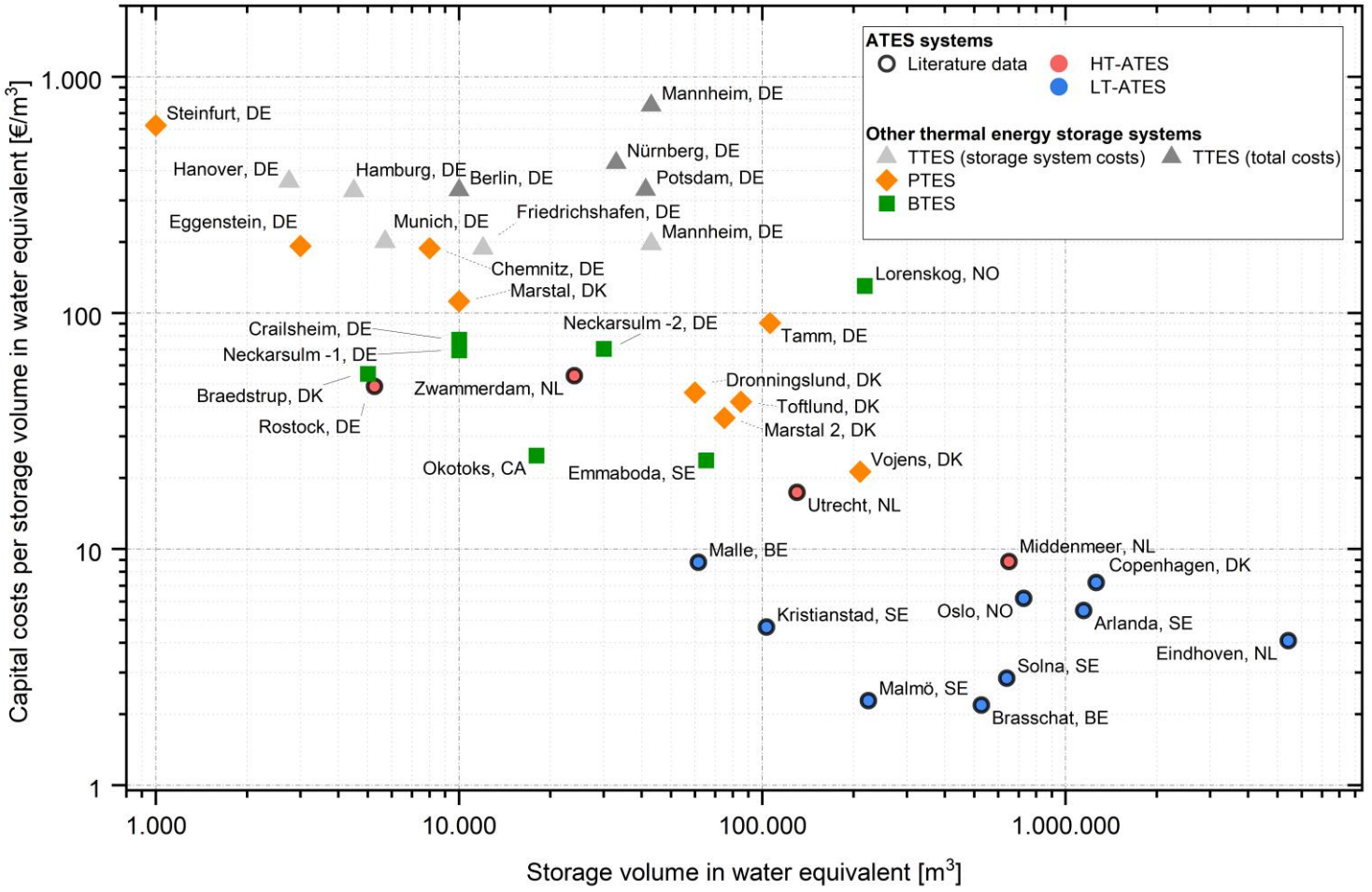


- The higher the flow rate the lower the capital costs per installed capacity.
  - Higher flow rates correlate with larger systems
- Maximum depth of data set is 250 m.

Herrmann et al. (RSER, in review)

ATES vs other STES

LT-ATES with the lowest capital costs per storage volume

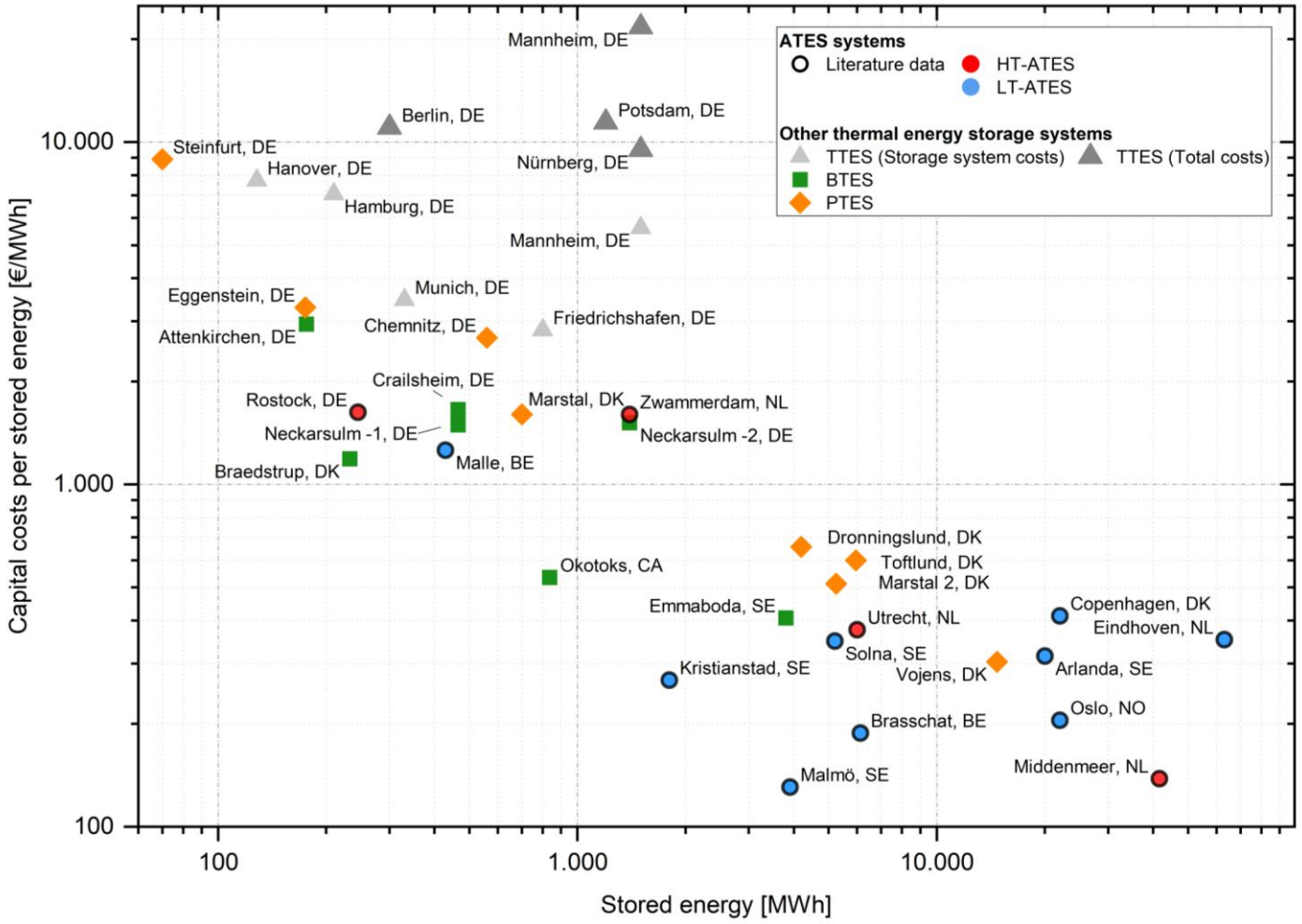


- TTES and BTES can be used for short-term / mid-term storage.
- Costs for PTES, TTES and HT-ATES are incomplete.
  - Heat source is missing
- For TTES and PTES also capital costs of piping and grid connection are missing.
- LT-ATES and BTES provide heat and cold.

Herrmann et al. (RSER, in review)

ATES vs other STES

ATES with the lowest capital costs per stored energy



- Stored energy depends on the site-specific ΔT

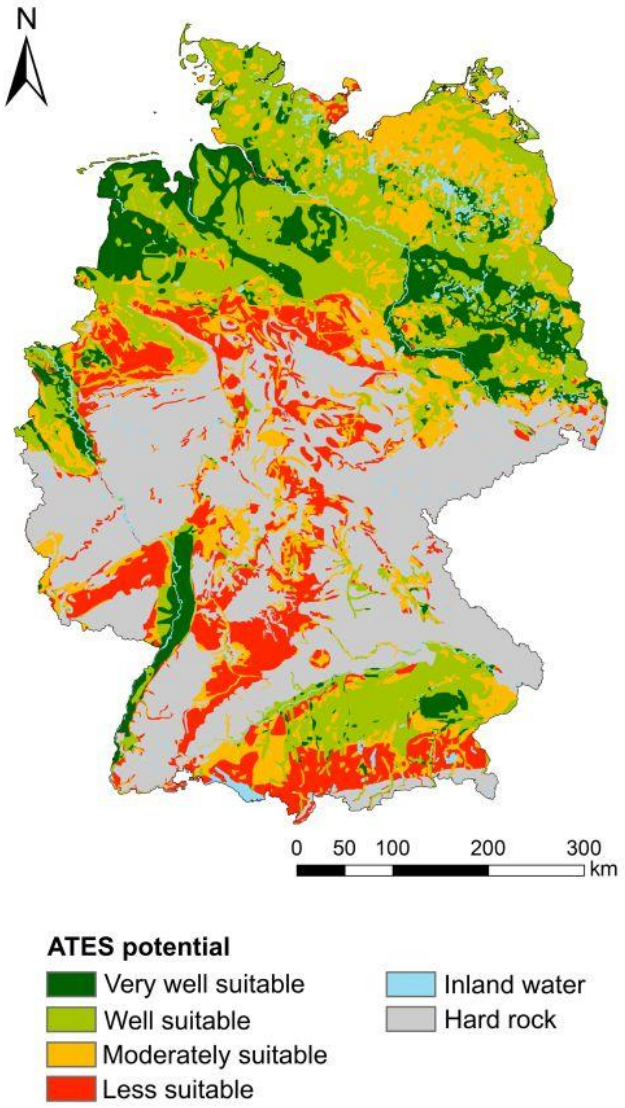
Herrmann et al. (RSER, in review)

Conclusion and outlook

- Capital costs per installed capacity of ATES converge to a minimum of 300 €/kW at around 2 MW!
  - Ideally, larger ATES systems should be built > 2 MW.

- LT-ATES provide the cheapest capital costs per installed capacity compared to other STES
  - Hence, ATES should be considered to store energy, if the geological and hydrogeological conditions are favorable.

- In Germany > 50 % are very well and well suitable for ATES systems!



Stemmle et al. (2022)

Thank you for your attention

Stemmle R, Hanna R, Menberg K, Østergaard PA, Jackson M, Staffell I, et al. Policies for aquifer thermal energy storage: international comparison, barriers and recommendations. Clean Techn Environ Policy 2024. https://doi.org/10.1007/s10098-024-02892-1.

Fleuchaus P, Godschalk B, Stober I, Blum P. Worldwide application of aquifer thermal energy storage – A review. Renewable and Sustainable Energy Reviews 2018;94:861–76. https://doi.org/10.1016/j.rser.2018.06.057.

Contact

Matthias Herrmann
KIT-AGW
matthias.herrmann@kit.edu