

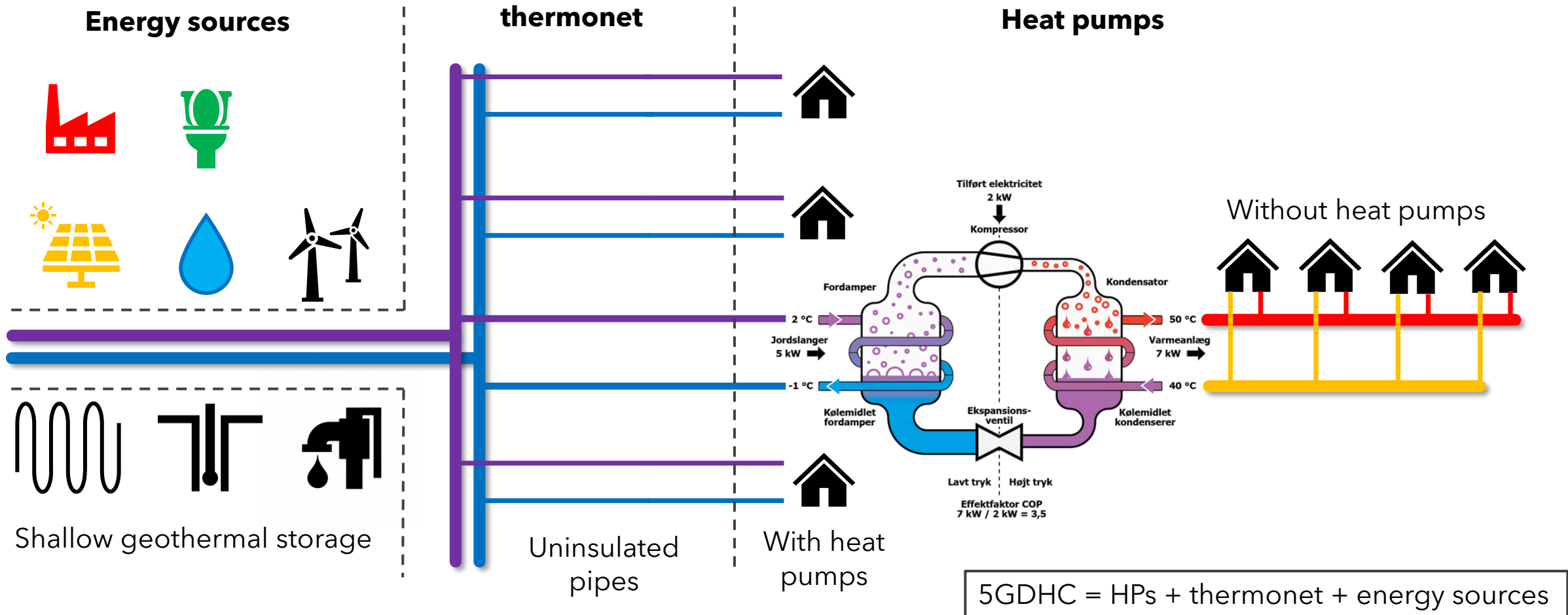


Find vejen frem
VIA University College

Integration of Energy Geostructures into future District Heating and Cooling systems

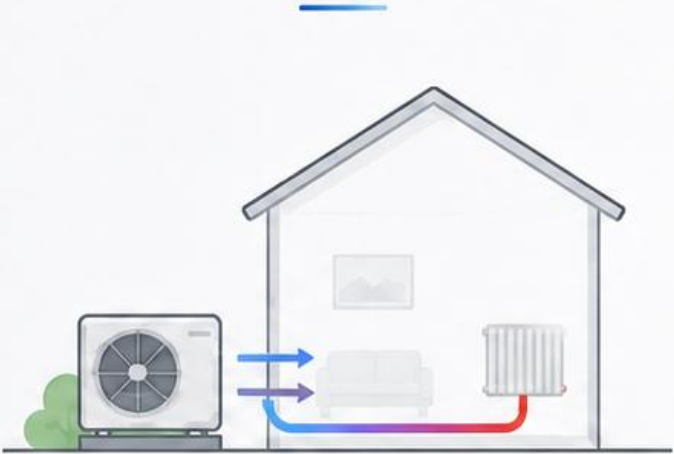
Dr. Søren Erbs Poulsen, Head of Research Programme
VIA University College, Horsens, Denmark

Shallow geothermal district heating and cooling (SGDHC)

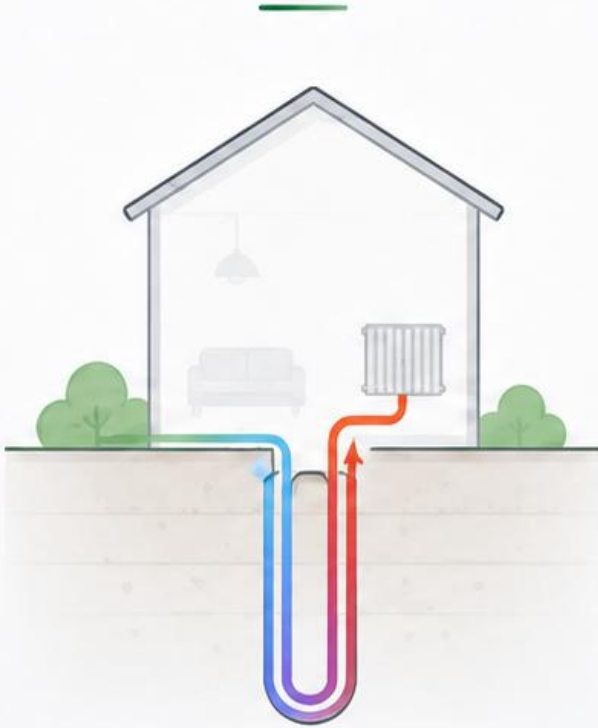


Measured operational efficiency of 1023 heat pumps in Central Europe including Denmark

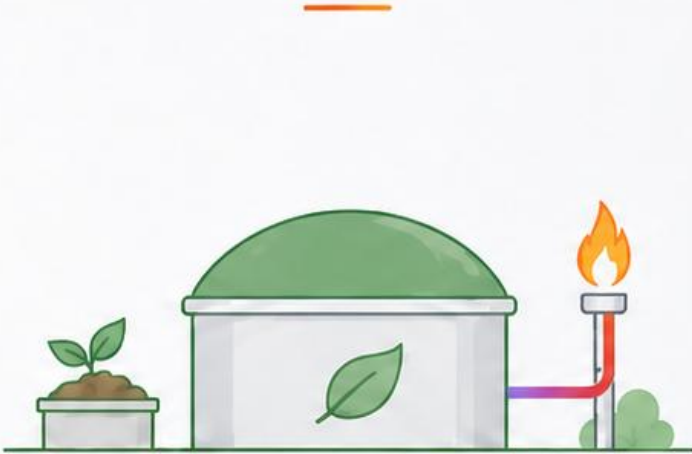
Air Source Heat Pump



Ground Source Heat Pump



Biogas



$SCOP_{\text{heating}}$: 2.5-4.7 (4.0)
 $SCOP_{\text{dhw}}$: 2.3-3.2 (2.95)

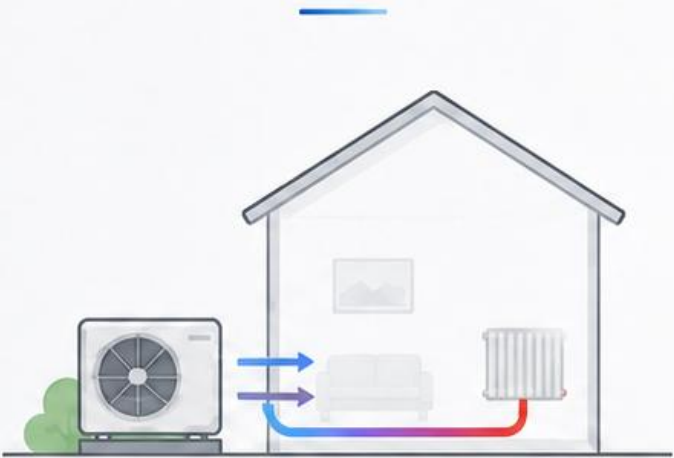
$SCOP_{\text{heating}}$: 3.4-5.6 (4.9)
 $SCOP_{\text{dhw}}$: 2.6-3.3 (3.13)

"SCOP" : 0.9-0.95

Brudermueller, T., Potthoff, U., Fleisch, E., Wortmann, F., & Staake, T. (2025). Estimation of energy efficiency of heat pumps in residential buildings using real operation data. Nature Communications, 16, 2834. <https://doi.org/10.1038/s41467-025-58014-y>

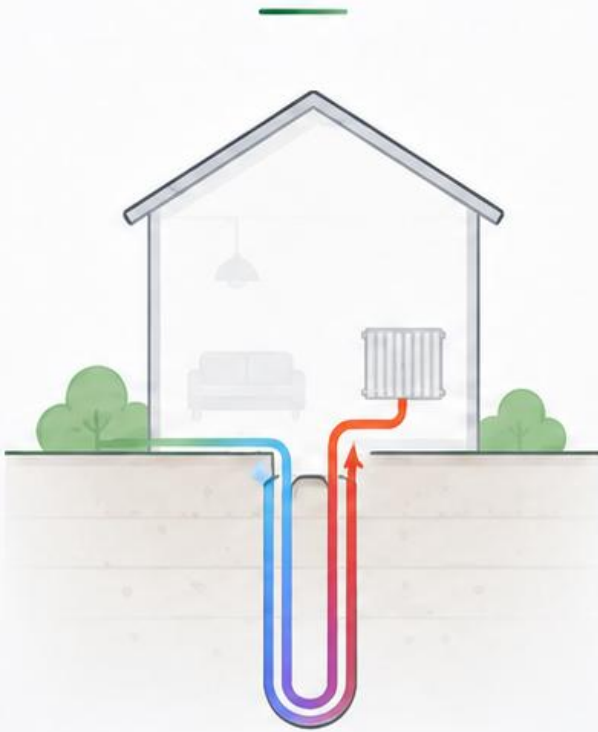
Measured operational efficiency of 1023 heat pumps in Central Europe including Denmark

Air Source Heat Pump



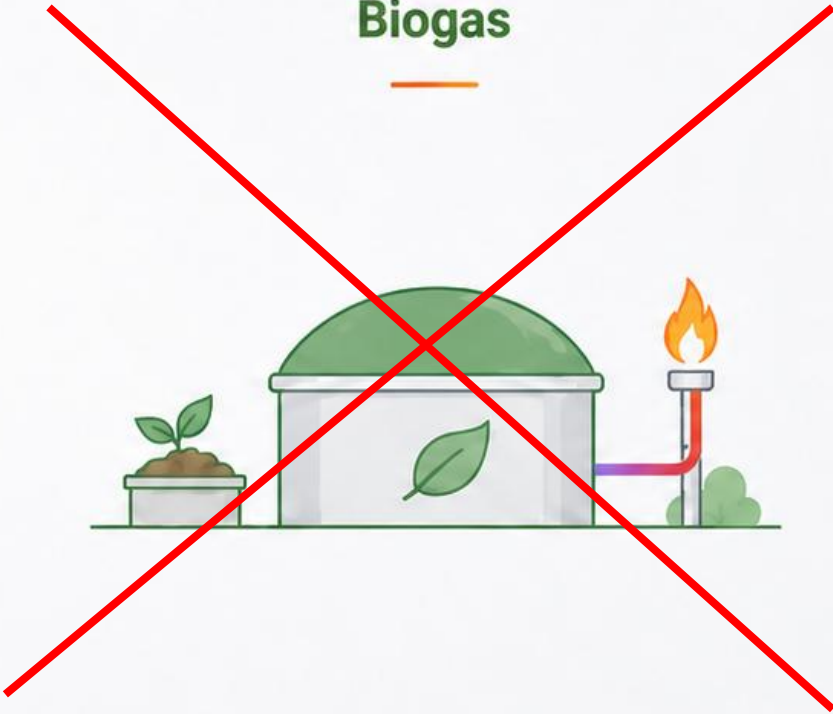
SCOP_{heating}: 2.5-4.7 (4.0)
 SCOP_{dhw}: 2.3-3.2 (2.95)

Ground Source Heat Pump



SCOP_{heating}: 3.4-5.6 (4.9)
 SCOP_{dhw}: 2.6-3.3 (3.13)

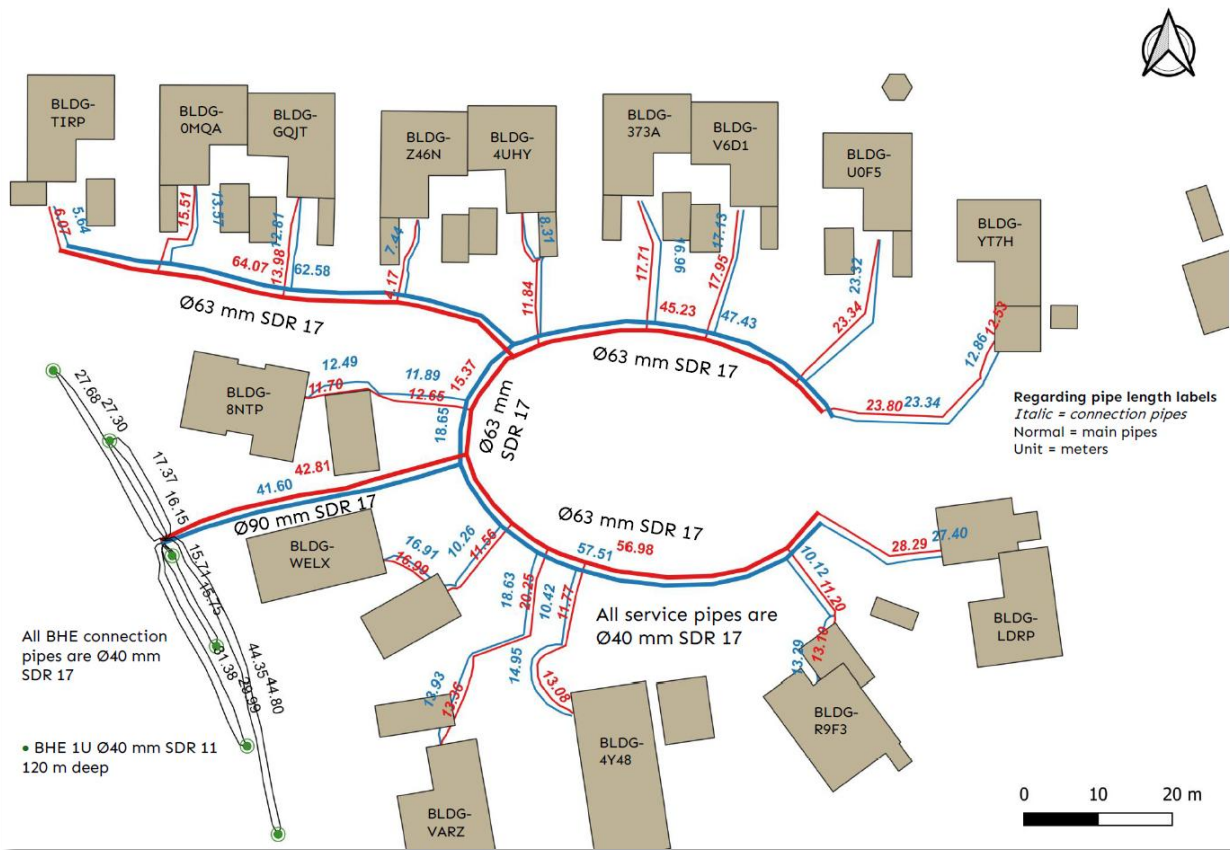
Biogas



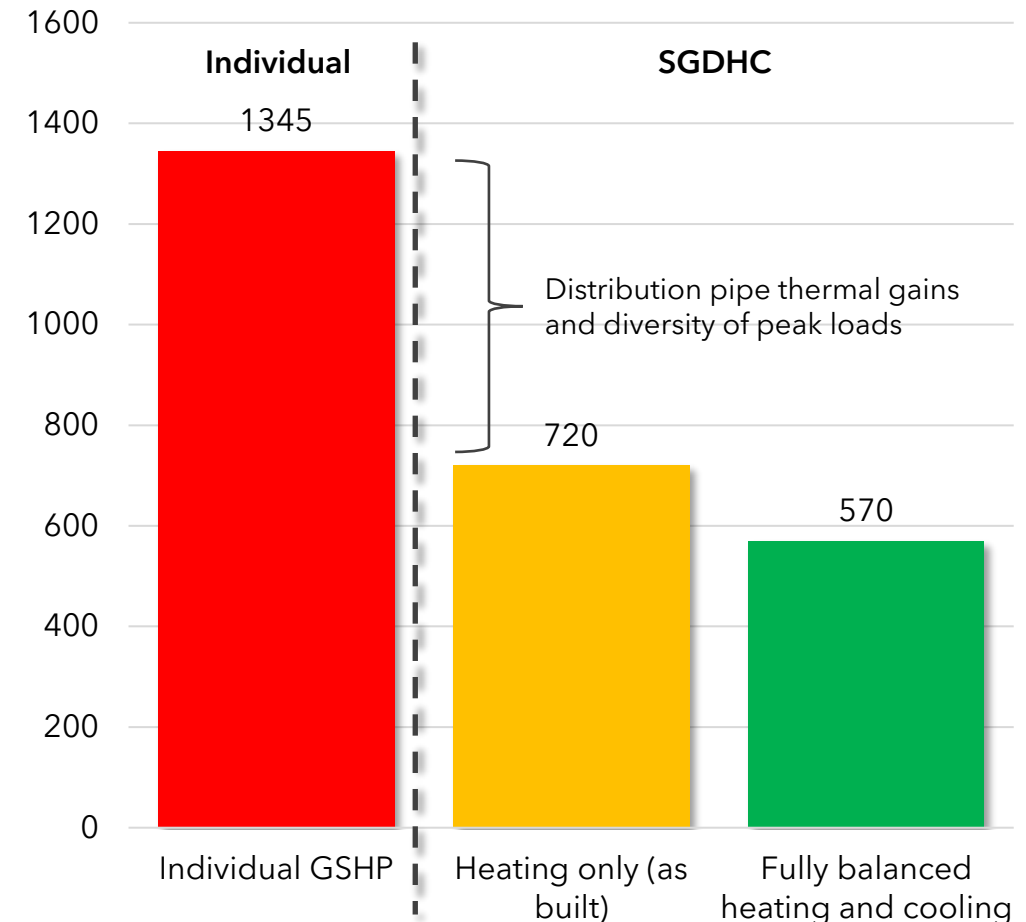
"SCOP" : 0.9-0.95

Brudermueller, T., Potthoff, U., Fleisch, E., Wortmann, F., & Staake, T. (2025). Estimation of energy efficiency of heat pumps in residential buildings using real operation data. Nature Communications, 16, 2834. <https://doi.org/10.1038/s41467-025-58014-y>

SGDHC reduces the need for dedicated thermal infrastructure



Borehole meters Silkeborg



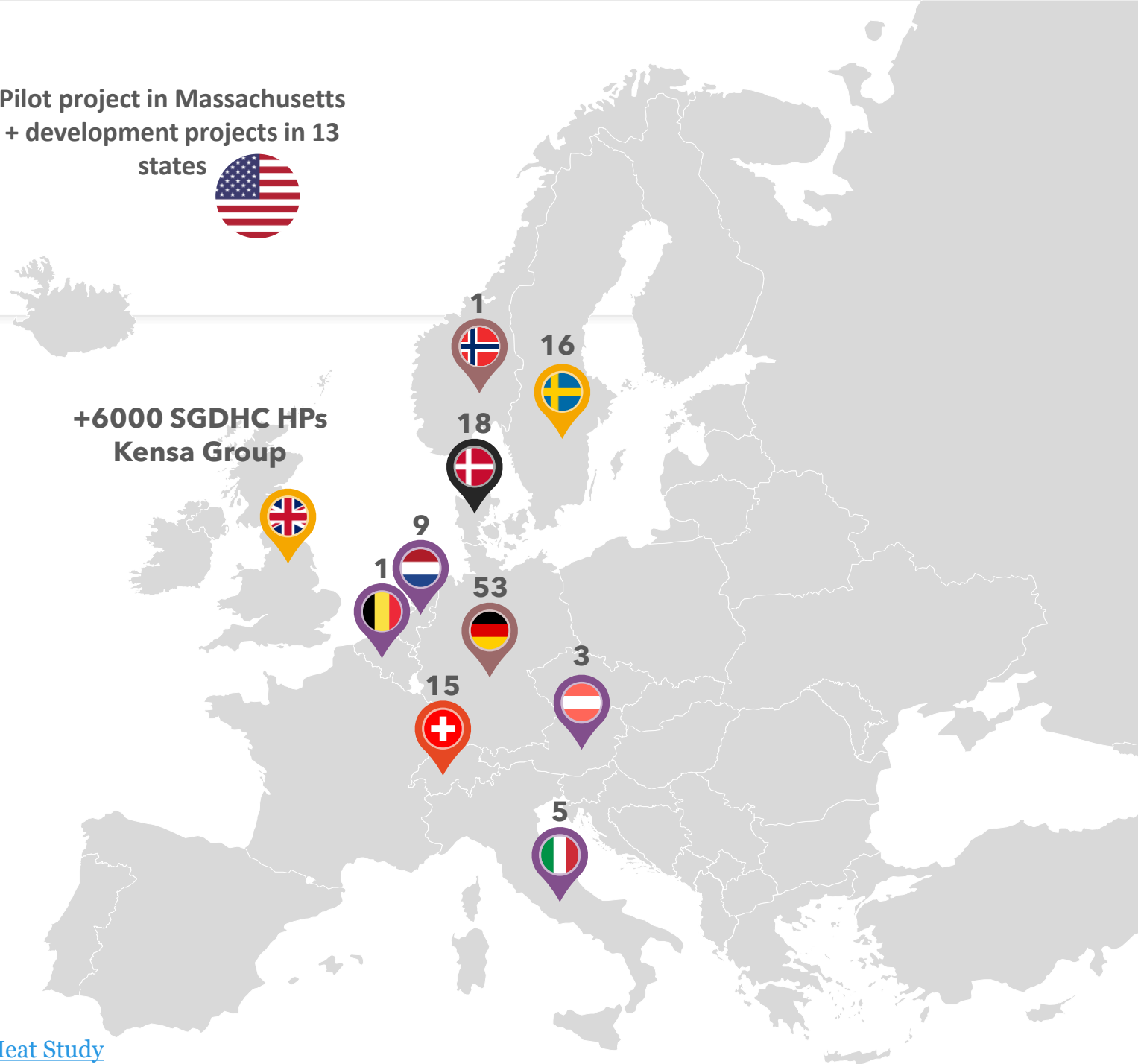
International developments

Pilot project in Massachusetts
+ development projects in 13
states



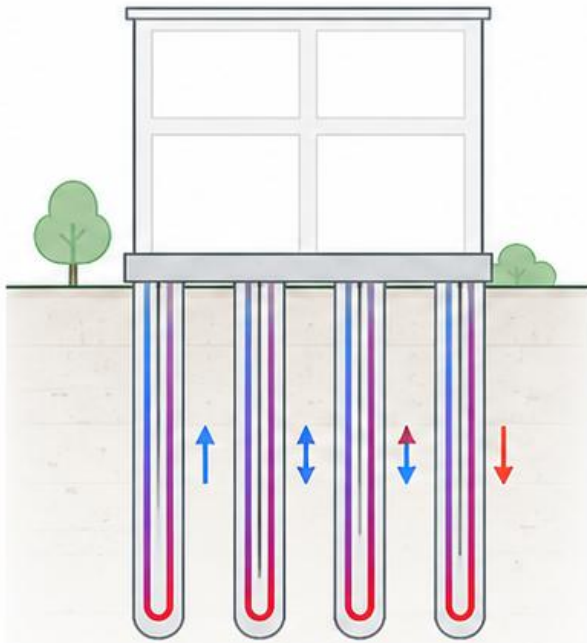
- The oldest known SGDHC was established **in Germany in 1979**
- If SGDHC displaces all individual air source heat pumps in the UK, **electricity capacity savings equivalent to the Hinkley Point C nuclear power plant production are possible.**
- The company Kensa Group **offers SGDHC to the UK market.**
- **First SGDHC established in the USA.** Further pilot projects underway with political support and action

+6000 SGDHC HPs
Kensa Group

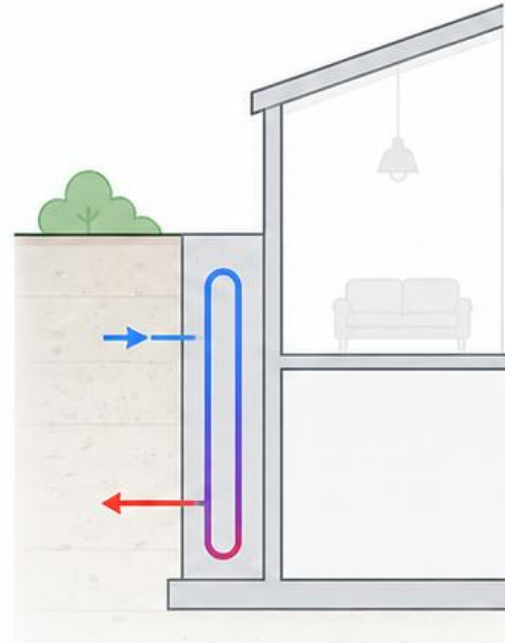


Energy Geostructures

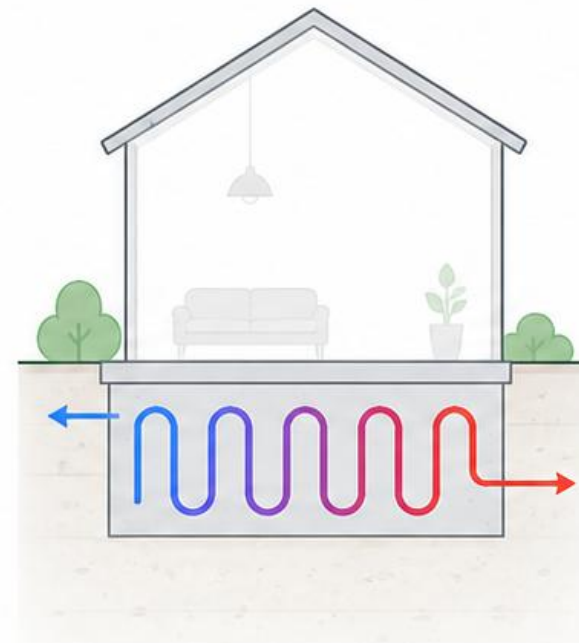
Energy Piles



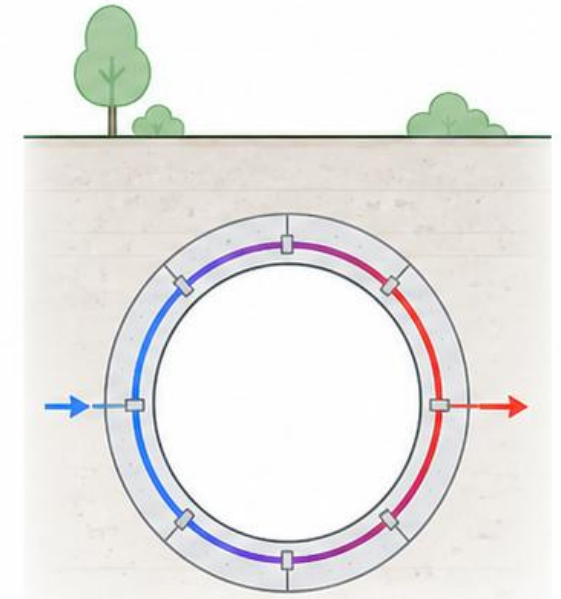
Energy Walls



Energy Slabs

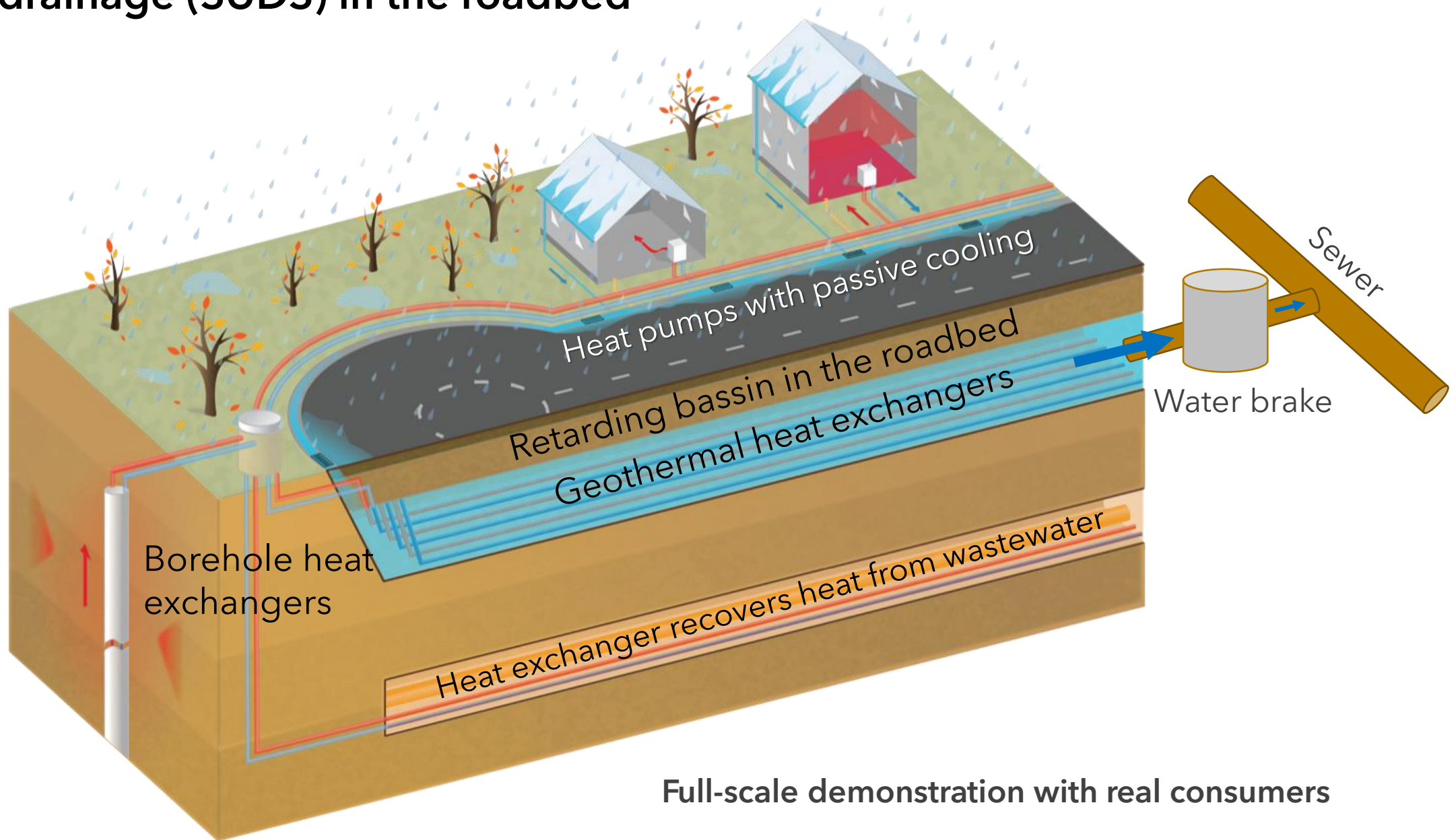


Energy Tunnels



Energy piles were developed by the industry in the mid-1980s. They **reduce CAPEX significantly** relative to borehole heat exchangers (>40%). In Austria, **more than 200,000 buildings** are founded on energy piles, with about **7,000 new buildings on energy piles per year**.

Thermoroad - a novel utility geostructure that integrates SGDHC and sustainable urban drainage (SUDS) in the roadbed



A construction site for a roadbed. In the foreground, there is a large pile of gravel. In the middle ground, a stack of orange corrugated pipes stands prominently. To the left, a worker in a dark jacket and white pants is visible near a yellow excavator. The background shows a deep excavation with earthen walls and various construction materials like pipes and ladders. The sky is clear and blue.

Two consecutive 100 year precipitation events can be retained in the roadbed

1U heat exchanger buried with wastewater pipe



1U heat exchangers



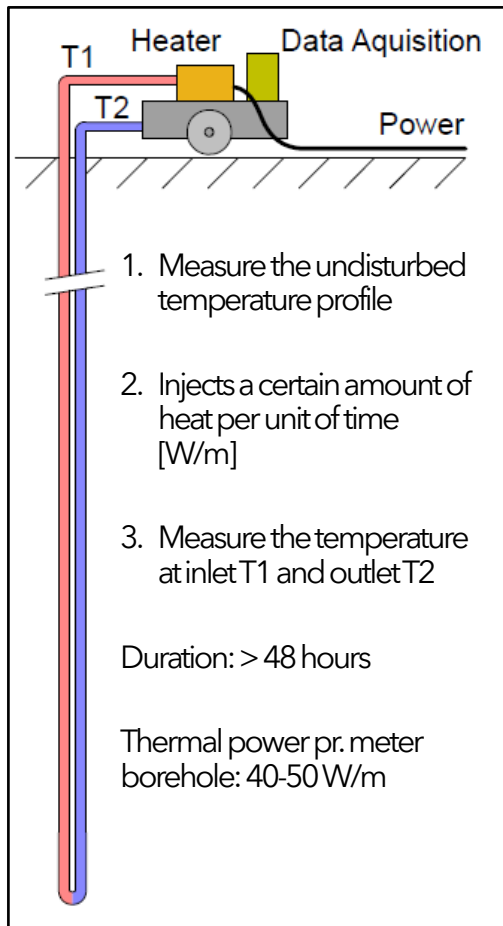
Drilling rig



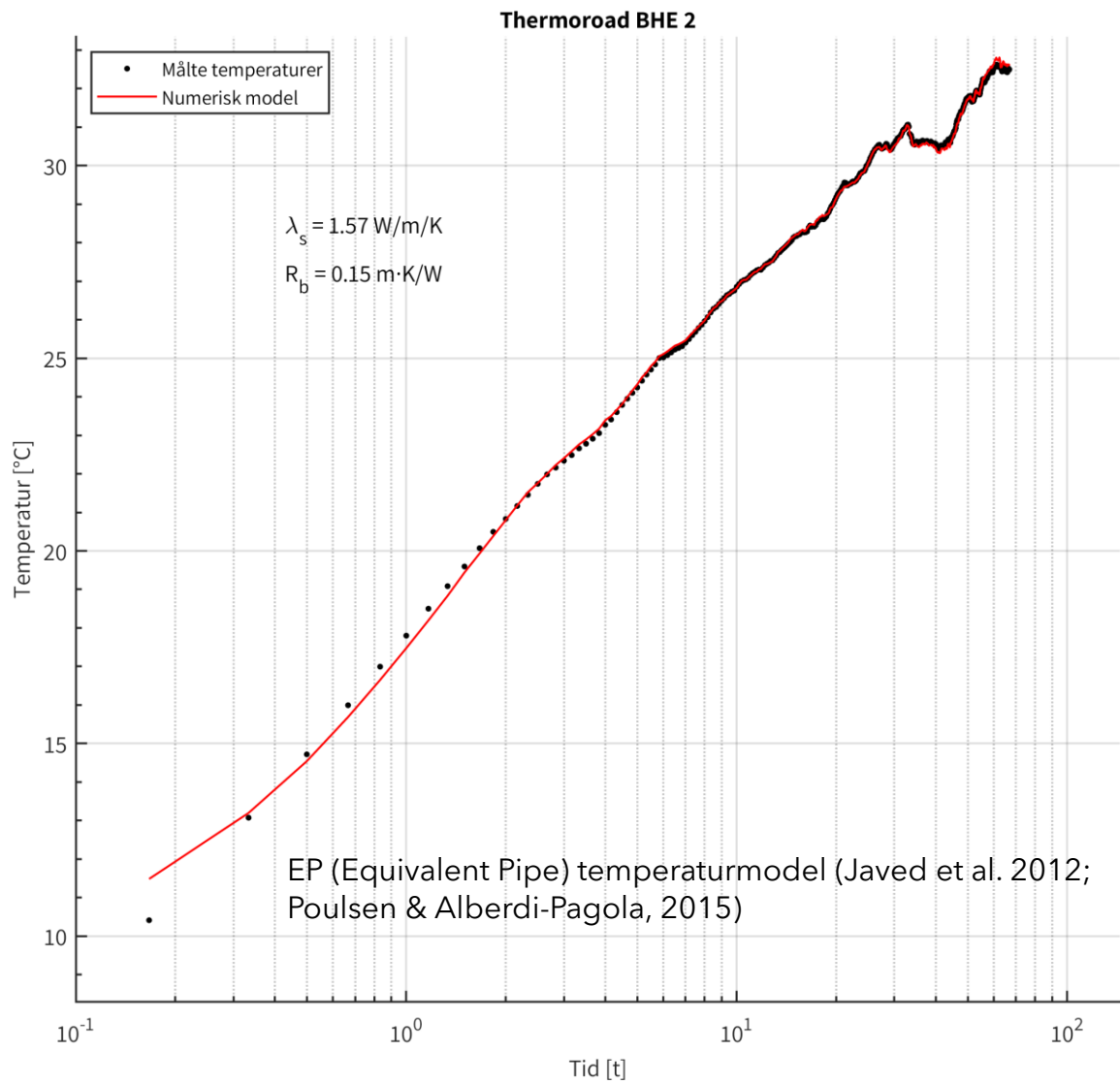
Thermal Response Test equipment



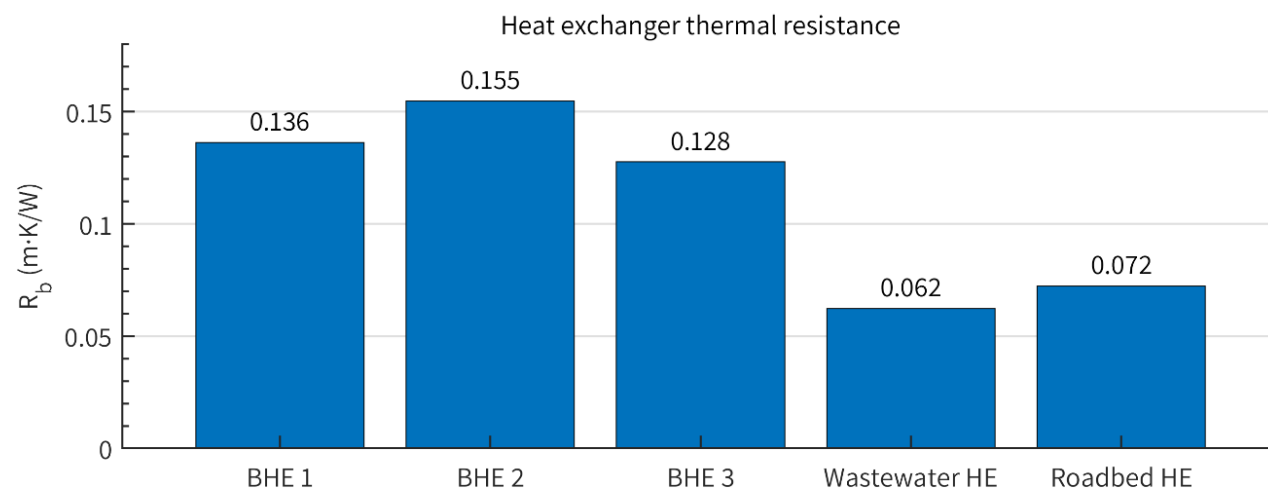
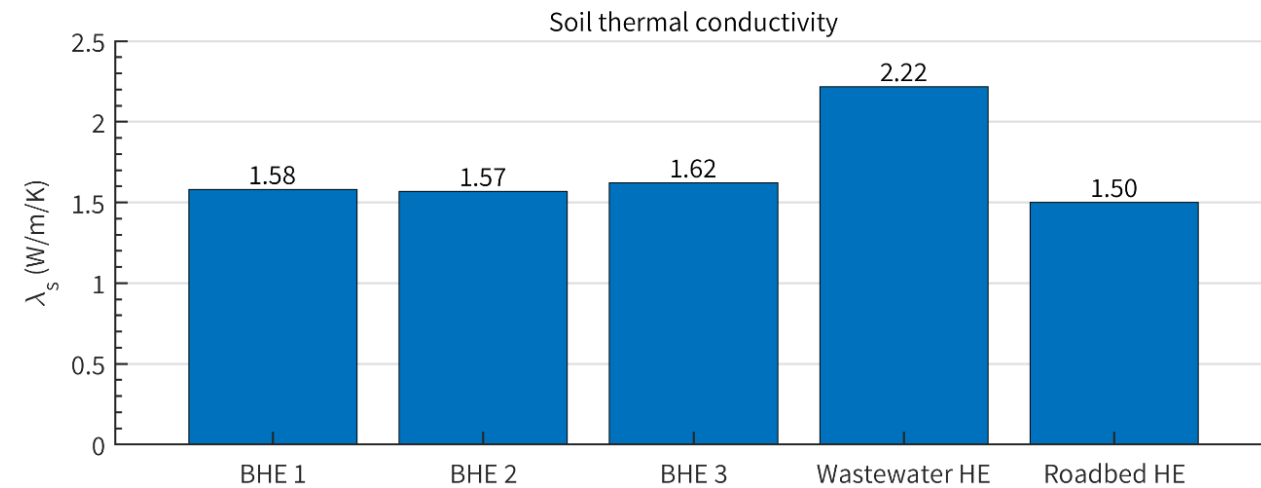
Thermal Response Test of borehole heat exchangers



TRT model interpretation



Overall thermal characterization



Instrumentation

Kamstrup energy meters on:

The evaporator side of the twelve heat pumps

Each of the four HE groups:

- 3 BHEs

- 2 x 3 HHE (1U pipes) in the roadway

- 1 1U pipe along the central wastewater pipe

Dynamic valves on the four HE groups

Central pump

Flow bypass to charge boreholes with the hot roadbed in summer

The flagpole antenna collects and distributes data

Professional Cumulus weather station located 880 m from the thermal road

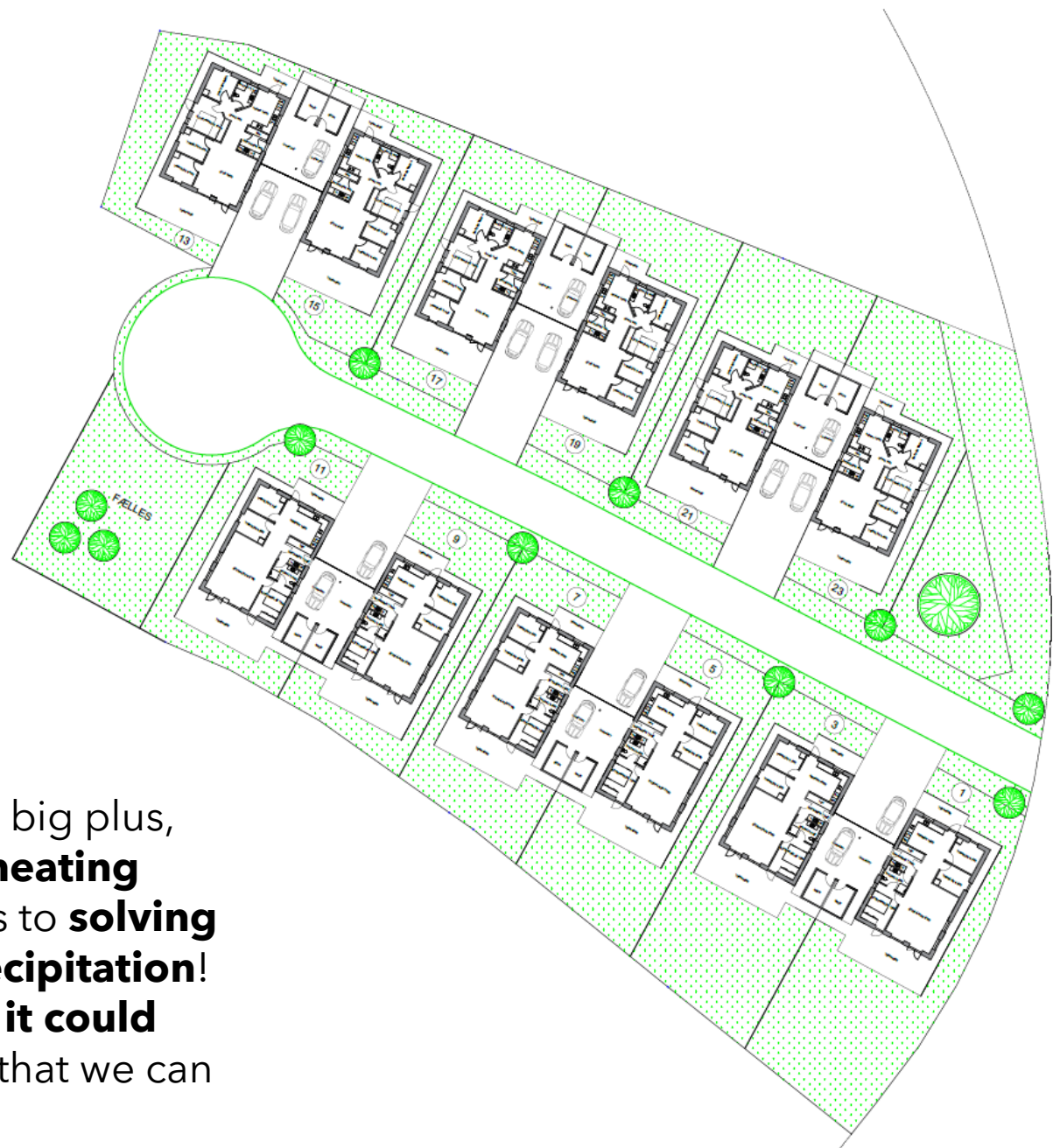


Buildings

- The private developer **GS Bolig** built twelve single-family houses of 118 m² in 2024.
- Domestic hot water supply, space heating and passive cooling
- Metrotherm Delta ground source heat pumps
- Gradual commissioning from August 2024

Christian Skifter, CEO of GS Bolig:

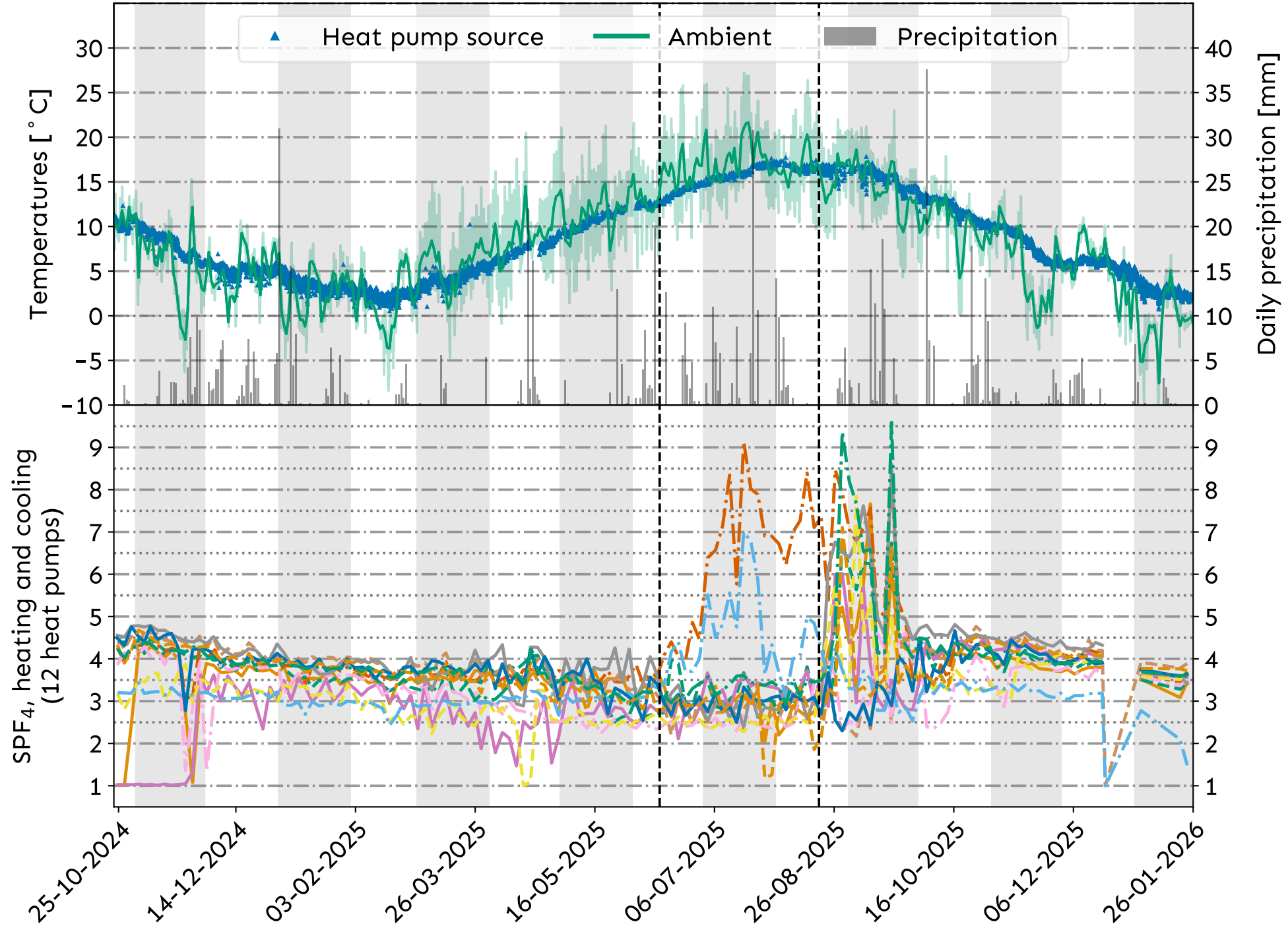
"The possibility of **providing cooling to the houses** is a big plus, and also the whole concept of a **common geothermal heating and cooling system**, which at the same time contributes to **solving the great challenge of the time with far too much precipitation!** So I think **the system is unique**, and it would be great if **it could become an economically sustainable future solution** that we can use elsewhere."



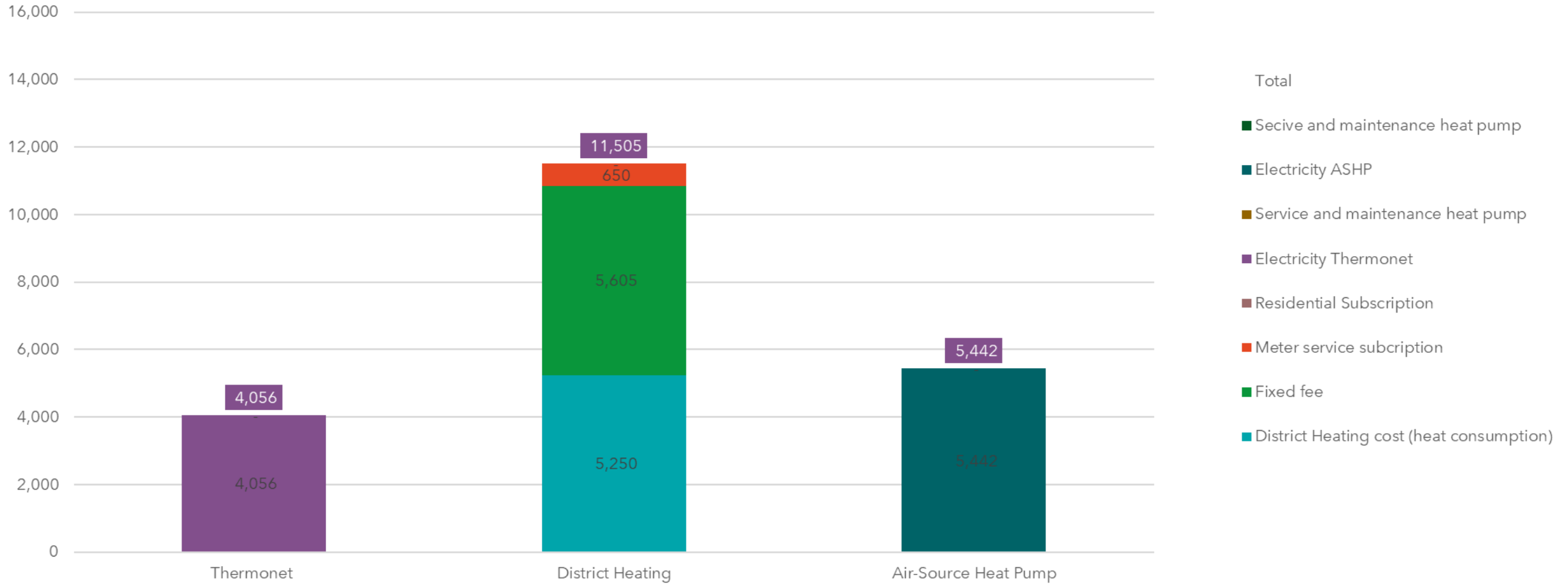
Metro Therm Delta - a heat pump developed for SGDHC

- Wall-mounted fluid source heat pump - same size as a wall-mounted gas boiler
- 3 kW (source 0°C) and 4-5 kW (source 20°C)
- Refrigerant R290 (propane)
- Heating and hot water supply
- Passive (and active) cooling option
- Wide source temperature operating range
- Source options:
 - SGDHC/Ground
 - Roof Mounted PVT Panels



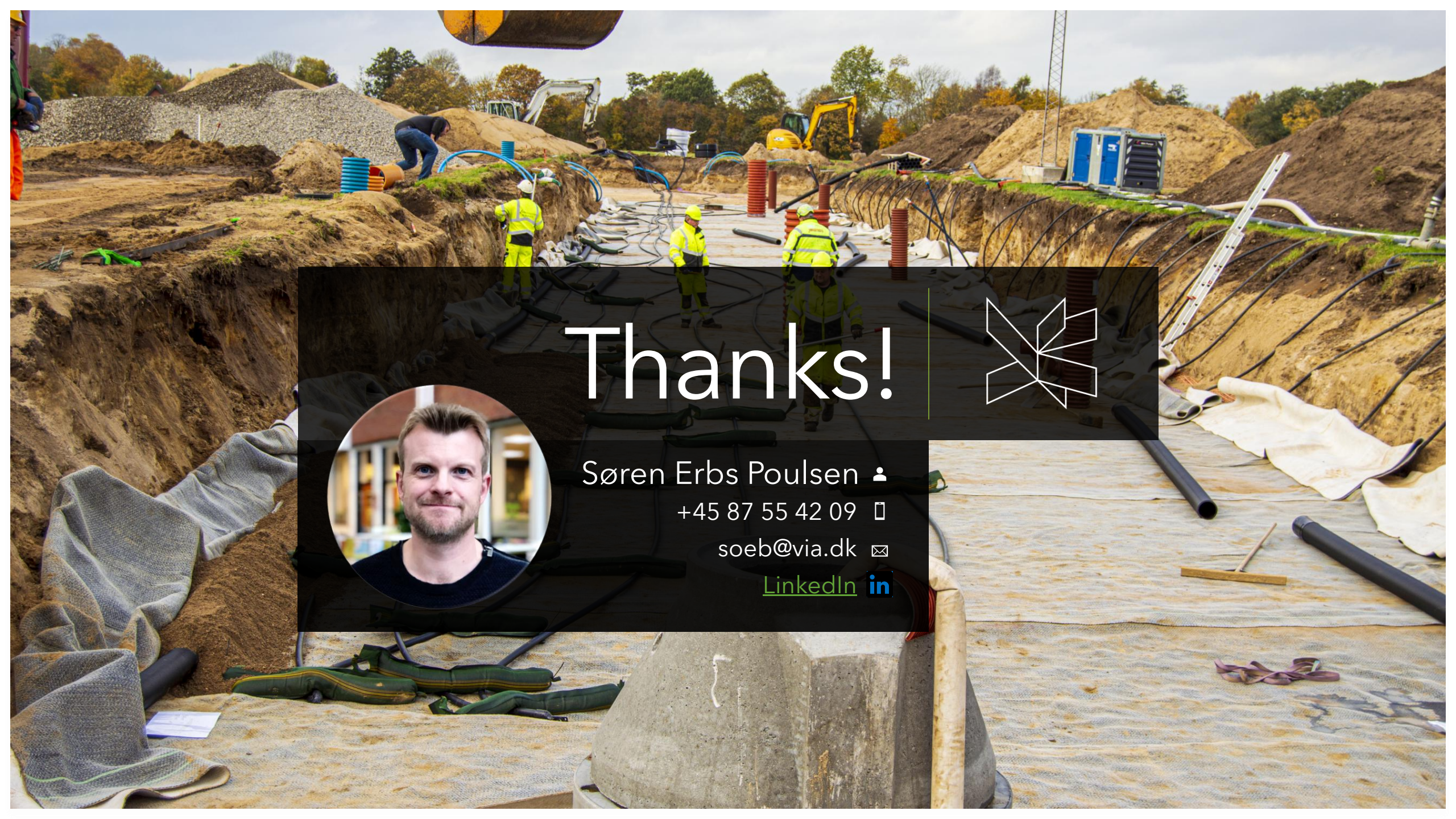


Yearly cost incl. VAT in DKK per residence




Concluding remarks


- **Cost:** Energy geostructures have strong potential in future SGDHC systems due to their low added costs.
- **Area use:** They can provide heating, cooling and thermal storage within dense urban environments.
- **Electrification potential:** They may reduce infrastructure needs and power grid peaks while increasing the use of local renewable and surplus heat.
- **Sector integration:** The Thermo-road expands energy geostructures into a multi-utility concept for new residential areas for climate mitigation and adaptation
- **Barriers:** However, scaling requires better design standards, operational experience, and mature business, financing and regulatory frameworks.



Thanks!



Søren Erbs Poulsen 

+45 87 55 42 09 

soeb@via.dk 

[LinkedIn](#) 