Closed-loop ground source facilities in Denmark

Maria Alberdi-Pagola, Ph.d. student (mapa@civil.aau.dk)
Dr. Søren Erbs Poulsen, Docent (soeb@via.dk)

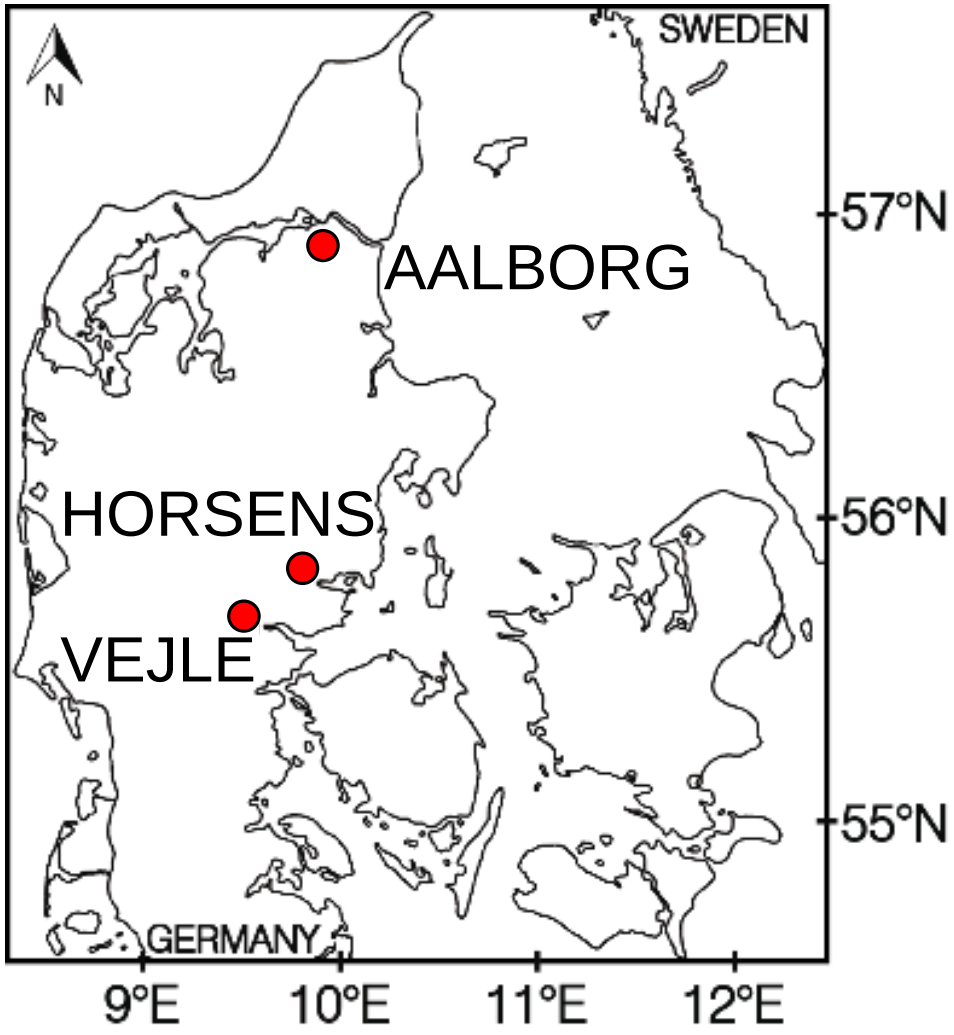
CENTRUM

VIA University College

AALBORG UNIVERSITY DENMARK

INSERO HORSENS

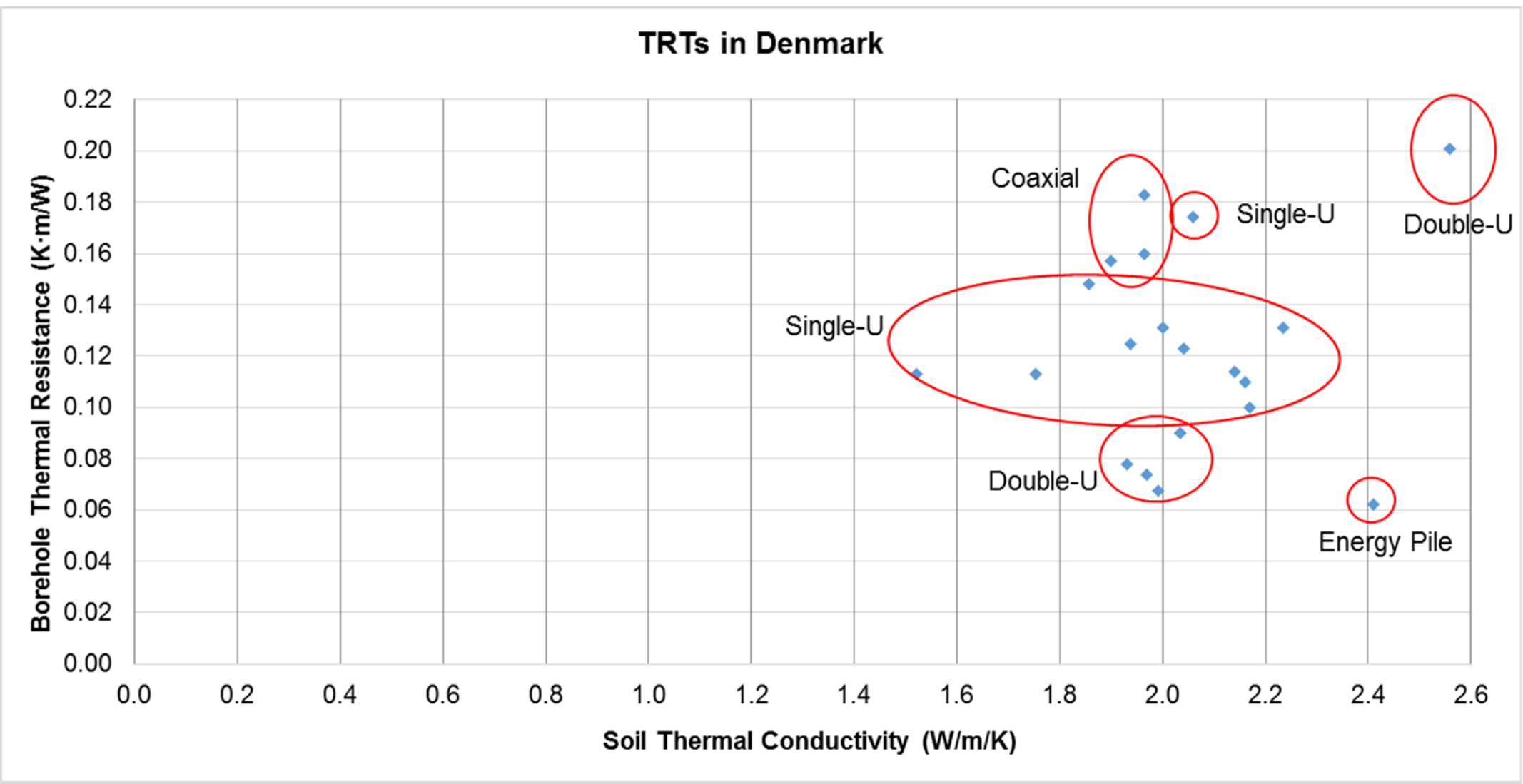
Innovationsfonden


N
SWEDEN
AALBORG
HORSENS
VEJLE
GERMANY
57°N
56°N
55°N
9°E
10°E
11°E
12°E

- Determination of thermal properties of soils

  - Inhouse TRT model & interpretation procedure
  - Diagnostic tool for ongoing TRTs
  - Statistically based stopping criterion for ongoing tests

TRT equipment (UBeG, Germany)

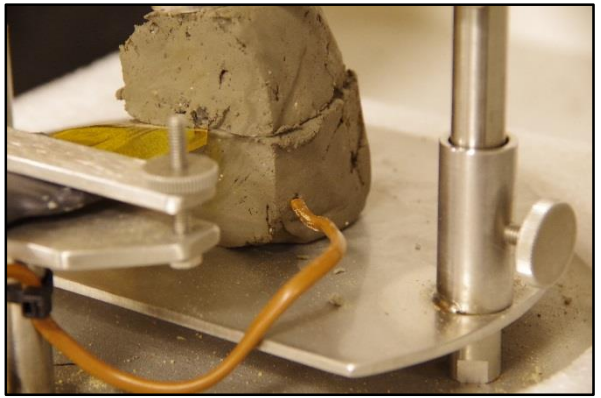

TRTs in Denmark
Borehole Thermal Resistance (K·m/W)
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
Soil Thermal Conductivity (W/m/K)
Coaxial
Single-U
Double-U
Single-U
Double-U
Energy Pile

- Determination of thermal properties of soils

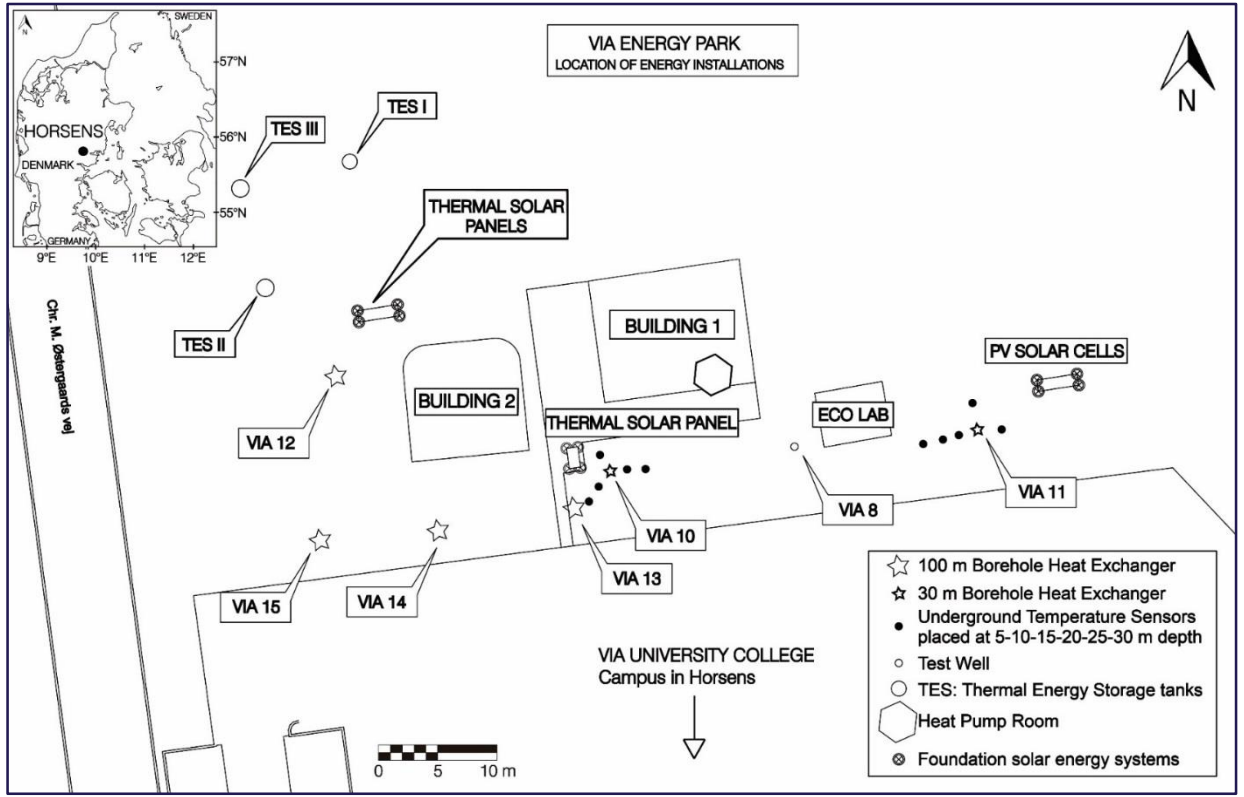
Measurement in lab:

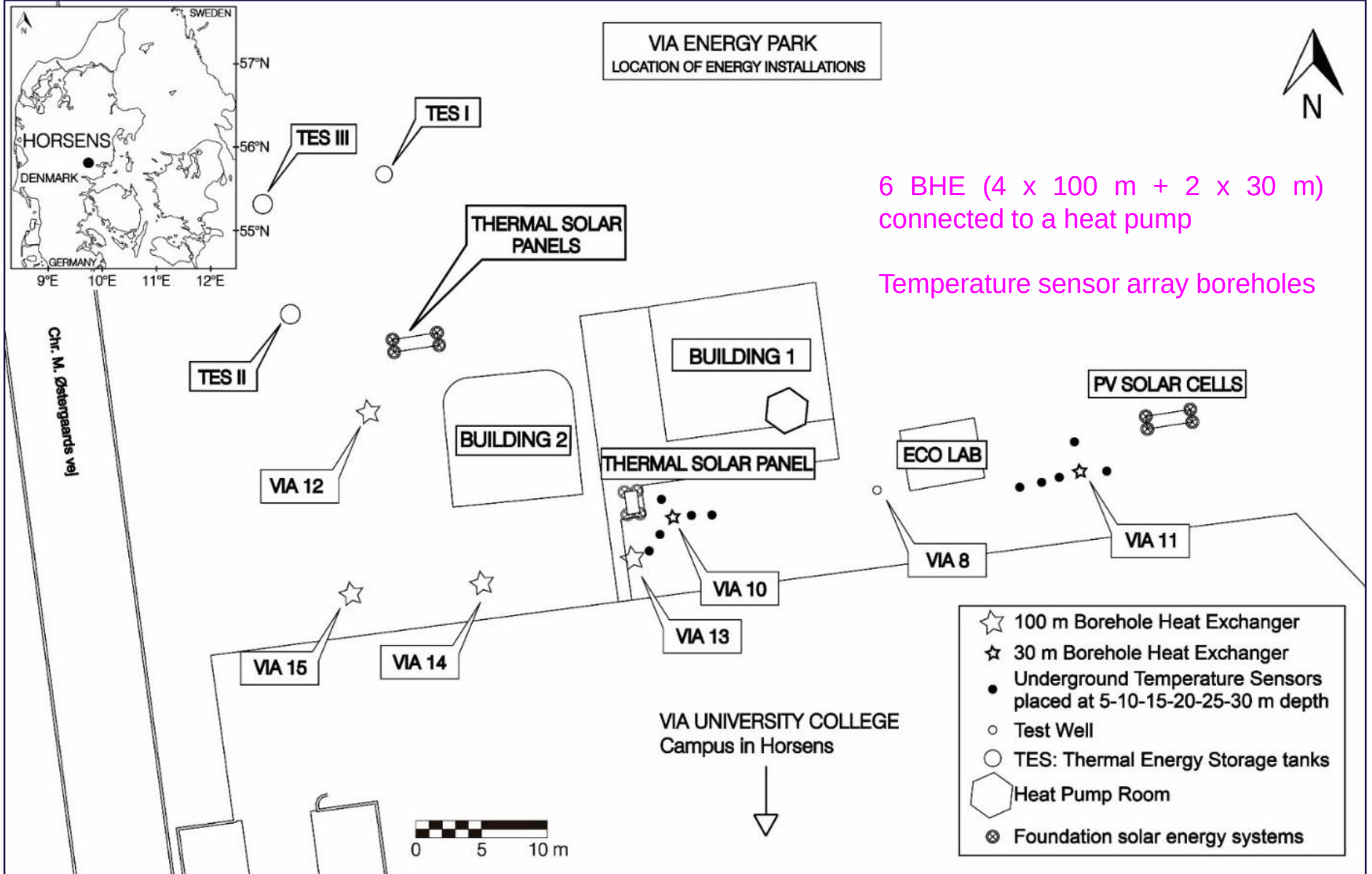
- Hot Disk (VIA)
- Thermal needle probe (VIA)
- Guarded hot plate (AAU)
- Laser flash (AAU)

Hot Disk

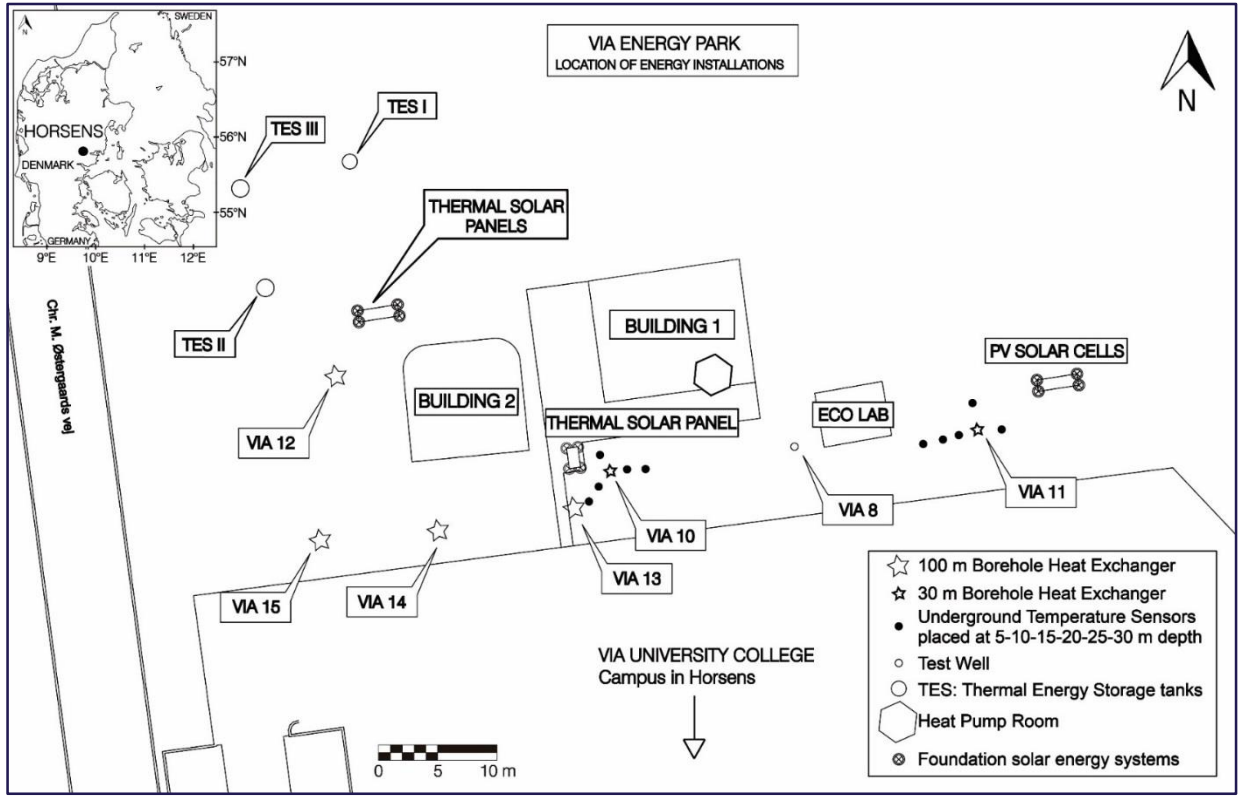


- Determination of thermal properties of soils
- VIA Energy Park, Horsens




VIA ENERGY PARK
LOCATION OF ENERGY INSTALLATIONS
N
SWEDEN
HORSENS
DENMARK
GERMANY
57°N
56°N
55°N
9°E
10°E
11°E
12°E
TES I
TES III
TES II
THERMAL SOLAR PANELS
6 BHE (4 x 100 m + 2 x 30 m) connected to a heat pump
Temperature sensor array boreholes
Chr. M. Østergaards vej
BUILDING 1
BUILDING 2
PV SOLAR CELLS
ECO LAB
THERMAL SOLAR PANEL
VIA 12
VIA 11
VIA 10
VIA 8
VIA 13
VIA 15
VIA 14
VIA UNIVERSITY COLLEGE
Campus in Horsens
0
5
10 m
100 m Borehole Heat Exchanger
30 m Borehole Heat Exchanger
Underground Temperature Sensors placed at 5-10-15-20-25-30 m depth
Test Well
TES: Thermal Energy Storage tanks
Heat Pump Room
Foundation solar energy systems

- Determination of thermal properties of soils
- VIA Energy Park, Horsens

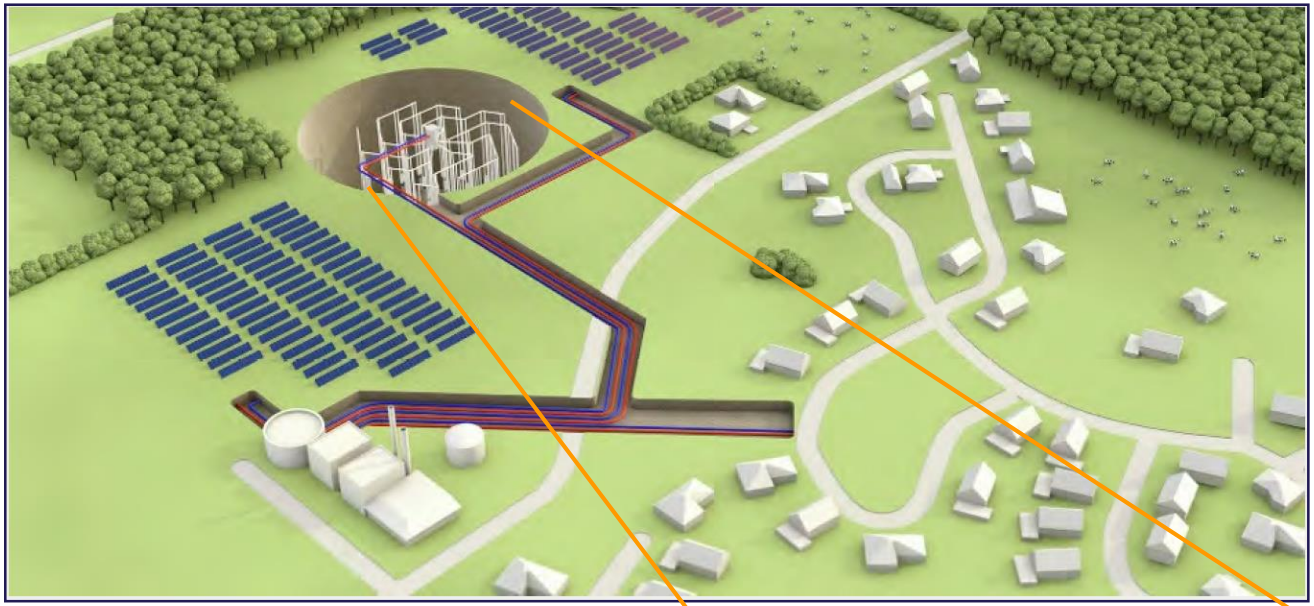


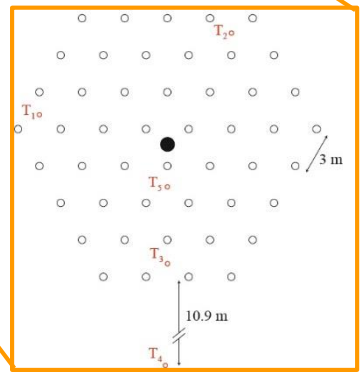
- Determination of thermal properties of soils
- VIA Energy Park, Horsens
- Langmarksvej, Horsens, precast energy piles

Validating TRT of energy piles:

- 8 precast energy piles [12 or 18 m + 1U or 2U]
- 1 BHE [17 m + 2U]
- 5 TRT + lab measurements

- Determination of thermal properties of soils
- VIA Energy Park, Horsens
- Langmarksvej, Horsens, precast energy piles
- BTES, Brædstrup, 15 km from Horsens, monitored installation





- 48 BHE BTES
- DHP seasonal balancing of solar panel heat production
- 5 temperature sensor array borehole (20 measurement levels)
- Soil temperature ~ 50^{o}C
- λ_s scaling effects (full 3D 6-layer calibrated model: λ_s 21% > λ_s TRT)

- Determination of thermal properties of soils
- VIA Energy Park, Horsens
- Langmarksvej, Horsens, precast energy piles
- Brædstrup, BTES, monitored installation
- Energy piles, Rosborg Gymnasium, Vejle, monitored installation

  - 200 energy piles
  - 4,000 m^2 living area
  - 200 kW heat pump

- Determination of thermal properties of soils
- VIA Energy Park, Horsens
- Langmarksvej, Horsens, precast energy piles
- Brædstrup, BTES, monitored installation
- Energy piles, Rosborg Gymnasium, Vejle, monitored installation
- Energy piles, Rosborg Gymnasium, Vejle, new building

  - 220 energy piles

8/12/2015

Interpretation of ongoing thermal response tests of vertical (BHE) borehole heat exchangers with predictive uncertainty based stopping criterion.
Energy. S.E. Poulsen & M. Alberdi-Pagola, 2015.

Thermal response testing and performance of quadratic cross section energy piles (Vejle, Denmark).
Proceedings of the XVI ECSMGE Geotechnical Engineering for Infrastructure and Development.
M. Alberdi & S.E. Poulsen.

Model analysis of operational data from pilot borehole thermal energy storage (BTES) in Brædstrup, Denmark: calibration, validation and upscaling.
K.W. Tordrup, S.E. Poulsen & H. Bjørn, 2016 (peer-reviewed journal paper in prep.).
Soil temperature time series and operational data will be published with the paper.

A performance case study of the energy pile foundation at Rosborg Gymnasium (Denmark).
M. Alberdi-Pagola, S.E. Poulsen, S. Madsen & R. L. Jensen, 2016 (in prep.).