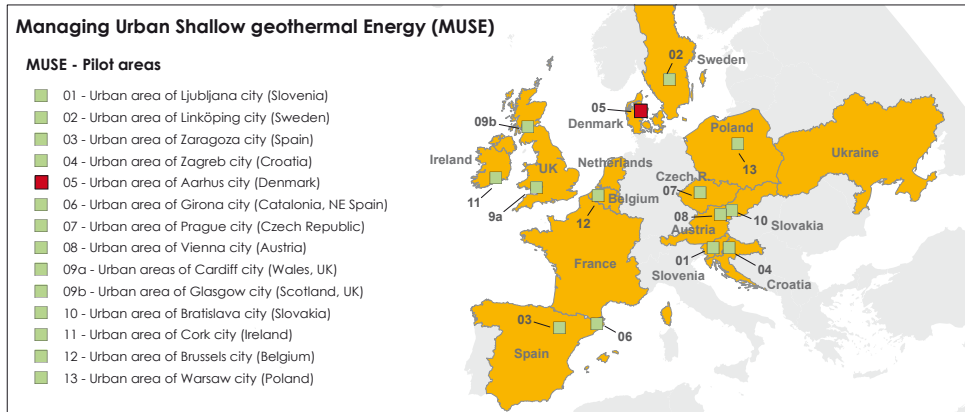


Pilot area information



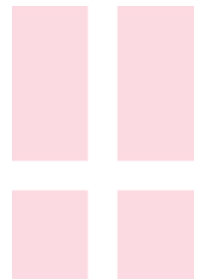
This pilot area comprises the municipal area of Aarhus, and the aim of the desktop case study is to investigate the possibilities of integrating SGE and energy storage in a mature central heating system. Potential geothermal resources will be mapped using a wide arrange of existing geological and geophysical data. A catalogue of relevant SGE technologies prepared in WP2 will feed into a current update of the heating plans for Aarhus. Furthermore, the work will focus on the local possibilities of geological energy storage, mapping of potential sites for storage and extraction of heat; mapping potential conflicts; prioritising possible sites in relation to expected yield and proximity to the existing grid; and the integration of the results into the local energy plans.

Pilot Area	Aarhus
Task (MUSE)	T-4.6
Country	Denmark
Area (km ²)	469 km ²
Total number of inhabitants (date)	336,411 (2017)
Inhabitants per km ²	717
Level of urbanization	Unknown
Elevation range (m a.s.l.)	0 -128 (1-100 populated)

Climatological settings

HDD/CDD data accordingly to the local methodologies at the Pilot areas	
Heating degree days (HDD) / a/baseline reference values / period of data for calculations (note unit is hours)	2722; (17°C/17°C) (period 2011-2017)
Cooling degree days (CDD) / a/b values / period of data for calculations	Unknown
Length of the heating season (days)	Unknown
Length of the cooling season (days)	Unknown

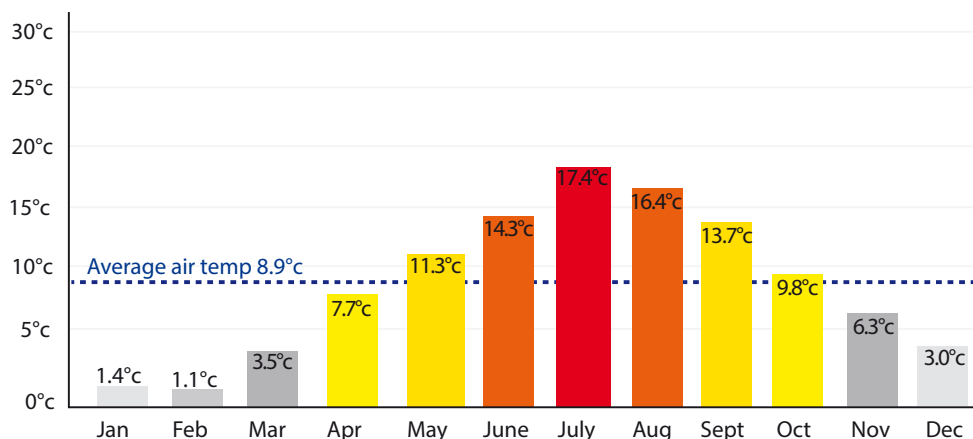
Source of data: Eurostat. <https://ec.europa.eu/eurostat/data/database>



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Average monthly and annual air temperature



Market situation

Number of SGE installations in pilot area	OLS V-CLS H-CLS	4 plants (36 boreholes) (EST)
Current growth rate	Heat production	
Estimated share of open loop systems		
Estimated share of closed loop systems		
Estimated total share of shallow geothermal methods in the heating market	Unknown	
Other SGE technologies: Eg. Inter-seasonal heat storage schemes or energy piles	Unknown	
Estimated total share of RES in the heating energy market (%) (specify local or national values)		

Economic boundary conditions

Estimated average installation costs for shallow geothermal systems (€/kW output) ¹	
Open loop systems	Unknown
Closed loop systems	Unknown
Estimated average heating costs (€/kWh)	
Open loop systems	Unknown
Closed loop systems	Unknown
Drilling cost range per meter (€/m) for Open Loop	Unknown
Drilling cost range per meter (€/m) for Borehole Closed Loop	Unknown

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Regional geological and hydrogeological characteristics

Geological Situation in Pilot area

Bedrock Age: Danien to Miocæne
 Bedrock Depositional Environment: Marine, shallow marine and fluvio-deltaic
 Bedrock lithologies: (Danien Limestone. Paleocene –Oligocene smectitic marine clays. Miocene marine silty muds and deltaic quartz rich sands

Quaternary: Glacial (Devension and older) including deep buried valleys . Shallow marine, (Holocene), Anthropogenic 800 AD and younger in city center up to 5 m approx.

Hydrogeology

Target aquifer unit(s): Glacio- fluvial sand and gravel in buried valleys. Groundwater flow direction (general). Towards the coast (eastwards). Locally following buried valleys.

Is pump tests data available Yes

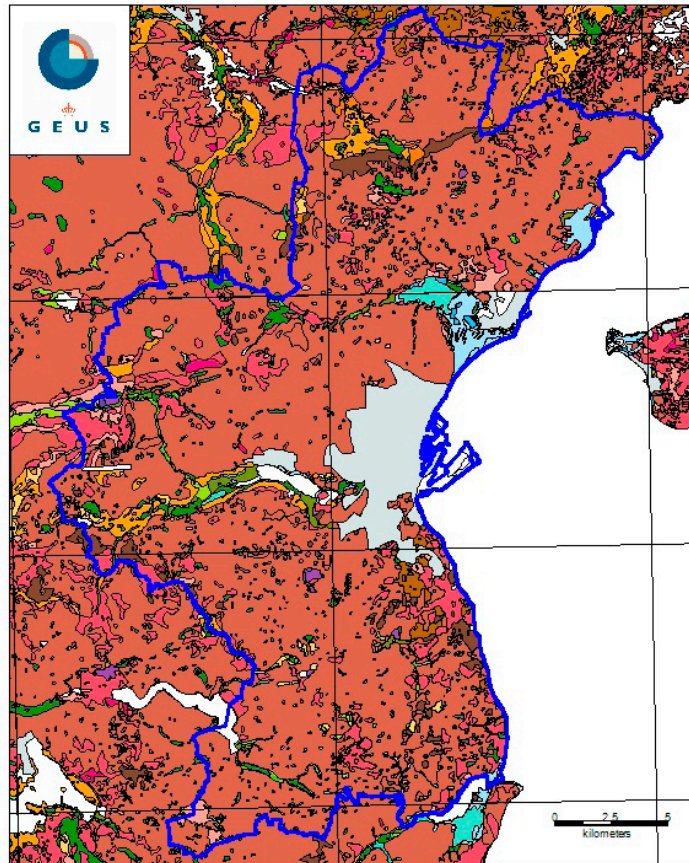
Is TRT test data available Probably not

Depth to water table(s): 1 to 30 m below surface

Aquifer unit thickness: (0-50m)







Thermogeology

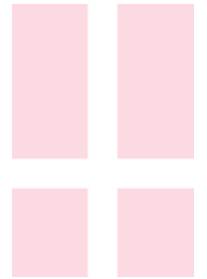
Groundwater temperature: (Ave, Min Max range) 8,5 oC, (7-11 oC)



Surface geological map
Pilot Area Aarhus

Main lithologies:

- | | | |
|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
|  Clay Till |  Diluvial Sand |  Postglacial fresh-water dep. |
|  City center (not mapped) |  Extramarginal glacio-fluvial sand |  Postglacial marine dep. |



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Summary of works and timeline

Main Objectives	
✓	Evaluation and characterization of geology/ hydrogeology / thermal conditions
✓	SGE assessment resources (for OCS and/or CLS) / and evaluation of UTES-BTES)
	Study of conflicts of use (OLS / GWL - OLS/CLS). Hazards/interferences, effects on sub-surface
	Strategies and actions for management and local energy plans
Relation of foreseen tasks	
✓	Data collection (TRT, DTRT, rock samples, GWL, T-profile's etc)
	New field works (TRT/geophysics /new samples and lab etc)
	Monitoring existing SGE/GWL/T etc)
✓	Mapping (in general terms)
	2D/3D Modelling (in general terms)

Detailed summary of works at the Pilot Areas and brief timeline

March 2019 – March 2020 MUSE monitoring period.

Planned activities for March 2019 – March 2020 MUSE monitoring period.

Screening existing geological and geophysical data for

- 1) Aquifers with limited drinking water interests. Seeking pumping test from these areas
- 2) Deposits with limited groundwater flow suited for BTES installations

Mapping the amount, temperature and location of excessive heat in the district heating system as well as the seasonal variations.

Introducing technologies from WP2 to the local stakeholder

References

<http://data.geus.dk/geusmap/?mapname=varmelagrning&lang=en>

<https://aarhus.dk/english/collaborate-with-the-city/urban-development/the-environment/#1>

Contact

Managing Urban Shallow geothermal Energy
Project number GeoE.171.006

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