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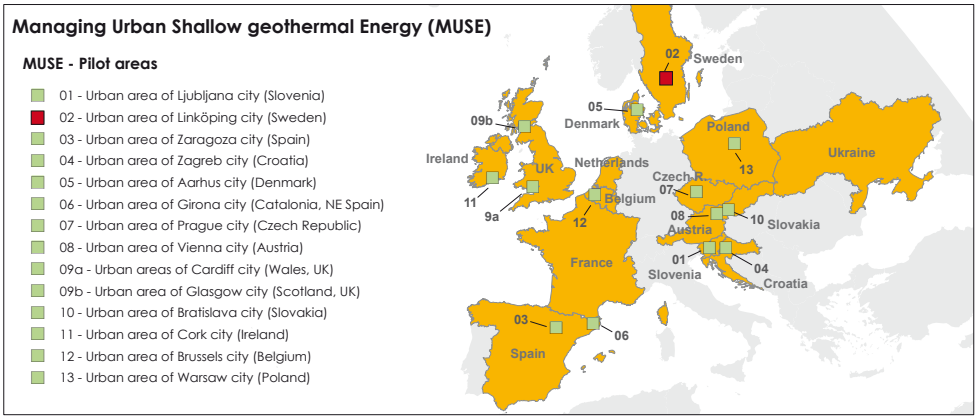
Pilot area information



Linköping is the fifth largest urban area in Sweden with c. 160 000 inhabitants. The heating demand is mainly supplied by the district heating system. The heat resource is primarily a waste to energy plant with a heat capacity of 510 GWh corresponding to the heating of 25 000 houses. The scope of the pilot is to investigate the possibility to build a large H-BTES to switch 100 GWh heat from summer to winter. Preliminary design involves 1300–1400 wells to 300 m depth with an individual distance of c. 5 meters. A number of potential locations are now investigated and assessed regarding their geological, hydrogeological and thermal prerequisites as well the potential risks and environmental impacts.
Besides the large-scale H-BTES c. 4000 private closed loop systems exists in the Linköping area of which 62 are located in the pilot area.
The site lies at 35–45 m a.s.l. and the yearly mean temperatures vary between -2.7 and 16.8 °C.

Pilot Area	Linköping
Task (MUSE)	T-4.3
Country	Sweden
Area (km²)	1568.57 km² Linköping community 11.1 km² site area
Total number of inhabitants (date)	158 841 (2018) Linköping community 106 502 (2015) Linköping city
Inhabitants per km²	111
Level of urbanization	90% (live in urban areas)
Elevation range (m a.s.l.)	35-45

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)	4682; (15°C/15°C) (period 2011 – 2016)
Cooling degree days (CDD) / a/b values / period of data for calculations	(21°C/21°C) (period 2011 – 2016)
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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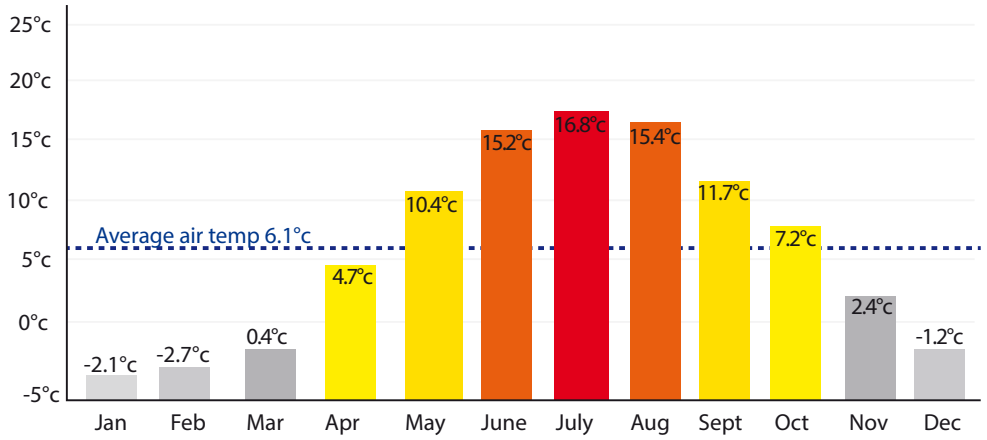
Average monthly and annual air temperature



Market situation

Number of SGE installations in pilot area	V-CLS	0 (OD) 62 (OD) 10 (EST)
Current growth rate	No. of Installations	10 (EST)
Estimated share of open loop systems		0
Estimated share of closed loop systems		100
Estimated total share of shallow geothermal methods in the heating market	V-CLS	100
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)		Unknown

Economic boundary conditions

Estimated average installation costs for shallow geothermal systems (€/kW output) [1]	
Open loop systems	Unknown
Closed loop systems	1 500 - 2000 €/kW
Estimated average heating costs (€/kWh)	
Open loop systems	Unknown
Closed loop systems	0.06 €/kWh
Drilling cost range per meter (€/m) for Open Loop	100 €/m
Drilling cost range per meter (€/m) for Borehole Closed Loop	100 €/m

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Regional geological and hydrogeological characteristics

Bedrock Age: Precambrian (1700-2000 Ma)

Bedrock lithologies: Svecofennian granite and gneissic granitoids, and metabasite

Quaternary: 5-10 m thick glacial sandy-silty till and postglacial clay

Faults and deformation zones: the pilot area is transected by several brittle deformations zones resulting in increased fracturing

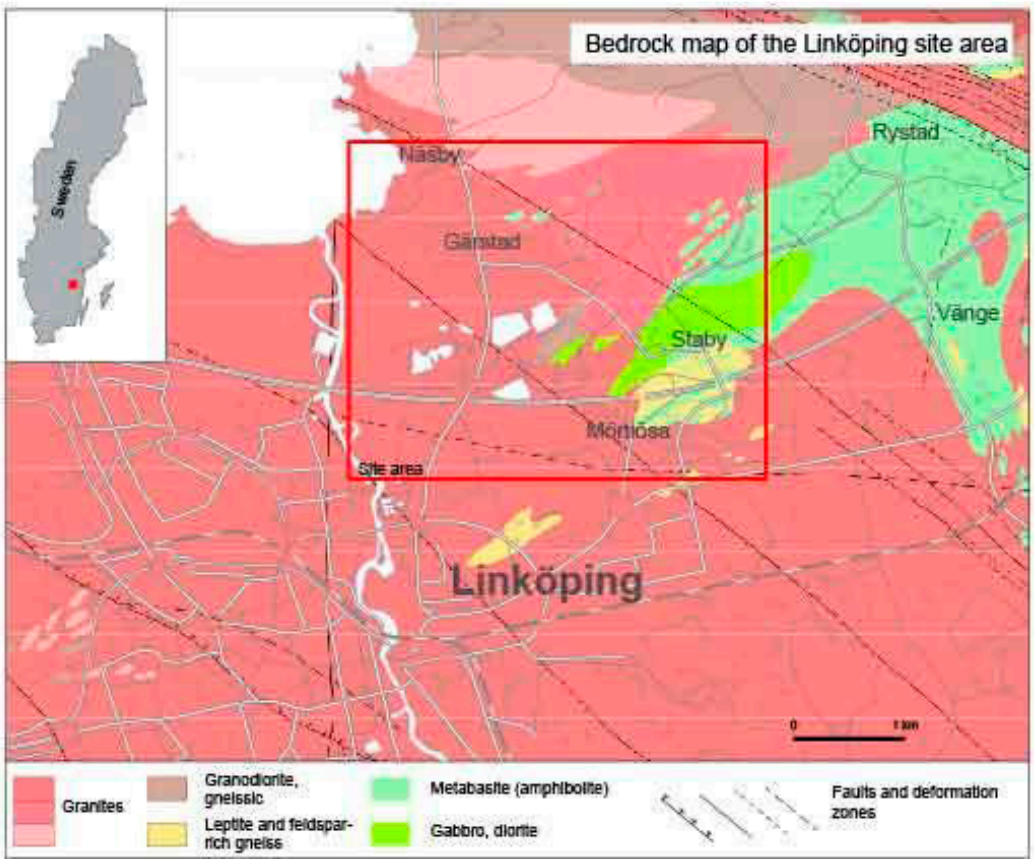
Target aquifer unit(s): minor local aquifers in the Quaternary deposits. Main aqiufer consists of the fractured bedrock domain down to c. 150 m depth where the salinity of the groundwater disqualifies its use as freshwater resource.

TRT data indicate a Lambda values between 2.73 and 3.28 W/mK

Depth to water table(s): 2-3 m below surface

Average groundwater temperature: 9.5°C

Temperature at 300 m: 11.6°C



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Description of the works

The geological survey of Sweden has been involved in the design of the pre-investigations intended to define the most suitable location of a multi- well High temprature-BTES plant in Linköping. The ongoing thermal evaluations are performed by consulting agencies specialized in design and monitoring of borehole heat exchangers using distributed temperature measurements (DTRT). These investigations are to be complemented by geological and hydrogeological characterizations of the site area. The intention is to evaluate the pre-investigations with respect to the composition of the bedrock mass and groundwater conditions. The thermal data will be available for the GeoERA project as well as the possibility to perform additional measurements and tests in the existing wells. The geological survey is today working with compiling maps of the thermal properties of the bedrock, based on models of modal composition of rocks and TCS measurements as well as collecting TRT and DTRT data from SGE systems. The Linköping pilot will give an opportunity to further evaluate this data as well as testing the relevance and relation between different types of data sets in the selection process as well in the assessment of risks and environmental impact. The stakeholder "Linköpings Tekniska Verk" has committed to let us use the data involving the properties necessary for the modelling and to be a stakeholder contact. The planned activities include geophysical ground measurements and wire-line logging as well as thermal measurements on rock samples and thermal modelling using petrological modal data.

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)

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Detailed summary of works at the Pilot Areas and brief timeline

March 2019 – March 2020 MUSE monitoring period.

Measurement of thermal properties on rock types occurring in the site area

Construction of bedrock geothermal prognosis map

Characterization of groundwater conditions

Geophysical Investigations for location of hydraulically significant fracture zones

Wire-line logging of test wells

Geological correlation of DTRT data

Communication with stakeholder

Contact

Managing Urban Shallow geothermal Energy
Project number GeoE.171.006

Website - www.geoera.eu/projects/muse
MUSE Project office: MUSE@geologie.ac.at
Pilot area contact person: Mikael Erlstrom

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