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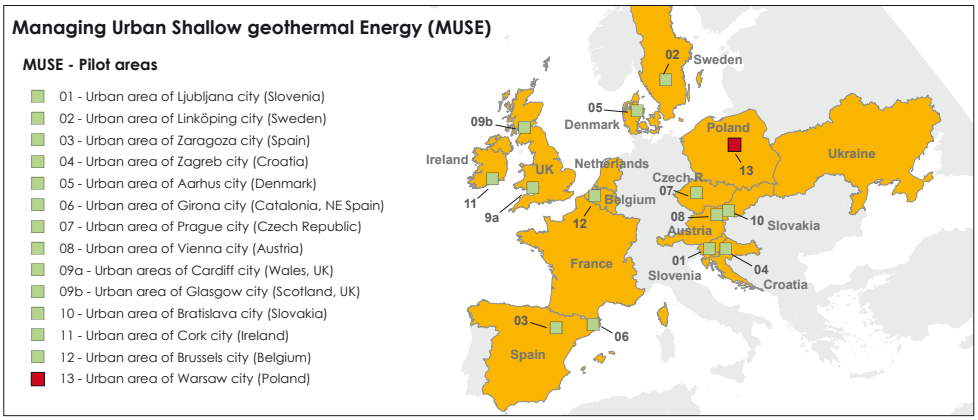
Pilot area information



Warsaw, the capital city of Poland, is the largest city in the country and its second largest urban agglomeration. It has a well-developed heating district system based on coal combustion. The SGE market is however poorly-developed - until present only a limited number of the closed-loop systems have been installed in both private and public buildings. The topographical level varies from 78 to 121 m a.s.l. Air temperature ranges from -2,2 to 18,9 °C, with a mean value of 8,3 °C, maximum of 37 °C and minimum point values of -30 °C. Relative humidity is 79%. The Vistula River divides Warsaw into two major parts, while its valley is the paramount geomorphological unit. The shallow geology is dominated by unconsolidated Quaternary and Neogene sediments – mainly sands, gravels, tills and clays. Hydrogeological conditions are rather complicated showing several unconfined and confined aquifers interbedded with aquitards and aquicludes.

Pilot Area	Warsaw
Task (MUSE)	T-4.10
Country	Poland
Area (km²)	Pilot Area 2847 km² Warsaw City area – 517 km²
Total number of inhabitants (date)	1 764 615 (1.01.2018) – city area ≈3 101 000 - metropolitan area
Inhabitants per km²	3412 (Warsaw City area)
Level of urbanization	57%
Elevation range (m a.s.l.)	78-121

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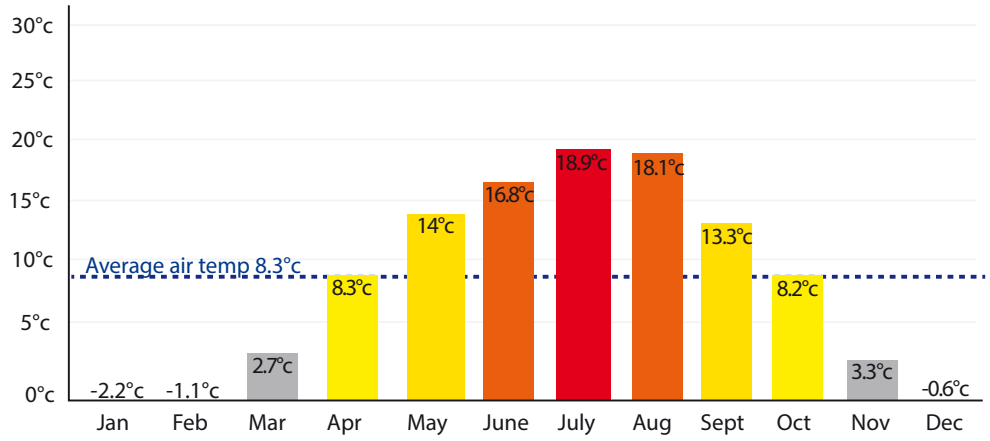
Climatological settings

HDD/CDD data according to EUROSTAT method	
Heating degree days (HDD); [baseline reference values]; (period for data calculations)	3054 [15/18] (2017)
Cooling degree days (CDD); [baseline reference values]; (period for data calculations)	32 [21/24] (2017)
Length of the heating season (days)	182[1] 264[2]
Length of the cooling season (days)	Unknown

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

Average monthly and annual air temperature



Market situation

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

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Economic boundary conditions

Estimated average installation costs for shallow geothermal systems (€/kW output) [1]	
Open loop systems	Unknown
Closed loop systems	1300-1800 €/kW
Estimated average heating costs (€/kWh)	
Open loop systems	Unknown
Closed loop systems	0,04 €/kWh [3]
Drilling cost range per meter (€/m) for Open Loop	25-50 €/m
Drilling cost range per meter (€/m) for Borehole Closed Loop	25-50 €/m

Regional geological and hydrogeological characteristics

Warsaw is located in the central part of the geological unit called the Masovian Synclinorium. The unit is filled mainly with the sediments of the Cretaceous, Paleogene, Neogene and Quaternary periods. The oldest drilled bedrock of the Masovian unit is a Cretaceous chalk formation described mainly as white or gray marl (sometimes sandy), limestone and sandstone. Paleogene period comprises only the Oligocene deposits – predominantly fine and medium-grained sands with glauconite, sometimes lined with extensive clays. Neogene period is represented by Miocene deposits, mainly sands interbedded with lignite, as well as Pliocene deposits 95% of which are plastic clays. Quaternary period consist mainly of the Pleistocene clays, tills, fine and coarse grained sands, glaciolacoustrine deposits and Holocene anthropogenic deposits [4].

Hydrogeology:

Two main aquifers – Oligocene, Quaternary
Oligocene:

- Fine and medium-grained sands,
- Pumping efficiency: 30-50 m3/h,
- Aquifer unit thickness: 30-40 m,
- Depth to water table: 180-270 m

Quaternary:

- Fine and coarse grain sands,
- Pumping efficiency: 50-100 m3/h,
- Aquifer unit thickness: 5-60 m,
- Depth to water table: 5-100 m

Groundwater flow – Vistula river direction

Thermogeology

Groundwater temperature: to be measured
Zone of Seasonal Fluctuations (typically upper 20 m below surface)

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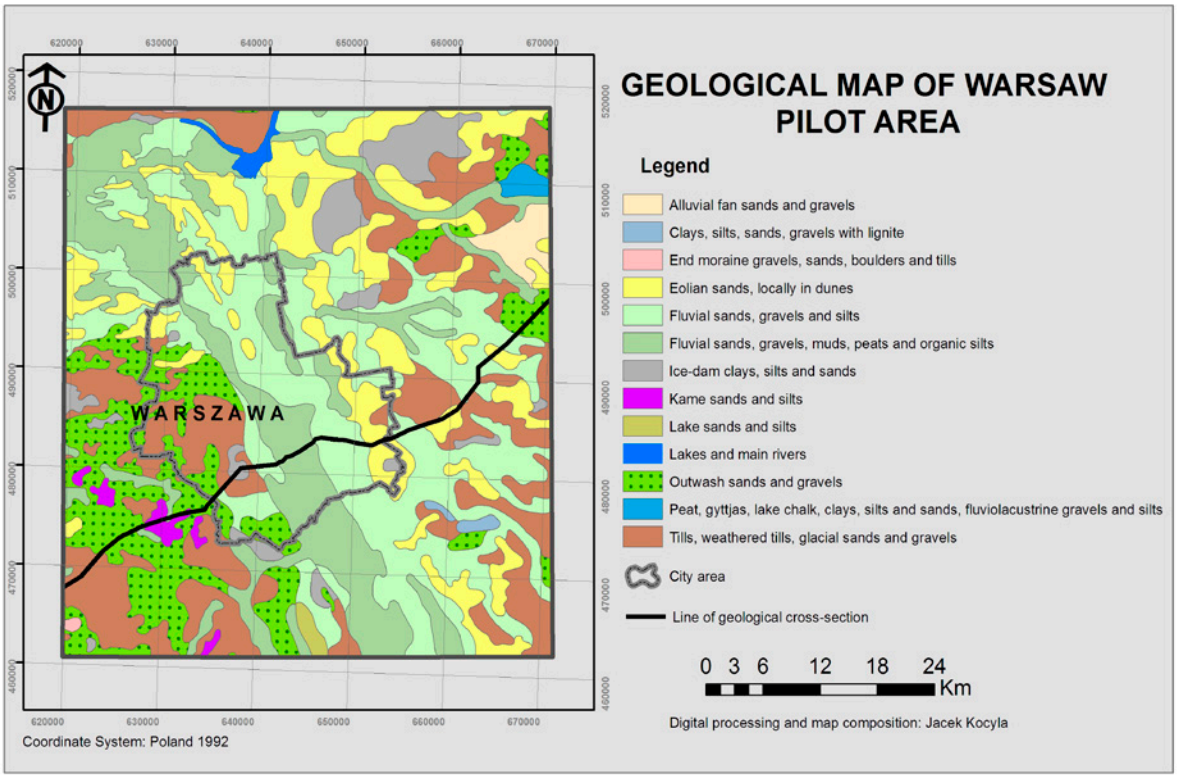

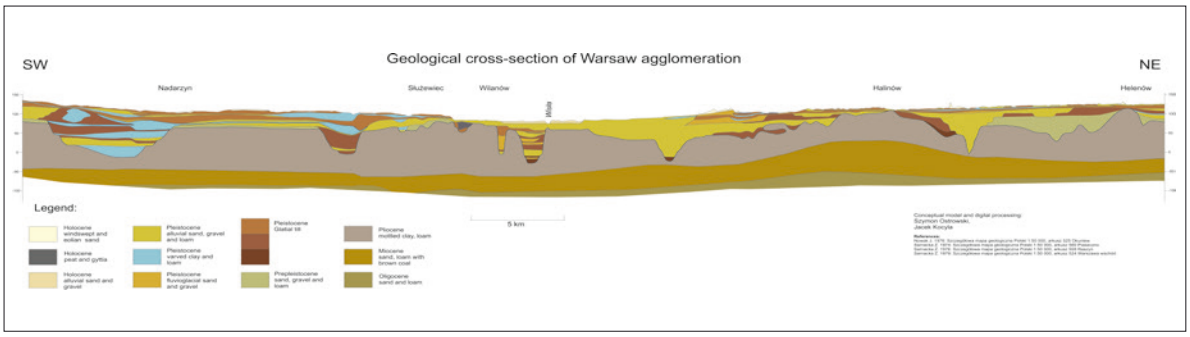

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Summary of works and timeline

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 subsurface
✓	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

- Design and construction of monitoring well (thermopiezometer): design, installation, tests (TRT) and monitoring
- Geophysical investigations: Vertical Electrical Sounding, Electrical Resistivity Tomography, Seismic Refraction Tomography
- Thermal conductivity lab and field testing
- Geological database including field verification of boreholes and verification of archive borehole data
- GIS layers: SGE potential, hydrogeology, environmental conflicts
- 2D – 3D geoscientific modelling

Reference

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Project number GeoE.171.006

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