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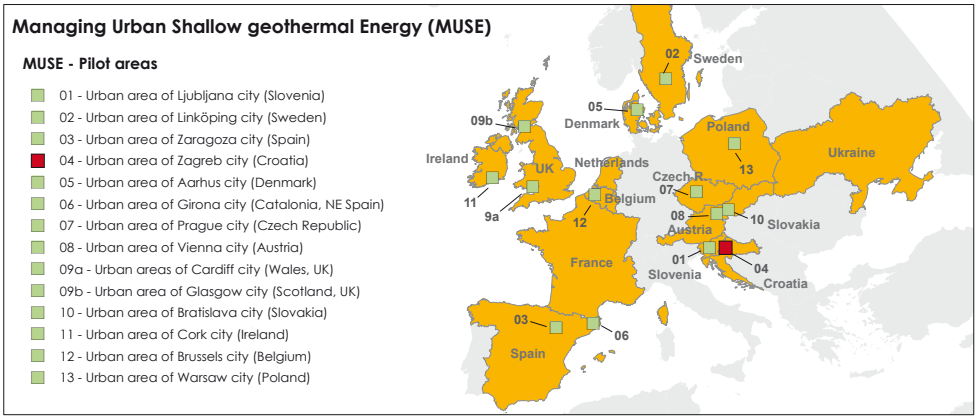
Pilot area information



Pilot actions in the City of Zagreb urban area will concentrate on the influence of open-loop groundwater heat pump systems at two locations. The systems are abstracting water from, and reinjecting it into, the shallow aquifer which is also used for public water supply of the City of Zagreb. A continuous monitoring scheme will be established using their wells and the nearby observation boreholes to determine groundwater level draw-downs and temperature changes in the investigated shallow aquifer.

Heat pump utilization in Zagreb (as well as in Croatia in general) is regulated only for open-loop systems since they need to obtain water permits and concession for economic utilization of water. However, closed-loop systems are unregulated in the whole country, so their existence and number are only a matter of speculation and educated guesses, since no permitting is required.

Pilot Area	Zagreb
Task (MUSE)	T-4.7
Country	Croatia
Area (km²)	641 km²
Total number of inhabitants (date)	802,338 (2018)
Inhabitants per km²	1,232
Level of urbanization	Unknown
Elevation range (m a.s.l.)	120 - 1,033 (majority 120 - 300)

Climatological settings

HDD/CDD data according to EUROSTAT method	
Heating degree days (HDD); [baseline reference values]; (period for data calculations)	2396 [15/18] (2017)
Cooling degree days (CDD); [baseline reference values]; (period for data calculations)	196 [21/24] (2017)
Length of the heating season (days)	220
Length of the cooling season (days)	Unknown

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

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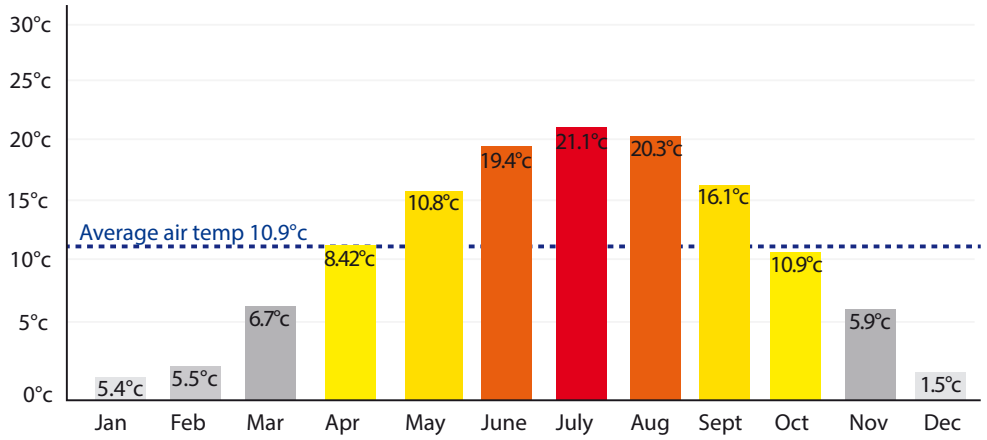
Average monthly and annual air temperature



Market situation

Number of SGE installations in pilot area	Unknown	0 (OD) 20 (OD) 10 (EST)
Current growth rate	Unknown	
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	800 (based on 500 kW system)
Closed loop systems	1333 (based on 12 kW system)
Estimated average heating costs (€/kWh)	
Open loop systems	0.05 - 0.07
Closed loop systems	0.07 - 0.08
Drilling cost range per meter (€/m) for Open Loop	120
Drilling cost range per meter (€/m) for Borehole Closed Loop	60

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Regional geological and hydrogeological characteristics

Geological Situation in Pilot area

Bedrock Age: Triassic
Bedrock Depositional Environment: marine - intertidal
Bedrock lithologies: limestone and dolomite
Tertiary: thick layers of marls, fine-grained sandstones, siltstones and claystones
Quaternary - Holocene: alluvial sediments, anthropogenic deposits.

Hydrogeology

The aquifer system comprises two Quaternary aquifers. Quaternary deposits are divided into three basic units: the overburden of clay and silt; a shallow Holocene aquifer of medium-grain gravel mixed with sands; and deeper aquifers from the Middle and Upper Pleistocene, with frequent lateral and vertical alternations of gravel, sand and clay.
Major Faults/ Hazards: major fault at the foothills of Medvednica Mt., active, epicenters usually W from Zagreb; landslide hazard
Target aquifer unit: Zagreb aquifer - a thick, mostly gravelly aquifer, also utilized for water supply of the urban area
Pumping test data and TRT data are available.
Depth to water table(s): 1 to 11 m below surface
Aquifer unit thickness:

Thermogeology

Groundwater temperature: 11.4 - 17 °C; average 13.5 [06]
Zone of Seasonal Fluctuations: 12 m below surface [07]

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.
Planned activities for March 2019 – March 2020 MUSE monitoring period.
(Dec 2018 - as long as possible, probably also after project closure)
Investigation of aquifer properties
Baseline temperature monitoring
GSHP pilot monitoring
Mapping installed systems and potential conflicts of use
Heat flow or Hydrogeological models.
3D Geological Models (software used)

Reference

City of Zagreb official web-site (https://www.zagreb.hr/)

Croatian bureau of statistics (https://www.dzs.hr/default_e.htm)

Official Gazette (https://narodne-ovine.nn.hr/clanci/sluzbeni/2015_11_128_2428.html; https://narodne-novine.nn.hr/clanci/sluzbeni/2010_03_36_930.html; https://narodne-novine.nn.hr/clanci/sluzbeni/dodatni/408177.pdf

Croatian meteorological and Hydrological Service (http://meteo.hr/klima.php?section=klima_podaci&param=k1&Grad=zagreb_maksimir)

Naki , Z., Ruži i , S., Posavec, K., Mileusni , M., Parlov, J., Ba ani, A., and Durn, G., 2013, Conceptual model for groundwater status and risk assessment - case study of the Zagreb aquifer system: Geologia Croatica, v. 66, no. 1, p. 55-76.

Kova , Z., Naki , Z., and Pavli , K., 2017, Influence of groundwater quality indicators on nitrate concentrations in the Zagreb aquifer system: Geologia Croatica, v. 70, no. 2, p. 93-103.

[07] - Kurevija, T., 2010, Energetic evaluation of the shallow geothermal potential in the Republic of Croatia [PhD: University of Zagreb, 183 p.

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: Staša Borovi sborovic@hgi-cgs.hr

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