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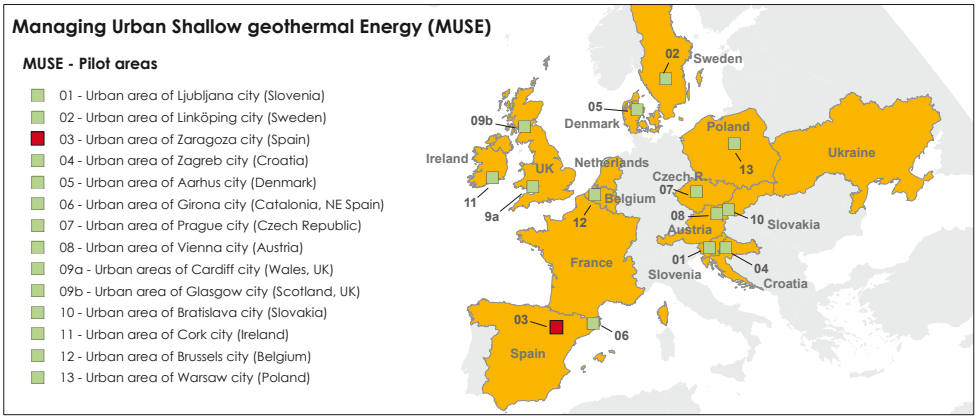
Pilot area information



The pilot area is located In the central sector of the Ebro River basin (Spain), where the confluence of the Gállego and Huerva River tributaries occurs. In this area there is an important alluvial aquifer that is overlain in part by the Metropolitan Area of Zaragoza. The main uses of groundwater are watering public parks and gardens (14%), processing water supplies (8%), recreational use (10%) and geothermal use (68%). The urban alluvial aquifer has experienced an intensive geothermal exploitation since the early 2000s. A total of approximately 250 wells are currently in use in the urban area of Zaragoza, where a total of 71 GWHPs involve 176 geothermal wells (105 are production or pumping wells, and 71 are for injection) that reach depths ranging from 20 to 60 m. The first estimates of the total heat power installed can add up to 110 MWt for cooling purposes (of which only 67 MWt is actually supplied for cooling purposes), where 21 installations are equipped with reverse-cycle heat pumps with 34 MWt of heat power that is actually supplied for heating demand.

Pilot Area	Zaragoza
Task (MUSE)	T-4.4
Country	Spain
Area (km²)	106.03 km²
Total number of inhabitants (date)	697,895 (2018)
Inhabitants per km²	721.66
Level of urbanization	Unknown
Elevation range (m a.s.l.)	184-265

Climatological settings

HDD/CDD data according to EUROSTAT method	
Heating degree days (HDD); [baseline reference values]; (period for data calculations)	1749 [15/18] (2017)
Cooling degree days (CDD); [baseline reference values]; (period for data calculations)	283 [21/24] (2017)
Length of the heating season (days)	155
Length of the cooling season (days)	124

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

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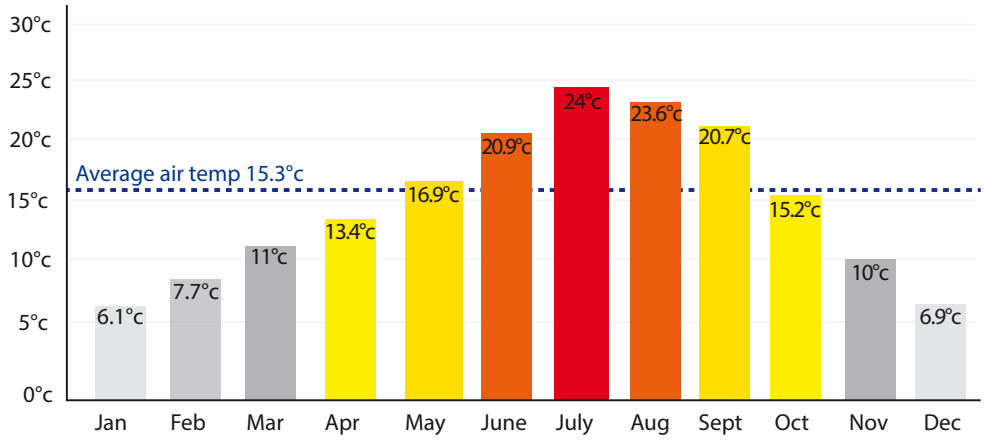
Average monthly and annual air temperature



Market situation

Number of SGE installations in pilot area	OLS	71 (OD)
Current growth rate	No. of Installations	2.8% (EST)
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: Are there inter-seasonal heat storage schemes or energy piles in your pilot area?	Unknown	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	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

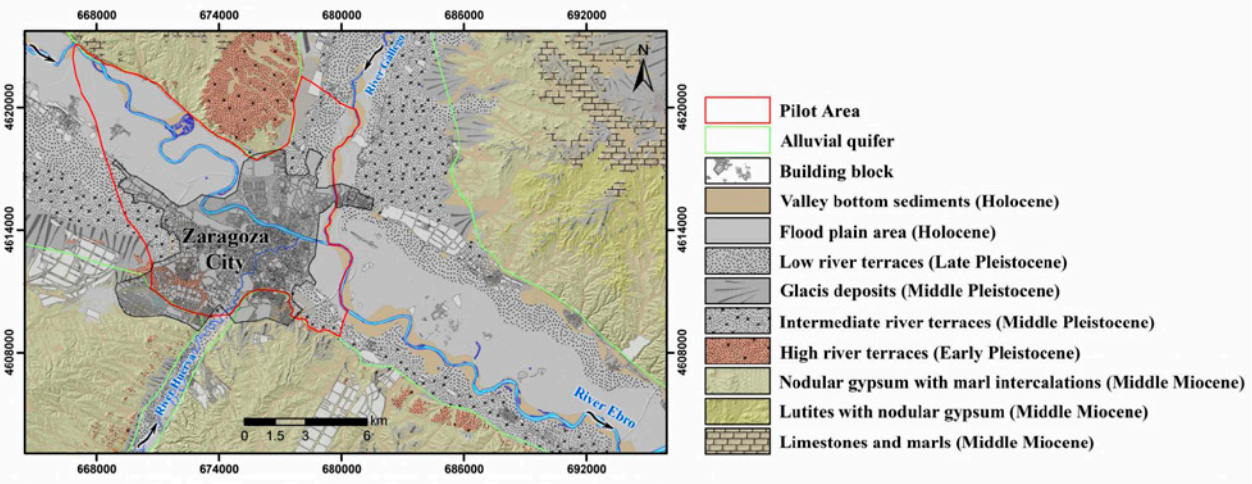
Bedrock Age: Oligo-Miocene
Bedrock Depositional Environment: Extensive high-salinity playa-lake Bedrock lithologies: Anhydrite/gypsum, halite and glauberite, with interlayered marls and mudrocks including calcite, dolomite and quartz grains
Quaternary: alluvial deposits formed by gravels dominated by carbonate and siliciclastic materials with a sand-silt matrix, frequently cemented by carbonates.

Hydrogeology

The city of Zaragoza overlays the alluvial aquifer of the Ebro River [1]. The portion of this alluvial aquifer under the city of Zaragoza is called the "Urban alluvial Aquifer of Zaragoza". The aquifer is composed of two primary sedimentary domains corresponding to Quaternary alluvial terraces related to the Ebro River and tributaries and to a Quaternary alluvial fan area in genetic relation with the Huerva tributary. The terrace deposits are formed by channel facies with siliceous and carbonate gravels, generally grain supported, which are presented in high lateral extension with several meters thickness. Generally, these deposits are tabular bodies with cross-bedding; however, channel bodies with trough cross-bedding are dominant locally. A general W–E flow pattern in the northwest sector of the pilot area can be identified that changes to a NW–SE flow pattern in the southeast. At the south, the hydraulic connection of the Huerva alluvial aquifer with the Ebro River alluvial aquifer in the central sector generates a groundwater flow toward the Ebro River through the alluvial fans and discharges into the terraces, where the groundwater acquires a W–E flow direction nearly parallel to the Ebro River. Transmissivities vary from 3·102 up to 4·103 m2day-1[2].
Pumping tests are available but TRT test data is not
Depth to water table(s): 5 to 34 m below surface
Aquifer unit thickness: (5-60 m)

Thermogeology

Groundwater temperature: (Ave, Min Max range)= 17.0 oC, 16.9 17.2 0.3 oC)
Zone of Seasonal Fluctuations: 9-12 m
42 groundwater monitoring points.



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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

The aim of MUSE in the pilot area of Zaragoza is to exchange problems, experiences, solutions and research results with other pilot areas in order to develop management indicators to be applied. This will allow us to provide a scientifically-based procedure to assess the state of the shallow geothermal resources and identify possible existing conflicts of use in the resource exploitation at a city scale.

March 2019 – March 2020 MUSE monitoring period.
Baseline temperature monitoring
OLS monitoring
Mapping installed systems and potential conflicts of use
Heat flow or Hydrogeological models (FEFLOW)
3D Geological Models (ESRI)

Reference

García-Gil, E. Vázquez-Suñe, E. Garrido, J.A. Sánchez-Navarro, J. Mateo-Lázaro, The thermal consequences of river-level variations in an urban groundwater body highly affected by groundwater heat pumps, Science of the Total Environment (2014).

García-Gil, E. Vázquez-Suñé, J.A. Sánchez-Navarro, J. Lázaro, Recovery of energetically overexploited urban aquifers using surface water, Journal of Hydrology 1(1) (2015) 111.

Contact

Managing Urban Shallow geothermal Energy
Project number GeoE.171.006

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