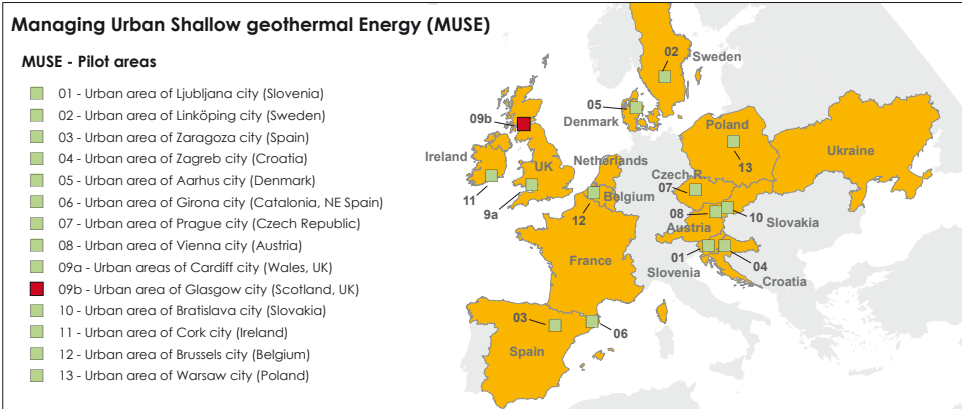


# GLASGOW FACTSHEET

UK/WP4/D4.1/FS9B/2018



## Pilot area information



The east end of Glasgow, Scotland's largest city, is the location for the UK Geoenergy Observatories 'Glasgow Geothermal Energy Research Field Site'. Permissions for this research facility into low temperature mine water geothermal energy have been granted and borehole drilling starts in Autumn 2018. The challenges are similar to other towns and cities across Europe where coal mines closed and became flooded, and there is a legacy of industrial land use. There is interest in integrated district heating/storage networks plus a small mine water geothermal scheme has been operating successfully at nearby Shettleston. The mine waters are expected to be around 12°C and this will be confirmed when the 6 mine water, 5 environmental baseline and 1 seismic monitoring boreholes are drilled. The Observatory will provide openly accessible data on ground motion, soil/ground gas, surface and groundwater and soil chemistry environmental baseline monitoring.

|                                    |  |
|------------------------------------|--|
| Pilot Area                         | Glasgow  |
| Task (MUSE)                        | T-4.10   |
| Country                            | UK   |
| Area (km <sup>2</sup> )            | Pilot Area - 45.7 km <sup>2</sup><br>Glasgow City area - 176 km <sup>2</sup> |
| Total number of inhabitants (date) | 621020 (total for whole of Glasgow City, 2017, National Records of Scotland) |
| Inhabitants per km <sup>2</sup>    | 3500 per km <sup>2</sup> for Glasgow City area (not the pilot area)          |
| Level of urbanization              | Unknown  |
| Elevation range (m a.s.l.)         | 0-196m   |

## 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) | 0 [21/24] (2017)    |
| Length of the heating season (days)  | Unknown             |
| Length of the cooling season (days)  | Unknown             |

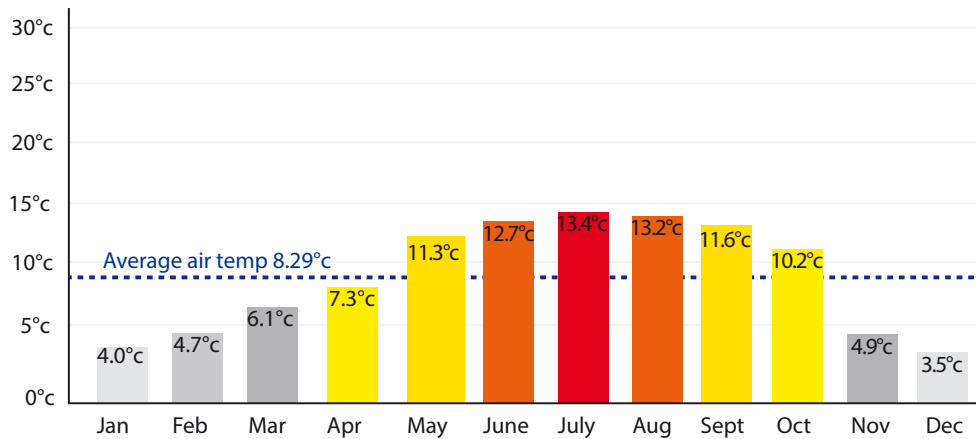
Source of data: Eurostat. <https://ec.europa.eu/eurostat/data/database>



# GLASGOW FACTSHEET



## Average monthly and annual air temperature



## Market situation

|  |  |                               |
|--|--|-------------------------------|
| Number of SGE installations in pilot area  | Unknown  | 0 (OD)<br>20 (OD)<br>10 (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:<br>Eg. Inter-seasonal heat storage schemes or energy piles               | A operating mine water scheme (Shettleston), plus the UK Geoenergy Observatory |                               |
| 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) <sup>1</sup> |         |
|--|---------|
| 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 |

# GLASGOW FACTSHEET



## Regional geological and hydrogeological characteristics

### Bedrock

Faulted Carboniferous, extensively mined for coal and ironstone  
Bedrock Depositional Environment: fluvio-deltaic coal swamps with marine incursions  
Bedrock lithologies: mudstone, siltstone, paleosol, coal, sandstone

### Quaternary

Glacial and post-glacial marine, fluvial, lacustrine, extensive artificial ground some with land contamination.  
Thickness superficial deposits 0-30 metres.

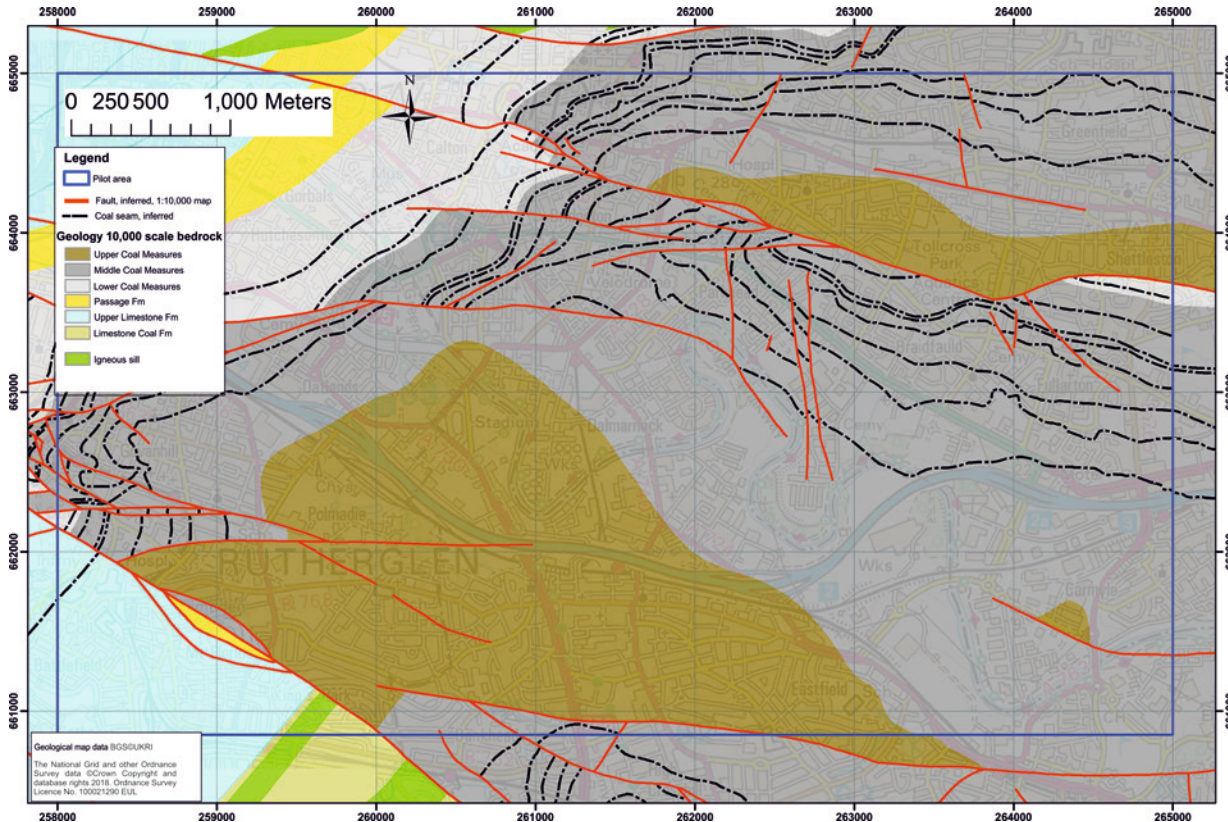
### Hydrogeology Heterogeneous Quaternary aquifer system

Three units form a linear aquifer approximately 2 to 3km wide and typically between 10 and 30m thick beneath central Glasgow.

**Bedrock** - Unmined Carboniferous sedimentary rocks typically form multi-layered and vertically segmented aquifers. Groundwater flow paths thought to be complex. Mining has significantly changed natural hydrogeological conditions and increased aquifer transmissivity.  
Variable depth to water table. Limited data in bedrock.

### Thermogeology Bedrock groundwater temperature

Likely 12-15 °C at depths to a few hundred metres



GLASGOW

# GLASGOW FACTSHEET



## 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.**

Borehole construction and environmental baseline monitoring  
Baseline temperature, level, conductivity monitoring  
Baseline groundwater chemistry monitoring  
Pumping tests  
Investigation of aquifer properties  
Geophysical downhole monitoring – resistivity and temperature  
3D Geological Models (GOCAD-SKUA)  
Heat flow and Hydrogeological models

## Reference

Monaghan et al. 2018 <http://nora.nerc.ac.uk/id/eprint/521444/>  
Monaghan et al. 2017, <http://nora.nerc.ac.uk/id/eprint/518636/>  
[www.bgs.ac.uk/research/energy/esios/glasgow/home.html](http://www.bgs.ac.uk/research/energy/esios/glasgow/home.html)

## Contact

Managing Urban Shallow geothermal Energy  
Project number GeoE.171.006  
Website - [www.geoera.eu/projects/muse](http://www.geoera.eu/projects/muse)  
MUSE Project office: [MUSE@geologie.ac.at](mailto:MUSE@geologie.ac.at)  
Pilot area contact person: Alison Monaghan [als@bgs.ac.uk](mailto:als@bgs.ac.uk)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731166