



## STEAM

# GigaWatt-Hour Subsurface Thermal Energy storAge: Engineered structures and legacy Mine shafts

[University of Strathclyde](#)

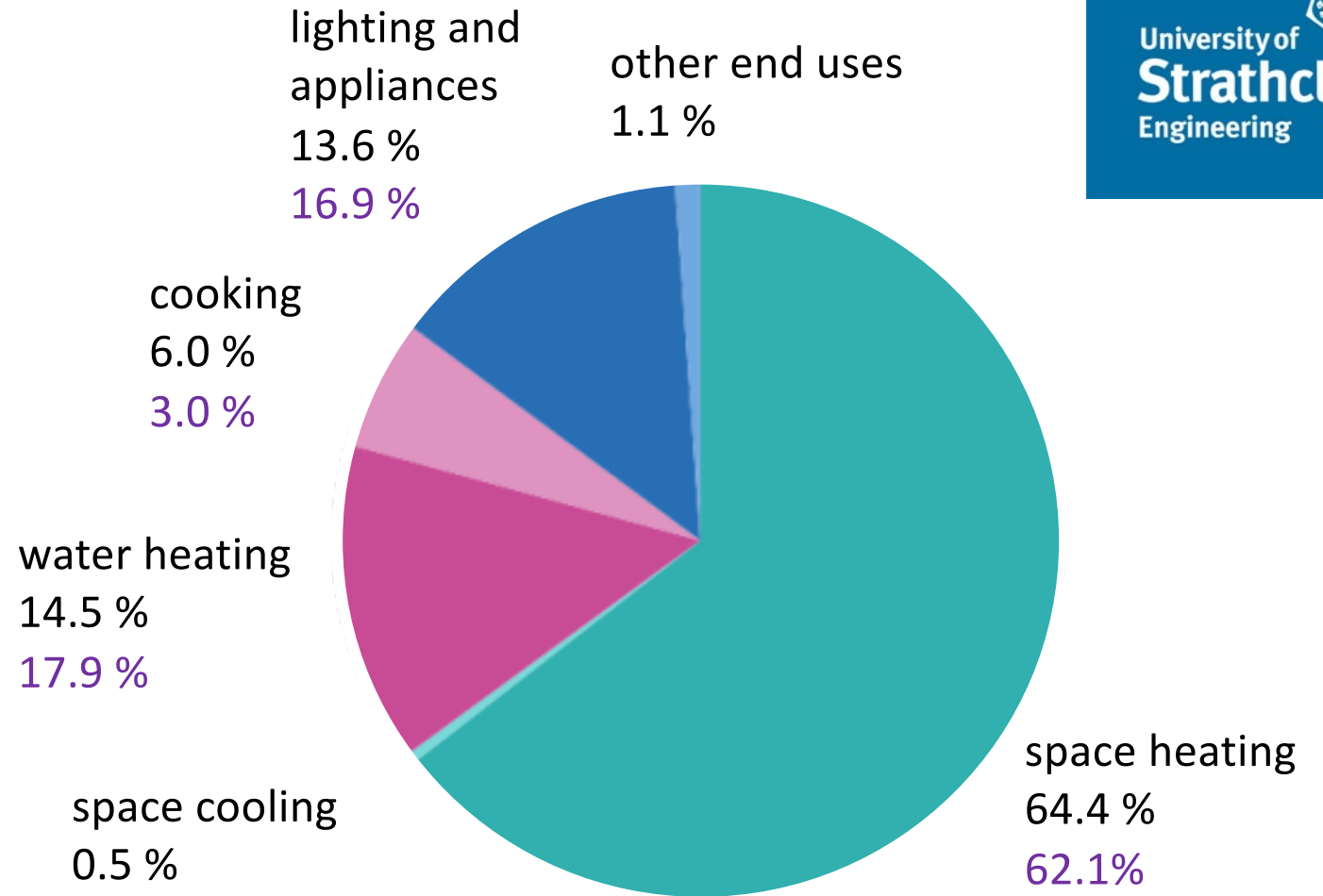
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[University of Edinburgh](#)

Ian Molnar, Chris McDermott,  
*Jessica Dassow*

# Why care about decarbonising heat?

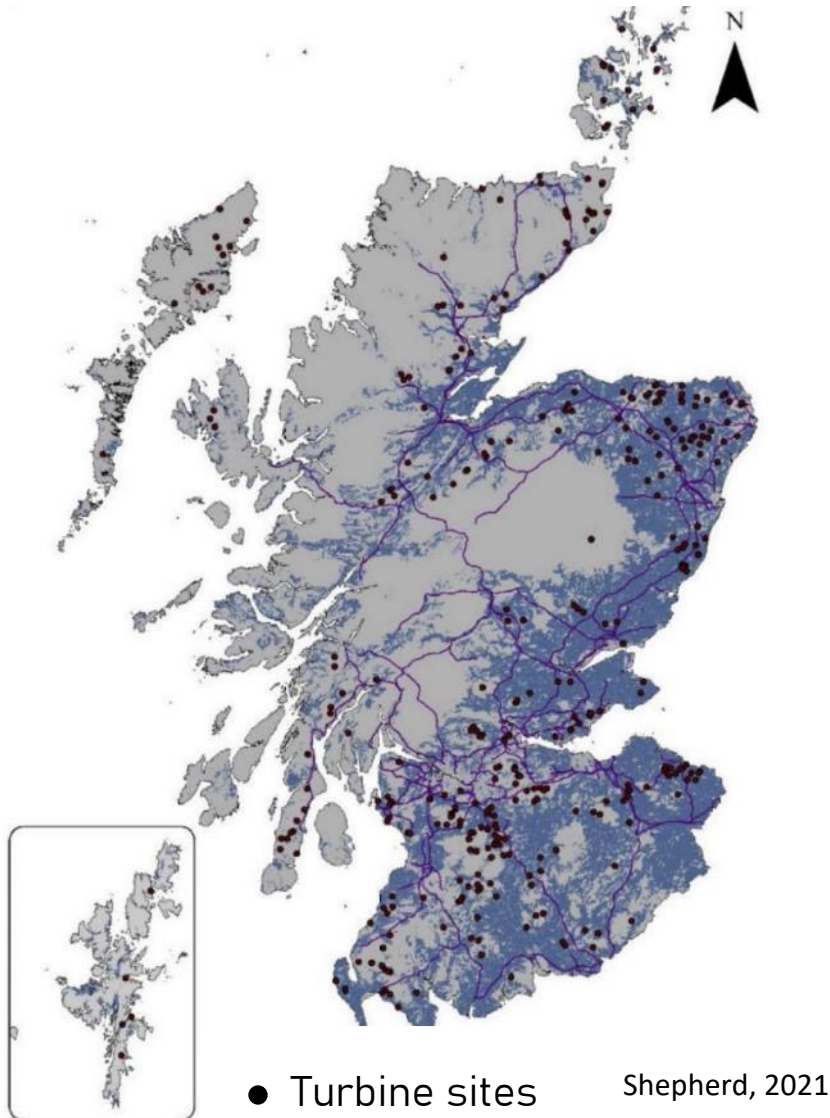
→ Around 80% use natural gas



Domestic energy use 2021

eurostat   
gov.uk statistics 2021

# How can we decarbonise heat?



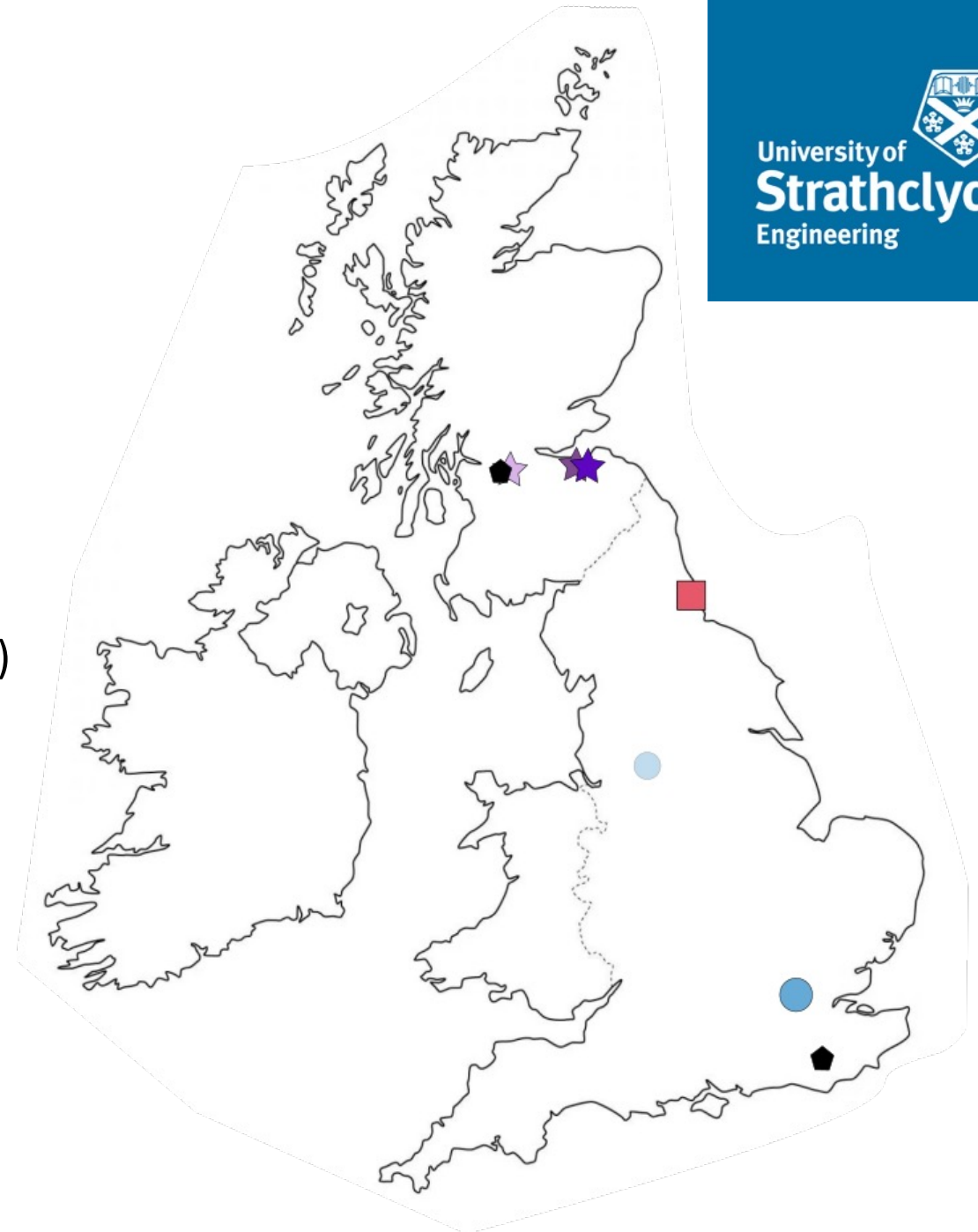
- Renewable electricity sources are intermittent
- Scotland's gross renewable electricity production almost meets its demand, but not all can be/ is used

Estimated: UK spent over £500m on wind energy curtailment payments in 2023, wasting thousands of GWh during valuable high output times

→ **Storage**

# Overview UK

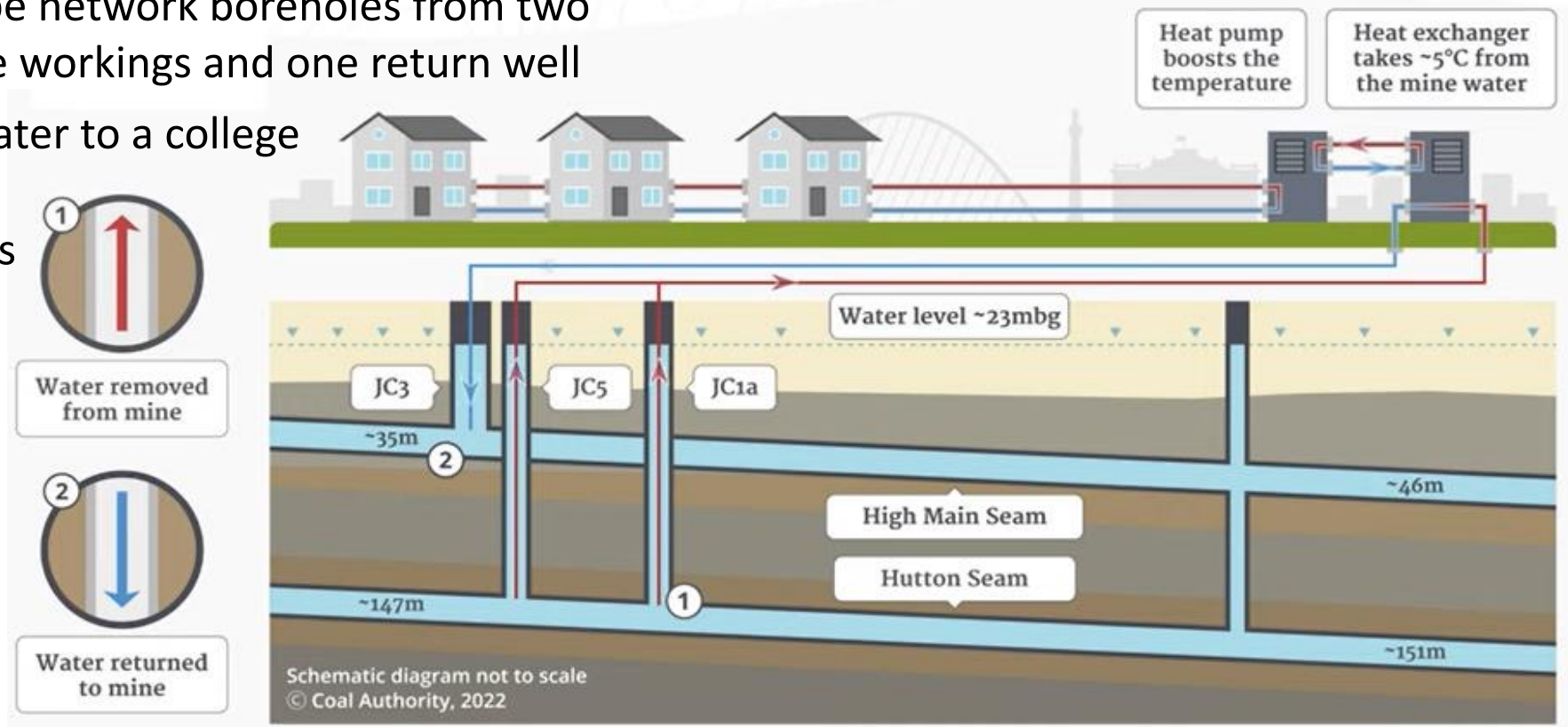
- Gateshead (example Mine water energy scheme)
- ATEs: several projects primarily in London for commercial and apartment block buildings
- ◆ BTES: Several providers of different BTES applications usually for large commercial buildings (Example SWG3)
- ★ UKGEOS
- ★ Galleries to calories
- ★ Mineshafts a vast unexplored opportunity (STEAM)





# Gateshead

- Largest mine water heat network in UK
- Heat from old mine workings 150 m below surface
- 6.2 MW through 5 km pipe network boreholes from two abstractions wells in mine workings and one return well
- Providing heat and hot water to a college Arts Centre, Offices and 350 council-owned homes
- Minewater heating warehouse (Lanchester Wines) also at Gateshead

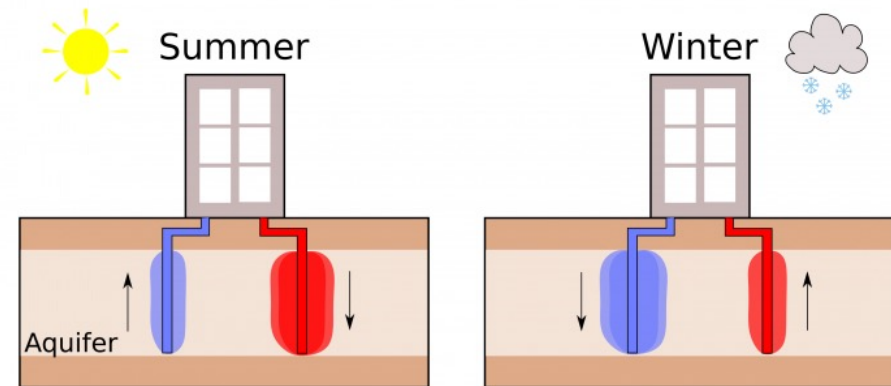


A collaborative research project between Imperial College London, the British Geological Survey and the University of Manchester

# ATES

## Aquifer thermal energy storage for decarbonisation of heating and cooling: Overcoming technical, economic and societal barriers to UK deployment (ATESHAC)

- 11 installations over past 16 years supplying ca. 12 MW
- Projects in fractured Chalk aquifer beneath London and Permo-Triassic sandstone aquifers beneath Manchester and Liverpool
- Large potential for ATES developments in UK
- Project ATESHAC



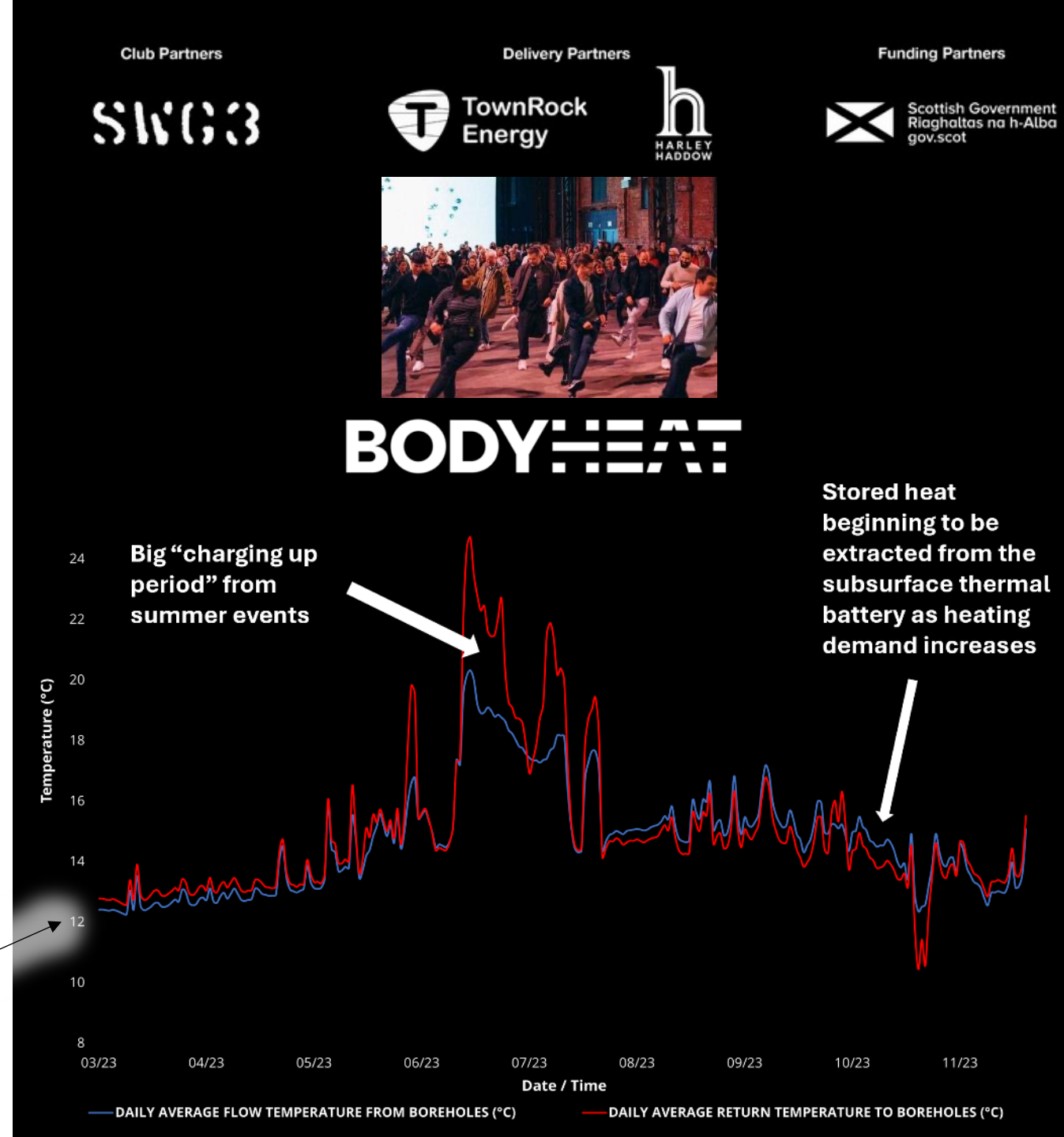
Regnier, 2022

Contact: Jackson, Matthew D: [m.d.jackson@imperial.ac.uk](mailto:m.d.jackson@imperial.ac.uk)

# BTES example at SWG3

- SWG3: Glasgow venue for arts, nightlife and culture
- BODYHEAT system: capture the body heat emitted from venue's visitors stored across 12 underground boreholes in 200 m depth
- Carrier fluid through a closed network of pipes to heat pumps
- Annual consumption of 70 MWh and 170 MWh (thermal) for heating and cooling respectively
- Average flow temperature from boreholes

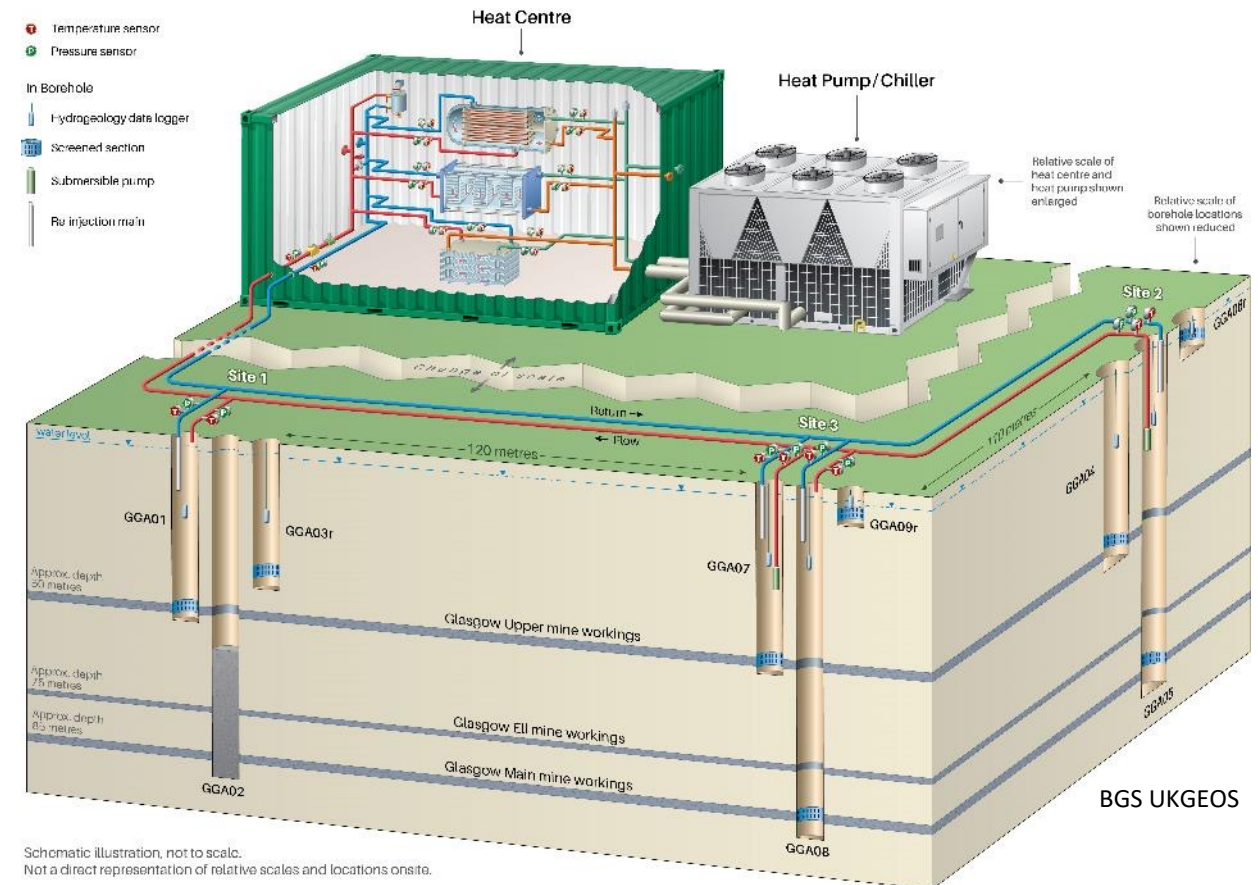
<https://townrockenergy.com/2021/12/15/bodyheat-a-world-first/>



# UK Geoenery Observatories



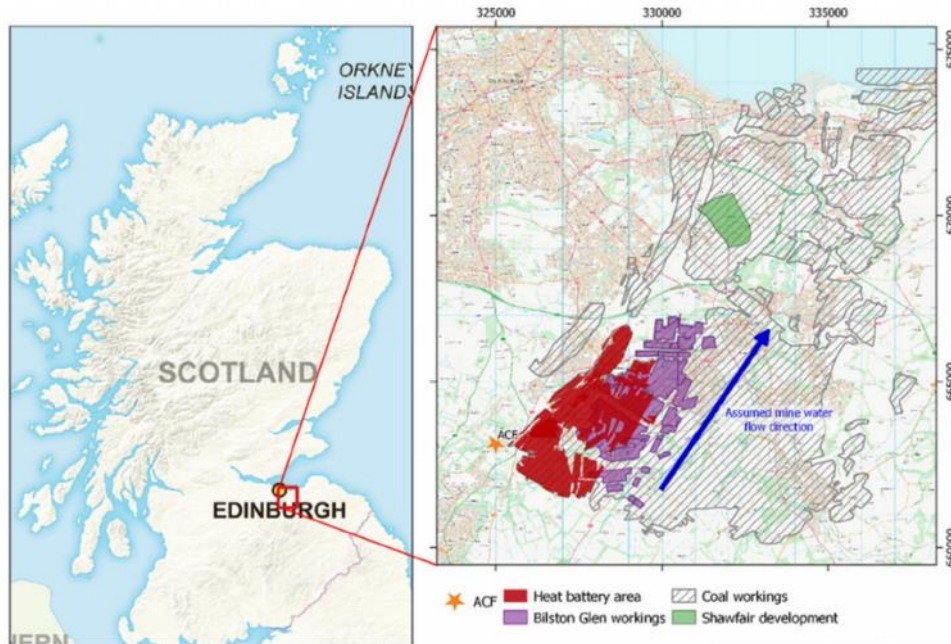
- **Glasgow Observatory** = Research facility for shallow, low-temperature coal mine water heat energy systems and heat storage
- Extensive surface monitoring capability
- Boreholes penetrating flooded mine workings:
  - hydrogeological tests such as tracer tests
  - study of fractured rock mass
  - open water filled voids
  - equipment testing
- **Cheshire Observatory** (open late 2024) = Research into shallow aquifer e.g. thermal storage, contaminant transport etc
- Borehole heat exchangers, 3D imaging of subsurface processes in real time, multilevel groundwater monitoring and hydraulic control



Contact: [ukgeosenquiries@bgs.ac.uk](mailto:ukgeosenquiries@bgs.ac.uk)

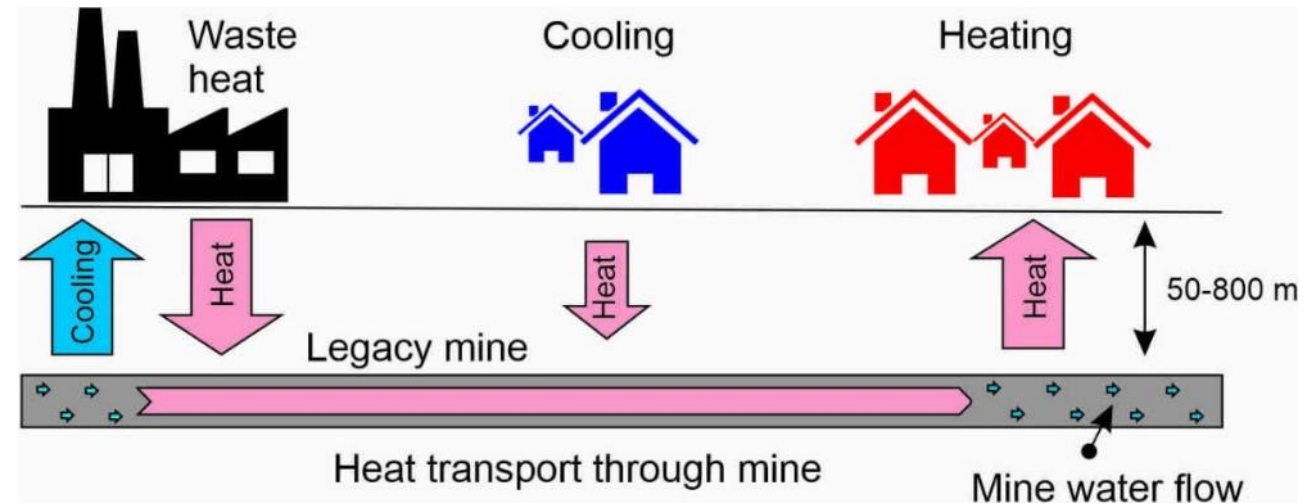


# Galleries to calories



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Fraser-Harris 2022



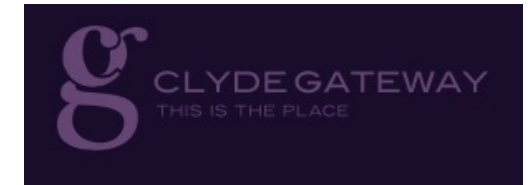
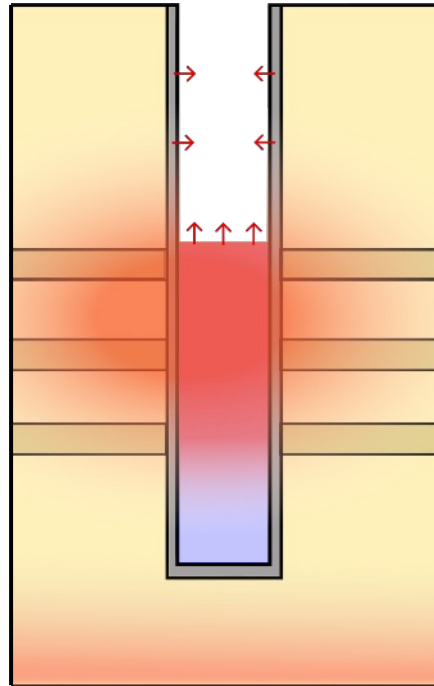
- Feasibility of shallow flooded mine workings to act as a large-scale heat battery
- Low-enthalpy (40°C) heating & cooling technology
- Heat source from University of Edinburgh's Advanced Computing Facility currently up to 70 GWh of excess heat per year with plans to scale up to 272GWh

Contact: [christopher.mcdermott@ed.ac.uk](mailto:christopher.mcdermott@ed.ac.uk)

# STEAM

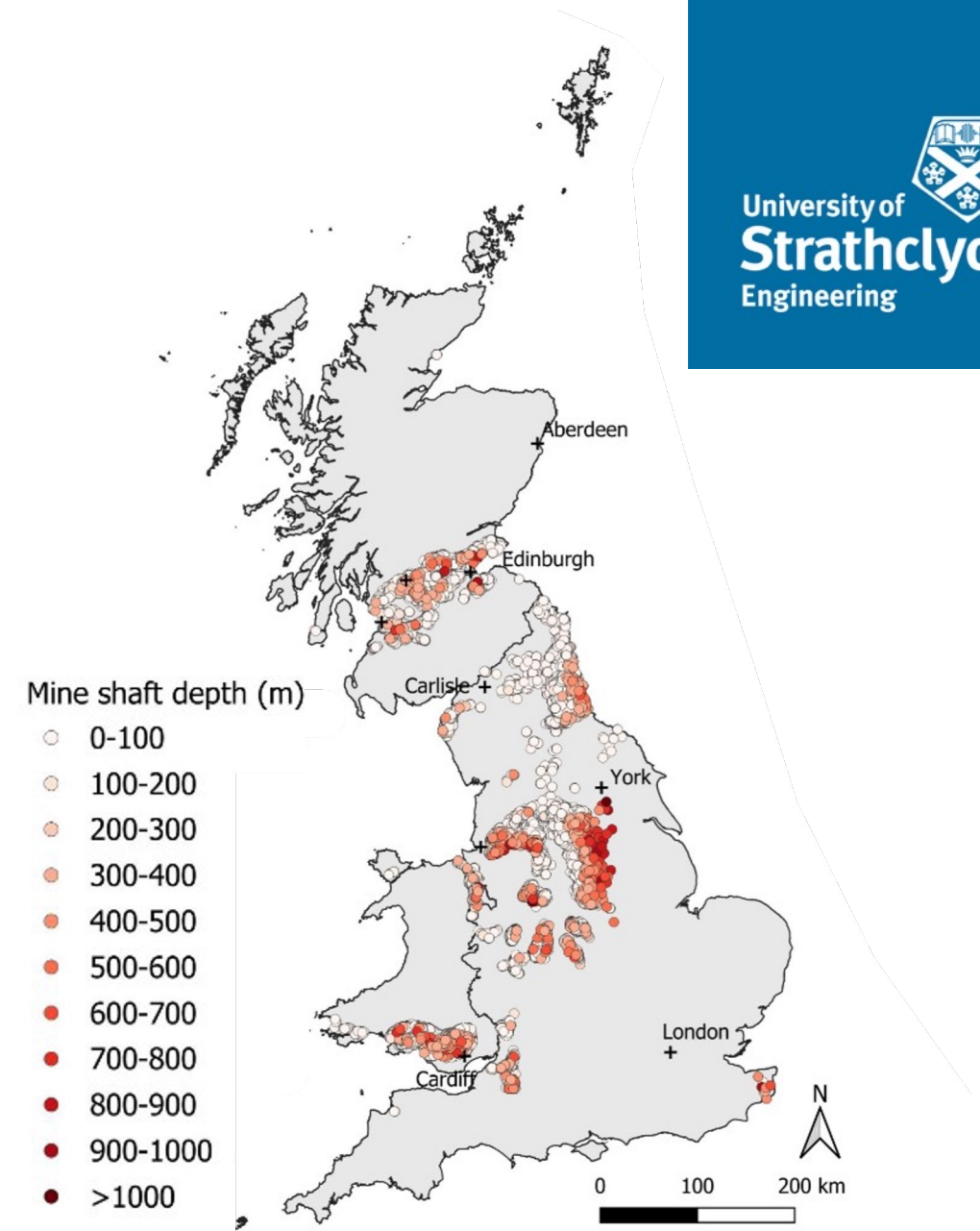
GigaWatt-Hour Subsurface Thermal Energy storage:  
Engineered structures and legacy Mine shafts

Project partners:



# Why shafts?

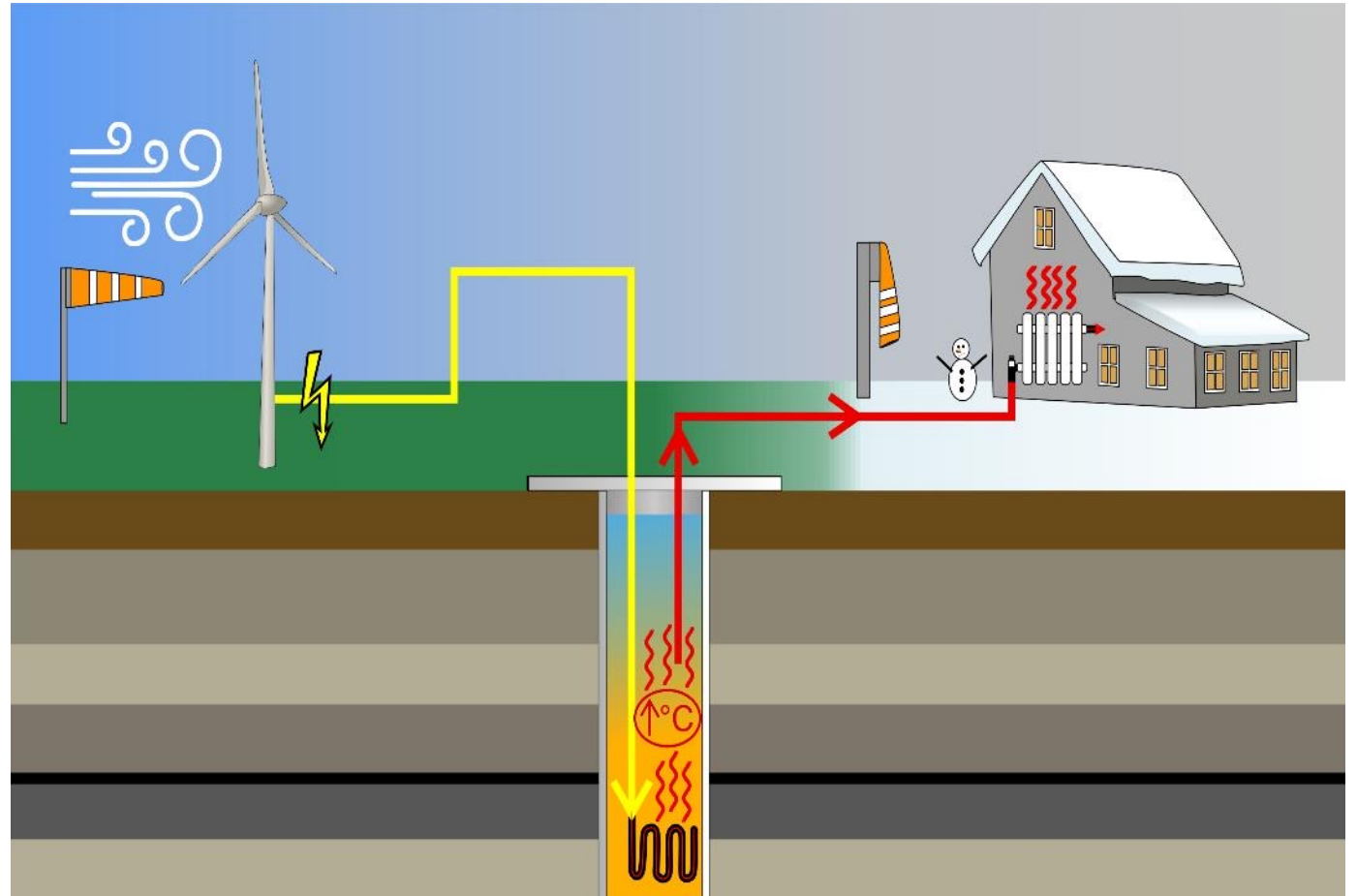
- Pre-existing structures for low-cost heat storage systems close to high population density areas
- 177,000 known mine entries in UK (~ 134,000 mine shafts, filled or open)
- Often concrete lined surrounded by low permeability rocks
- Large volume of water
- Less complexity than mine workings



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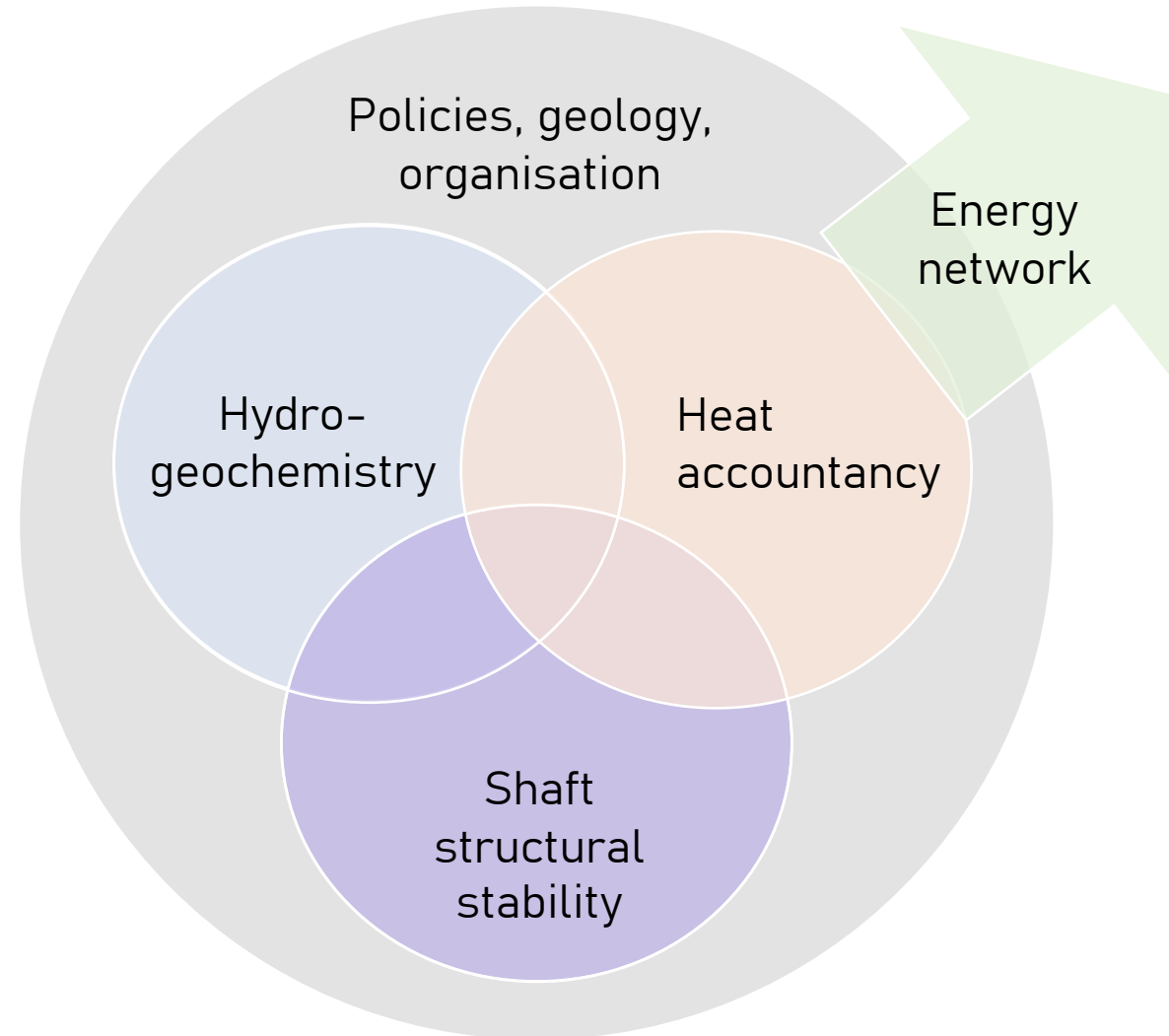
# Why shafts?

- Large volume of water:  
Shaft could store up to 1 GWh(th),  
enough to heat 1600 homes in a worst-  
case weather week (cold, no wind)
- Less complexity than mineworkings:  
Some loss into mineworkings/  
redistribution of heat  
→ More control over the system in a  
mineshaft

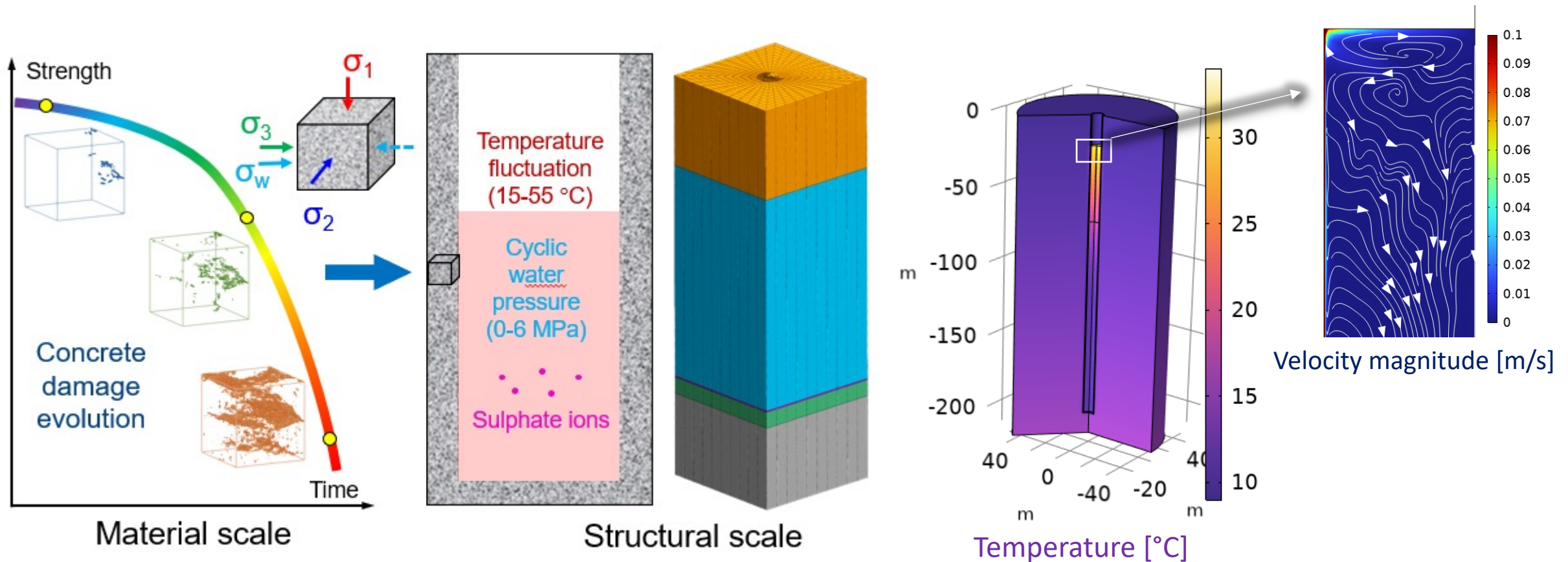




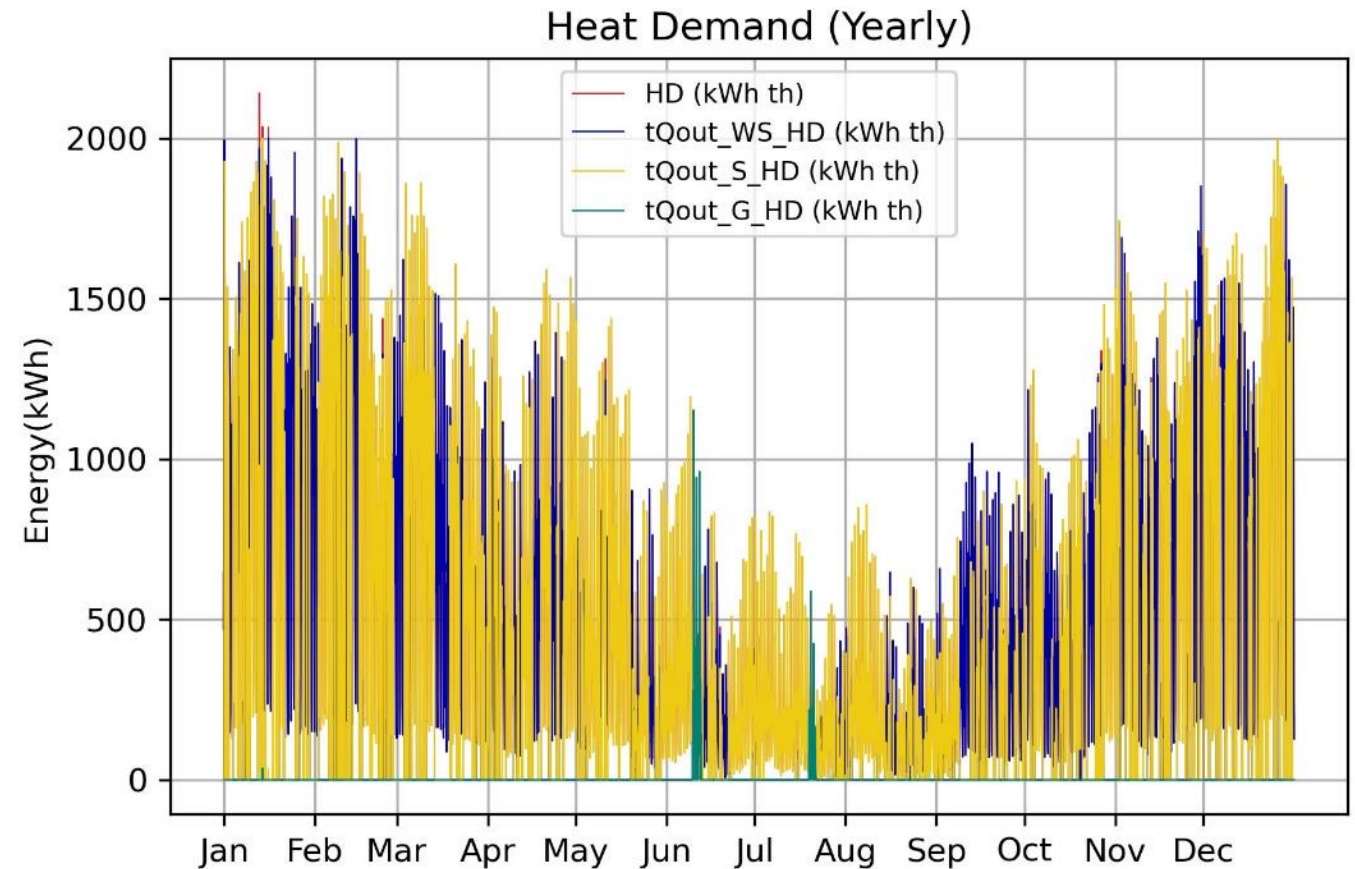
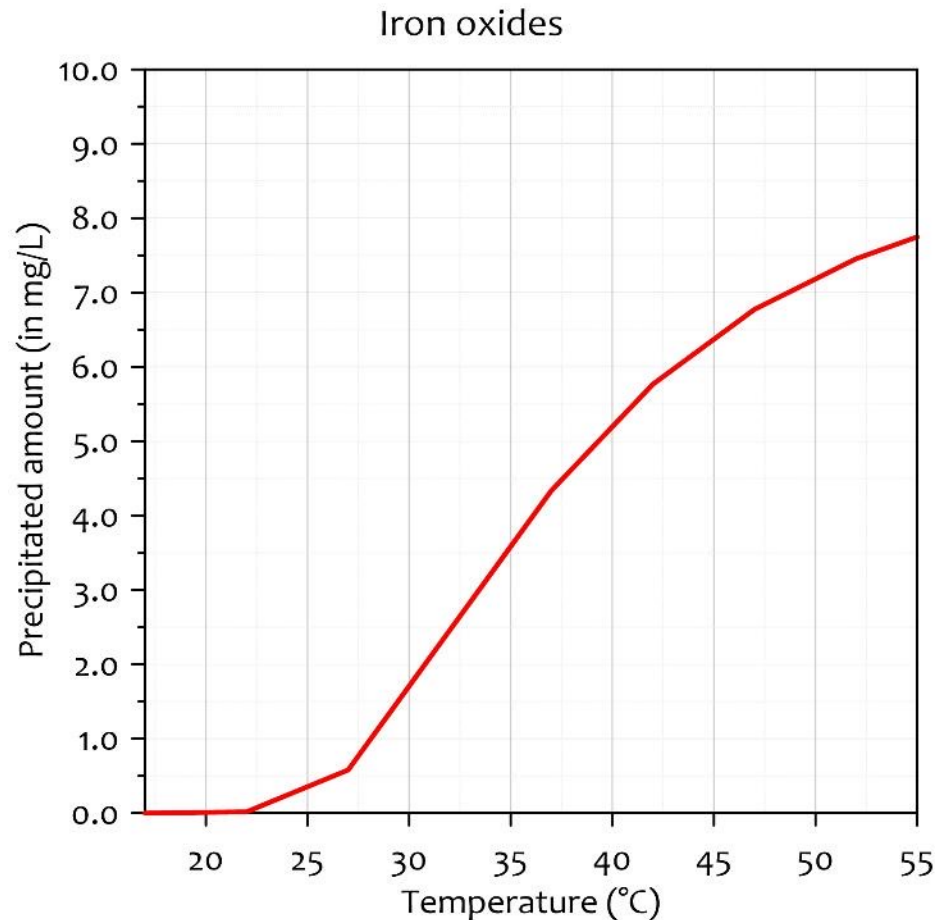
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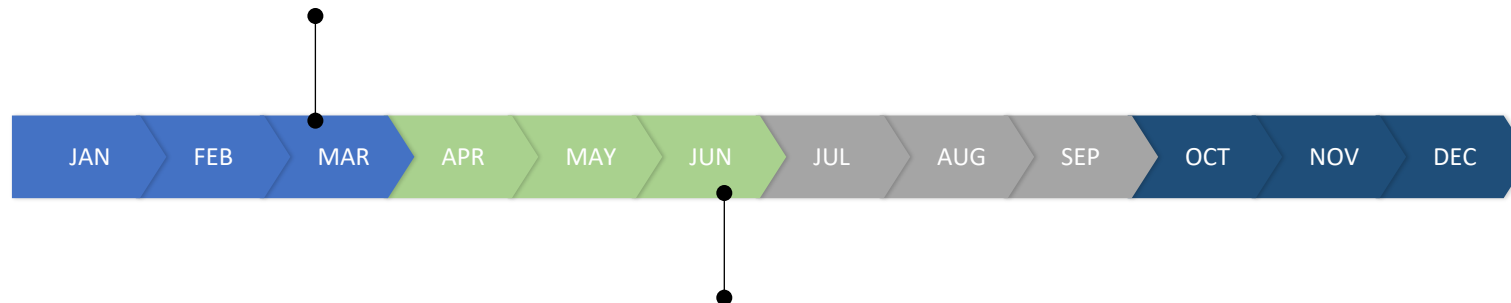
# What is STEAM going to do?



# What will the experiment involve?

## Baseline characterization (Dec 22-May 24)

- Collecting water samples
- CCTV cameras to examine shaft lining
- Structural stability model of shaft lining and cap
- Local geology and groundwater



## Heat injection experiment (June 24-Aug24)

- Small crane/winch for sensors/dataloggers, heater/hotwater pipe
- 'boiler' for hot water



# Conclusion

- **STEAM**

**Investigating challenges and efficiency of heat storage in abandoned coal mine shafts refilled with water**

**Joint experimental/modelling investigation and an upcoming pilot project at a legacy mineshaft in Scotland**

- **Location, availability and volume of flooded mine shafts make them a great asset for energy storage for space heating and cooling especially in Scotland utilising/integrating technology that is available right now**