Expert presentation

Heat pads for the wall

Dr. Felix Marske

“For chemical start-ups, we need innovation which enables top research and flexible development on every stage of technological readiness.”

Shape-Stabilized Phase Change Materials

Novel Heat Storage Units for Hot Water Storage, Construction Materials and PV

Dr. Felix Marske / TU Berlin / Start Up Nanolope / CET Presentation 24.10.2023

Gefördert durch:

Bundesministerium für Wirtschaft und Klimaschutz

aufgrund eines Beschlusses des Deutschen Bundestages

EXIST Existenzgründungen aus der Wissenschaft

ESF Europäischer Sozialfonds für Deutschland

EUROPÄISCHE UNION

Zusammen. Zukunft. Gestalten.

CHEMICAL INVENTION FACTORY John Warner Center for start-ups in Green Chemistry

CENTRE FOR ENTREPRENEURSHIP BERLIN

TU Berlin

Challenge of heat transition

Renovation of energy-inefficient buildings

Daytime dependent renewable resources

Space requirements of storage systems

Phase Change Material (PCM)

Heat Storage by a Phase Change

Ice as PCM

PCM Melting

Water as PCM

Phase Change Material (PCM)

Heat Storage by a Phase Change

Ice as PCM

PCM Melting

Water as PCM

Δ Energy

Cold Water

Water Heating

1 °C to 80 °C

Hot Water

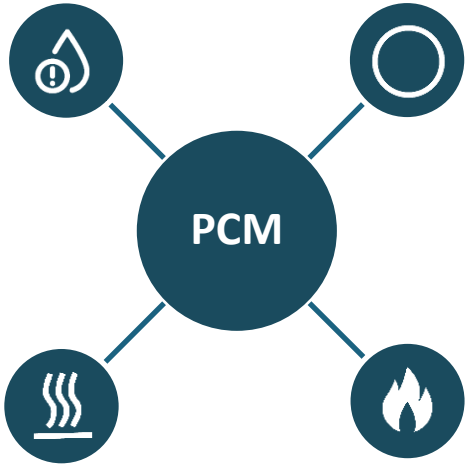
Current Problems of PCMs

PCM leakage

Phase separation

Low thermal conductivity

Moderat flammability



Nanolope PCM as Solution

A Novel Shape-Stabilized PCM

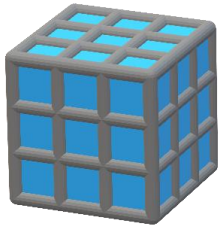
PCM melts

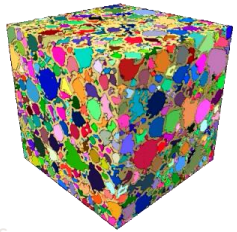
in porous carrier

Nanolope PCM

Nanolope PCM

Silica carrier





10 µm

PCM in pores

Nanolope PCM

Energy

150 – 200 J/g

Stability

2 – 3 MPa, ~ 200°C

Durable

> 32 years

End-customer benefit of Nanolope Storage Tanks

Nanolope Tank

- Demand for heat ↓
- Electricity, gas, oil ↓

Savings by heating

- Electric: 3200 €/year
- Gas: 2100 €/year
- Oil: 1300 €/year

Costs

- 2x 600l Nanolope Storage Tanks for 7800 €

Calculations based on a 2x 600l Hot Water Storage Tank for apartment buildings with 75.000 kWh annual consumption (Bosch Study)
Market prices → gas: 0,25 € / kWh, electricity: 0,39 € / kWh, oil: 0,16 € / kWh

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Amortisation

- 2 to 6 years

Calculations based on a 2x 600l Hot Water Storage Tank for apartment buildings with 75.000 kWh annual consumption (Bosch Study)
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Future Application Fields of shape-stabilized PCMs

Increasing Heat Storage Capacity

Shape-stabilized PCM

Enabling Passive Cooling

Construction Materials

Thermal Water Heating

Photovoltaic

Batteries

Electrical Heater

What ss-PCMs do we need?

ss-PCM with high thermal conductivity for batteries

ss-PCMs with no flammability

Broader range of inorganic ss-PCMs

ss-PCM as papers to cool electronic devices

Contact

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EUROPEAN PARTNERSHIP

Sustainability

9 / 12 Principles of Green Chemistry

Carbon Footprint of 0.34 t per 1 t PCM

90% Recycling by Phase Separation

Bio-Based Educts and no rare metals

Local and European Manufacturer

Expert presentations

Galeries to calories

Hester Claridge

TownRock Energy

Heatstore for electricity

Dorien Dinkelman

Geoscientist at TNO Energy Transition

Underground Thermal Energy Storage

Diversification and resilience for the EU energy system

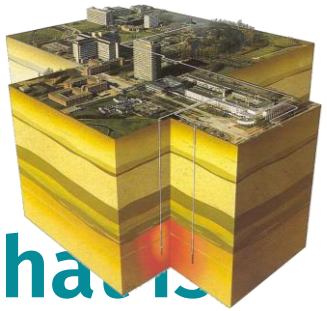
TNO innovation for life

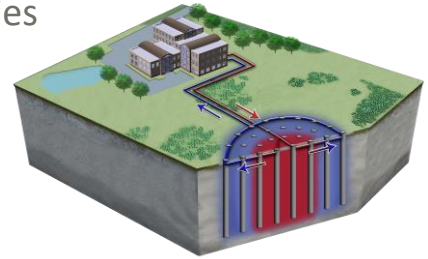
CETPartnership Annual Conference 24 October 2023
Dorien Dinkelman, Joris Koornneef, Ivo Vos (TNO)

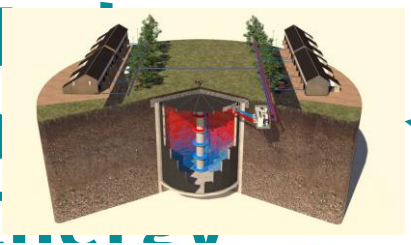
Underground Thermal Energy Storage (UTES)

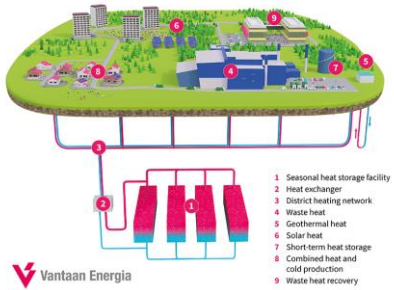
TNO innovation for life

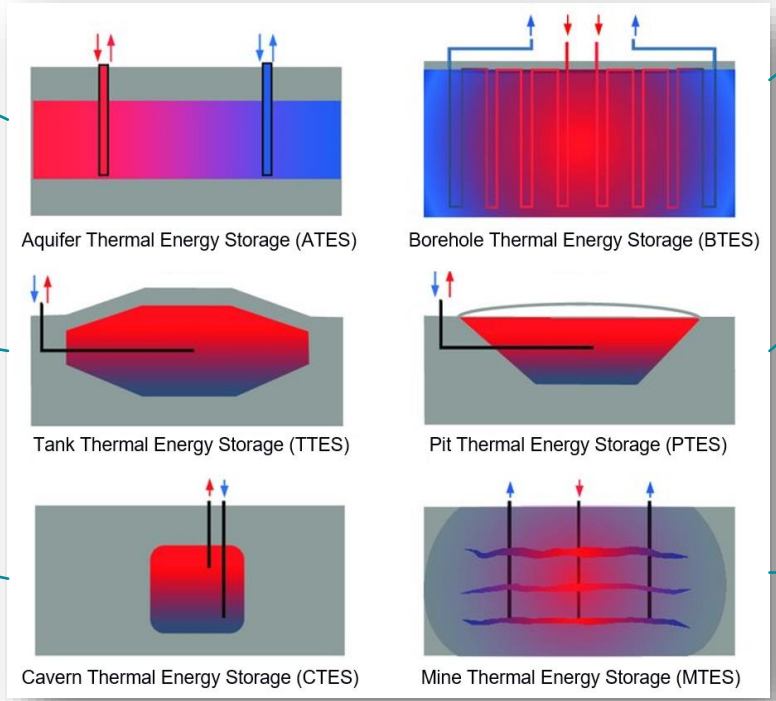
- Matching subsurface suitability with different UTES technologies
  - Water volumes: 1.000 m^3 to 1.000.000 m^3
  - Storage capacities: 100 - 90.000 MWh



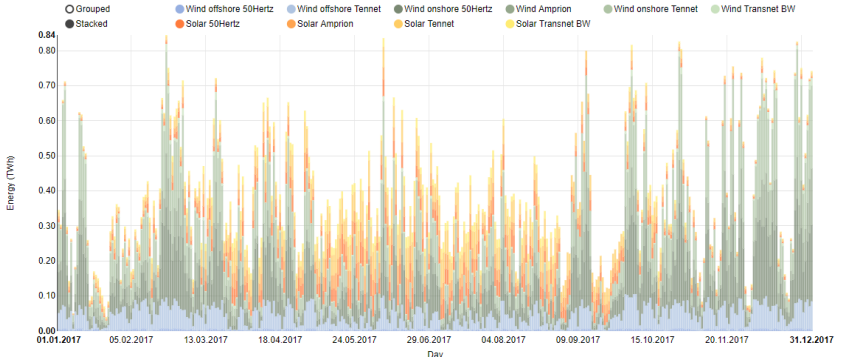




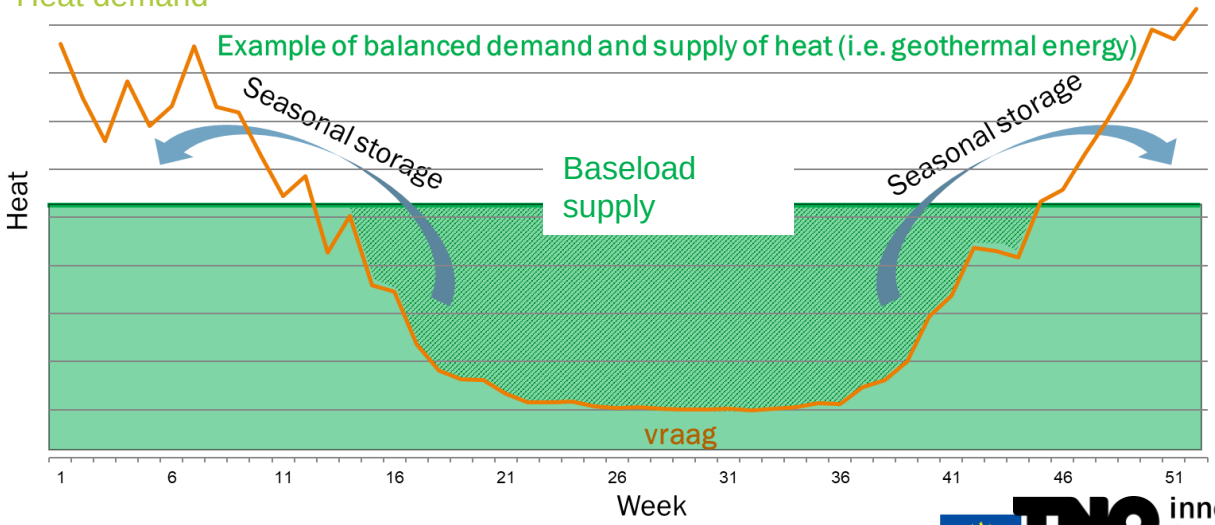




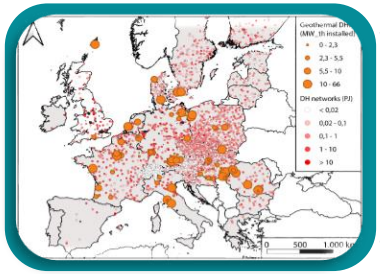
Electricity supply profile



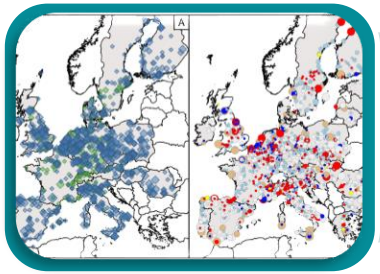
Heat demand



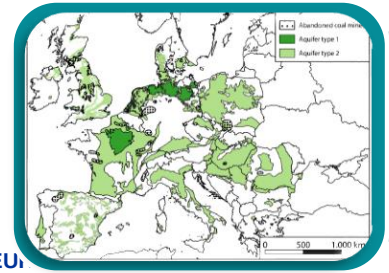
Untapped EU potential for Underground Thermal Energy Storage



Heating demand

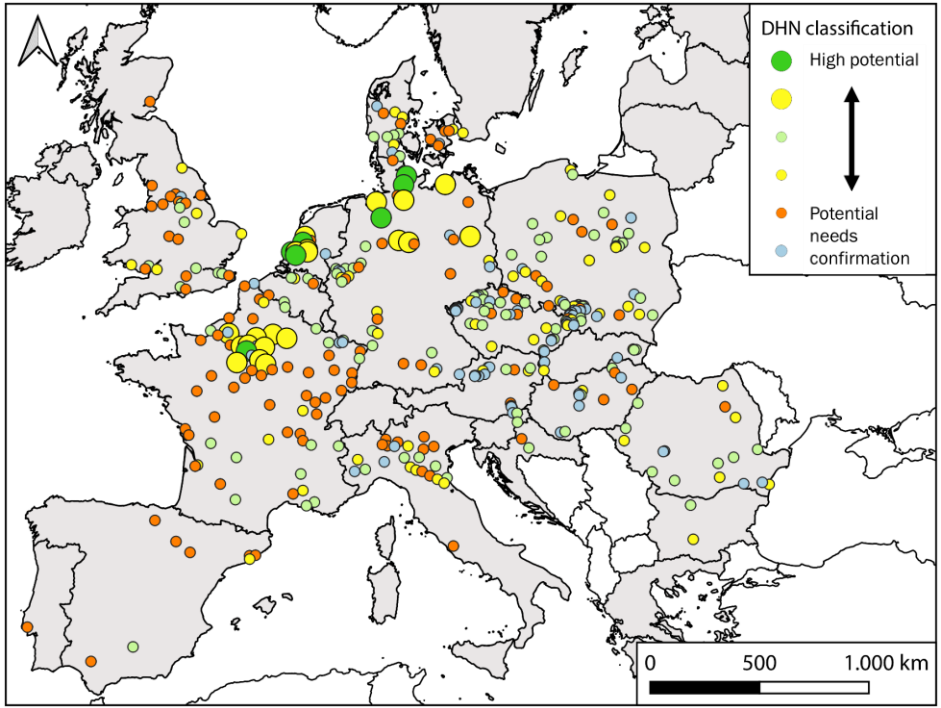


Excess heat

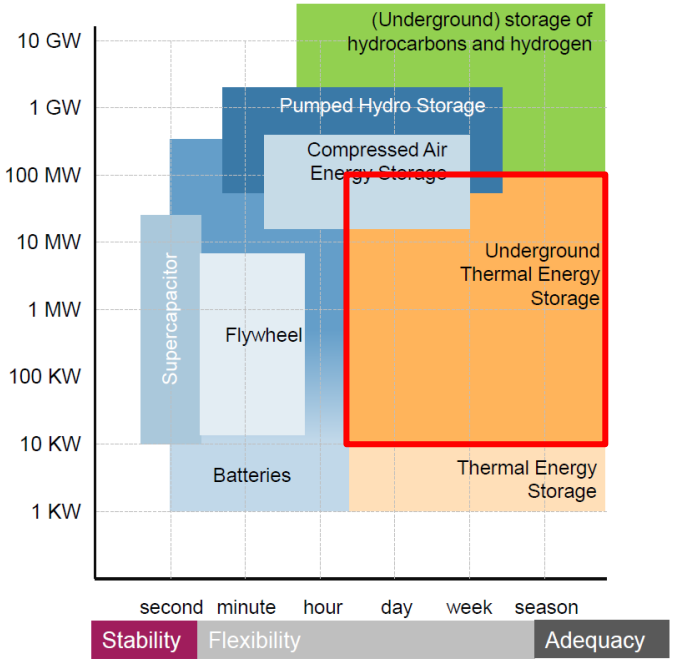


Subsurface suitability

Result: 690 PJ of excess heat within 5 km of a DH network and located above an aquifer or mine, spread over 387 locations



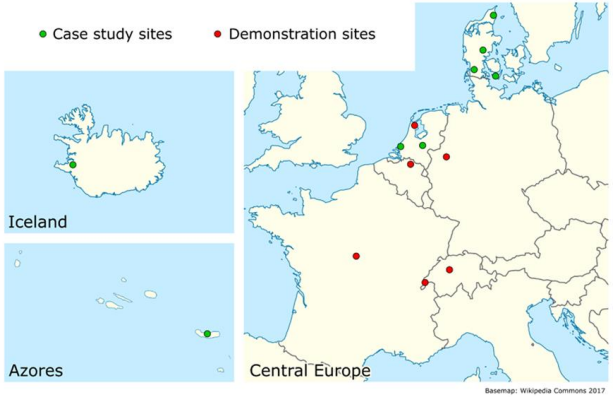
Source: Van der Stoel (2022)



Colours (infrastructure):
Electricity grid
(Renewable) gas infrastructure
Heat networks

Source: TNO, inspired by IEA

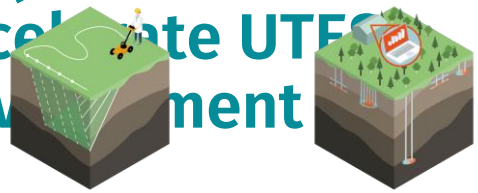
heatstore
High Temperature Underground Thermal Energy Storage

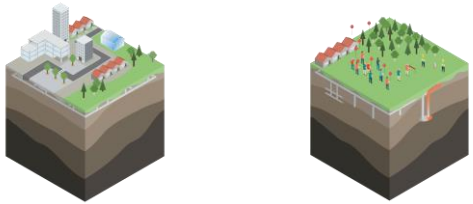


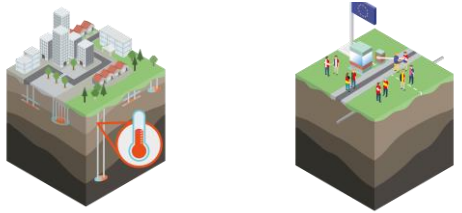
GEOTHERMICA

- 6 demonstration sites, 8 case studies
- 23 partners in 9 European countries
- EU Geothermica Era-Net co-fund
- 16.3 MEUR total project budget

HEATSTORE project to accelerate UTES development







Characterization of UTES	Modeling subsurface dynamics	System integration & UTES design optimisation	Demonstration	System performance monitoring	Fast track market uptake

EUROPEAN PARTNERSHIP

HEATSTORE Roadmap for flexible energy systems with underground thermal energy storage towards 2050: www.heatstore.eu/downloads

TNO innovation for life

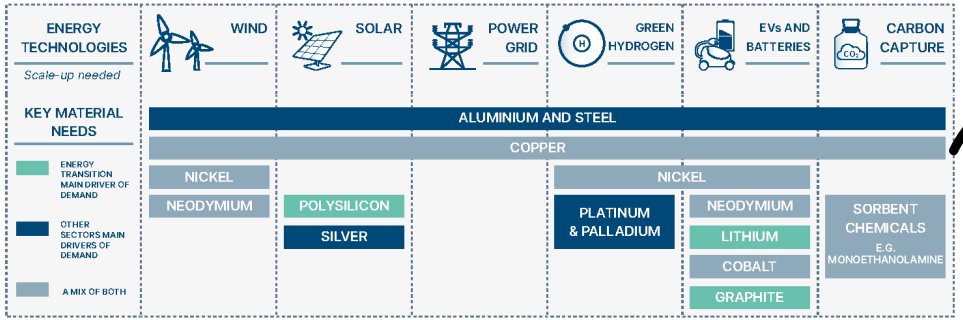
We need successful demonstrators and commercial projects

- Example: HT-ATES Middenmeer
- Largest (unknown) battery of the Netherlands
- Combination of geothermal source + subsurface storage: interesting for business case and material supply chain

Pictures at Ennatuurlijk Aardwarmte (former ECW Energy)

Very low pressure on critical material supply chains

- Deploying clean energy technologies will require a range of materials
- Underground Thermal Energy Storage uses the subsurface and water as storage medium, and diversifies from other storage technologies regarding supply chain.
    - Innovation ecosystem needed: subsurface knowledge, engineers (human capital)!



UNDERGROUND THERMAL ENERGY STORAGE

- **Plastics** (PVC, high density polyethylene (PEX), Glassfiber Reinforced Epoxy)
- **Insulation materials** (polyolefin foam, polystyrene, glas/rock wool, polymers, vacuum panels, aerogels, mussel shells)
- **Packer material** (grout/cement, gravel, bentonite clay)
- **Stainless steel**
- **Antifreeze**

“Urgent action is needed to tap into the very large European potential of underground thermal energy storage to diversify the energy storage portfolio and reduce our dependency on critical material supply chains.”

Thank you!

Dorien Dinkelman, Joris Koornneef, Ivo Vos (TNO)

TNO innovation for life

Galleries2Calories (G2C)

Presented by: Hester Claridge, Project Manager

Date: 24.10.2023

G2C – Heat GeoBattery

Using abandoned flooded coal mines to store and transport waste heat

Co-funded by:
Scottish Enterprise, Scotland
Geological Survey Ireland (GSI)
Department of Energy (DoE) USA
European Union

Plus significant own contributions from project partners.

Research Questions

1. Feasibility Study for ACF Cooling Using Mine Water

- Quantification of Waste Heat Available
- Abstraction & Discharge Locations Identified
- Cost Engineering
- Environmental & Social
- Risk Assessment

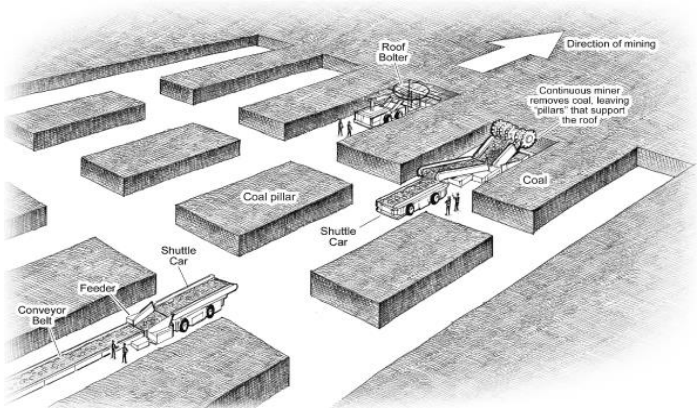
2. Development of the Experimental Field Site

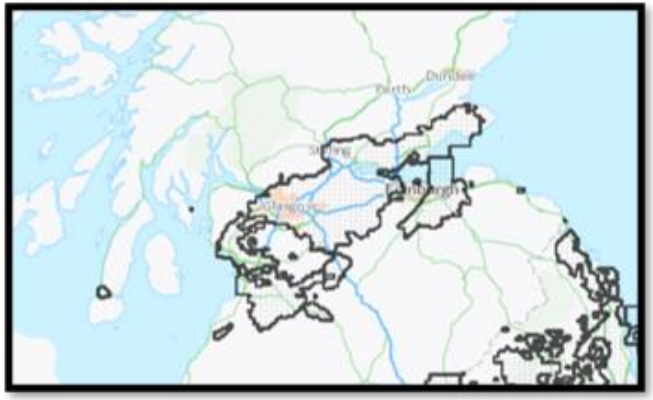
- Baseline Monitoring
- Borehole drilling:
- 1 x abstraction borehole
- 1 x discharge borehole
- 1 x monitoring borehole
- Hydraulic and Tracer Tests
- Local Monitoring

3. Modelling, Monitoring and Making It Happen

- Heat Discharge
- Heat Storage
- Heat Transport
- Heat Recovery
- Heat Ownership
- Regulation & Policy
- Techno-economic Case

Historic mine workings = geothermal resource?





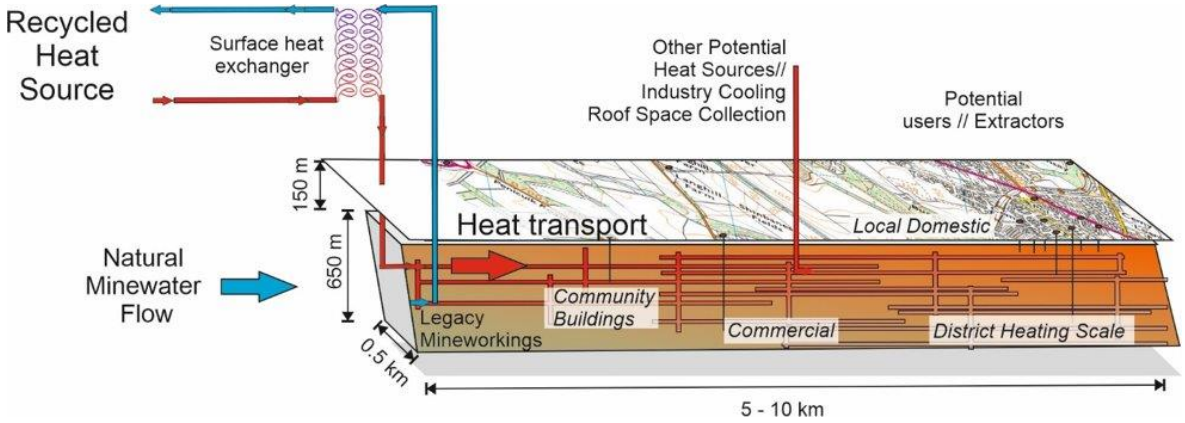
- About **600,000** households are facing fuel poverty in Scotland
- Up to **1 in 4 households in the central belt of Scotland**
- **1,677 GWh** of waste heat across ~1000 sites in Scotland
- Mine workings acting as a free heat network

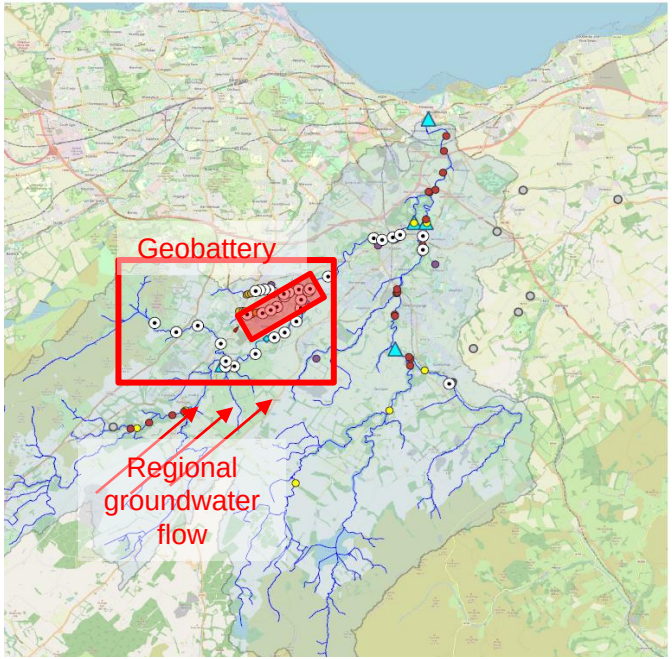
https://www.climatexchange.org.uk/media/4481/waste-heat-sources-for-heat-networks-scotland-final-nov-20.pdf

https://mapapps2.bgs.ac.uk/coalauthority/home.html

https://www.gov.scot/publications/scottish-house-condition-survey-2019-key-findings/pages/6/

GeoBattery Concept

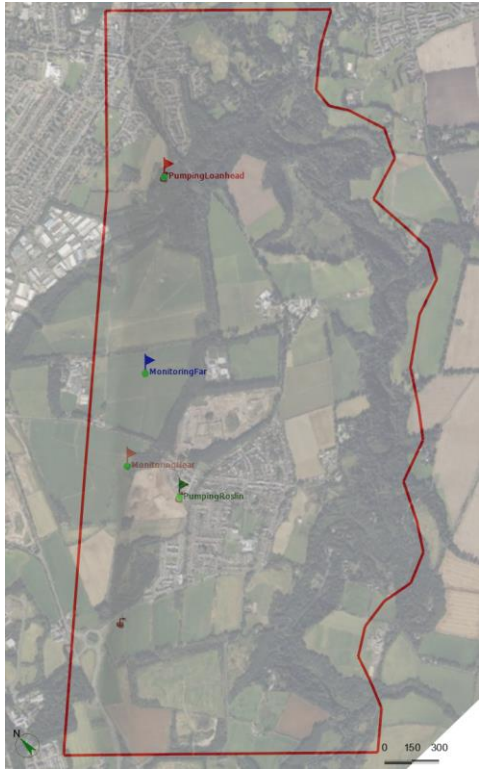


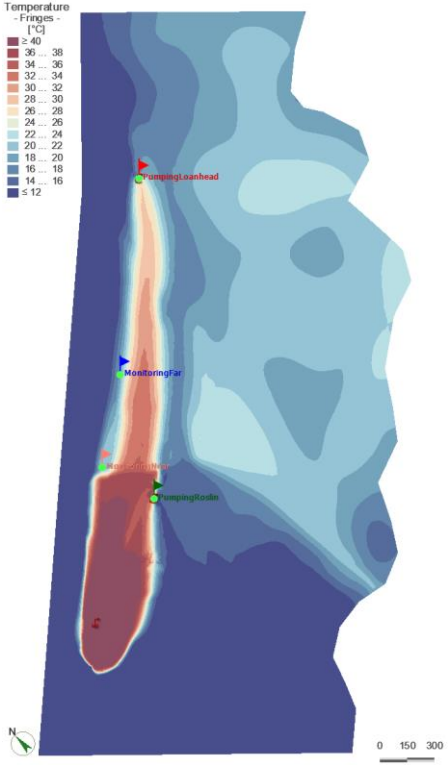


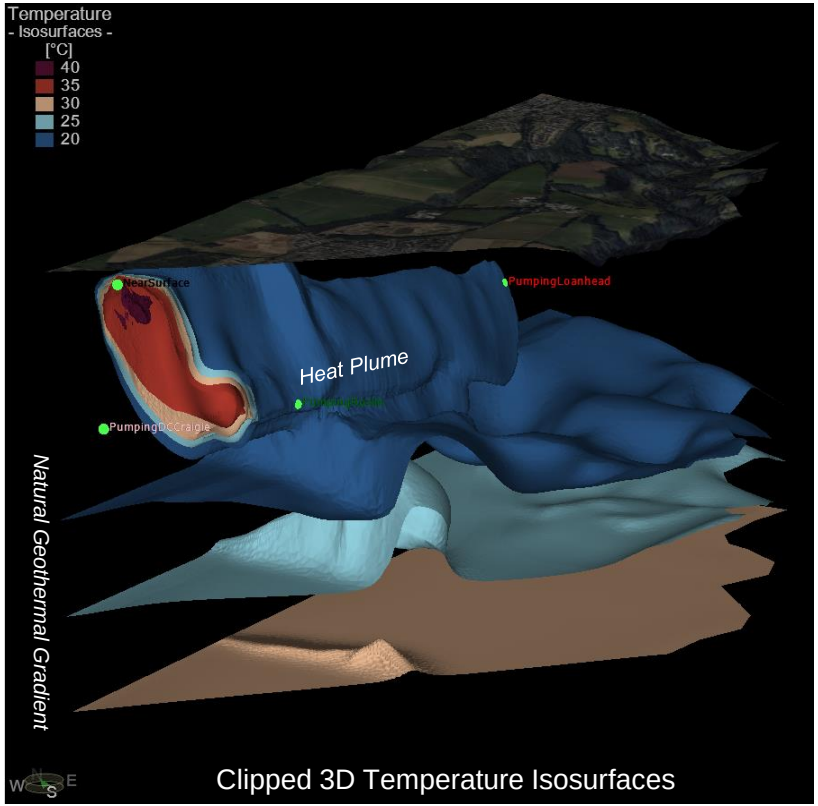
GeoBattery 'footprint'

- Geobattery footprint covers ~5km^2
- Interacts locally with a number of watercourses
- Historic, shafts/adits near watercourses could be activated
- Potential interactions minewater discharges in Dalkeith and Vogrie

3D Numerical Model Area and Initial Results







Outcomes, Further Research and Innovation

- Outline techno-economic modelling tool for the Heat GeoBattery concept
- UK and Scottish Governments policy and regulatory recommendations for the use of mine workings as thermal stores
- Guidance on potential application of Heat GeoBattery concept to European & United States of America flooded mineral mines
- Best Practice Guidelines from G2C project for future projects
- Archetyping types of mines for thermal storage and transfer properties, by region
- Support documentation for Local Authorities / Municipalities to permit and support projects including the interface with heat networks

Thank you for listening

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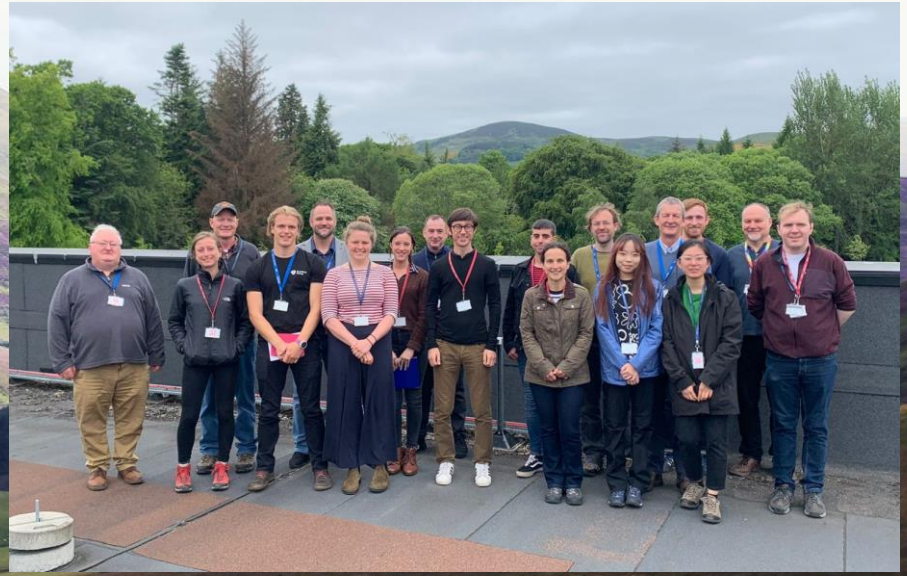

Presented by:
Hester Claridge

Date:
24.10.2023

Slido Poll 2

What are open research topics with respect to the presented concepts?

- Sustainability aspects of digitalization of the energy system
- Multiple energy storage types working together
- Energy storage (power, heat and molecules)
- Battery Diagnostics durability
- Lighting technologies
- Bring a device that does both generate or store energy on demand to comply with the needs of the grid
- Hydrogen technology
- Super condensators
- Flexible Energy systems for better management of the energy demand
- Regenerative business models
- Dynamic cable
- Policies and regulation, development and know-how on a municipal level (building permits, competence, expertise) that increases local government competences, decreases administrations times etc.
- Bring technologies to the market

Slido Poll 2

What are open research topics with respect to the presented concepts?

- Carbon-zero action/application
- Cradle to the grave analysis
- Scalability of technologies and processes
- Integration of energy sources
- Flow batteries
- Heat transition
- Innovative technologies for energy production from low temperature heat sources
- Role of seasonal storage
- Social and societal aspects
- Long-term usability of ATES - for example plugging problems
- Competition for "waste" materials
- Heat Transition
- Re- and upcycling if materials
- Security issues of decentralised energy
- Circularity pure lignin production
- Social equality and decentralisation