



THE UNIVERSITY
of EDINBURGH



Galleries2Calories

*Techno-economic feasibility of using
abandoned flooded mines for storage
and transport of data-centre waste heat*

Leah Swan (TRE)

Sam Smith (TRE)

Sean Watson (UoG)

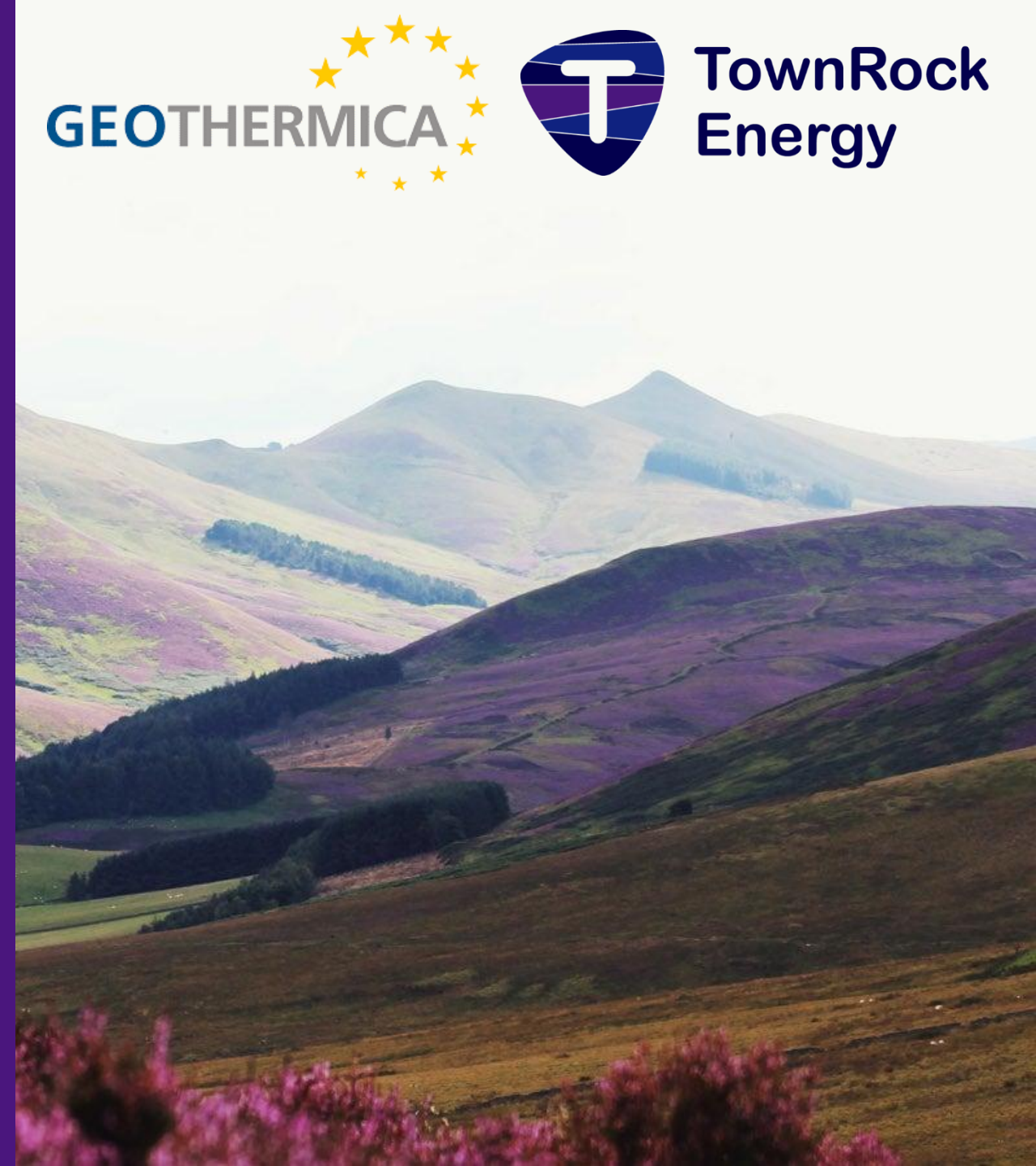
Alejandro Perez Silva (UoE)

David Townsend (TRE)

March 2026



**TownRock
Energy**



Contents

01

Background

02

Supply & Demand
Assessment

03

Techno-Economic
Modelling

Part 1

Background

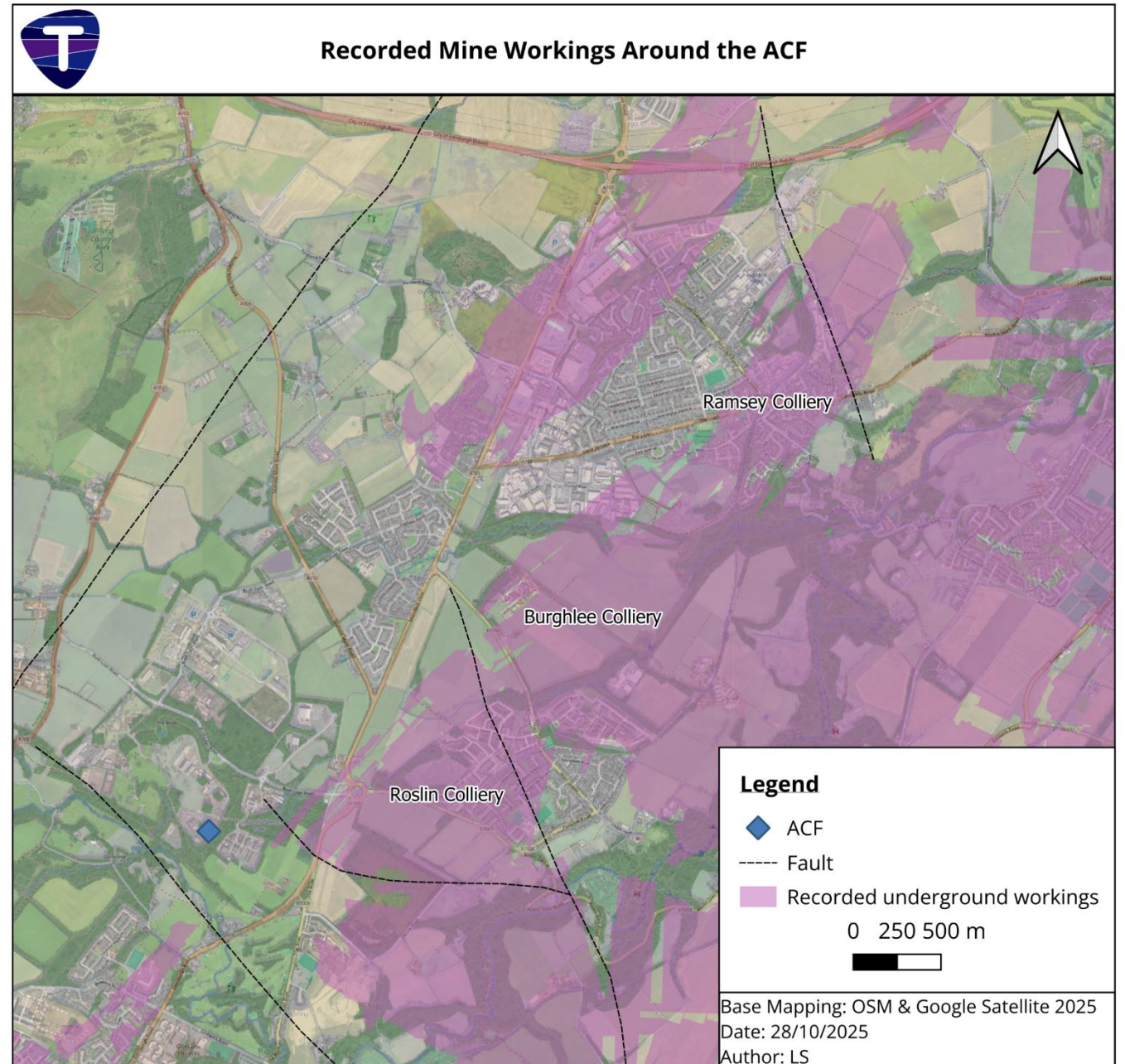
Galleries in pillar and stall workings

Galleries 2 Calories

- G2C aims to demonstrate, for the first time, the use of **legacy mine workings (galleries) to store and transport data centre waste heat (calories!)**
- Data centres currently use 3% of global electricity.
 - Cooling accounts for up to 50% of this.
 - **High cost for cooling.**
 - **Large potential waste heat source.**
- Long term aim to use this excess heat to provide heating to homes and businesses.

The "geobattery" concept

- **Case study:** University of Edinburgh Advanced Computing Facility (ACF).



Part 2

Supply & Demand Assessment

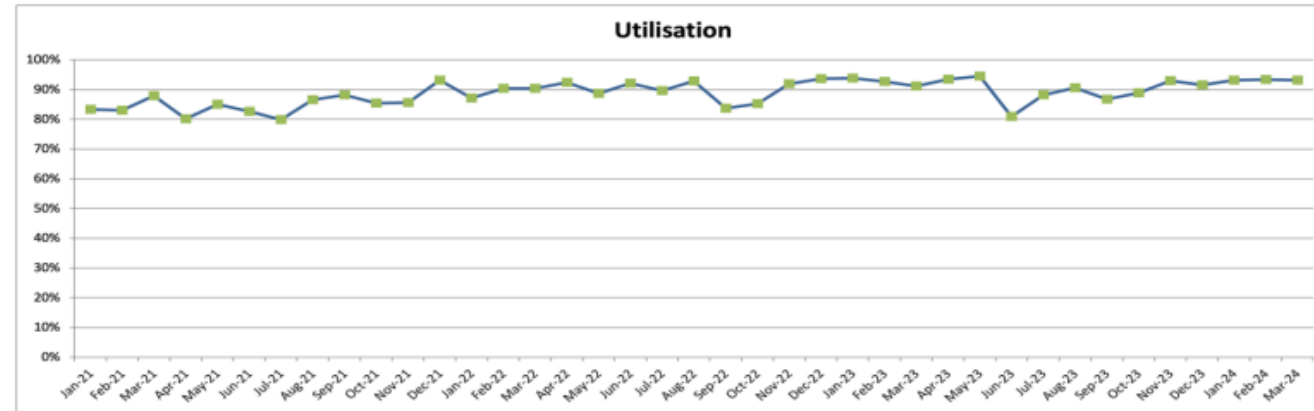
Waste Heat Supply Assessment



- ACF infrastructure and capacity assessed to quantify size of the waste heat resource available.
- National importance of ACF computing equipment means utilisation throughout the year is high.

→ **Means lots of waste heat available!**

- Due to Edinburgh's cool climate, atmospheric free cooling can be employed for three quarters of the year.
- **Future expansion could increase demand to 30 MW and reduce potential for free cooling.**



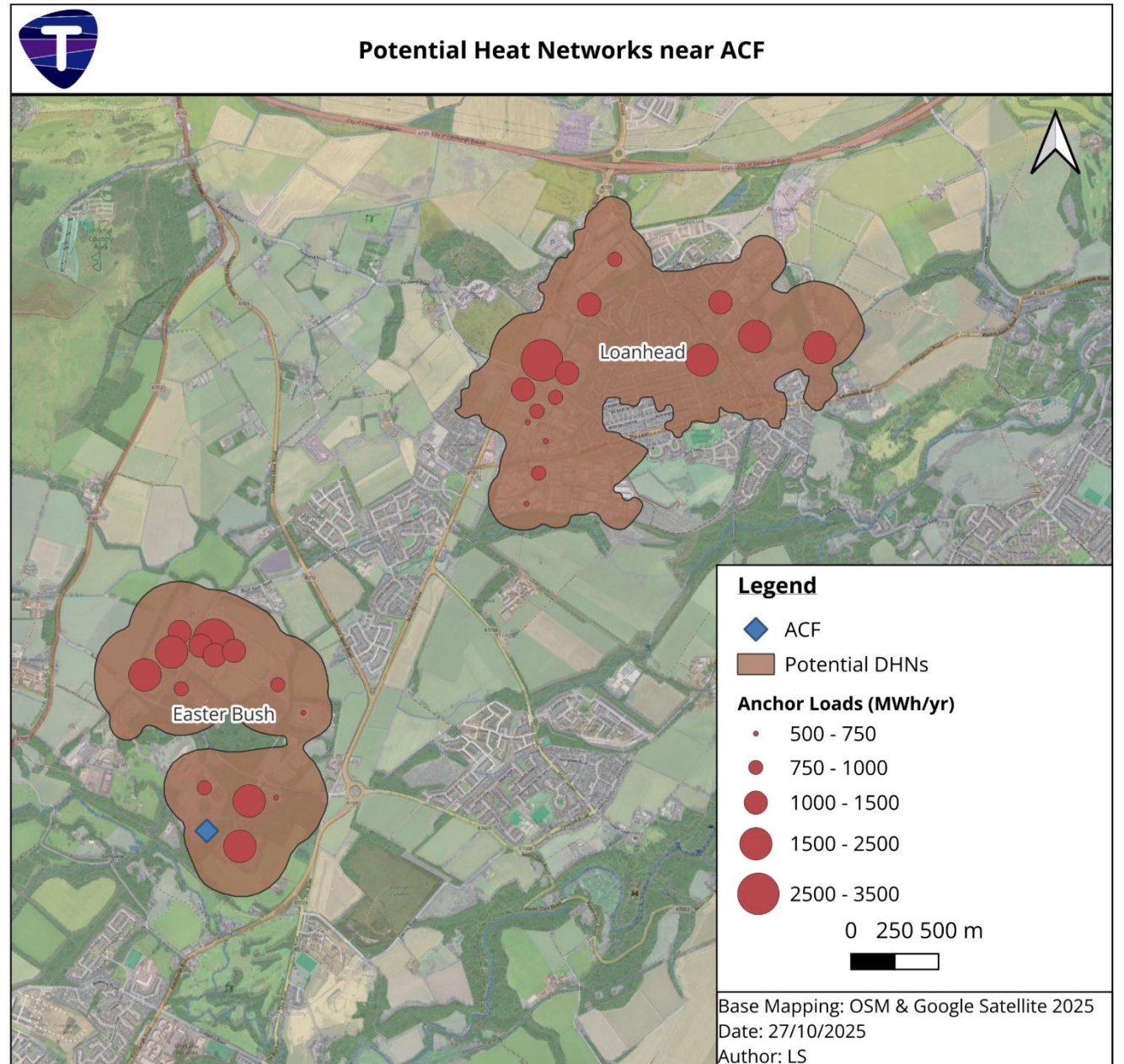
ARCHER2 utilisation from January 2021 - March 2024.

Current cooling demand	6 MW
Waste heat temperature	32 °C

Heat Demand Assessment

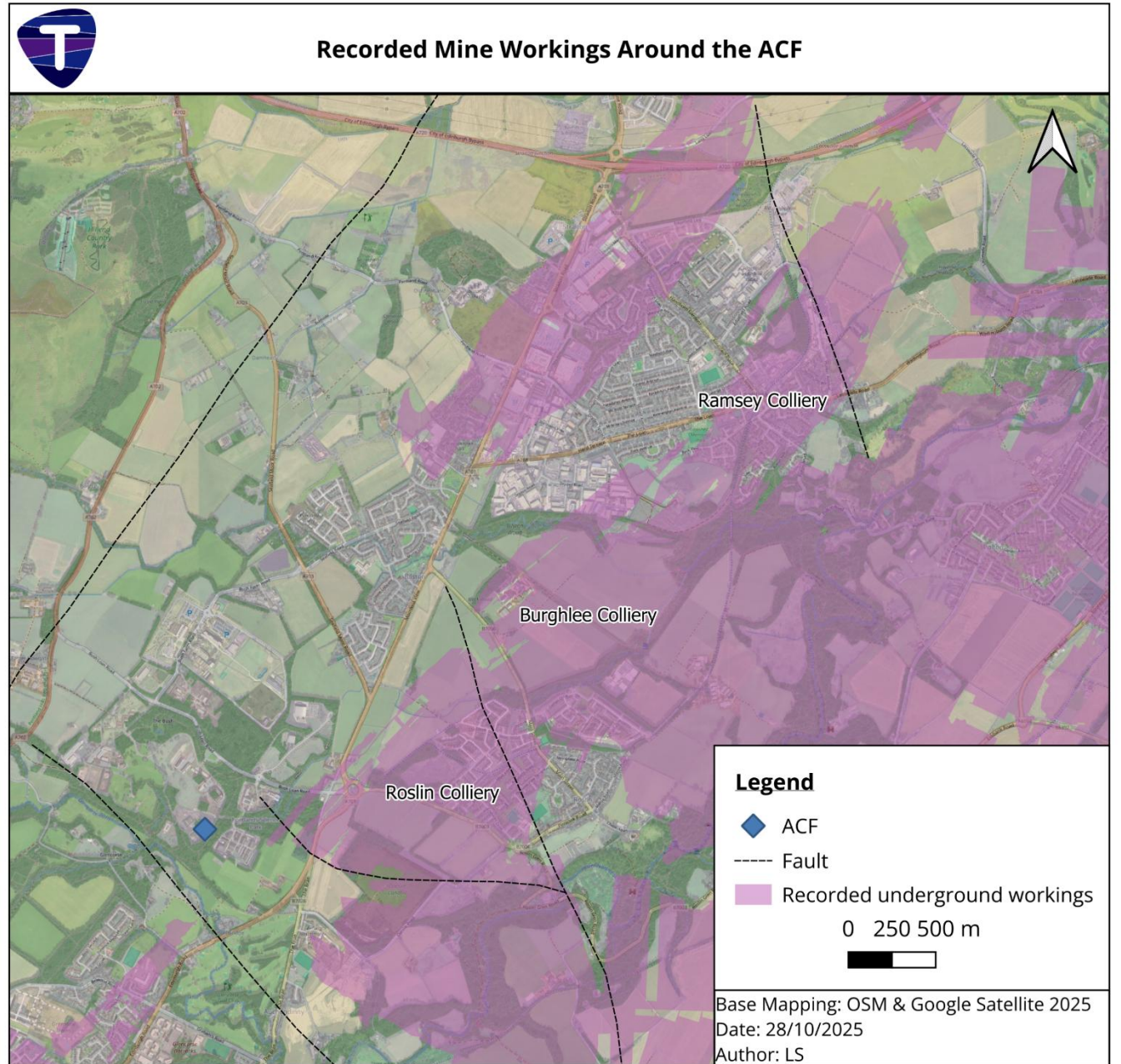
- Performed to identify potential heat network zones in area surrounding the ACF.
- Approach uses two main parameters to identify potential heat network zones:
 - **Anchor loads** (> 500 MWh/year);
 - **Linear heat density.**

Zone	Estimated annual demand (GWh/yr)	Estimated peak demand (MW)
Easter Bush	23.7	12.8
Loanhead	68	27.8



Subsurface Assessment

- Extensive mine workings adjacent to ACF.



Subsurface Assessment

- Extensive mine workings adjacent to ACF.
- Research, modelling and drilling performed in other WPs informed subsurface assessment.

168 m



173 m

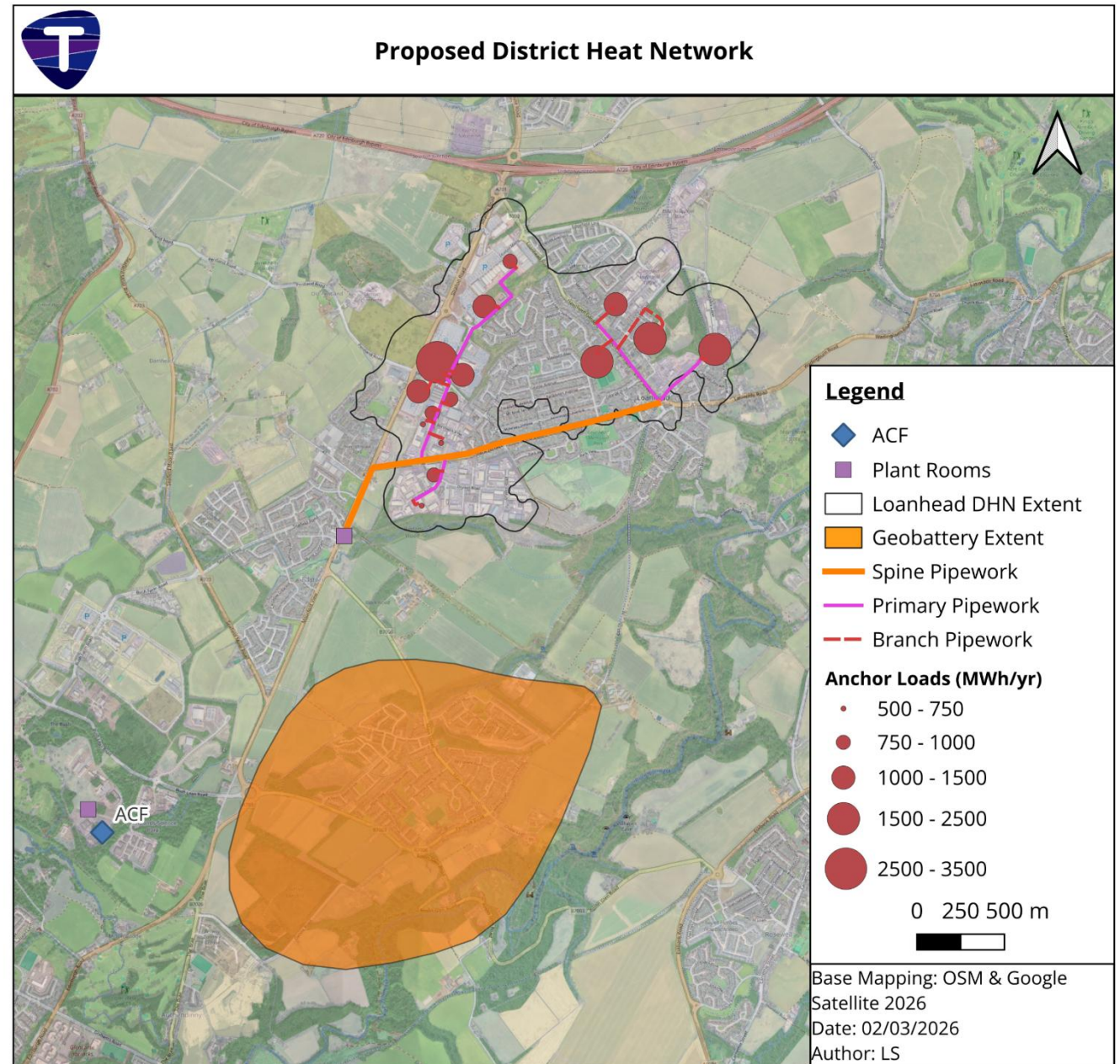
Subsurface Assessment

- Extensive mine workings adjacent to ACF.
- Research, modelling and drilling performed in other WPs informed subsurface assessment.
- Drilling programme:
 - ✓ Proved **presence and depth** of mine workings;
 - ✓ Proved **mine water temperature** (16.3 °C at BH);
 - ✓ Proved **groundwater level** (104 m BGL);
 - ✓ Allowed determination of subsurface hydrogeological properties.



Subsurface Assessment

- Inputs used to model subsurface heat flow associated with waste heat injection at ACF.
- Subsurface understanding and modelling indicate a **thermal plume with limited extent**.
 - Indicates a heat network in Easter Bush may be best suited to utilise waste heat.
- Low demand of Easter Bush heat network is not well suited for returning investment.
- This presentation focuses on the **more financially viable heat network in Loanhead**.

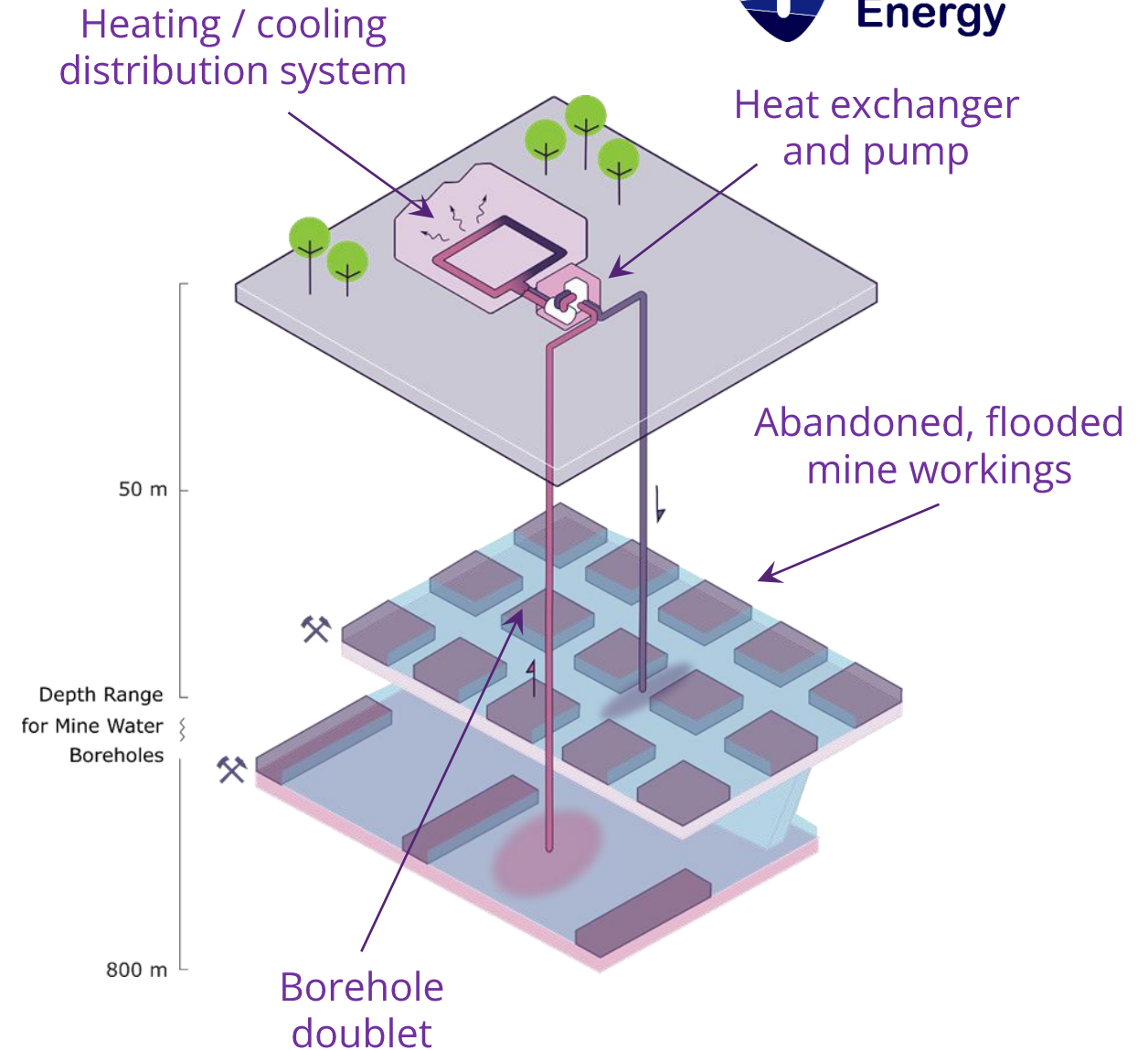


Part 3

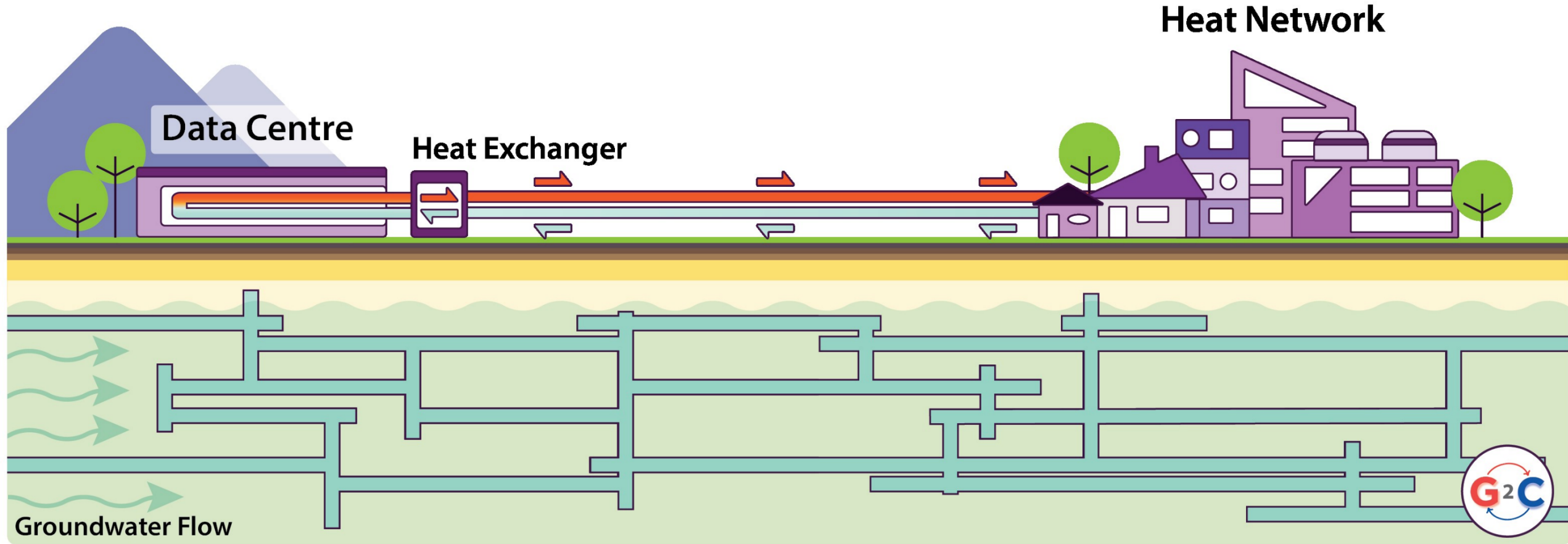
Techno-Economic Modelling

Modelling Scenarios

- Three scenarios were modelled:
 1. Direct waste heat connection
 2. Geobattery
 3. MTES
- For each scenario, a **conceptual system design** was performed to determine system CAPEX and OPEX.



Case 1: Direct waste heat connection



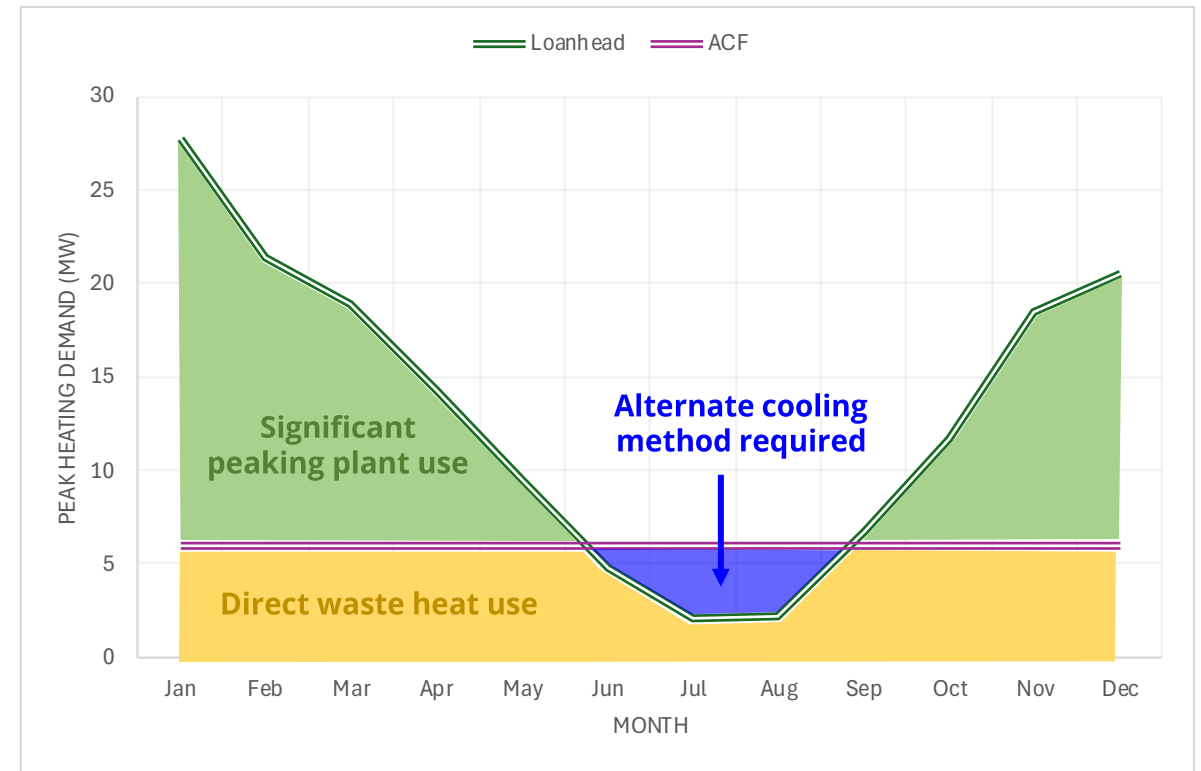
Case 1: Direct waste heat connection



- No mine water system so no wells are required, reducing CAPEX.
 - Waste heat supply not well matched to heat demand.
- ACF cannot meet the peak heating demand.
- Not all heat can be shed to DHN in summer months.

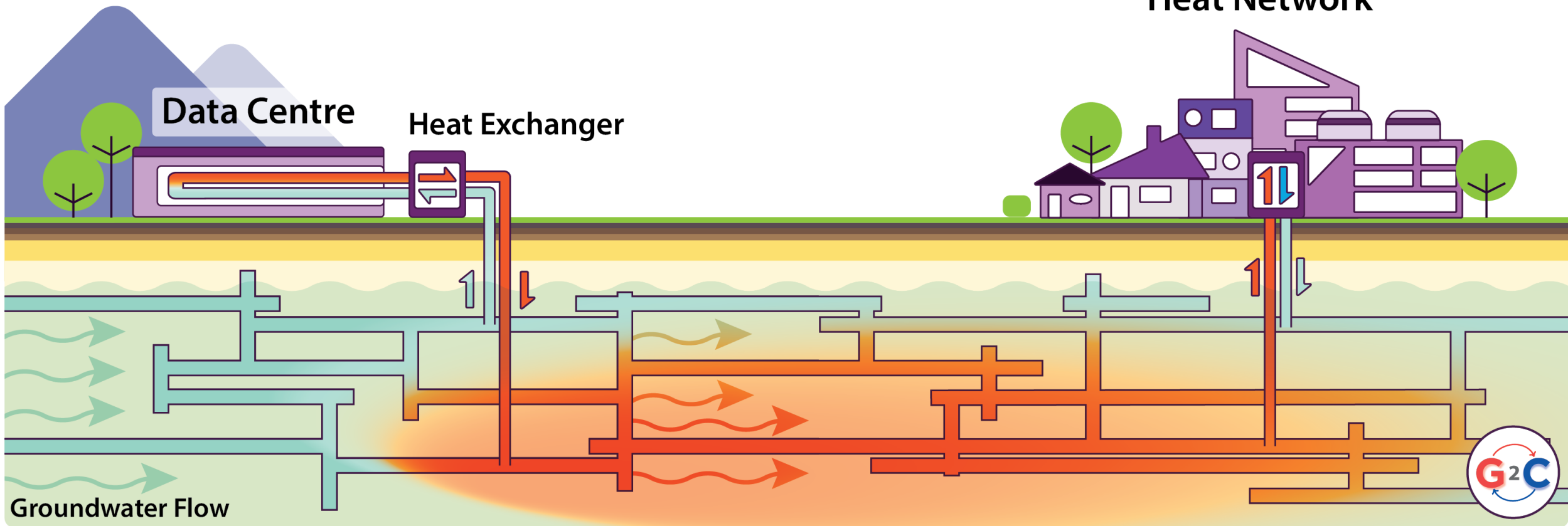
Comparison	LCOC	LCOH
Business as Usual	0.7 p/kWh	6.3 p/kWh*
Direct Connection	0.2 p/kWh	9.8 p/kWh

*Gas price cap at time of study



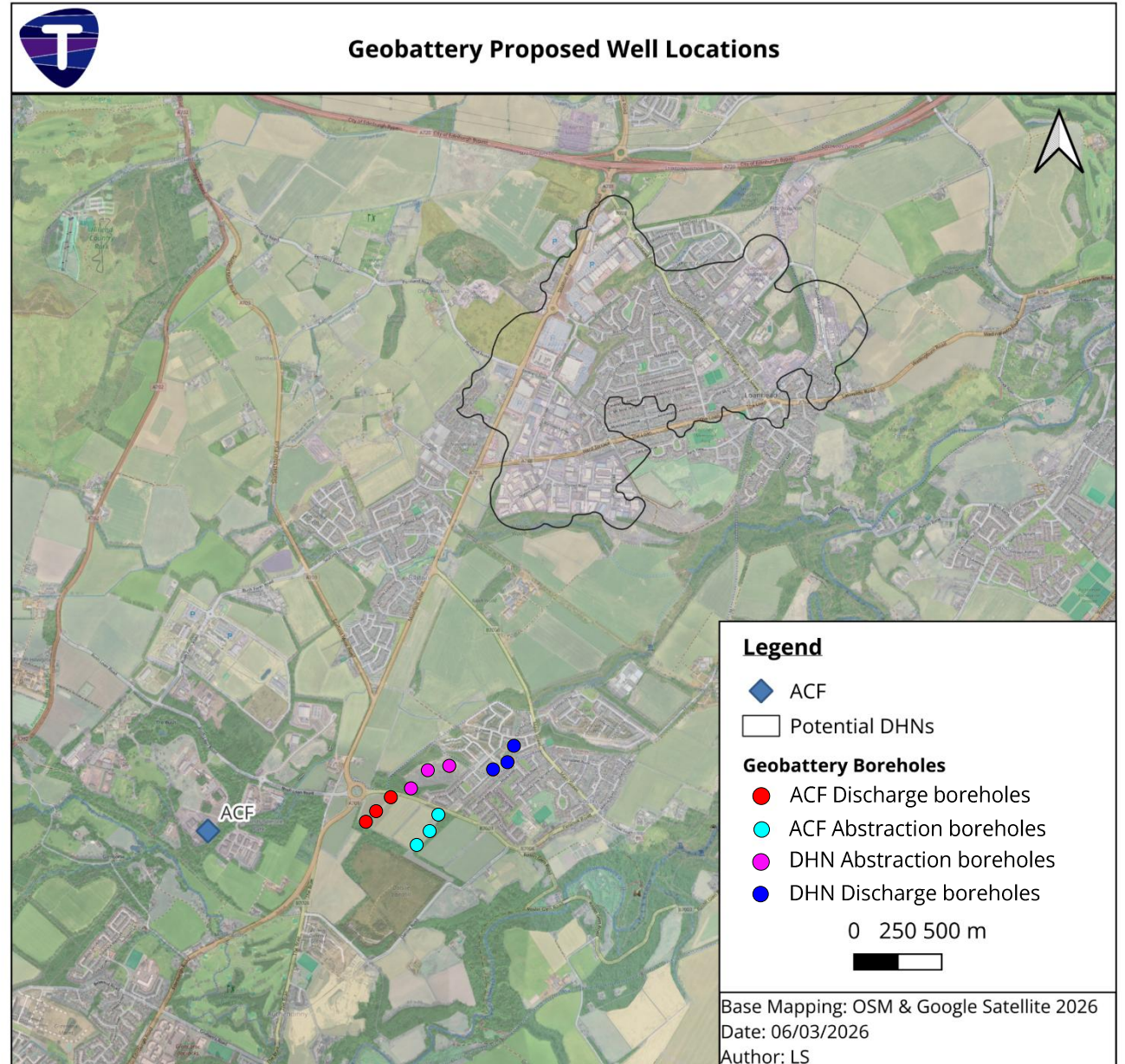
Case 2: Geobattery

Heat Network



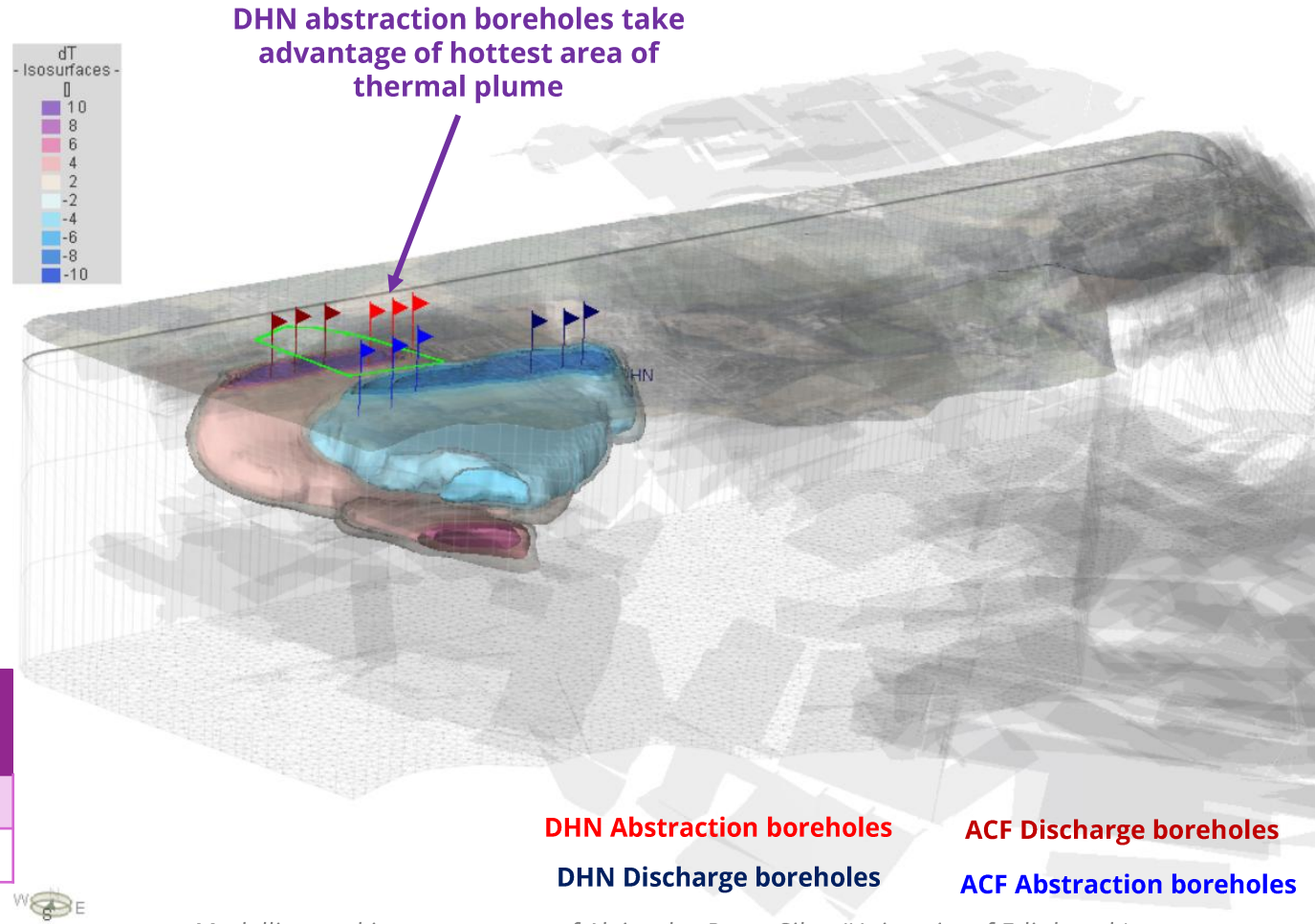
Case 2: Geobattery

- 3 abstraction and 3 discharge boreholes required for each system.
- Boreholes can be located close together as heat abstraction downstream prohibits thermal feedback for cooling system.



Case 2: Geobattery

- 3 abstraction and 3 discharge boreholes required for each system.
- Boreholes can be located closer together as heat abstraction downstream prohibits thermal feedback for cooling system.
- Geobattery acts as large thermal store reducing requirement for peaking plant.

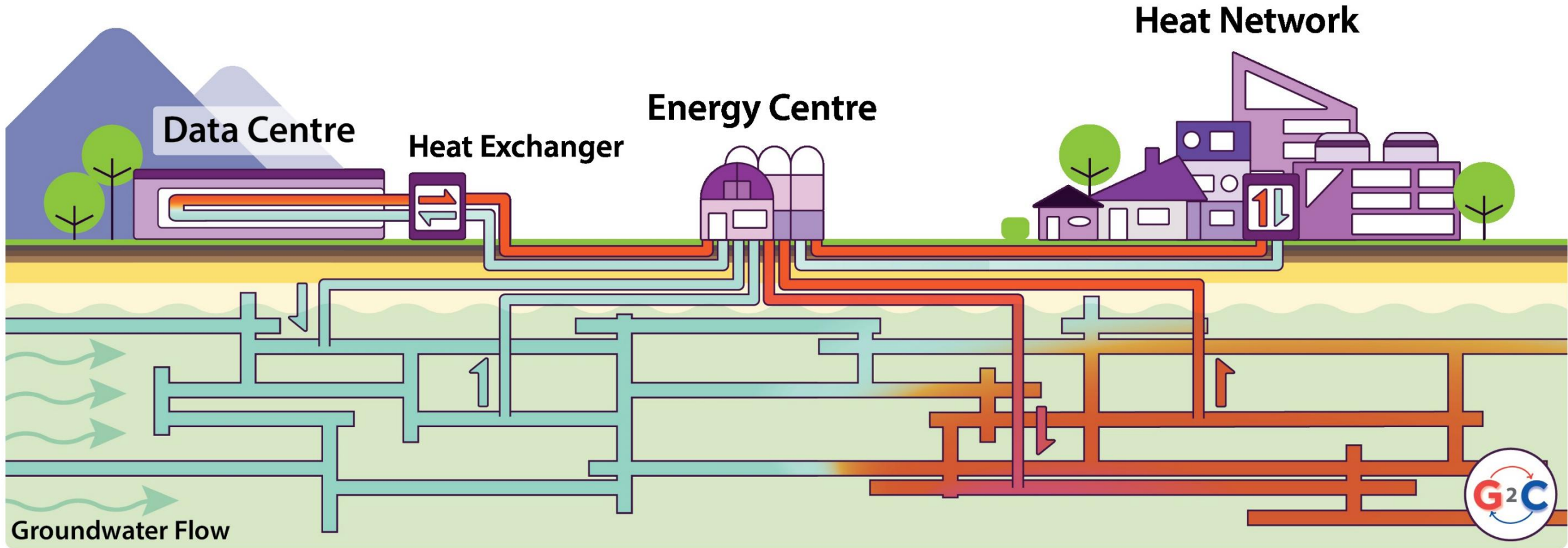


Comparison	LCOC	LCOH
Business as Usual	0.7 p/kWh	6.3 p/kWh*
Geobattery	0.08 p/kWh	6.4 p/kWh

*Gas price cap at time of study

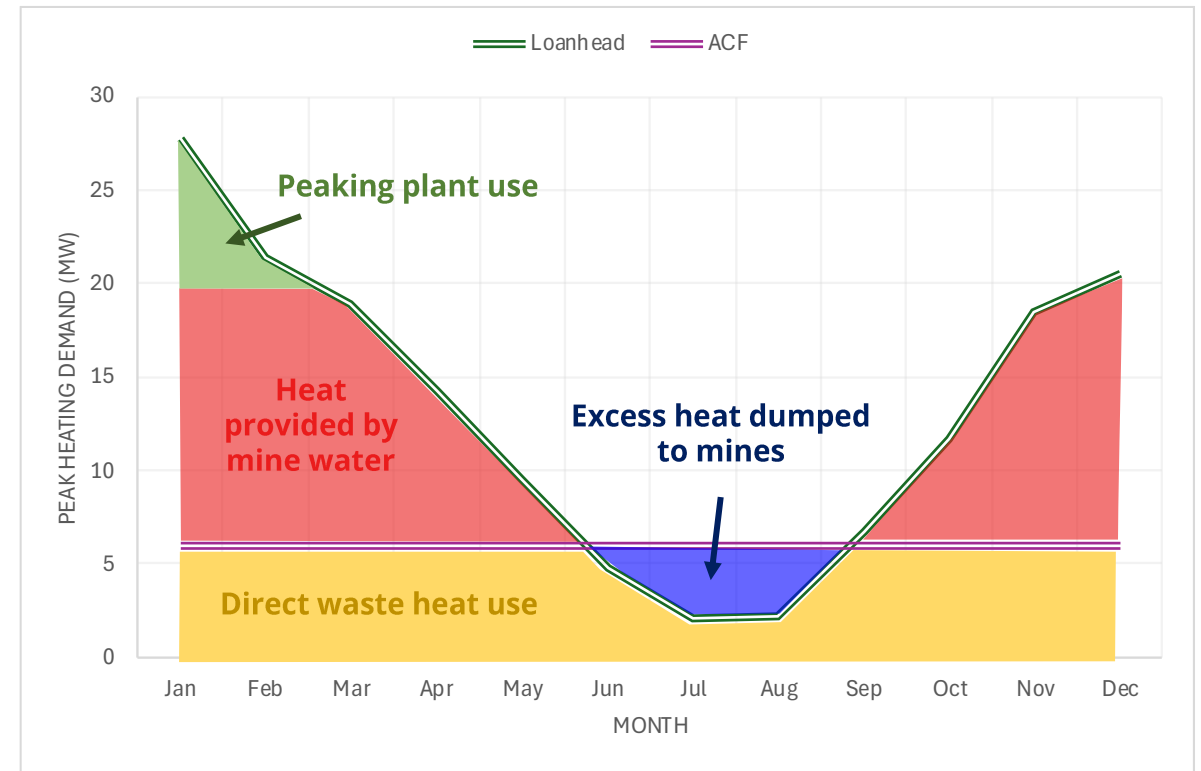
Modelling and image courtesy of Alejandro Perez Silva (University of Edinburgh).

Case 3: MTES



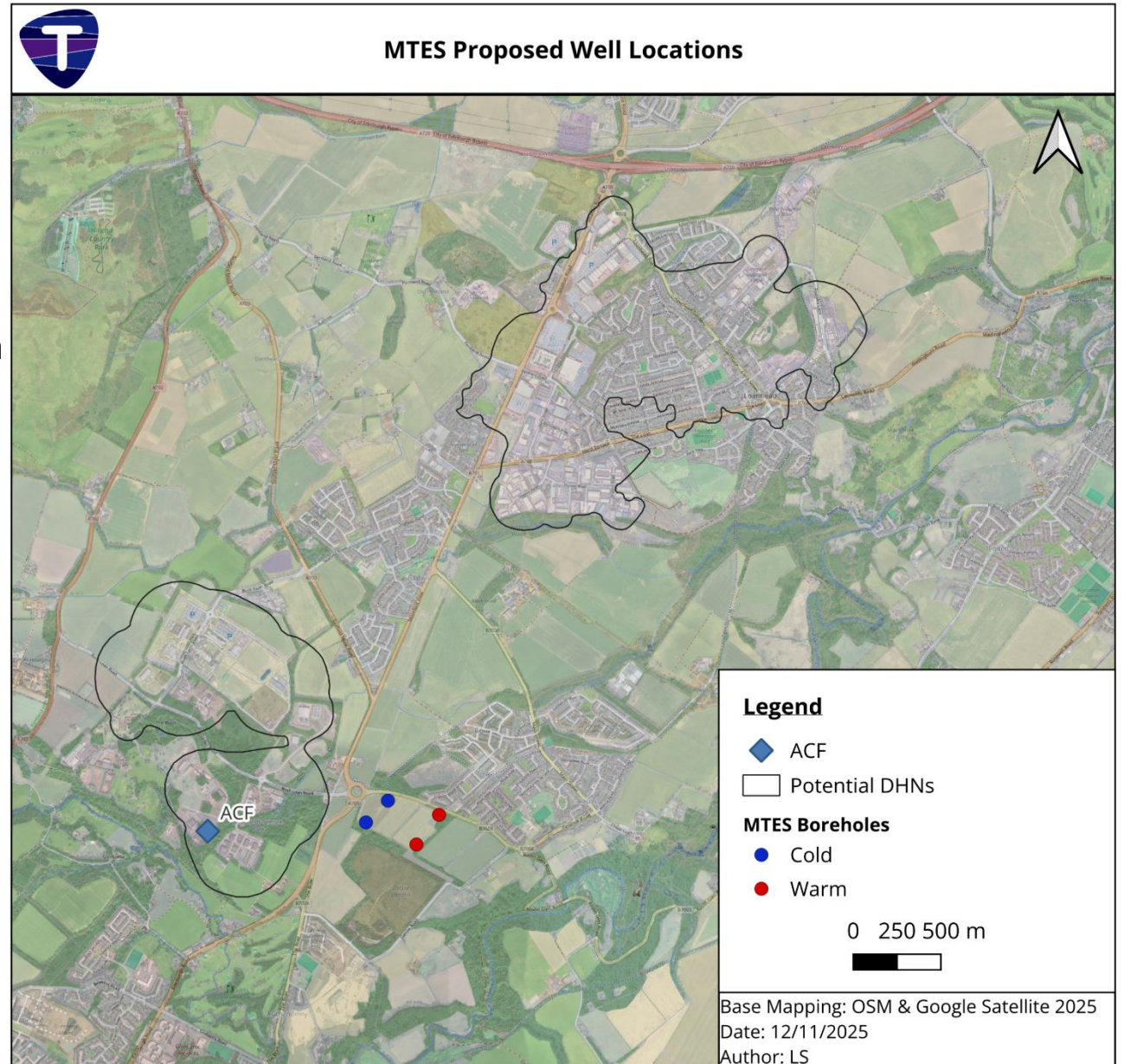
Case 3: MTES

- Direct connection used when DHN demand matched to waste heat supply.
- Mines used to provide heat during periods of high heating demand, and to remove excess heat when DHN demand low.
- Mines balance supply and demand.



Case 3: MTES

- Direct connection used when DHN demand matched to waste heat supply.
- Mines used to provide heat during periods of high heating demand, and to remove excess heat when DHN demand low.
- Mines balance supply and demand.
- Only 4 boreholes required – 2 warm and 2 cold.

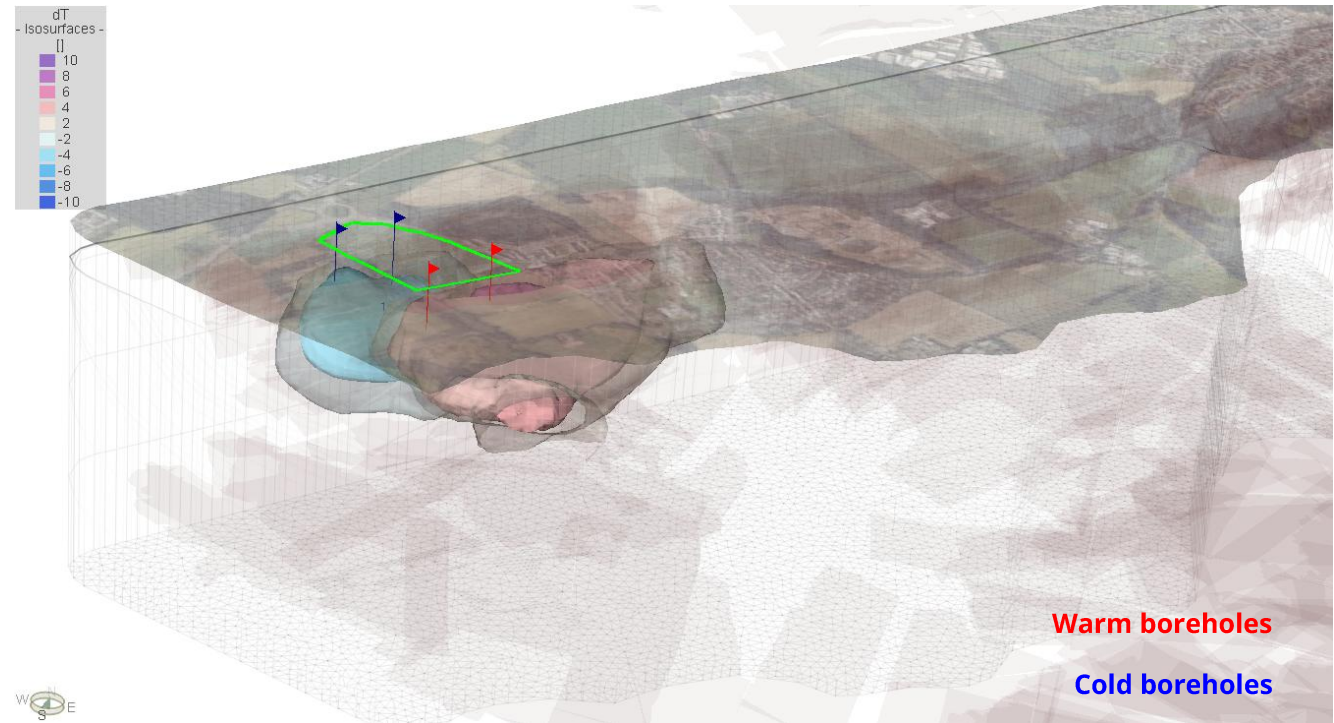


Case 3: MTES

- Direct connection used when DHN demand matched to waste heat supply.
- Mines used to provide heat during periods of high heating demand, and to remove excess heat when DHN demand low.
- Mines balance supply and demand.
- Only 4 boreholes required – 2 warm and 2 cold.
- Distinct warm and cold thermal plumes created.

Comparison	LCOC	LCOH
Business as Usual	0.7 p/kWh	6.3 p/kWh*
MTES	0.08 p/kWh	5.5 p/kWh

*Gas price cap at time of study

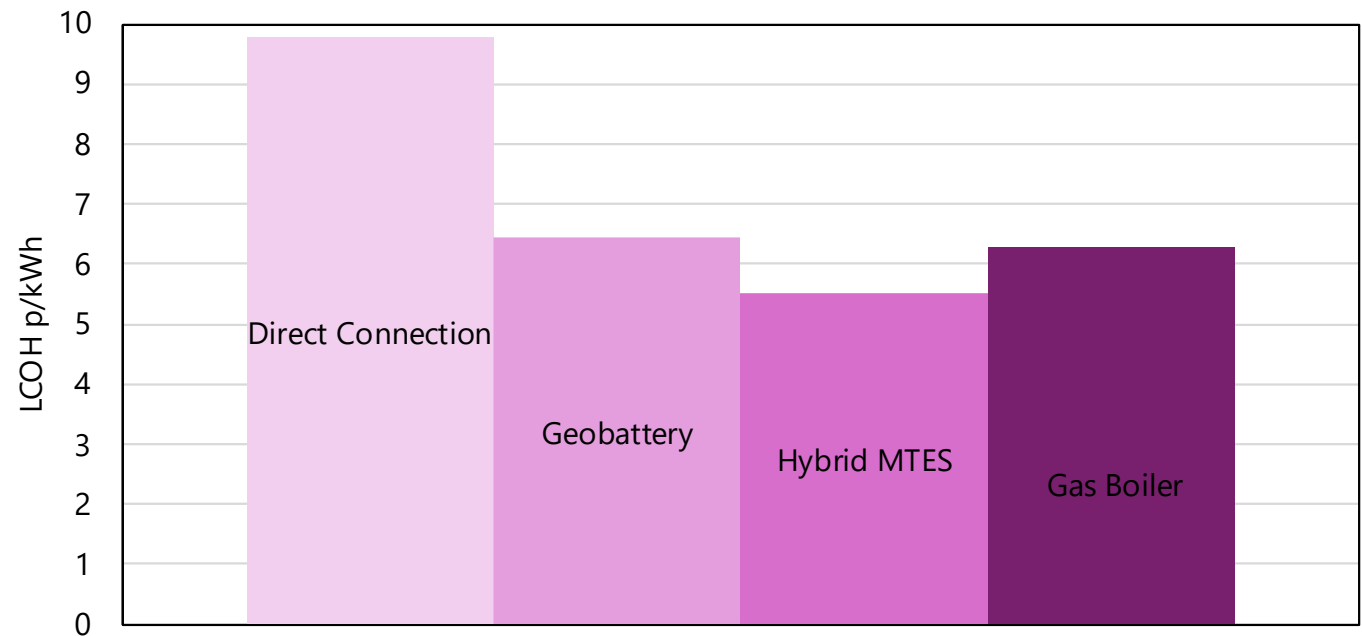
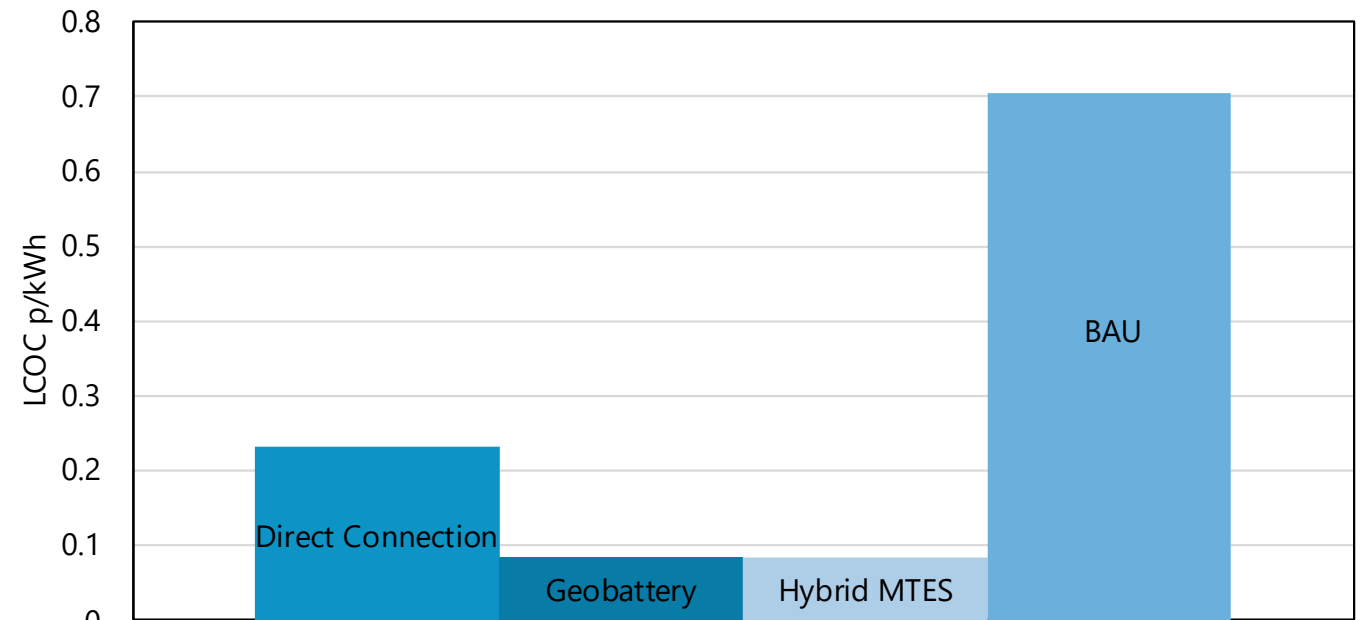


Modelling and image courtesy of Alejandro Perez Silva (University of Edinburgh).

Conclusions

Key takeaways:

- **LCOC very low as DHN operator absorbing most of the cooling costs** (in exchange for free heat).
- LCOH for the direct connection more expensive as more peaking plant use required.
- **Both mine water heating options have a strong potential economic feasibility.**
- MTES more favourable as fewer wells reduces pumping costs.
 - Significant at this site due to deep water level.



Thank you for listening

hello@townrock.com

Leah Swan

Date:
March 2026

