



# CAUSEWAY ENERGIES

## Heating and cooling cities with geothermal energy

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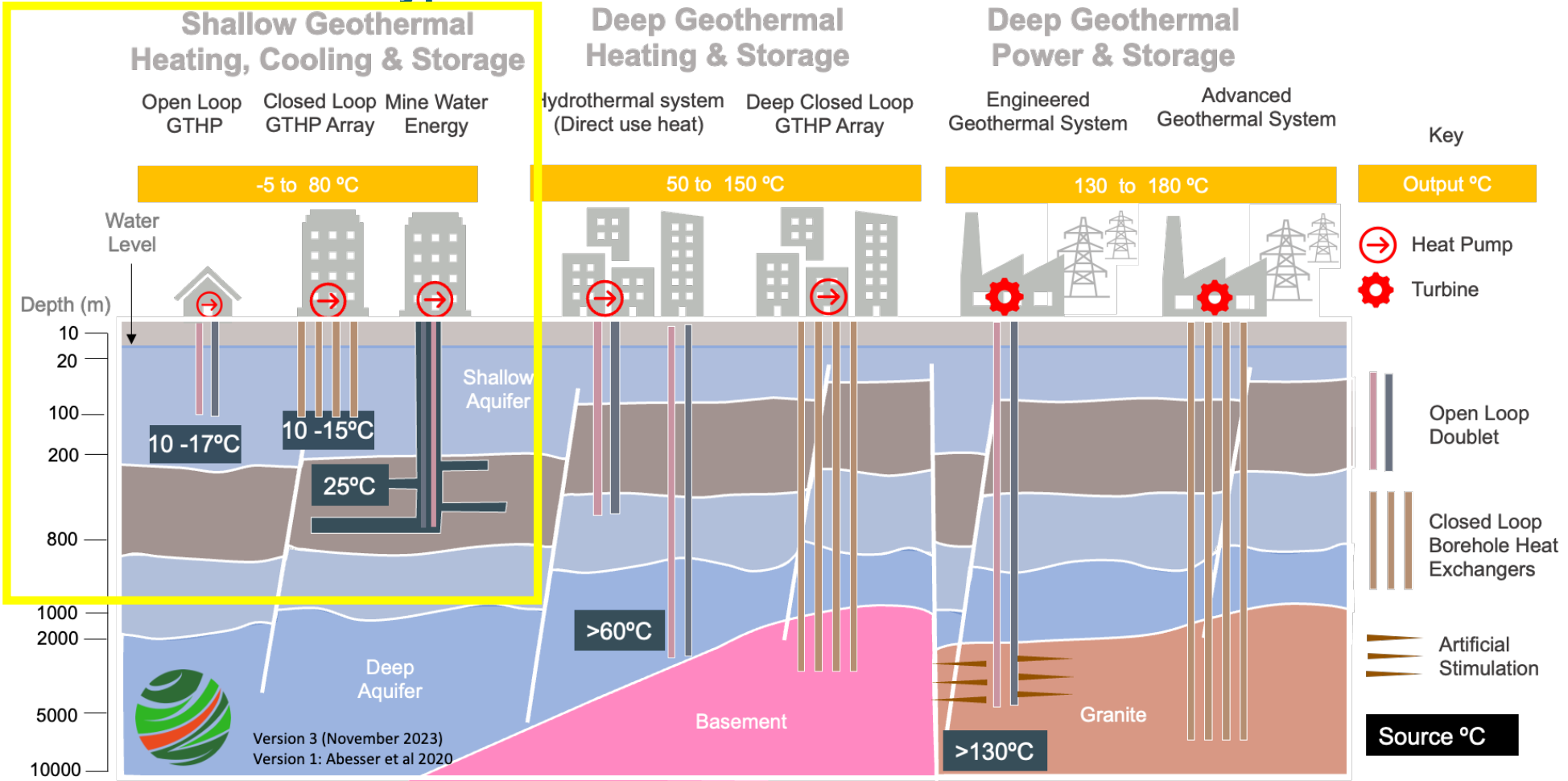
## Geothermal in Liverpool

### Summary

- Geothermal (or ground source) heat pump heating and cooling is an underutilized renewable energy application in Liverpool, despite a great resource (Sherwood Sandstone) under our feet.
- Geothermal heating can be cost competitive with gas and 70 to 100% less GHG emissions.
- Geothermal is being considered for the Blackstock St site, with the ambition to build 400 units of housing to a high standard of sustainability.
- Blackstock St is well positioned as a greenfield development to take the lead on geothermal heating & cooling with an existing borehole on site that can be used for testing and design, as well as part of the system.
- Projects like this get material capital funding from Green Heat Network Fund, as demonstrated in Liverpool by Peel and Torus with their river source heat pumps.
- Collaboration between the private sector (landowners, developers) and public sector (council, university) is desirable at these early stages of development.



# Geothermal archetypes

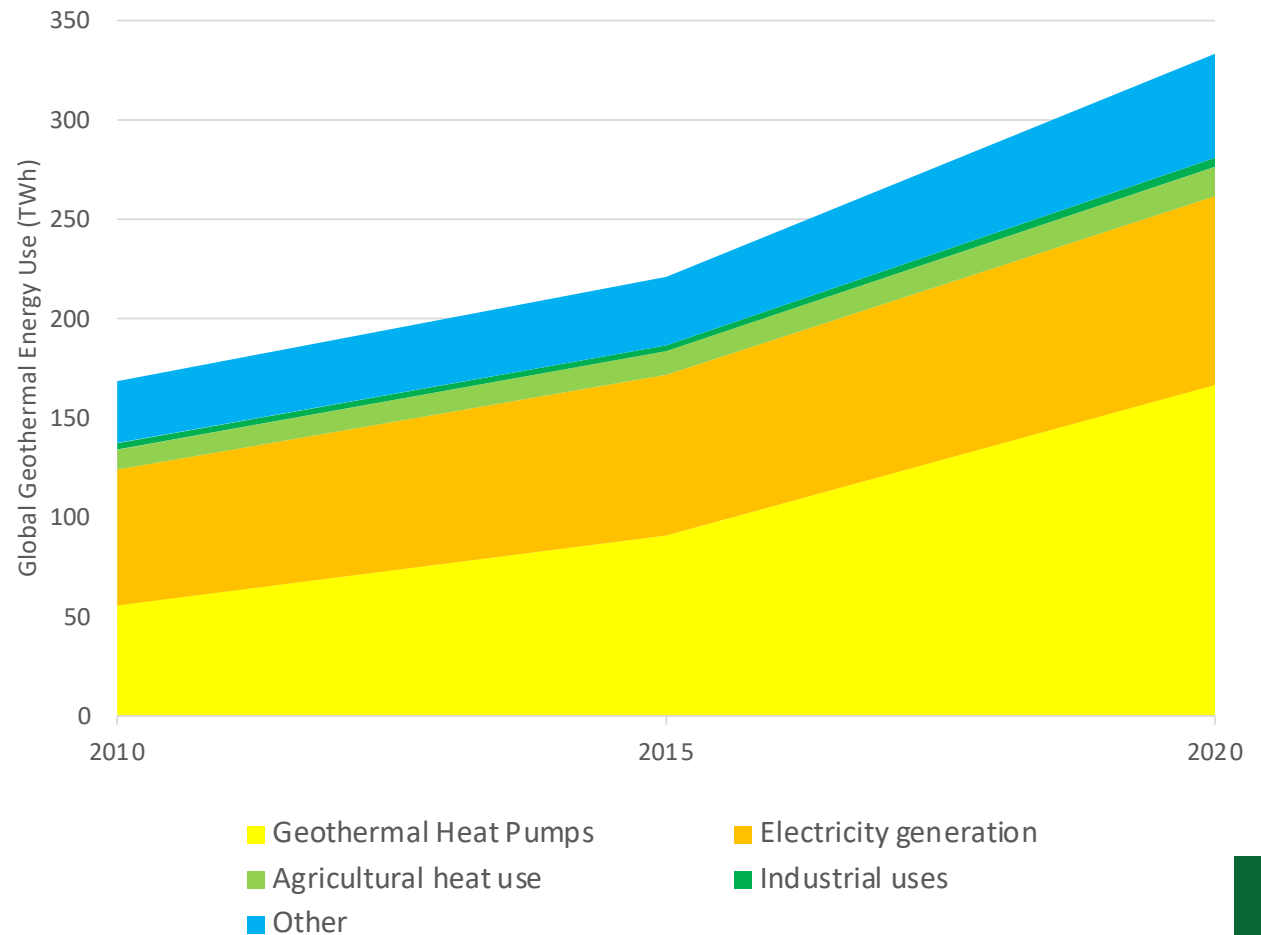


Geothermal Heat Pumps = Ground Source Heat Pumps



## Geothermal is a very useful and used energy source

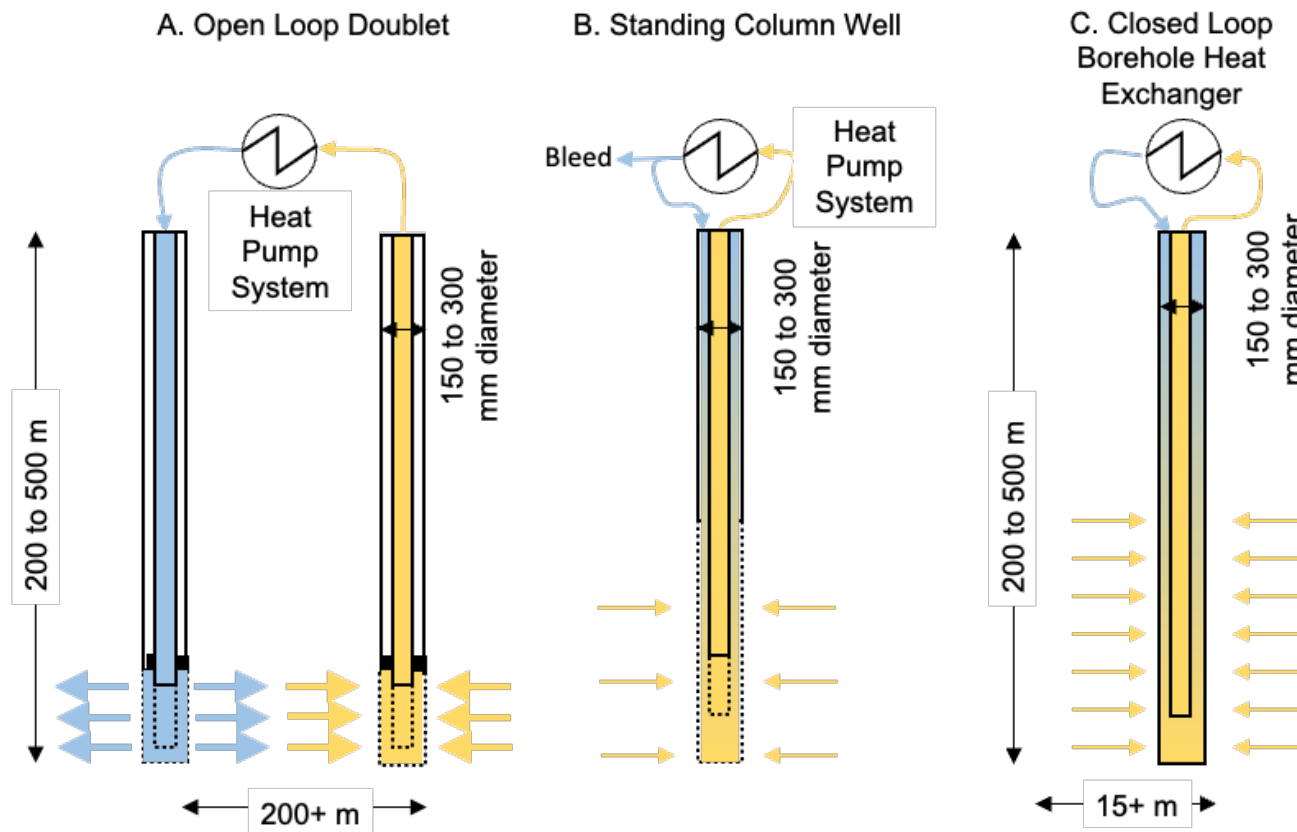
- Geothermal Energy is used around the world.
- Domestic, commercial and industrial shallow geothermal (aka ground source) heat pumps comprises about 50%.
- Substantial electricity generation from lower temperature resources (80 to 180 °C).
- Very uneven geographic distribution of use - not necessarily about resource quality, e.g. Sweden uses 17 TWH per year from modest geothermal resources.
- UK has good resources, but utilisation is low and patchy, because of:
  - Cheap North Sea Gas
  - Lack of climate ambition / pricing for carbon
  - Lack of awareness
  - Upfront capital costs





## Geothermal well types for heat pumps

All of these options are possible in Liverpool area

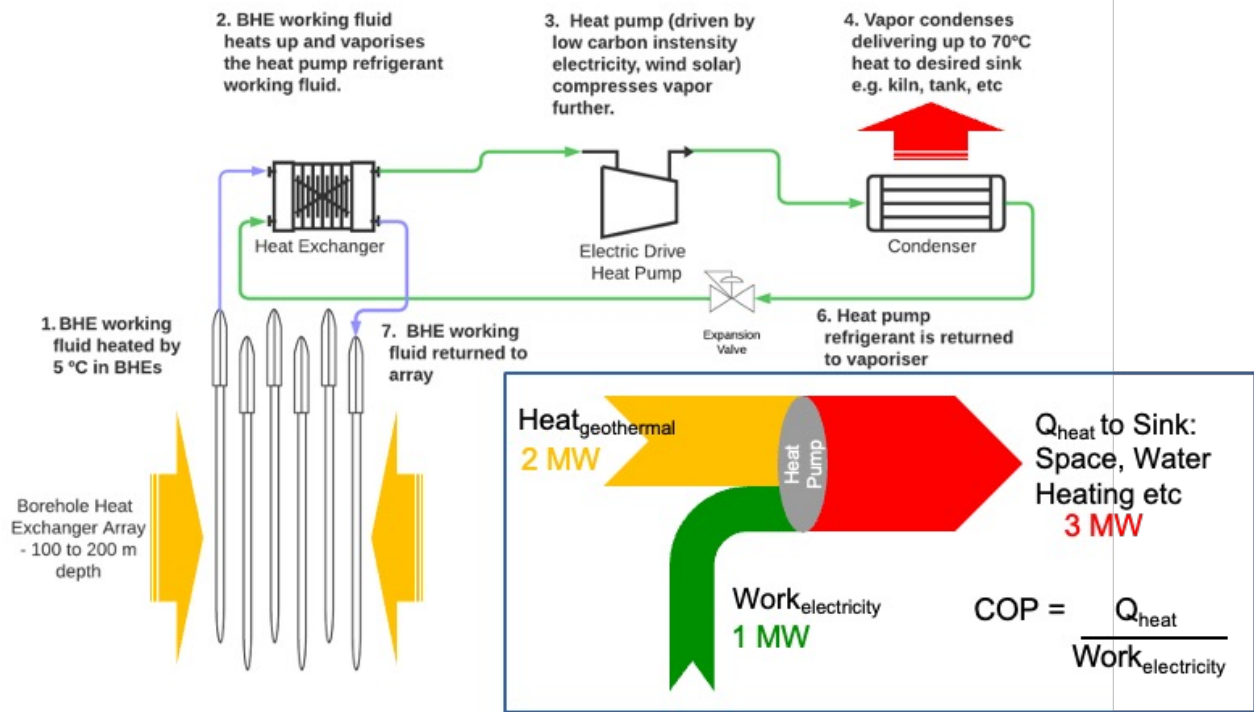


- Open Loop Doublet (A) takes water from aquifer, extracts some heat which is boosted in heat pump, and then water is return to aquifer
  - Sherwood Sandstone underlies most of Liverpool
  - Similar to Peel Liverpool Waters and Torus Lightbody Street except geothermal (ground) source instead of river/canal water source
- Closed Loop Borehole Heat Exchanger (C), heating medium circulated inside borehole.
  - Most common application in UK
  - Many more (10x) boreholes required than Open Loop, so may be space constrained.
- Standing Colum Well (B) is a hybrid semi-open loop
  - Unusual in the UK, but may be very good application



# Cost and carbon benefits of geothermal heat pumps

Closed Loop Borehole Heat Exchanger is illustrated



- COP is the efficiency of the heat pump: the higher the COP the less electricity used to generate a unit of heat
- COP is mostly controlled by the difference between the temperature of the source heat and that of the required output.
- Hence Geothermal > Water > Air for efficiency.
- Cost competitiveness with gas boilers mainly controlled by COP versus Electricity/Gas Unit Price ratio (aka “Spark Gap”).
  - IF COP > Spark Gap, then Heat Pump will likely be cost competitive
- Carbon savings controlled by COP and the carbon intensity of the electricity
  - 70 to 100% reductions in CO2e.
- Geothermal heating and cooling is cost competitive with fossil fuels and is 70+ % lower emissions



## Similar projects in the Green Heat Network Fund

Blackstock Street is a greenfield opportunity with an existing borehole to calibrate design



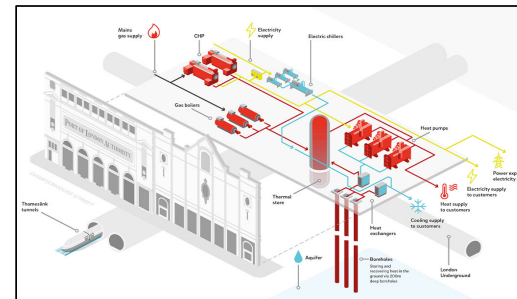
### Whiteknight Campus, Reading

Geothermal heat pump using aquifer water to replace fossil fuel heat in district heat network. £2.2m GHNF funding awarded to University of Reading.



### Handforth Garden Village, Cheshire

1 MW aquifer ground-water source heat pumps to serve to 600 homes, hotel, school, shops and an extra care facility. Cheshire East Council awarded £2.6m GHNF.



### Citigen, London

4 MW aquifer ground-water source heat pumps to serve to service heat network in central London. The project also uses waste heat from power cooling.



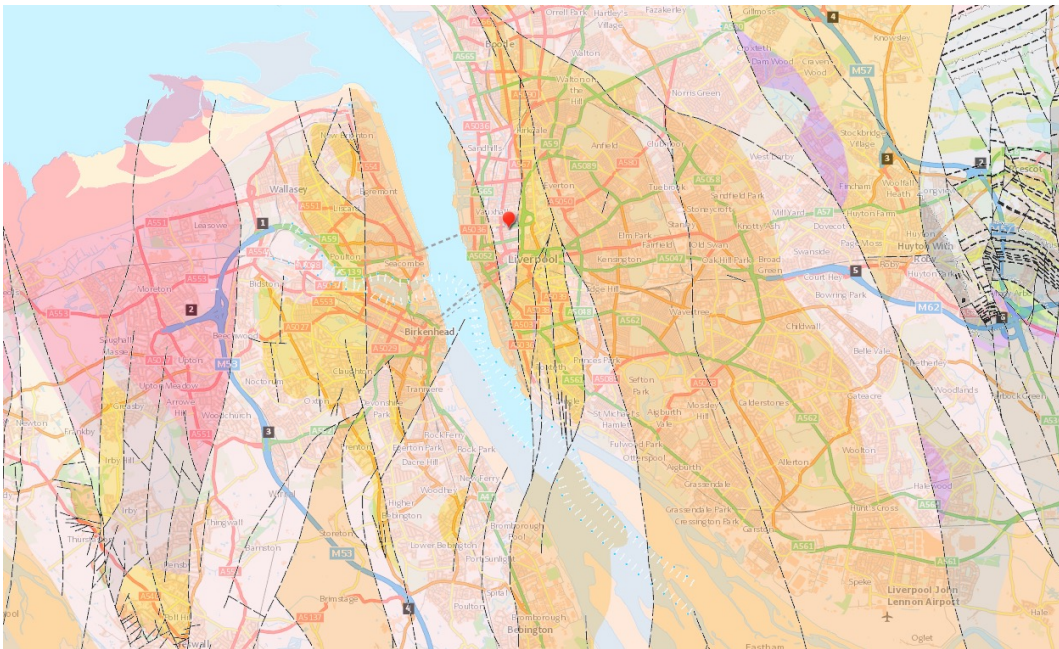
### Paddington Village, Liverpool

LCC feasibility study to see how effective ground source heating and other low carbon technologies could be for Paddington Village in the Knowledge Quarter.



# Geothermal potential of Liverpool

## Blackstock Street as a demonstrator of sustainable geothermal heating and cooling



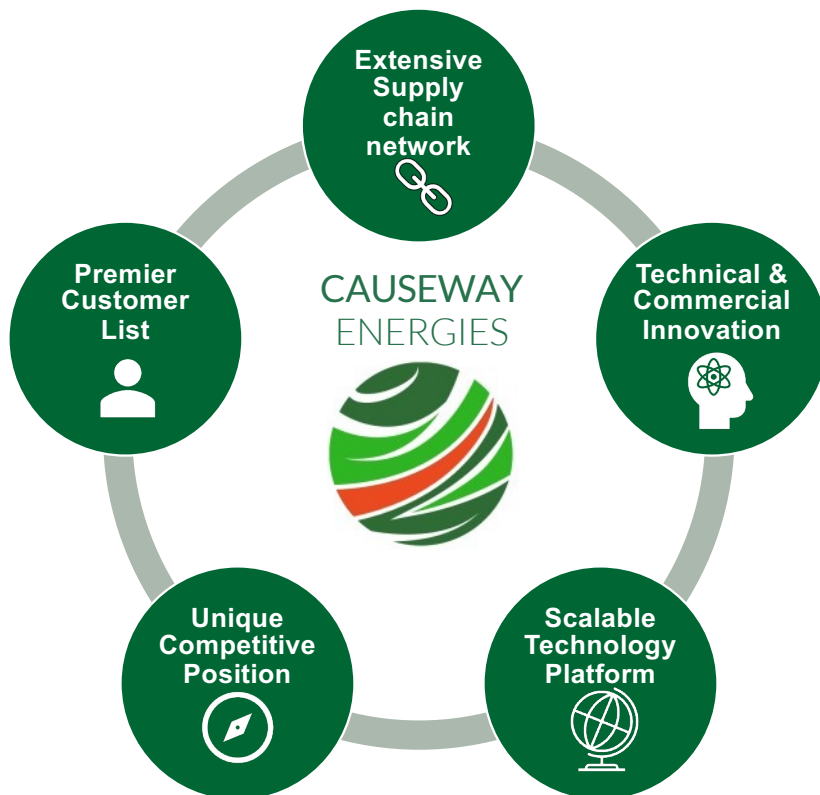
Bedrock Geology of Liverpool. (BGS)

- Blackstock St is not close enough to a surface water source such as canal or dock for water source heat pump application.
- On the Blackstock St site 1924 water well is still operable, with current abstraction approval of 76,000 m<sup>3</sup> per year.
- 200 m of Sherwood Sandstone – representative of bedrock under Liverpool – permeable water bearing aquifer.
- Well has produced at 24 liters/second.
- An open loop doublet will produce 400 KW of thermal power, 500 KW from heat pump – more than enough for space and water heating in two buildings with 100 units each.
- Next step for feasibility and concept design study, including new testing of the existing borehole.
- Test data and a subsequent build at Blackstock St would be a demonstrator for similar renewable heating systems at scale in Liverpool.



# Causeway Energies

An innovative designer, development and financier of renewable heating projects



- UK-Ireland-US startup in 4<sup>th</sup> year of operation, focused on UK and Ireland markets
- Focused on decarbonising larger scale heating and cooling
- An Energy as a Service Company, designing, developing and financing renewable heating projects
- Heat pumps and geothermal energy at the core of the technology offer
- Financing including off balance-sheet of upfront capital costs
- Completed or active projects in public services, agriculture food and beverage, heat networks.
- At the cutting edge of technology, bringing new advances to our projects for more cost and carbon savings
  - Proven component put together in new ways
  - Transfer of technology from other regions (e.g. US) or from other industries (e.g. oil & gas)
  - New technology including patent-pending innovation to widen and deepen our impact