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ATES National Tool

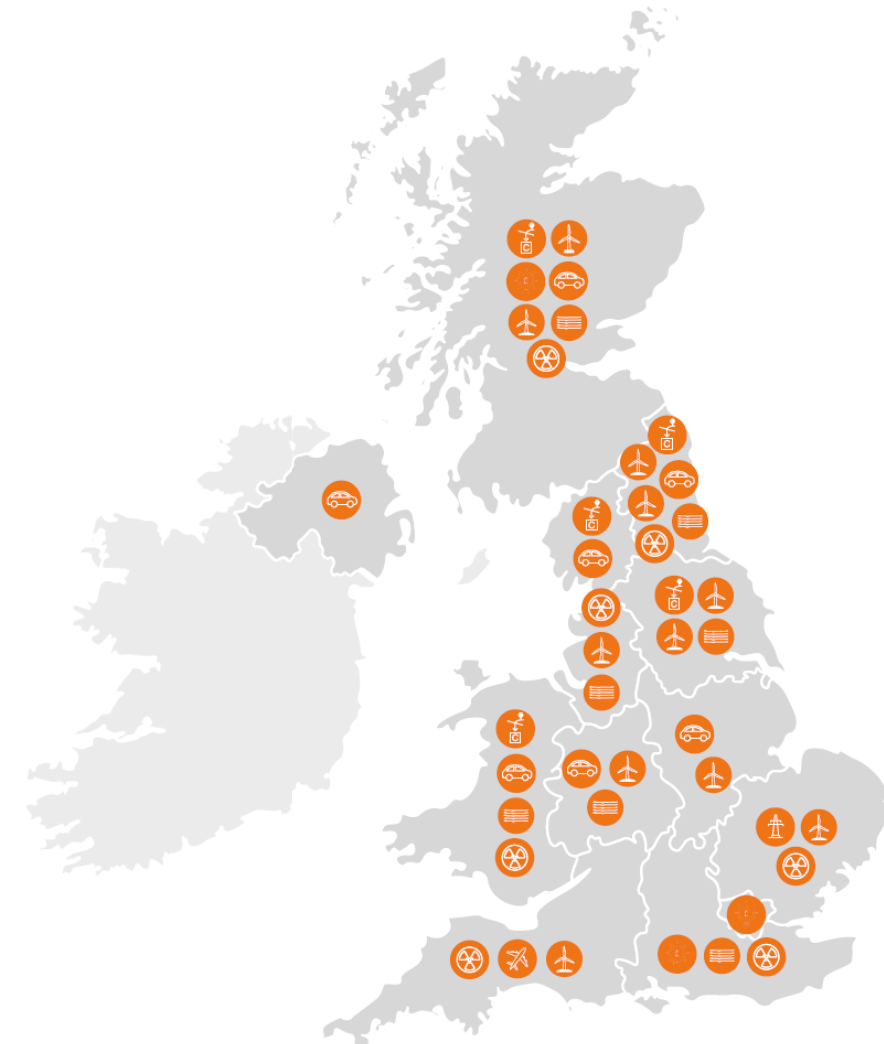
Imperial College
London



British
Geological
Survey

Aims of the ATEES National Tool

- The UK uses around 221 TWh of space heating and 6.2 TWh of space cooling per year
- Seasonal with peak heat demand with a peak heat demand of 131 GW
- Aquifer thermal energy storage (ATES) has been widely applied in other countries
- Aim to provide a national scale tool to understand the potential of ATES to meet in the UK's net zero strategy
- Work as part of the ATESHAC (EPSRC Grant: EP/V041878/1)



Net Zero Strategy: Build Back Greener (Gov.uk)

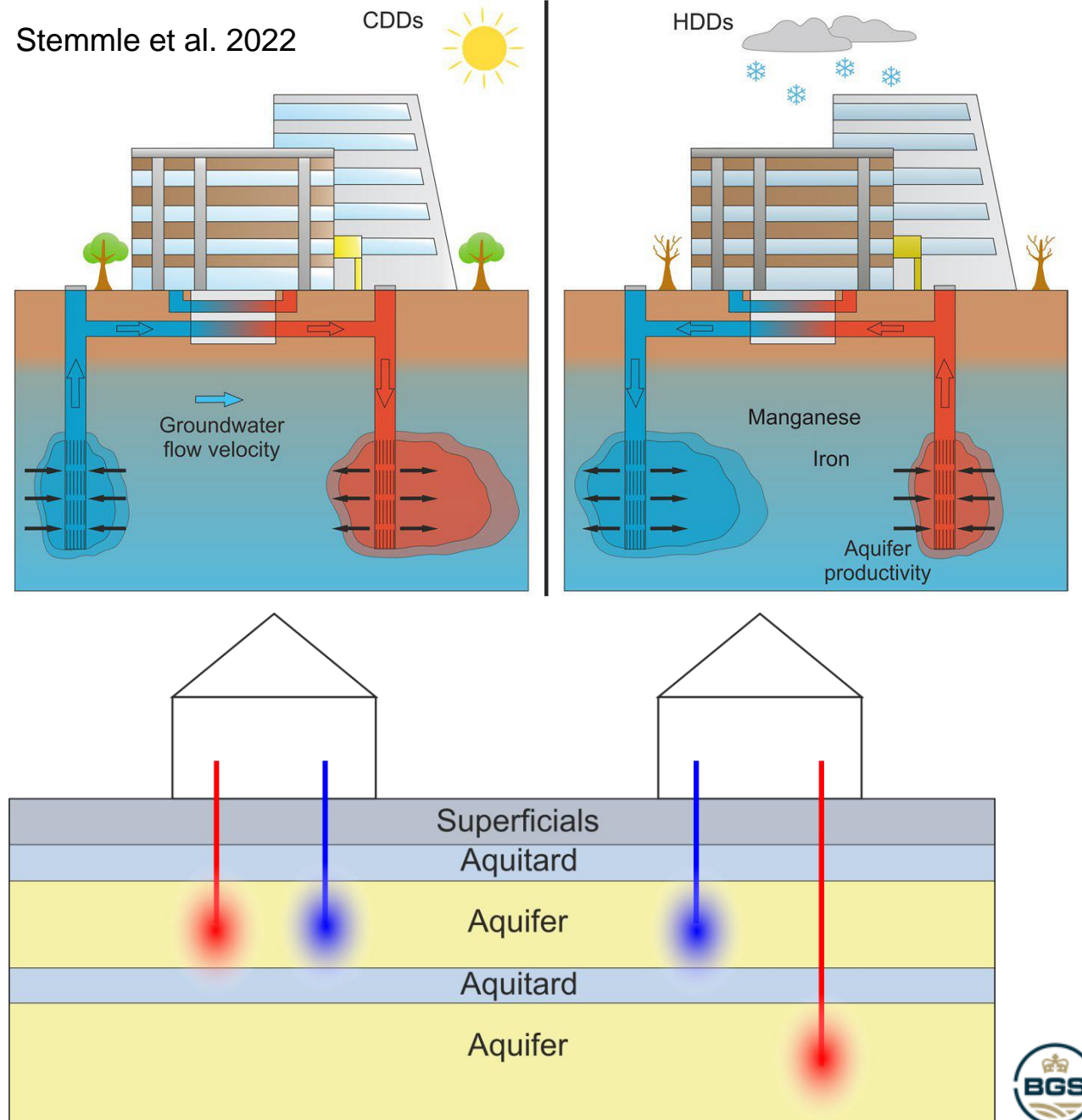
- | | | | |
|----------------------------|------------------------|----------------------|-----------------------------------|
| Heat Pumps | Heat Networks | Low Carbon Hydrogen | Public Transport and Cycling |
| CCUS | Retrofit | Electricity Networks | Onshore Wind |
| Offshore Wind | Nuclear | Green Finance | Solar |
| Automotive | Aerospace | Maritime | Tidal |
| Rail | Forestry | Agriculture | Smart Systems |
| Waste and Circular Economy | Oil and Gas | Steel | Nature Conservation & Restoration |
| Climate Change Adaptation | Science and Innovation | | |

UK-wide

A grid of 16 orange icons arranged in two rows and eight columns. The icons represent various energy and infrastructure sectors, including heat pumps, heat networks, low carbon hydrogen, public transport, onshore wind, solar, tidal, smart systems, and nature conservation & restoration.

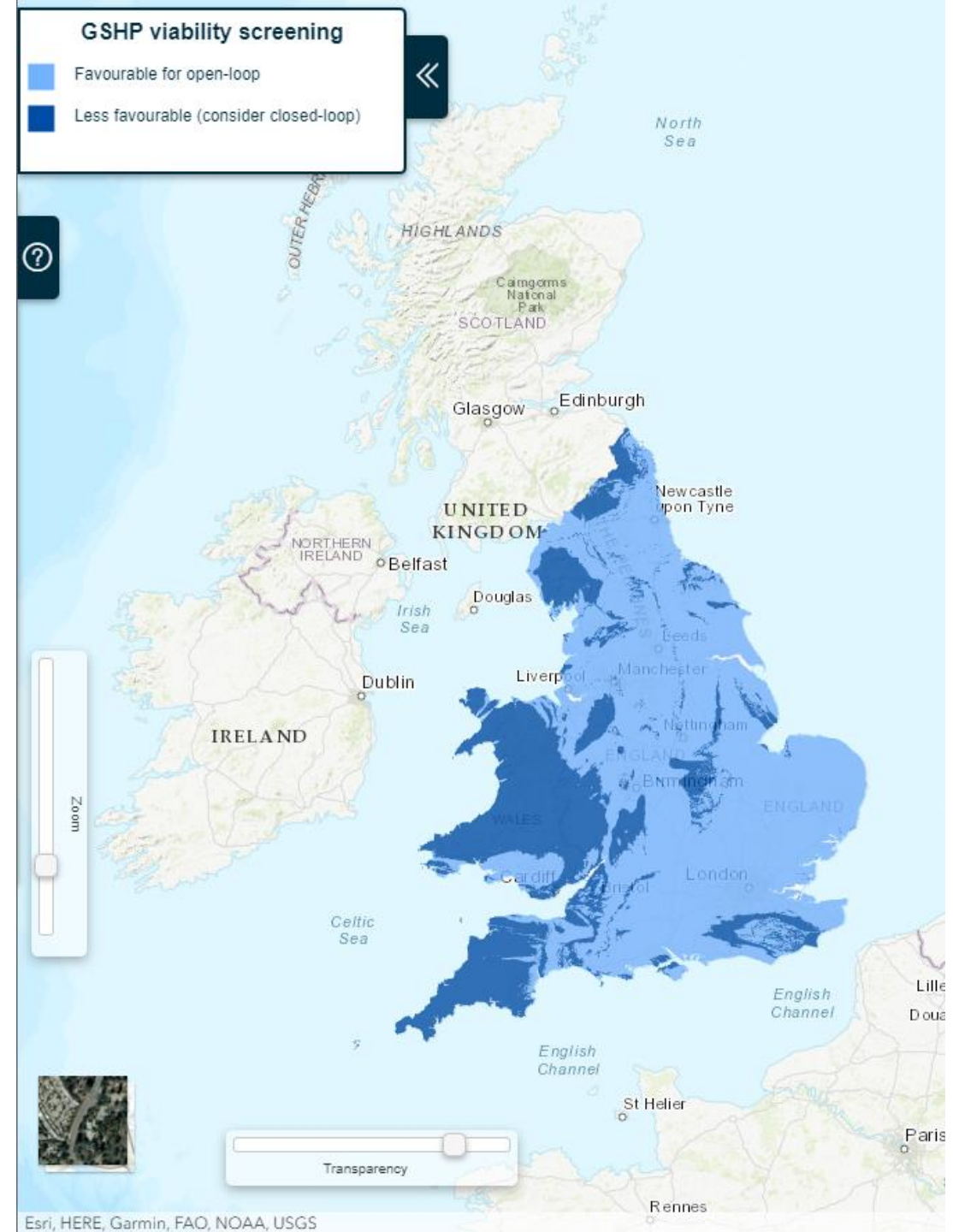
ATES Systems

- Doublet system with a hot well and a cold well
- Inject warm water and abstract cool water during summer
- Inject cool water and abstract warm water in winter
- Engineering and system optimisation and balancing at or above surface



GSHP tool (BGS-EA)

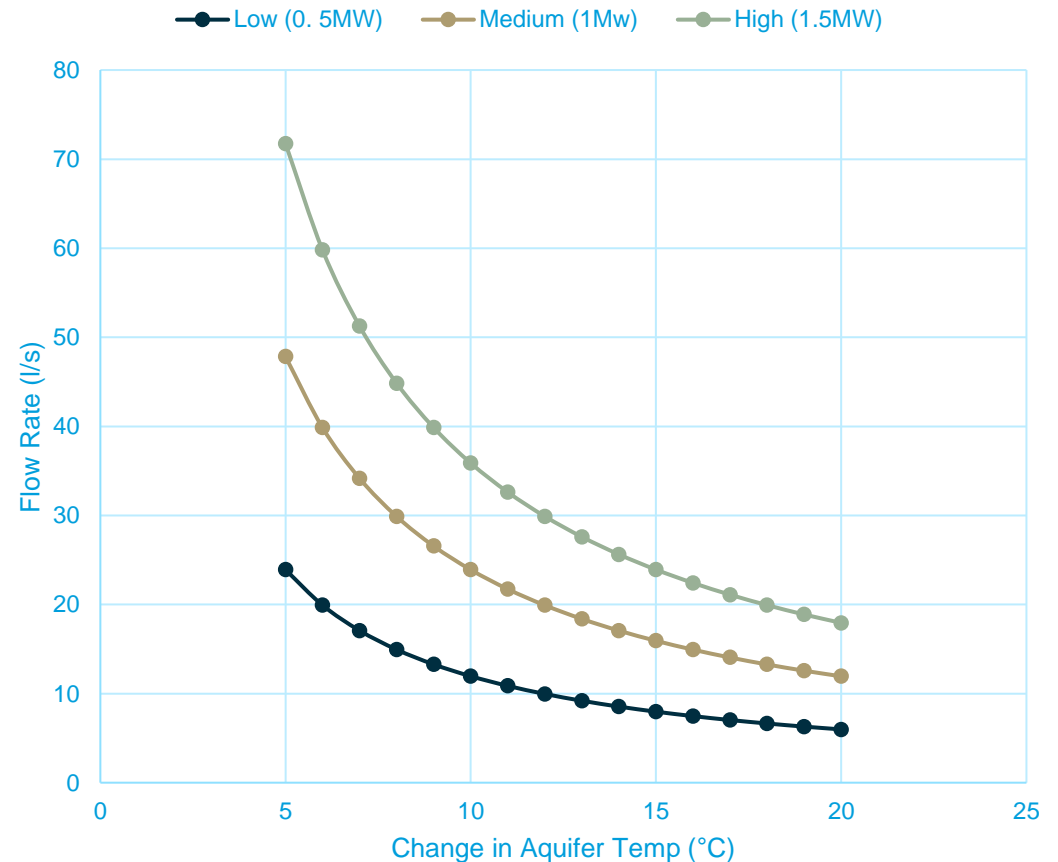
- Open loop ground source heat pump viability screening tool
- Published in 2012
- Only England and Wales
- Based on an energy output of 0.1MWth with flowrates > 1l/s
- Generally considered smaller systems for residential and small commercial properties



Assumptions

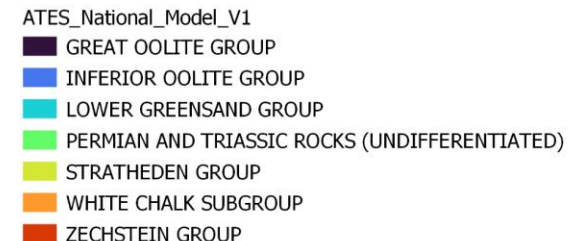
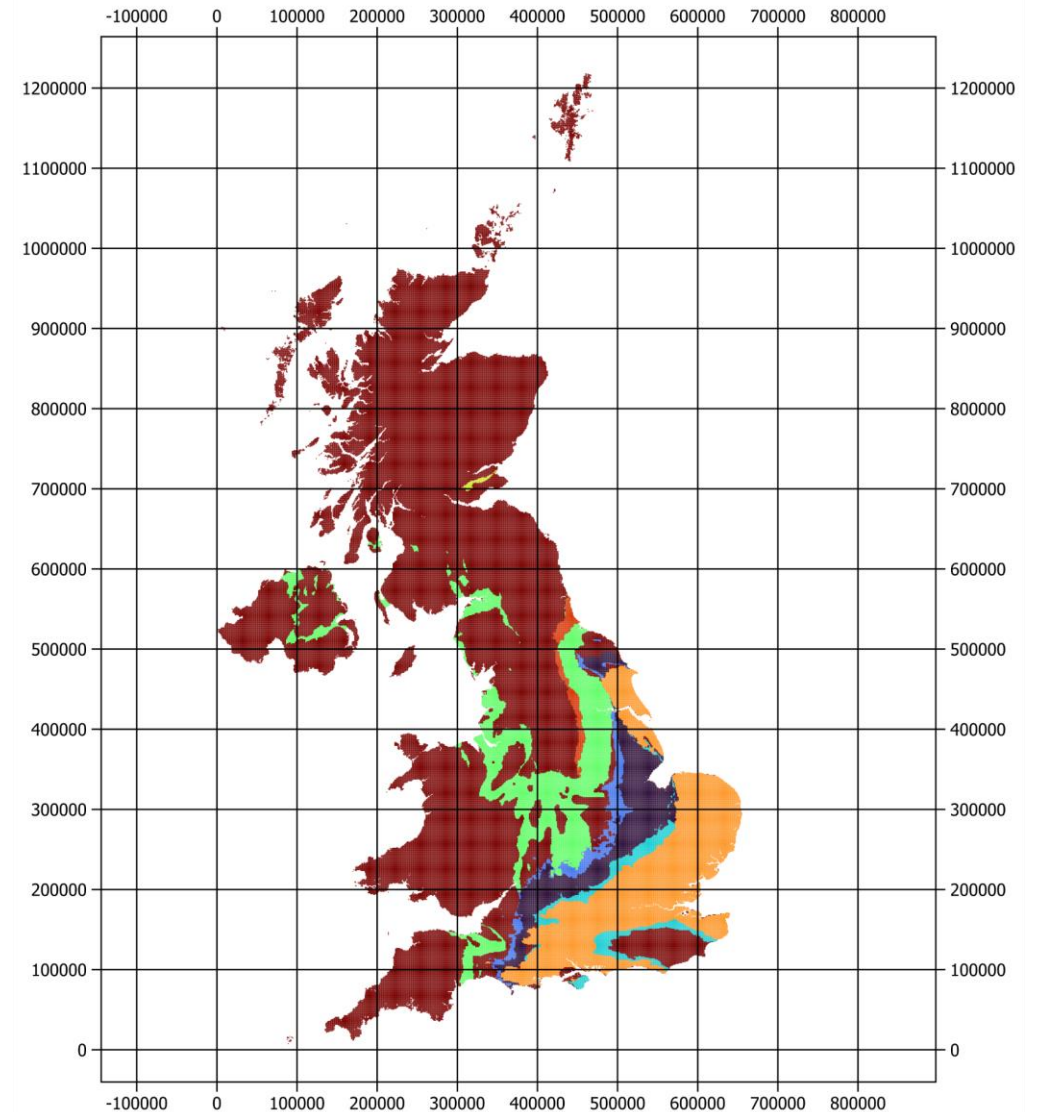
- Medium to large scale system for commercial and public sector e.g. Hospitals
- Minimum 0.5 MWth ATES system
 - Change in temp $\sim 10^{\circ}\text{C}$
 - Requires flow rate $> 12\text{l/s}$
- Geological considerations only
- Where covered by superficial deposits or at surface the top of the aquifer is assumed to be at surface.
- At a national scale aquifers are considered homogeneous

$$Q_{ATES} = \frac{P}{C_w \cdot (T_{out} - T_{in})}$$



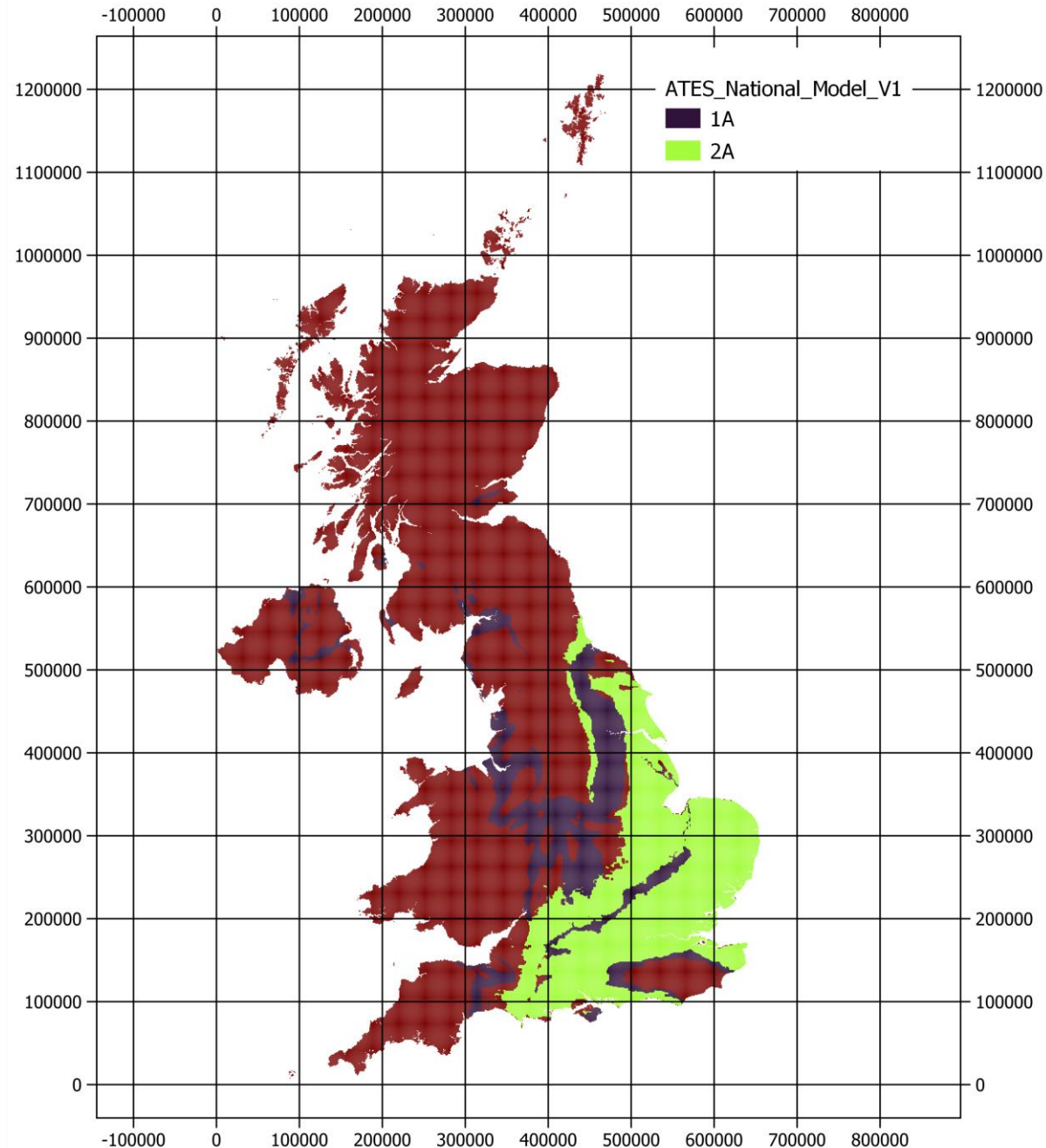
Aquifers

- Based on published aquifer yield values and the UK Hydrogeology map (uncertainty and variability in borehole yield values)
- Principal aquifers (categories 1A and 2A) consistently produce at or above the required yield rates
- 3D problem
 - Depth to top of aquifers is taken from the GIS Atlas
- Depth range for aquifers considered are
 - England and Wales 400m
 - Northern Ireland 400m (limited to the Permian and Triassic Sandstone)
 - Scotland All (limited to a few small basins of Stewartry Group and Stratheden Group)



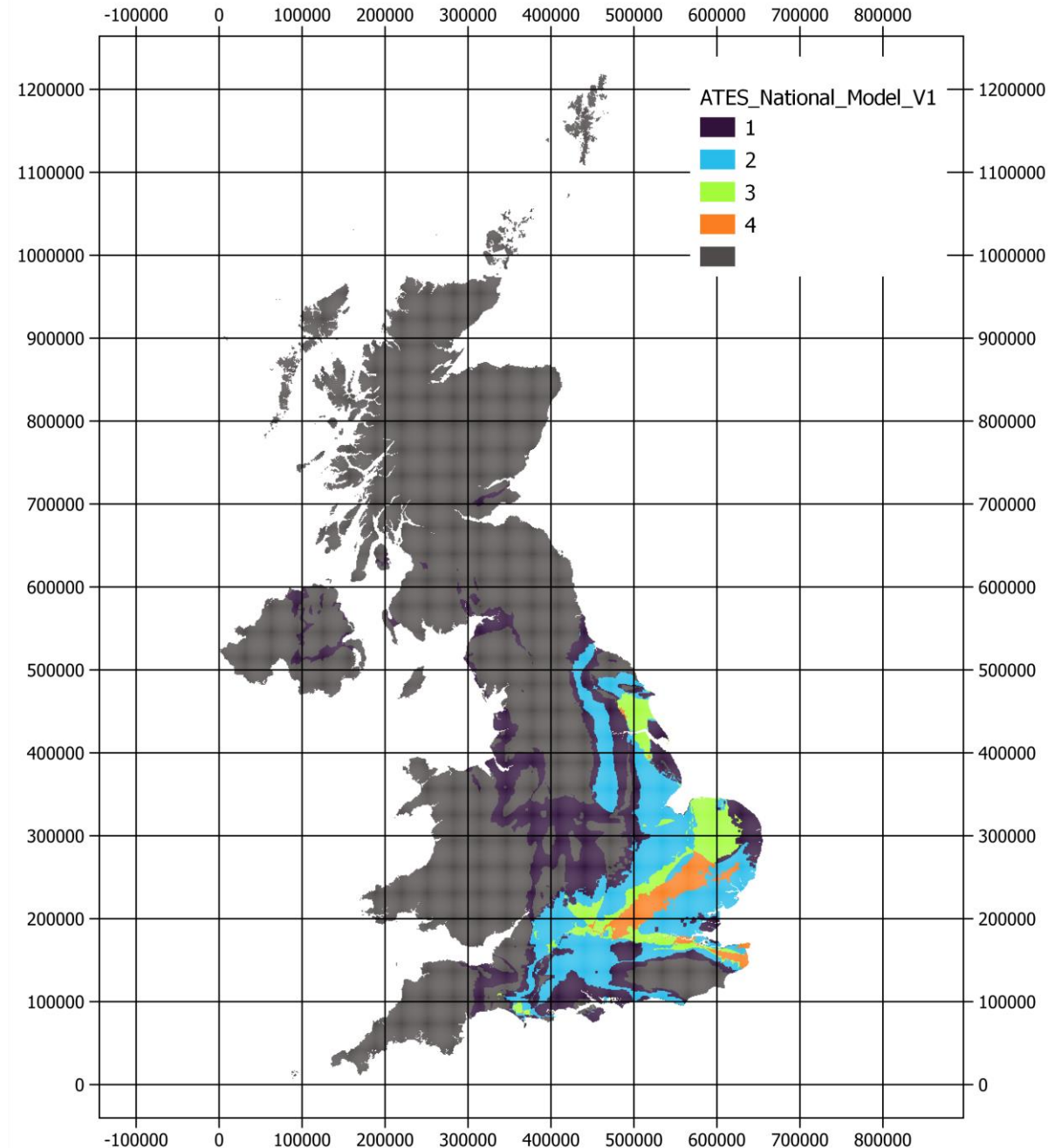
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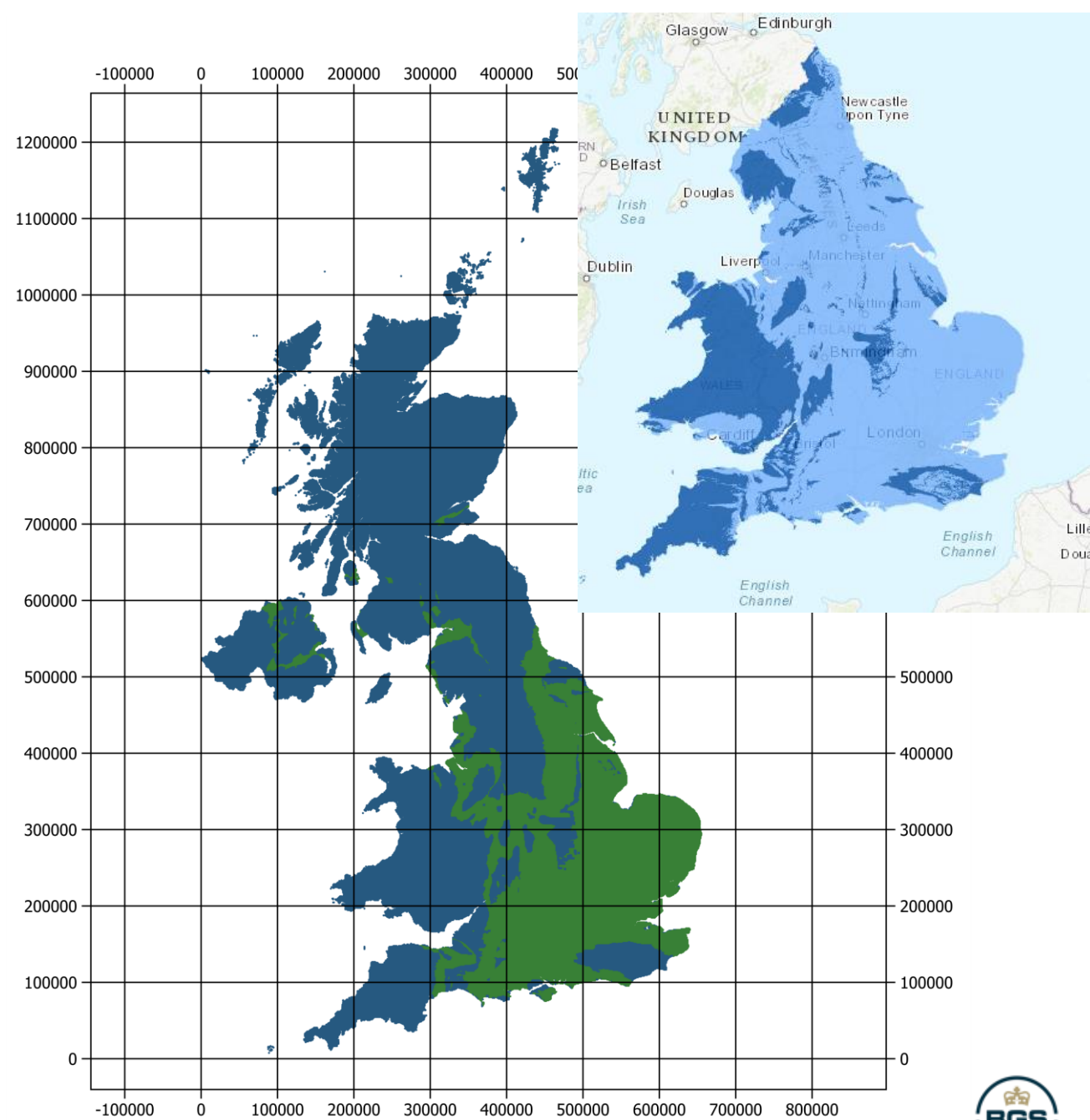
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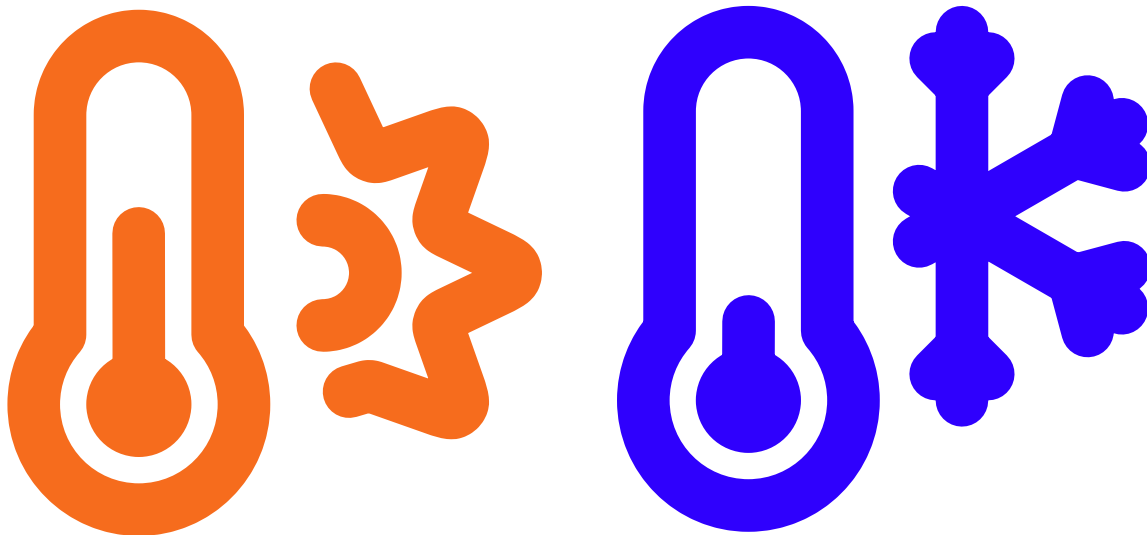
National Map of ATES favorability (per 1km² grid cell)

- Map is coded to show 2 categories
 - Favourable for ATES
 - Area is underlain by at least 1 principal aquifer that can sustain a yield greater than 12 l/s
 - Less favourable for ATES
 - Areas where local aquifers may have potential for ATES but additional local investigation may be required to prove the resource
 - Consider the GSHP Tool in England and Wales



Limitation

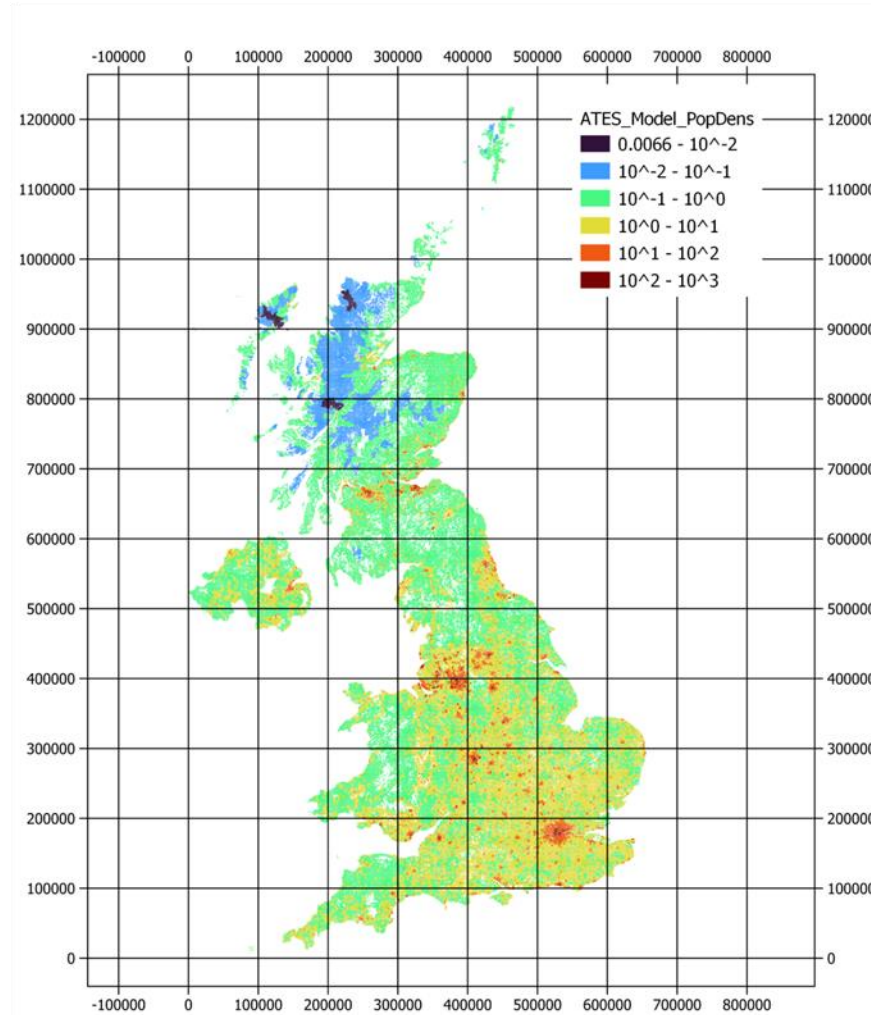
- Onshore only
- National scale - 1:625, 000 scale
- Systems greater the 0.5 MWth
- Selected aquifers – minor aquifers may have potential
 - Aquifer productivity and variability (borehole yields)
- Only considers abstraction rates; limited injectivity data available
- Does not consider
 - Protected Areas including source protection zones
 - Existing ground water abstraction licences
 - Reduction in aquifer productivity near the outcrop boundaries due to decreasing thickness of the aquifer
 - Groundwater chemistry
 - Groundwater gradients
 - Storage capacity
 - Superficial Deposits
 - Sustainability of system
 - Above ground system engineering and optimisation



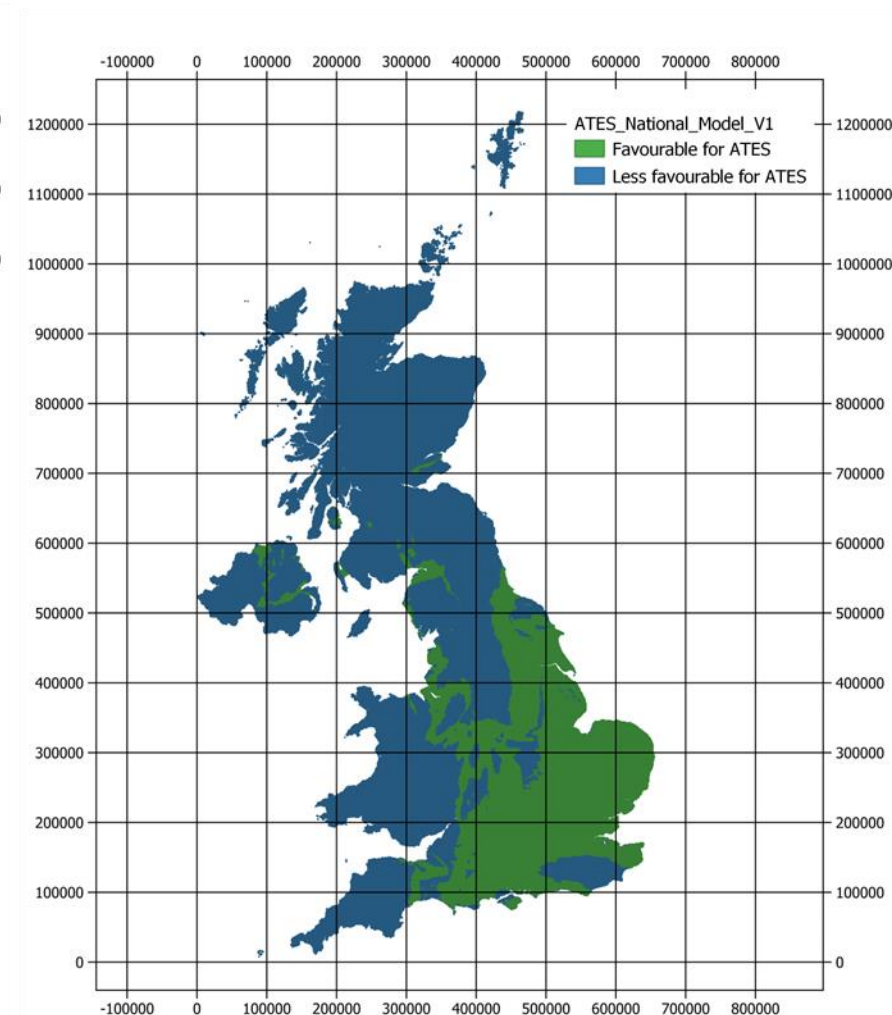
Conclusions

- UK has significant potential for ATEs systems
- ~33% of the country area within areas favourable for ATEs
- ~53% of the country with a population over 10 people/km favourable for ATEs
- Better mapping of energy storage requirements (especially cool)
- Secondary aquifer properties and variability

Population Density



ATES Favourability



Questions?