GEOGUARD

De-risking Geothermal Heat Extraction from Tight Hot Sedimentary Aquifers

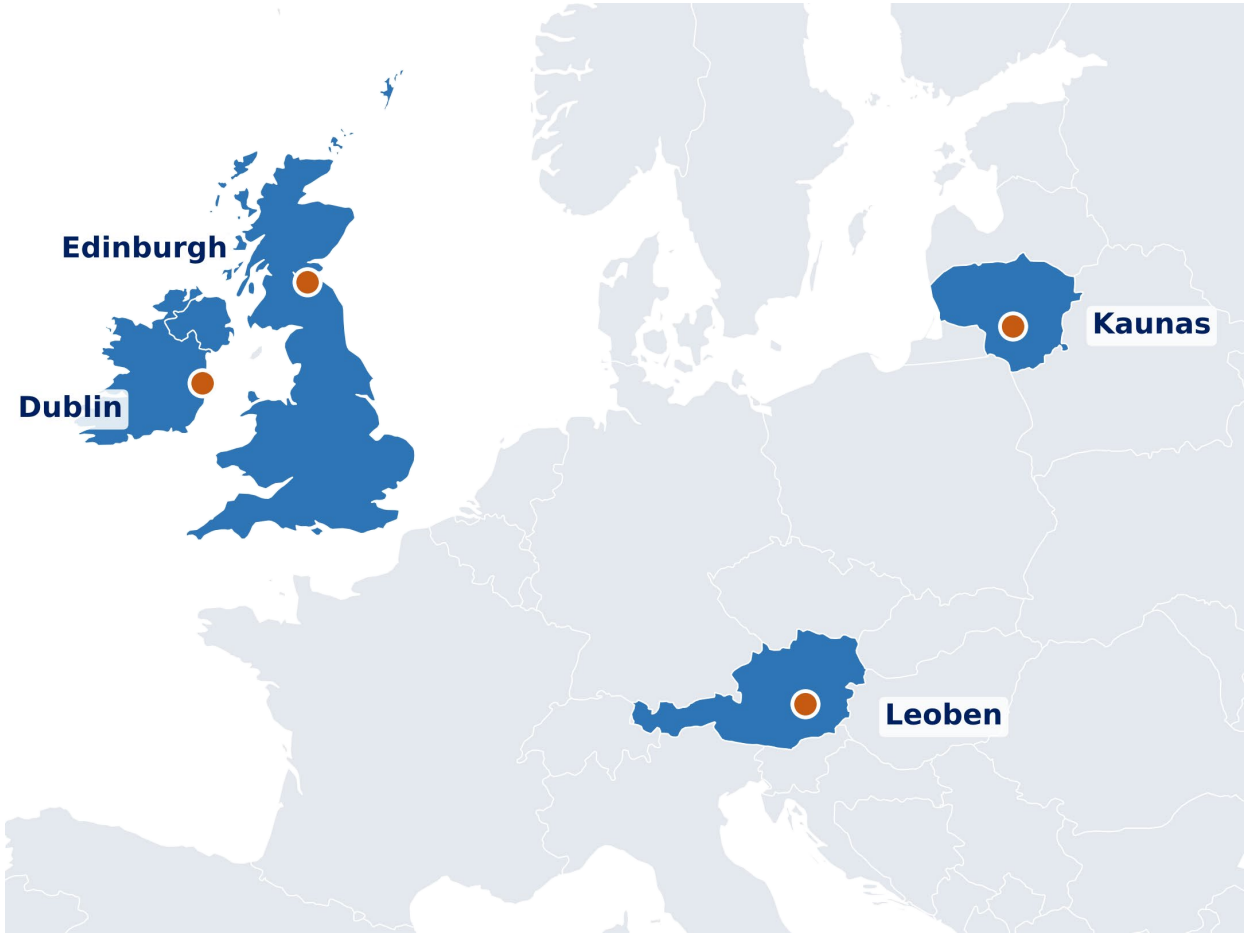


Andreas Busch (a.busch@hw.ac.uk)

Prof of Earth Sciences, Heriot-Watt University

Co-Director Lyell Centre for Earth and Marine Sciences

Consortium: six partners, four countries



United Kingdom · Edinburgh

Heriot-Watt University (coordinator)

TownRock Energy

Scene

Ireland · Dublin

University College Dublin

Lithuania · Kaunas

Kaunas University of Technology

Austria · Leoben

Montanuniversität Leoben

What is a (tight) Hot Sedimentary Aquifer?

Hot Sedimentary Aquifers (HSAs)

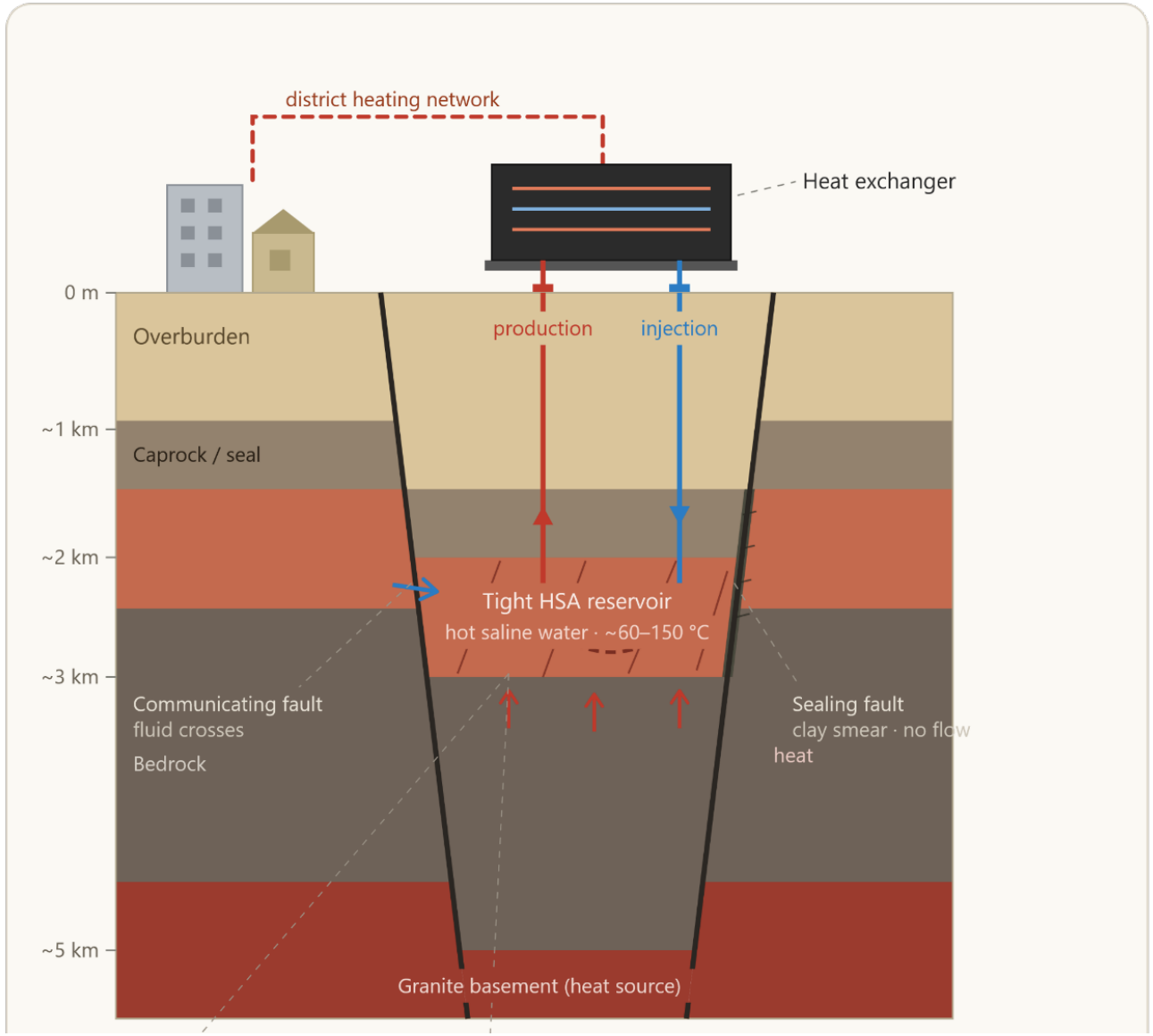
Deeply buried sandstone or limestone holding large volumes of hot saline water; conduction-dominated, widespread across Europe, typically 50–200 °C.

Why they are attractive

Baseload, weather-independent heat 24/7. Low operating cost, decentralised, ideal for direct heat; decarbonising heat without electrifying it.

What makes one “tight”

Low matrix permeability, often with natural fractures. Flow to the well is the bottleneck, so commercial flow rates are uncertain at the exploration stage.



A large, under-used resource for heat

~50%

of EU final energy is heating & cooling

2.8%

geothermal share of EU renewables today

>5×

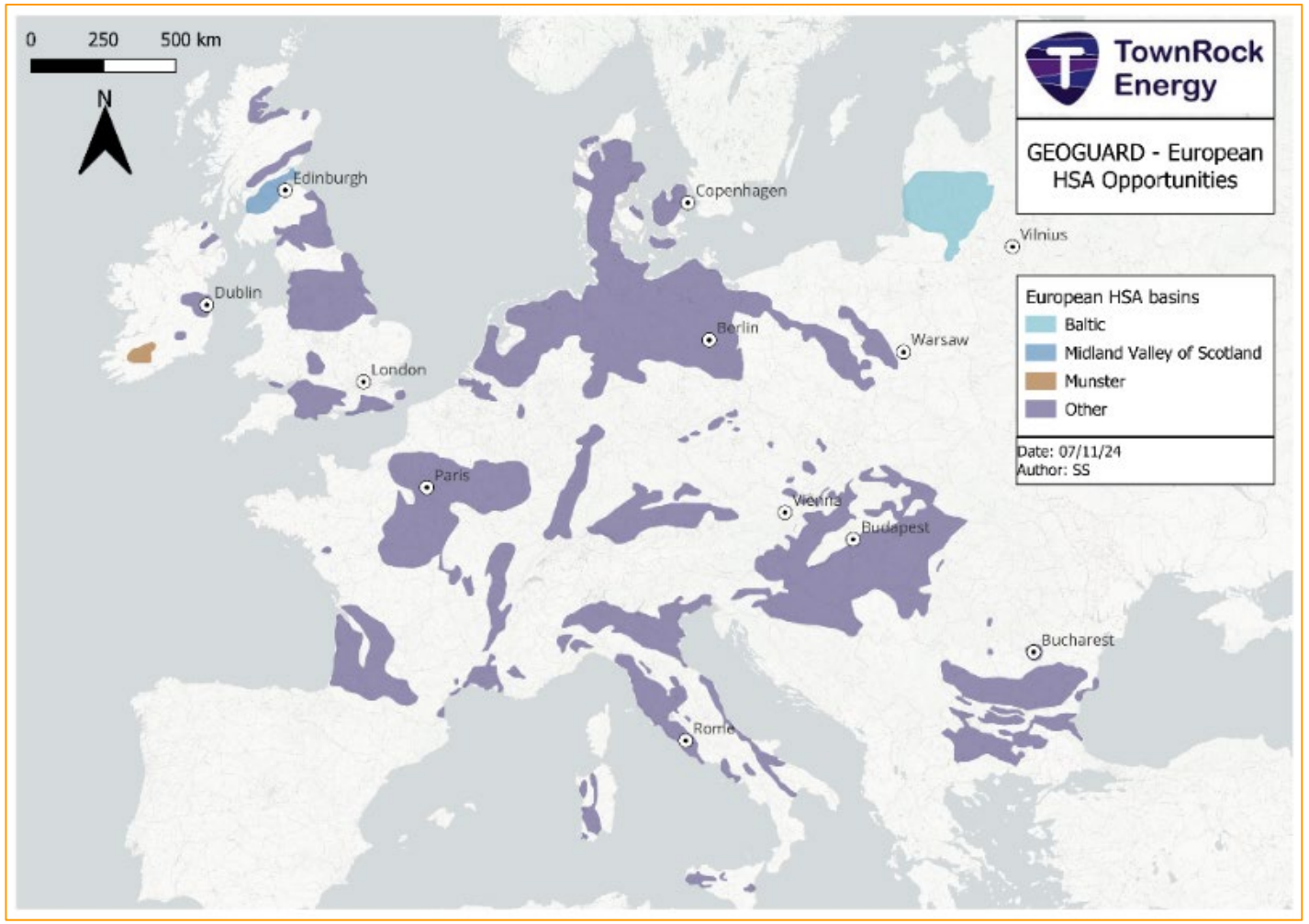
projected geothermal growth to 2050 (IEA)

9/10

biggest UK cities overlie tight basins

The opportunity: ~100 years of UK heat demand sits in tight sedimentary reservoirs.

The barrier: almost all of it is too tight to flow commercially without stimulation.



Flow rate is the make-or-break variable

1. **Low matrix permeability**
2. **Low flow rate to the well**
3. **Low energy output / revenue**
4. **Project stalls at feasibility**

Two-way strategy

1 — De-risk what is already there

Better characterisation + uncertainty quantification, so the flow-rate forecast is trusted before drilling.

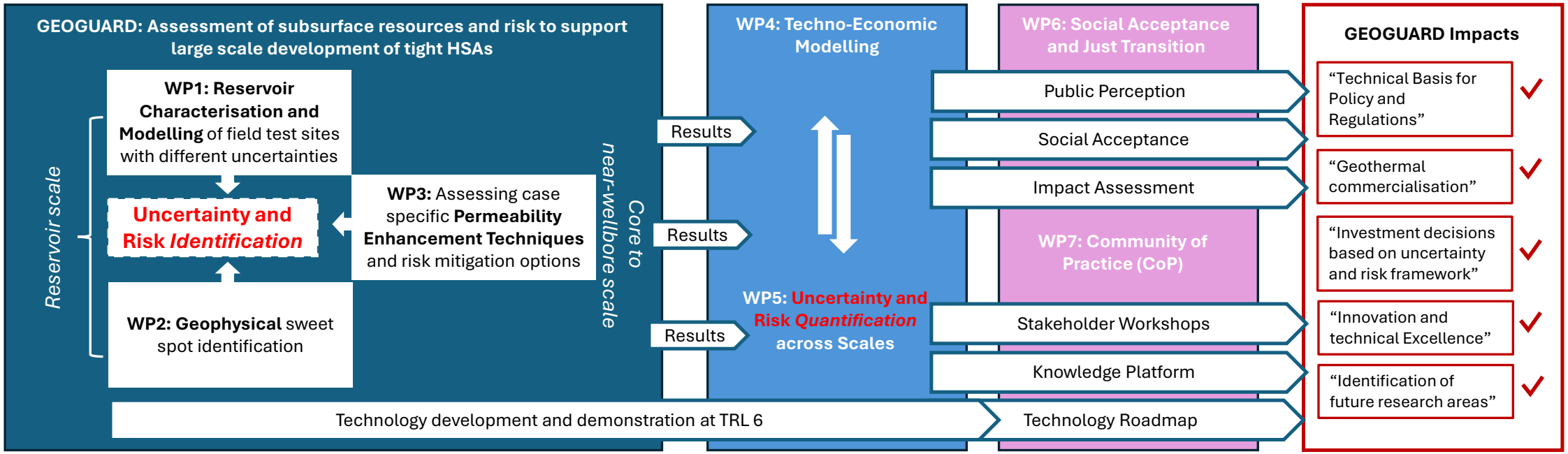
2 — Enhance permeability where needed

Acidisation, hydroshearing, thermal stimulation — borrowed from oil & gas, with quantified seismic risk and social licence.

Stimulation is costly, poorly understood for HSAs, and socially contentious — GEOGUARD treats this head-on.

An open-source toolbox that bridges scales

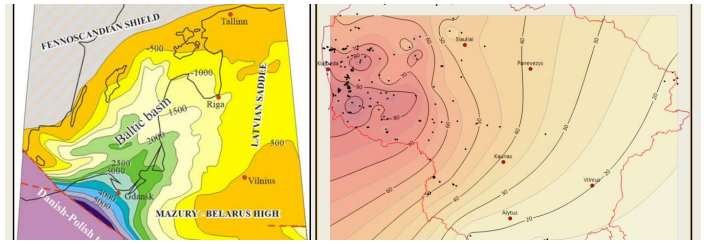
De-risked, uncertainty-quantified workflows — validated on real case-study data — that bridge the lab, the wellbore and the reservoir into one open-source decision chain.

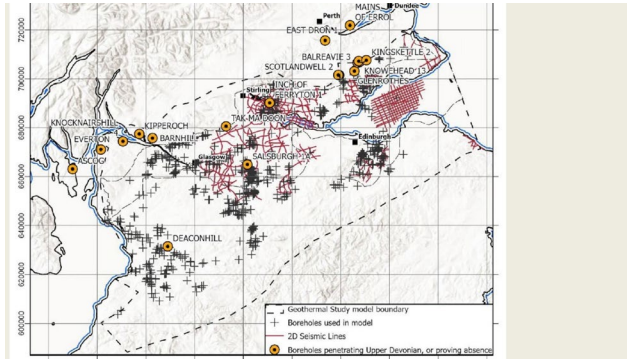


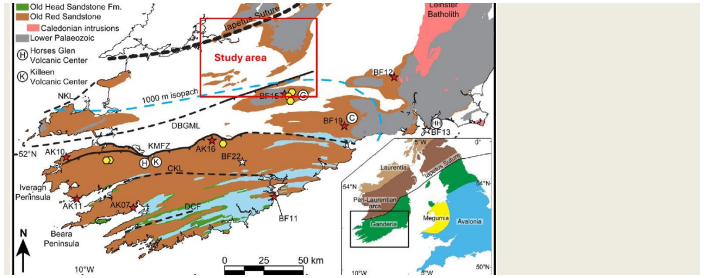
GEOGUARD work-package integration and Technology Readiness Levels (proposal Fig. 1)

Not new technology — GEOGUARD integrates proven methods into a validated open-source workflow that moves projects toward final investment decision. Target: TRL 2–4 → 6.

Three case studies: from benchmark to frontier







CASE 1
Baltic Basin, Lithuania

LOCATION
Western Lithuania

TARGET
Cambrian – Devonian saline aquifers

DATA
Data-rich: 2D/3D seismic, >300 wells

Mature site — our benchmark

CASE 2
Midland Valley, Scotland

LOCATION
Central Scotland (Glasgow–Edinburgh)

TARGET
Upper Devonian sandstones

DATA
Variable: old 2D seismic, shallow wells

Demonstrator — HW campus

CASE 3
Limerick Basin, Ireland

LOCATION
Limerick & N. Munster Basin

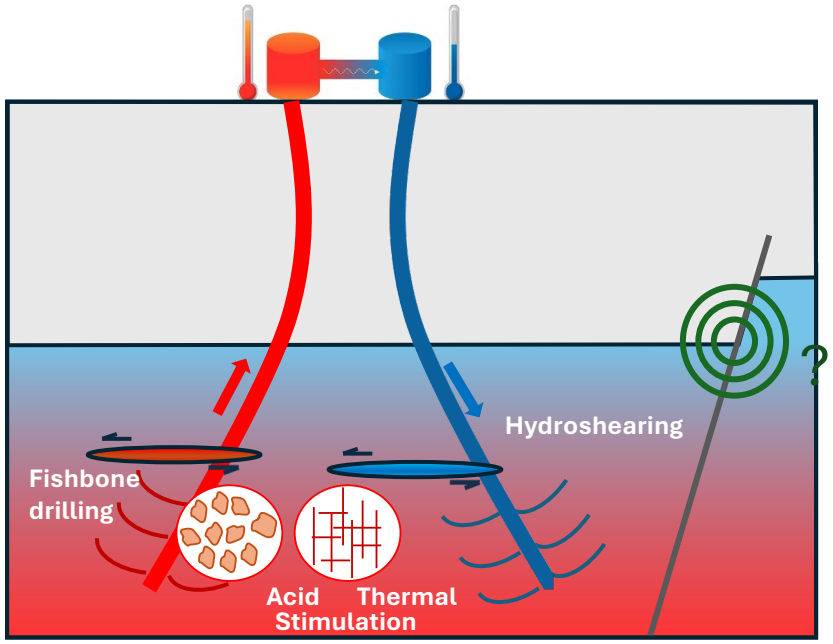
TARGET
Old Red Sandstone (ORS)

DATA
Sparse: few 2D lines, ORS core

Frontier — least developed

Soft stimulation — the good, the bad, the ugly

Tight, fractured reservoirs will need stimulation. Each technique trades reservoir gain against seismic and operational risk — induced seismicity is the biggest threat to licence to operate.



Acidisation	Hydroshearing	Thermal stimulation
GAIN Dissolves carbonate cement → ↑ near-well porosity	**GAIN** Reactivates & props natural fractures → ↑ connectivity	**GAIN** Thermal cracking enhances near-well permeability
RISK Rock weakening, fines migration, pore clogging	**RISK** Fault instability → induced seismicity	**RISK** Stress redistribution, uncertain persistence

Key for the public dialogue: *permeability enhancement is far broader than "fracking" — most techniques are controllable and routine in other industries.*

Social licence: built in from the start

Why it matters

Heat is local
Wells sit under towns, campuses and city districts — people live above the reservoir.

“Stimulation” sounds like “fracking”
The UK’s 2019 moratorium is still fresh in public memory.

Felt seismicity can stop a project
whatever the geology says — trust has to be earned before drilling.

1 **LISTEN**
Public perception

Stakeholder workshops and perception work in the case-study regions — understanding local concerns before decisions are made.

2 **ASSESS**
Social acceptance

A social-acceptance framework and impact assessment with a just-transition lens: who benefits, who carries the risk, and how that is shared.

3 **EXPLAIN**
Stimulation ≠ fracking

A policy brief setting out how soft-stimulation techniques differ from fracking, and how seismic risk is monitored and managed.

4 **SUSTAIN**
Community of Practice

Training, a digital knowledge platform and a technology roadmap — open to developers, regulators and communities.

Also delivered for science and industry: open-source simulation toolbox · techno-economic cashflow tool · best-practice exploration guide · stimulation value/risk ranking · ML proxy and coupled skin models

GEOGUARD

Turning tight, written-off reservoirs into a de-risked, bankable heat resource.

THE PROBLEM

Flow rate — not heat — limits tight HSAs

THE APPROACH

Integrate lab→reservoir →region, quantify uncertainty

THE PROOF

Three case studies, benchmark to frontier

CONSORTIUM

Heriot-Watt University · TownRock Energy · Montanuniversität Leoben · Kaunas University of Technology · University College Dublin · Scene

Andreas Busch · a.busch@hw.ac.uk · www.geoguard.hw.ac.uk

Thank you for your attention!

