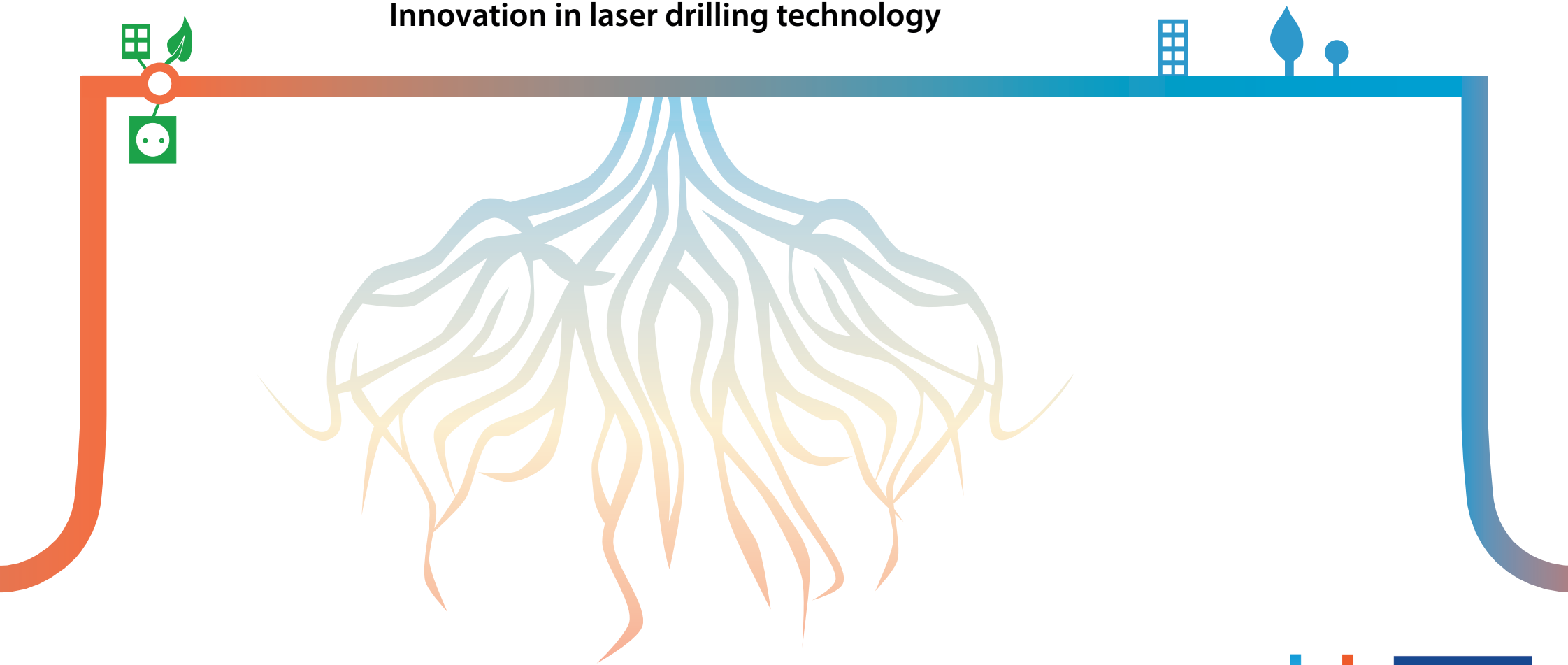


Innovation in laser drilling technology



to unlock the Earth's Limitless Energy

Imagine tapping into the clean, constant heat beneath our feet, anywhere on Earth. DeepU makes this possible with a game-changing breakthrough in laser drilling technology that overcomes the limitations of conventional drilling methods in developing deep closed-loop heat exchangers.



Deep U-tube heat exchanger breakthrough: combining laser and cryogenic gas for geothermal energy exploitation



www.deepu.eu

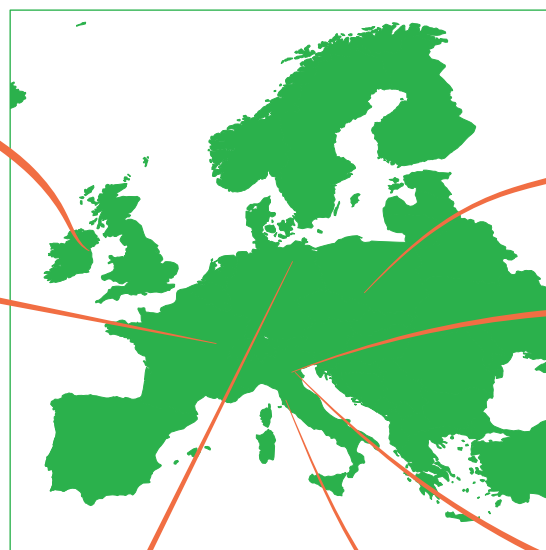
7 partners, 4 countries for a multidisciplinary geothermal challenge: innovate drilling technology for developing deep heat exchangers

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IRELAND

Prevent
CO₂

GERMANY

Fraunhofer
IAPT



Wrocław University
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DeepU is a Research Project funded by the European Union (G.A. 101046937) under the EIC Pathfinder, which supports early-stage projects (TRL 1-4) having the potential to create new markets and address global changes, making a real difference for our lives.

However, the views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union or EISMEA.

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Why It Matters

Geothermal energy is a renewable, sustainable, and reliable source of energy - yet accessing it remains a challenge. DeepU's laser drilling technology changes that, opening the door to affordable, zero-emission energy for homes, industries, and entire communities

How It Works

- **Laser precision:** Our innovative laser drill bit melts and evaporates rocks or breaks them down into tiny particles (spalls), without the mechanical interactions of conventional drill bits
- **Smart flushing:** A stream of supercritical cryogenic gas clears debris and keeps the borehole clean
- **Extreme resilience:** The process works at any rock's temperature, any hardness, or water content, even in the most challenging conditions found deep underground
- **Energy production anywhere:** With DeepU technology, we laser-drill deep, closed-loop heat exchangers, efficiently transporting energy from deep underground to the surface

What We Have Achieved

- Proven efficiency, non-contact laser drilling of a closed-loop heat exchanger in the lab
- Built a drill string prototype ready for field testing
- Identified optimal laser settings for varying rock types
- Assessed environmental and safety standards to ensure responsible deployment
- Explored the drilling cost reduction potential

In more detail

Laser drilling and cryogenic gas flushing:

Studies demonstrated that combining laser drilling with cryogenic gas flushing is highly effective. Rock fragments (spalled or evaporated particles) are removed via the borehole annulus, using supercritical nitrogen as the flushing and cooling medium. A model was developed to simulate and analyse particle transport, cryogenic gas fluid flow, and pressure-temperature variations

Efficient drill string:

Our full-scale drill string prototype is now ready for field testing trials. Experiments fine-tuned the drill string while adjusting the layout in terms of laser energy and gas flushing. Novel insulated, quick, and secure drill pipe connections ensure smooth and efficient operation

Fast drilling speed:

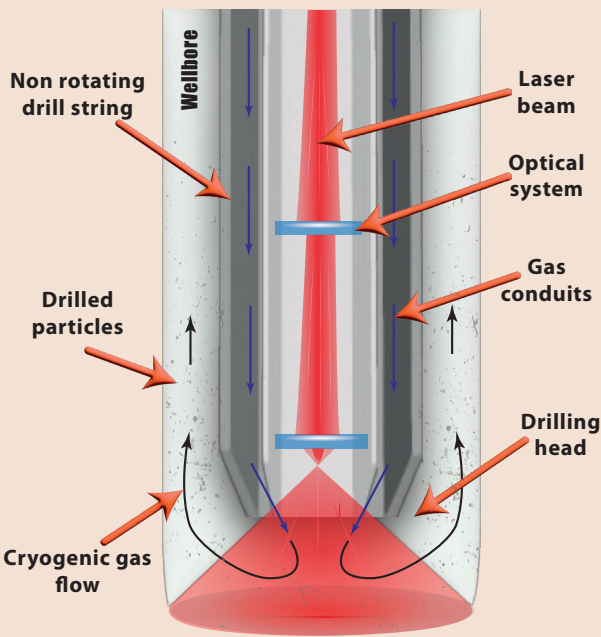
Boreholes were drilled with the DeepU laser drilling technology in various rock types, achieving a drilling speed (ROP) of 20-25 m/h in hard rocks

Laser-rock interaction:

By studying how rock responds to lasers, we identified the energy thresholds for spallation, melting, and evaporation, and determined the optimal settings for different lithologies and conditions

What Is Next

We are preparing to bring DeepU to the field—paving the way for large-scale, cost-effective geothermal energy. With the DeepU technology, the Earth's heat can power a cleaner, more resilient future.



Path to improvements:

Analyses of spalled particles and vitrified layers provided insights that will guide future enhancements of the DeepU technology

Economic comparison:

System-level simulations compared deep closed-loop with conventional open-loop systems. The Levelized Cost of Energy (LCOE) for electricity and heat, including investment and operating costs, was calculated for both conventional mechanically driven technologies and the non-contact DeepU technique. The results emphasise the opportunities that DeepU can offer over conventional approaches

Safety and regulation:

Using methods like Failure Mode and Effects Analysis and Environmental Risk Assessment, we benchmarked DeepU against conventional drilling. We also anticipated regulatory requirements for Health, Safety, and Environmental compliance