THE PROJECT TEAM

Seven partners from three European countries have joined forces to develop a technology that has the potential to implement the share of geothermal energy worldwide

R.E.D. SRL

RED SRL is a spin-off Company of the Italian CNR that designs and installs heating and cooling systems for buildings, in particular on geothermal based and other renewable energy sources. RED SRL is also active in the energy management of small and medium-sized enterprises and owns an Italian patent on an innovative co-axial borehole heat exchanger. In DeepU, RED SRL leads the exploitation and market planning activities, including the IPR management strategy.

UNIVERSITÀ DEGLI STUDI DI PADOVA

The University of Padova (UNIPD), founded in Italy in 1222, is one of Europe's oldest and most prestigious seats of learning. The geothermal research group belonging to the Department of Geosciences is at the forefront of the research in geothermal energy, especially related to rocks' thermal properties characterisation, the effect of heat transport, underground heat storage, geothermal heat pumps and deep closed loop wells. UNIPD is the DeepU project's coordinator and is directly responsible for the petrophysical characterisation of the rocks.

PREVENT GMBH

Prevent is a German engineering company with affiliated prototyping and manufacturing in the field of plasma drill and laser drill strings, working on optimising lightweight multiple drill pipes and drill heads for plasma and laser deep hole drilling. The company has a long experience in the fields of drilling technology, shaft sinking technology, electrics and electronics, as well as drill rig engineering. For the DeepU project, it develops and manufactures different multiple drill pipes and drill heads for laser drilling with different cryogenic gases.

FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV

Fraunhofer IAPT takes part in the Fraunhofer community of currently 76 institutes in Germany with over 30.000 employees, which is the world's leading organisation, especially for applied research. At its location in Hamburg, Fraunhofer IAPT conducts R&D in the field of laser technologies and additive manufacturing. In the DeepU project, Fraunhofer IAPT is responsible for developing the combined laser and gas process and designing the drilling head using 3D printing technologies.

TERRA GEOSERV LIMITED

GeoServ is a leading Irish and international SME that specialises in providing tailored services to the geothermal, natural resource, energy and environmental sectors. Its specialist services are focussed on delivering turnkey geothermal systems for heating, cooling and energy storage applications and providing project management at the exploration and development stages. Geoserv coordinates the activities related to regulatory and environmental aspects of the DeepU project.

CONSIGLIO NAZIONALE DELLE RICERCHE

The Italian National Research Council (CNR) is a public organisation with Italy's largest network of institutes. It carries out, promotes, spreads, transfers and improves research activities in the main sectors of knowledge growth. Its Institute of Geosciences and Earth Resources (IGG) has provided technologies and solutions for geothermal assessment for many decades and promotes geothermal applications and innovation in the leading international platforms. CNR-IGG is responsible for the DeepU resource modelling and the dissemination and communication activities.

WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY

Established in 1945, WUST has evolved into one of Poland's leading technical universities, boasting a legacy built on resilience and academic excellence. WUST has cultivated unparalleled expertise in cryogenic technology, notably being the sole European country where helium is being extracted from natural gas and then liquefied. Their prowess extends to the development, design, production supervision and commissioning of complex cryogenic distribution systems supplying with liquid cryogens superconducting accelerators, free electron lasers, thermonuclear reactors and other Big Science machines.

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

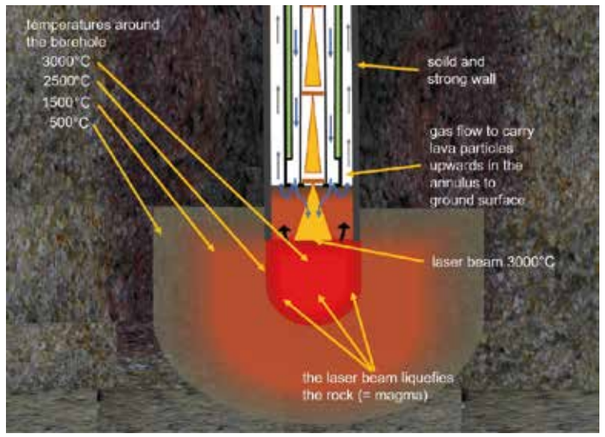
www.deepu.eu

This research is funded by the European Union (G.A. 101046937). 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. Neither the European Union nor the granting authority can be held responsible for them.

INNOVATIVE DRILLING TECHNOLOGY

What happens to a rock, even the hardest, if a high-temperature laser melts it and then a cryogenic gas suddenly cools it?

Vitrified, waterproof, non-cracked borehole surfaces are expected. The resulting glazed layer on the borehole walls acts as a casing so that a deep heat exchanger is ready immediately after drilling



In the DeepU concept, a laser drill-head is combined with special drill strings to sustain the coupled action of laser and cryogenic gas. The fine particles are transported to the surface in the gas stream via the earth tube required for the geothermal heat exchanger. Specific temperature control analysis and innovative laser lenses convey the heat and sustain multilateral drilling. In addition, gases have to be kept cryogenic over a long distance. These innovations guarantee the liquefaction and vitrification of the rocks from the ground surface to significant depths.

INCREASED DRILLING SPEED

The rate of penetration (ROP) should be increased up to 20 to 30 meters per hour, increasing by a great far the drilling speed of traditional drilling methods (i.e. ten times that of rotary methods, reaching max 1-2 m/h in hard rock).

Laboratory tests will prototype the concept. Drilling experiments in a box of about 250 m^3 filled with different rock types will validate and refine the technology. The petro-thermo-mechanical phenomena affecting different rocks will be analysed, and the borehole wall vitrification and integrity will be assessed.

THE DeepU PROJECT CONCEPT

Increasing accessibility of deep geothermal resources for low carbon heating and power generation is a fundamental requirement to accelerate the development of decarbonised and indigenous energy supplies in Europe.
Geothermal technologies provide baseload, indigenous and dispatchable renewable power and heat for space heating and industrial applications throughout the EU. However, besides shallow geothermal heat exchangers used in combination to heat pumps for heating and cooling applications, current geothermal development is limited to accessing water-bearing rocks or creating cracks or fissures to circulate and heat water at depth. The economic viability of existing technologies depends on favourable subsurface conditions to facilitate fluid circulation and on the cost of well drilling and completion. The latter represents over 55% of total project costs.

DeepU can potentially disrupt the geothermal industry by offering a substantial reduction of well drilling costs to deliver deep heat exchange systems.
Since the underground heat is transported by a secondary fluid circulating in deep, closed-loop systems, the high-risk innovation concept of DeepU has the potential to make

geothermal energy systems accessible anywhere

in a targeted and demand-oriented manner, offering a complementary approach and an alternative solution to traditional geothermal energy storage and production.

The DeepU solution will decentralize the power supply also in areas where this is currently deemed uneconomic, to significantly contribute to the energy sector's decarbonisation.

MARKET ANALYSIS FOR A SUSTAINABLE DEPLOYMENT

The project will analyse the exploitation potential and economics of the developed drilling technology utilising numerical simulations calibrated by the laboratory data. In addition, it will assess the legislative aspects and environmental, health and safety (EHS) standards related to the proposed solution. An EHS risks assessment comparing DeepU technology to conventional deep drilling will be performed based on the laboratory results.