Agenda

- 9.00 – 9.30 Arrival and registration
- 9.30 – 9.45 Welcome by Zorlu
- 9.45 – 10.00 Introduction Workshop by Zorlu/DEEPLIGHT WP6
- 10.00 – 10.20 The DEEPLIGHT project – motivation and scope
  - DEEPLIGHT: Motivation and background (Frank van Bergen, TNO)
  - DEEPLIGHT: Overview of the project (Jens Wollenweber, TNO)
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  - DEEPLIGHT drilling, how it works? (Geertjan Von Og, Well Engineering Partners)
  - Electro Pulse Power (EPP) drilling tool design (Erik Neumann, Technical University Dresden)
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- 13.30 – End of Public Workshop

Motivation and Background

DEEPLIGHT - Novel concepts to construct cost effective geothermal wells with Electro Pulse Power Technology

Public Workshop, February 27th, 2025, Istanbul

Frank van Bergen, Gert-Jan Heerens, Jens Wollenweber – TNO

The project DEEPLIGHT is subsidized through the GEOTHERMICA and JPP Smart Energy Systems Joint Call by Netherland Enterprise Agency, RVO, German Federal Ministry for Economic Affairs and Energy BMWi, Icelandic Research Institute, RANNIS, The Scientific and Technological Research Council of Turkey, TÜBİTAK, United States Department of Energy, DOE.
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Role of geothermal energy in energy transition

- Many countries have the ultimate goal of zero net carbon emissions in 2030 or 2050 at the latest.
- To meet this challenge, solutions for heating and cooling systems need to come from a mix of renewable resources.
- Geothermal energy is the only sustainable energy source that offers stable and reliable heat and electricity production and is considered to be a major future heat source
  - e.g., it should have a share of 23% of the heat demand in the Netherlands with 700 geothermal doublets by 2050

Economic and market challenges

- Drilling, completion and operation of geothermal wells are associated with considerable uncertainties and risks
  - Substantial need for improving the drilling process and constructing long-living wells, preferably with a higher energy output per well as can be achieved today
- Standard well construction concepts have clear limitations to substantially reduce the costs of well constructions

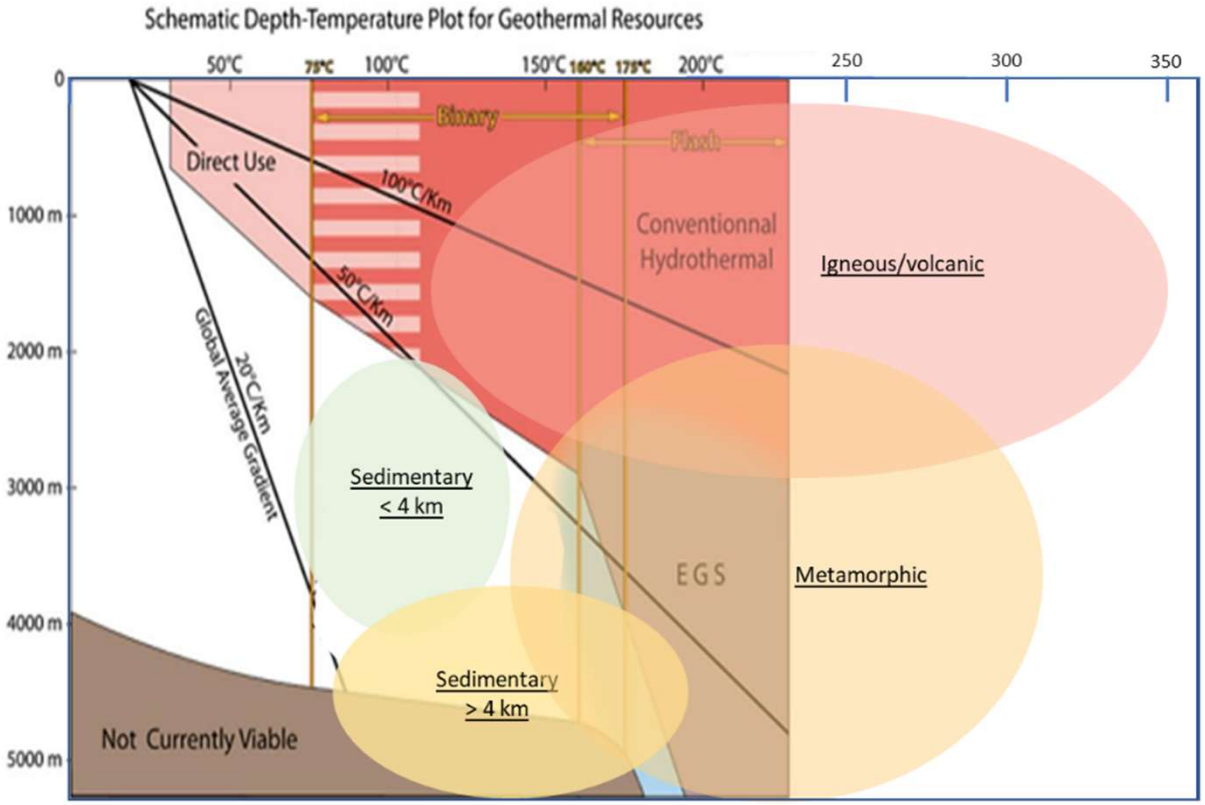
Image of drill-bit tear from the Geysers EGS Demonstration Project

(Garcia et al., 2016)

Why another drilling technology?

- Novel and ultra-deep geothermal systems offer great opportunities in the energy transition
- Hard and tight formations with high temperatures are targeted while current rotary drilling technology primarily developed for softer formations
- A step-change in technology is needed to enable ways to drill harder and hotter rock at lower cost
- Electro Pulse Power Drilling offers such enabling possibilities

Geothermal heat harvesting and geothermal plays



Highest geothermal potential in marked zones (ellipses)

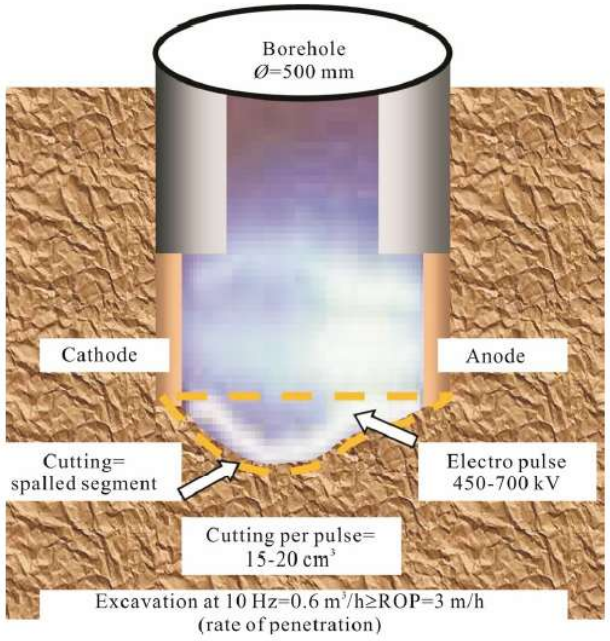
Source: International Geothermal Association (2020), modified); superheated/supercritical igneous/volcanic trials (e.g. IDDP-1/2) not included

Technical challenges

- Showstoppers are indicated with red, severe limitations with orange, no problem with green

Challenges of current well construction technology					
Geothermal heat harvesting setting		Sedimentary less than 4 km tvd	Sedimentary beyond 4 km tvd	Igneous/volcanic	Metamorphic
Aspect	**Challenge**				
Deviated well reach	Torque/Drillpipe strength limits reached				
Ultra deep well reach	Torque/Drillpipe strength limits reached				
Drilling technical/cost limits	Increased drilling costs not matched with better heat harvest				
Slow drilling, bit life	Increased drilling costs not matched with better heat harvest				
Wellbore stability	Severe wash-outs, loss of well risk			Maybe	
Compressional casing failure due to thermal expansion	Expensive repairs, loss of well risk				Maybe
Overtorqued threaded connections in HT drilling	Twist-offs, pipe failure, unsafe rig-floor operations				Maybe
Torque for Casing Drilling	Current threaded connections cannot transfer the requird torque for efficient drilling			Maybe	
Corrosion	Expensive repairs, loss of well risk driving need for replaceable flow string	Except for closed loop	Except for closed loop	Maybe	Maybe
Scaling problems	Plugging, loss of production, need for replaceable flow string	Except for closed loop	Except for closed loop	Maybe	Maybe

Advantages of Electro Pulse Power Drilling



(Schiegg et al., Journal of Earth Sciences, 2015)

Figure 6. Electro-pulse-boring (EPB) principle.

- Touchless drilling through high voltage electric pulse
- Shorter drill time, fewer trips for drill bit replacement due to wear
- No heavy rotary equipment since there is no need for torque and weight
- Large diameter well without major additional costs
- Larger diameter well will increase the production per well, allowing faster return on investments that are currently prohibitive
- Casing can be placed while drilling

DEEPLIGHT – Project Objectives

- **From TUDr trial runs to standard drill rig test**
  - EPP drilling of rock sample at a depth of ~50-100m under continuous circulation (TRL 3 => 6)

- Develop complementary high-temperature technologies:
  - Cement based barriers
  - Large bore heat production modelling
  - Flexible casing coupling

Research drill rig at TNO's Rijswijk Centre for Sustainable Geoenergy

DEEPLIGHT - Key targets

- Increase confidence in geothermal operations by reduced risks of deep geothermal projects
- Reduce geothermal well construction costs ***by 20-30% depending on the locations which can save billions of upfront investments***.
- Increase heat production capacity per well location, ***geothermal heat production capacity per production location can be boosted by 30-40%***
- Enhance energy production from geothermal formations ***which can lead to 35% to 65% production increase and enabling the exploitation of deeper formation and hard-rock plays***
- Smaller CO_2 footprint, waste reduction and energy savings

Project Overview

DEEPLIGHT - Novel concepts to construct cost effective geothermal wells with Electro Pulse Power Technology

Public Workshop, February 27th, 2025, Istanbul

Frank van Bergen, Gert-Jan Heerens, Jens Wollenweber – TNO

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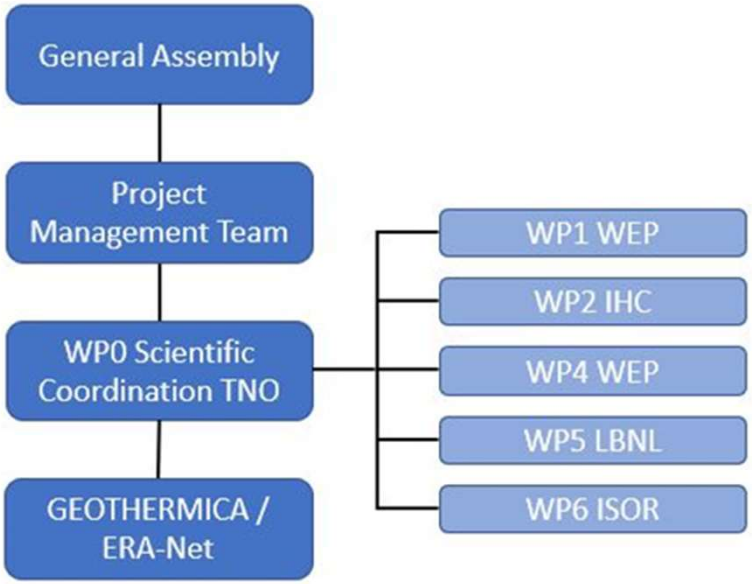
DEEPLIGHT - Facts

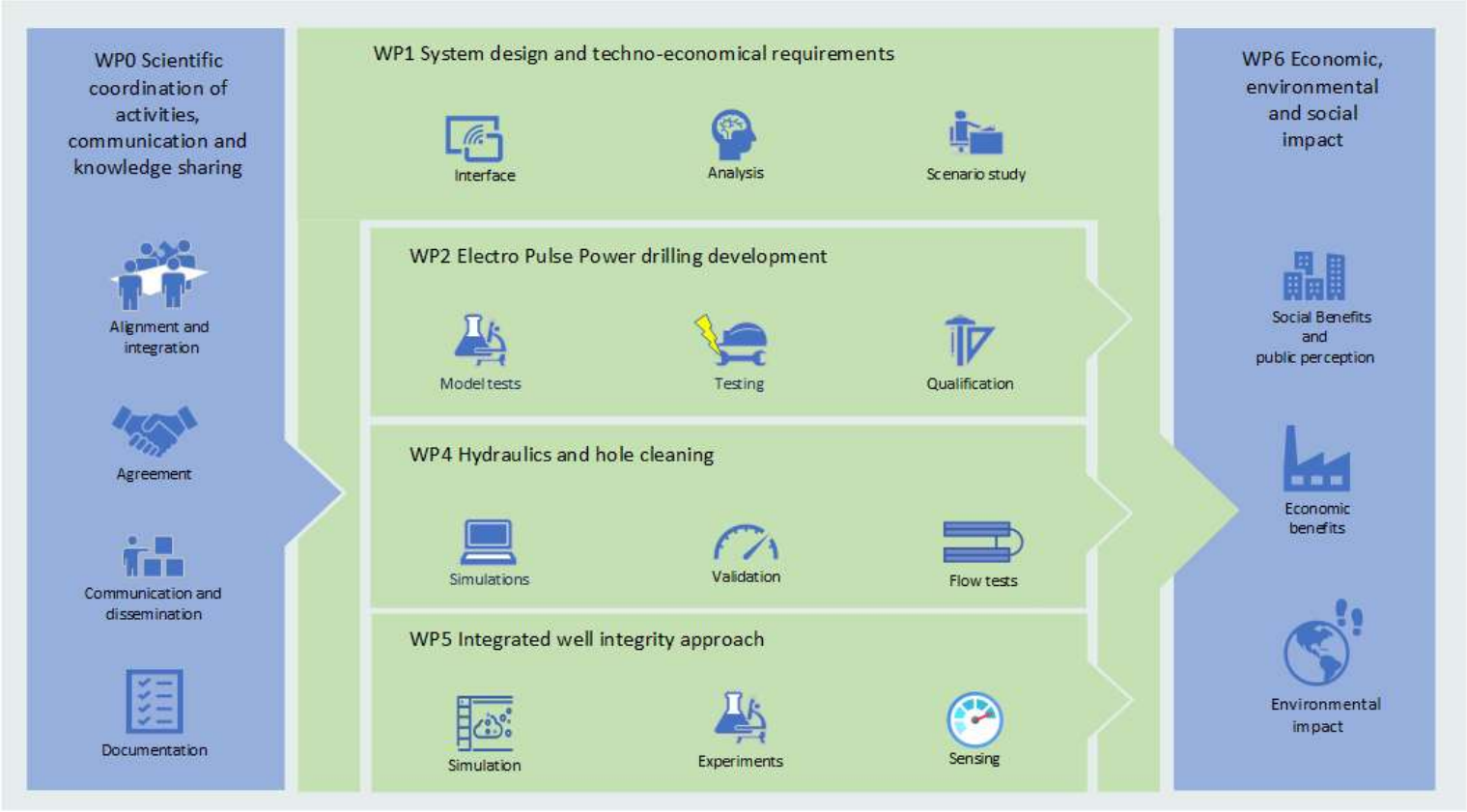
- Duration: November 1st 2023 – October 31st 2025
- Budget: 4.94 M€
- Funding: 3.87 M€
- 12 partners from 5 countries

Consortium & organisation

Participant no.	Name and abbreviation	Type of organisation	Country
1	Netherlands Organisation for Applied Scientific Research (TNO)	R&D	Netherlands
2	IHC Mining B.V. (IHC)	SME, technology provider	Netherlands
3	Technische Universität Dresden (TUD)	Academia	Germany
4	Eindhoven University of Technology (TUE)	Academia	Netherlands
5	Well Engineering Partners B.V. (WEP)	SME, service company	Netherlands
6	ÍSOR - Iceland Geo Survey (ISOR)	R&D	Iceland
7	Iceland Drilling Company (IDC)	Drilling company	Iceland
8	Zorlu Enerji Elektrik Üretím A.S. (ZRN)	Geothermal Operator	Turkey
9	Lawrence Berkeley National Laboratory (LBNL)	R&D	U.S.A.
10	Oklahoma State University (OSU)	Academia	U.S.A.
11	Werk für industrielle Elektronik (WIE)	SME, technology provider	Germany
12	BITSz Electronics GmbH (BIT)	SME, technology provider	Germany



DEEPLIGHT Project Structure



Specific project objectives

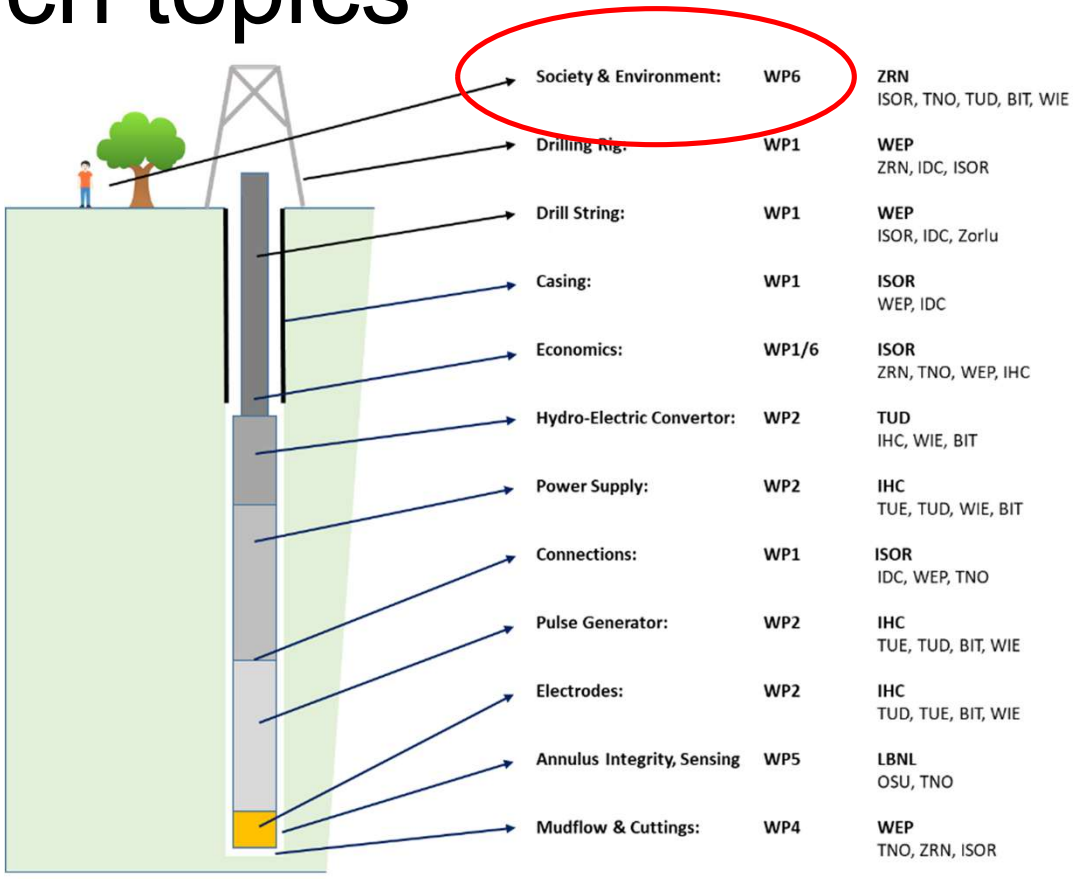
- A game changing drilling and well construction system:

1. Develop contactless drilling with Electrical Pulsed Power (EPP) technology
2. A design for casing placement while drilling
3. Investigate thermal flexible, smart cement
4. Develop a DEEPLIGHT EPP-casing while drilling (EPP-CwD) system design

DEEPLIGHT research topics

- System design approach

Prototype of drill head and drilled hole (12 ¼")



Some impressions

Prototype test
June 14th 2024

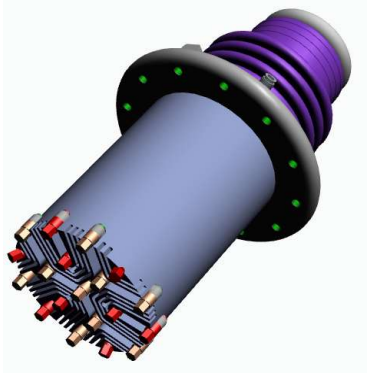


Figure 1 EPP rock breaking principle

Figure 2 Test rig at TNO RCSG

Figure 3 The current test set-up at TUD

Figure 4 TTC straight stab connections

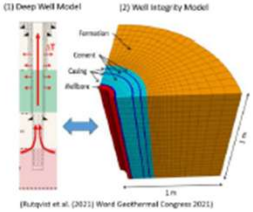
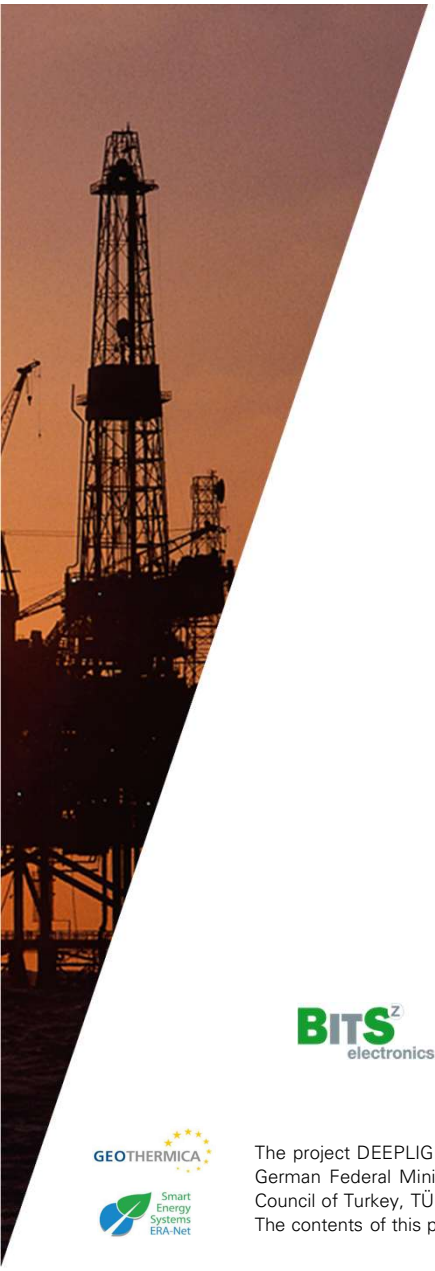


Figure 5 Well integrity modelling at LBNL/OSU



Novel concepts to construct cost effective geothermal wells with Electro Pulse Power Technology

Deep Light

Thank you for your attention

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Dissemination

- Celle Drilling ’23 (Germany) by TUD: “Novel concepts to construct cost effective geothermal wells with Electro Pulse Power Technology”
- A similar presentation given by TUD at the Iceland Geothermal Conference, end of May 2024
- Abstract submitted for GeoTherm ’25 by WEP/IHC – pending acceptance
- Abstract submitted for EGC ‘25 by WEP/TNO – pending acceptance
- EAGE GET 2024 - Overview of Plasma-Pulse Drilling Technology for Deep Geothermal Resources, 4-7 November 2024

Project objectives

- Cost reduction of well constructions by drilling a well with a single EPP "bit" with no need for replacement due to wear, by avoiding costs for drill bits, drill pipe, or additional directional drilling services and by significantly reducing idle time by reducing the risk of loss of circulation or time for cementing jobs
- Increased production per geothermal well by larger well diameters and reservoir contact and by drilling efficiently into deep and/or hard-rock high temperature reservoirs
- Improved reliability and safety of geothermal energy production by the development of self-mitigating, smart cements tailored to the EPP based well construction concept and the innovative DEEPLIGHT well design
- Lower environmental footprint of geothermal operations by substantial material, fuel and energy savings and reduced CO2 emissions due to an efficient EPP drilling concept