

**HALLIBURTON**

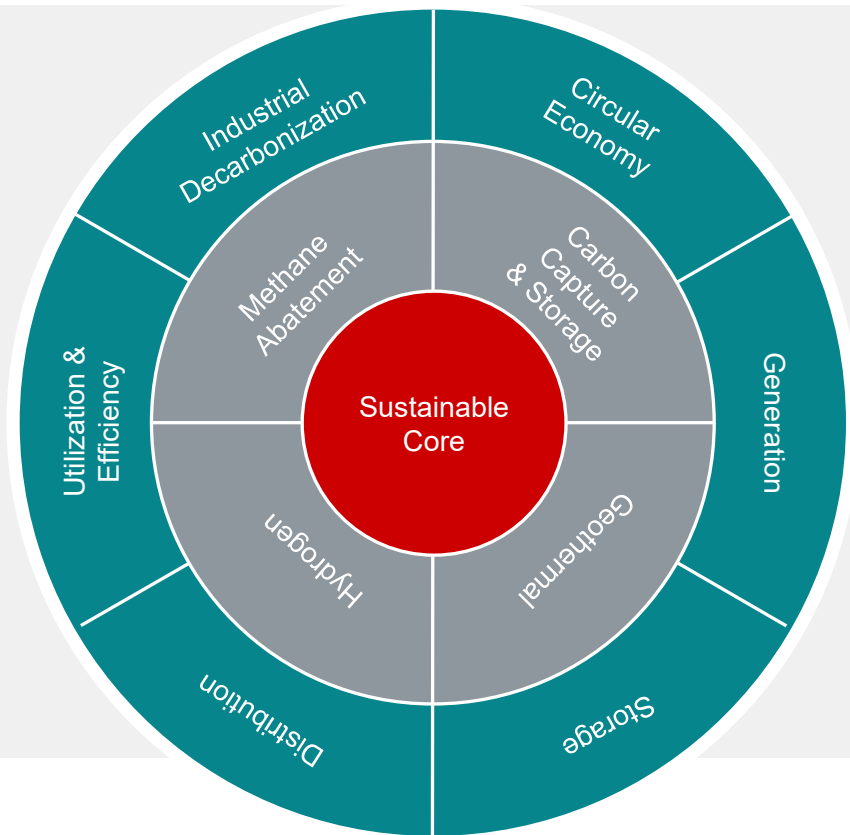
## Geothermal Association of Norway

*Transfer of Oil&Gas drilling and well competence for  
geothermal resource extraction*

University of Stavanger

13<sup>th</sup> March 2024

# Halliburton Approach to Decarbonization



## Decarbonize Core Operations

Quantifiable low-impact solutions across the well lifecycle

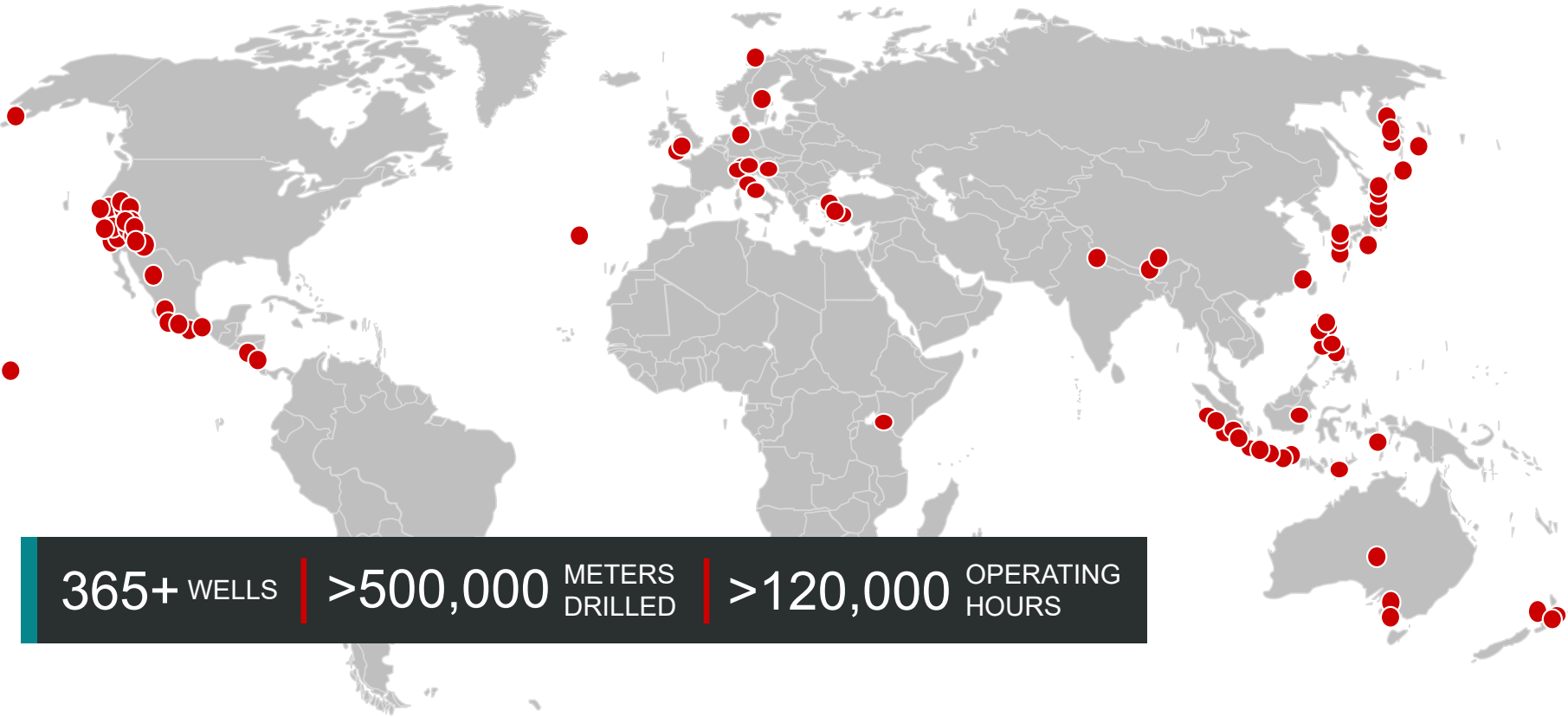
## Advance Low Carbon Solutions

We deploy our technologies in some of the fastest-growing new energy segments, such as carbon capture and storage, geothermal, hydrogen, and emissions management

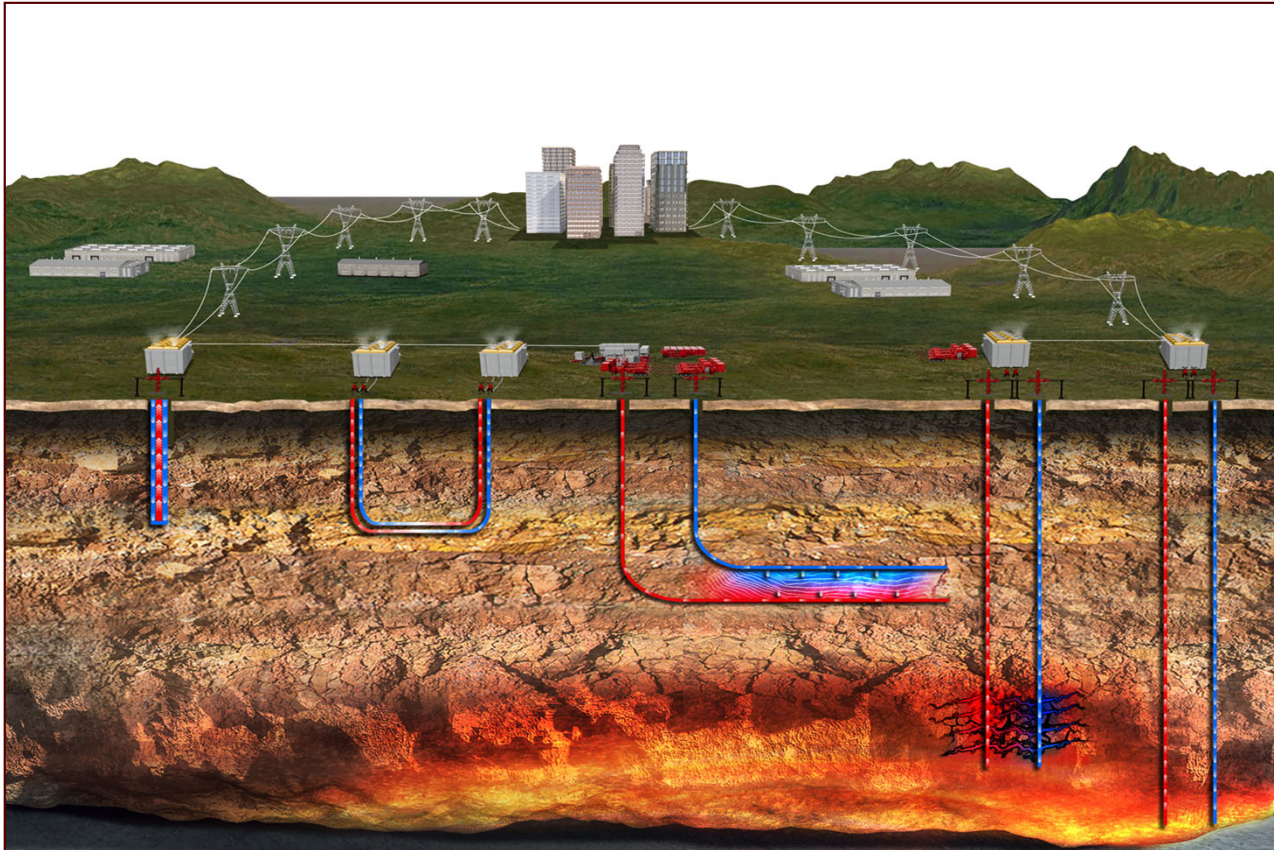
## Explore Emerging Energy Markets through Halliburton Labs

Collaborative environment to scale novel clean energy solutions

# Halliburton's global geothermal footprint



# Geothermal wells are complex systems



## GEOHERMAL WELL SYSTEMS

### Direct-use Geothermal

- Heating and cooling of residential and industrial buildings

### Hydrothermal Resource Geothermal Current geothermal wells - conventional

- Expensive, time-consuming exploration
- Producing fields far from demand centers

### Enhanced Geothermal System (EGS)

#### Communication between wells

- Wider geographic range than conventional

### Advanced Geothermal Systems ( AGS)

Closed Loop Heat conducting fluids never contact the rock

- Tube-in-tube design
- Loop technologies

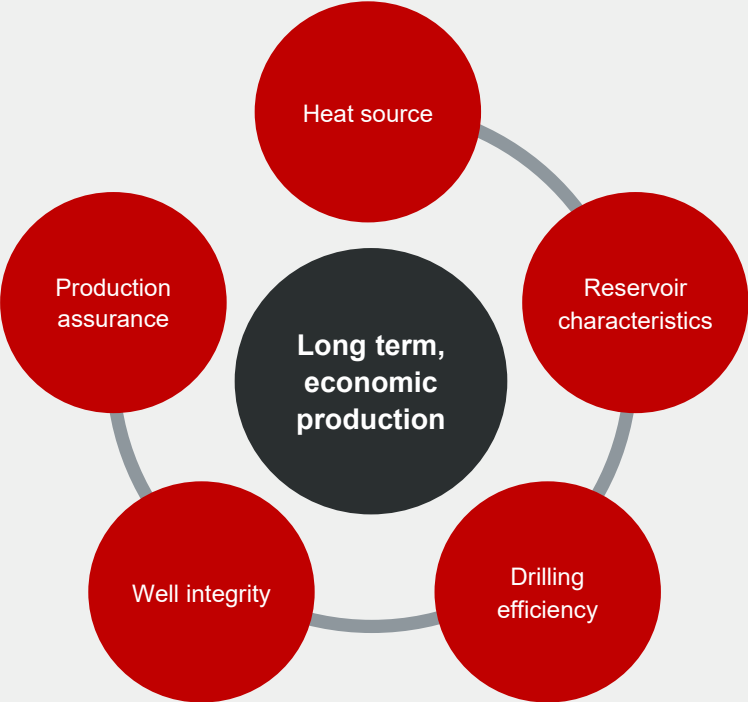
### Supercritical Geothermal

- Extreme depths (> 10,000')
- Pressures (> 3,200 psi)
- Temperatures (>374°C/705°F)

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# Where we focus

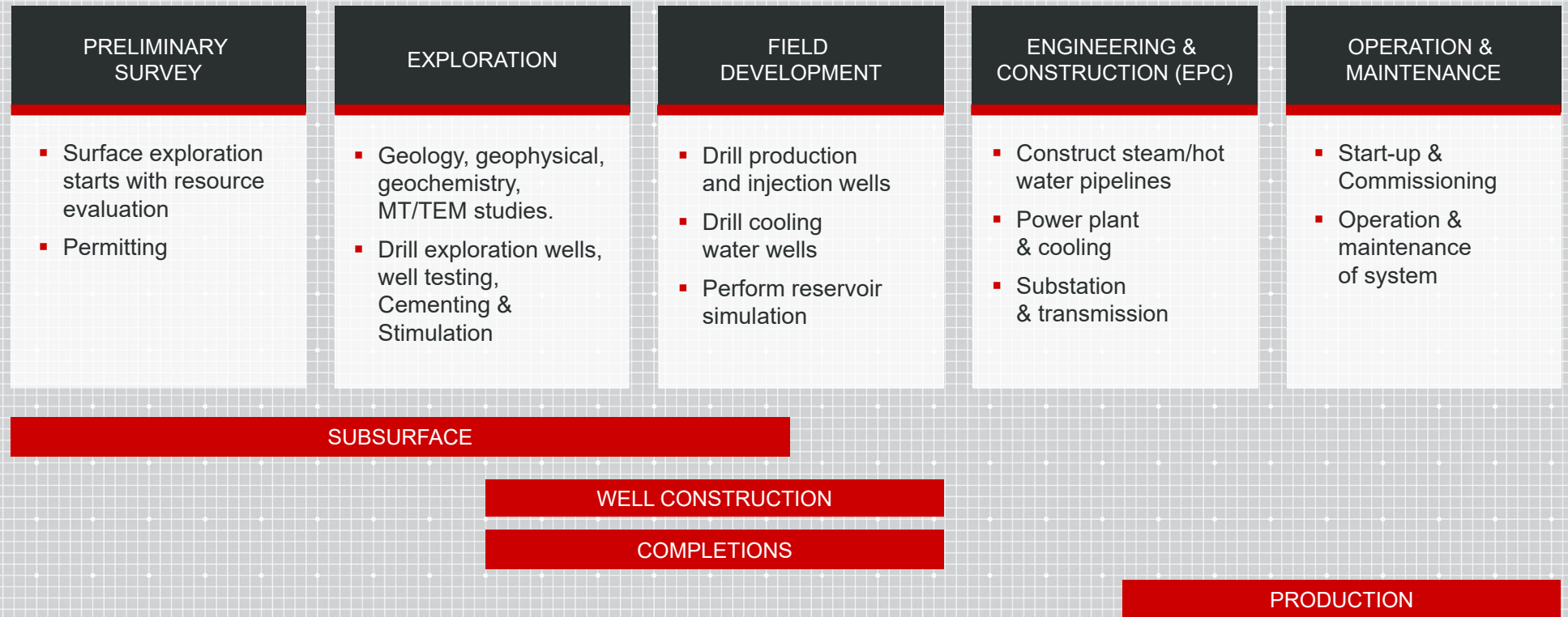
## Geothermal Challenges



## Value Drivers

- Subsurface insight
- Maximize heat extraction
- Risk mitigation
- System integrity

# Where we play in the lifecycle





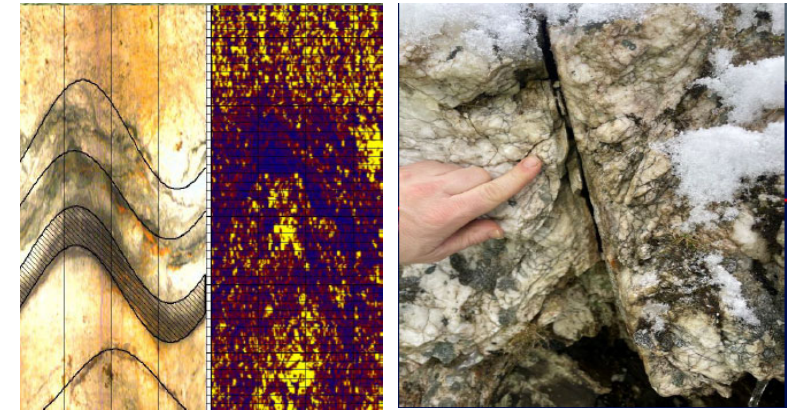
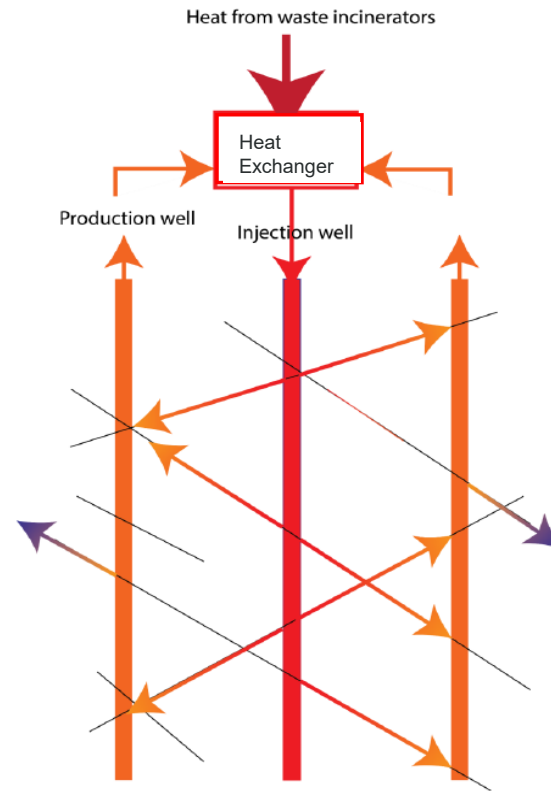
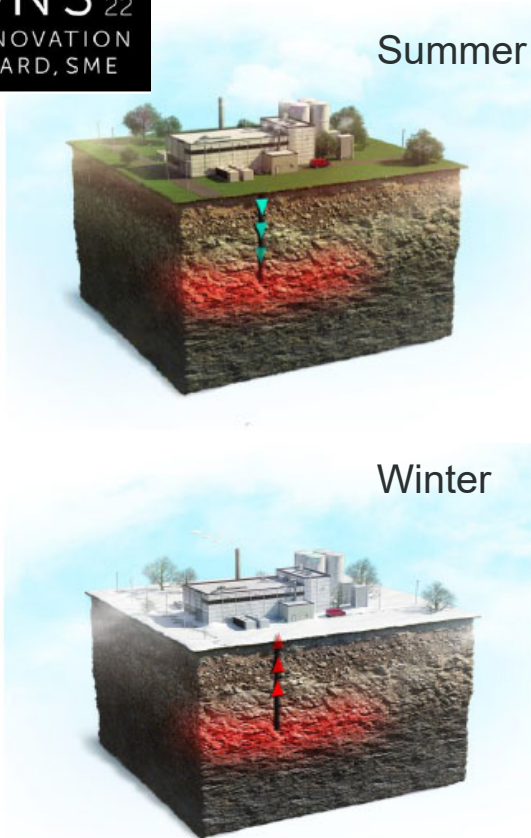


# Geothermal Norway Case Study

Kvitebjørn Varme

# Tromsø, Norway Case Study: High Enthalpy Aquifer Technology (HEAT) concept - store and recover seasonal waste heat from industrial processes

WINNER  
**ONS** 2022  
 INNOVATION  
 AWARD, SME



Effect:	5-9 MW
Injection:	140°C
Return temp:	65-100°C
Number of wells:	11
Well depth:	300m
Store:	20 GWh
Retrieve:	10+GWh



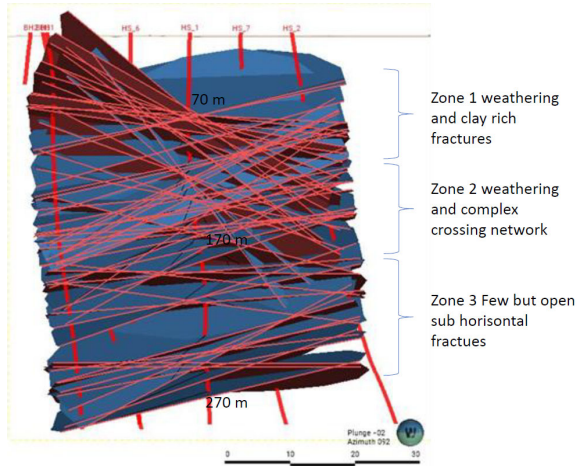
# Tromsø, Norway Case Study: High Enthalpy Aquifer Technology (HEAT) concept - store and recover seasonal waste heat from industrial processes



- Network of injector and production well(s) drilled into bedrock
- Underground fracture system to be established between injector(s) and producer(s) to maximize contact area between circulating water and bedrock.
- **Halliburton SurgiFrac®** method is a key technology enabler for this concept.
- Risk assessment
- Monitoring, tremors and leaks
- Ground conditions - very low probability of surface tremors
- Sand and water – no chemicals



# Tromsø, Norway Case Study: High Enthalpy Aquifer Technology (HEAT) concept - store and recover seasonal waste heat from industrial processes



## Stimulation results:

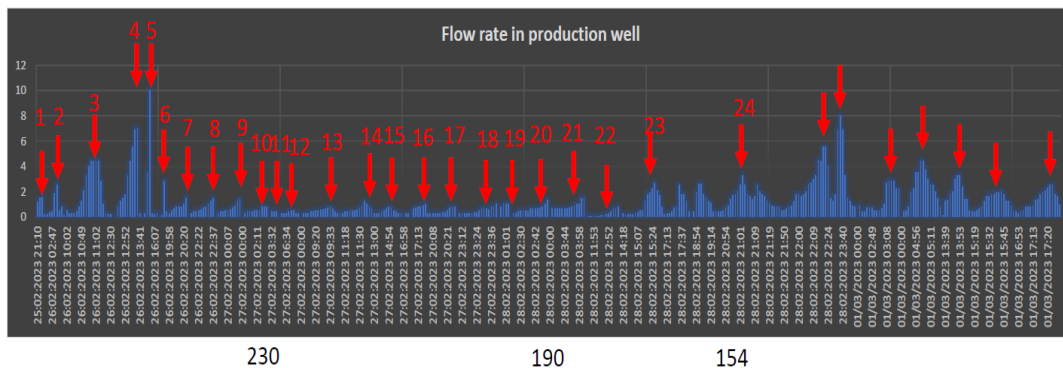
- 1,288 m<sup>3</sup> water; 88 tonnes sand
- 35 Hydra-jet stimulation stages
- Achieved distributed water injection and good communication between wells
- Test production in October 23 – April 24
- Full scale storage summer 2024



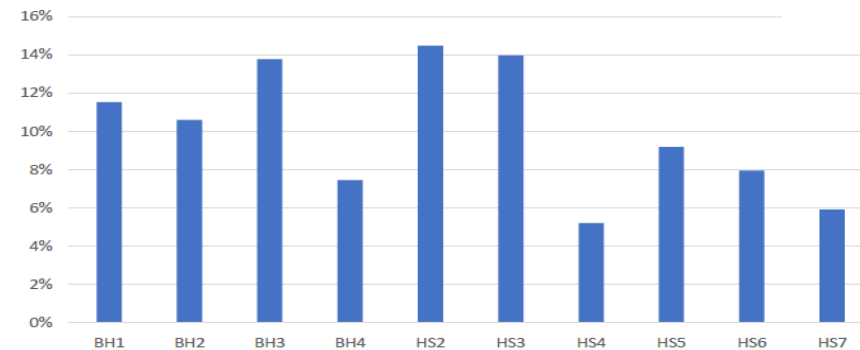
Zone 1 subhorizontal Sigma 3 fractures

Zone 2 complex tight fracture network

Zone 3 weathering zone



Distribution of flow





# THANK YOU

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