Fraunhofer Institution for Energy Infrastructures and Geothermal IEG

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Mine thermal energy storage (MTES) systems in abandoned collieres within the Ruhr area, Germany

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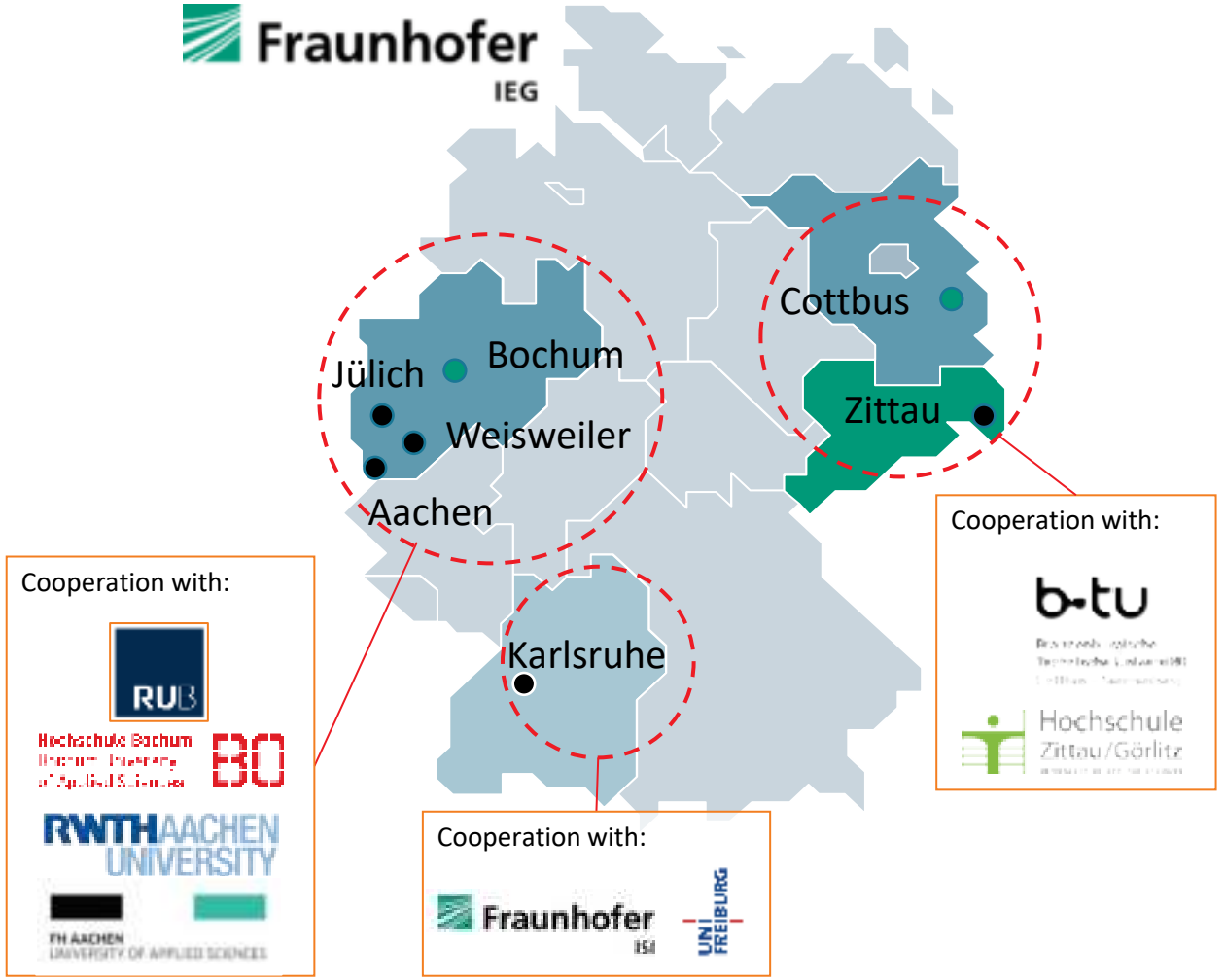
Morgantown,
25th April 2024

Research Institution for Energy Infrastructures and Geothermal Systems IEG

Facts and figures

- Foundation as an independent institution as of 01.12.2019
- Locations in the German coal regions
- Employees: ~300
- 6 business units with 24 competence centres
- Coordination of the Fraunhofer hydrogen network (32 institutes)
- Directorate: Prof. Dr. Rolf Bracke &
  Prof. Dr. Mario Ragwitz



MTES Case Studies

Bathtub challenge

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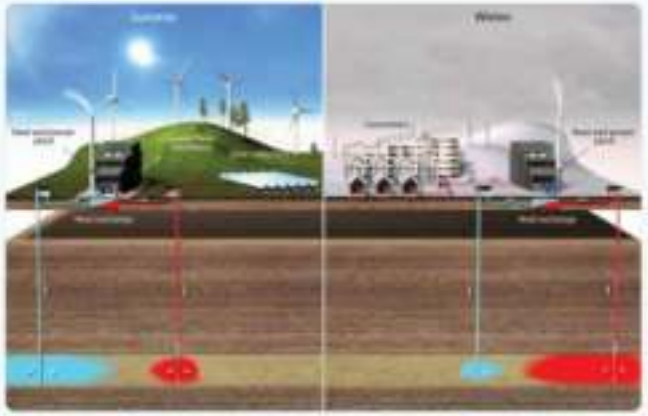
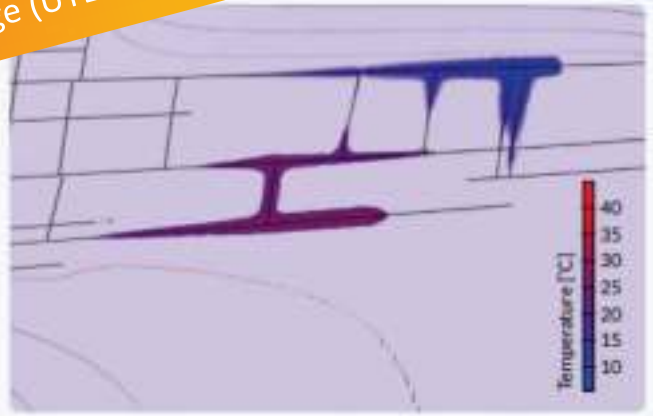


Aquifer Thermal Energy Storage
ATES can take place by injection and later re-production of hot water in aquifers in both shallow and deep geological formations. The aquifers can be both unconsolidated sand units, porous rocks like sandstones or limestone or fractured rock formations. It is an open system using geothermal or water wells and storing the heat in the groundwater and in the formation around it.

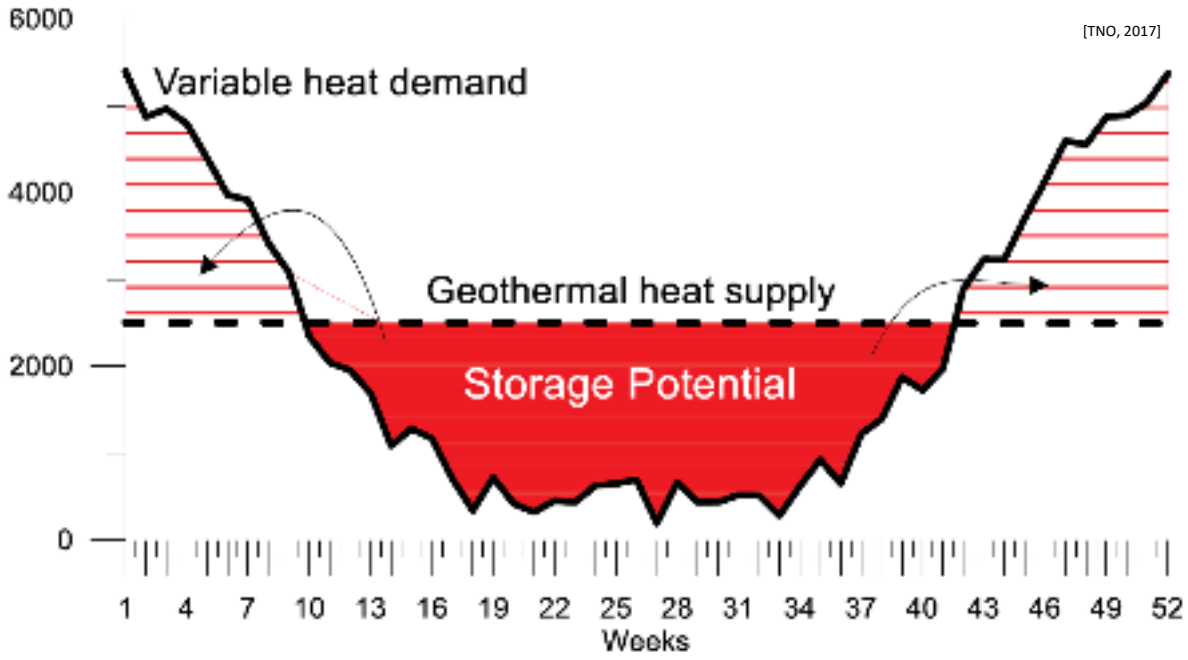
Pit Thermal Energy Storage
Hot water is stored in very large (multiple) excavated basins with an insulated lid. Sides and bottom are typically covered by a polymer-liner, but can also be made of concrete.

Underground Thermal Energy Storage (UTES)

Borehole Thermal Energy Storage
The natural heat capacity in a large volume of underground (unconsolidated) soil or rock is used to store thermal energy with or without groundwater as the storage medium. It typically has several closely spaced boreholes, between 50 and 200 m deep; they act as heat exchangers to the underground, usually in U-pipe form.



Mine Thermal Energy Storage
Mine water of abandoned and flooded mines is used as a storage medium for high temperature storage. The mine water can also be used as an ambient energy source in combination with heat pumps.



How are we going to meet the heating demand with a distinct seasonal profile without fossil fuels but with the same security of supply?

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Mine water utilisation concepts

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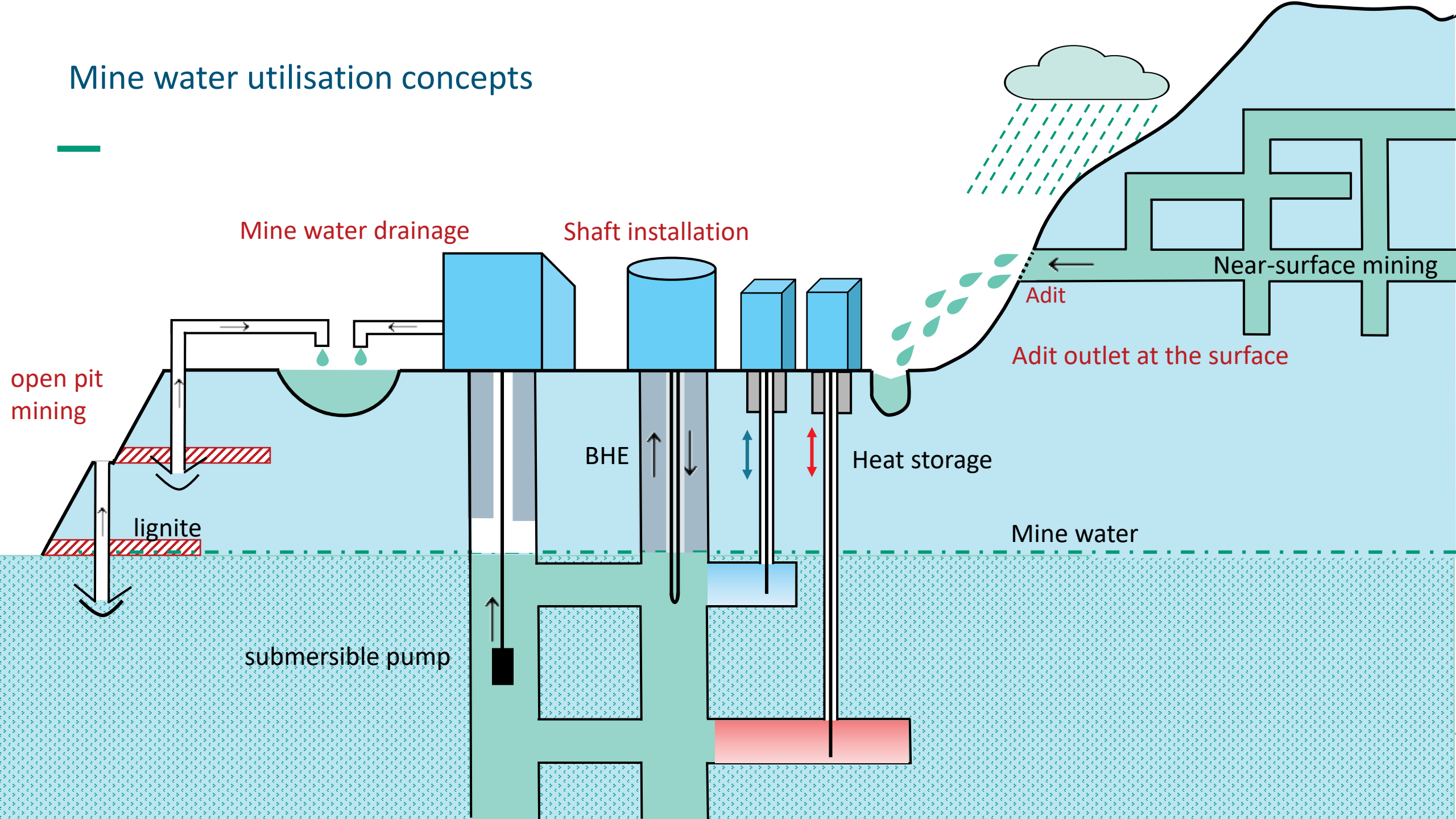
Mine water utilisation concepts



MTES Case Studies

HEATSTORE Project Bochum

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HEATSTORE

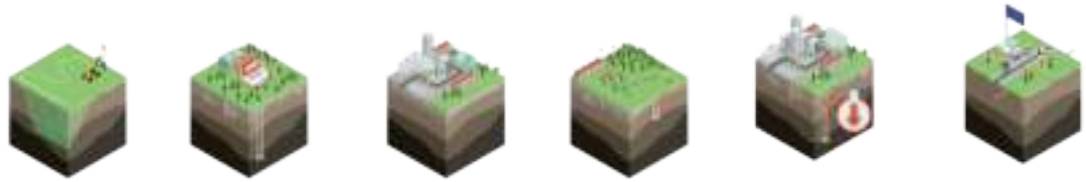
IEG Colliery

Former main shaft (1954)

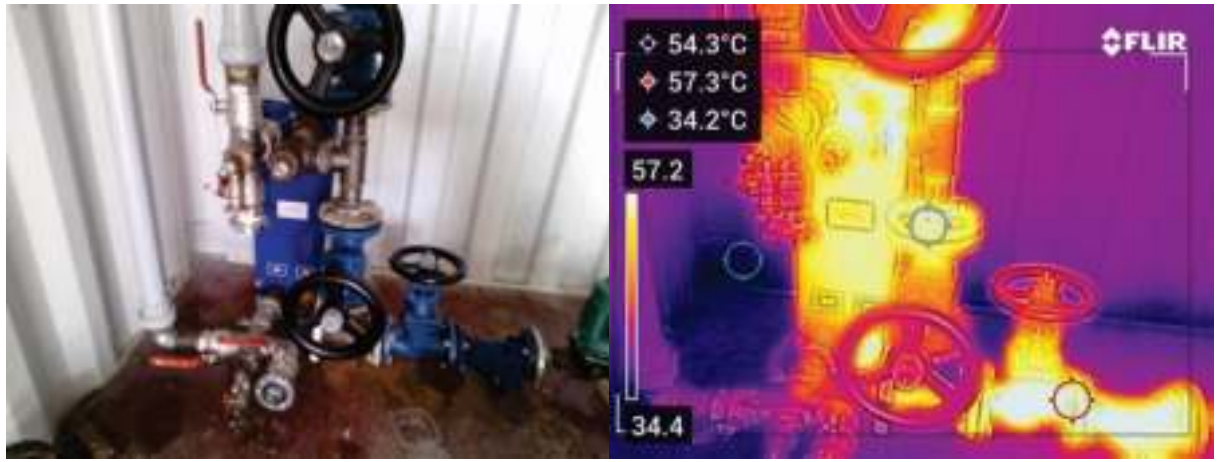
Nightingale visitation colliery in Witten, Germany (wooden beam construction)

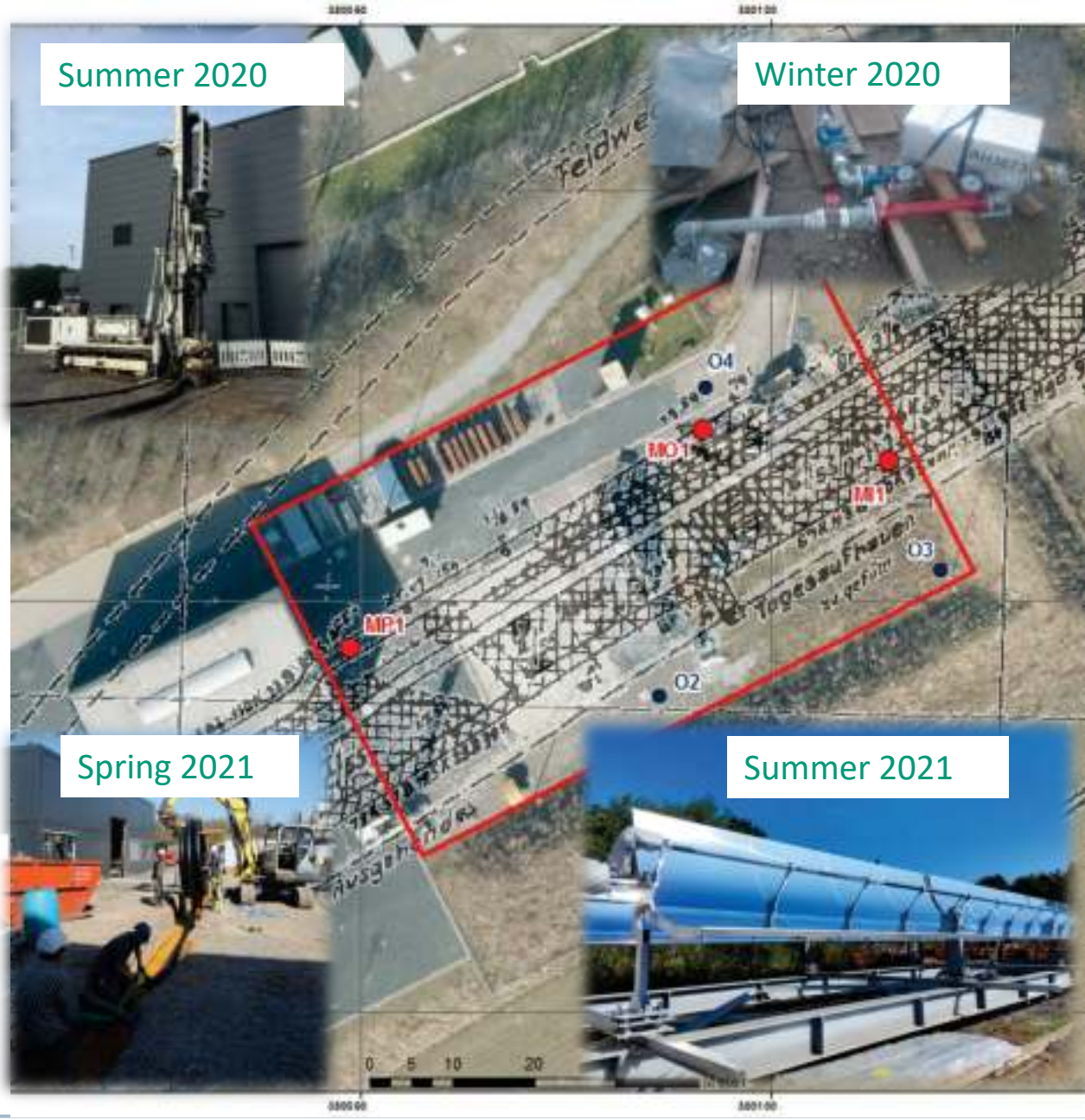
HEATSTORE

Work packages



WP1: Legal Framework and pre-feasabilty	WP2: Numerical Modeling of the subsurface	WP3: Integration of a Power Plant with surplus heat	WP4: Establishment of Underground Storage	WP5: Proof of Concept	WP6: Market Uptake and Dissemination





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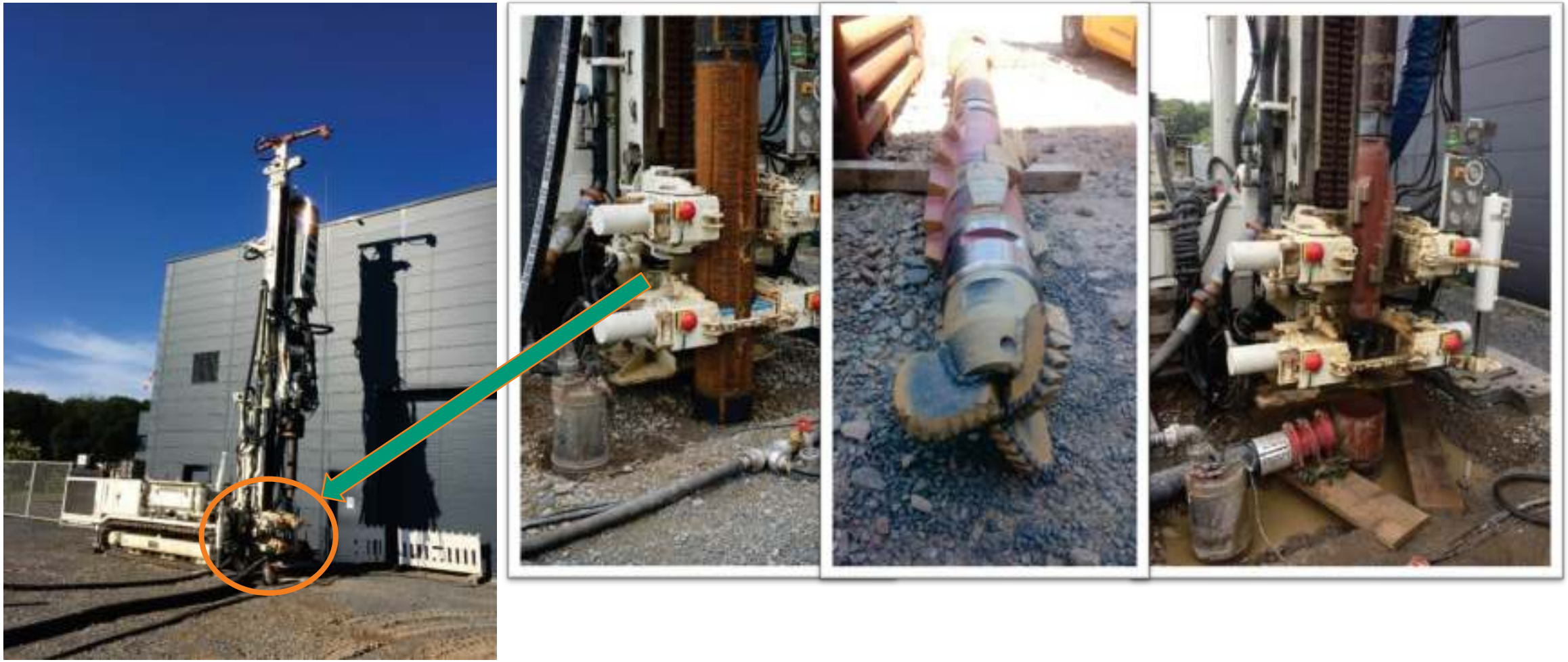
HEATSTORE

Bochum Research and Drilling Rig (Bo.ReX)



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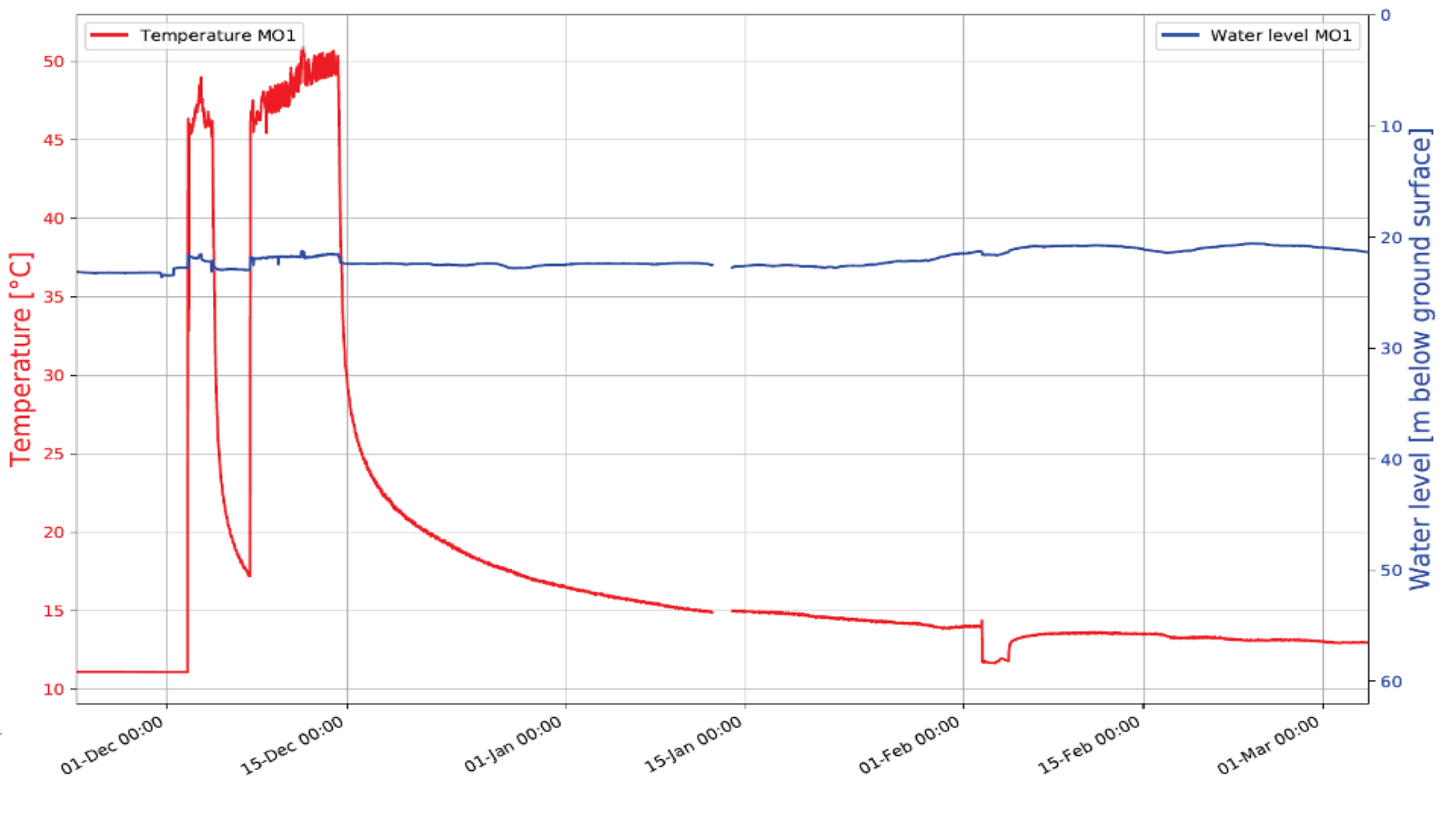
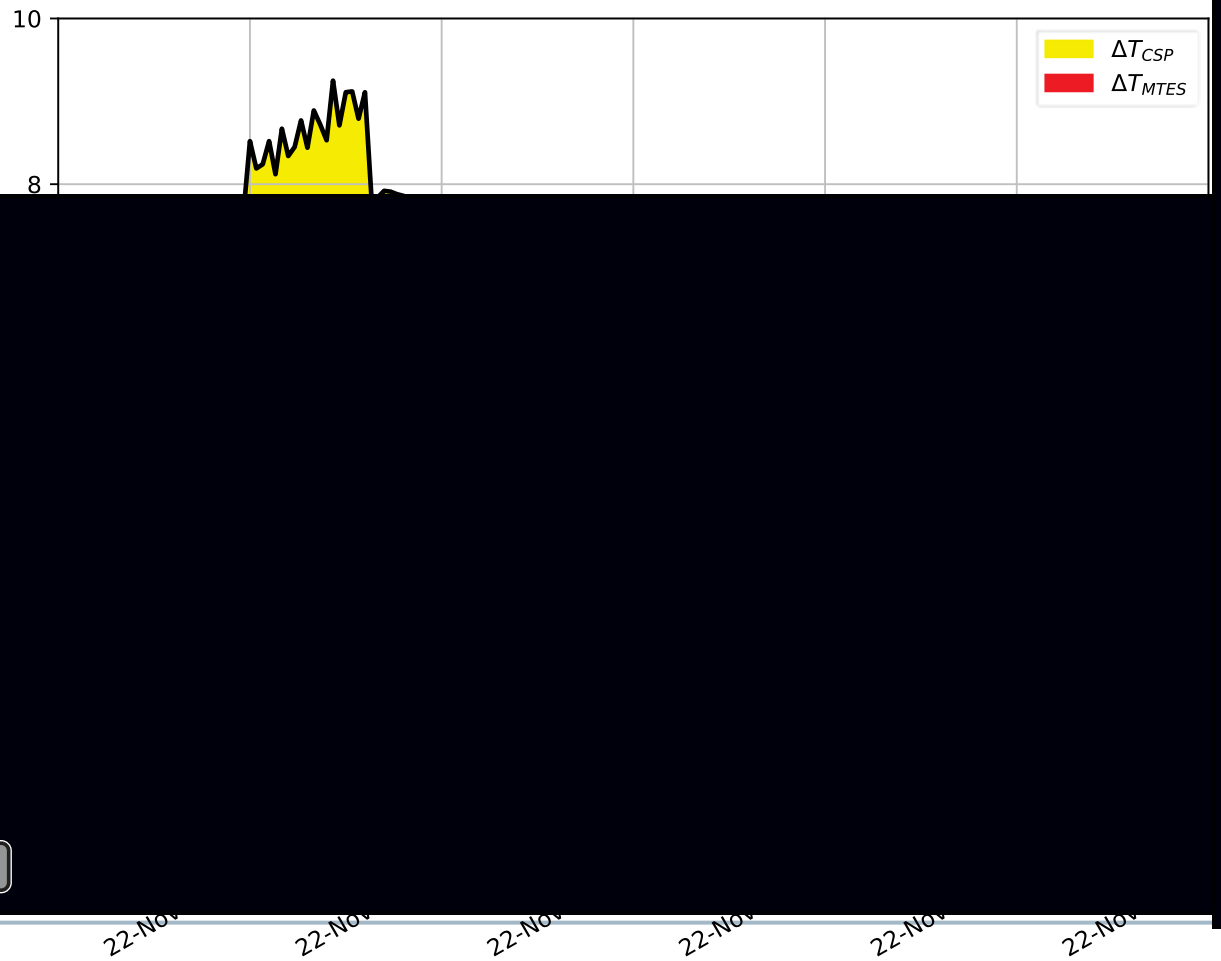
Cuttings


Temperature MO1
Water level MO1
Temperature [°C]
Water level [m below ground surface]
50
45
40
35
30
25
20
15
10
0
10
20
30
40
50
60
01-Dec 00:00
15-Dec 00:00
01-Jan 00:00
15-Jan 00:00
01-Feb 00:00
15-Feb 00:00
01-Mar 00:00

Proof of Concept



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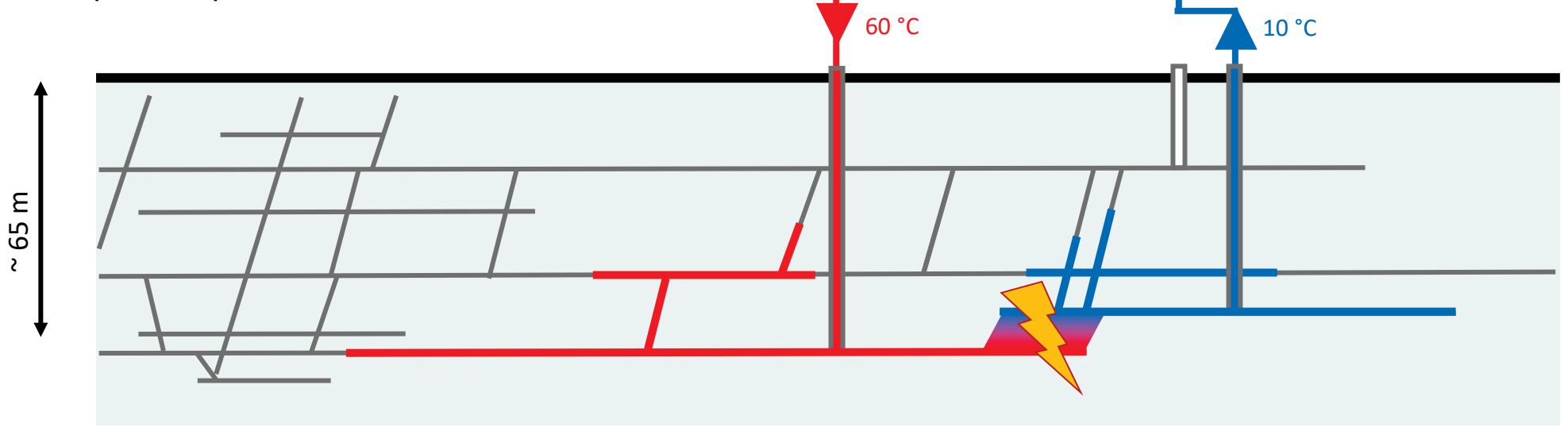
Summer mode

# of modules	12
# of rows	2
collector area	108 m²
max. capacity	60 kW_{th}
temperature	max. 60 °C
medium	water

[Solitherm GmbH]



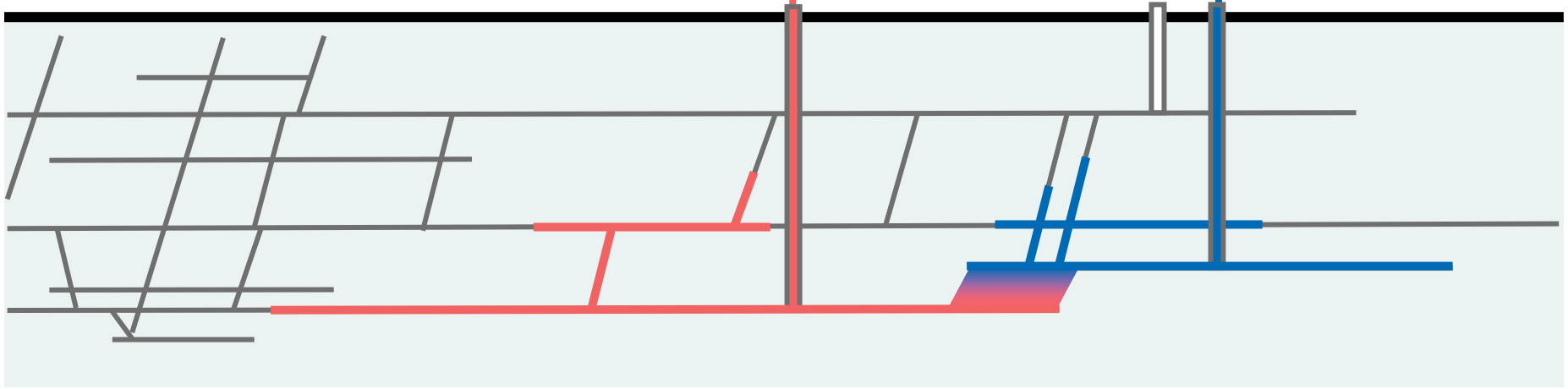
Winter mode

[Johnson Controls]

80 – 120 °C

60 – 65 °C

~ 65 m



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PUSH-IT

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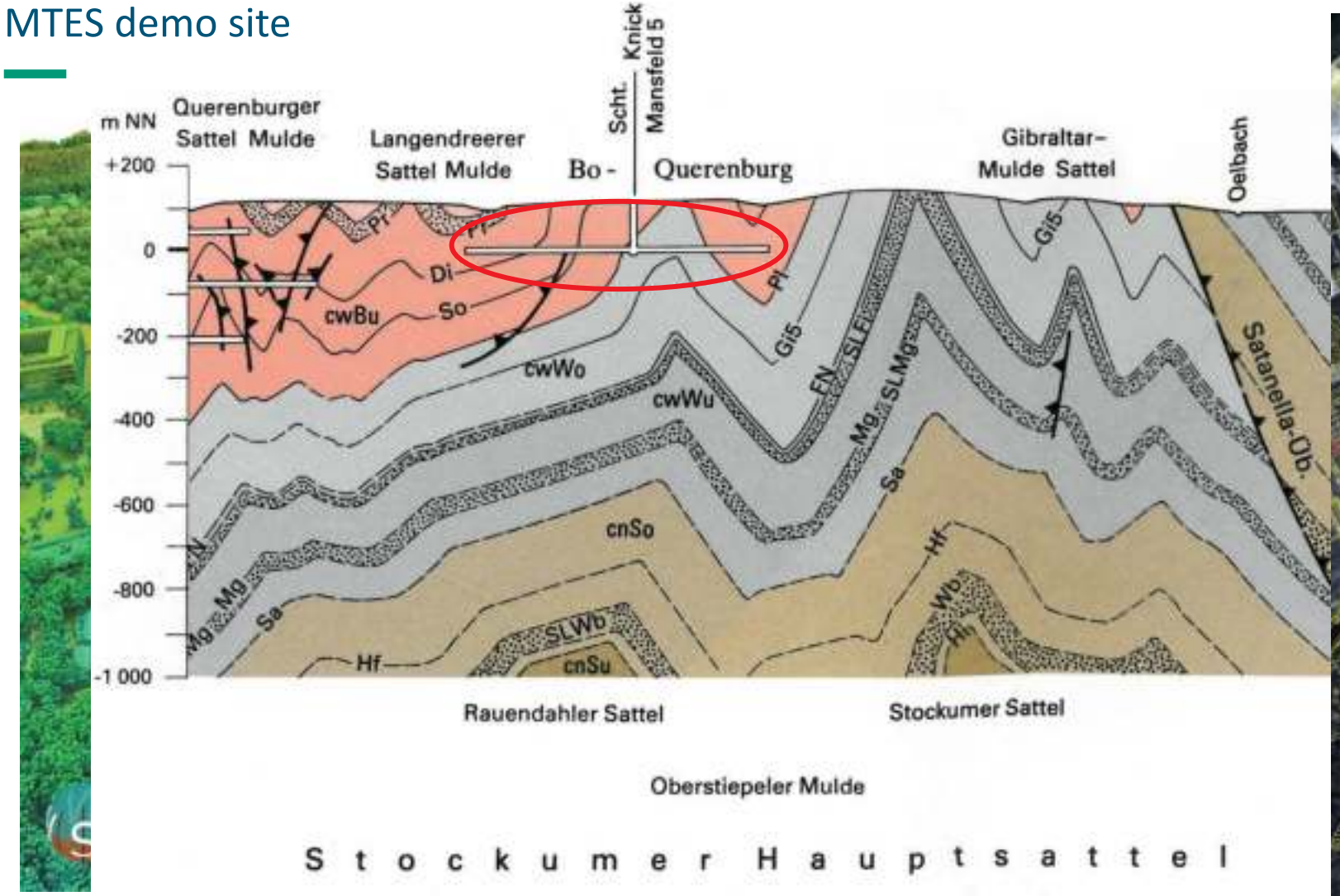
Piloting Underground Seasonal Heat Storage In geoThermal reservoirs

MTES demo site



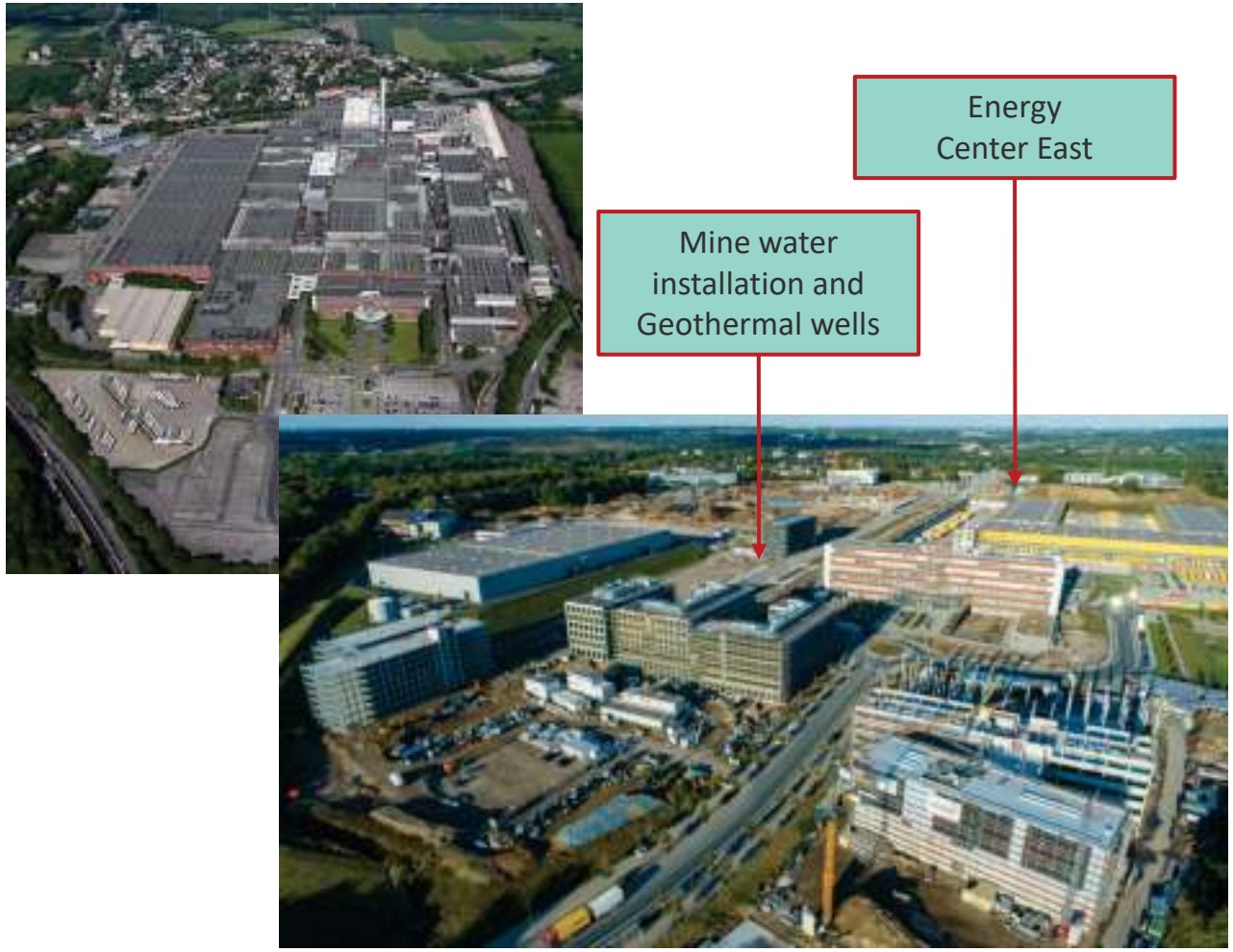
MTES Case Studies

Mark 51°7 Bochum: 5GDHC and mine water

Project Mark 51°7 Bochum

5G DHC with mine water

1. Area
   - 68 ha – Area in Bochum-Laer
   - 1859-1958: Colliery Dannenbaum
   - 1958-2014: Auto production Opel
   - Now: Redevelopment industrial, technology and knowledge campus Mark 51°7
   - Building area approx. 210,000 m2
2. 5G DHC
   - National Funding Program Wärmenetzsysteme 4.0
   - 35% of Investment
   - Grids and Energy Center East
3. Minewater
   - Funding Interreg D2Grids
   - 60% of Investment
   - Minewater installation and wells
   - Demonstrator Energy Center

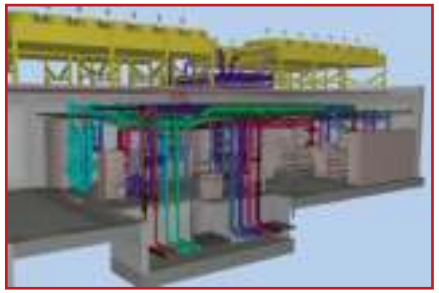


Project Mark 51°7 Bochum

Scope 5G DHC grid

Bundesministerium für Wirtschaft und Energie

Interreg North-West Europe D2Grids



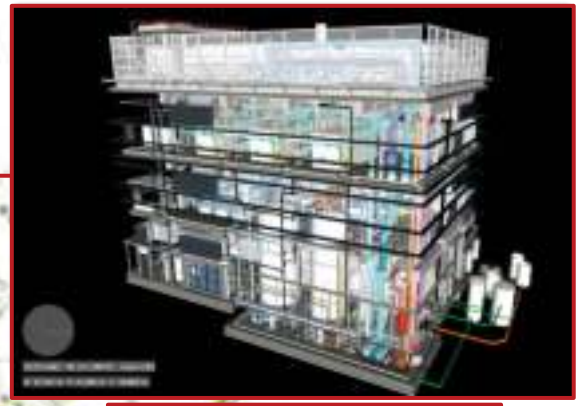
Q3 2025

Decentralized Energy Center Landmarken
1,150/900 kW

Q4 2023

Decentralized Energy Center Zetcon
220/190 kW

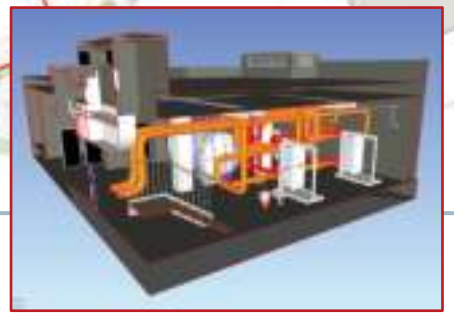
Q4 2025



Decentralized Energy Center East (Low-Ex DHC grid)
11,500/8,500 kW

Q2 2025

Mine water installation and Geothermal wells



Q1 2022

- District heating grid (HT) 90/40°C
- Exchange grid 7.5/25 – 24/45 °C
- Heating grid (Low-Ex) 48/33°C
- Cooling grid (Low-Ex) 10/16 °C

Total heat demand: 12.8 MW; 16 GWh
Total cold demand: 9.6 MW; 10 GWh

Minewater: 2.9 MW; 8.3 GWh; 430,000 m3 (27 °C)
Minewater: 3.5 MW; 5.6 GWh; 240,000 m3 (17 °C)

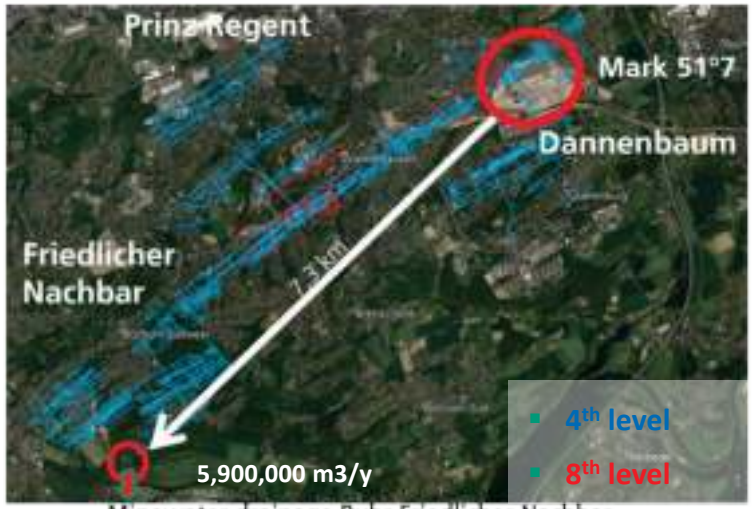
FUW STADTWERKE BOCHUM STADTWERKE BOCHUM Fraunhofer IEG

Project Mark 51°7 Bochum

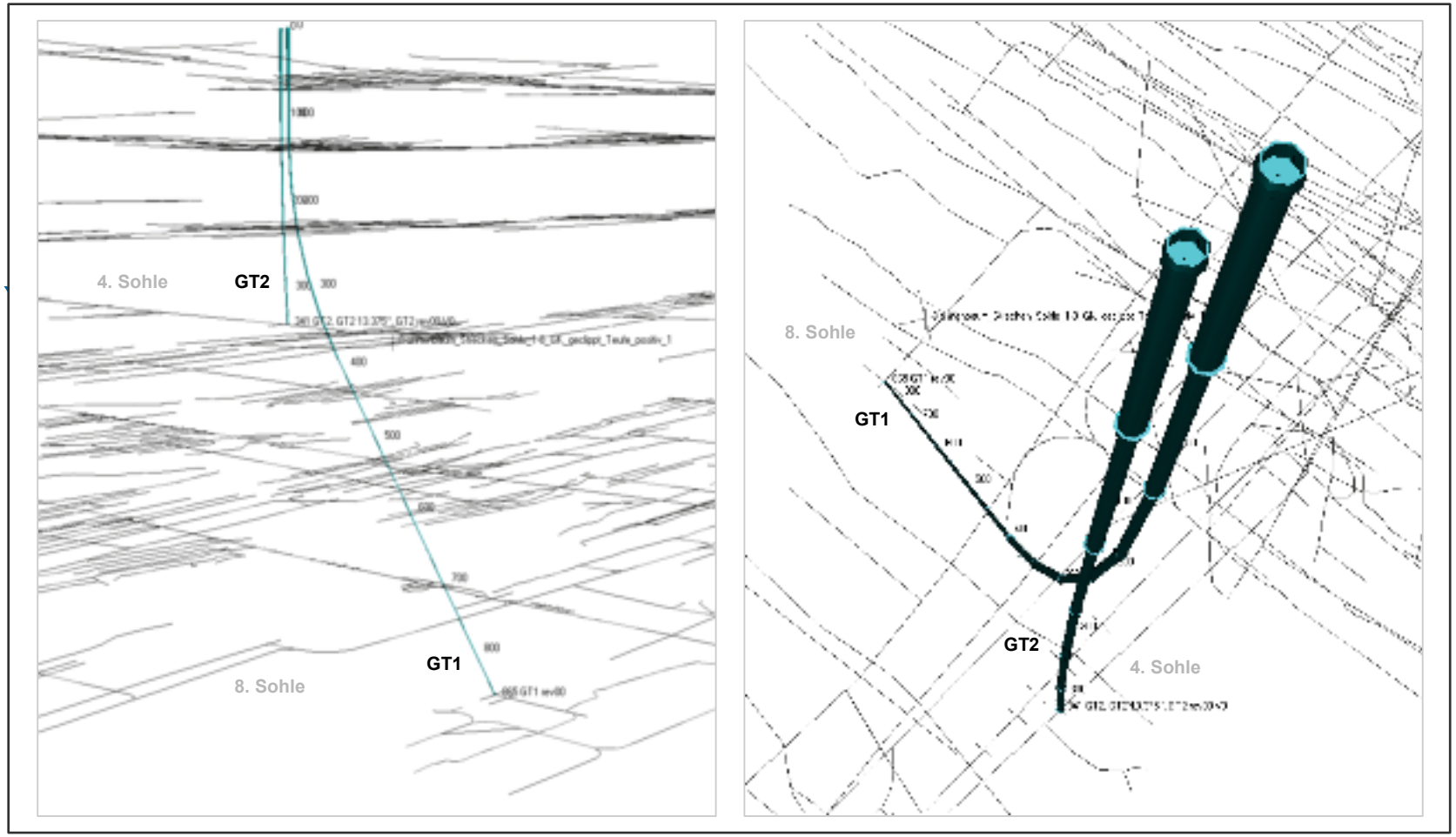
Access mine water use

Drilling concept:

- Singular drilling location
- Cold well vertical drilling
- Hot well directional drilling



Minewater drainage Ruhr Friedlicher Nachbar



Project Mark 51°7 Bochum

Drillings and pump tests

1. Geothermal wells
   - The first drilling (GT-02) was completed on 28.01.2022
   - The second drilling (GT-01) was completed on 09.03.2022
2. Pump tests
   - Pumps tests were executed in March 2023
   - Postponed due to hick-ups in approval procedure

Results of pump tests (48 hours):

- *Hydraulic capacity + 150 m3/h*
- *Acceptable drop of water level during production*
- *Almost no rise of water level during injection hot well*
- *Anomaly injection cold well*
- *Hot mine water 27,6 °C (assumption: ≥ 30°C)*
- *Cold mine water 16,4 °C (assumption: ≥ 18 °C)*

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Mine Water Potential in NRW

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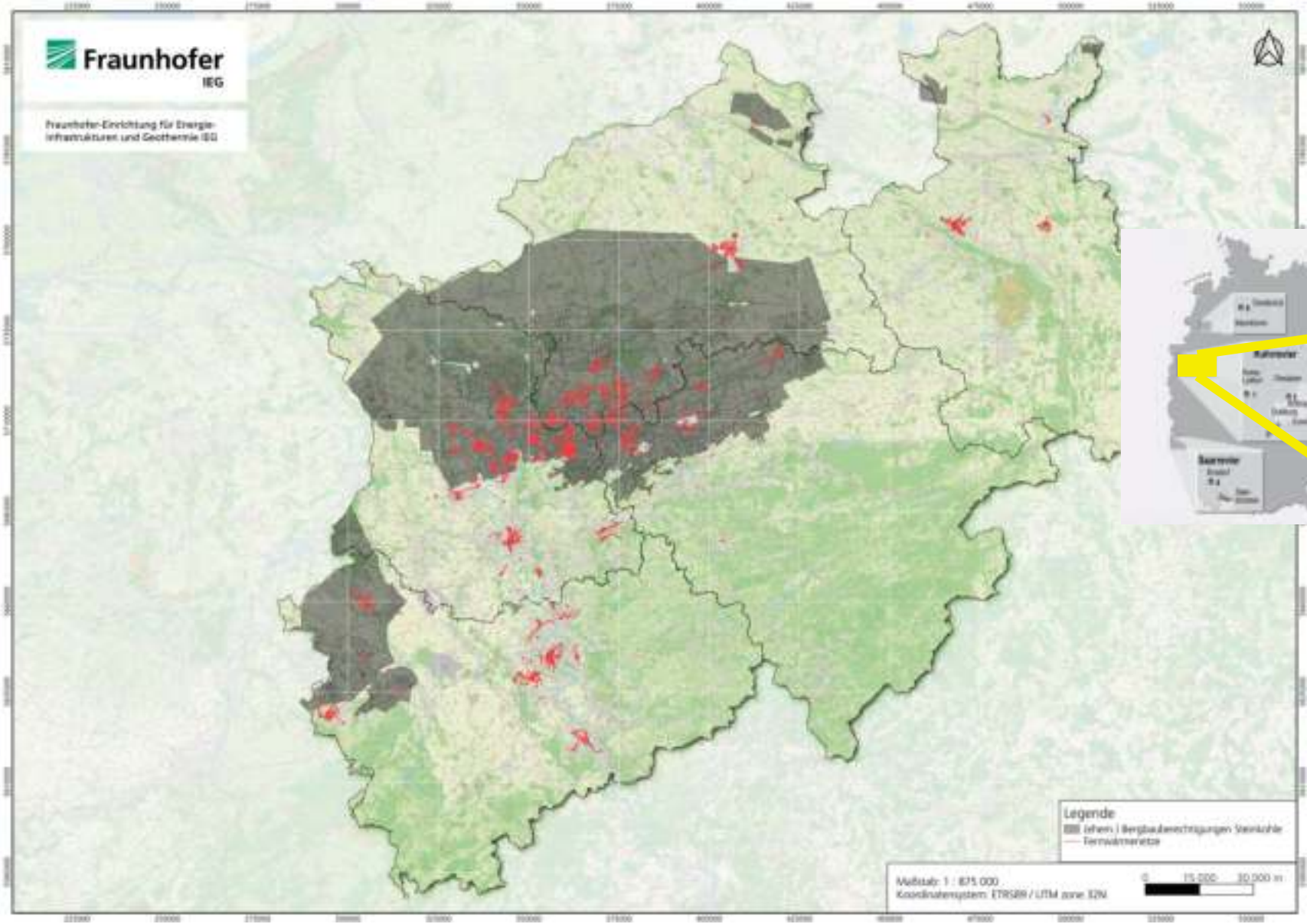
Mine Water Potential in NRW

Eternity benefits from industrial burdens!



www.schachtzeichen.de

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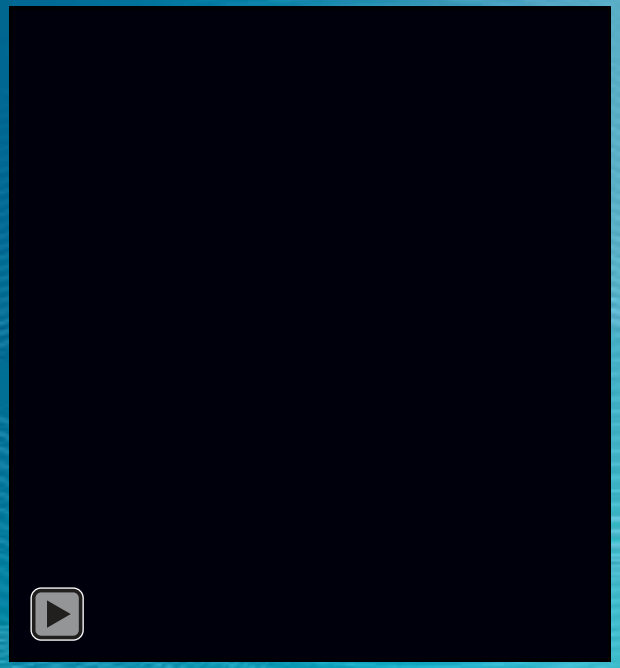
Glückauf!



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Storage and Underground Systems
Post-mining Exploitation (lead)

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