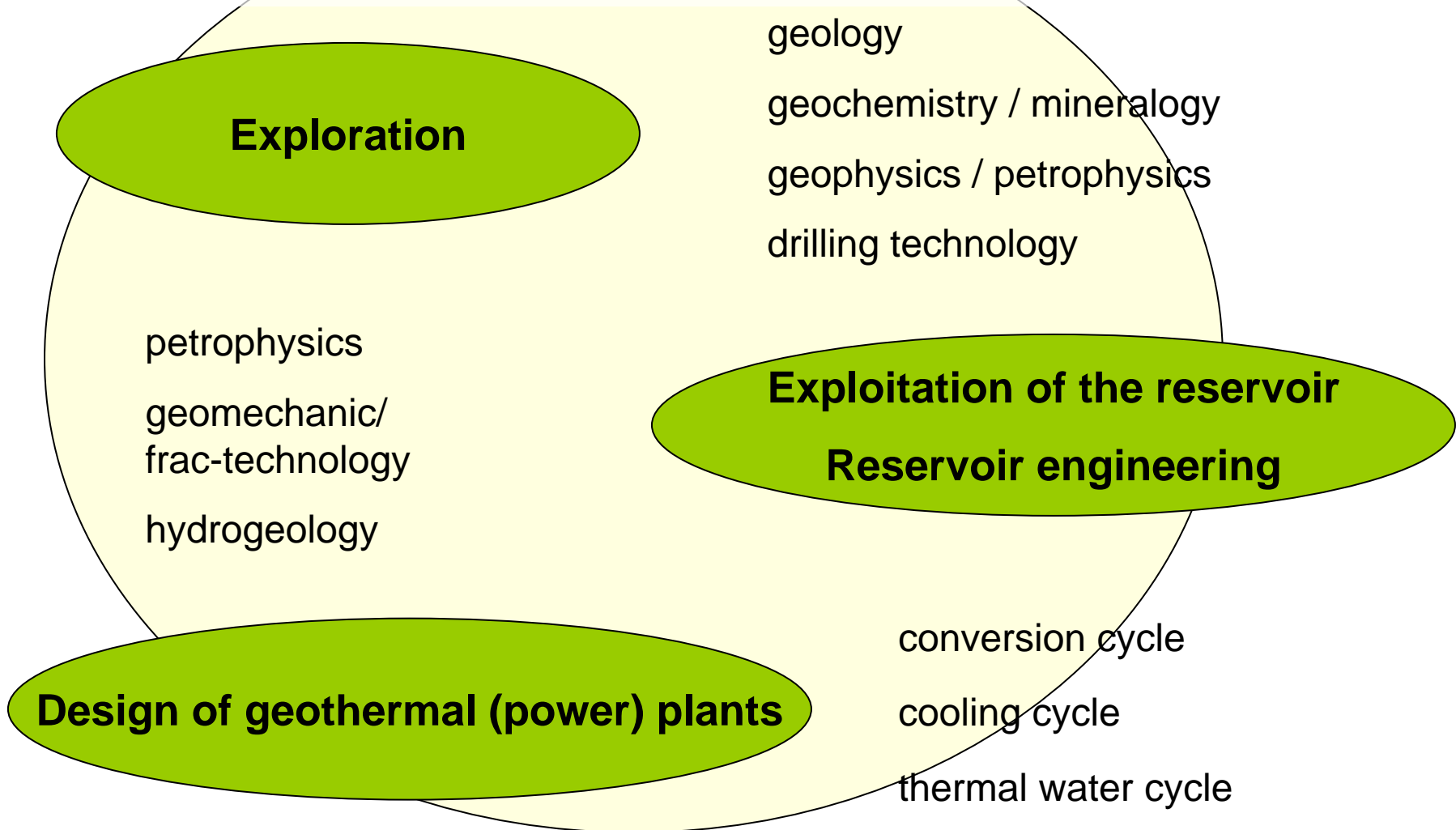


EGS in the Permian of the North German Basin, Europe: a borehole doublet utilizing a former exploration well

Ben Norden

Integrated Research: Technology Development for Geothermal Energy Utilization (electrical power, heating, cooling)

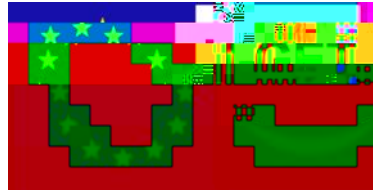




Geothermal technology

Section Geothermics





Commercial

Productive hydrothermal

Potentially commercial

Enhanced geothermal

Hot dry rock

* Hydrofracture, targeted injection, acid leaching, directional drilling, etc.

Oil and Gas Exploration in NE Germany

Structure: North German Basin
as part of the South Permian
Basin

Target Horizon
Lower Permian Red Beds
(Rotliegend)

Depth
3700-4400 m

(Main) exploration period
1960-1990 (1970-1985)

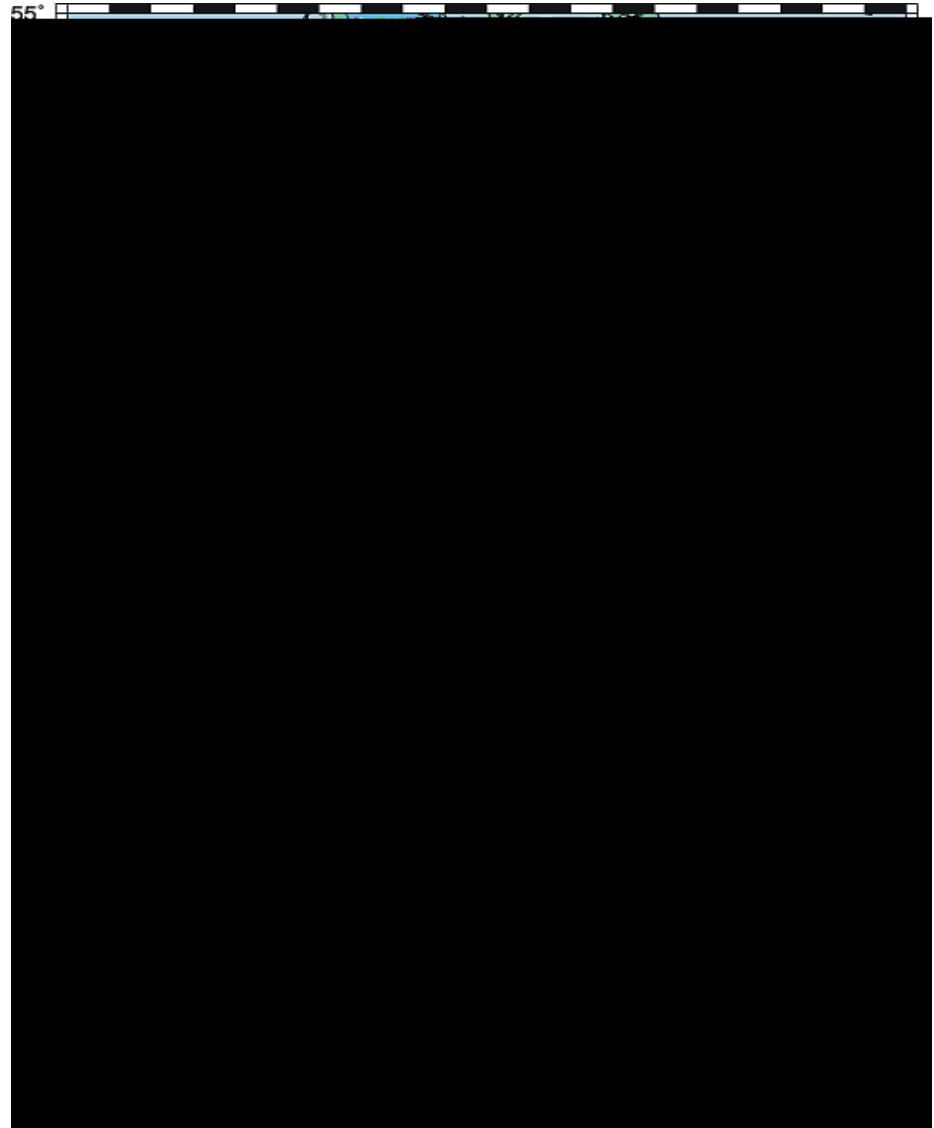
Distribution map of the sedimentary Rotliegend
(Lower Permian) in North Europe
(Norden and Förster, 2004)



Temperature map of Germany

Temperature distribution in 3000 m depth

At most sites are low to moderate enthalpy reservoirs. These reservoirs can be efficiently used by enhancing the permeability.



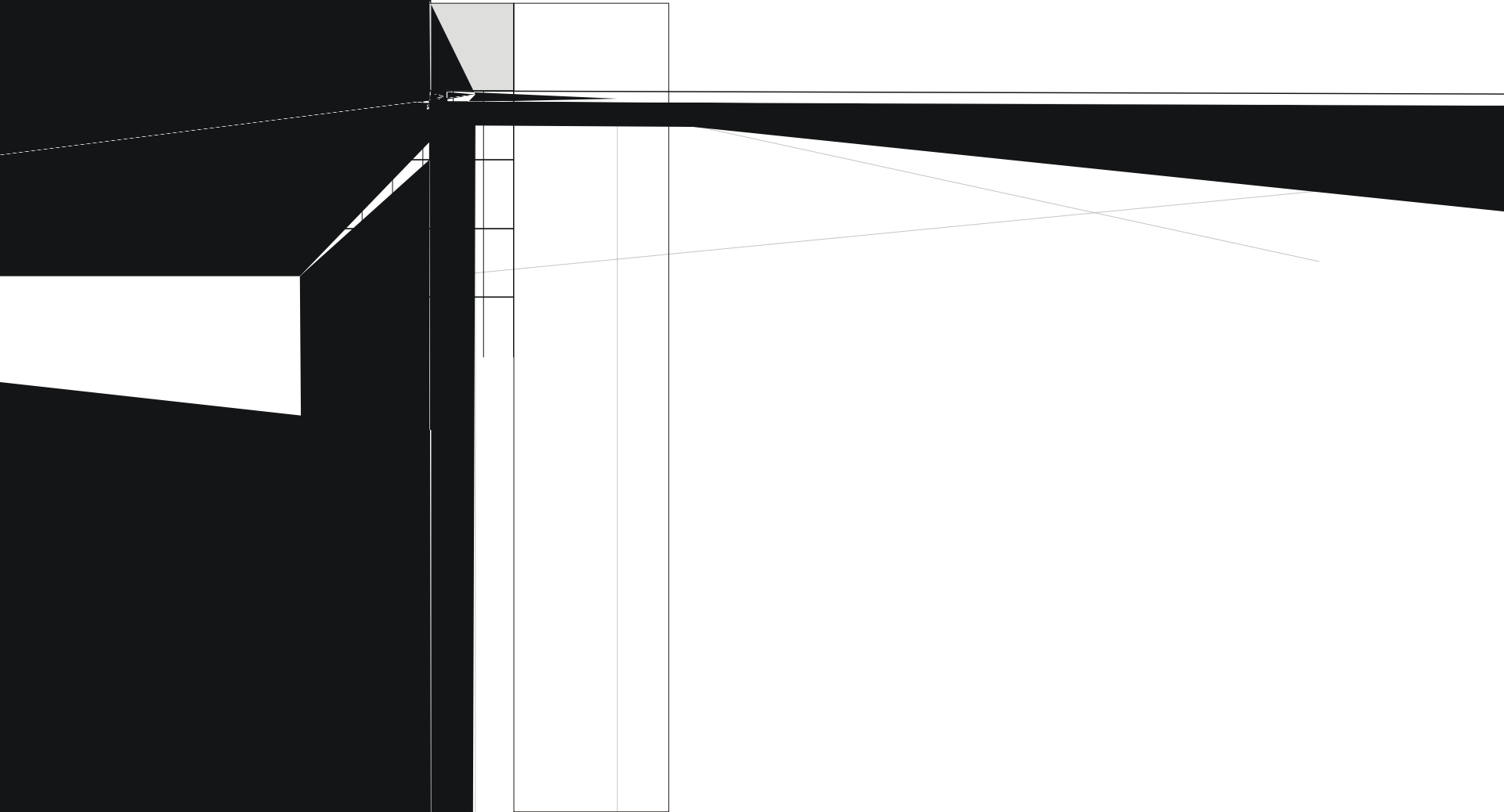
Geothermal technology

The key site in the NE German Basin – Groß Schönebeck *Re-using an existing gas exploration well*



Existing HC wells in the North German Basin

Interpretation from the existing well



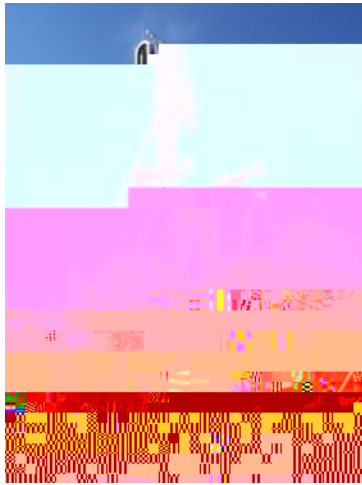
Re-using seismic and well data for new 3D Modelling



Thermal-Hydraulic simulation

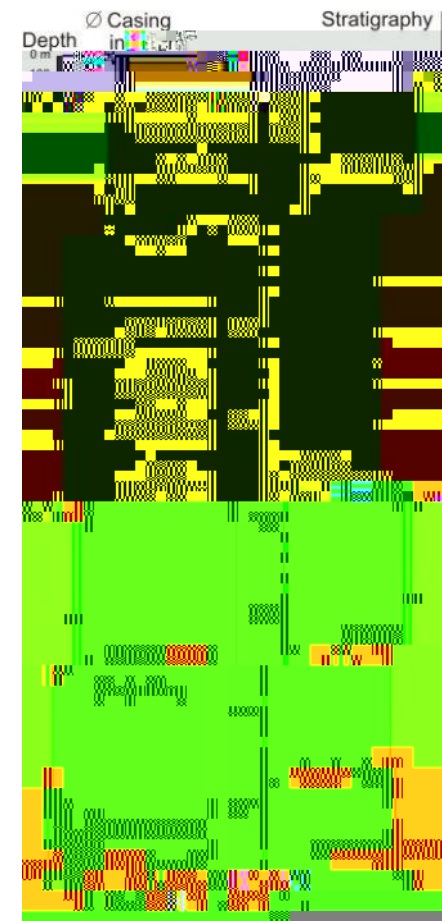
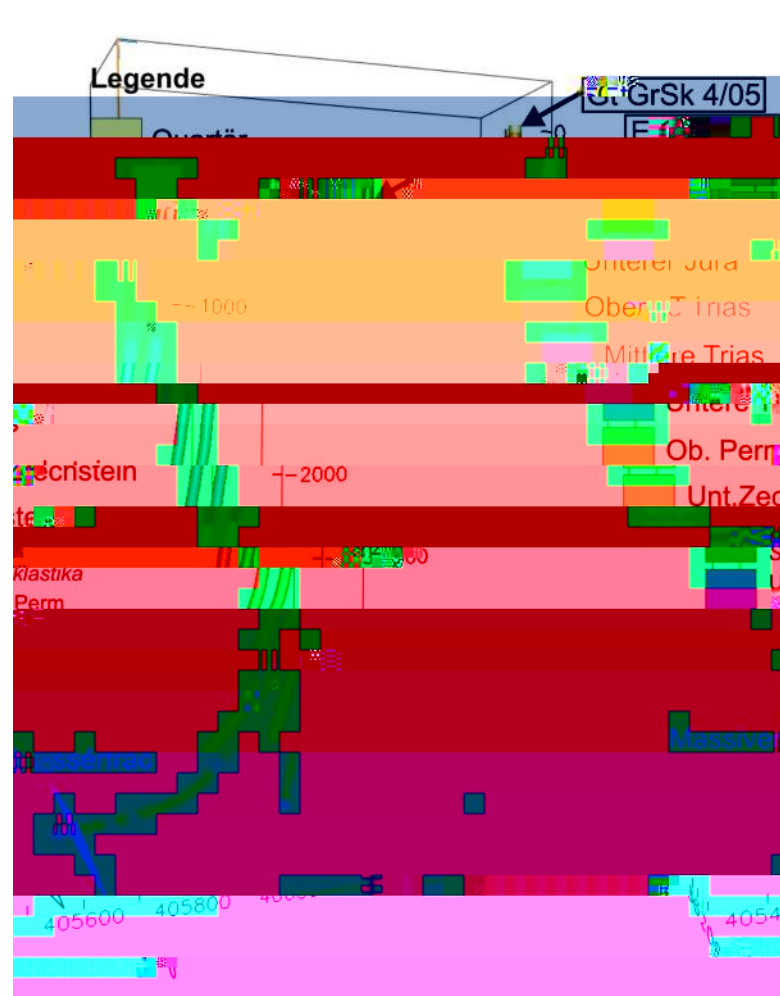
Installation of a well doublet II

Planning and drilling a new geothermal well



Requirements on geothermal wells

- large diameters
- directional drilling
- near-balanced drilling in the reservoir



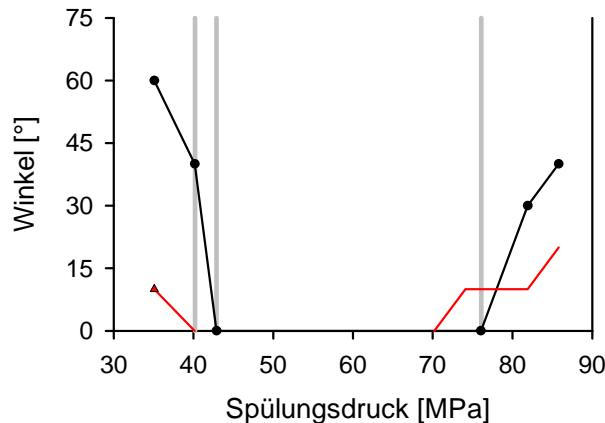
Well control and mitigation of formation damage

Fracture mechanical failure modell to understand borehole stability

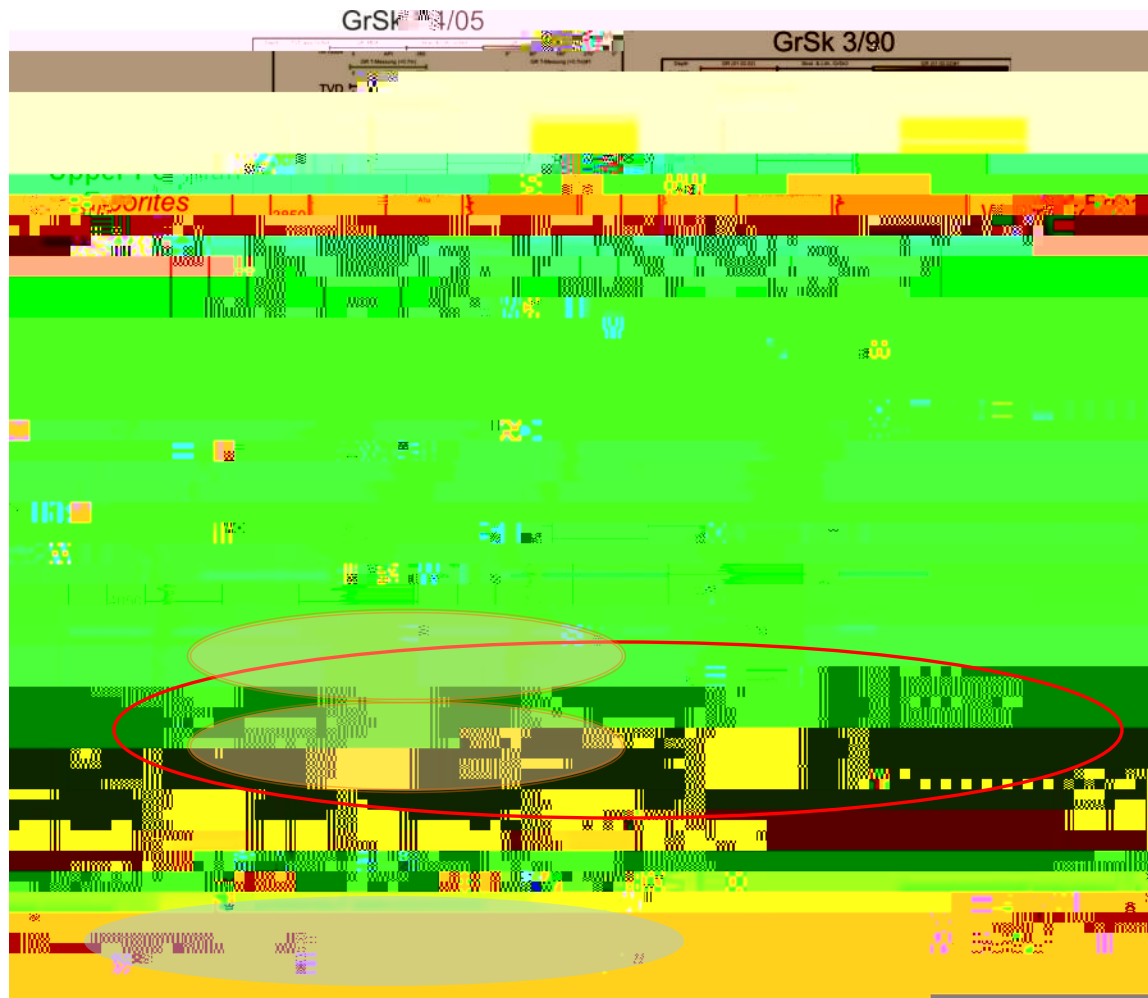
Near-balanced drilling in the reservoir

Analysis of borehole breakouts in 4100 m depth

Fracture mechanical analysis of initiation and growth of breakouts, using data from LOTs, FMI and core testing



Log correlation with existing and new well



Geothermal aquifer
 150°C, 10-100 mD
 vertical thickness: 80 m

Gel/Proppant frac

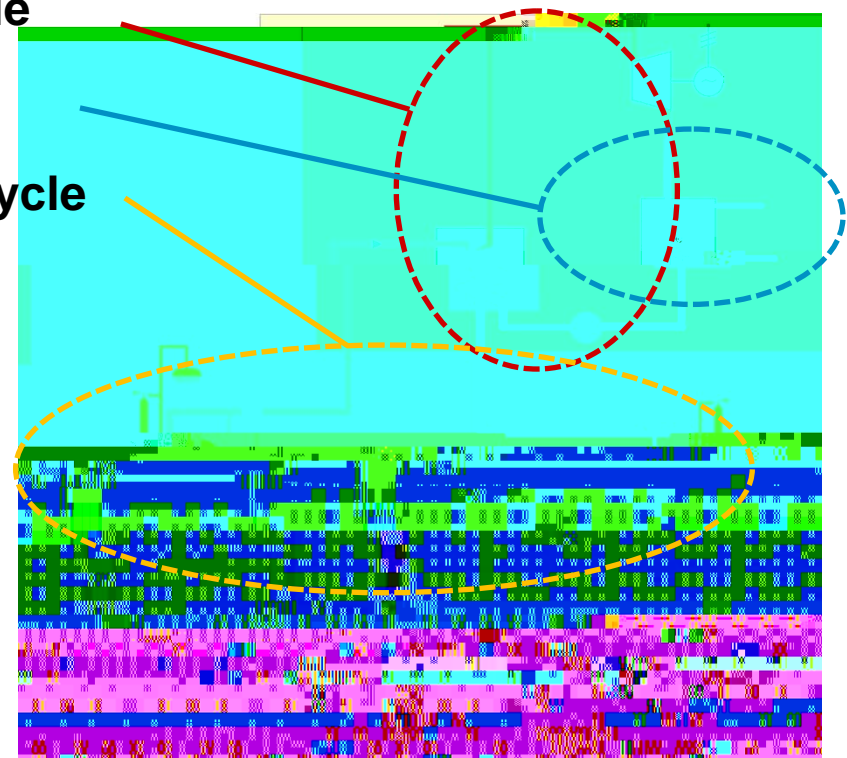
Outlook

Process engineering

Generation of energy

- Power plants serve for net power production
- Net power = gross power - auxiliary power
- Auxiliary power

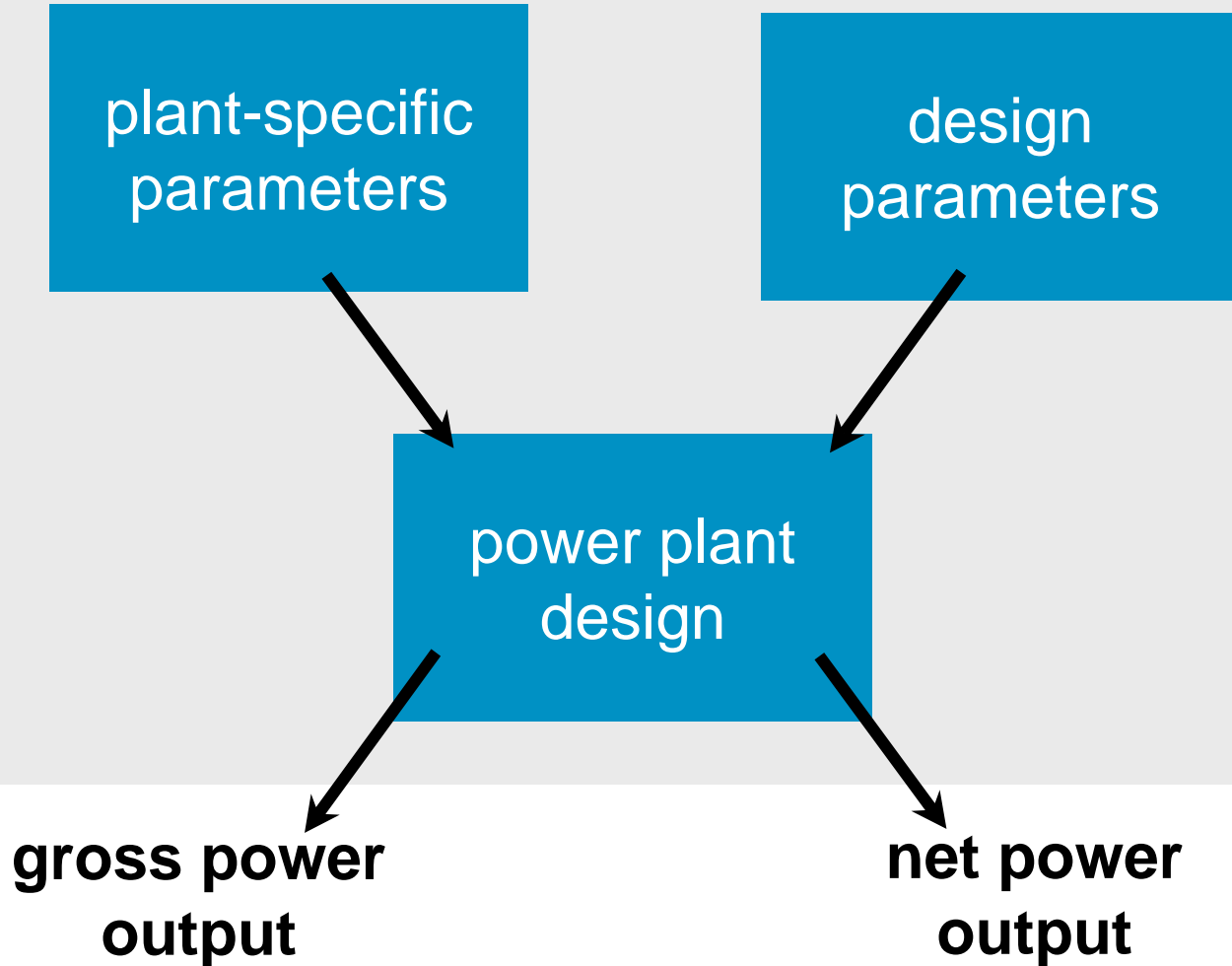
{ conversion cycle
 cooling cycle
 thermal water cycle

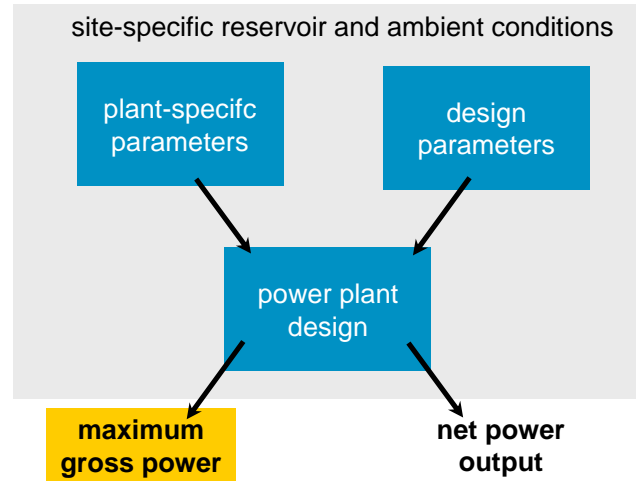


➔ A maximum net power output can't be reached by maximizing the gross power

➔ Geothermal power plant design needs a holistic approach

Approach to power plant design site-specific reservoir and ambient conditions





	maximum gross power (wet cooling)	maximum net power (wet cooling)
reservoir conditions	$T_{TW} = 150\text{ °C}$, $PI = 30\text{ m}^3/(\text{h MPa})$, $\text{depth}_{\text{reservoir}} = 4,500\text{ m}$	
thermal water mass flow	56 kg/s (14.8 gps)	
th. water injection temp.	66 °C (151 °F)	
condensation temp.	30 °C (86 °F)	
gross power	1,8 MW	
net power	460 kW	

Plant-specific parameters, ambient conditions = const.

Conclusions

- Geothermal technology combines engineering and geosciences is therefore multidisciplinary
- Groß Schönebeck demonstrates the feasibility of power generation from low-enthalpy EGS systems under economic conditions
- Fitting the power plant type and processes to the geological reservoir characteristics requires a holistic approach
- Our learning curve allows the adaptation of profitable workflows to equivalent sites



This project is funded by the German Federal Ministry of environment and reactor safety



Bundesministerium
für Umwelt, Naturschutz
und Reaktorsicherheit

