Green energy from abandoned mines

Lukas Oppelt, Timm Wunderlich, Tom Ebel, Thomas Grab

10.05.2023

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Mine Water

- Water in contact with mines (opencast, underground mining)
- Differentiation between surface and groundwater
- chemical composition strongly dependent on mined raw material/ surrounding rock, age of water, flow conditions, …
- Water volume and temperature increase with depth
- Drainage usually into receiving waters, sometimes considerable

considerable post-treatment necessary


Rote Spree [7]


Rothschönberger Stolln

Mine Water

- Abandoned mines / Post – mining Landscapes
  - High Costs for Renovation
  - Partial eternity tasks
  - Job loss
  - Environmental impact
  - Acceptance by the population

Mine Water

- Abandoned mines / Post – mining Landscapes
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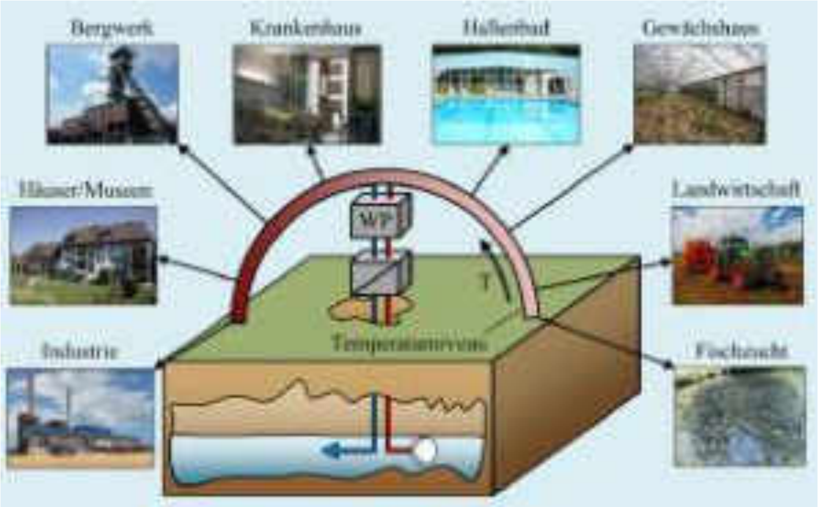
  - Environmental impact
  - Acceptance by the population
- Potentials
  - Linear reg. Energy Source (V↑, T= const.)
  - Storage for seasonal energy surpluses
  - Recovery of valuable materials



Groundwater and utilisation

Drinking water	Tap wasser	Energy supply
• in case of very low contamination (history)	• Cooling water - power plant (opencast mining) • Raw material extraction in combination with processing • Balneology	• Heating/ Cooling • Energy generation • Energy storage

Opening of a mine tunnel [2]

Water treatment plant Königstein [3]

Mine water plant Reiche Zeche

Dewatering in underground mining

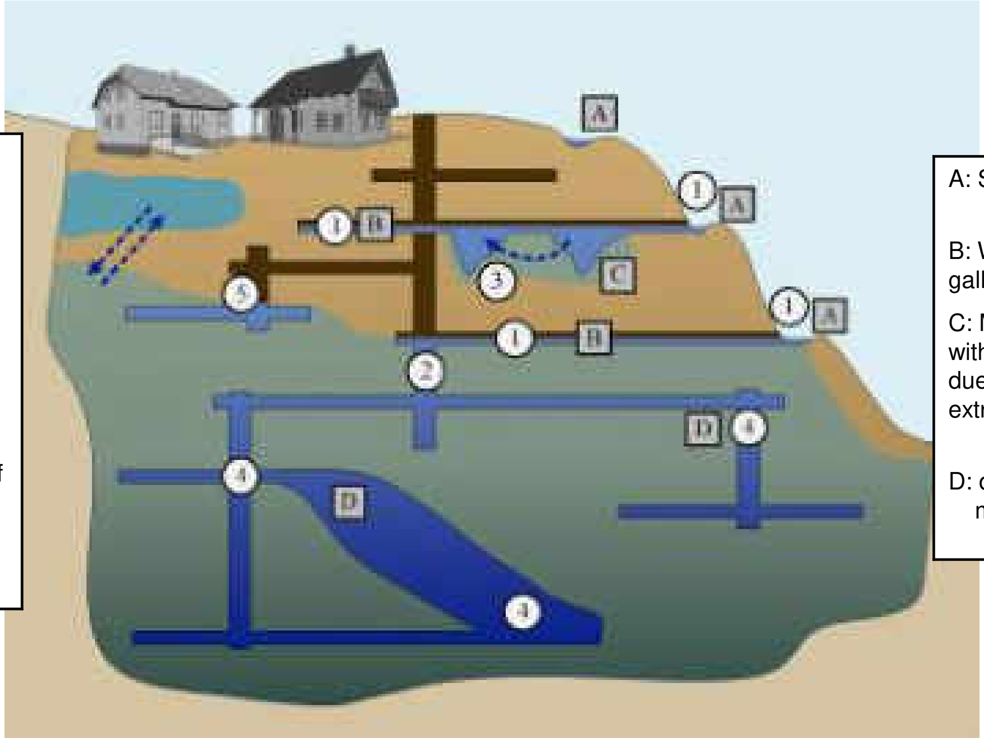
1: Water release gallery

2: rising Shaft water

3: water-bearing headings

4: deep, flooded, mining areas

5: for protection of Groundwater/ near the surface pumped mine water



A: Surface water

B: Water release gallery

C: Mining areas with hydraulic link due to the extraction point

D: deep, flooded, mining areas

Open pit mining Nochten (GER):

Dewatering in a open pit mining

circa. 144m³ per minute

→ Filter well

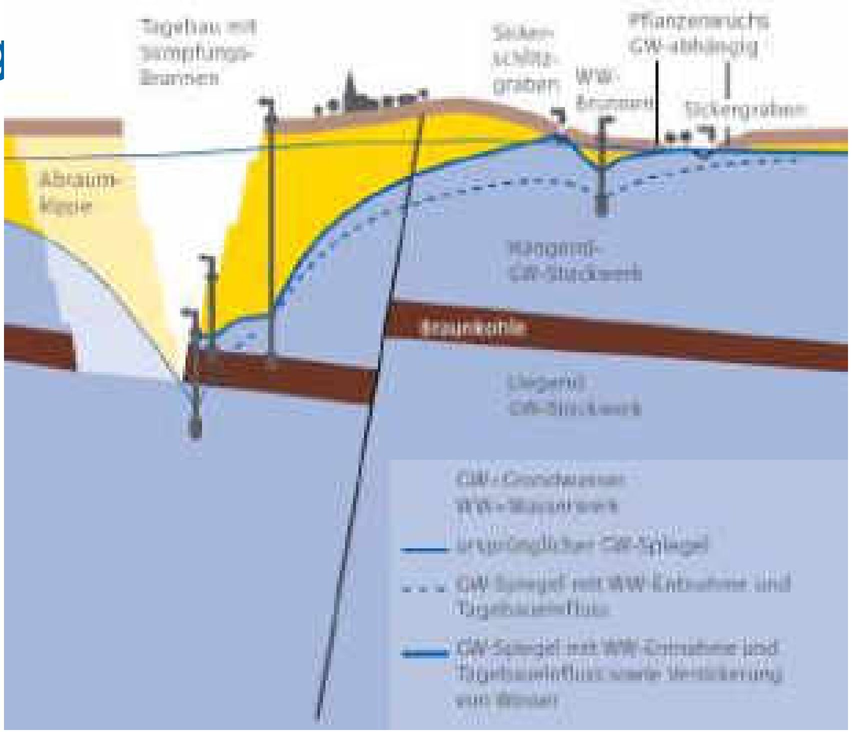
circa. 370mio m³

+ circa. 4mio m³ per year surface water

Ruhr area:

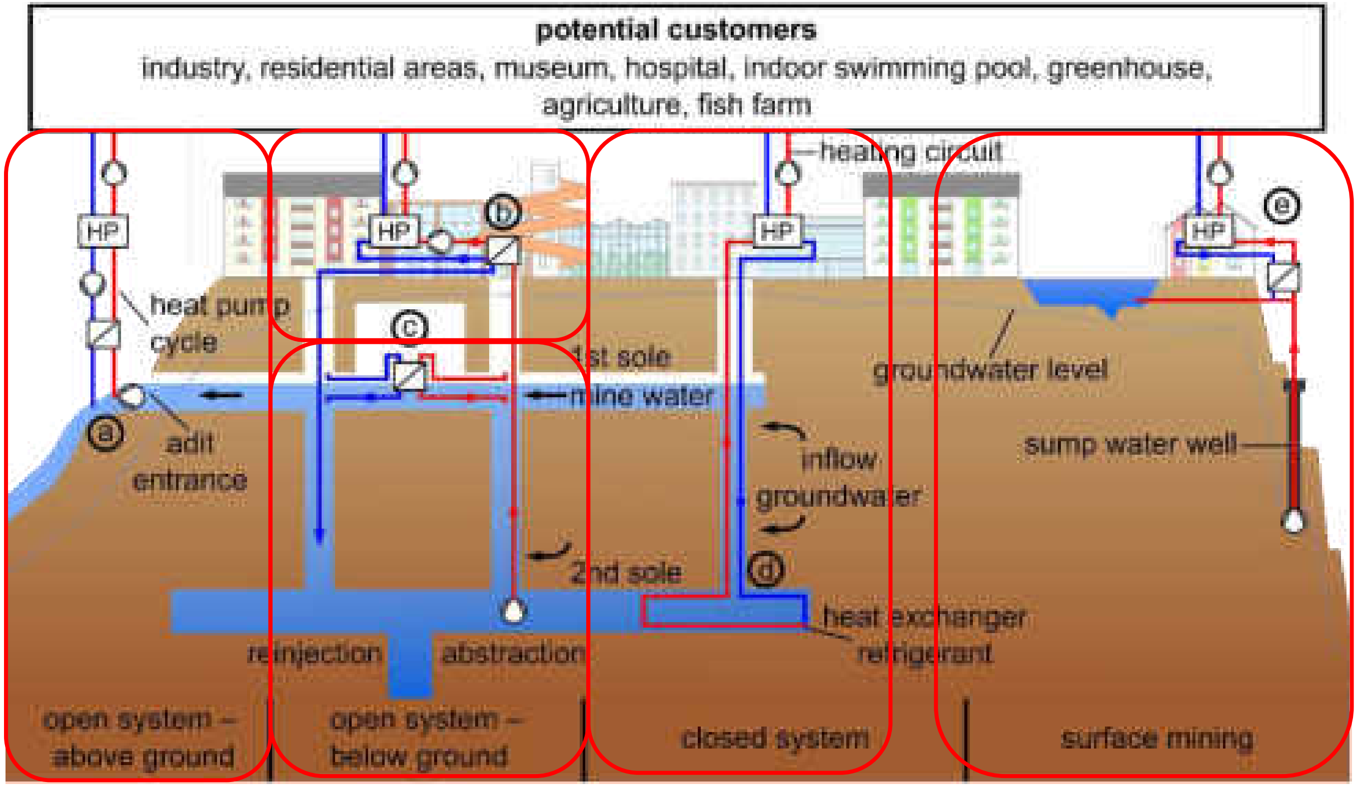
Eternal task

110 mio m³ per permanent



Schematic illustration of dewatering in open pit mine[4]

Technical realisation possibilities



Projects concerning mine water geothermal energy

Since 2022 — **WINZER** heat storage in coal mines of the Ruhr area

Since 2022 — **MineATES** heat storage in water loaded mines

Since 2022 — **BrineRIS** Brines of RIS countries as a source of CRM and energy supply

GEoQart District concepts combination with mine water

2021 — **MareEn** Development of an energy concept for supplying the communities in the Lugau/Oelsnitz mining area with mine water geothermal energy

2020-2021 — Heat transport in a flooded shaft with in the Schlema-Alberoda (Schacht 208), WISMUT

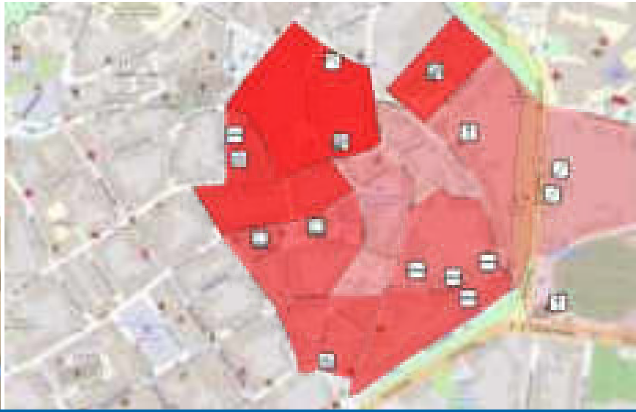
2019-2021 — **GeoMAP** Investigations on heat exchangers for the energetic use of mine water

2016-2020 — **VODAMIN II** Potentials and risks of mining waters

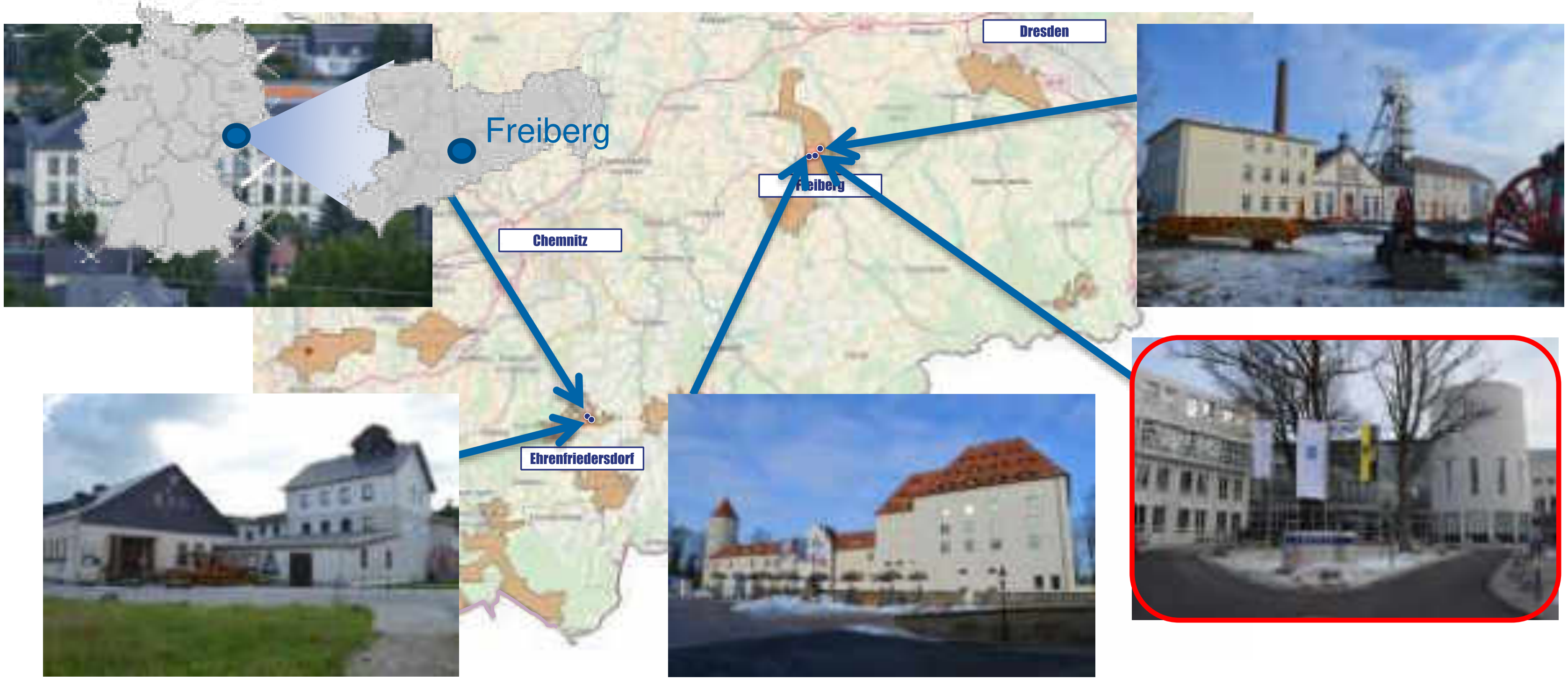
Seit 2010 — Monitoring of mine water power plants

Monitoring Results And Potentials

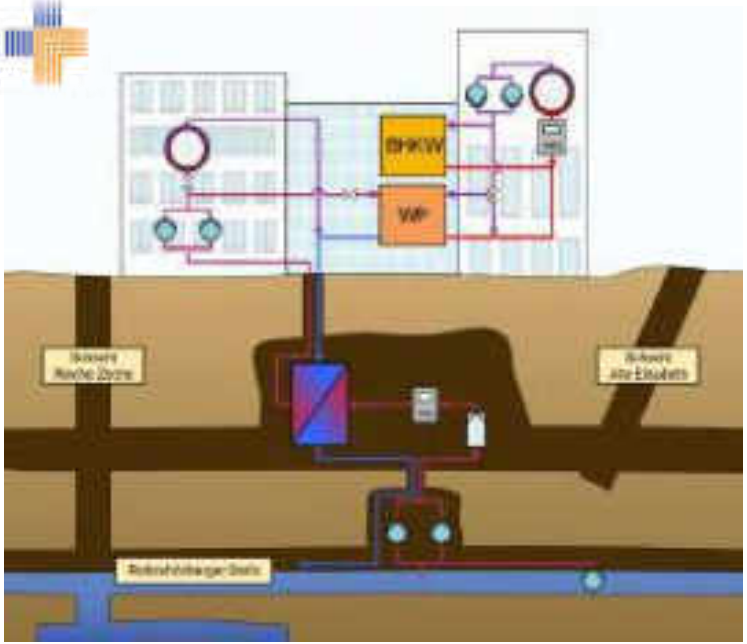




Monitoring of existing plants



District Hospital Freiberg

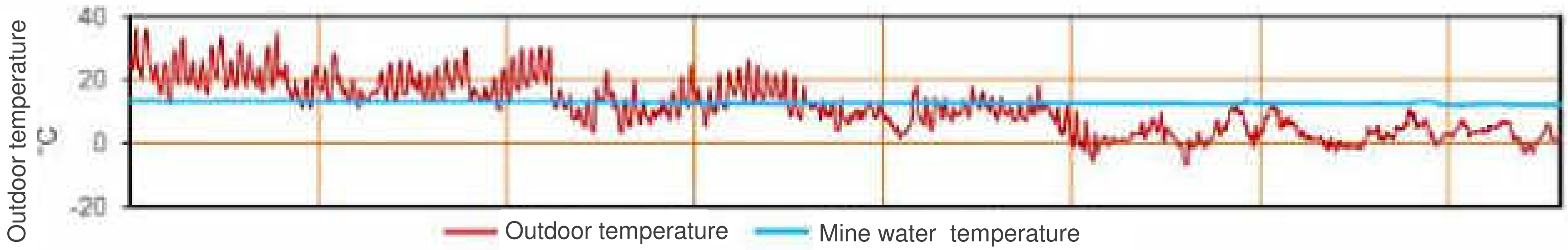


- Running since: 2014
- Use of germ and dust free air in the hospital

13 °C

860 kW

Energy source mine water



Energy improvement – Freiberg district hospital

- Cold for direct cooling
- Heat via a heat pump
- A block heating station to supply the hospital with an efficient cogeneration of heat and power for the heat pump
- Use of enthalpy and air quality of mine air

Energy source mine water

Rothschönberger Stolln

Alte Elisabeth shaft

Broring site

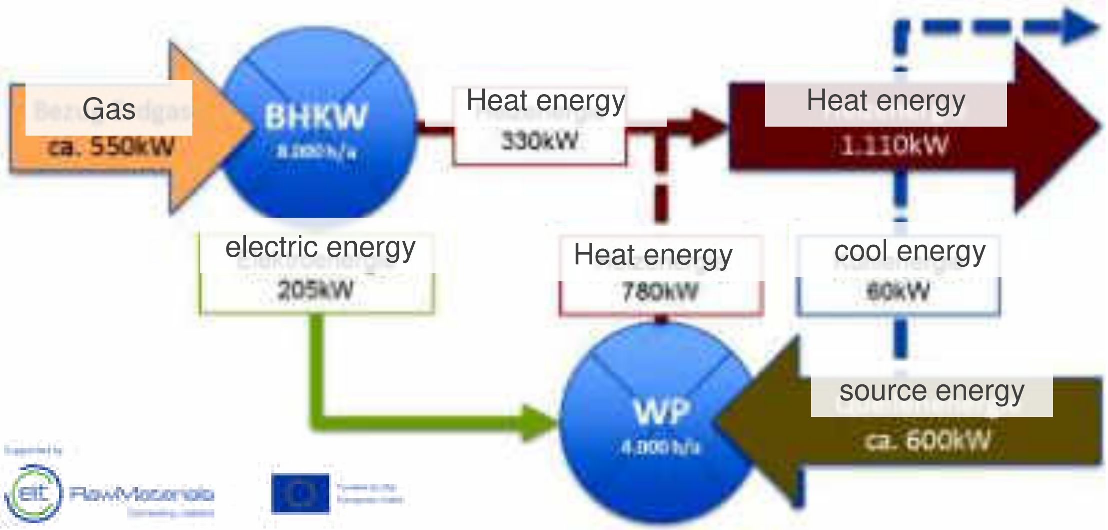
Energy optimisation- Freiberg district hospital

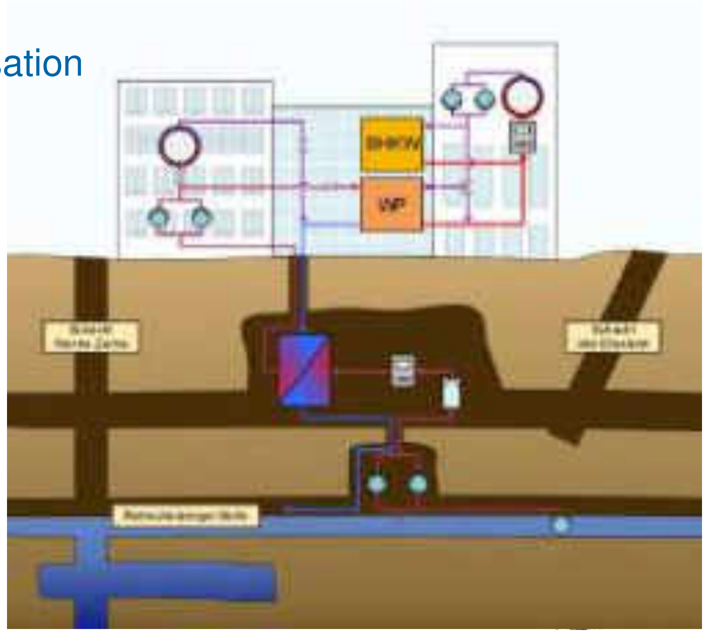
Utilise the energy of themine water

- Almost constant temperature level of 14 °C all year around
- Use for cooling with direct supply
- Use for heating via the heat pump

block heating station for cogeneration of heat and power

- All-year operation for self-supply
- Energy supply for the heat pumps for mine water utilisation

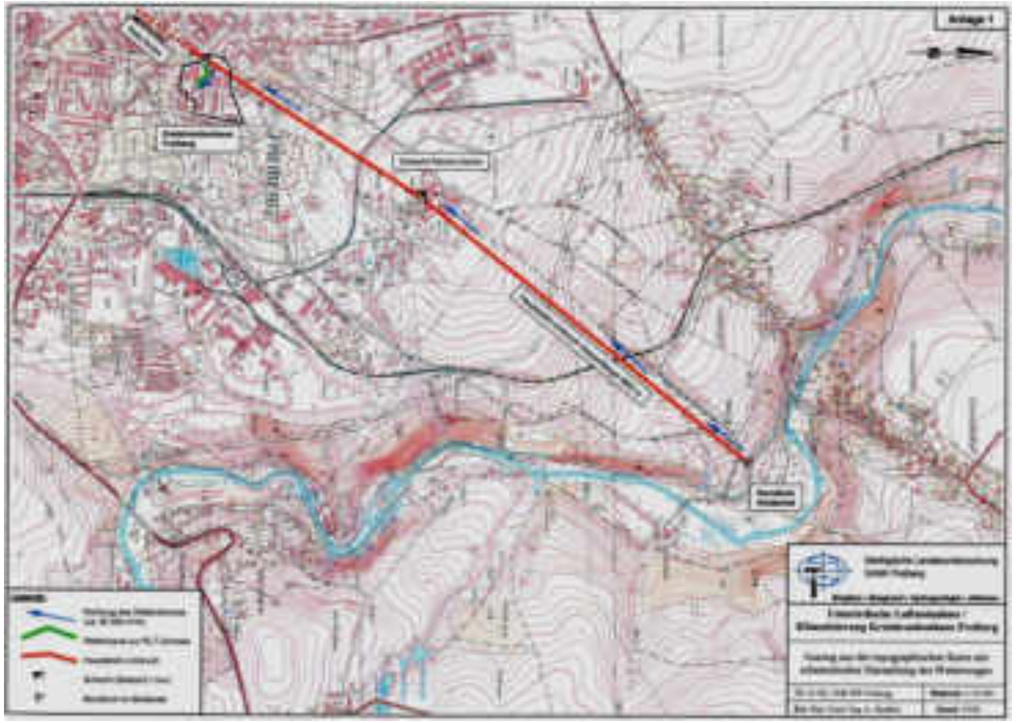




Further possible uses

Air from the mountain/ mine

- Almost constant temperature of approx. 13°C all year round
- 100% relative humidity
- High purity and air quality, high enthalpy
- Preheated, humid air in winter
- Chilled air in summer



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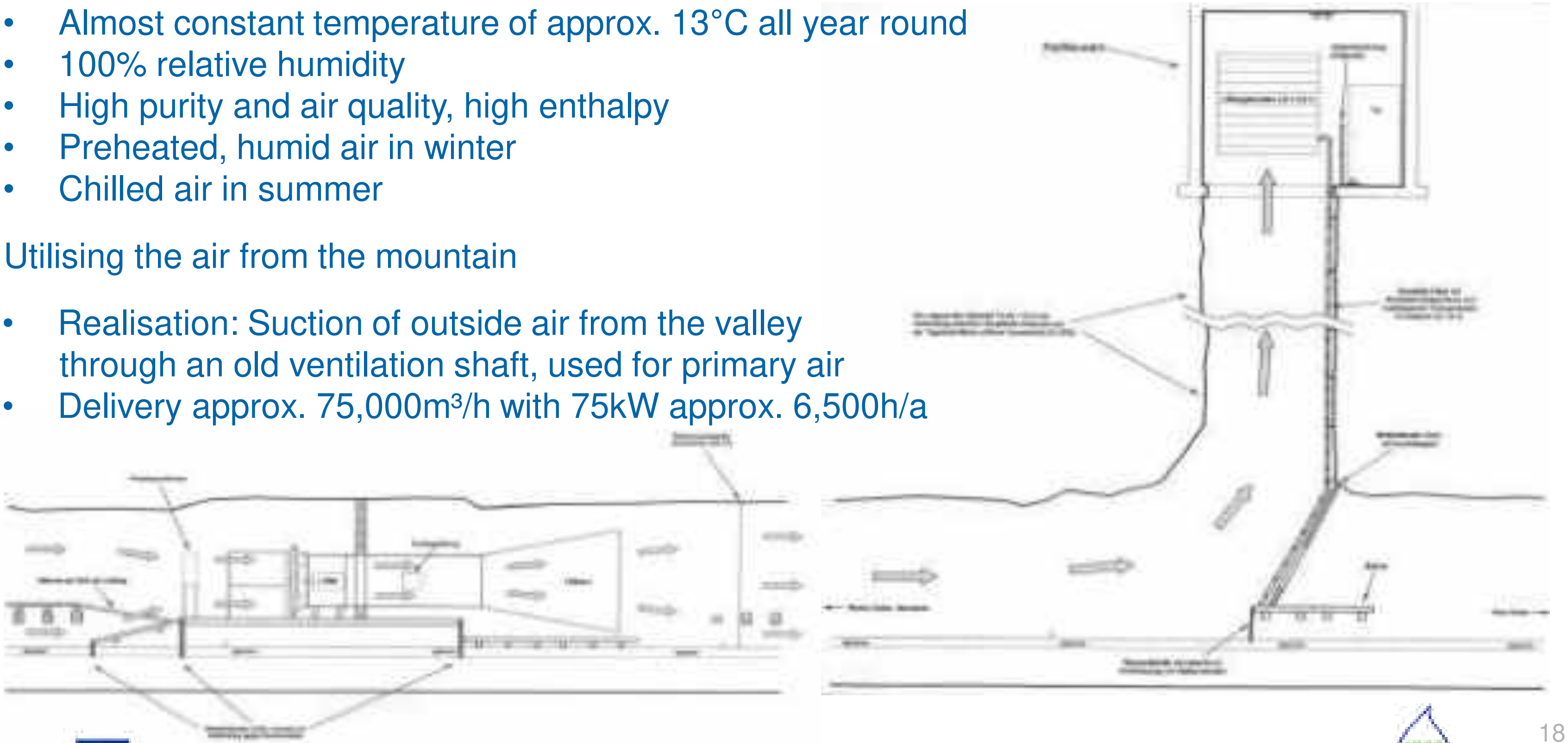
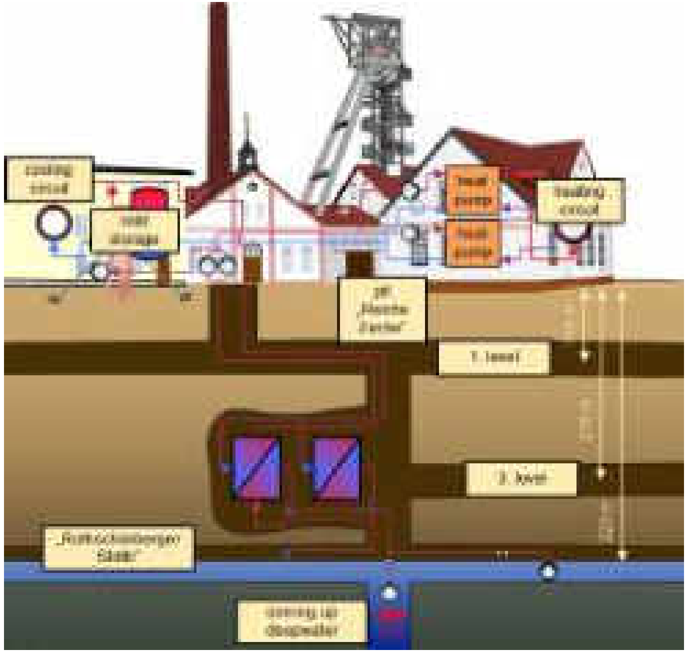
Utilising the air from the mountain

- Realisation: Suction of outside air from the valley through an old ventilation shaft, used for primary air
- Delivery approx. 75,000m³/h with 75kW approx. 6,500h/a



„Reiche Zeche“ Mine Freiberg



- In Operation since : 2013

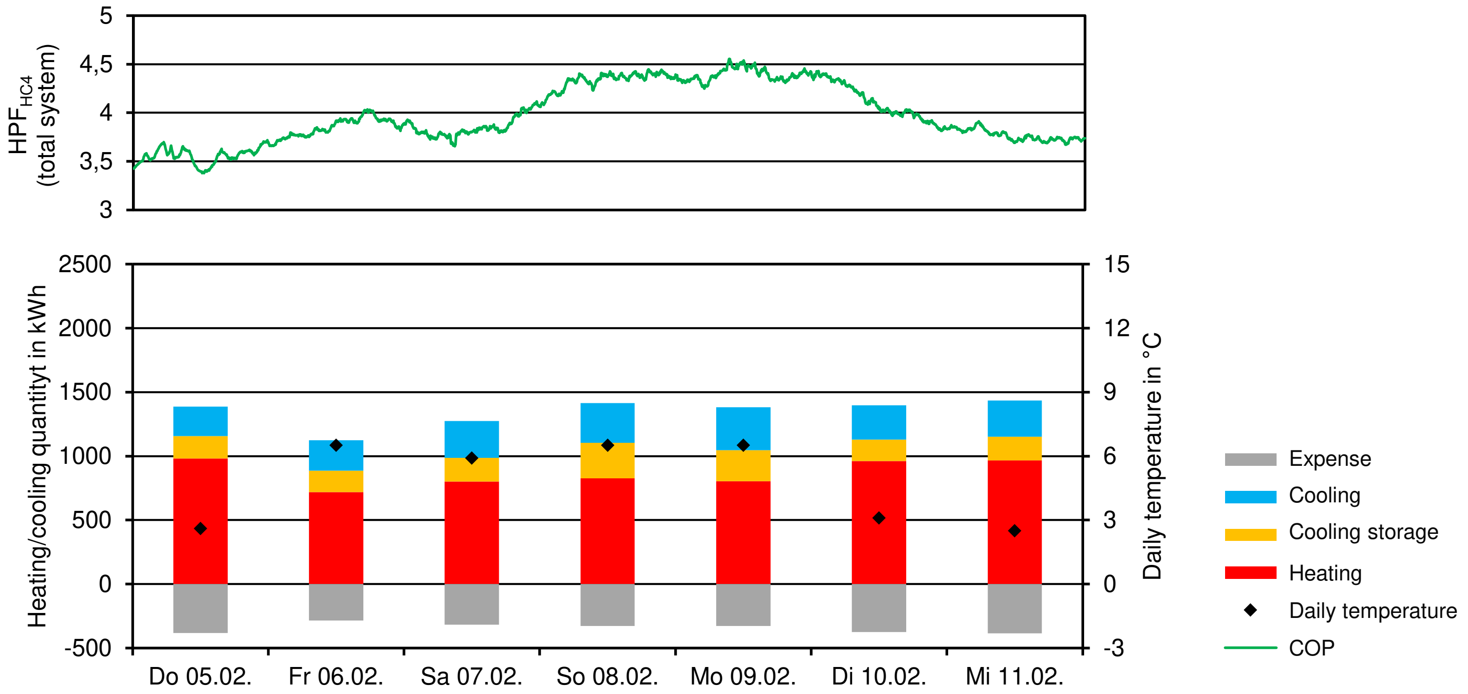
19 °C

175 kW

14 °C

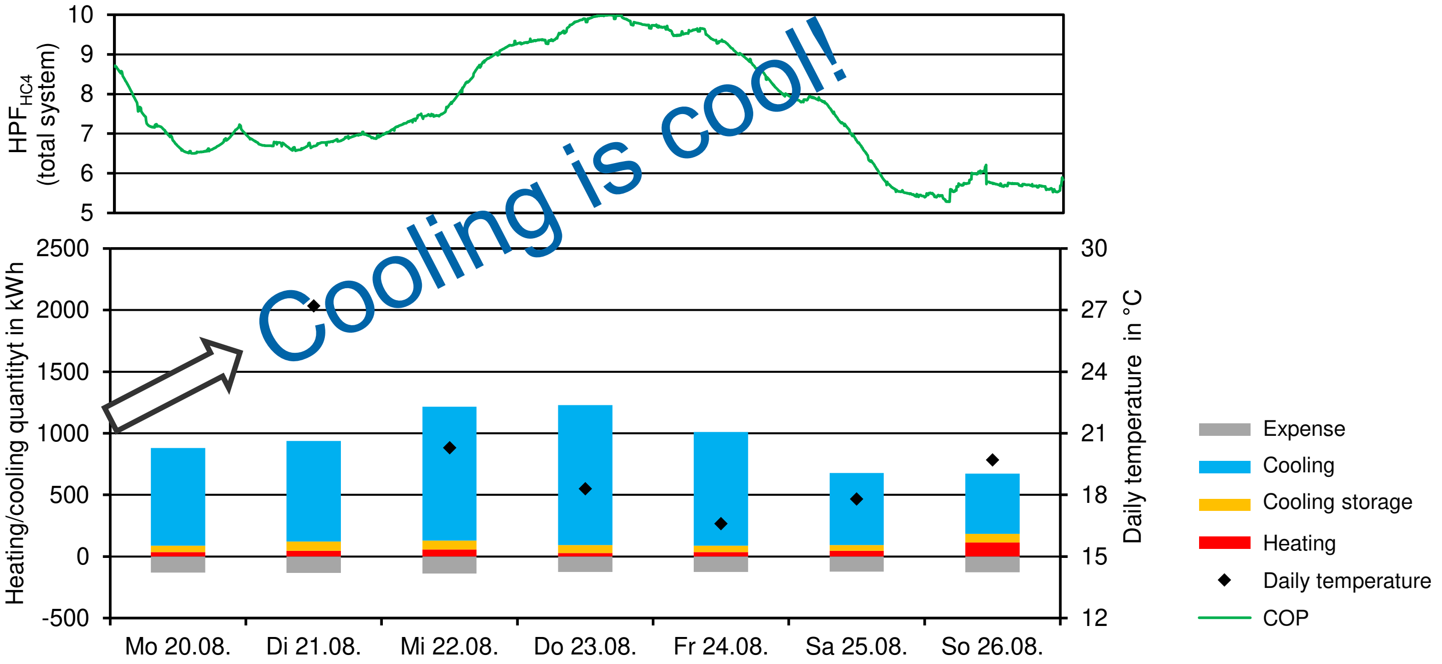
100 kW

„Reiche Zeche“ Mine Freiberg – winter week



Monitoring of existing plants

„Reiche Zeche“ Mine Freiberg – summer week



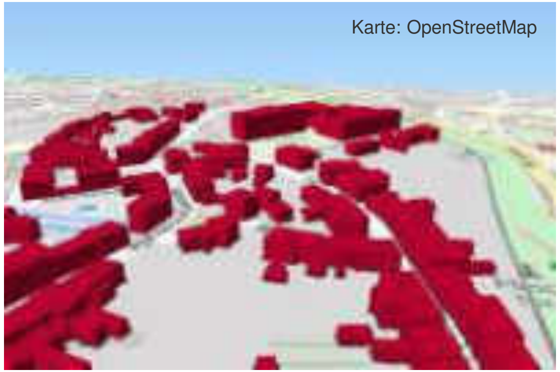
Potentials (in Saxony)

What heat is available?

- Capture / Researching mine water temperatures and volume flows
- Calculation of theoretical heat quantity

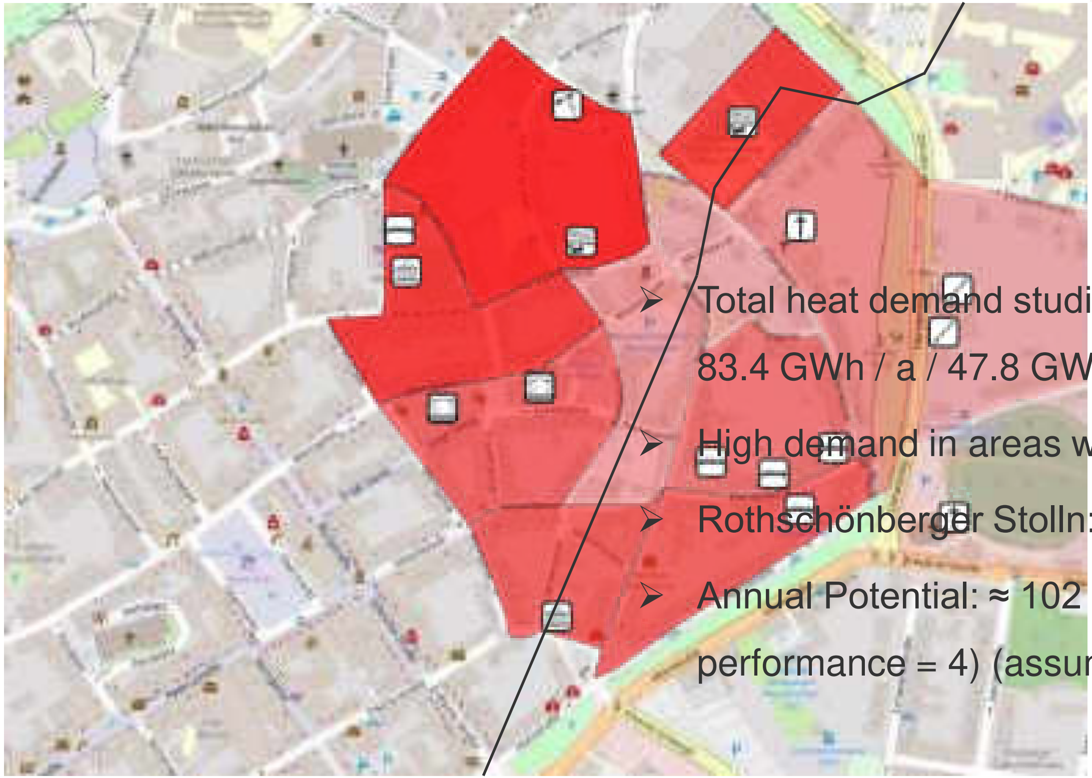
Cavity map of Saxony

Which heat demand is available?



- Use of the digital 3D city model (GeoSN, dl-en / by-2-0) → Heated Area
- 2 Scenarios for Heat Demand

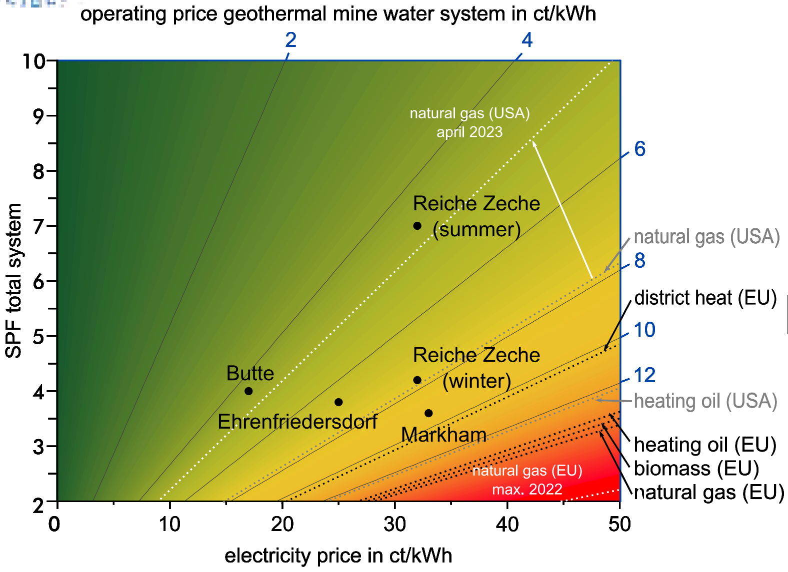
Potentials (in Saxony)



- Total heat demand studied area:≈ 83.4 GWh / a / 47.8 GWh/a
- High demand in areas with schools
- Rothschönberger Stolln: T≈ 11 °C
- Annual Potential: ≈ 102 GWh /a (coefficient of performance = 4) (assumption: cool water 5 K)

Map: OpenStreetMap

Economy



Butte, Montana

year mode
location: USA
SPF_{H1}: 4
electricity price: 17 ct/kWh*

Markham

year mode
location: Great Britain
SPF_{H1}: 3,6
electricity price: 33 ct/kWh*

Reiche Zeche Freiberg

summer mode (more cooling)
location: Germany
SPF_{HC4}: 7
electricity price: 32 ct/kWh*

winter mode (more heating)
location: Germany
SPF_{HC4}: 4,2
electricity price: 32 ct/kWh*

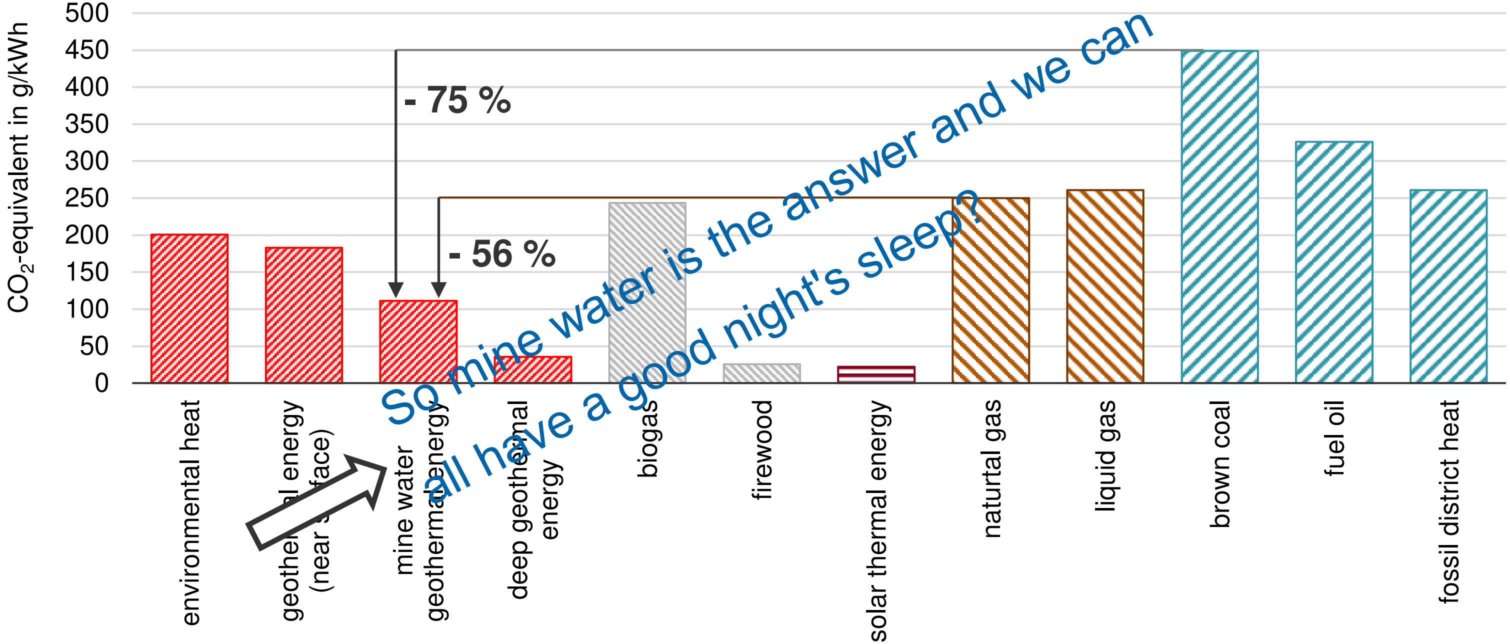
Exhibition mine Ehrenfriedersdorf

year mode
location: Germany
SPF_{H4}: 3,8
electricity price: 25 ct/kWh*

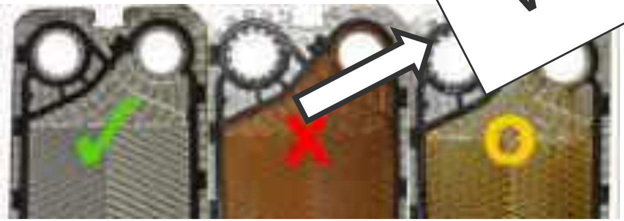
*Electricity price assumed/ estimated | conversion from national currency

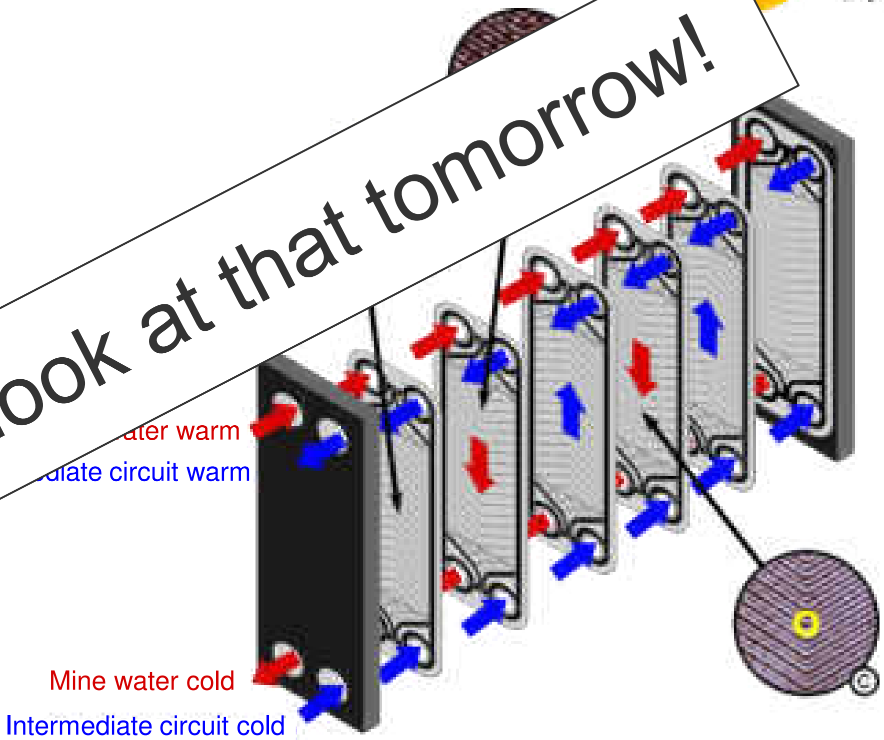
- Different conditions:
  - in Europe high fossil energy prices, but also high electricity prices ↯
  - In the USA, low electricity prices, but also low fossil energy prices ↯
- Mine water geothermal plants can run with operating prices under 5 ct/kWh (including maintenance, servicing, etc.)

Ecology (Exemplary life cycle assessment calculated for Ehrenfriedersdorf system)



Problem fouling





We'll look at that tomorrow!

Summary

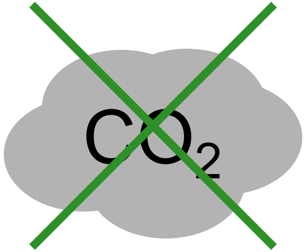
- Each mine is unique
- High initial investment → power ↑
- Compliance with mining law (BBergG, §3)
- High water elevation → High costs
- Chem. composition of mine water (fouling)

Energetic:

+ Large volume, heat quantities
+ No seasonal fluctuations
+ Possible in all climatic zones
+ Low risk of discovery

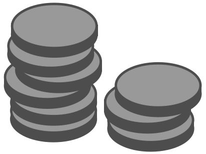
Ecological:

+ Renewable energy source
+ Reduction greenhouse gases and air pollution



Economic:

+ Reuse of decommissioned infrastructure (e.g. synergies during refurbishment)
+ lower energy costs (stable/calculable)



TU BERGAKADEMIE FREIBERG
Chair of technical thermodynamics,
Gustav-Zeuner-Straße 7, 09599 Freiberg

geothermie.iwtt.tu-freiberg.de

tu-freiberg.de/en/fakult4/iwtt/ttd

Thank you very much for your attention

Dipl.-Wi.-Ing. Lukas Oppelt
Tel. +49(0)3731 39-3277
Lukas.Oppelt@ttd.tu-freiberg.de

MBA. Timm Wunderlich
Tel. +49(0)3731 39-3276
Timm.Wunderlich@ttd.tu-freiberg.de