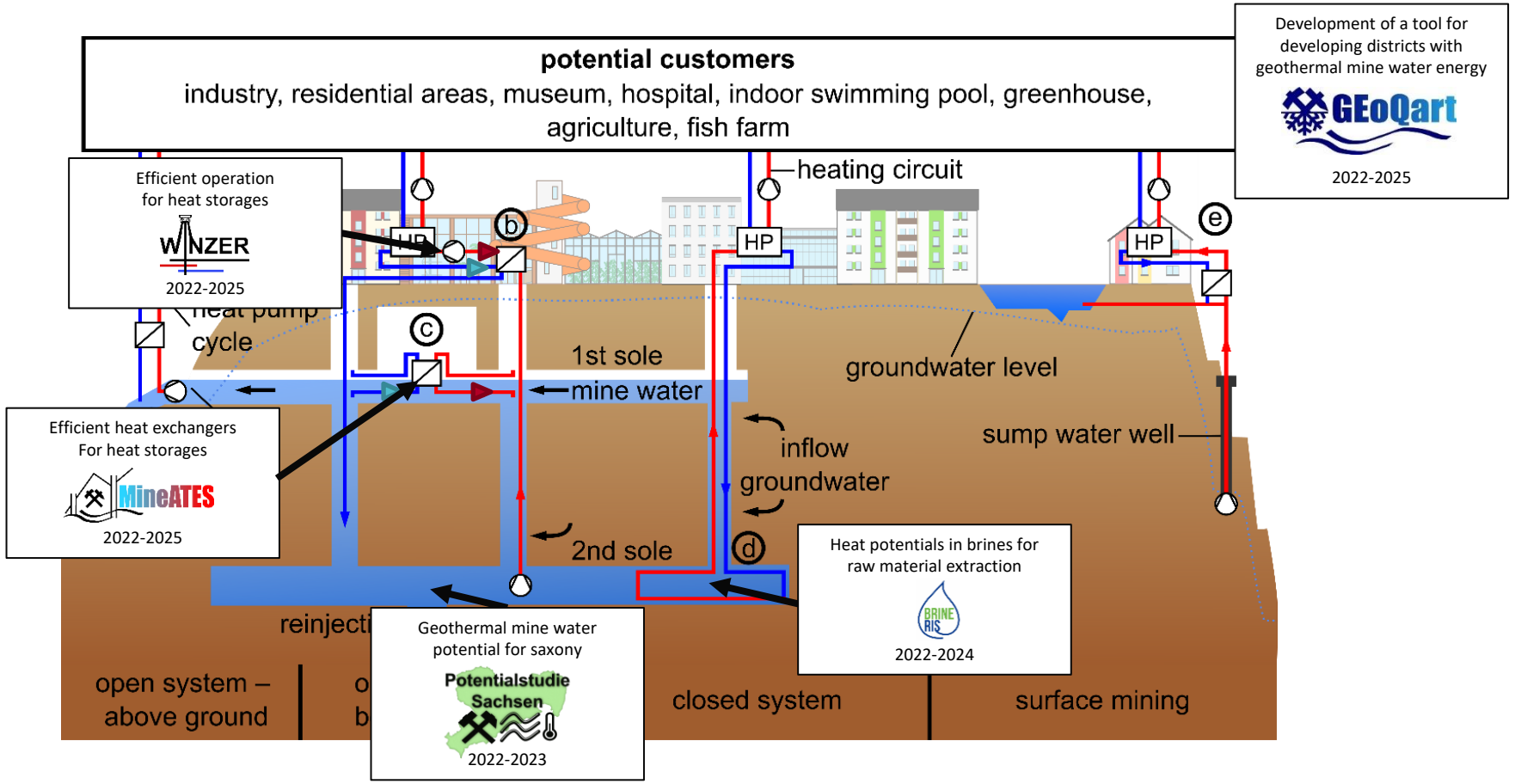
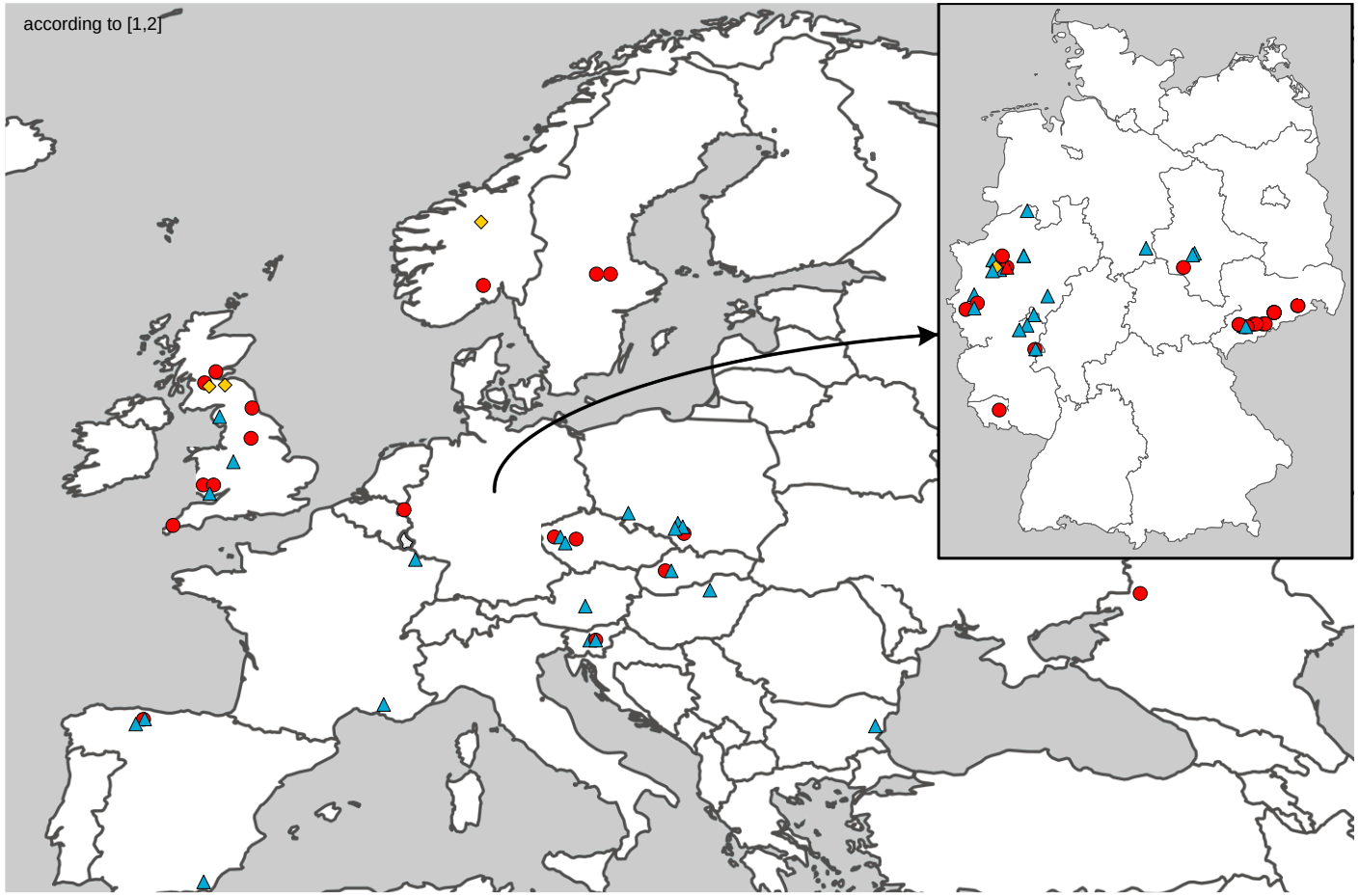
Abandoned mines as a source of heat and cold

Lukas Oppelt, Thomas Grab, Thomas Storch, Timm Wunderlich, Tom Ebel, Tobias Fieback

How is mine water used geothermally?



Current overview of geothermal mine water systems worldwide



- Systems in operation
- Systems decommissioned after operation
- Systems under construction or planned

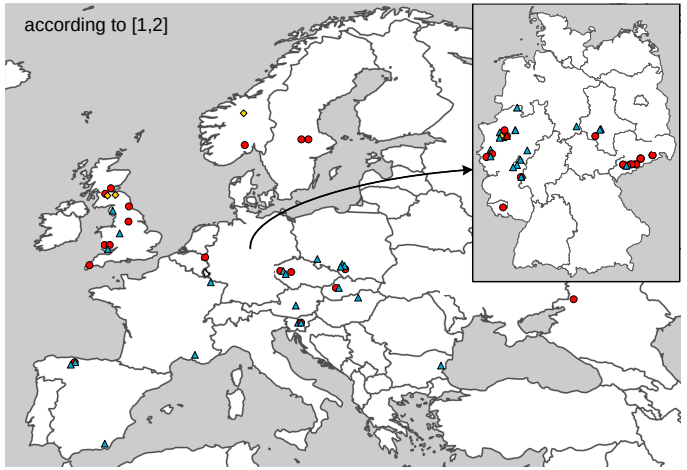
➢ Total installed power:

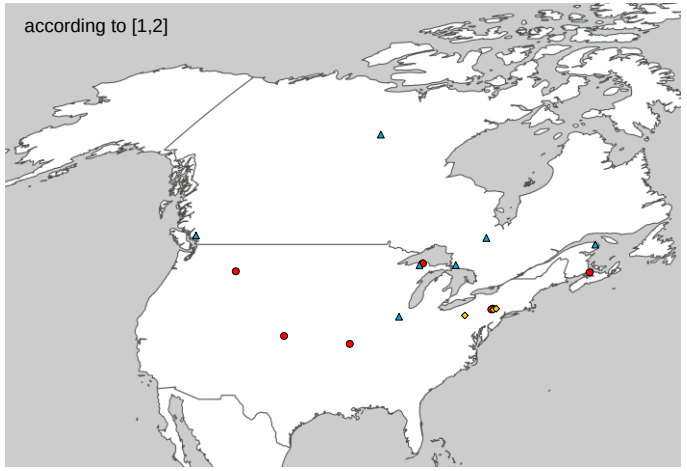
111 MW

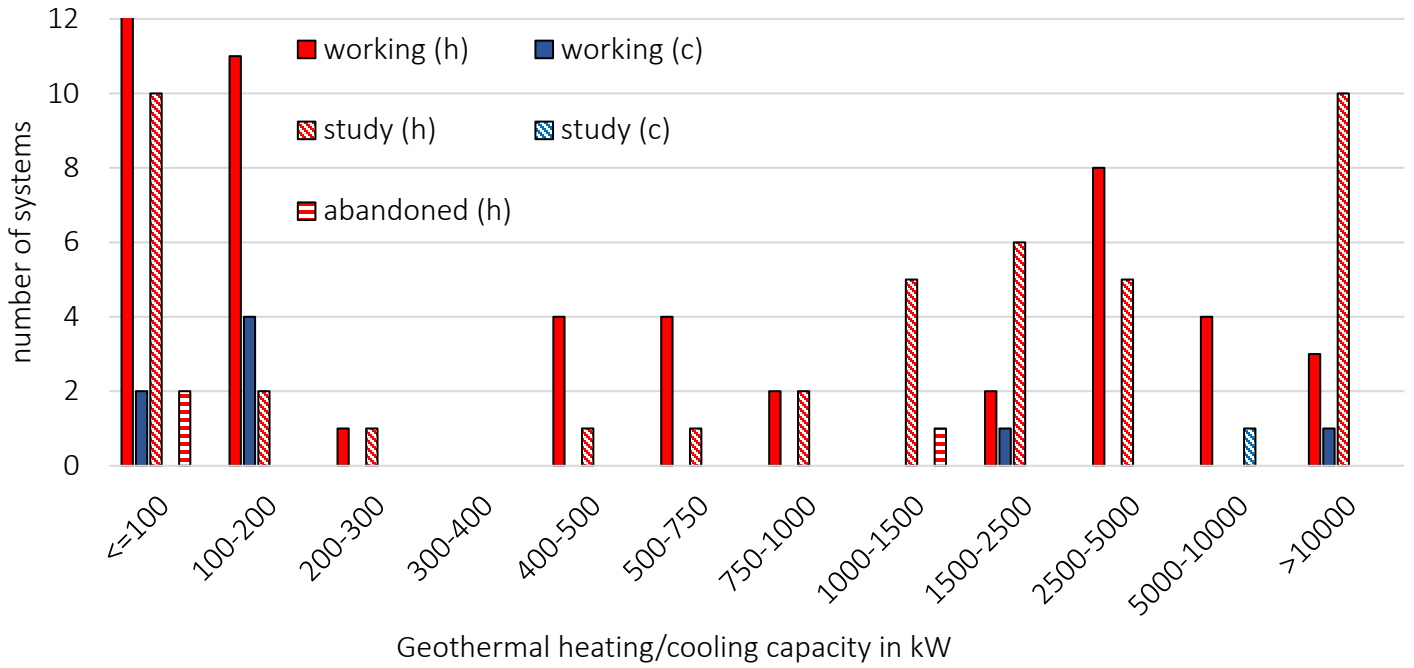
19 MW

➡ Great potential for cooling

Current overview of geothermal mine water systems worldwide



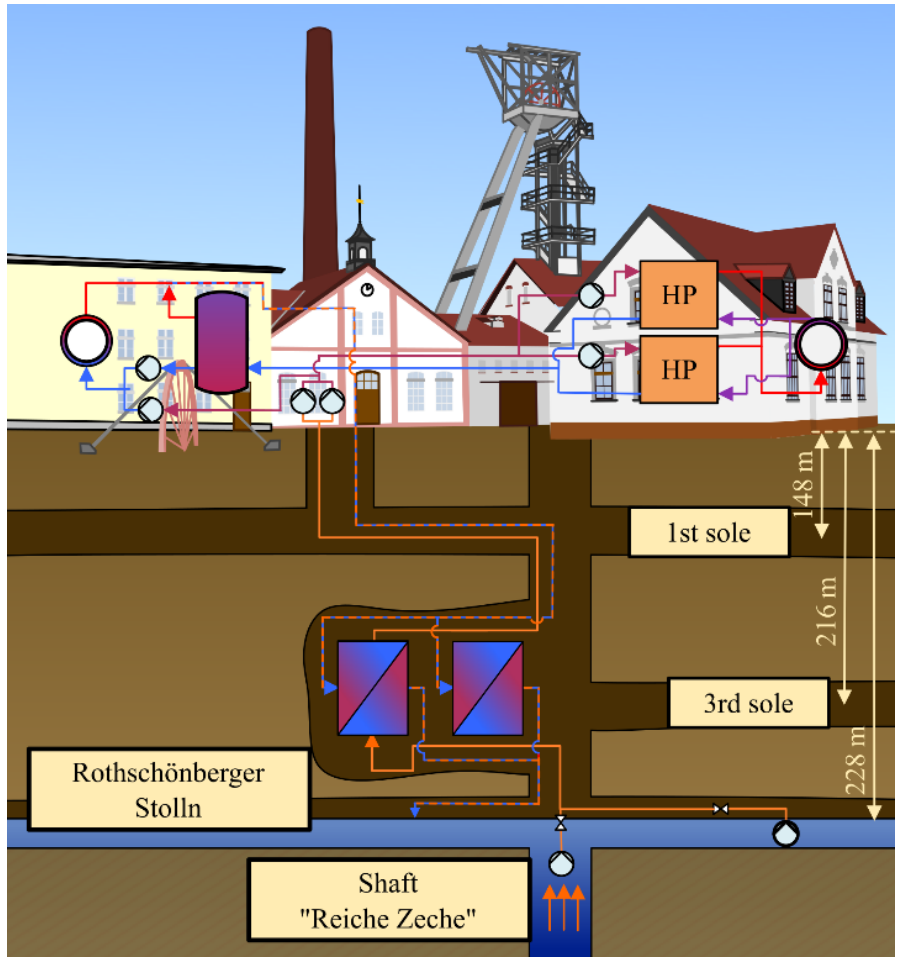




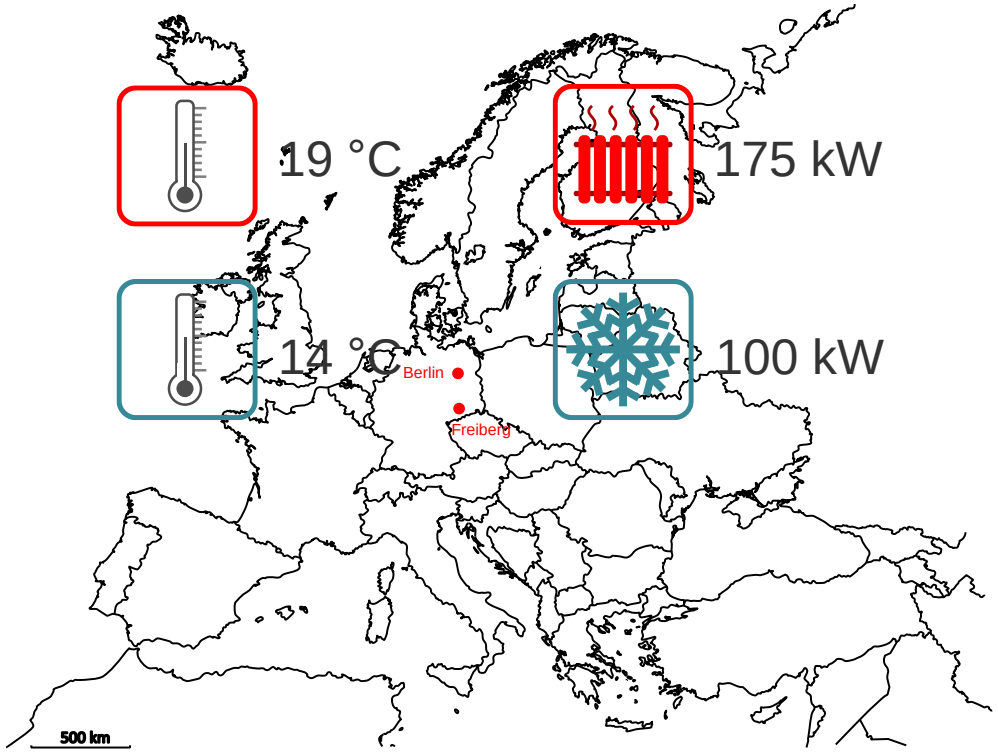
- Currently many small systems (especially in Europe)
- Trend towards large plants (e.g. Mieres, Spain > 6 MW planned)

Current overview of geothermal mine water systems worldwide

Example: Reiche Zeche, Freiberg

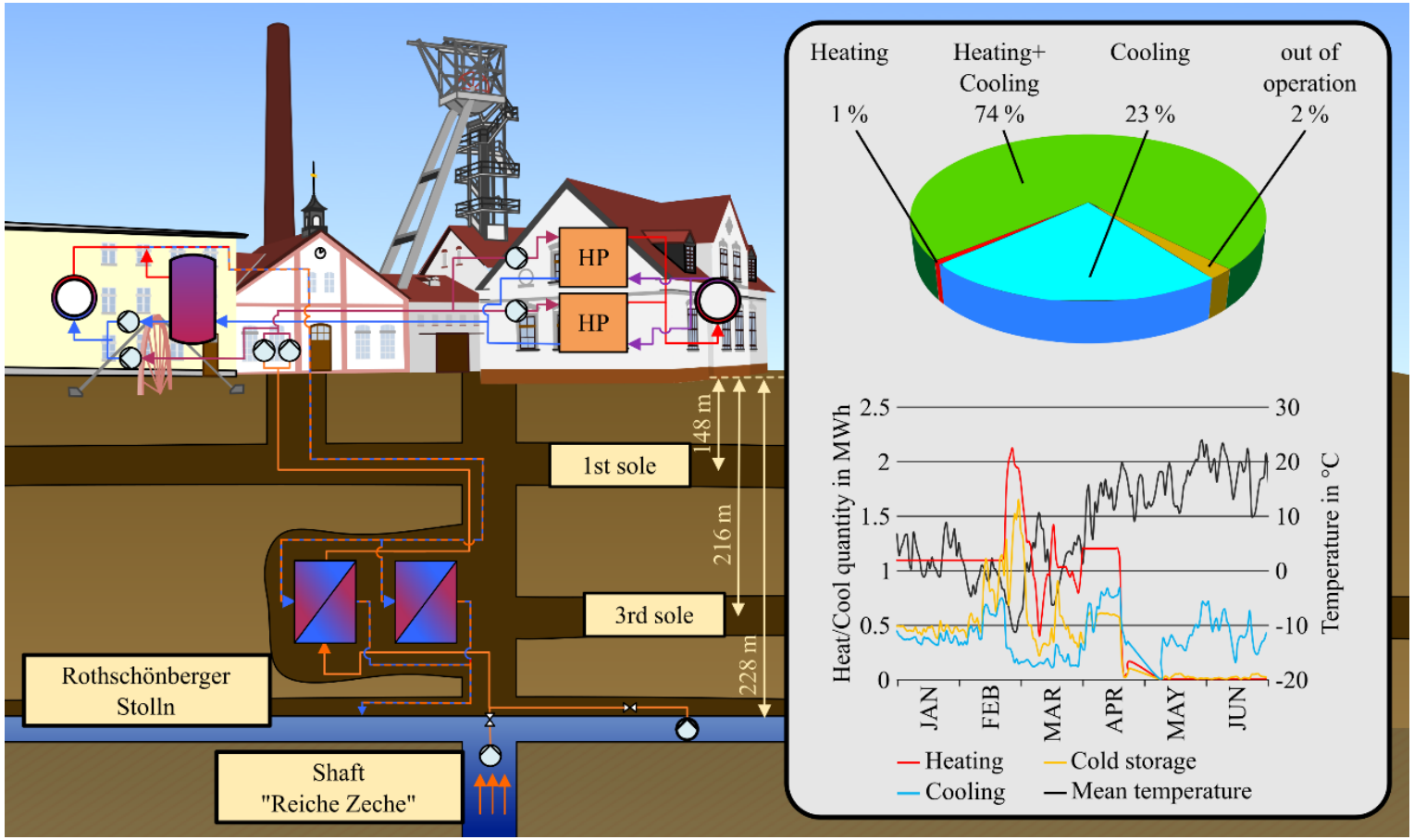


- In Operation since : 2013



Example: Reiche Zeche, Freiberg

Monitoring

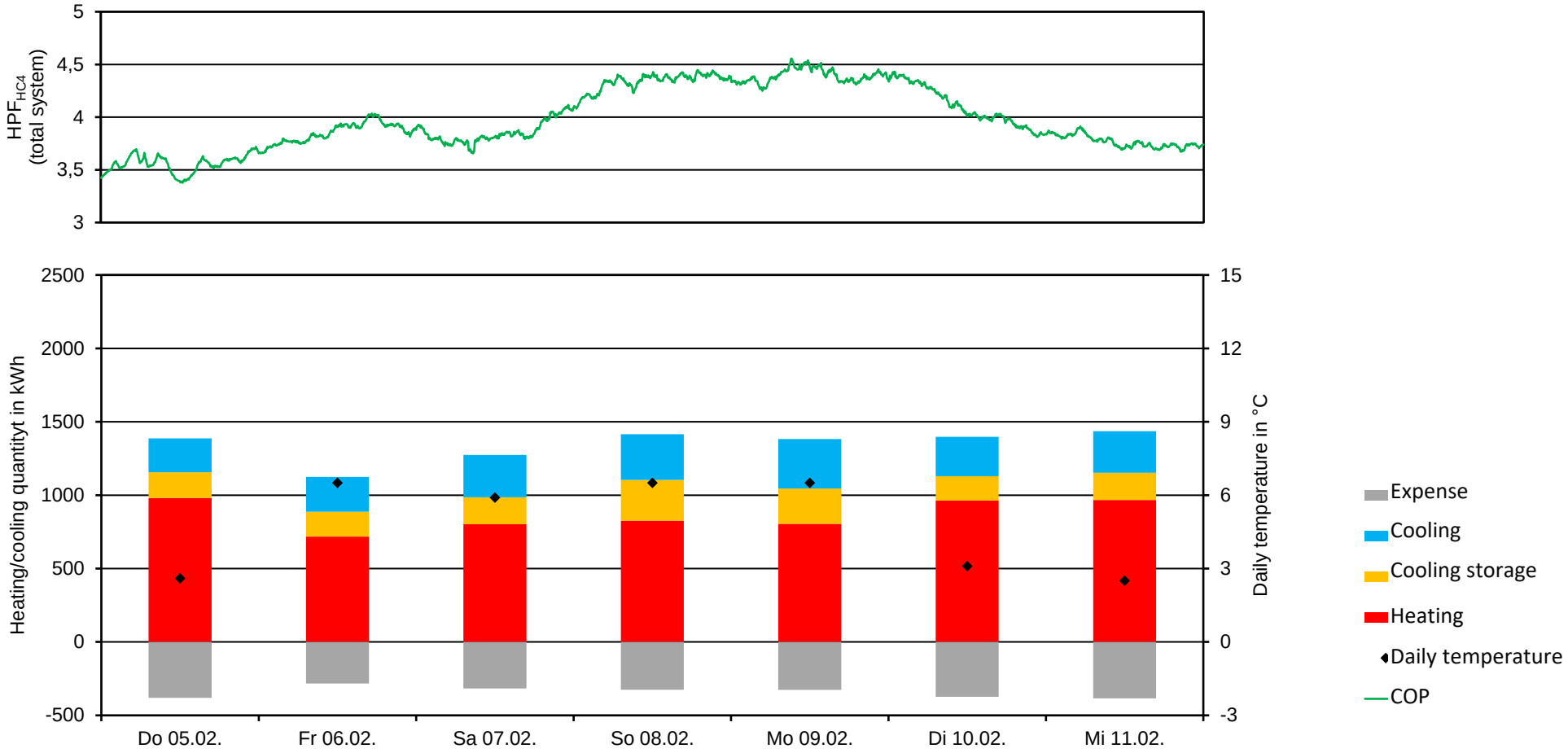


- Most frequented mode: heating + cooling in combination
- Heating until the end of April → Preferably heating mode below approx. 15 °C

→ But, how effective is all this actually?

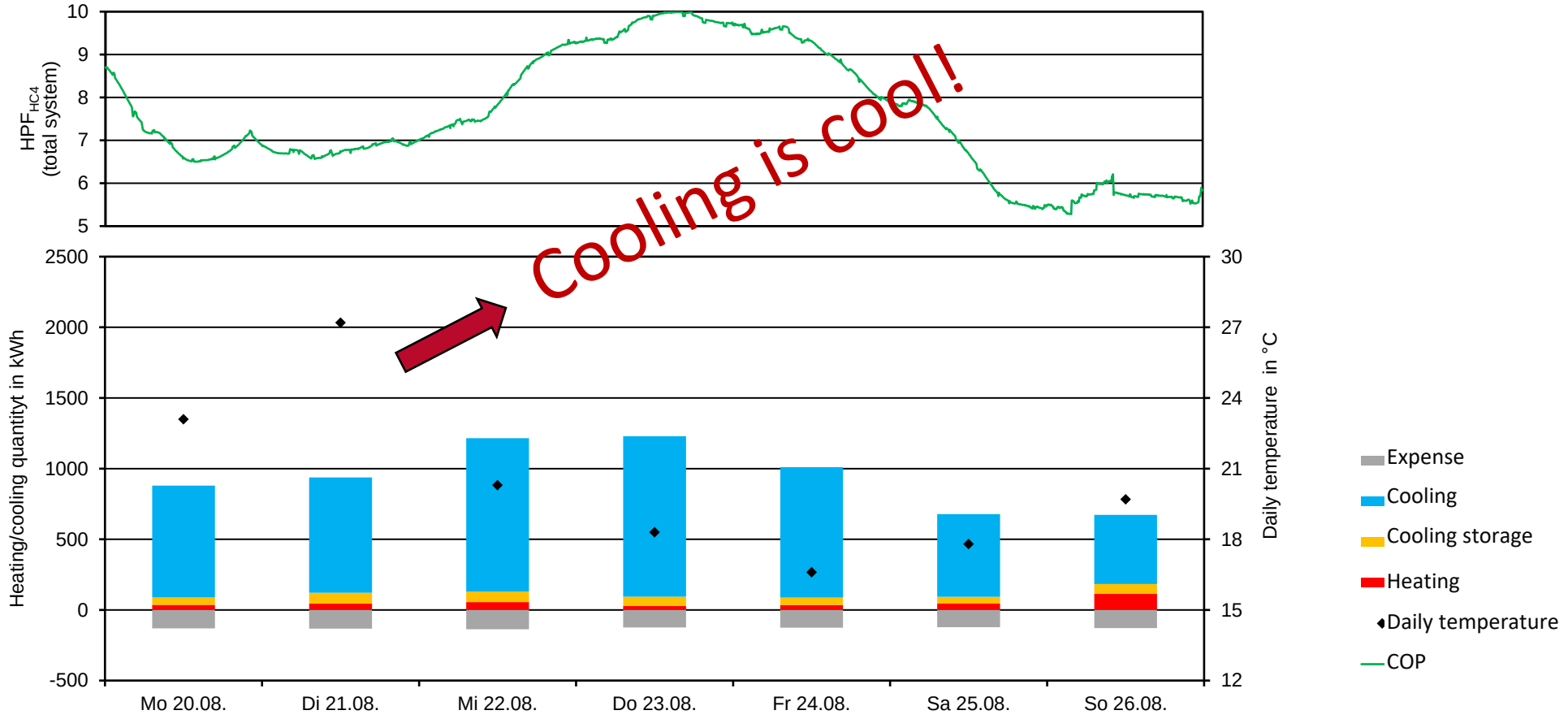
Example: Reiche Zeche, Freiberg

Representative winter week



Example: Reiche Zeche, Freiberg

Representative summer week



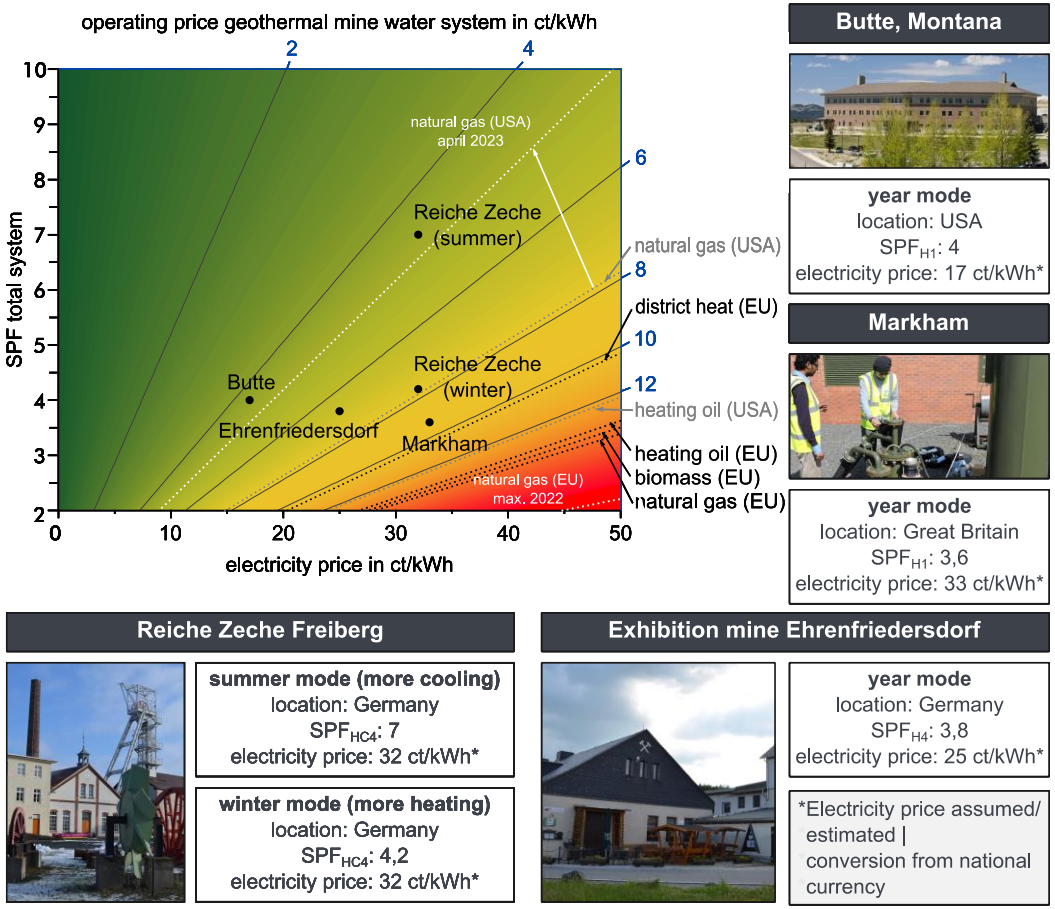
Monitoring results: comparison

	Reiche Zeche Freiberg (GER)	Ehrenfriedersdorf (GER)	Markham (GRB)	Butte (USA)
Operating modes	Winter (more heating) Summer (more cooling)	Heating	Heating	Heating
SPF_{H1} (heat pump)	3.6/-	3.8	3.6	4
SPF_{HC4} (total system)	4.2/7	3.6	1.6	3.5

→ Is it financially and environmentally viable everywhere?

Monitoring results: comparison

Economy



- 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 ↯

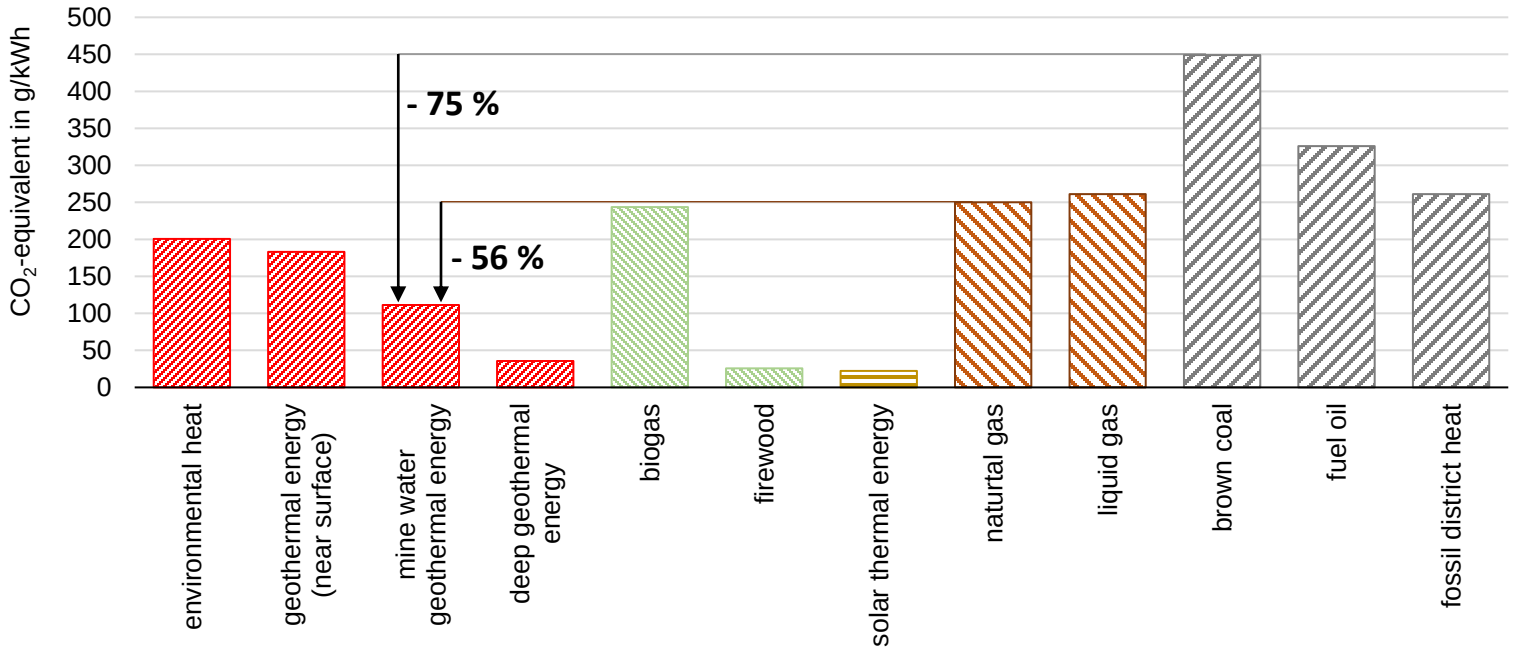
➡ Mine water geothermal plants can run with operating prices under 5 ct/kWh (including maintenance, servicing, etc.)

➡ Cooling significantly reduces operating price throughout the year

➡ BUT: low gas prices difficult to counteract

Monitoring results: comparison

Ecology

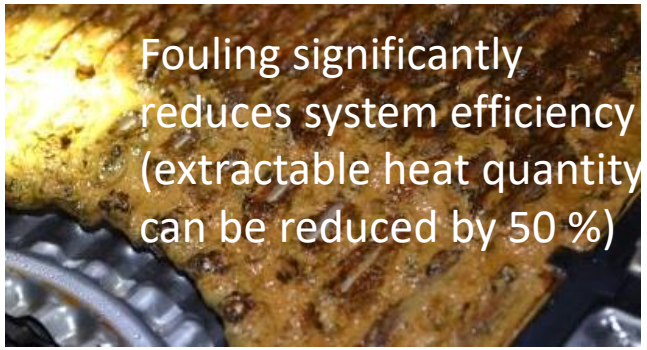


- Exemplary life cycle assessment calculated for Ehrenfriedersdorf system → compared for different energy sources

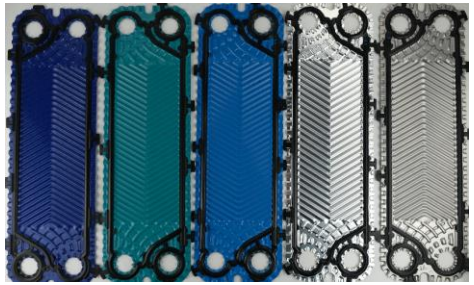
→ Mine water geothermal energy offers ecological alternative

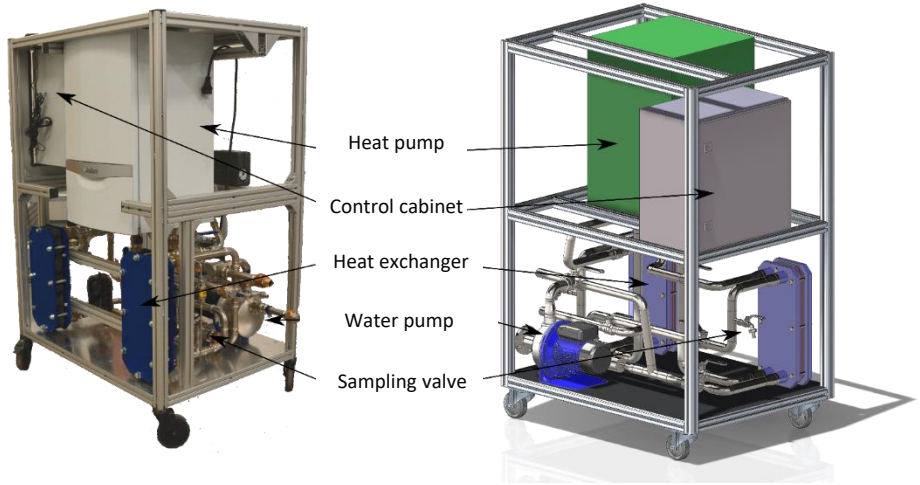
→ CO_2-emissions mainly due to electricity consumption heat pump and removal of refrigerant

Problem: Fouling in heat exchangers



But we are researching the solution: adapted heat exchangers)

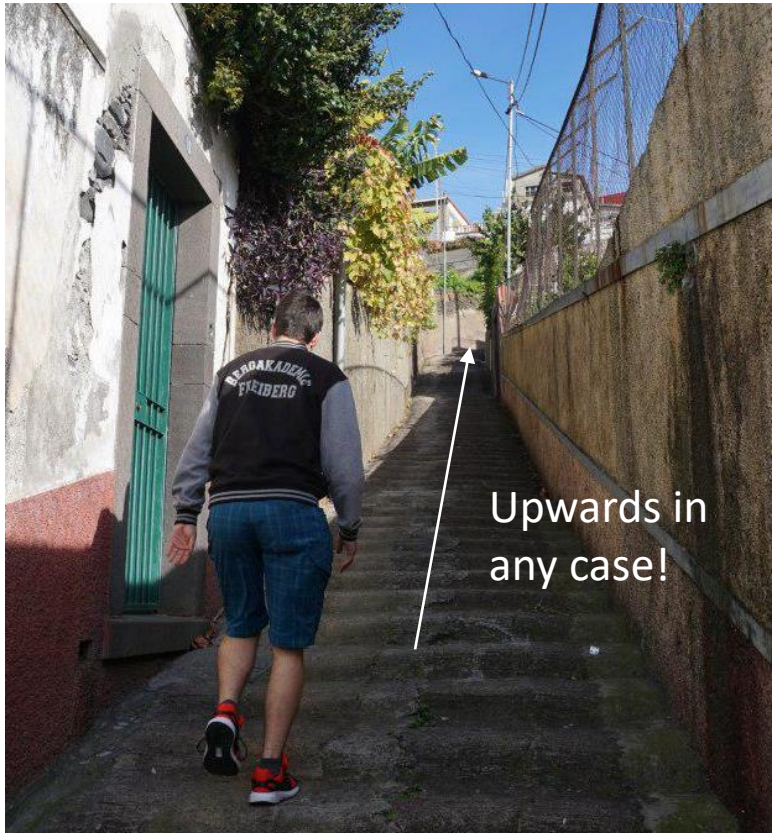


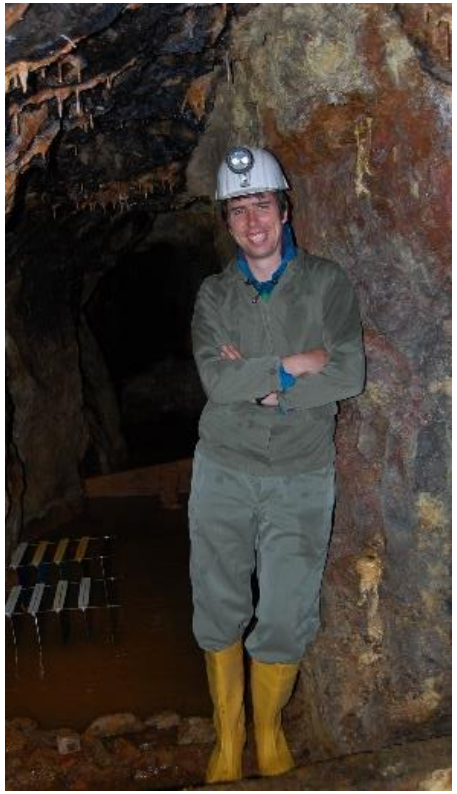


Mobile heat pump/heat exchanger test rig

Quo vadis?

- Large heat potential in abandoned mines
  - Systems mainly in Europe, North America
  - Predominantly heating applications
- Effective system operation possible
  - SPFs>5 possible on a regulary basis
- Running times must be increased
- Develop specific measures to prevent fouling at the site
- Economic and ecological solution
  - Big impact: how expensive are fossil energies?
  - What is the composition of the electricity mix?





TU BERGAKADEMIE FREIBERG
Gustav-Zeuner-Straße 7
09599 Freiberg

Lukas Oppelt
+49(0)3731 39-3277
lukas.oppelt@ttd.tu-freiberg.de

Dr. Thomas Grab
+49(0)3731 39-3004
thomas.grab@ttd.tu-freiberg.de

Prof. Dr. Tobias Fieback
+49(0)3731 39-3960
tobias.fieback@ttd.tu-freiberg.de

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[1] Grab, T.; Stroch, T.; Groß, U. Energetische Nutzung von Grubenwasser aus gefluteten Bergwerken, Erschienen in: Bauer, M. et. al (Hrsg.): Handbuch Oberflächennahe Geothermie, Kapitel 17, Springer Spektrum, 2018, ISBN: 978-3-662-50306-5

[2] L. Oppelt, T. Grab, S. Pose, T. Storch, T. Fieback: *Mine water geothermal energy as a regenerative energy source - status quo and results from five years of monitoring*, Oil Gas EUROPEAN MAGAZINE, 47. Edition, 1/2021, S 15-19, März 2021, DOI: 10.19225/2103054