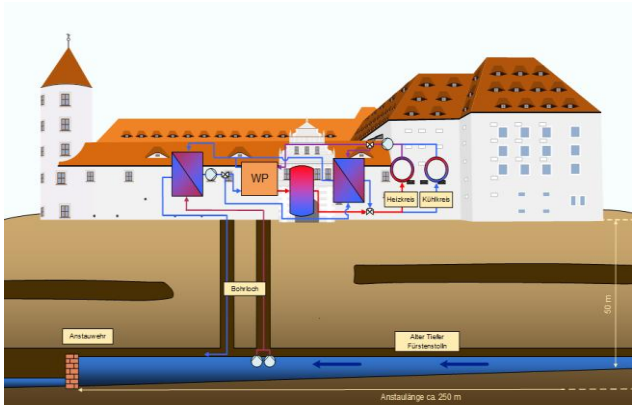
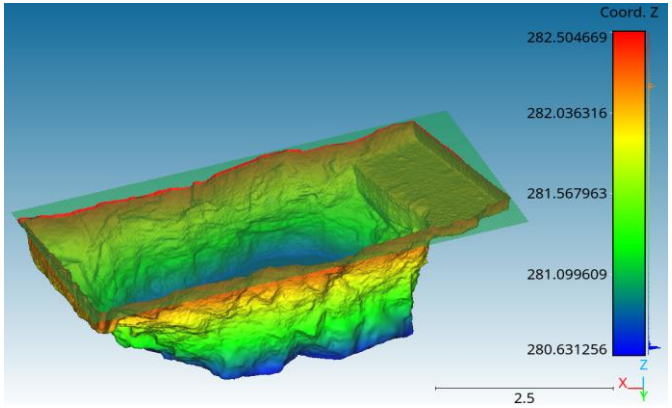
Workshop 3 - 15th IEA Heat Pump Conference
Mine water storage

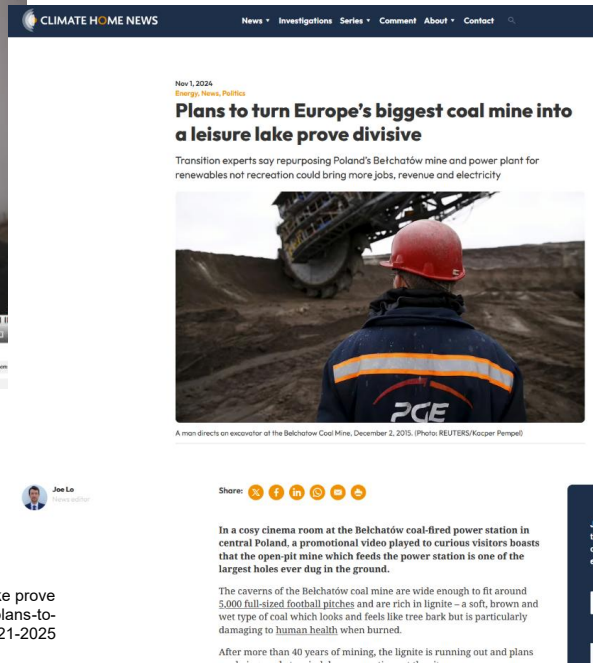




L. Oppelt, T. Wunderlich, A. Klein, F. Raithel, T. Grab, T. Fieback

Mines only cause problems?

Sky News (17.08.2020) After 200 years, this coal mine is closing - and it's England's last one [Video]. YouTube:, https://www.youtube.com/watch?v=aWKcTnnyMWY, accessed 05-21-2025



Lo, Joe (01.11.2024) Plans to turn Europe's biggest coal mine into a leisure lake prove divisive. Climare Home News, https://www.climatechangenews.com/2024/11/01/plans-to-turn-europes-biggest-coal-mine-into-a-leisure-lake-prove-divisive/, accessed 05-21-2025

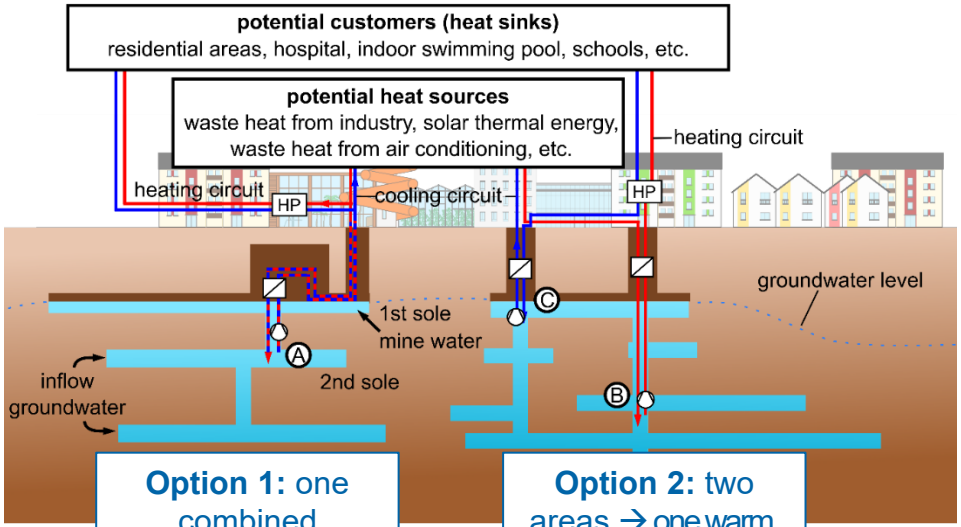
Post-mining areas

- High costs for remediation
- Partly perpetual tasks (dewatering)
- Acceptance, loss of jobs
- Environmental impacts

Is there really no benefit to be derived from this?

Mine water heat storage

Yes, there is an opportunity



Option 1: one combined reservoir (Freiberg test storage)

Option 2: two areas → one warm, one cold (Bochum test storage)

- Abandoned mines are often flooded
  - Possible energy source for heating and cooling
  - Possible option for heat and cold storage
- Research questions:
  - What is the efficiency of such storage units?
  - Do they run efficiently?
  - What kind of heat can we store?
  - Which mines are suitable for this?

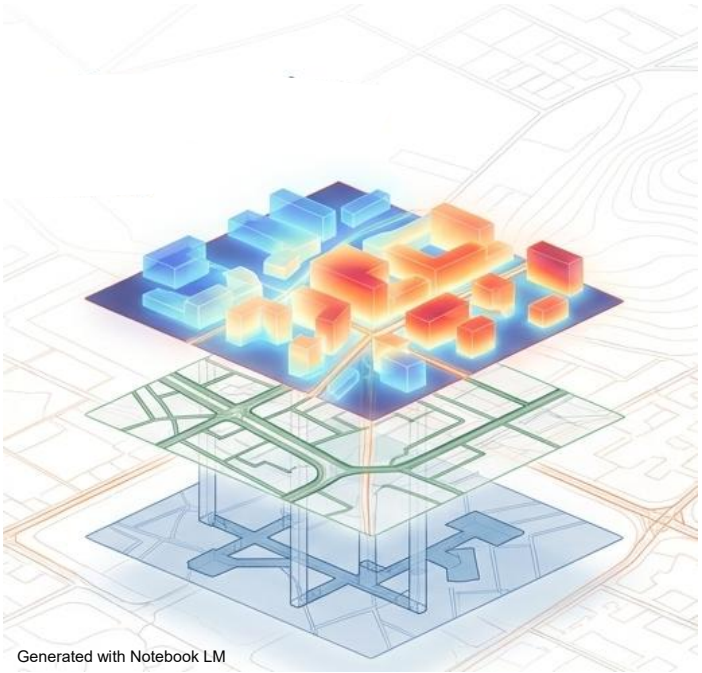
→ Two test sites in Germany (Bochum and Freiberg)

Mine water heat storage

- **Technical Performance & Efficiency:**
  - Thermal storage efficiency of approximately 50%
  - Fouling on heat exchanger surfaces can be reduced by up to 80% through the selection of optimized materials
  - The conditions inside the mine place high demands on the technology used

- **Economic Impact & Planning Tools:**
  - The project established a standardized criteria catalog
  - Sites can operate cost-effectively with mine water heat storage systems

⇨ **Mine water heat storage systems could be a solution for urban areas**



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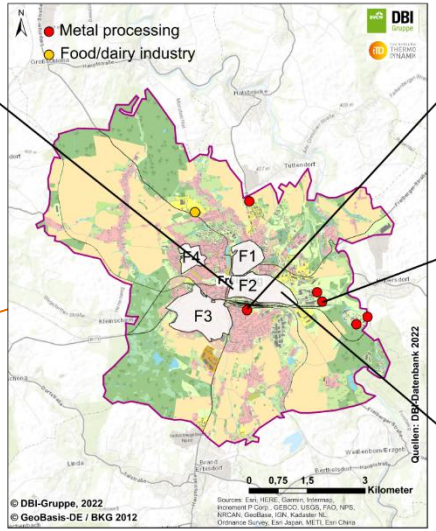
Example-District Freiberg

Quarter F2
Consumption data
Heat demand: 47,000 MWh
Housholds: 992
Network length: 13,300 m



Industrial waste heat potential (I1)
Annual waste heat potential: 3,750 MWh

Industrial waste heat potential (I2)
Annual waste heat potential: 39,580 MWh

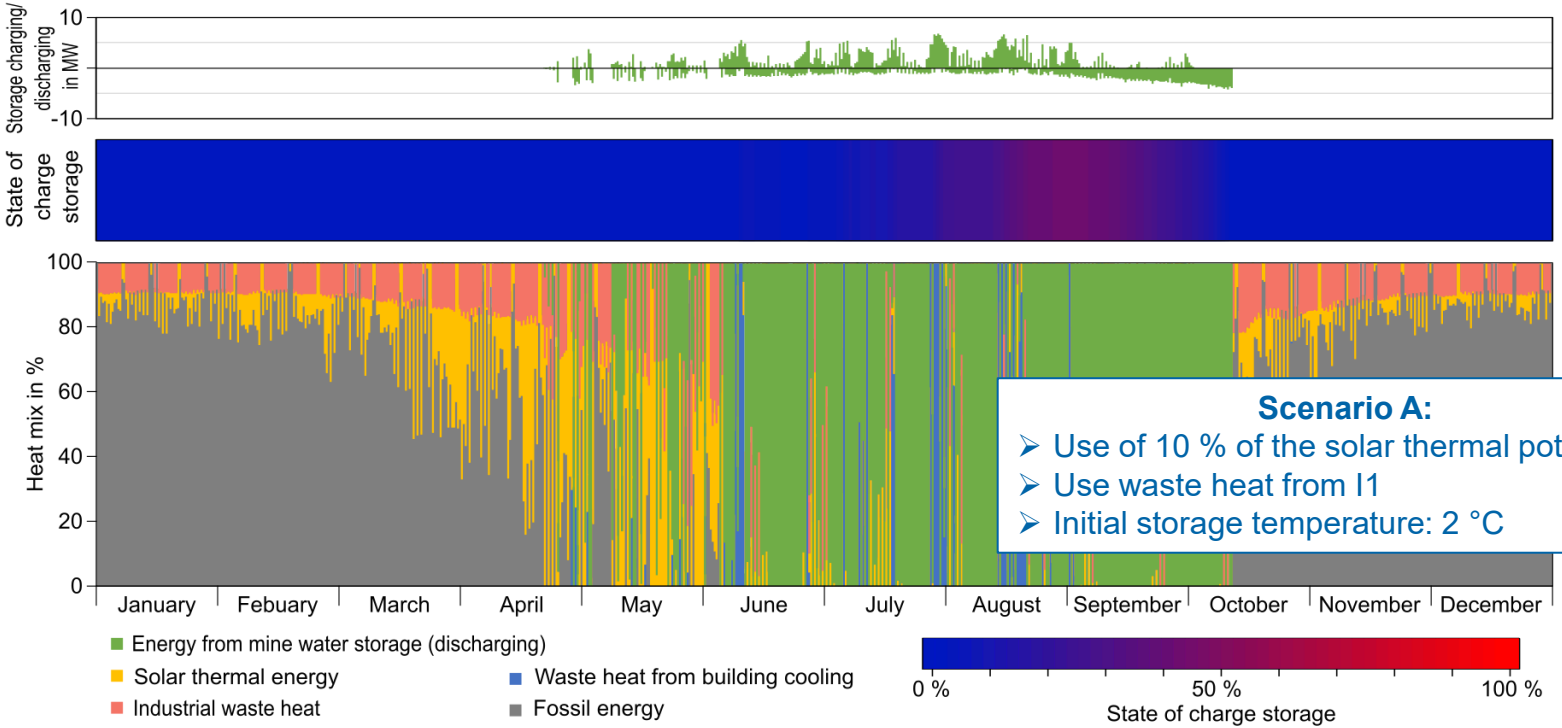
Quarter F2 Potential
Solar thermal: 47,600 MWh
Building cooling: 4,190 MWh

- In mathematical terms, more energy is generated in the district than is consumed
- However: potential and demand do not exist simultaneously

⇨ **Storage is necessary**

Example-District Freiberg – Scenario A

Published in:
Oppelt, L., Raithel, F., Wunderlich, T. *et al.* Mine water as seasonal heat storage in urban regions—a case study for Freiberg (Germany). *Grundwasser - Zeitschrift der Fachsektion Hydrogeologie* 31, 101–110 (2026). https://doi.org/10.1007/s00767-025-00601-3



Scenario A:
- Use of 10 % of the solar thermal potential
- Use waste heat from I1
- Initial storage temperature: 2 °C

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Example-District Freiberg – Scenario A

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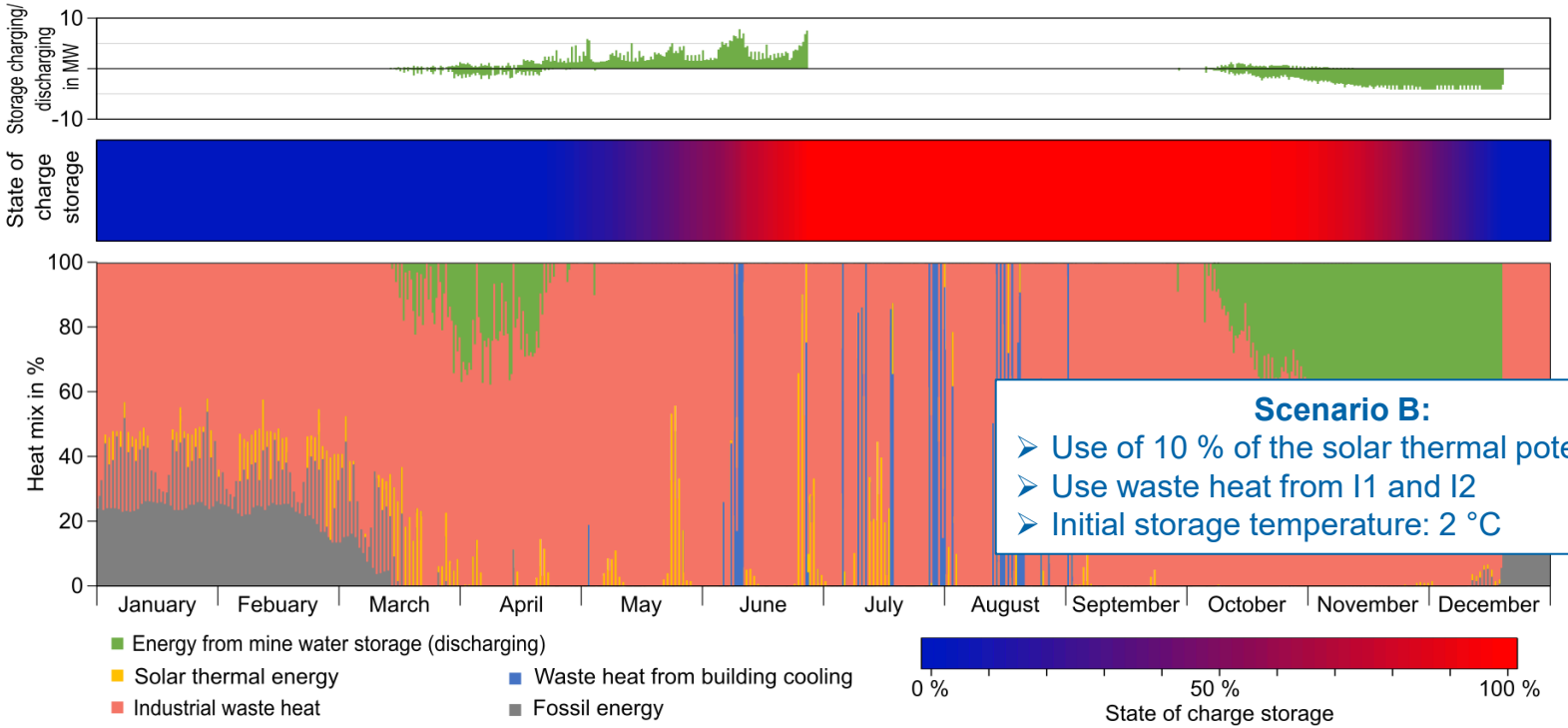
Oppelt, L., Raithel, F., Wunderlich, T. *et al.* Mine water as seasonal heat storage in urban regions—a case study for Freiberg (Germany). *Grundwasser - Zeitschrift der Fachsektion Hydrogeologie* 31, 101–110 (2026). https://doi.org/10.1007/s00767-025-00601-3



Scenario B:
- Use of 10 % of the solar thermal potential
- Use waste heat from I1 and I2
- Initial storage temperature: 2 °C

Example-District Freiberg

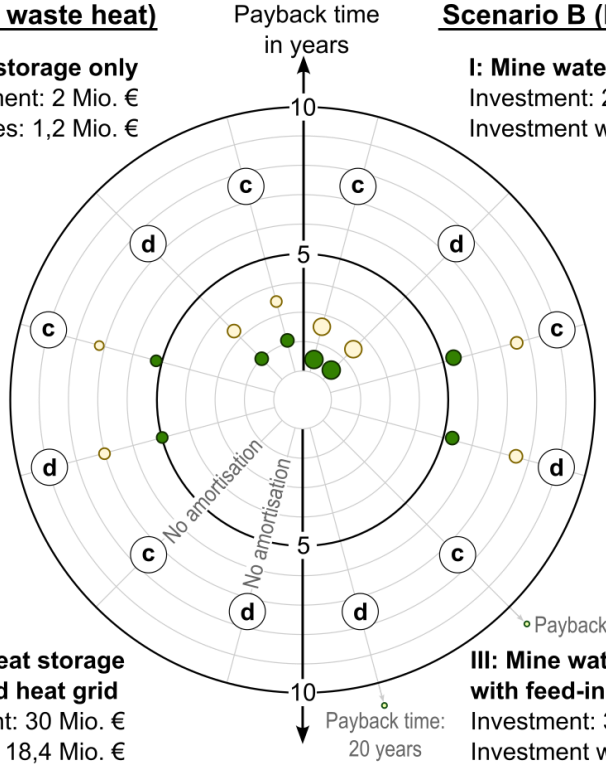
Published in:
Oppelt, L., Raithel, F., Wunderlich, T. *et al.* Mine water as seasonal heat storage in urban regions—a case study for Freiberg (Germany). *Grundwasser - Zeitschrift der Fachsektion Hydrogeologie* 31, 101–110 (2026). https://doi.org/10.1007/s00767-025-00601-3

Scenario A (low industrial waste heat)

I: Mine water heat storage only
Investment: 2 Mio. €
Investment with subsidies: 1,2 Mio. €

II: Mine water heat storage with feed-in sources
Investment: 4,3 Mio. €
Investment with subsidies: 3,1 Mio. €

III: Mine water heat storage with feed-in sources and heat grid
Investment: 30 Mio. €
Investment with subsidies: 18,4 Mio. €



Scenario B (high industrial waste heat)

I: Mine water heat storage only
Investment: 2 Mio. €
Investment with subsidies: 1,2 Mio. €

II: Mine water heat storage with feed-in sources
Investment: 6,1 Mio. €
Investment with subsidies: 4,1 Mio. €

III: Mine water heat storage with feed-in sources and heat grid
Investment: 32 Mio. €
Investment with subsidies: 19,6 Mio. €

Net present value
<10 Mio.€
10 Mio.€
20 Mio.€
without funding
with funding
Heating network
c Central network
d Decentral network

Assumptions
Electricity price: 0,32 €
Electricity price (heat pump): 0,25 €
Natural gas price: 0,17 €
Discount rate: 2,75 %
Price changes per year
Deposit/consumption-related costs: 6,27 %
Operating-related costs: 2,53 %
Maintenance costs: 7,04 %

Summary and Outlook

1. Under what conditions is a flooded mine suitable for use as a reservoir? How did it work in practice?
   - Initial small-scale trials successful
   - Validation of a simulation model for heat storage
2. How can I use and monitor the storage effectively?
   - The characteristics of mine water and flow patterns have a significant impact on efficiency
   - Further tests are currently being conducted using active cooling and higher storage temperatures
   - Deposits in the heat exchanger can be predicted
   - The most suitable material can be identified using the evaluation method developed
3. What heat sources are available for storage above ground?
   - Integrating storage systems makes sense from a technical perspective
     → currently under consideration from an environmental and economic perspective
   - Further heat sources need to be developed
     → Storing cooling energy from the summer is not sufficient for the winter

More information:
tu-freiberg.de/
en/mine-water

Thank you very much for your Interest!

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