Decarbonization of heat and co-products: Opportunities in the Upper Rhine region

Laura Herrmann
Dr. Thomas Kölbel
EnBW Research & Development
23.10.2024
DGK 2024, Potsdam

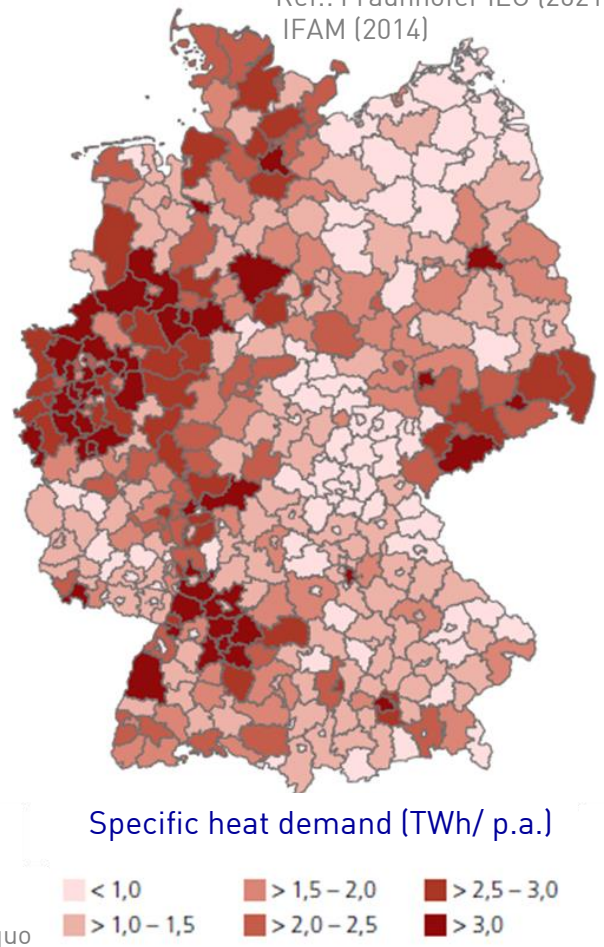
RE Heat from deep geothermal ressources...

Decarbonizing the heat sector

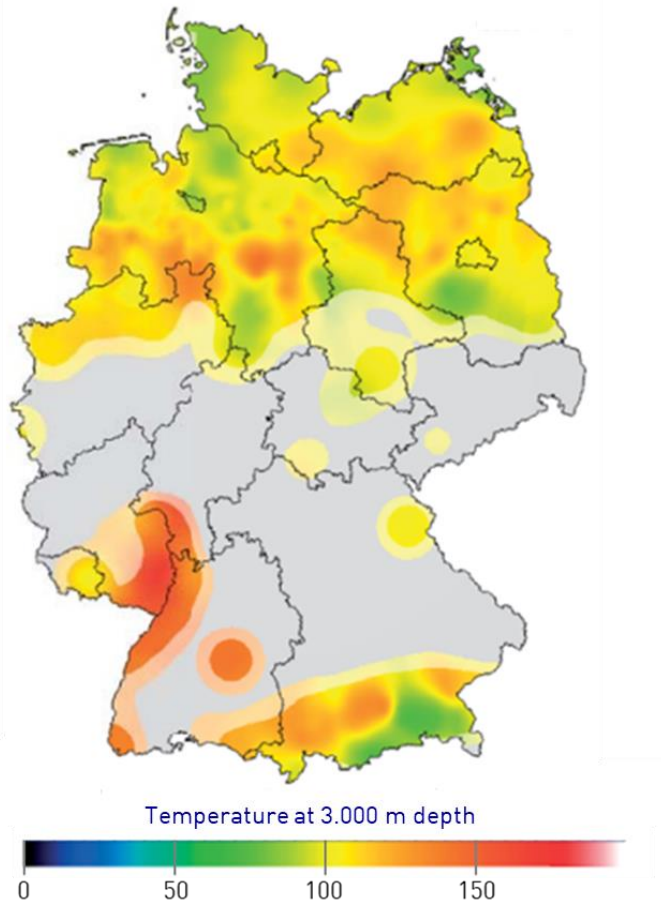
Current Situation

- The political decarbonization targets in the heating sector require the increased use of renewable energies[1)]
- This requires the utilization of domestic resources
- The increased district heating prices are currently significantly higher than the production cost of geothermal heat
- In the medium and long term, district heating prices are expected to rise faster than the production costs for heat from deep geothermal energy[2)]
- By 2045, deep geothermal energy is expected to contribute 138 TWh to the heat supply in Germany[3)]

Ref.: Fraunhofer IEG (2021), IFAM (2014)



Ref.: LIAG (2012)



[1)] BEW = Federal funding for efficient heating networks
[2)] UBA, 2020: OPEX comparatively little affected due to high efficiencies (COP 20 to 40)
[3)] LIAG on behalf of BMWK, 2022; About a hundredfold increase compared to the status quo

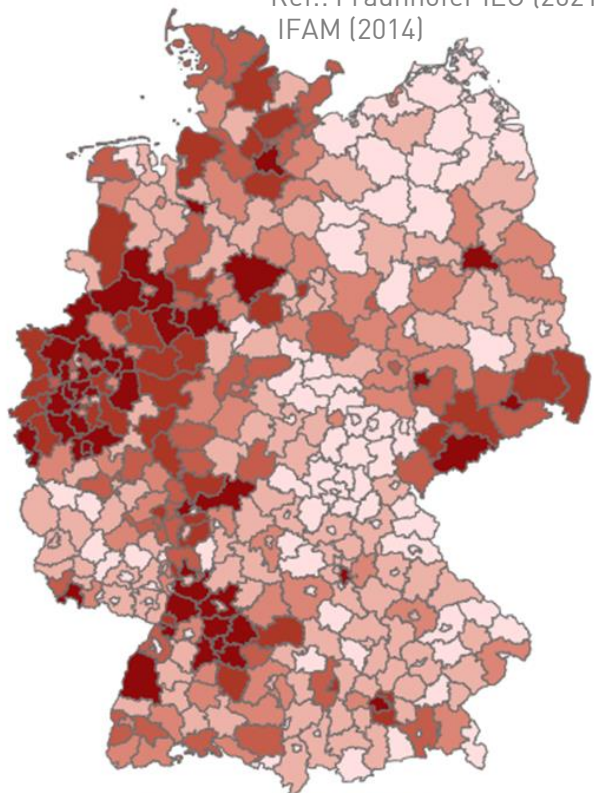
...and lithium as co-product from the same reservoir ?

Supporting e-mobility sector

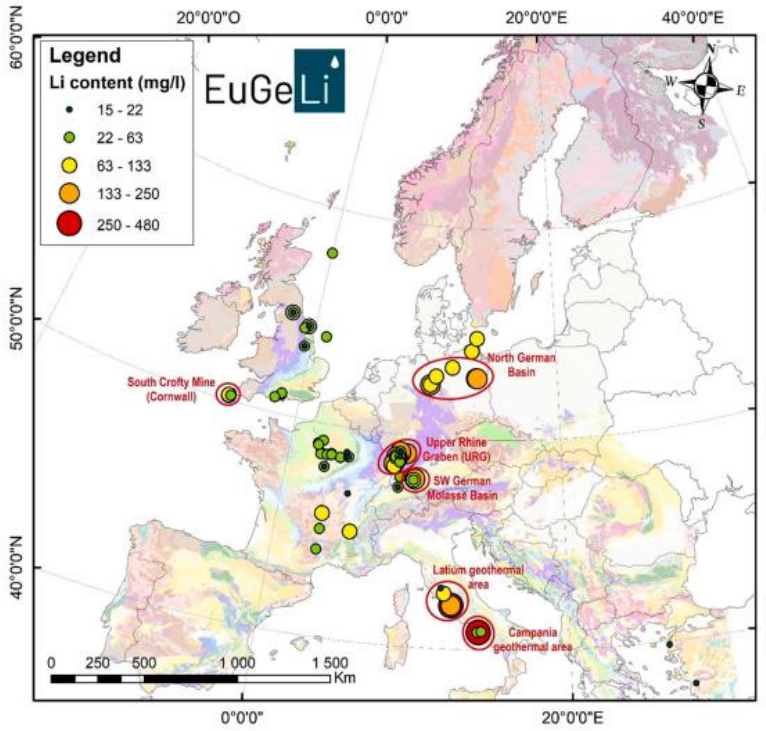
Current Situation

- The political decarbonization targets in the heating sector require the increased use of renewable energies[1)]
- This requires the utilization of domestic resources
- The increased district heating prices are currently significantly higher than the production cost of geothermal heat
- In the medium and long term, district heating prices are expected to rise faster than the production costs for heat from deep geothermal energy[2)]
- By 2045, deep geothermal energy is expected to contribute 138 TWh to the heat supply in Germany[3)]

Ref.: Fraunhofer IEG (2021), IFAM (2014)



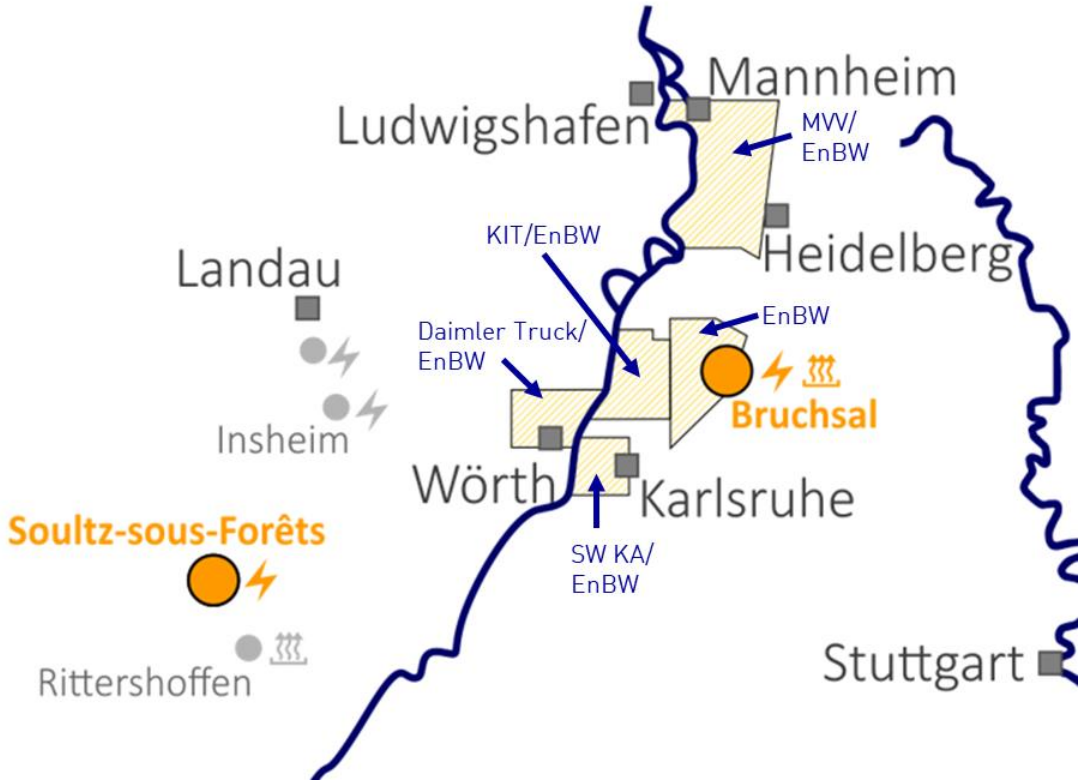
Ref.: Sanjuan (2022)



[1)] BEW = Federal funding for efficient heating networks
[2)] UBA, 2020: OPEX comparatively little affected due to high efficiencies (COP 20 to 40)
[3)] LIAG on behalf of BMWK, 2022; About a hundredfold increase compared to the status quo

Geothermal licenses of EnBW w/ or w/o partners

Exploration licenses under mining law and operating licenses

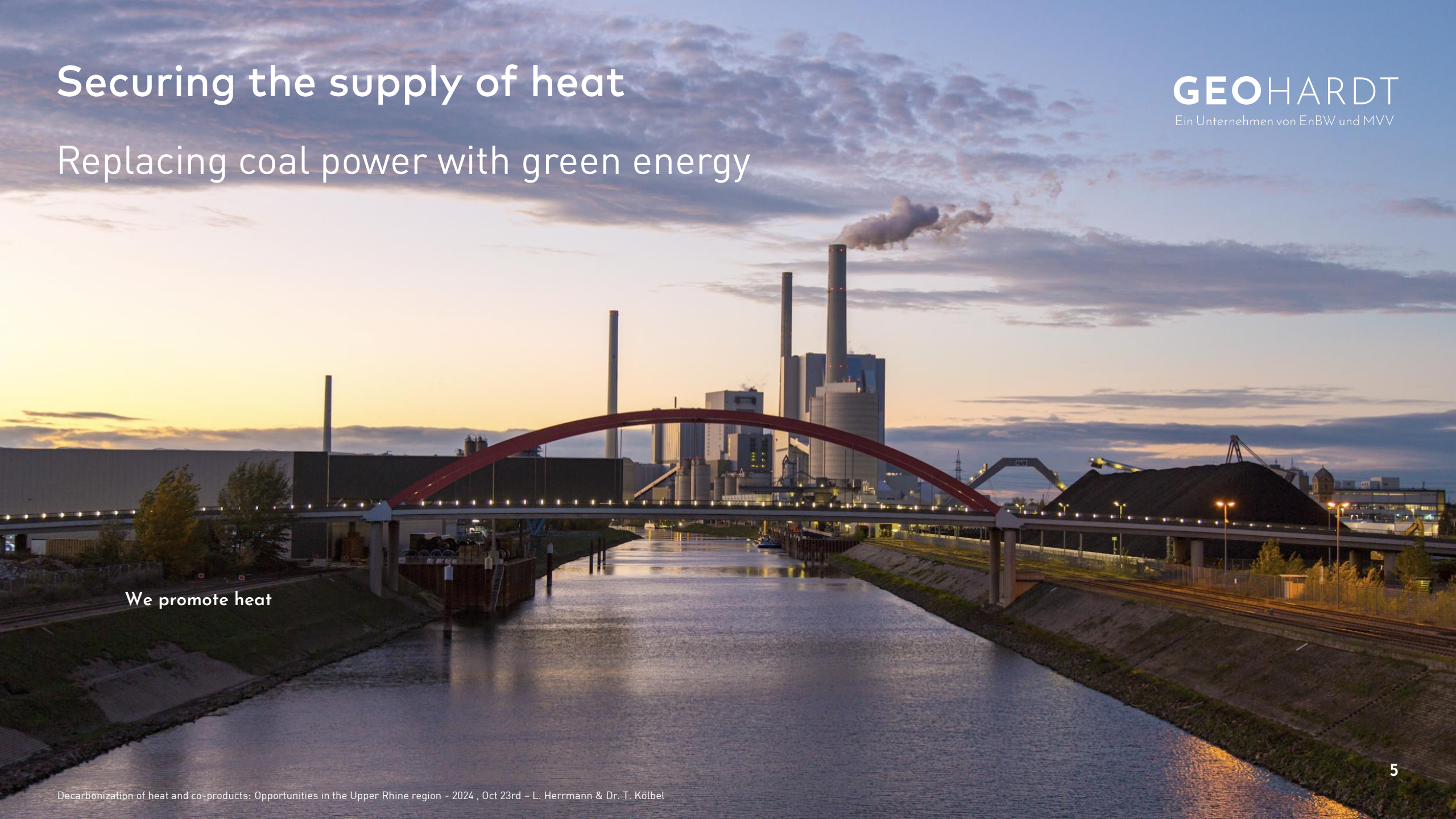


- **Rhine-Neckar/Hardt**: Replacement of heat supplies from the coal fired power plant in Mannheim together with MVV Energie AG
- **Bruchsal**: Expansion of the Bruchsal geothermal plant together with Stadtwerke Bruchsal
- **KIT Campus North**: Research project on the construction and operation of geothermal high-temperature storage facilities
- **Wörth/Bertha**: Provision of heat for industrial processes and the heat supply of Daimler Truck and the city of Wörth
- **Karlsruhe Rheinhafen**: Partial replacement of the heat supply from the Rheinhafen coal fired power plant together with the Karlsruhe public utility company
- **Soultz-sous-Forêts**: Generation of electricity, partnership with Électricité des Strasbourg
- Activities of various subsidiaries

Securing the supply of heat

Replacing coal power with green energy

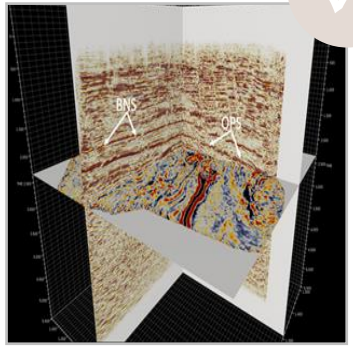
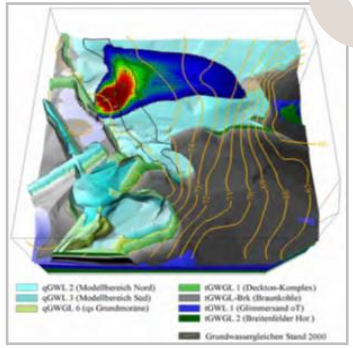
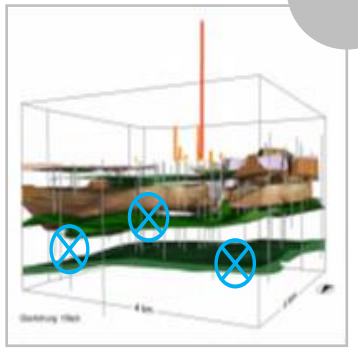
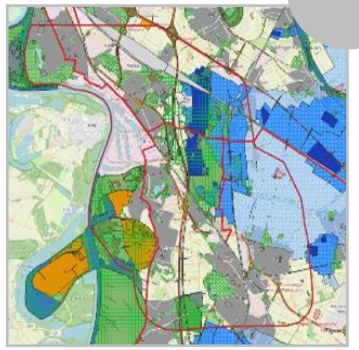
GEOHARDT
Ein Unternehmen von EnBW und MVV



Data preparation and interpretation

GEOHARDT
Ein Unternehmen von EnBW und MVV

What we are currently working on and what happens next

Execution 3D-Seismic	Data preparation	Data interpretation	Identification drill targets	Location options
✓	✓	✓	~	~
				
completed	completed	completed	on-going	

Process of dialogue

The project has been approved and launched.

The associated partners in DEKAPALATIN:

Gefördert durch:

Bundesministerium für Wirtschaft und Klimaschutz

aufgrund eines Beschlusses des Deutschen Bundestages

wärmewerk wörth.

DAIMLER TRUCK

ptj Projektträger Jülich Forschungszentrum Jülich

IGEM Institut für geothermisches Ressourcenmanagement

IAG Leibniz-Institut für Angewandte Geophysik

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN IN PUBLICA COMMODA SEIT 1737

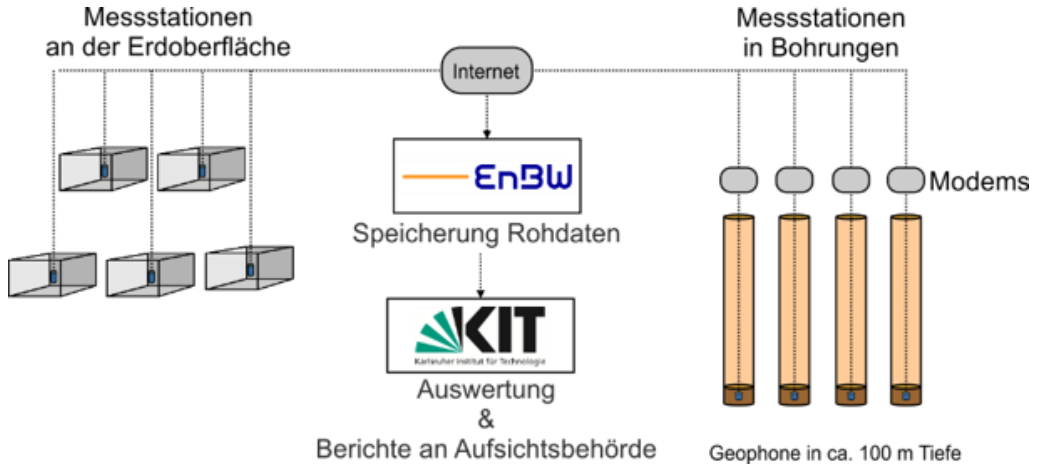
TECHNISCHE UNIVERSITÄT DARMSTADT

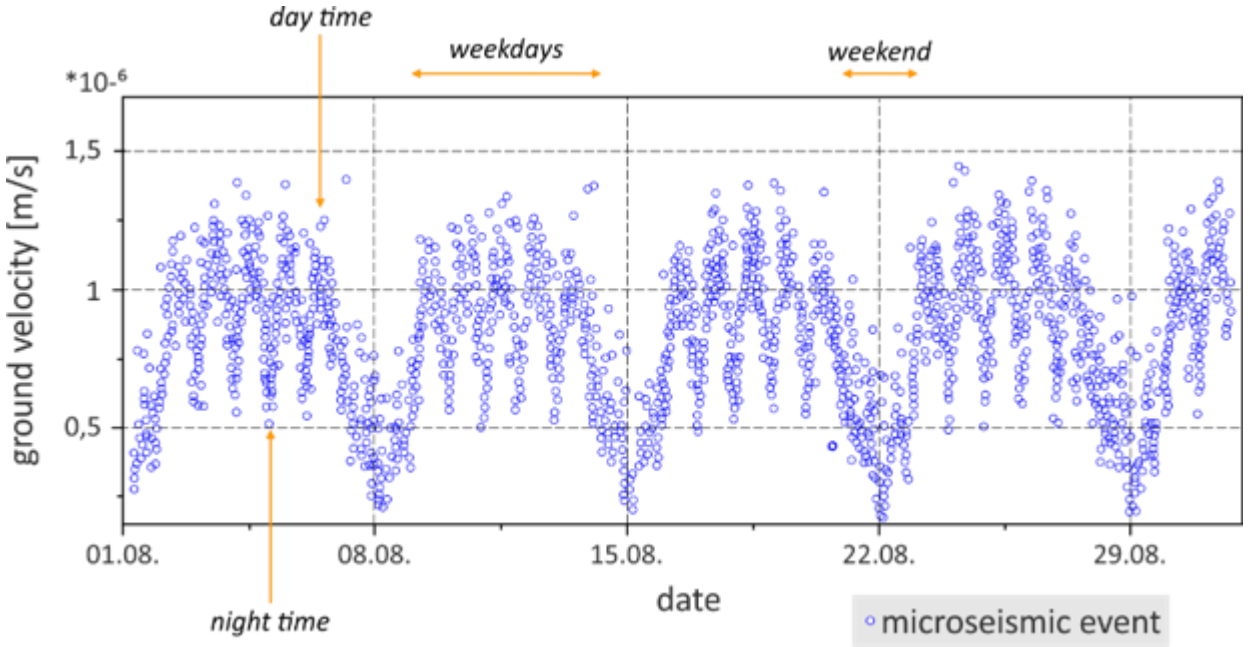
Challenges - ambitious timeline

2023	2023	2023 – 2025	2026 – 2027	2028
Create conditions	Foundation Joint Venture	Site search	Tapping geo-thermal heat	Heating plant and grid
Studies Granting of license LOI suscription	Agreement of all parties Joint Venture „WärmeWerkWörth“ Funding application	Gephysical pre-studies 3D Seismic Site determination	Drilling permit Drilling and testing well 1 Drilling and testing well 2 Circulation test	Design, construction and commissioning heat plant Optimization heat plant Commercial heat supply

Bruchsal Geothermal Plant – 15 years of operation

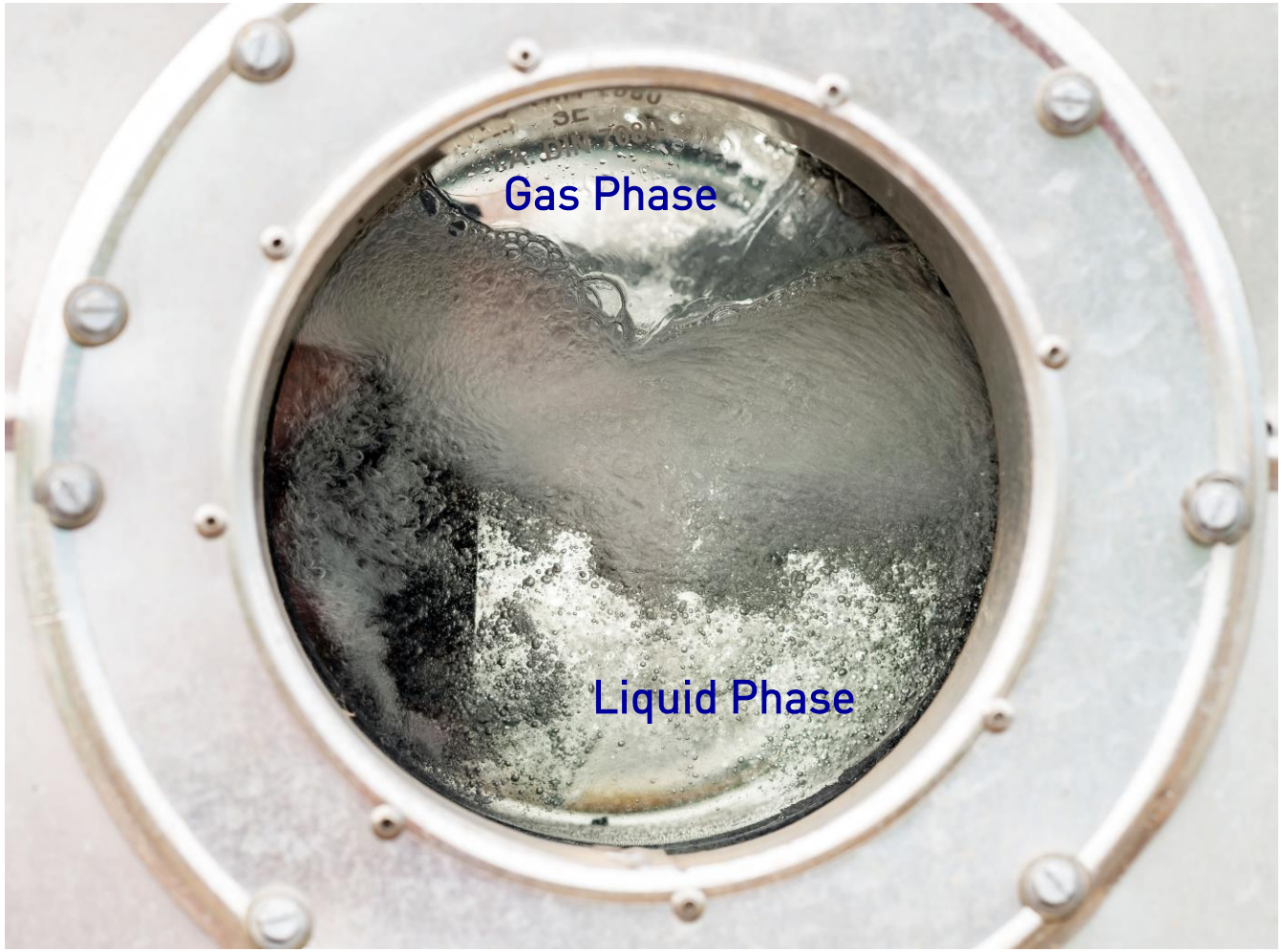
Expansion to 55 l/s in 2025, additional wells under development

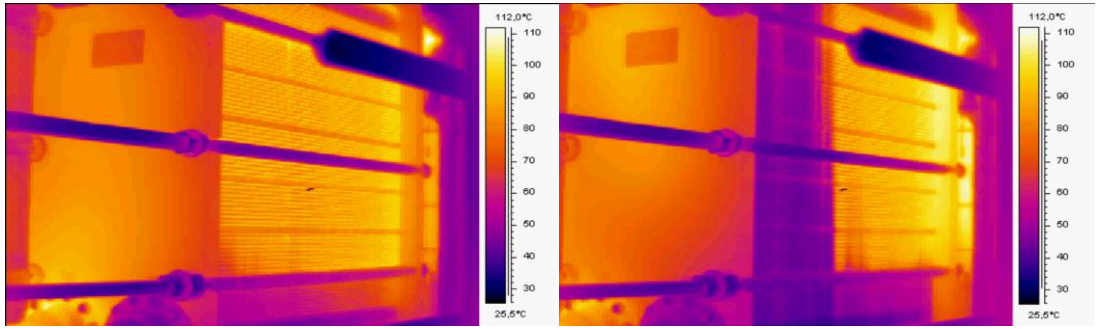


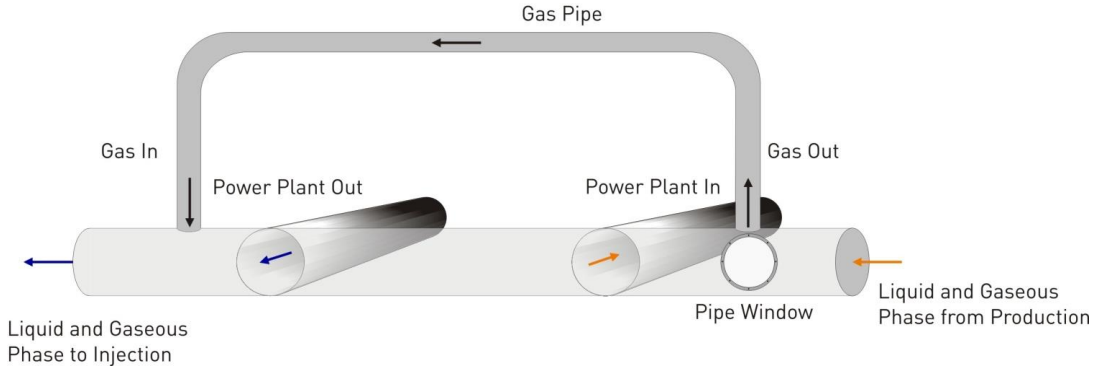


Brine Composition at Bruchsal

Gas phase: 2,2 L CO_2 per kg geothermal brine (norm conditions)

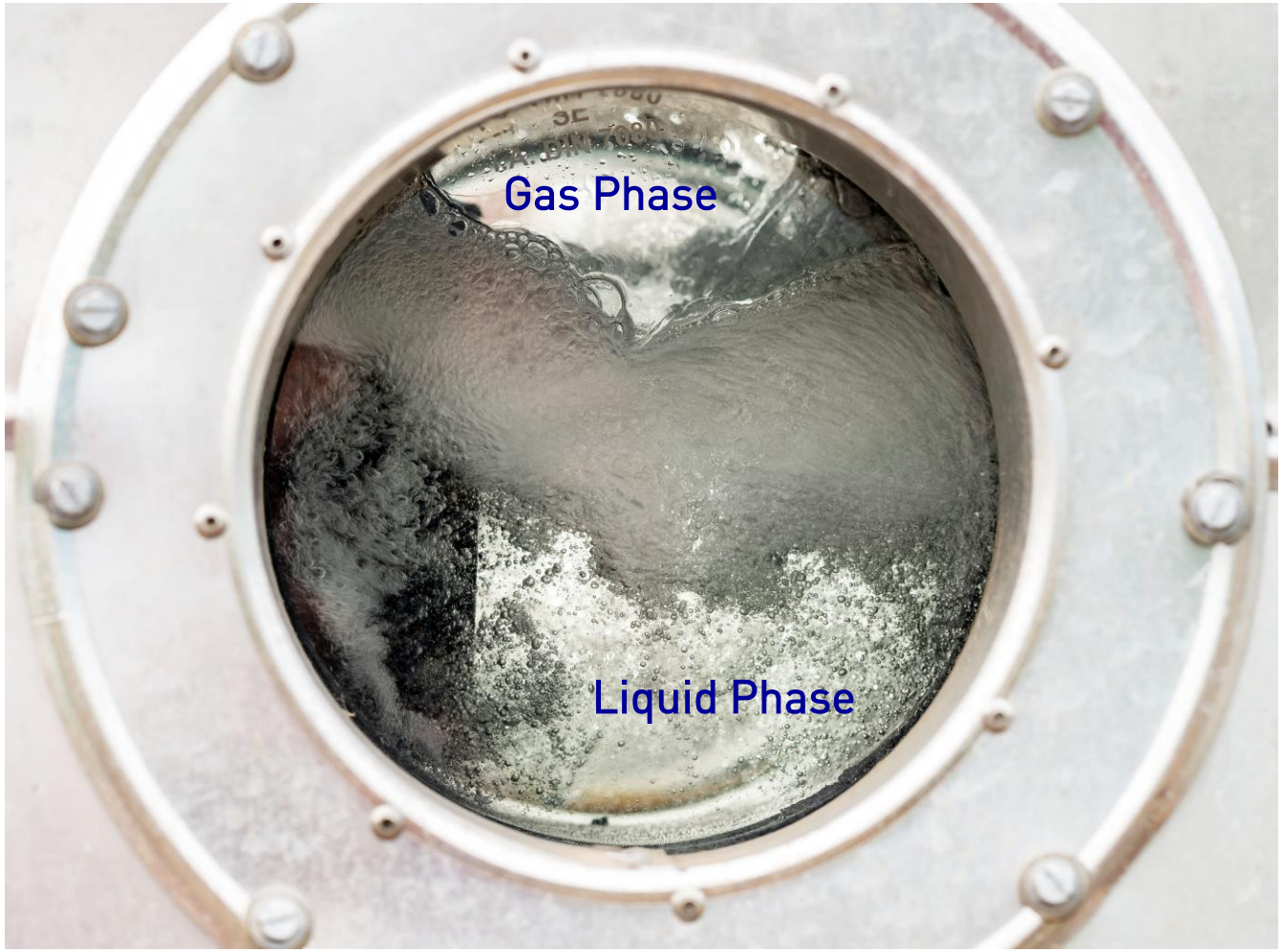


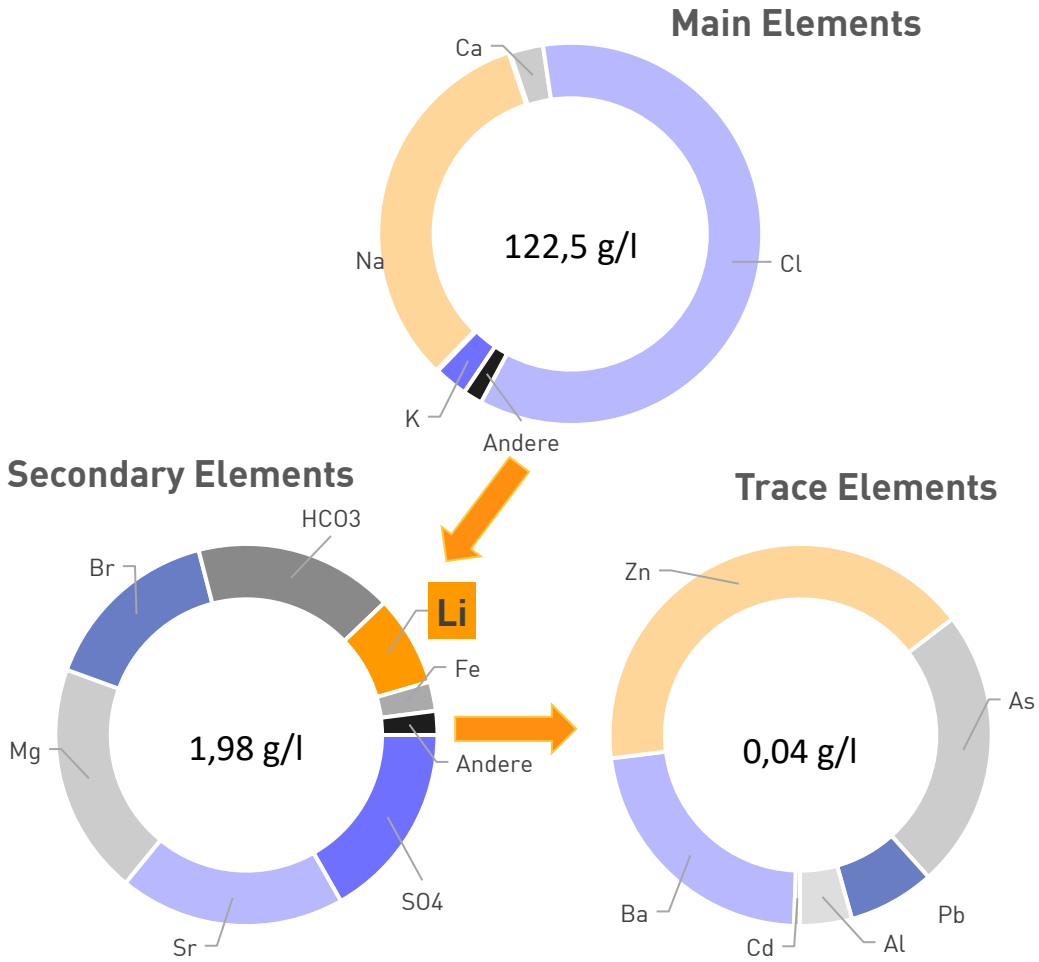




Brine Composition at Bruchsal

Liquid phase: Half as salty as the water of the Dead Sea

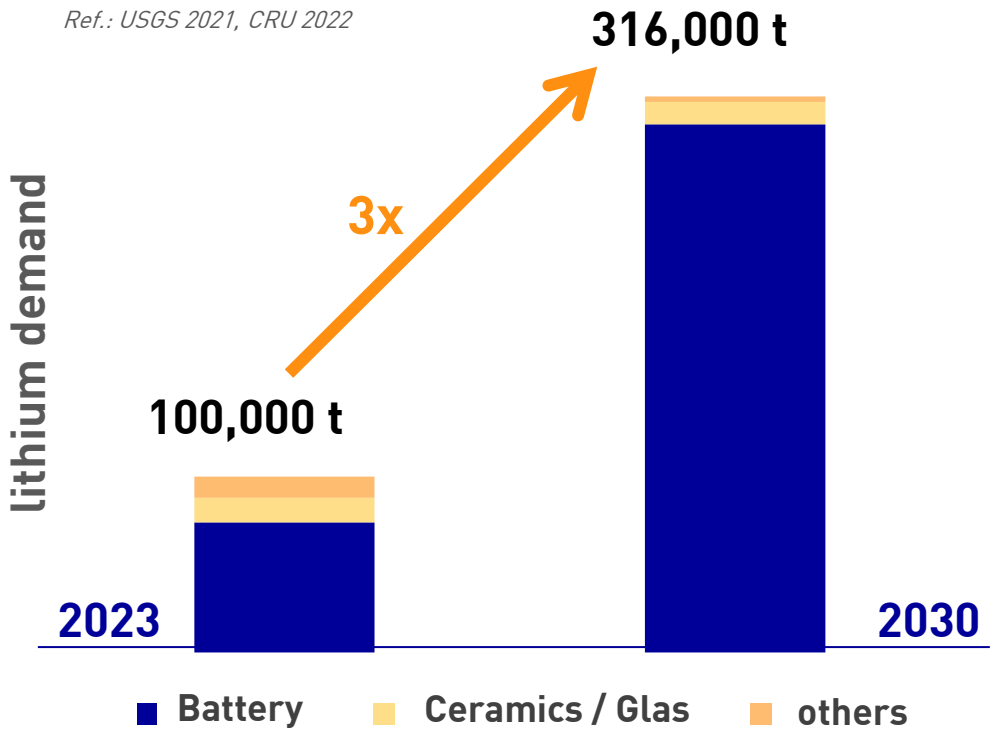




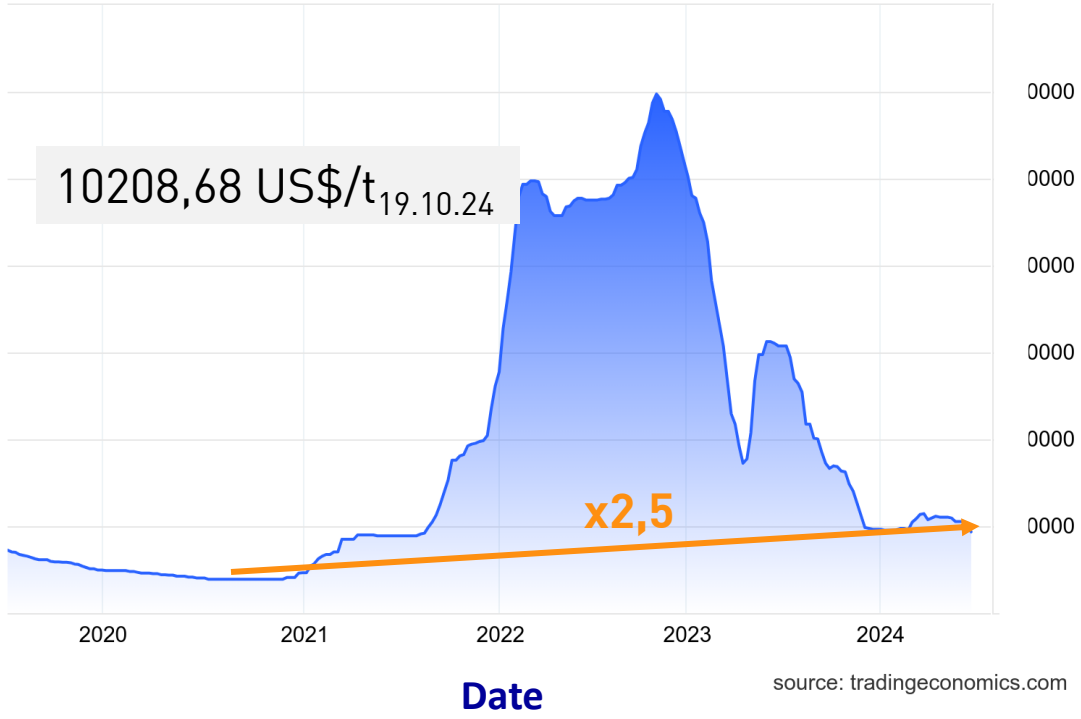
Lithium as co-product

Demand and price development

Development of lithium demand



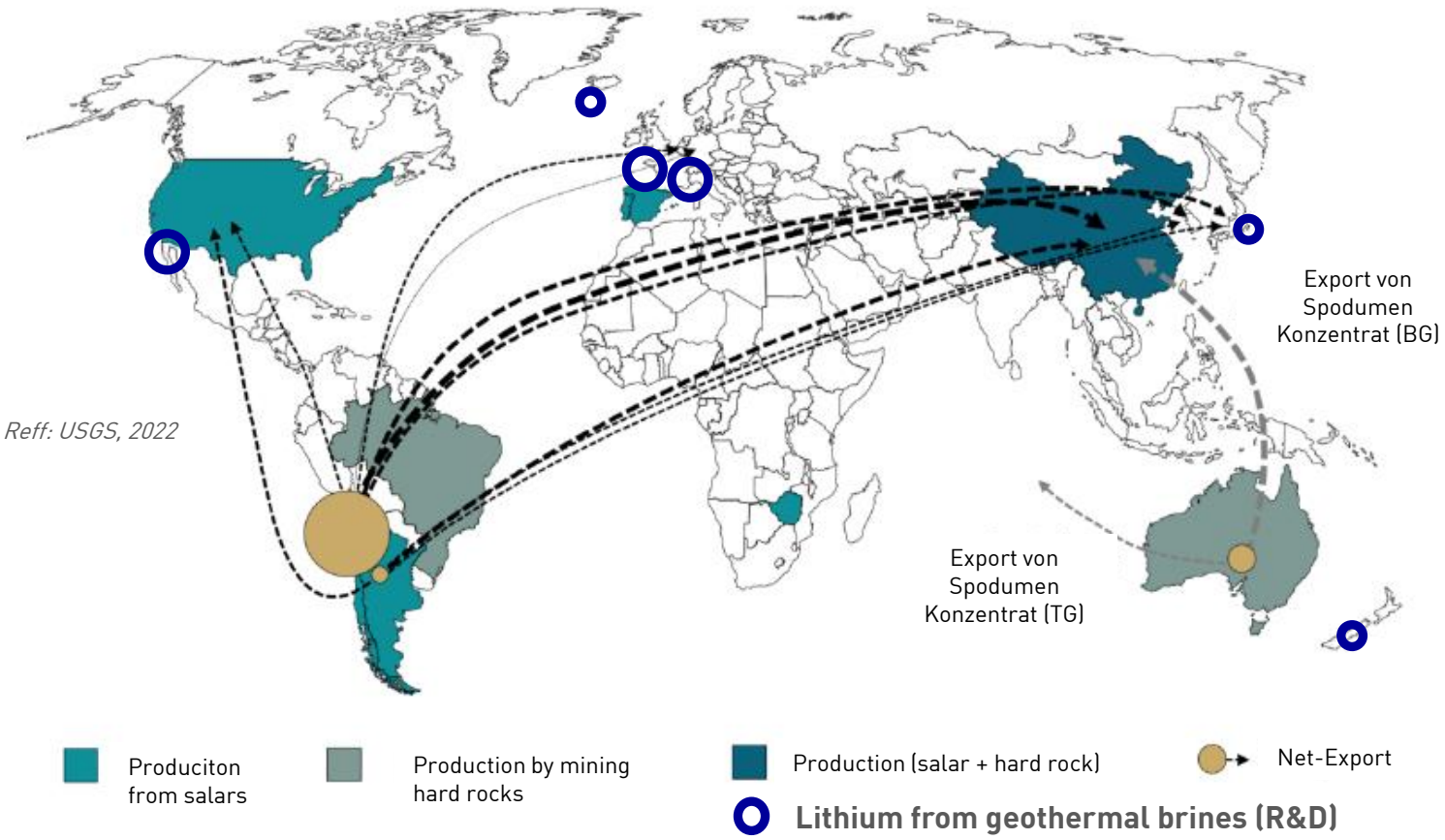
Price development of Li_2CO_3 (LCE)



Lithium production and conversion worldwide

Conventional resources

Important international trade routes (2021)
net-export of lithium (LCE)



Reff: USGS, 2022

	2014		2021
AUS	13 kt	+323%	55 kt
CHN	5 kt	+180%	14 kt
CHL	12.9 kt	+102%	26 kt
ARG	2.9 kt	+114%	6.2 kt

Lithium – EnBW's activities

Recent r&d projects

LiCovery

Direct Lithium Extraction (DLE)

Power & Heat Plant | Lithium Adsorption & Desorption

Hot geothermal brine

Cold geothermal brine

Li enriched solution

Lithium Production

Purification | Conversion | Battery Grade Lithium

Lithium Carbonate Li_2CO_3

or

Lithium Hydroxide $LiOH \cdot H_2O$

Production Well

Injection Well

UnLimited

Supported by: Federal Ministry for Economic Affairs and Energy

on the basis of a decision by the German Bundestag

LiCORNE

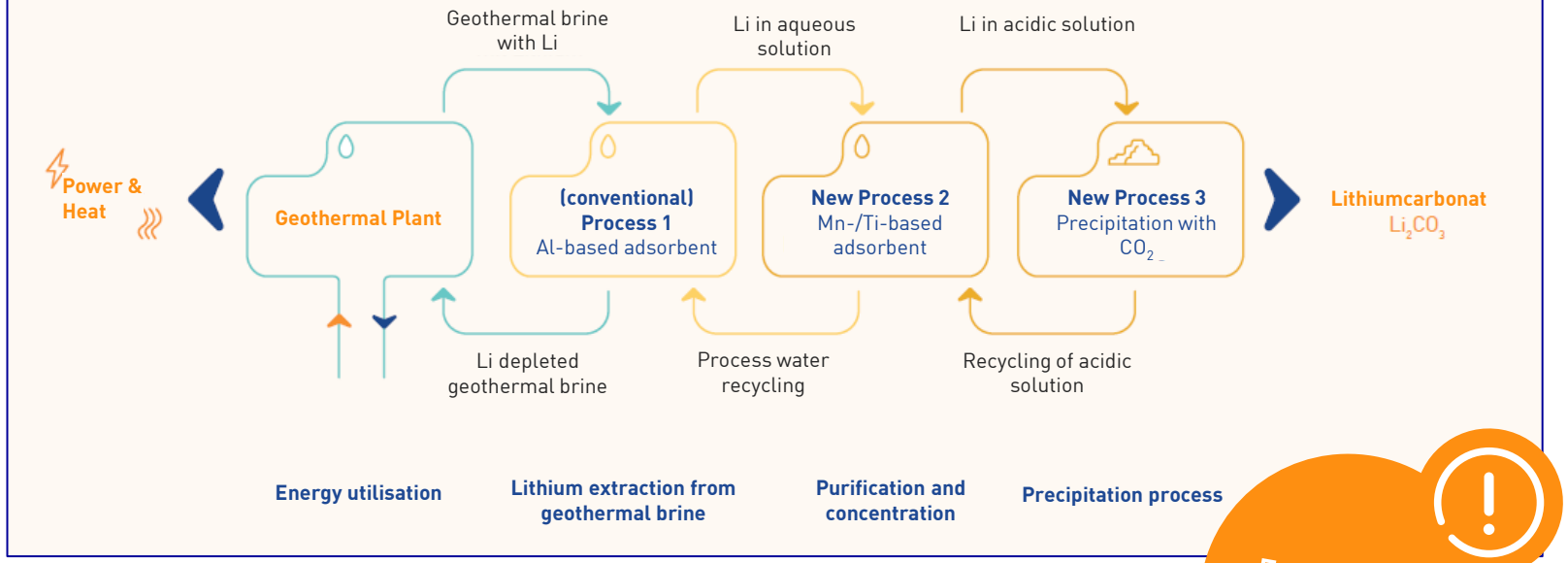
Funded by the European Union

Recent Project Results

New process scheme developed, battery grade lithium produced

- 3rd generation prototype

Less water consumption | **Reduced use of chemicals** | **Lower transport costs** | **Very good product purity** | **CO_2 consuming**

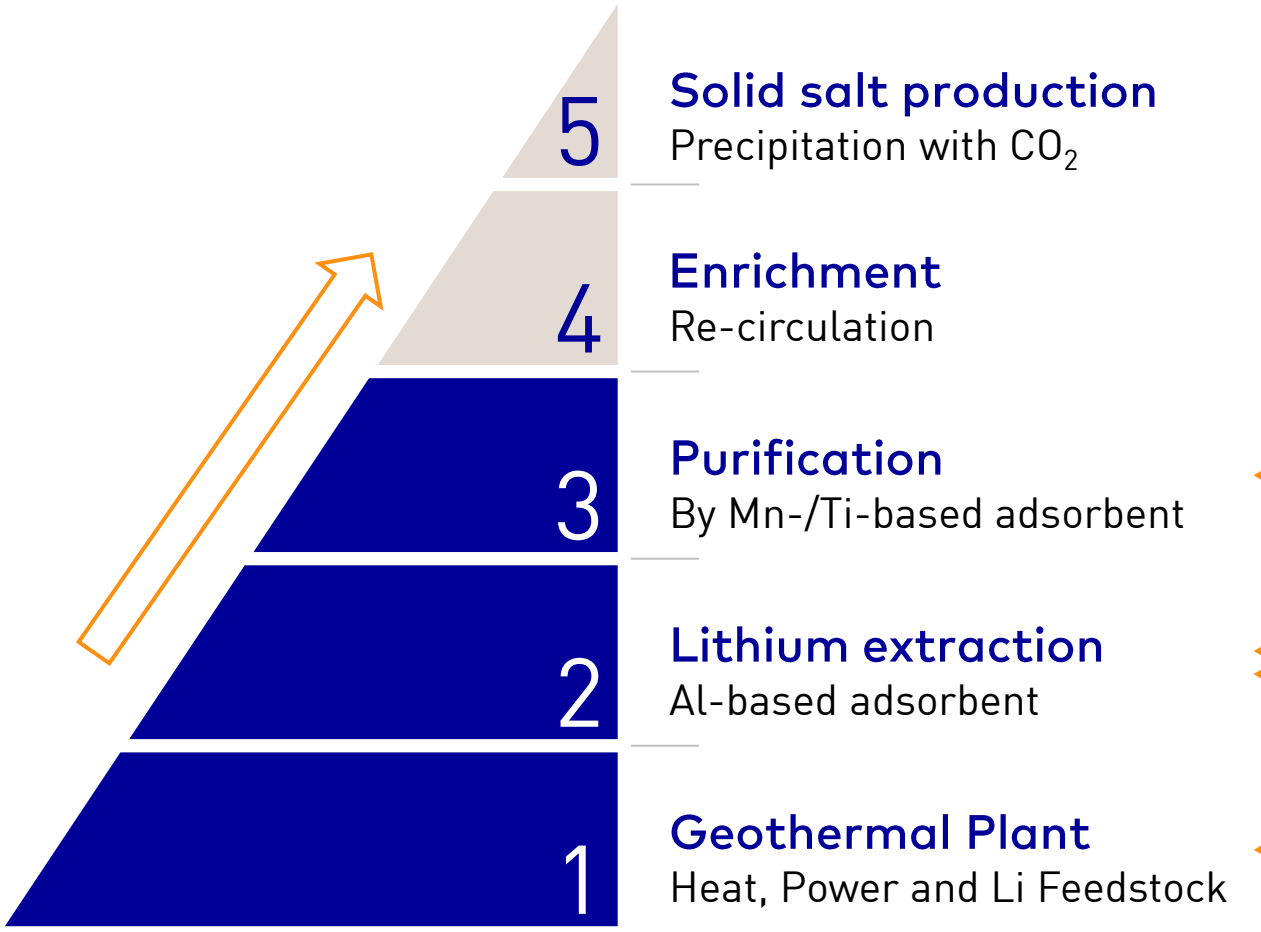


EnBW Patent Nr. 102023118 084.3

- Emission-free process set up and successfully tested
- Sustainability of the resource proven with measurements
- "Bruchsal lithium" produced with >99.54 % purity
- Life cycle assessment and determination of production costs in progress

CASCADE-Process

Lithium recovery rates



Solid salt production
Precipitation with CO_2

Enrichment
Re-circulation

Purification
By Mn-/Ti-based adsorbent

Lithium extraction
Al-based adsorbent

Geothermal Plant
Heat, Power and Li Feedstock

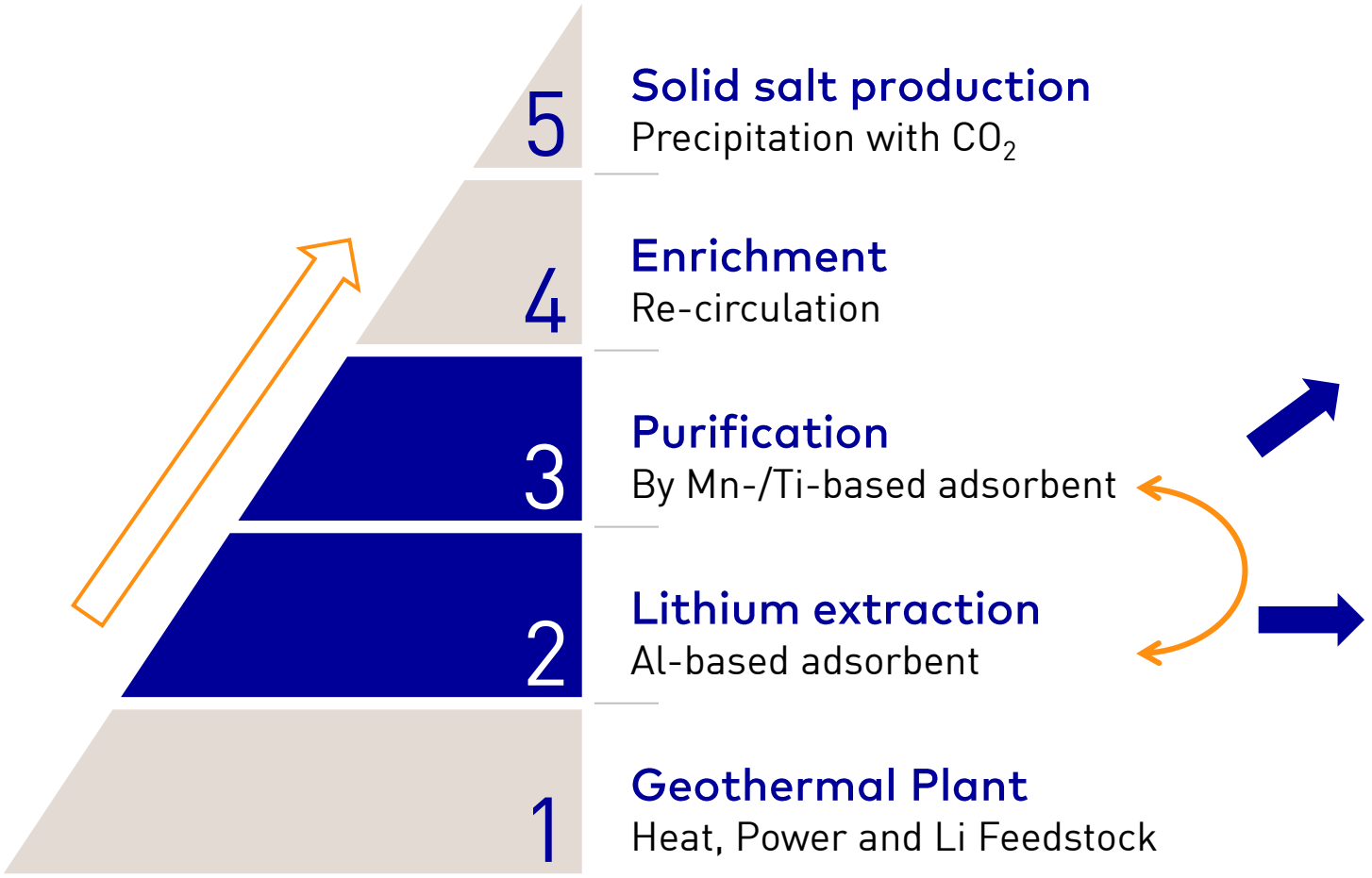
98,5 % Li recovery

79 % Li recovery

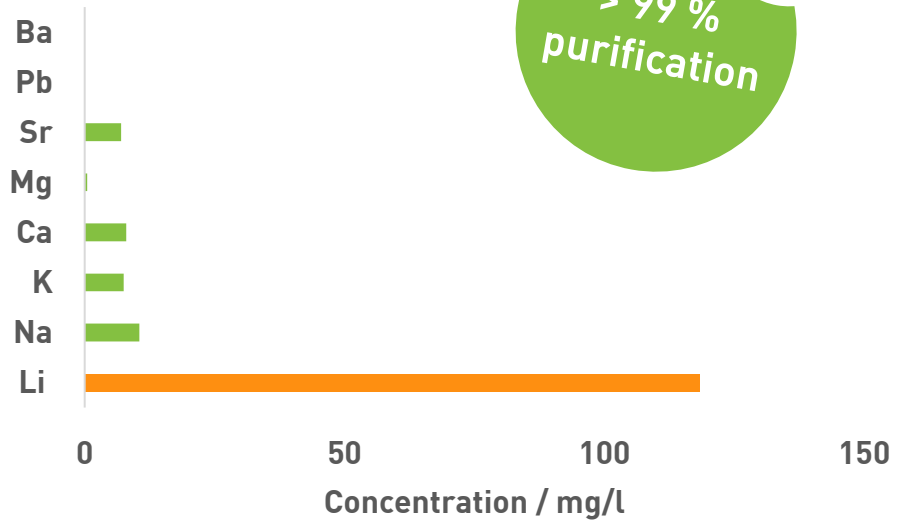
78 % Li recovery

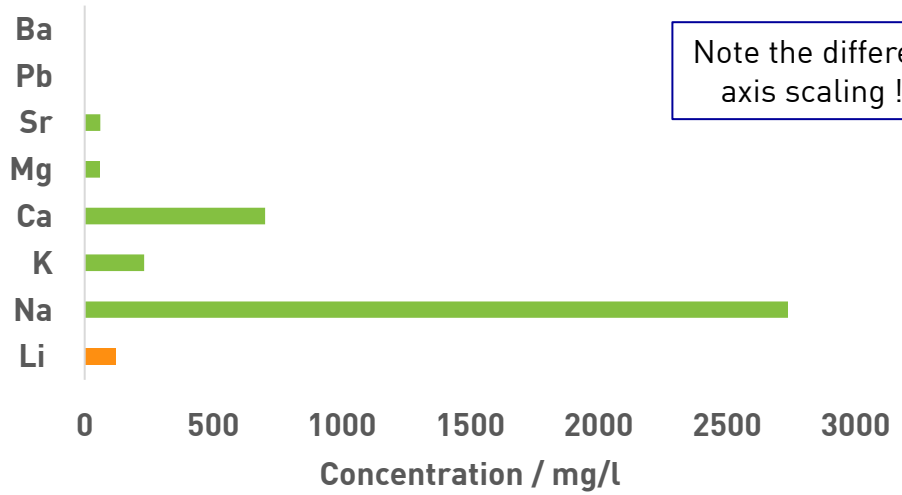
CASCADE-Prozess

Efficient purification with Mn-/Ti-based adsorbent



> 99 % purification

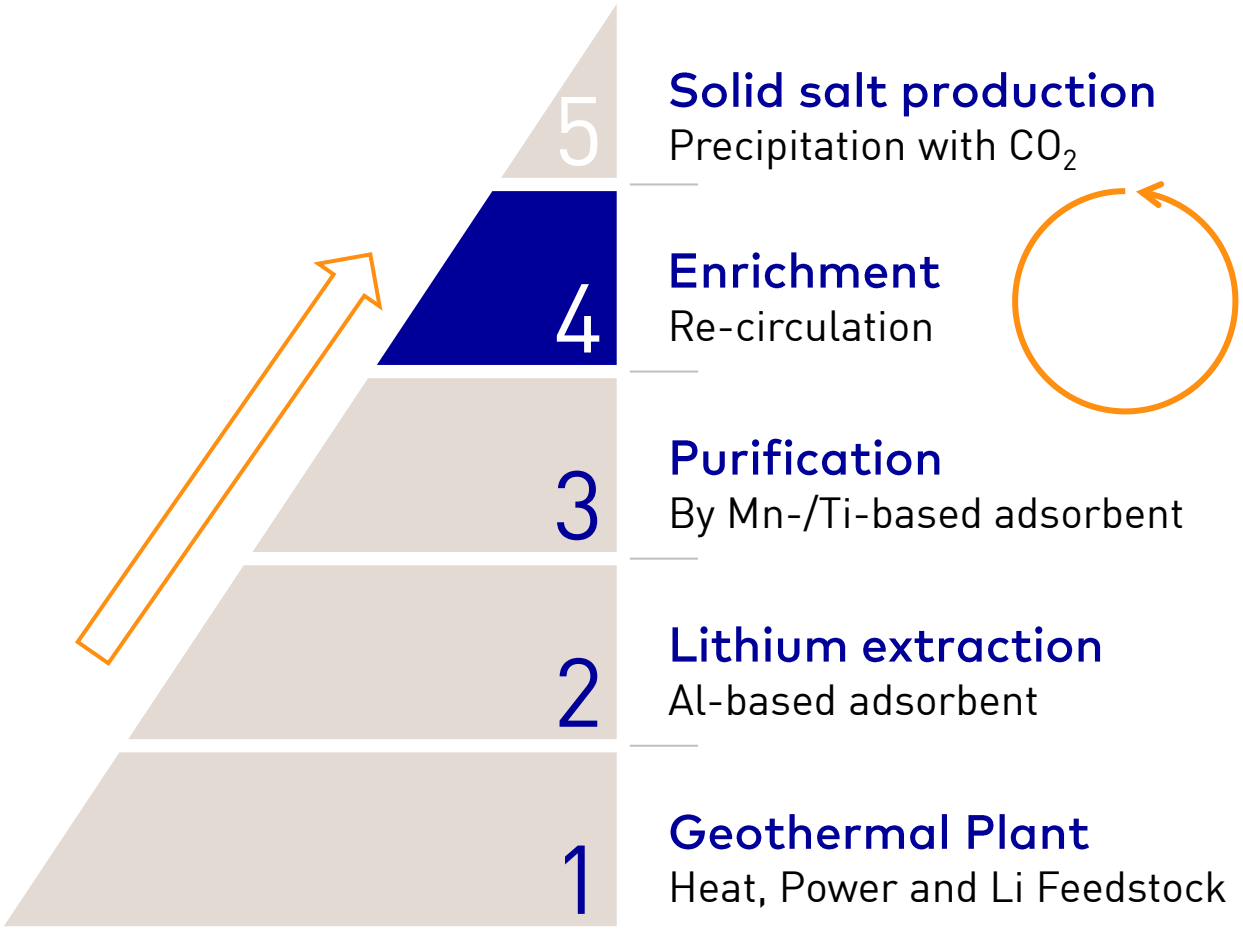




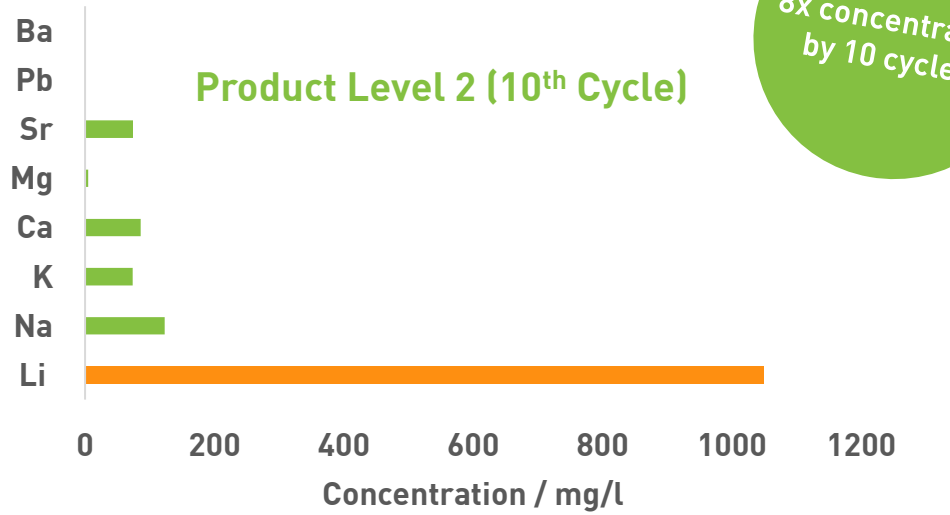
Note the different axis scaling !!

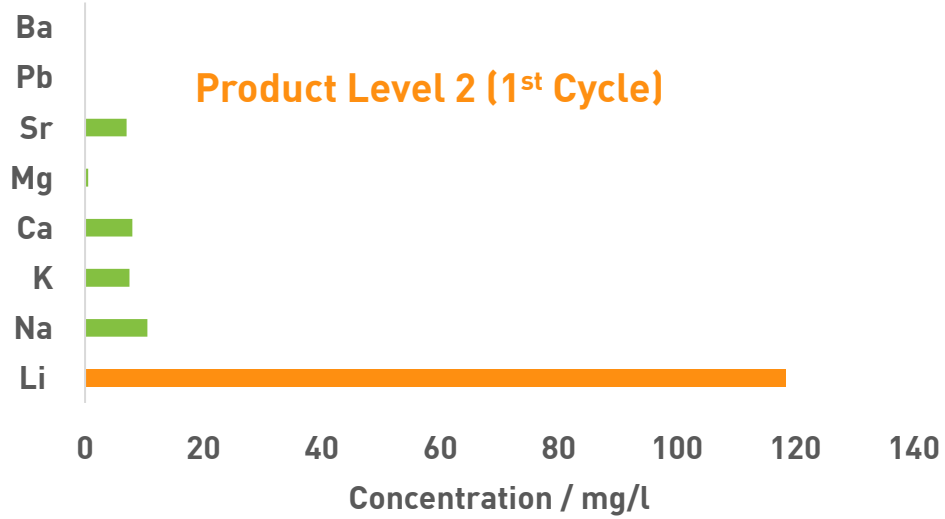
CASCADE-Prozess

Enrichment by re-circulation



8x concentration by 10 cycles





Many Thanks !

Author:

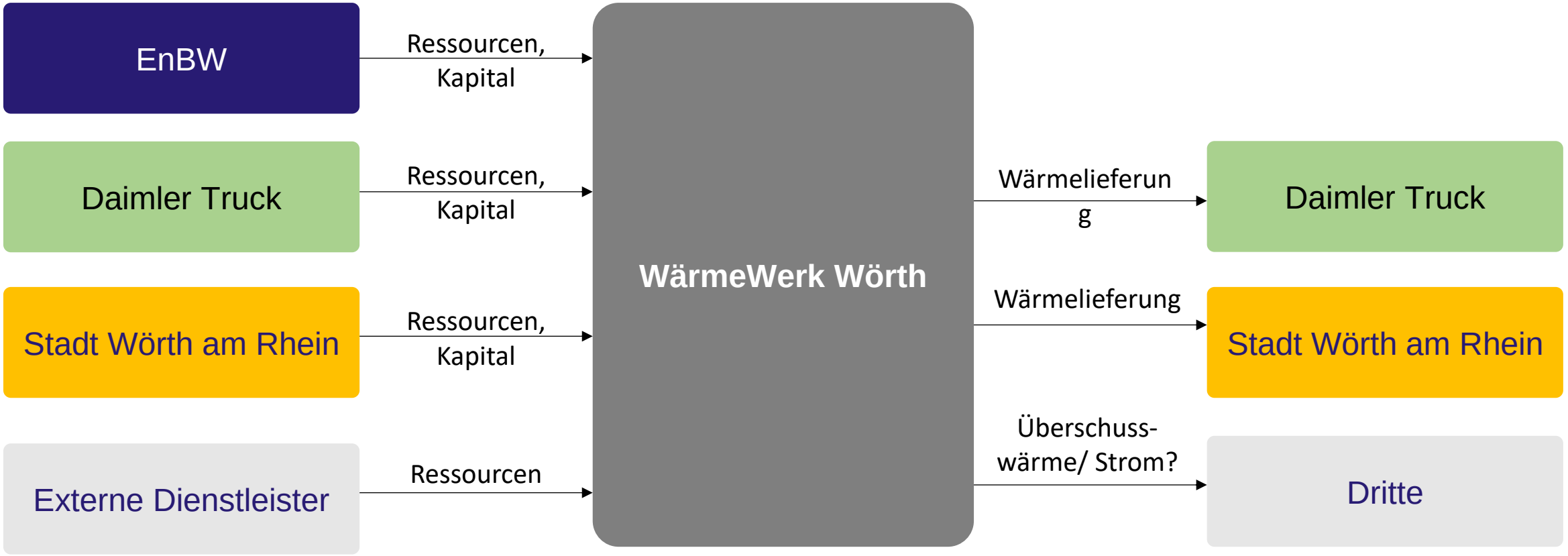
Laura Herrmann
Dr. Thomas Kölbel

EnBW Research & Development

Fettweisstr. 44
76189 Karlsruhe
Germany

t.koelbel@enbw.com

Business Modell – von Kunden zu Partnern

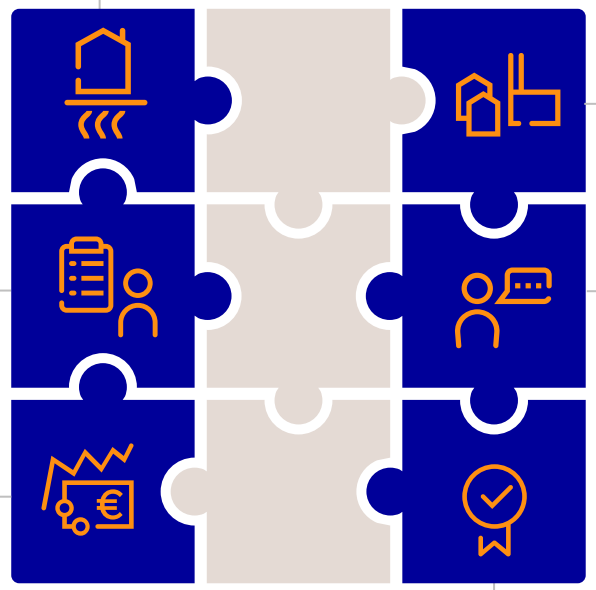


Heat supply for municipalities and industry

Risk sharing, alignment of interests, regional track record, local acceptance

Heat Distribution

- Existing district heating grids preferable



Industrial and Municipal Partner

- Heat demand at least 100 GWh p.a.

Risk Sharing

- Financial optimization considering partnering and funding schemes

Local Public Awareness

- Regional acceptance and citizen-focused dialogue

Exploration & Construction

- Local experience is required

Operation & Management

- Expertise in geothermal and heat supply busines required