

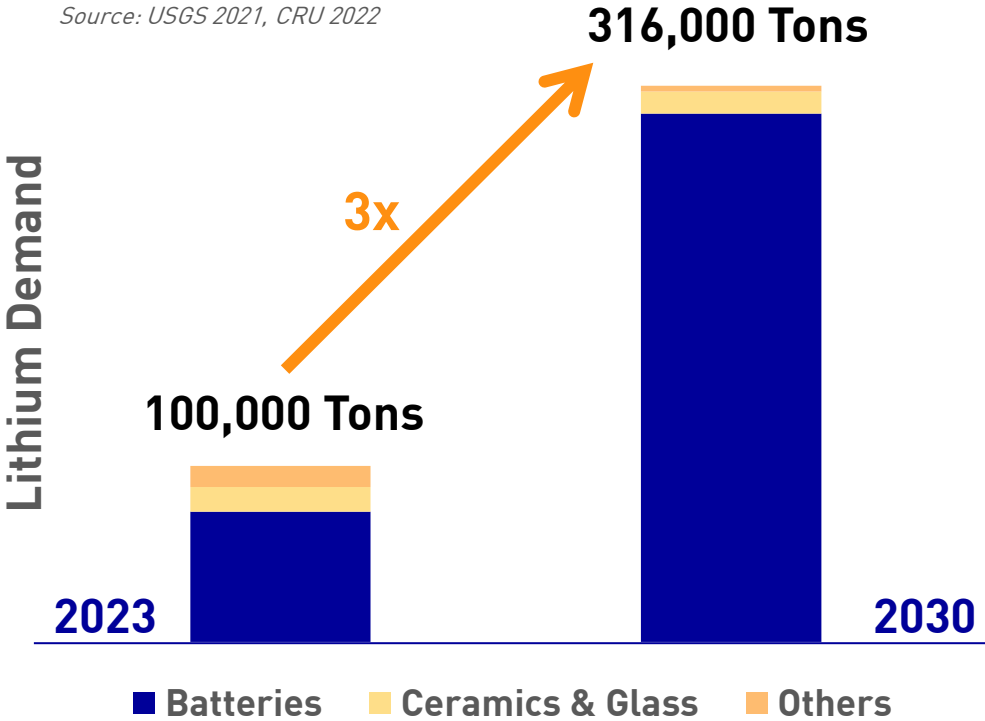
Lithium extraction from deep geothermal waters in the Upper Rhine Graben

EnBW T-FG R&D
M.Eng. Elif Kaymakci, Dr. Thomas Kölbel
21.09.2023, Karlsruhe

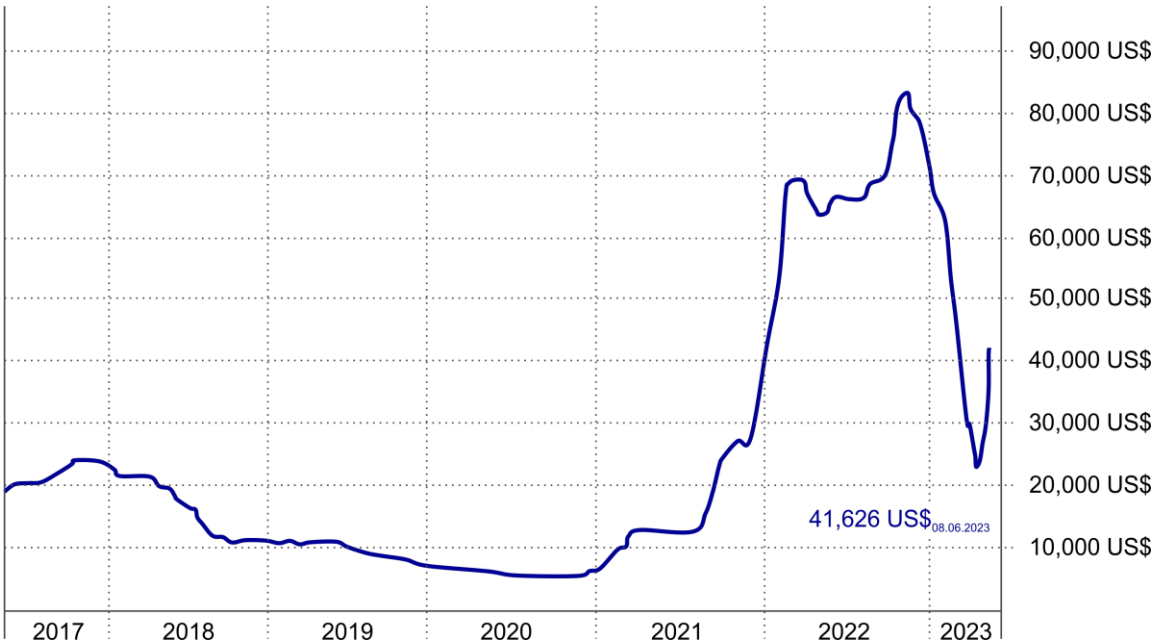


Lithium: Demand and Pricing

Li – Demand by end use



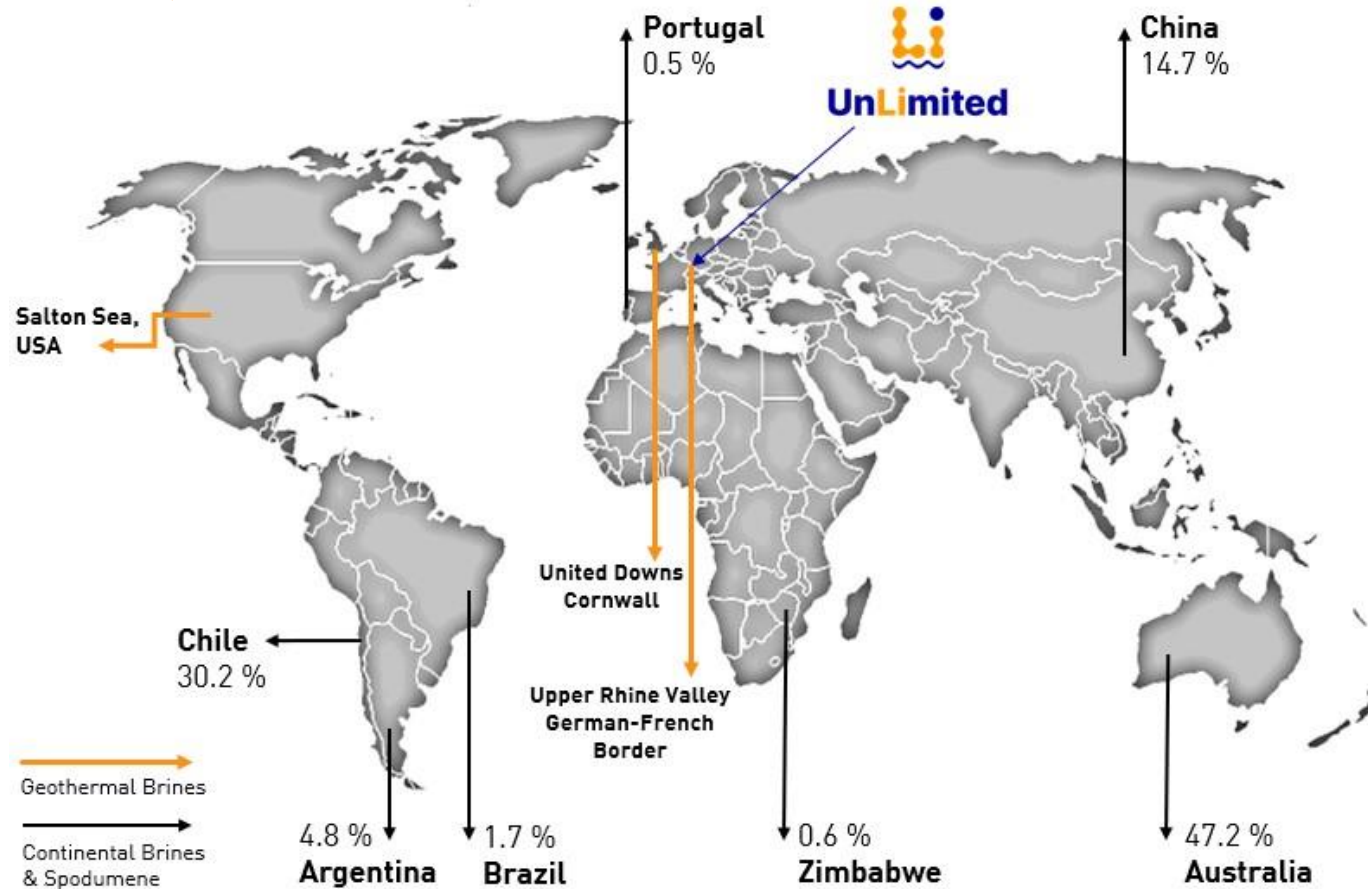
Li – Price Development



Source: Trading Economics, 2023

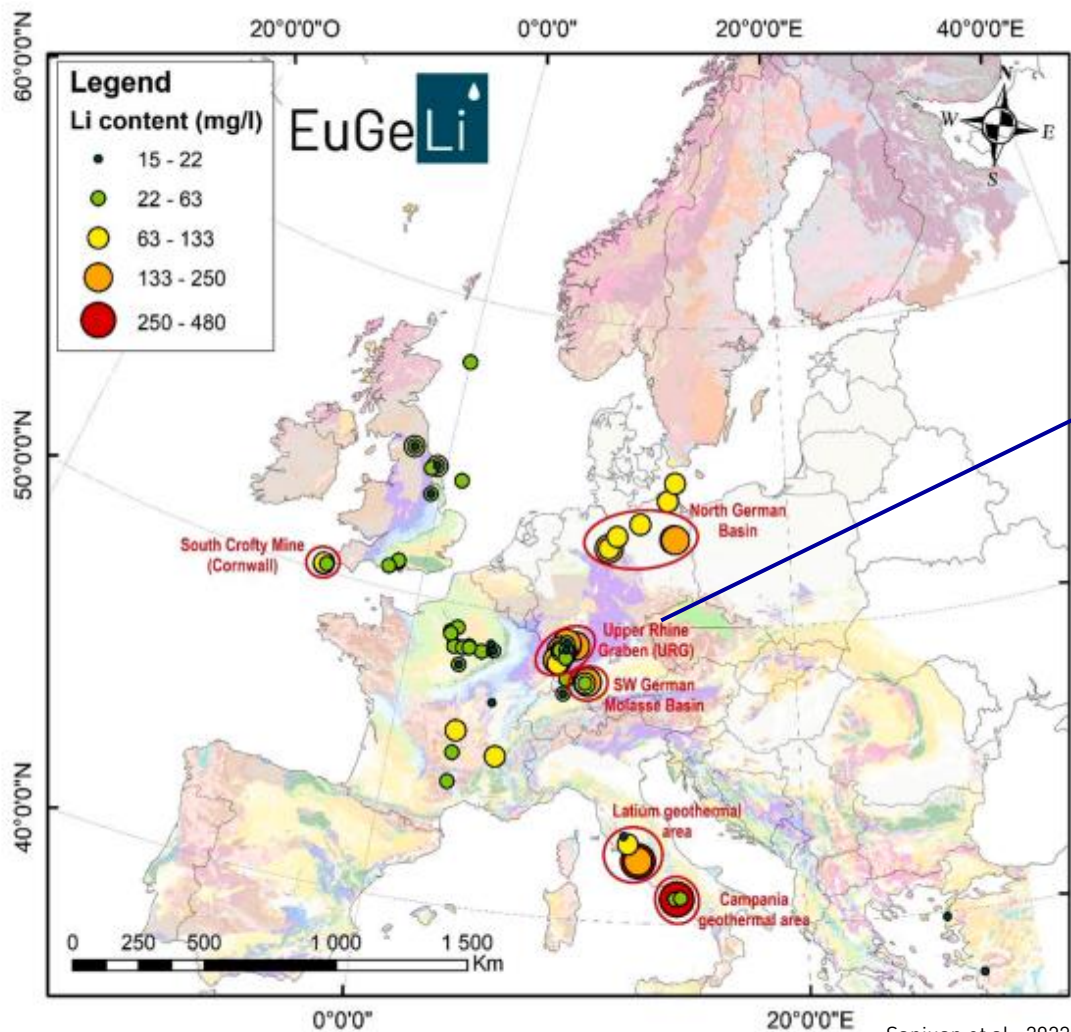
Lithium Production Worldwide

Lithium Supply 2022 (130,000 Tons)

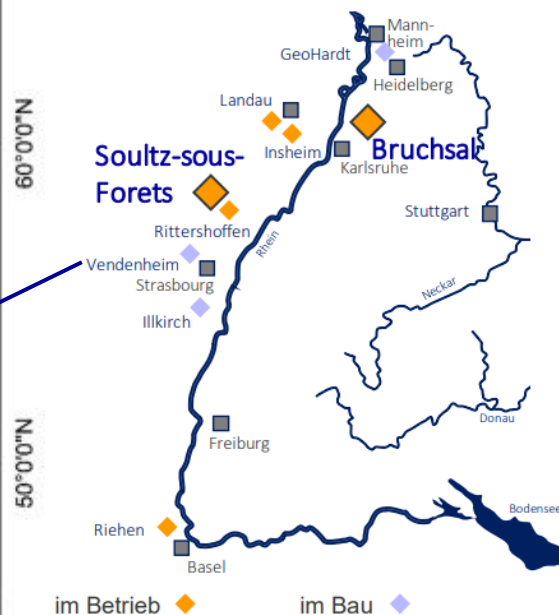


Source: USGS, 2022

Lithium in Geothermal Brines in Europe – Potential Local Li Production



Upper Rhine Valley



Geothermal Field / Brine Li Conc. (ppm)	Annual Potential LCE Production (t) *
Bruchsal 163	~ 6500
Sultz 173	
Rittershoffen 190	
Insheim 168	
Landau 168	

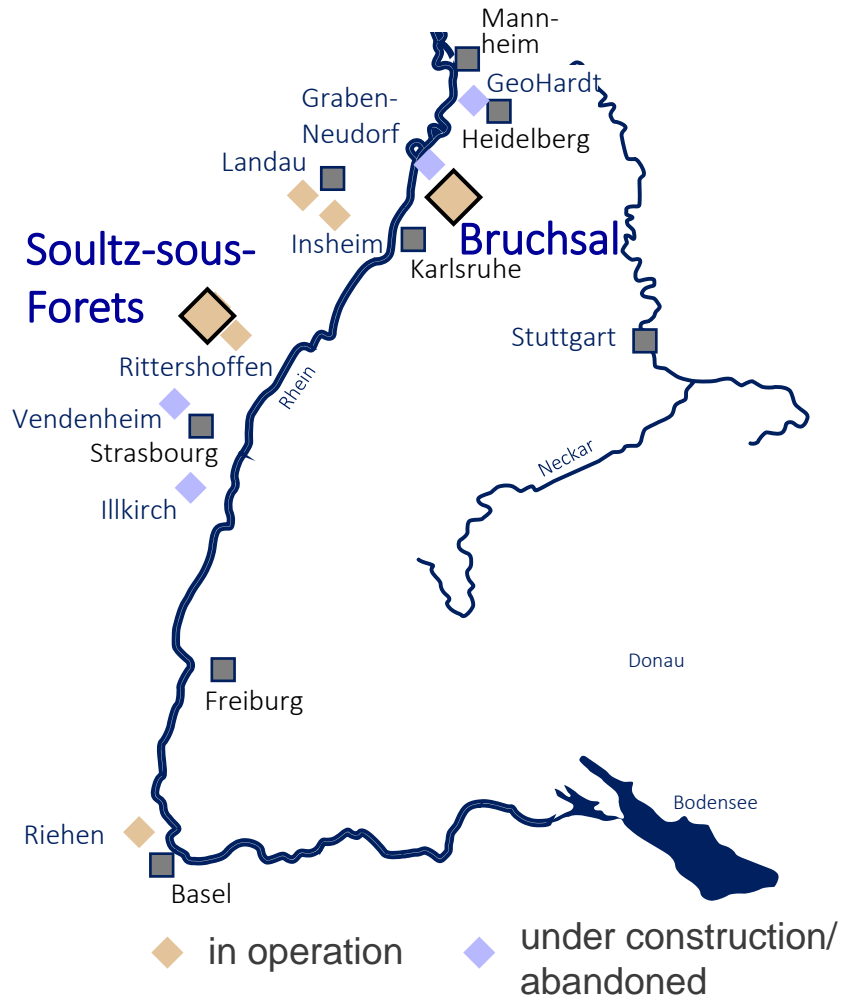
* 90% recovery rate and 90% operation time



corresponds to 1,3 % of today's global lithium demand

Geothermal Power and Heat in URG

Six plants in operation, two with EnBW participation



	Bruchsal	Soultz-sous-Forêts
Operator	Stadtwerke Bruchsal and EnBW	Electricité de Strasbourg and EnBW
Power Production	max. 580 kW	max. 2,300 kW
Heat Supply	ca. 1,200 kW	--
Power Plant Type	Kalina Cycle	Organic Rankine Cycle (ORC)
Cooling System	Water Cooler	Air Cooler
No. of Wells	2	4 (3 in operation)
Reservoir Temperature	134 °C	200 °C
Reservoir Type	hydrothermal	petrothermal
Flow Rate	ca. 28 l/s	ca. 30 l/s

Bruchsal Geothermal Plant

Combined heat and power

Brine Cycle

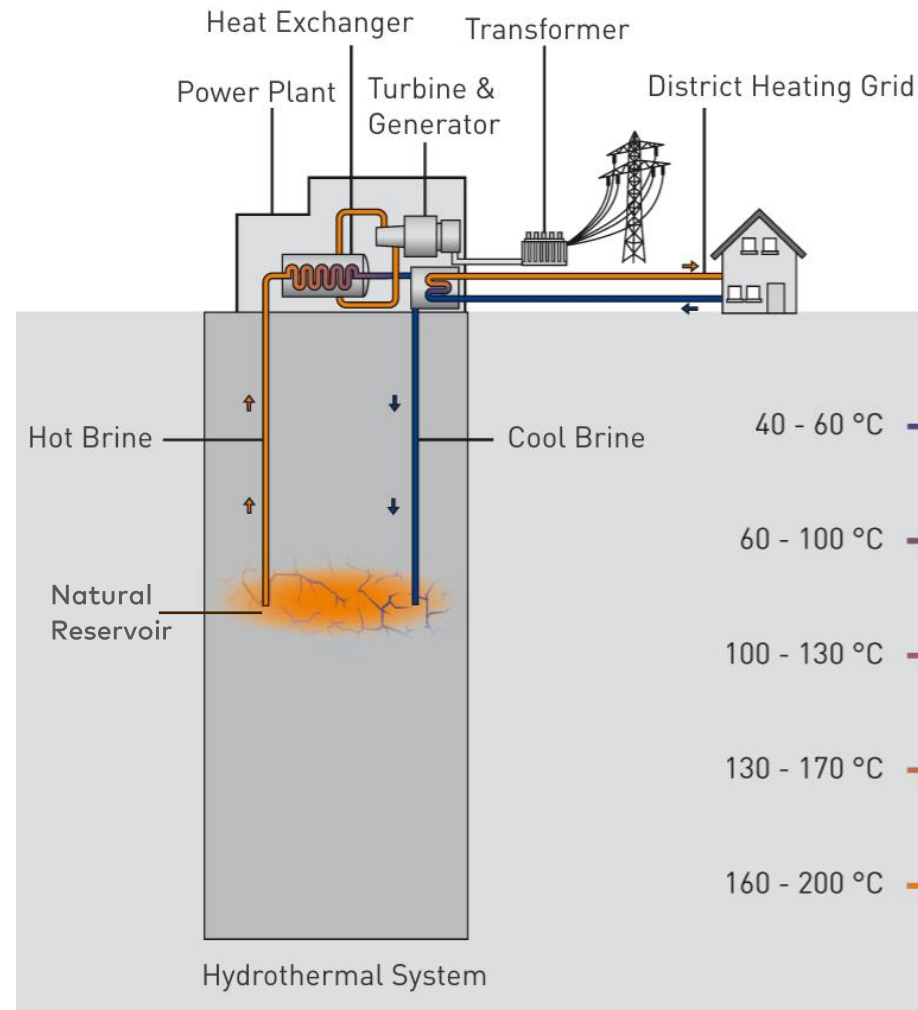
- + Flow Rate: 28 l/s
- + Inlet Temperature: 126 °C
- + Outlet Temperature: 60 °C
- + Operational Pressure: 22 bar

Power Production

- + Working Media: Ammonia/Water
- + Electric Power: 580 kW
- + Cooling: Wet Cooling Tower
- + Heat Exchanger: 2x Plate Heat Exchanger

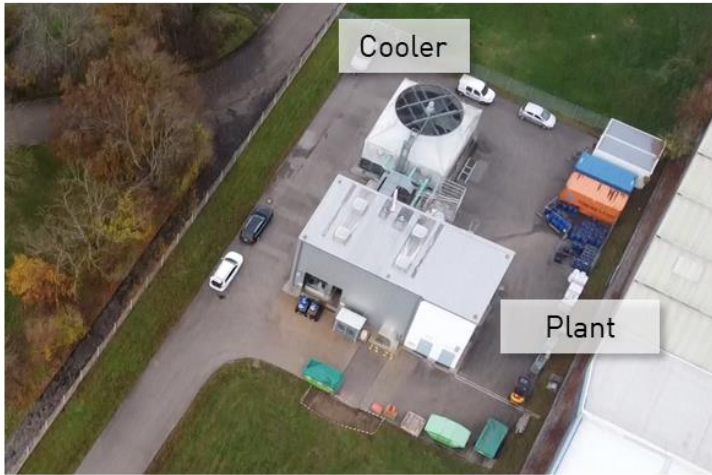
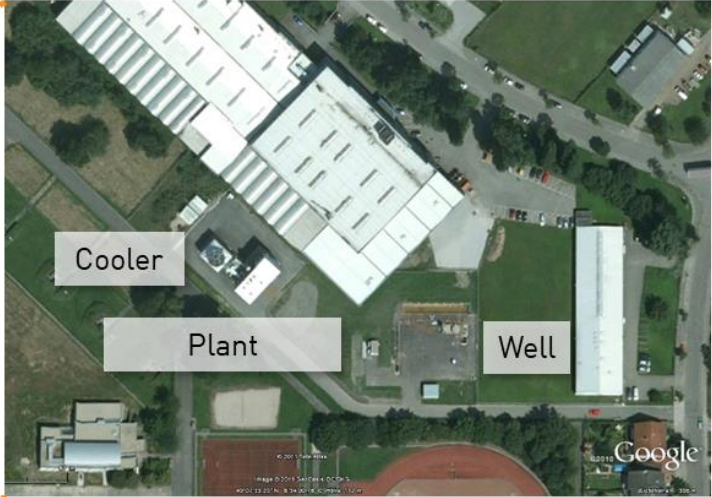
Heat Supply

- + Partial Flow Rate: 6,25 l/s
- + Inlet Temperature: 95 °C
- + Thermal Power: 1,200 kW



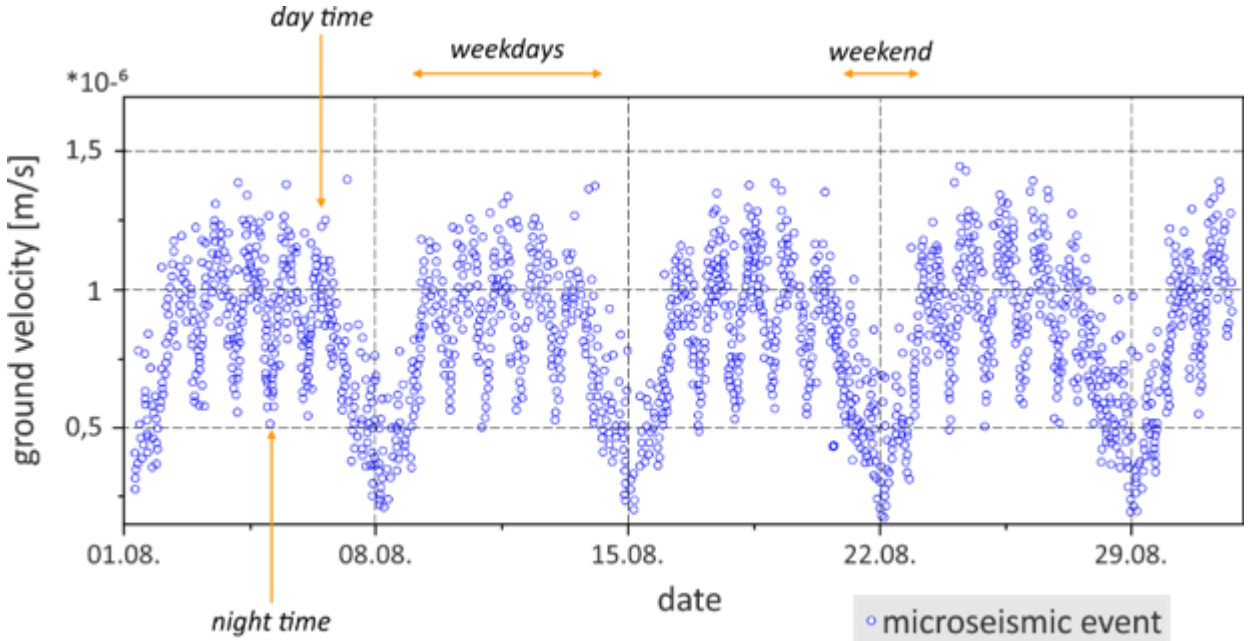
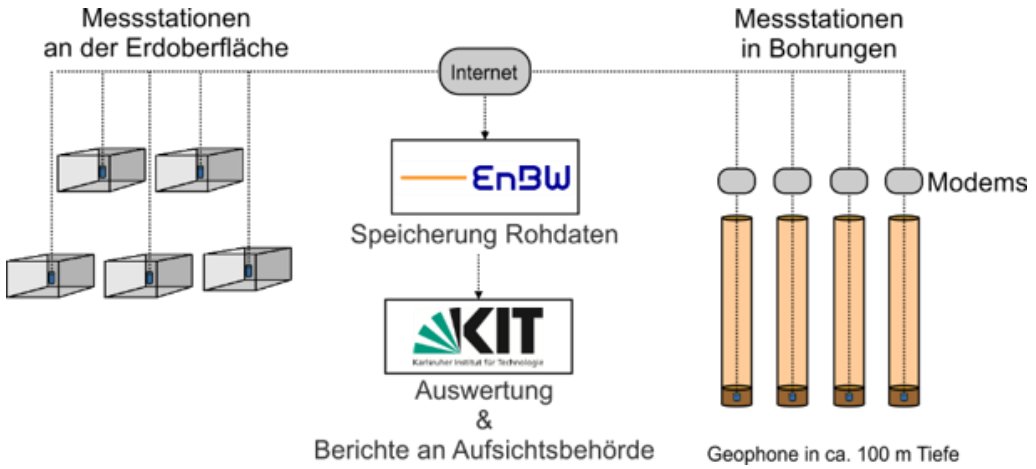
Bruchsal Plant: 14 Years of Operation

Low visibility & No complaints



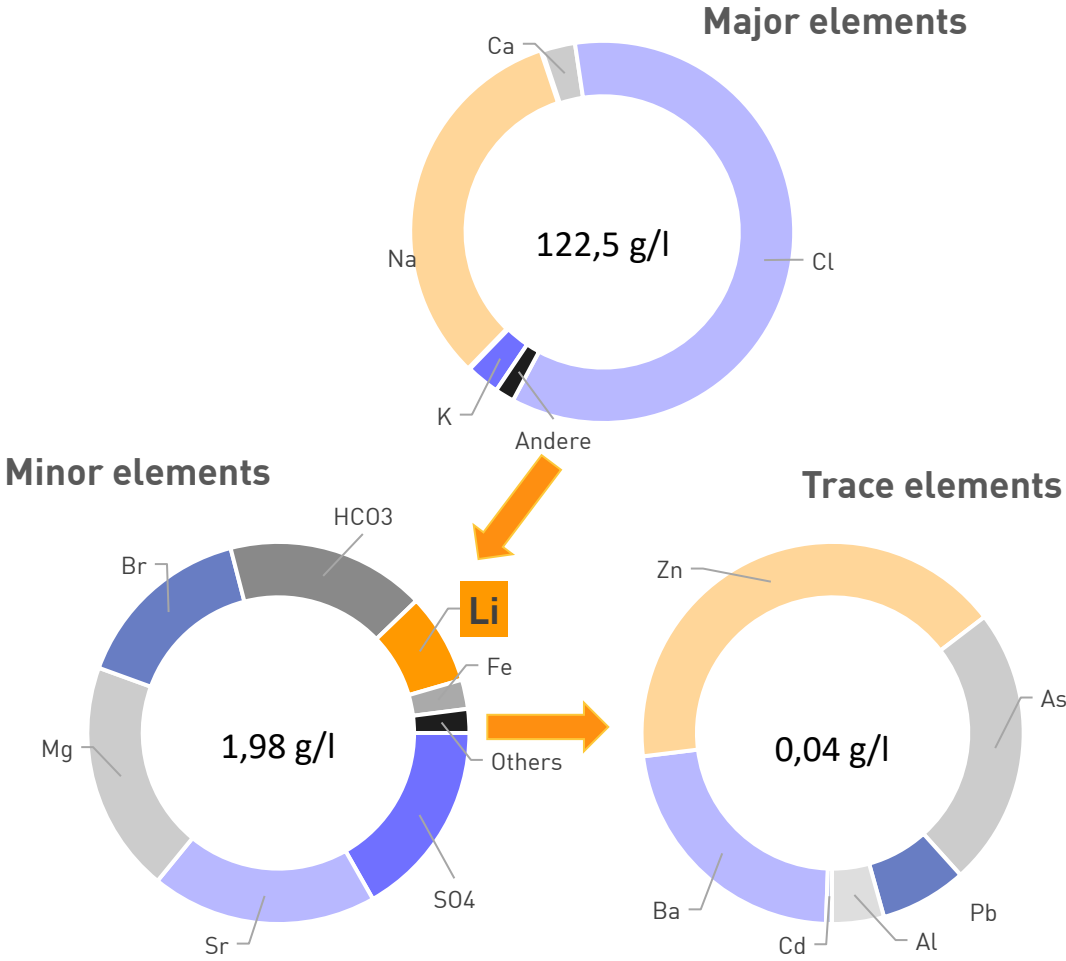
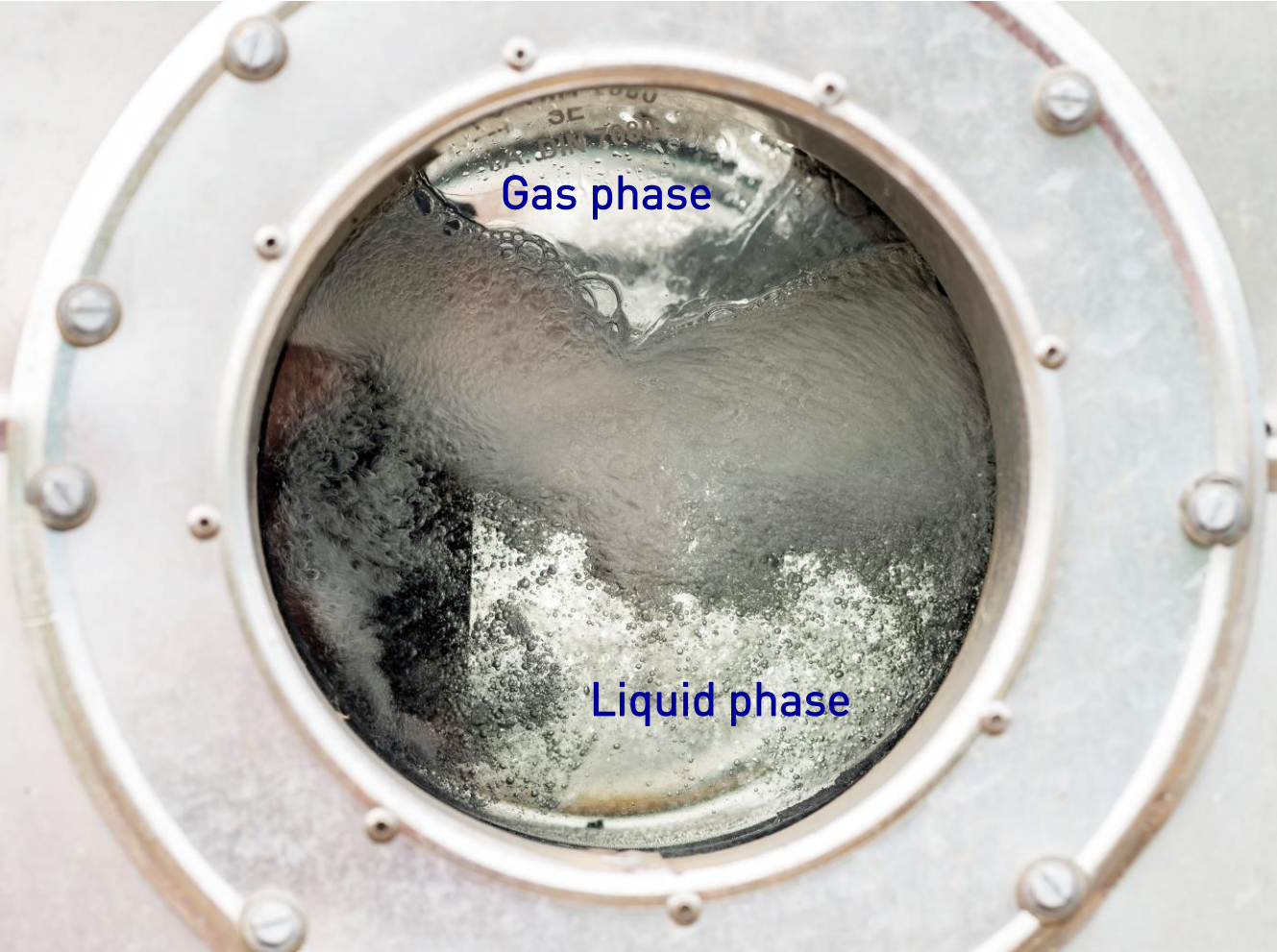
Bruchsal Plant: 14 Years of Operation

Low visibility & No complaints & No seismicity



Geothermal brine composition

Half as salty as Dead Sea water

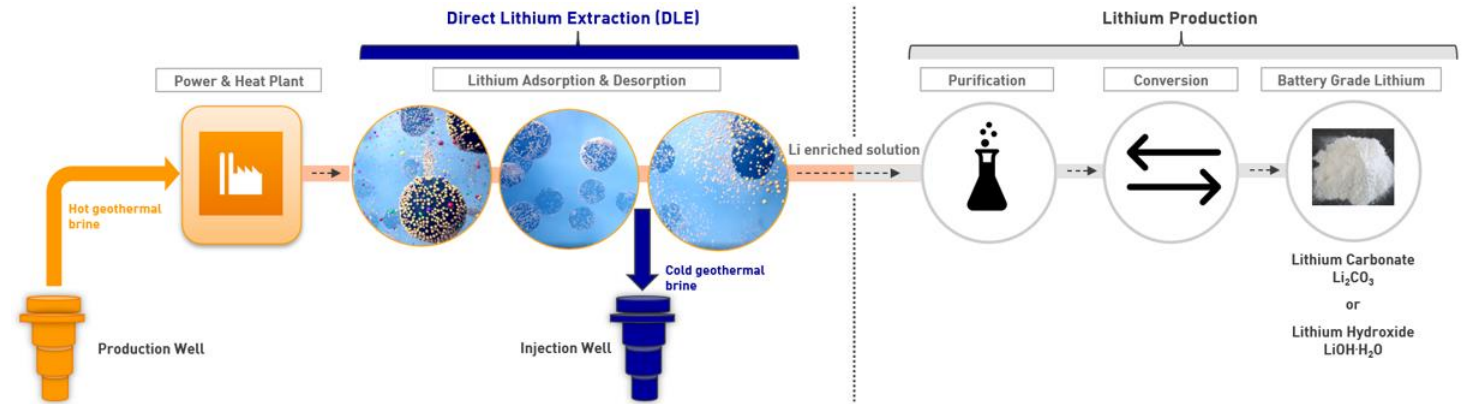


UnLimited's Li-extraction (DLE) Process

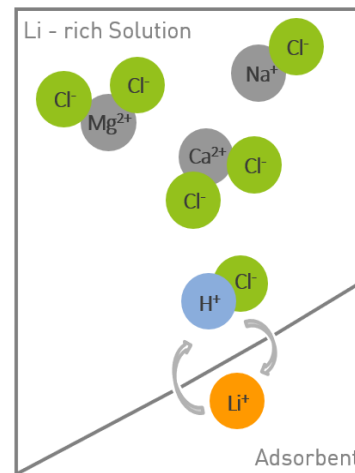
Co-production of Lithium in Bruchsal, Germany

Project Goals

- + Sustainable use of a domestic resource
- + Proof of Concept on Pilot scale
- + Design and testing of an emission-free process
- + Analysis of the techno-economic framework



Adsorption / Ion Exchange with Manganese oxides (MnOx) (Ion-Exchange)



Adapted from Jade Cove Partners, 2021



Supported by:



UnLimited

UnLimited | (geothermal-lithium.org)

on the basis of a decision by the German Bundestag

UnLimited at Bruchsal

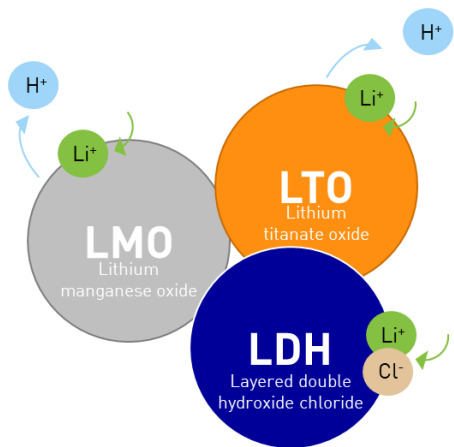
Project steps and progress

2020 - 2023

2023 - 2024

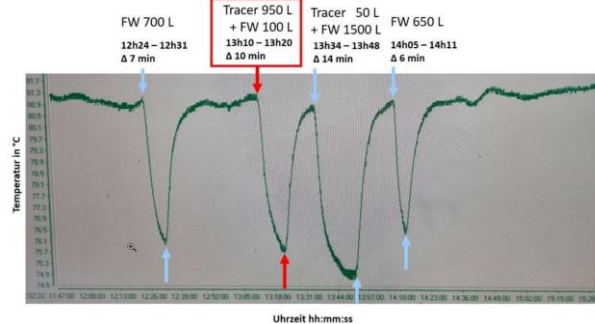
Sorbent Identification

- LMO: Ion-exchange
- LTO: Ion-exchange
- LDH: Adsorption of LiCl
- Zeolite and others



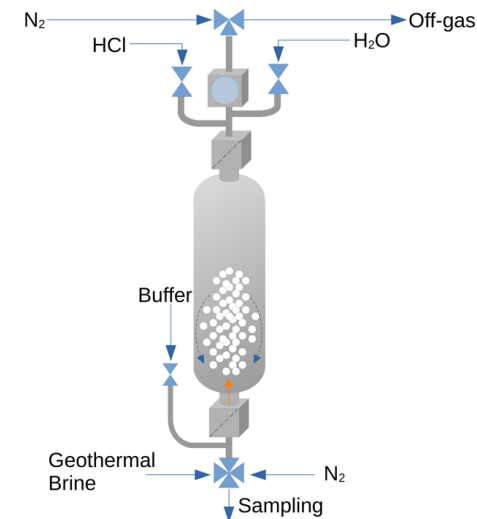
Sustainability Analysis

- Testing of fluid monitoring systems
- Drill cuttings analyzes
- Tracer Test



Pilot Plant

- Pilot Plant Design & Construction
- Repetitive tests
- Process optimization



Combined evaluation & LCA

- Combined evaluation of all results
- Life cycle assessment
- cost evaluation



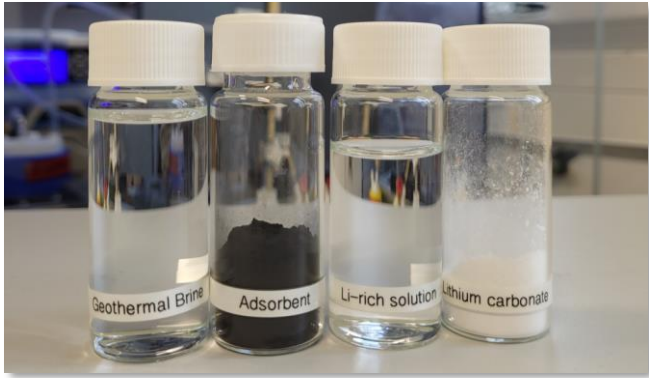
Lithium R&D at EnBW

Various projects and objectives

UnLimited (until Dec 2024)



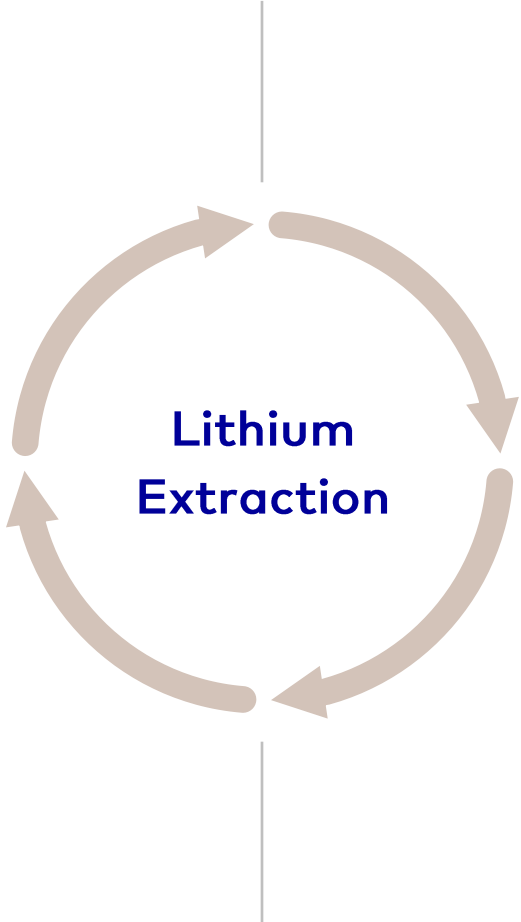
LiCORNE (until Sep 2026)



GeoLith (completed in 2022)



LiCovery (on-going)



Combined Evaluation & Life Cycle Assessment

Li Production Costs Outlook (DLE and Conventional)

Supported by:
 Federal Ministry for Economic Affairs and Energy
 on the basis of a decision by the German Bundestag



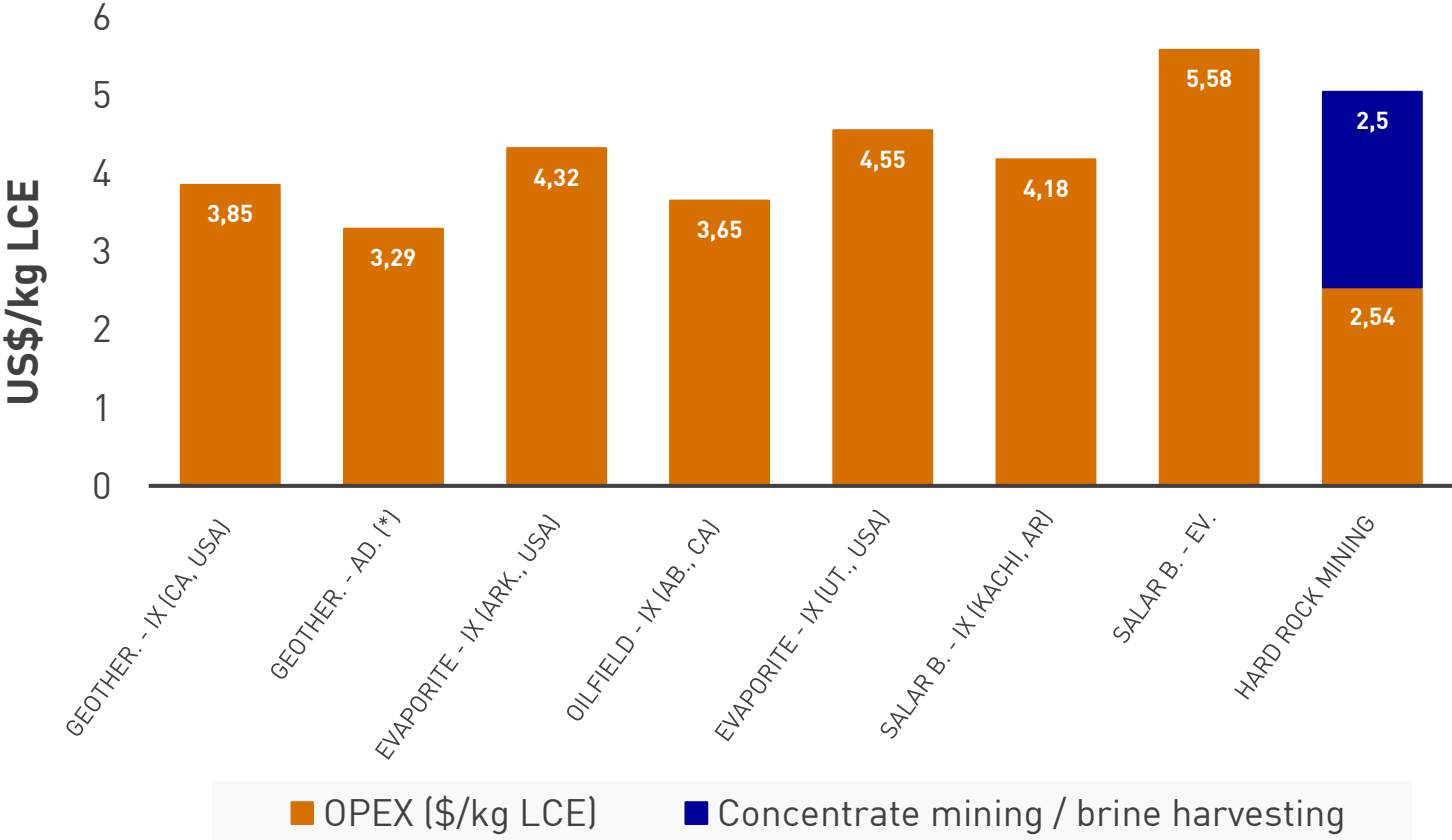
How high are the emissions of the product?

How does it compare to other products in our portfolio?

What are the biggest leverages to reduce the impact of our product?

Can we be more efficient in manufacturing it?

Lithium Production Cost



Ref.: NREL 2021

Strengths

- + Technically feasible, high recovery rate (>90%), fast-running process
- + Eco-friendly – no CO₂ emission in operation
- + Promising resource sustainability (initial findings)

DLE from Geothermal Brines

Challenges

- + Upscaling (complex chemistry, high salinity, high P & T)
- + Economic viability (volatility of the Li-market)



Thank you

EnBW Research & Development

Elif Kaymakci

e.kaymakci@enbw.com

+49 721 63-17932

Fettweisstr. 44,

76189 Karlsruhe

Germany

