Berlin, 23. Juni 2022

Rohstoffrisikobewertung – Lithium 2030
- Update -

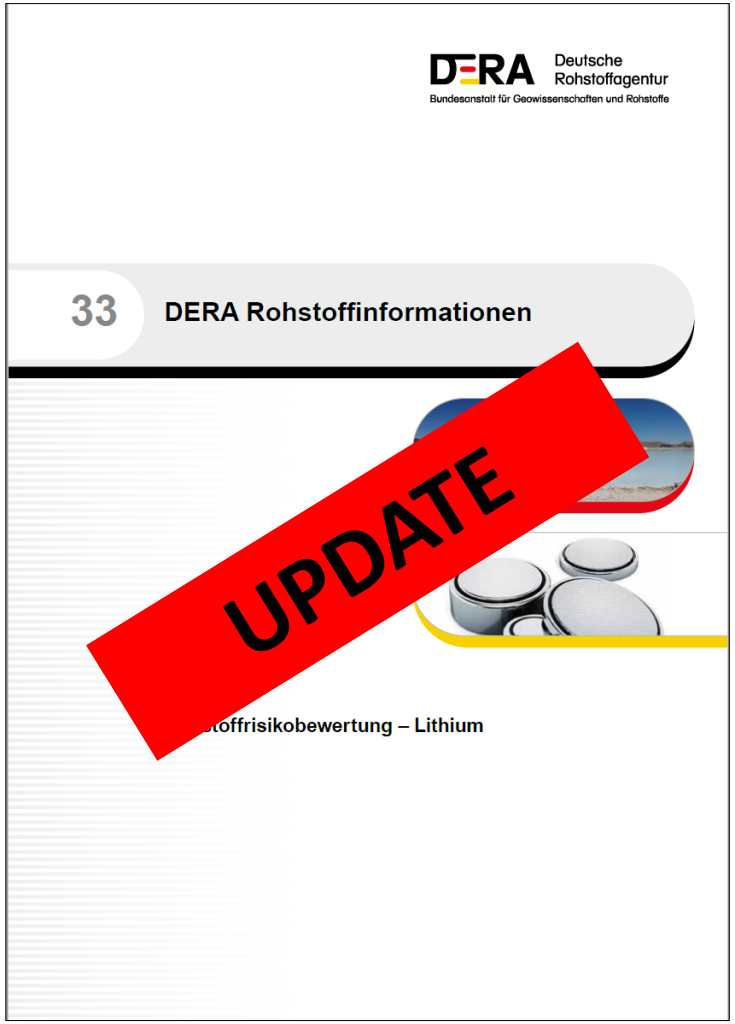
Michael Schmidt
Deutsche Rohstoffagentur (DERA)
in der Bundesanstalt für Geowissenschaften und Rohstoffe

Bundesministerium
für Wirtschaft
und Klimaschutz

Die Bundesanstalt für Geowissenschaften und Rohstoffe ist eine technisch-wissenschaftliche Oberbehörde im Geschäftsbereich des Bundesministeriums für Wirtschaft und Klimaschutz (BMWK).

DERA Risk Analysis Lithium 2017

- Extremely dynamic development in the battery sector.
- EV adoption much faster than anticipated.
- Possible ban of ICE vehicles.
- Off-grid energy storage demand gaining momentum.
- Very strong demand and demand projections.
- Prices at record levels.
- China with a strong strategic position.
- Europe as an EV hotspot.
- Global trend towards added value in countries of origin.



LITHIUM – CURRENT SUPPLY SCHEME

Source: AMG Lithium 2022

Hard Rock (60 %)

Source: SQM 2022

Brine (40 %)

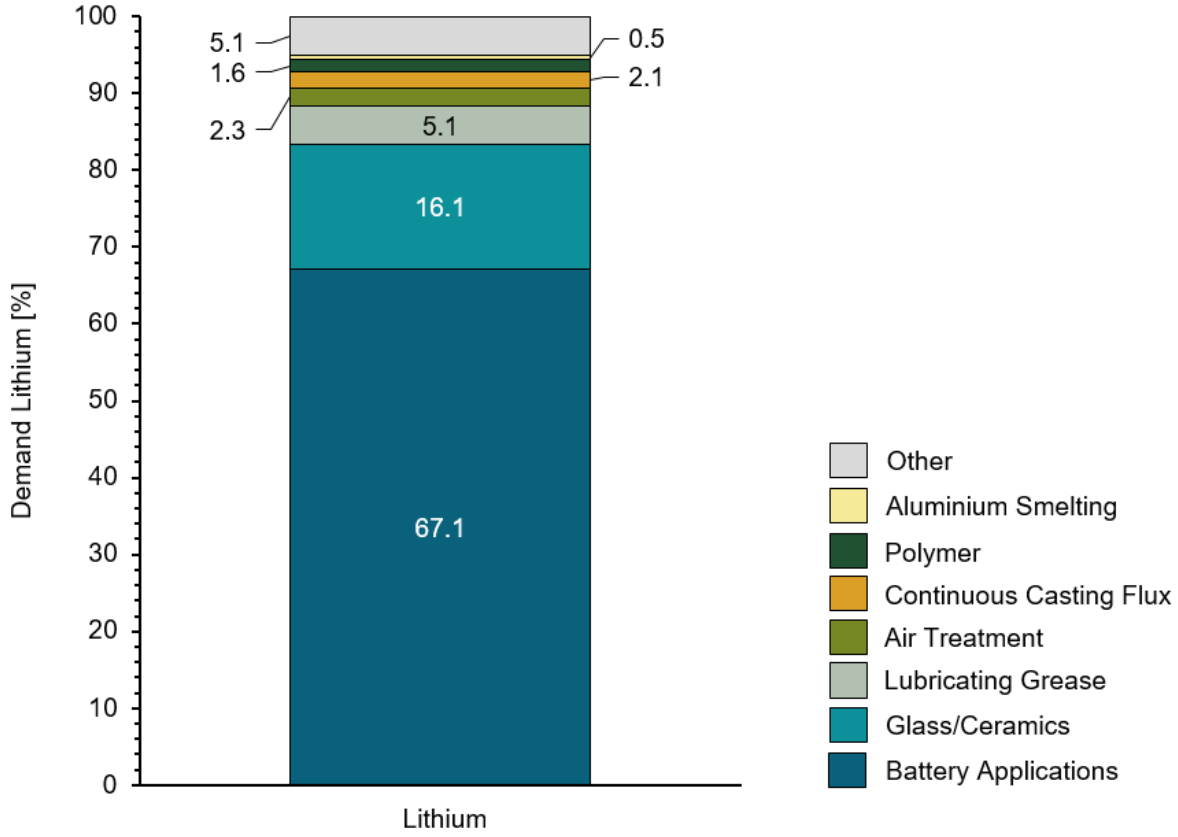
Source: EnBW 2022

Geothermal Brines (xx % in 20xx)

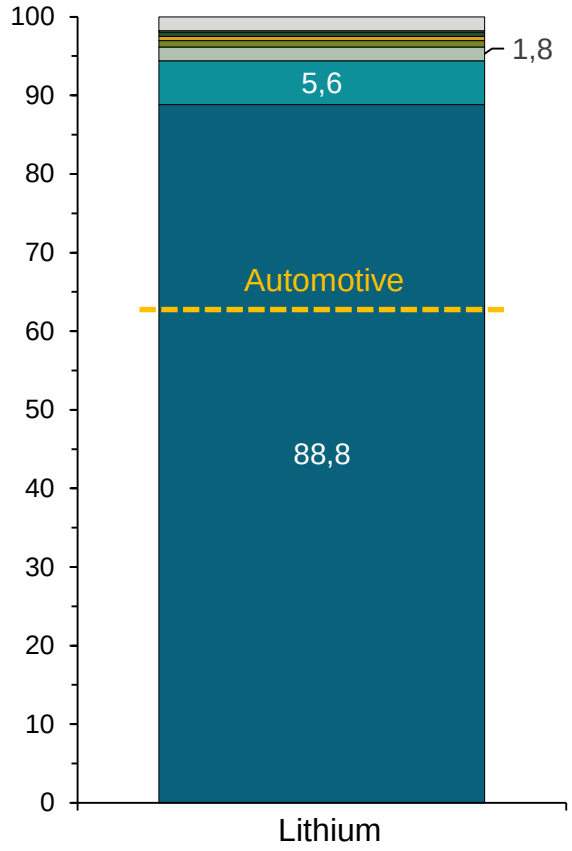
Different sources yield the same products through different processing routes, thus different environmental footprints.

APPLICATIONS AND DEMAND 2020

Demand 2020: 74,183 t Lithium



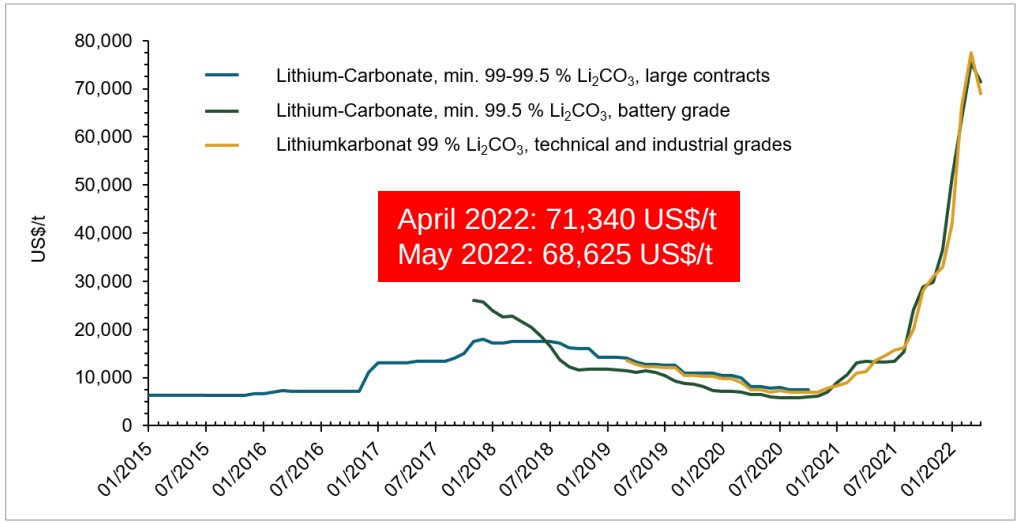
Demand 2030*: 316,307 t Lithium

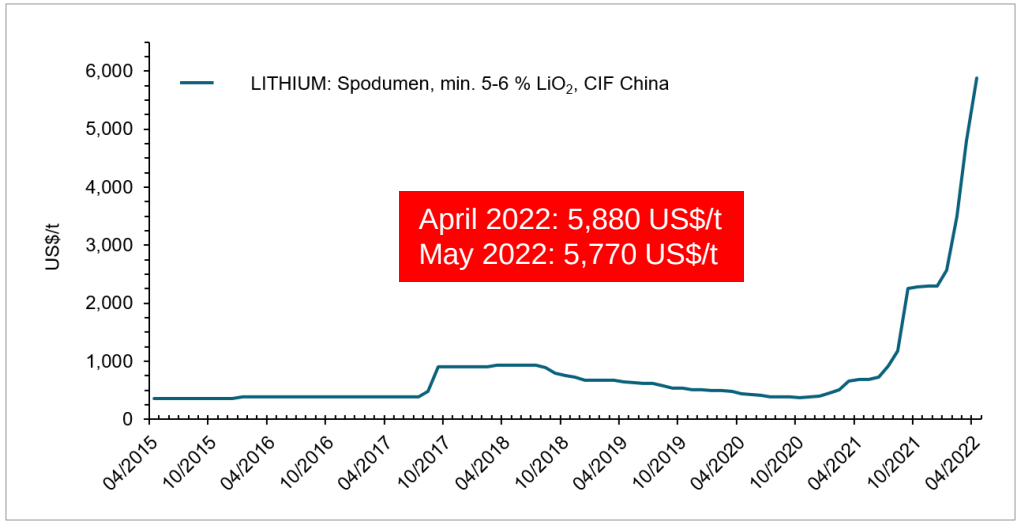


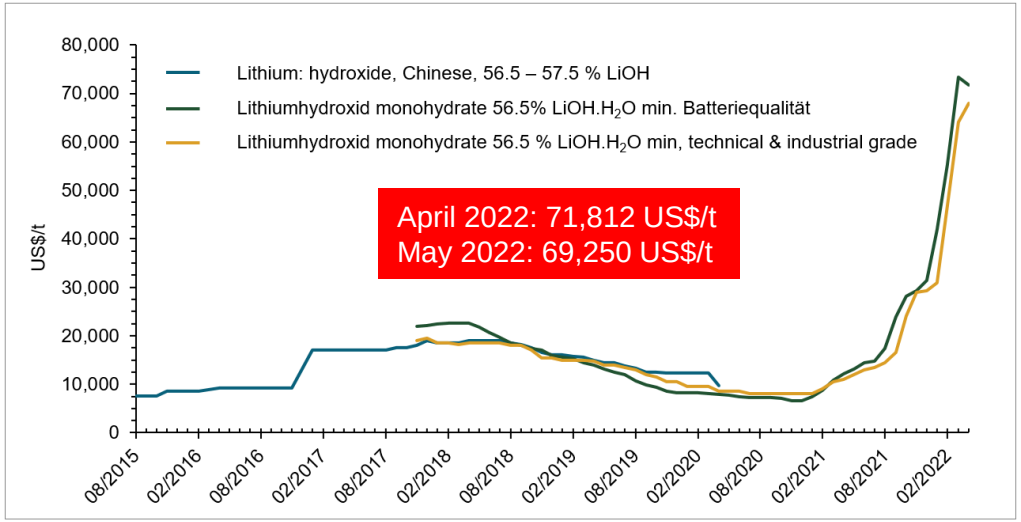
Source: CRU 2022

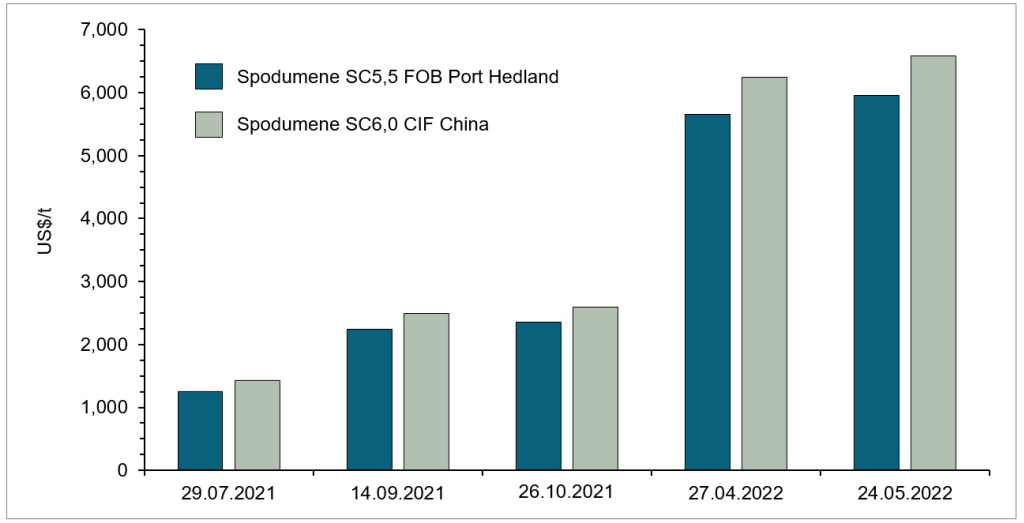
** Demand Scenario 2 based on SSP2*

PRICE DEVELOPMENT







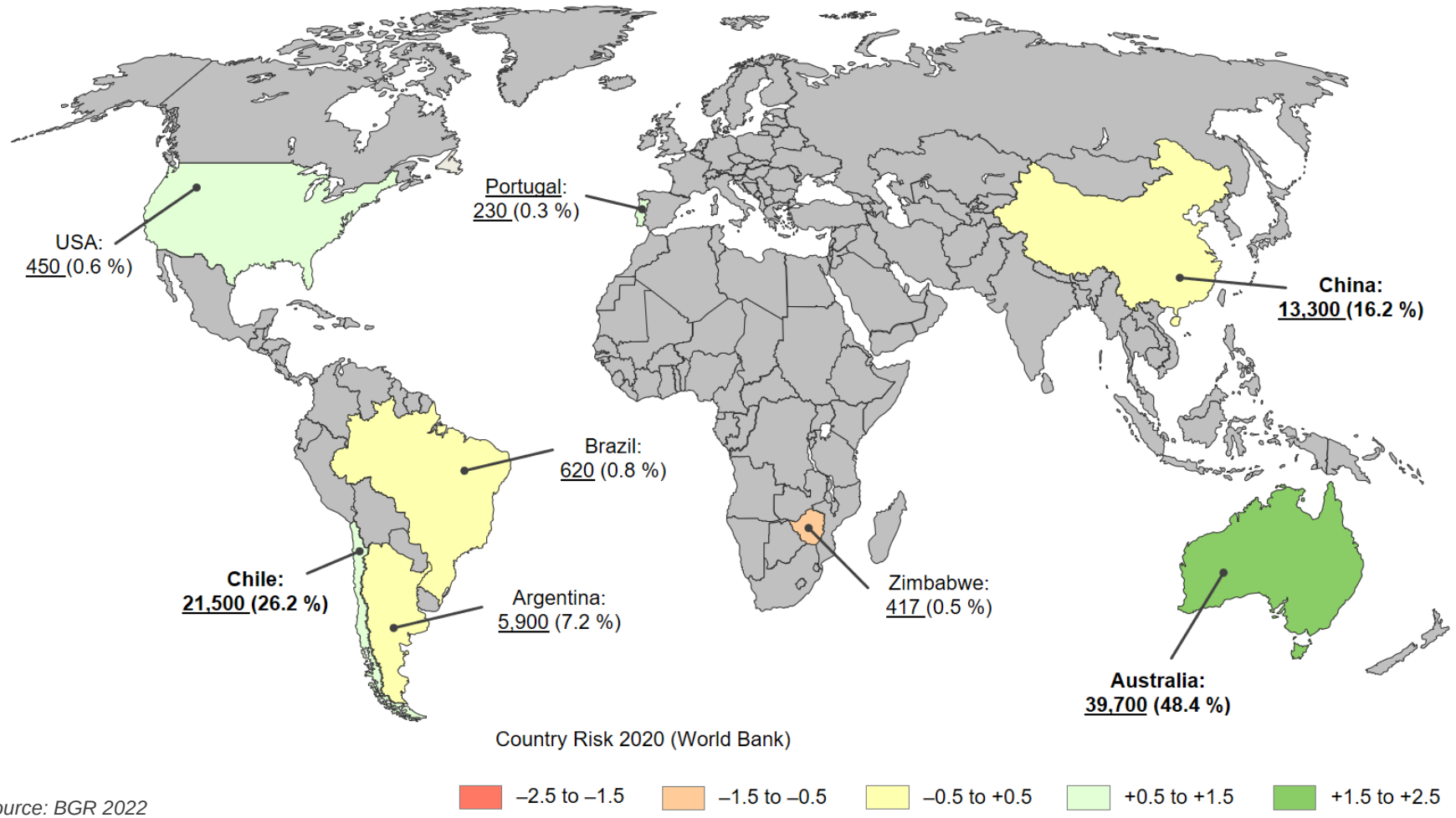


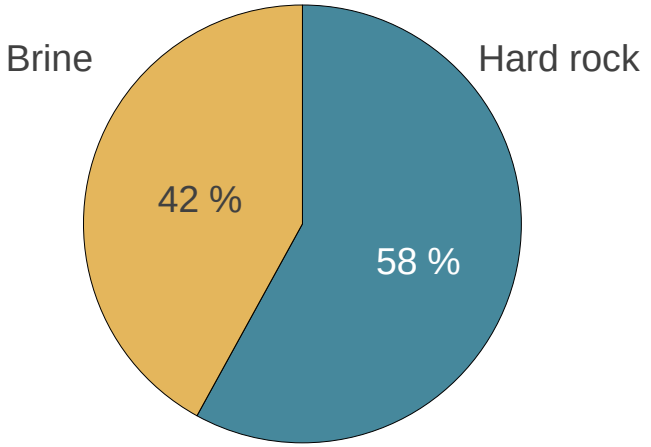
Source: BGR 2022

Source: Pilbara Minerals 2022

SUPPLY 2020

Global Lithium Supply 2020 (in t)
Top 3 countries: 74,500 t (approx. 90.7 %)



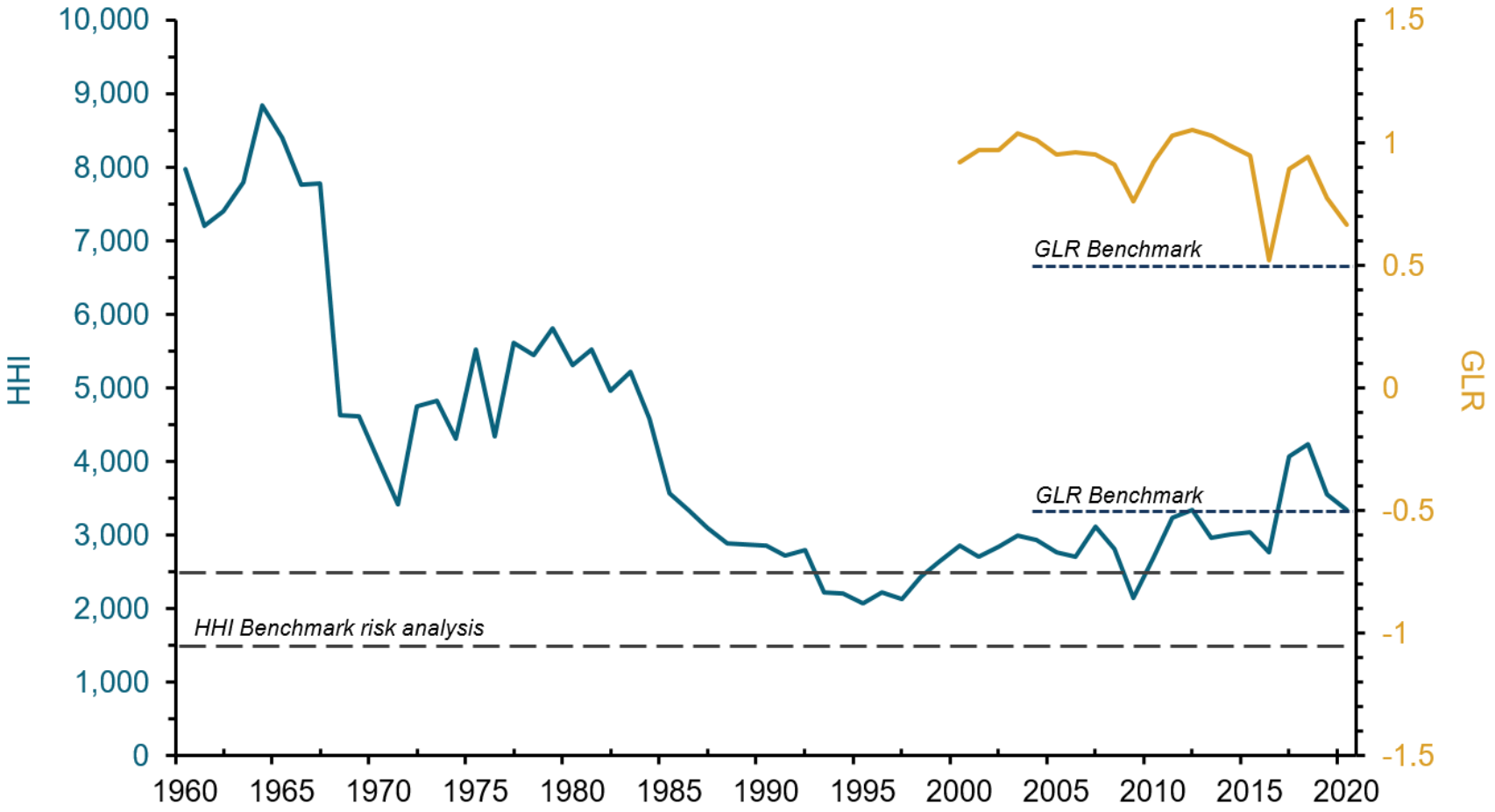


HHI: 3,380

GLR: 0.90

Source: BGR 2022

SUPPLY 2020



CAGR China
(1984 – 2015): **6.6 %**
(2015 – 2020): **46 %**
Share 2020: **16.2 %**

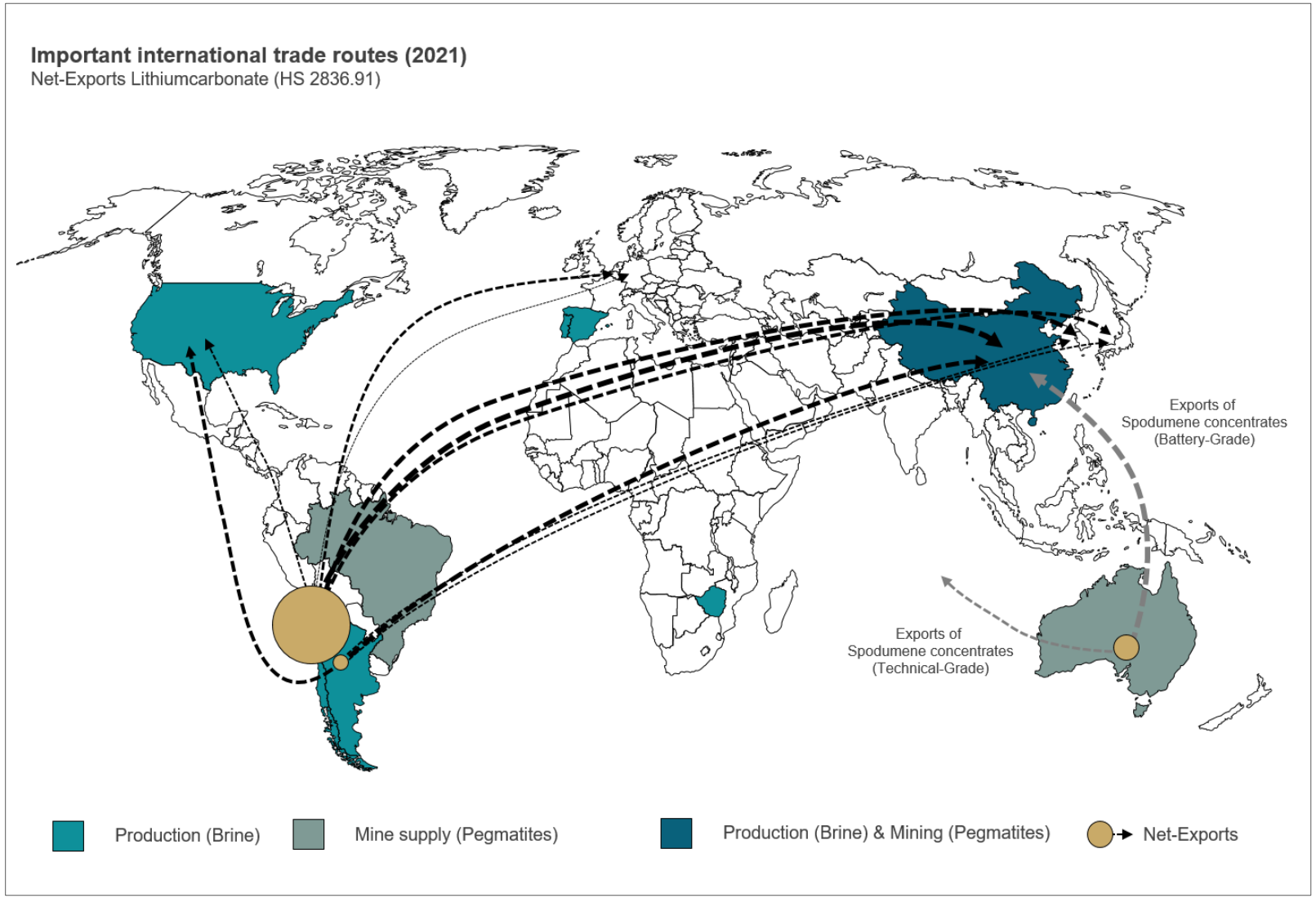
CAGR Argentina
(1984 – 2015): **30.1 %**
(2015 – 2020): **10.9 %**
Share 2020: **7.2 %**

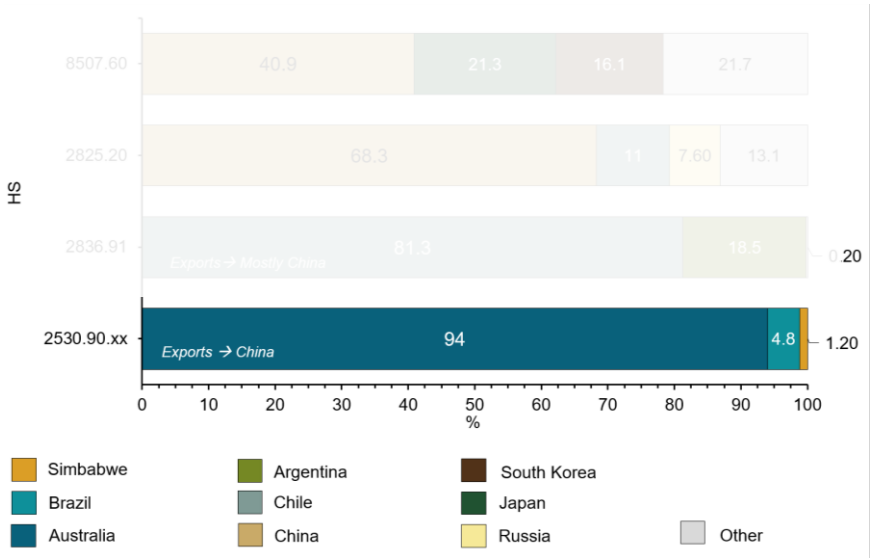
CAGR Chile
(1984 – 2015): **11.6 %**
(2015 – 2020): **12.8 %**
Share 2020: **26.2 %**

CAGR Australia
(1984 – 2015): **13.3 %**
(2015 – 2020): **24.7 %**
Share 2020: **48.4 %**

Source: BGR 2022

GLOBAL NET-TRADE





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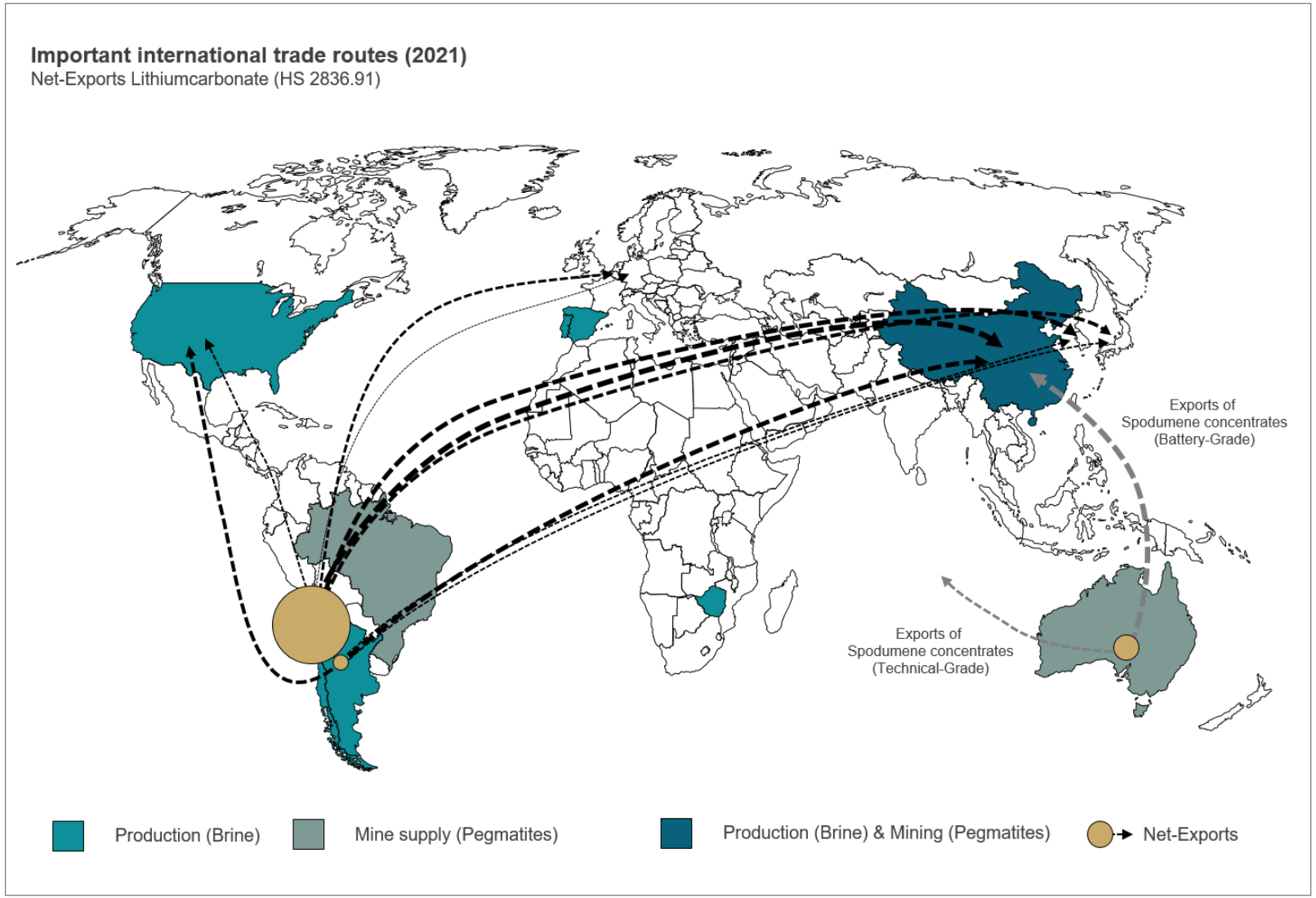
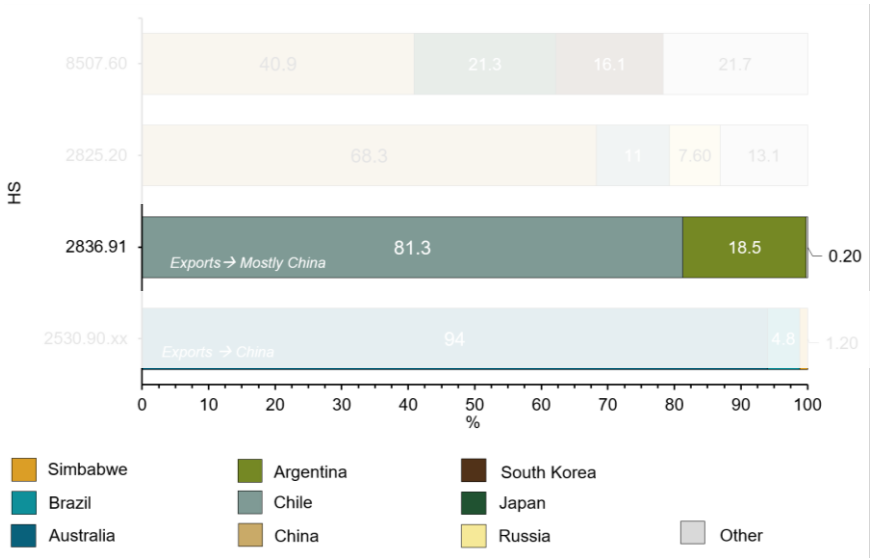
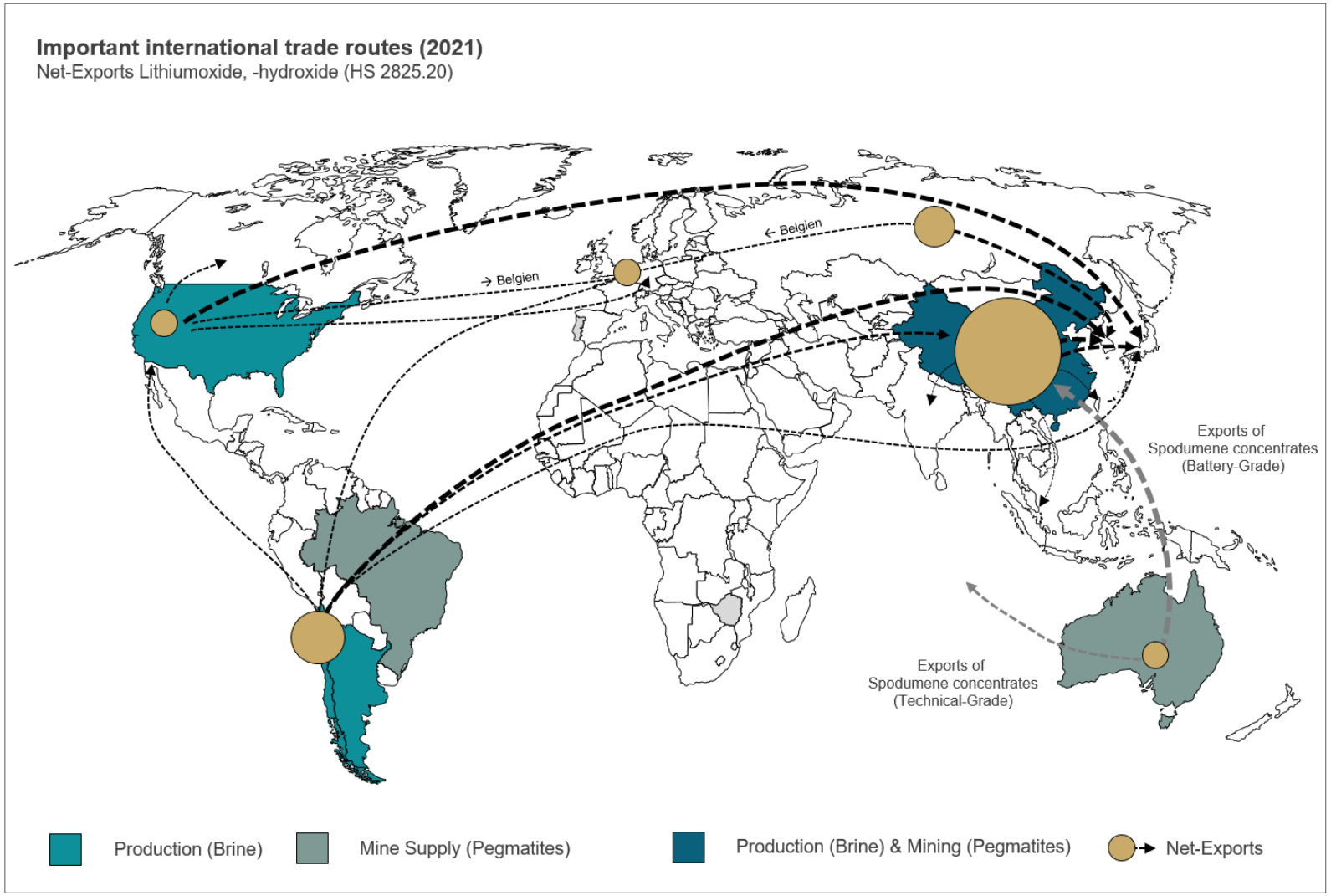
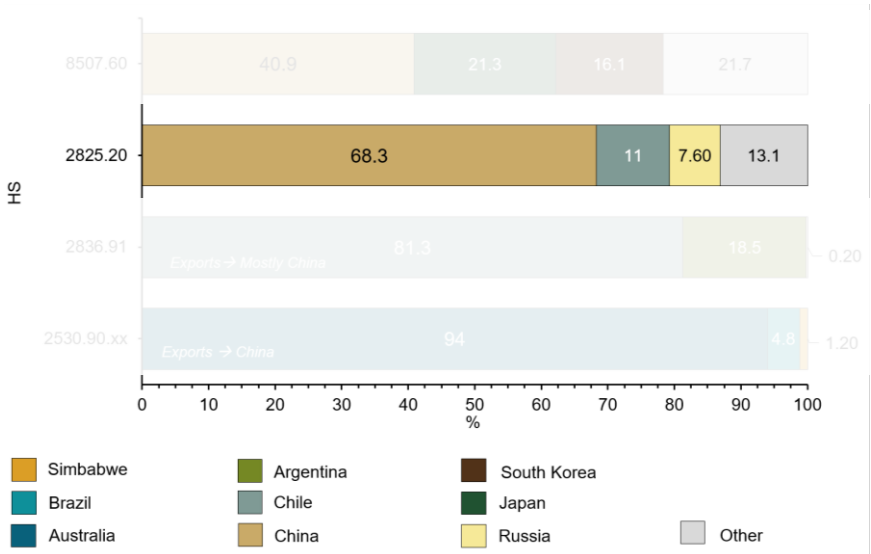


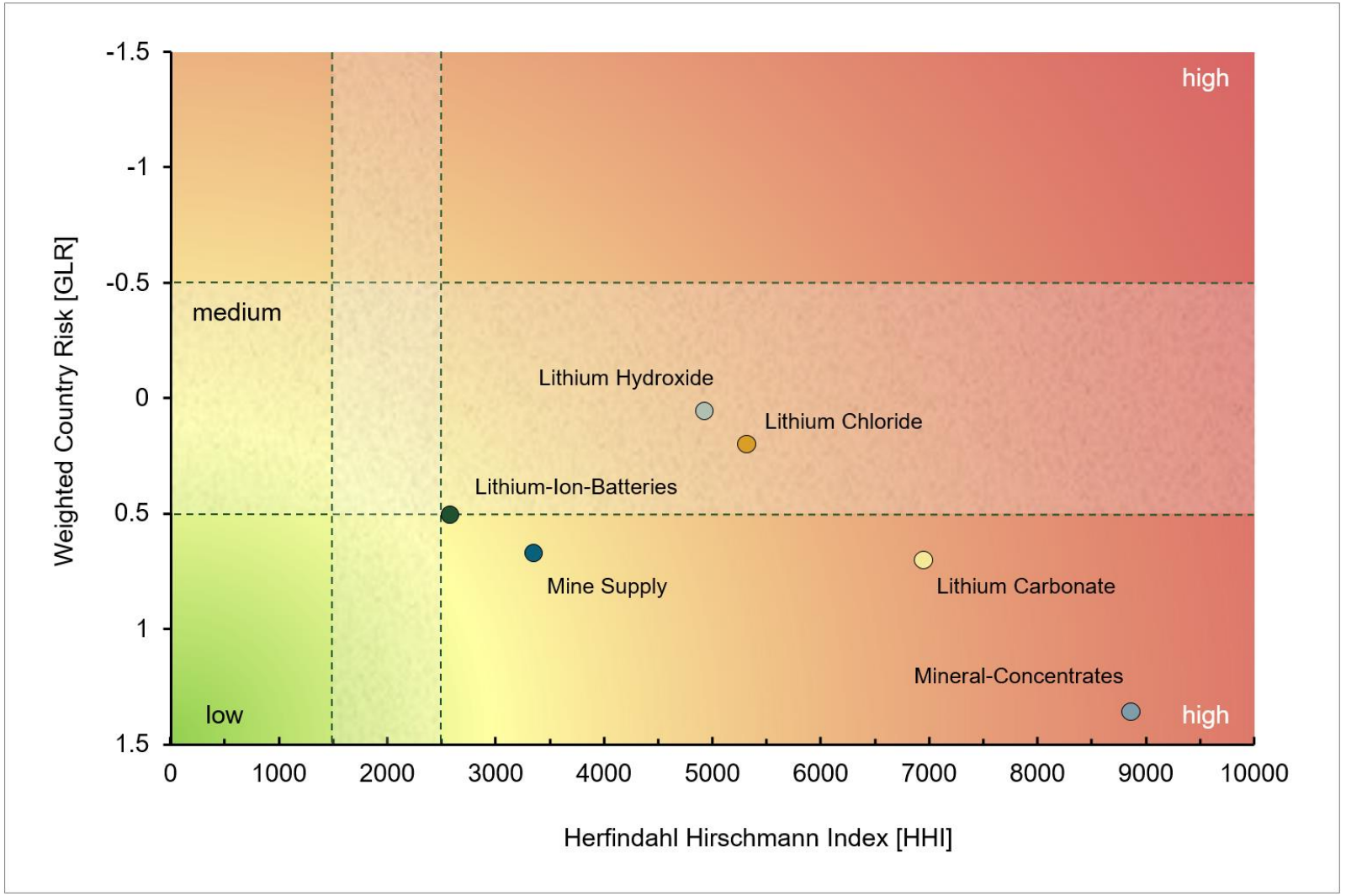


GLOBAL NET-TRADE

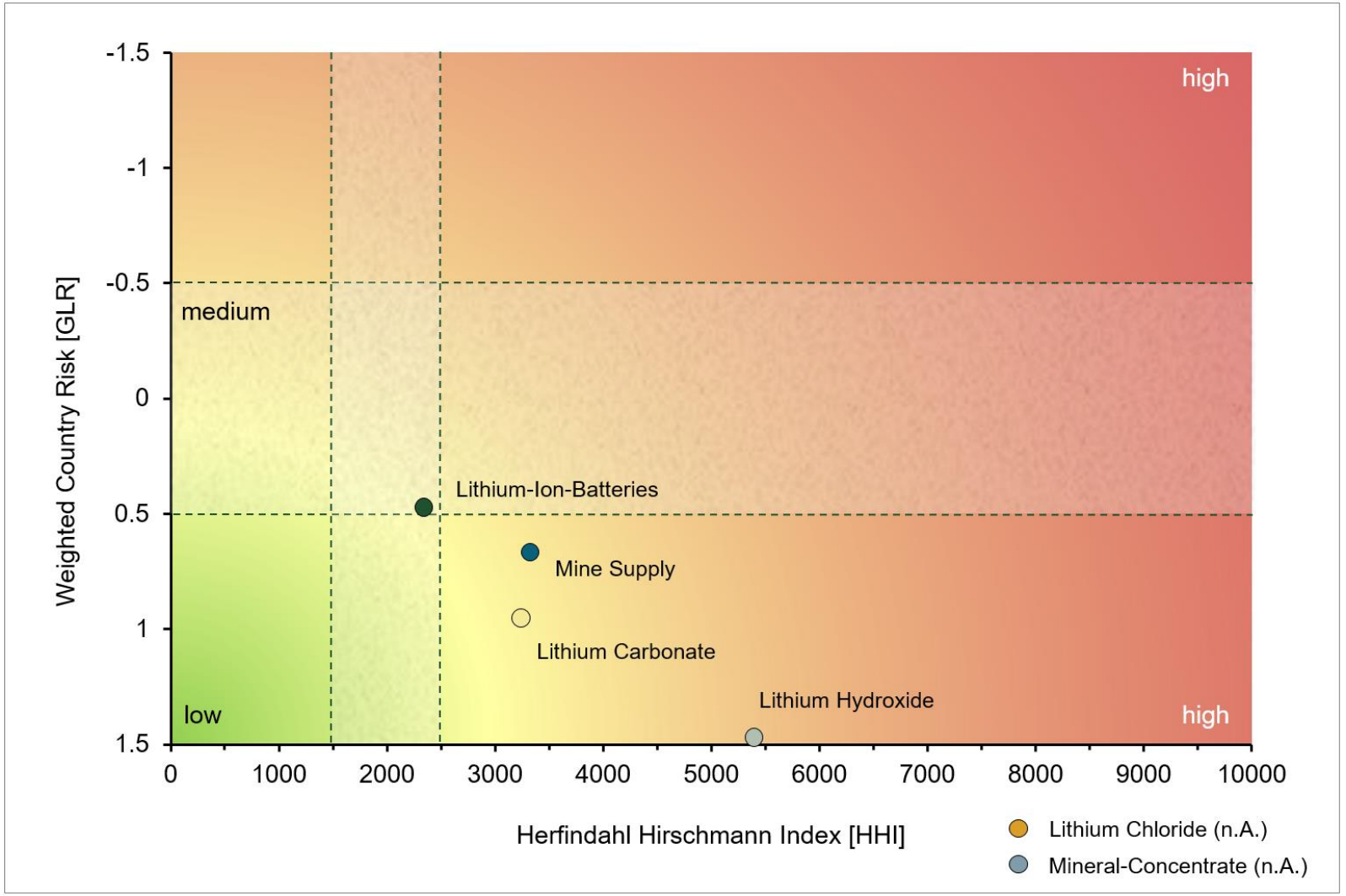


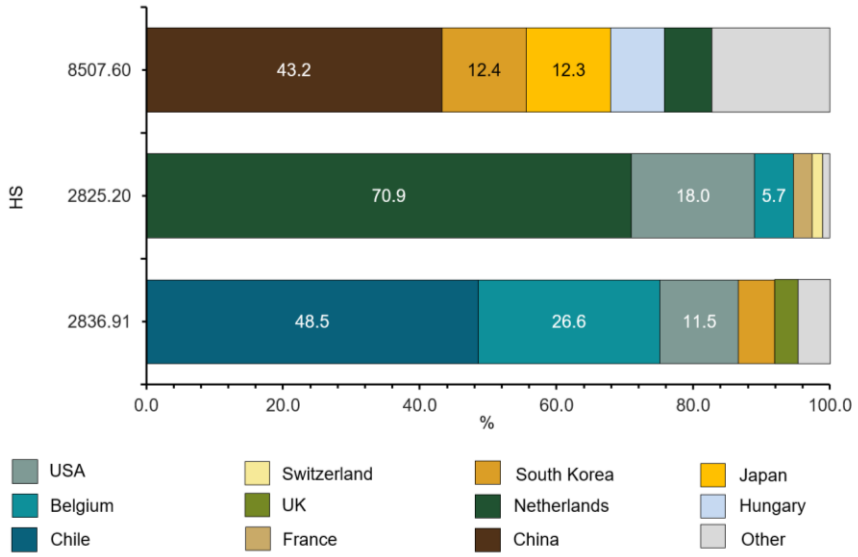


GEOPOLITICAL RISKS OF GLOBAL NET-EXPORTS 2021

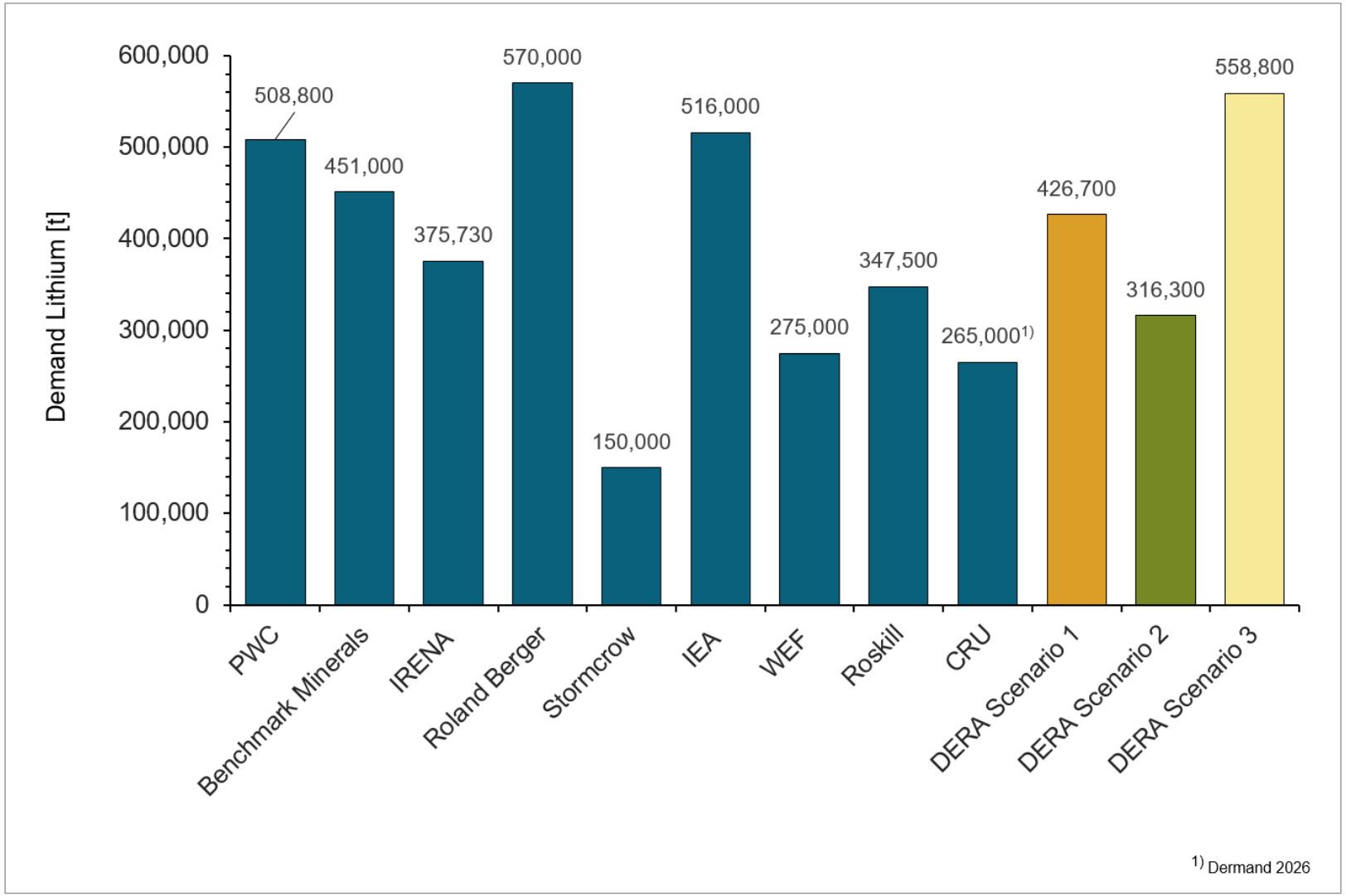


GEOPOLITICAL RISKS OF GERMAN IMPORTS 2021





DEMAND 2030 (WHO KNOWS….)



Quo Vadis E-Mobility??

- Extremely dynamic developments.
- Demand will be dominated by LIB.
- E-Mobility as major demand driver.
- China is key.
- EU and USA strong development.
- Regulatory frameworks will impact growth thus demand.
- Customer acceptance and infrastructure are important factors.
- Technological advances play a role.
- Sustainable use of lithium as demand driver (E-SUV vs. small cars).
- Global economy, inflation and energy crisis.
- War in Ukraine.

DEMAND 2030

- **Top 3** Applications 2020:
  - ***Lithium-Ion-Batteries (LIB)***
  - ***Glass/Glass Ceramics/Ceramics (aggregated)***
  - ***Lubricating Grease***

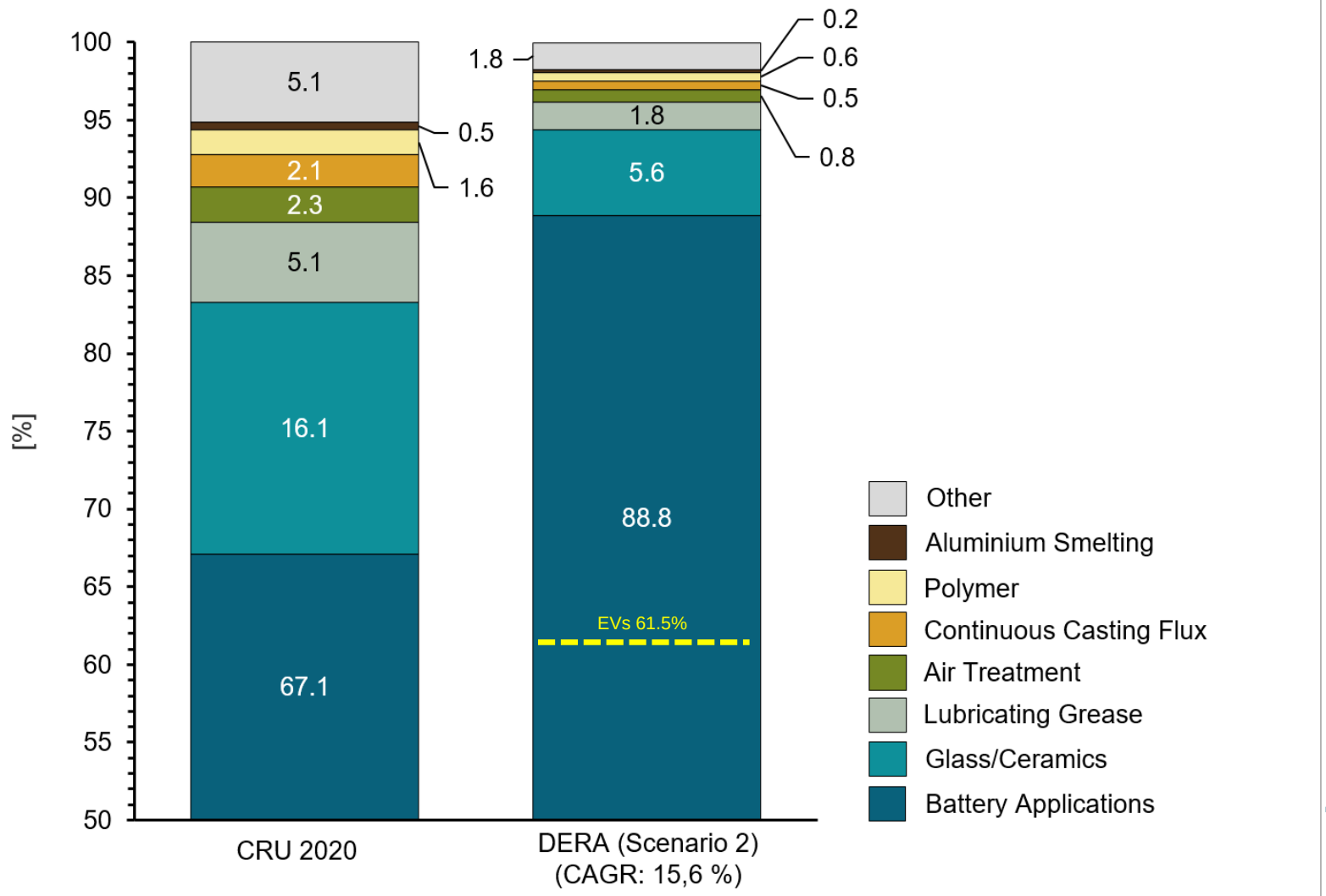
- Total demand growth until 2030: CAGR of **15.6** – **22.4** % p.a.
- Highest demand growth towards 2030 in Lithium-Ion-Batteries (**18.9** – **26.5** % p.a.).

  - E-Mobility: CAGR of **18** – **27.9** % p.a. (Three different scenarios)
  - 3C-Applications: CAGR of **5.3** % p.a.
  - Tools (incl. Drones, e-Bikes): CAGR of **22.6** % p.a.
  - Energy storage (ESS): CAGR of **29.1** % p.a.

- Glass/Glass Ceramics/Ceramics (aggregated): CAGR of **3.9** % p.a.
- Lubricating Grease: CAGR of **3.9** % p.a.

- Other: CAGR of **3.4** % p.a.

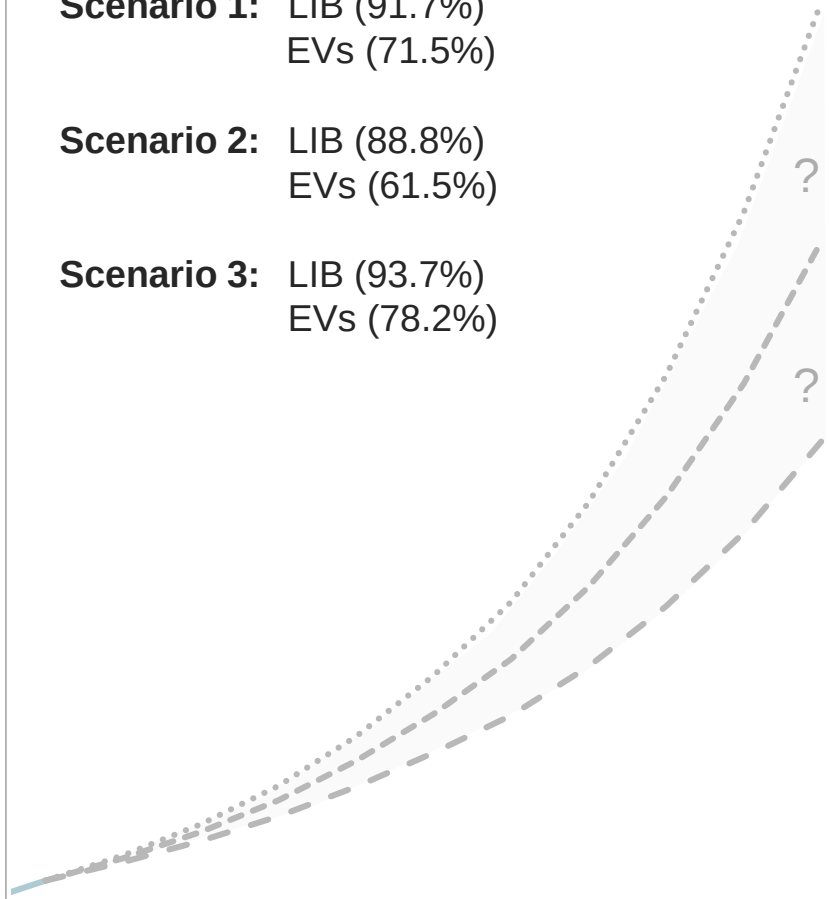
DEMAND 2030



Scenario 1: LIB (91.7%)
EVs (71.5%)

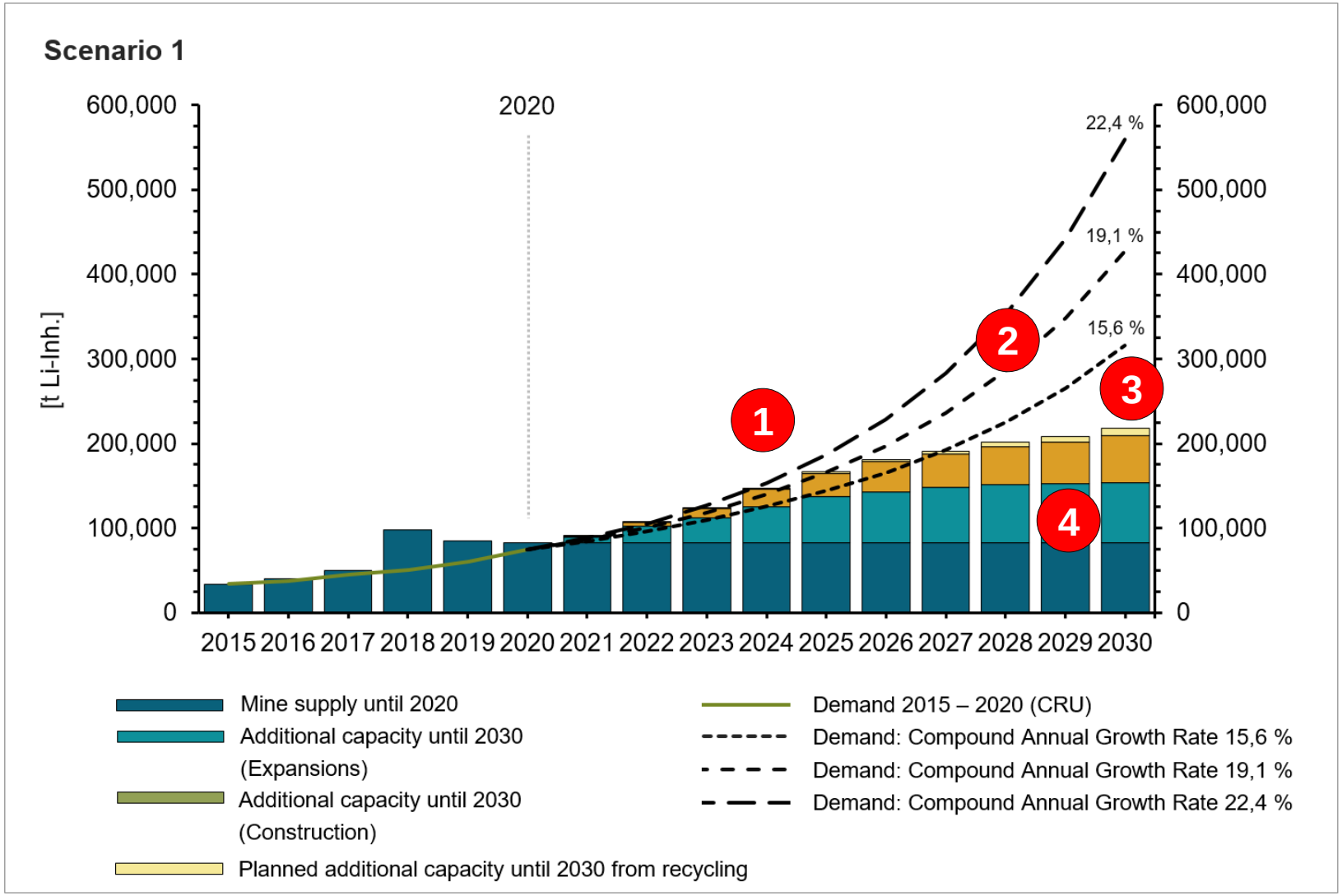
Scenario 2: LIB (88.8%)
EVs (61.5%)

Scenario 3: LIB (93.7%)
EVs (78.2%)



Source: BGR 2022

SUPPLY/DEMAND SCENARIO 1 (LOW CASE)



Supply 2020: 82.000 t

Supply 2030: 217,889 t

Demand 2030: 426,721 t (Scenario 1)

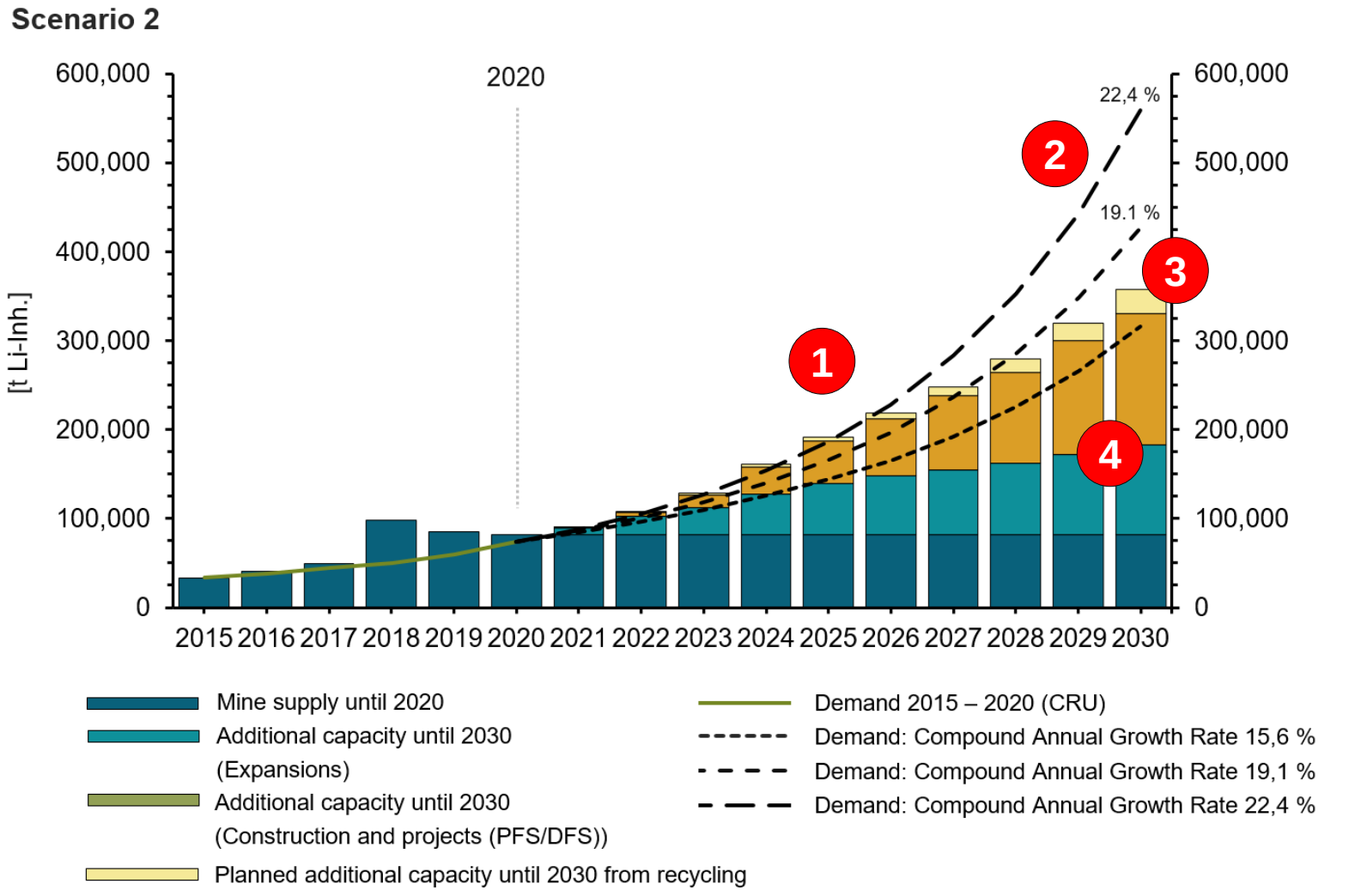
316,307 t (Scenario 2)

558,780 t (Scenario 3)

Supply/Demand Balance

- Scenario 1: **- 208,832 t** Lithium
  - 95.8 %
- Scenario 2: **- 98,418 t** Lithium
  - 45.2 %
- Scenario 3: **- 340,891** t Lithium
  - 156.5 %

SUPPLY/DEMAND SCENARIO 2 (HIGH CASE)



Supply 2020: 82.000 t

Supply 2030: 357,680 t

Demand 2030: 426,721 t (Scenario 1)

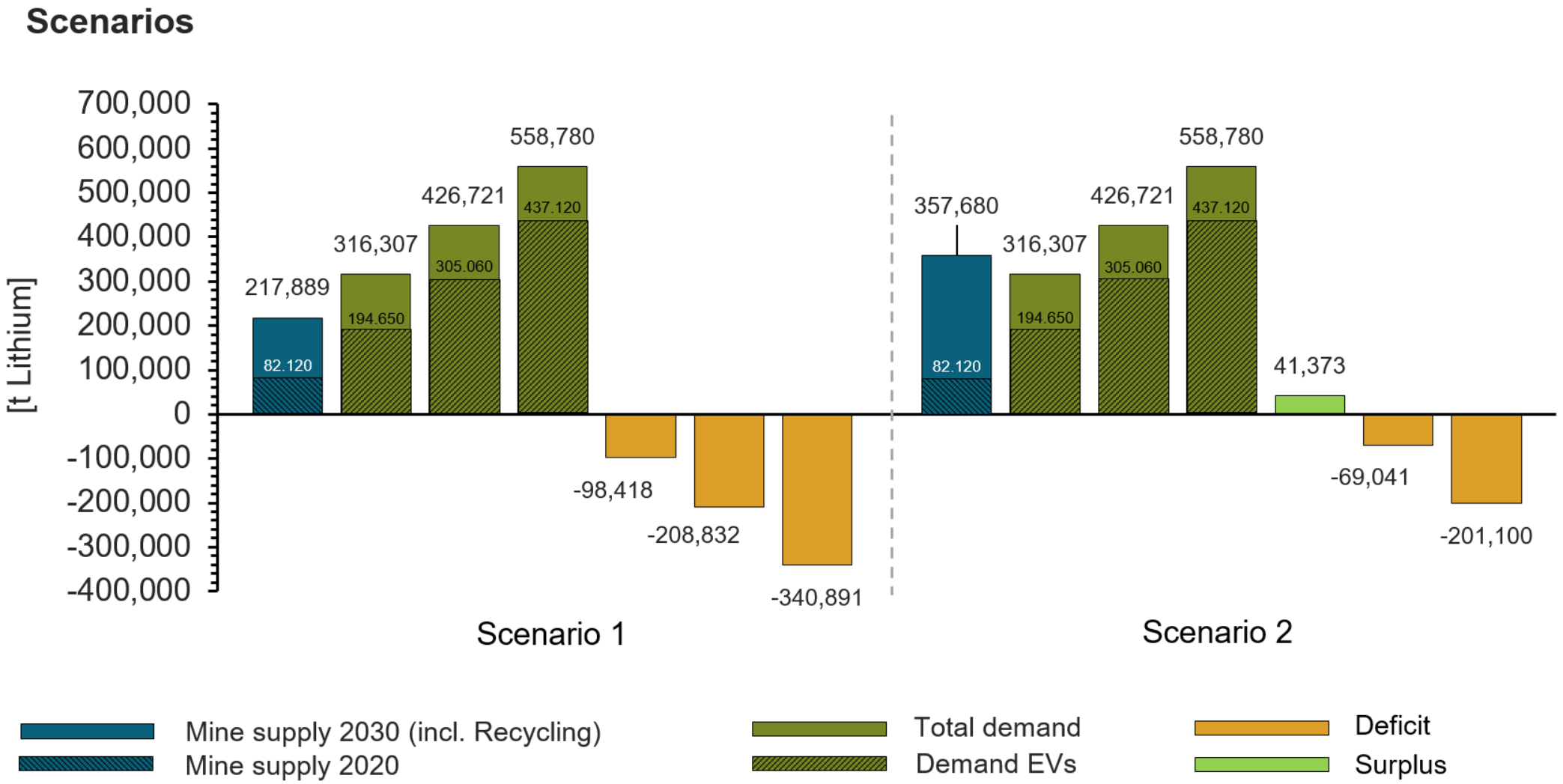
316,307 t (Scenario 2)

558,780 t (Scenario 3)

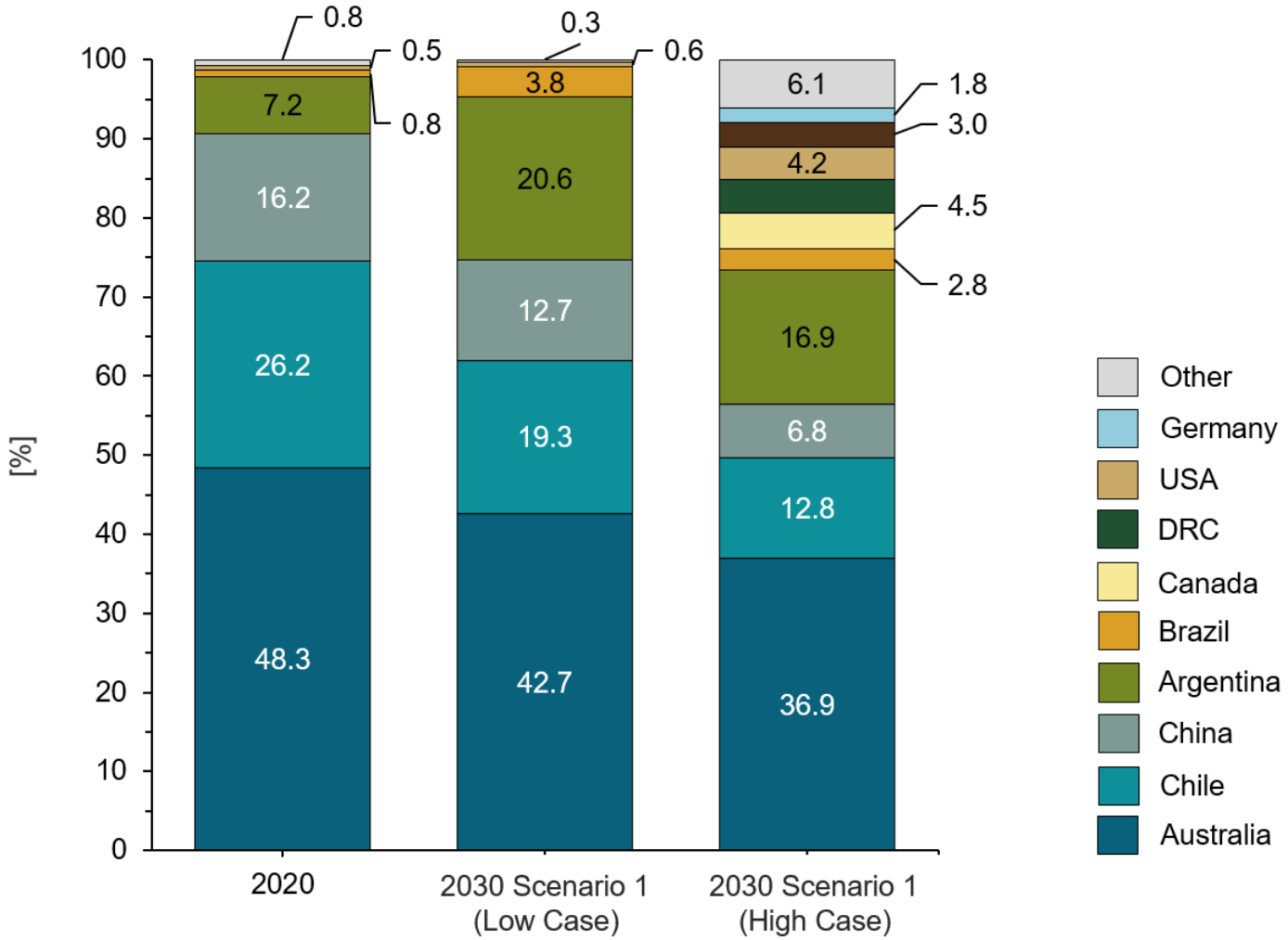
Supply/Demand Balance

- Scenario 1: **- 69,040 t** Lithium **-19.3 %**
- Scenario 2: **41,370 t** Lithium **11.6 %**
- Scenario 3: **- 201,100** t Lithium **-56.2 %**

SUPPLY/DEMAND SCENARIOS IN A NUTSHELL



SUPPLY 2030



Scenario 1

HHI: 2,795

GLR: 0.74

H/B = 53.7 % / 46.4 %

Scenario 2

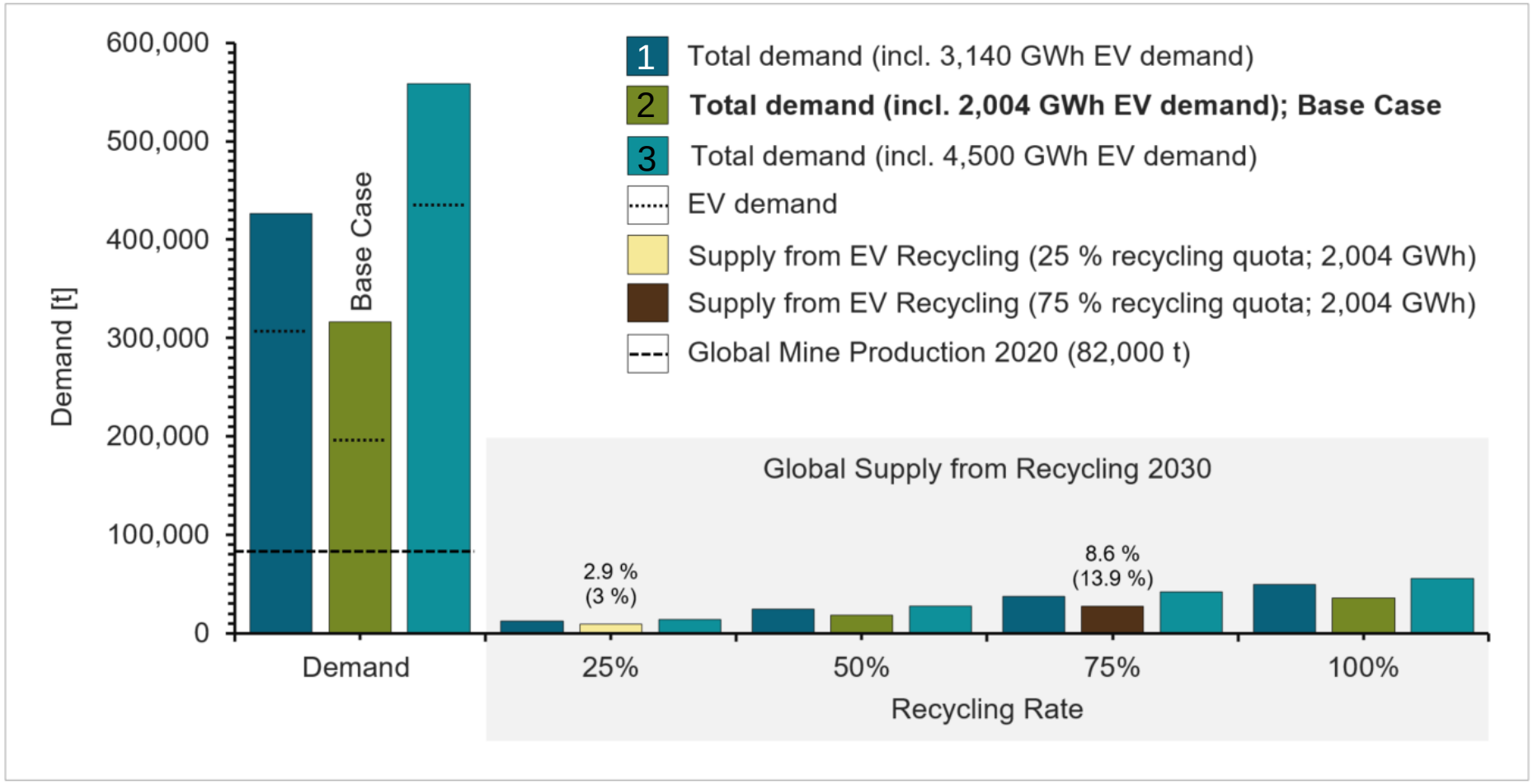
HHI: 1,938

GLR: 0.69

H/B = 62.6 % / 37 %

Source: BGR 2022

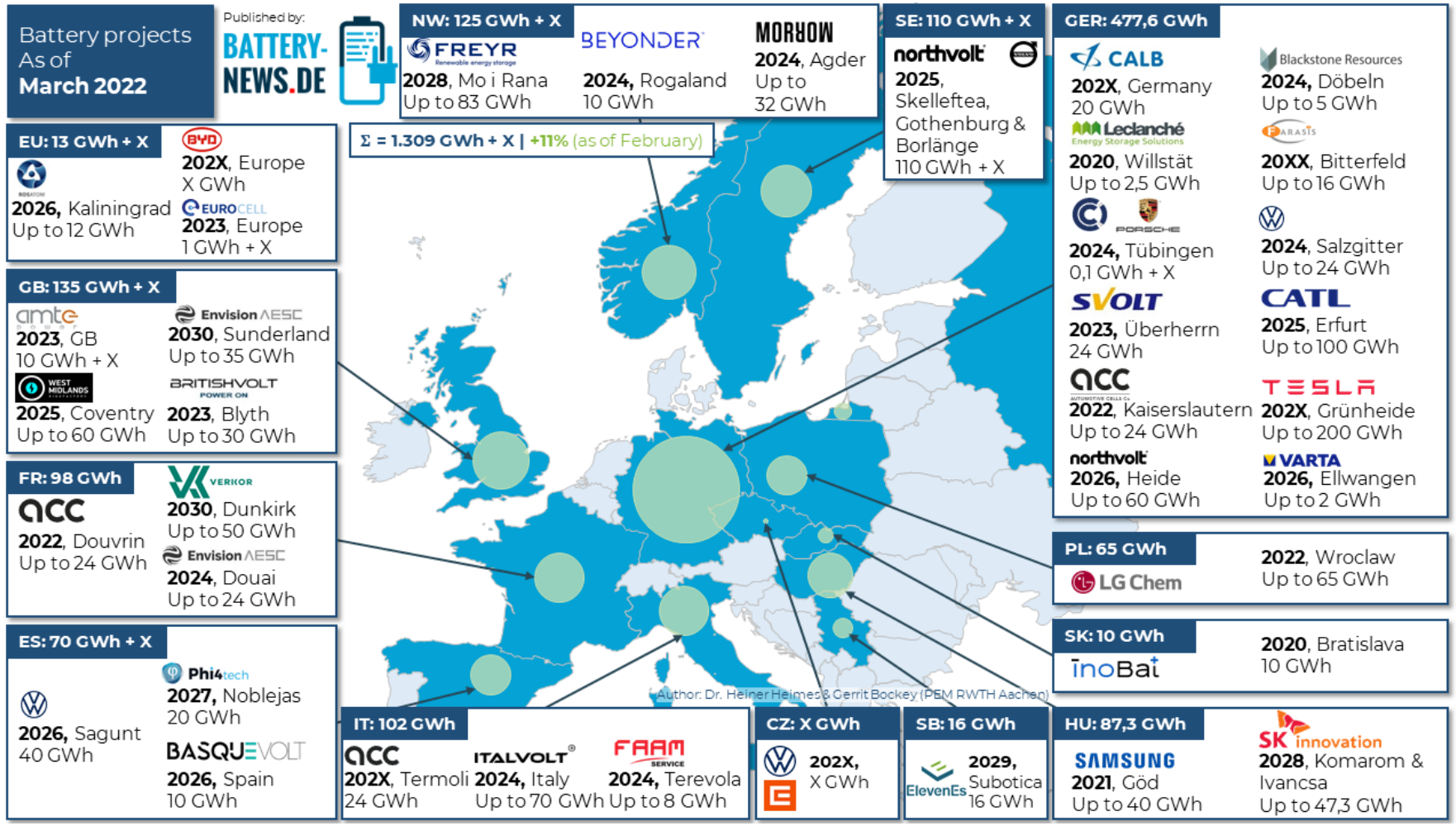
GLOBAL SECONDARY SUPPLY FROM SPENT EV BATTERIES



Key assumptions

- EV Batteries only.
- Return matrix based on demand 2020 – 2030
- 50 % return after 8 yrs.
- 60 % return after 10 yrs.
- 90 % return after 12 yrs.
- 10 % lost due to…
- Collection rate of 70 %.
- Recycling rate 25 %, 75 %.
- No secondary life.
- Material suitable for LIB.
- Processes are economically and ecoligically viable.

EUROPE AS A NEW EV INDUSTRY HOTSPOT



Demand 2030

@ 1.309 GWh = **127,300 t***

@ 1.000 GWh = **97,140 t***

@ 1.000 GWh = **72,500 t*** (75 % utilisation)

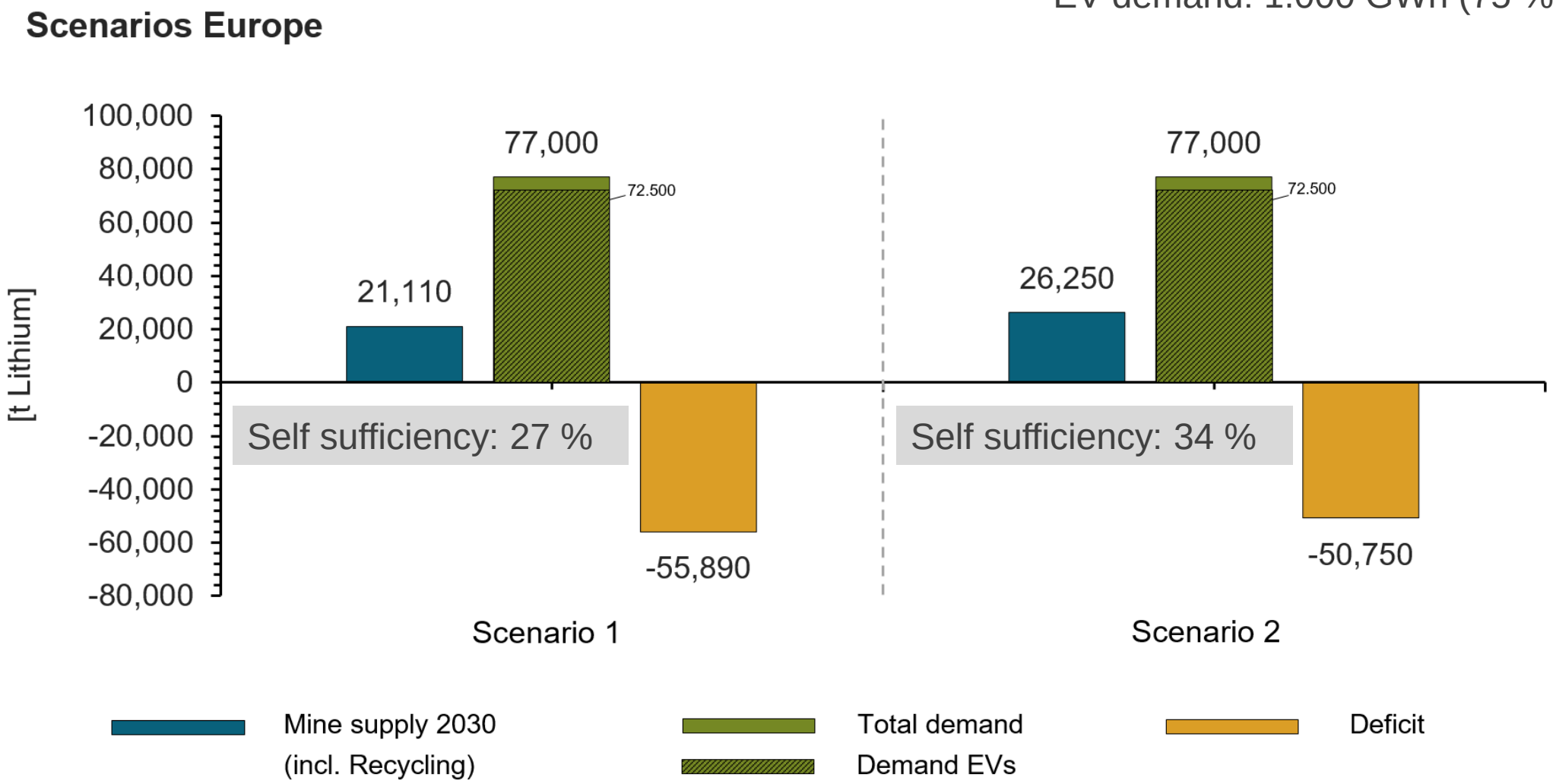
Base Case

Source: https://battery-news.de/index.php/2022/03/18/batterieprojekte-in-europa-stand-maerz-2022/

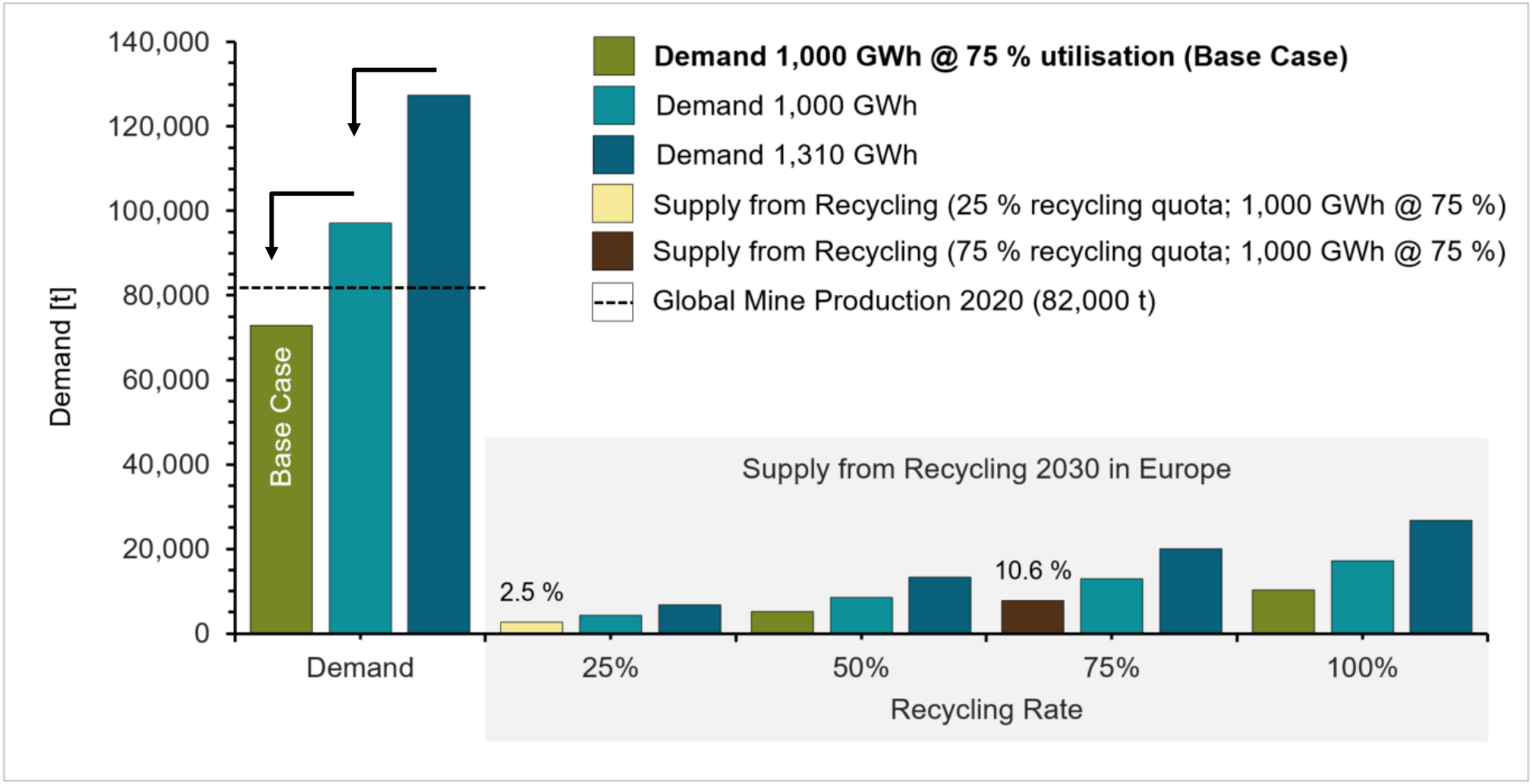
** Based on internal assumptions for cathode chemistry, cathode mix towards 2030, vehicle size and battery size.*

SUPPLY/DEMAND: A EUROPEAN PERSPECTIVE

EV demand: 1.000 GWh (75 % utilisation)



SUPPLY/DEMAND: A EUROPEAN PERSPECTIVE (SECONDARY SUPPLY)



EU Targets 2030/2035

- Key assumptions equal to global scenarios.
- **70 %** LIB collection rate
- **70 %** Lithium recovery rate
- **4 %** secondary lithium content in LIB (2030)
- **10 %** secondary lithium content in LIB (2035)

SUSTAINABILITY

Contents lists available at ScienceDirect

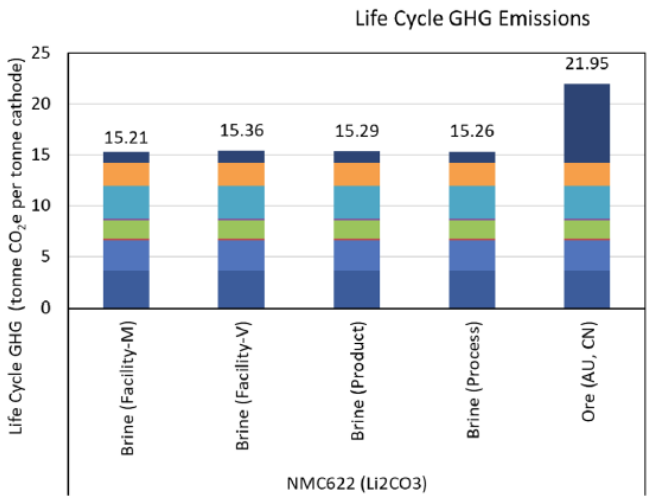
Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full length article

Energy, greenhouse gas, and water life cycle analysis of lithium carbonate and lithium hydroxide monohydrate from brine and ore resources and their use in lithium ion battery cathodes and lithium ion batteries

Jarod C. Kelly *, Michael Wang, Qiang Dai, Olumide Winjobi



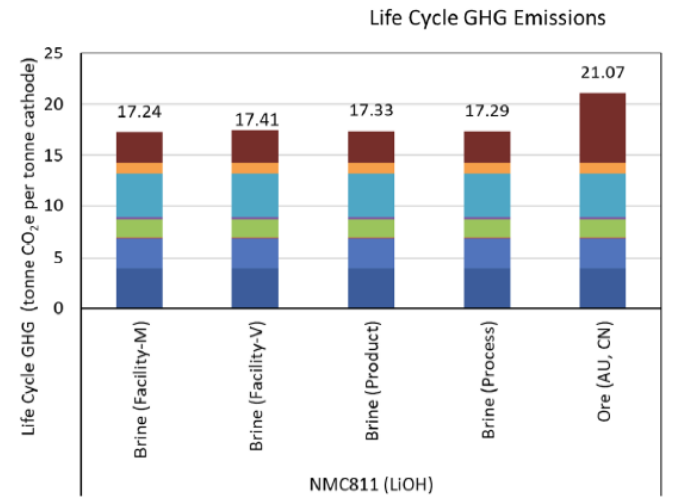


Table 6
Results of LCA for lithium concentrates and chemical products from brine and ore.

Lithium source	Stage of evaluation	GHG emissions	Energy consumption	Freshwater consumption
Brine	Lithium concentration	0.08–0.18 t CO_2e/tonne lithium concentrate	1300–2800 MJ/ tonne lithium concentrate	2.95–7.30 m^3/tonne lithium concentrate
	Production of Li_2CO_3 from lithium concentrate*	2.7 – 3.1 tonne CO_2e/ tonne Li_2CO_3	30,000–36,000 MJ/tonne Li_2CO_3	15.5 – 32.8 m^3/tonne Li_2CO_3
	Production of $LiOH•H_2O$ from lithium concentrate	6.9 – 7.3 tonne CO_2e /tonne $LiOH•H_2O$	76,600–82,900 MJ/tonne $LiOH•H_2O$	31–50 m^3/ tonne $LiOH•H_2O$
Ore	Spodumene concentration	~0.42 tonne CO_2e/tonne spodumene	5500 MJ/tonne spodumene	3.4 m^3/tonne spodumene
	Production of Li_2CO_3 from spodumene*	20.4 tonne CO_2e/tonne Li_2CO_3	218,000 MJ/ tonne Li_2CO_3	77 m^3/tonne Li_2CO_3
	Production of $LiOH•H_2O$ from spodumene	15.7 tonne CO_2e/tonne $LiOH•H_2O$	187,200 MJ/ tonne $LiOH•H_2O$	69 m^3/tonne $LiOH•H_2O$

Source: https://www.sciencedirect.com/science/article/pii/S0921344921003712

FINAL THOUGHTS ON EUROPE

- Europe is becoming is an major hotspot in the EV industry.
- Currently strong import dependency for lithium chemicals (i.e.: LiOH, Li_2CO_3).
- Import has a certain CO_2 footprint which depends on the source (Brine vs. Hard Rock).
- Downstream industry starts to develop (Refineries, Converter etc.).
- European lithium demand in 2030 approx. **410 kt LCE** (≈77 kt Li-cont.) [1,000 GWh EV @ 75 % scenario]
- Lithium projects in: Czech Republic, Germany, Portugal, Spain, Austria, Finnland.
- Additionally (non EU member projects): Serbia (Jadar, Rio Tinto [**ON HOLD**]; Valjevo), Bosnia (Arcore).
- Self sufficiency in the given Scenario **27** – **34 %** in 2030.
- Secondary supply as an alternative in the given Scenario **2.5** – **10.6** % in 2030 (EU target possible).
- **Import dependance will remain**.

FINAL THOUGHTS - THE GREAT DISCONNECT -

- The Lithium market is a specialty chemicals market and not conventional mining.
- Surplus in mine supply does **NOT** necessarily translate into sufficent chemical supply.
- Announced mine capacity is **NOT** equal to refining (chemical) capacity.
- Announced capacities and timelines of projects are „numbers“ and sometimes wishfull thinking.
- Derived chemical supply may or may not be directly suitable for downstream applications.
- In **Scenario 1** (low case) roughly **54 %** of supply is hardrock based.
- In **Scenario 2** (high case) roughly **63 %** of supply is hardrock based.
- This material needs to be converted into lithium chemicals. → **Mostly China**
- Therefore conversion capacity of spodumene will be key for future supply.
- Sustainability issues (Hard rock vs. Brine vs. Geothermal Brines).
- Many new brine based projects plan to introduce DLE technology for production that is yet not comercially applied in the industry.
- Supply uncertainties in many countries due to legal and regulatory issues (i.e. Mexico, Bolivia, Chile)

FINAL THOUGHTS

- Few major global players and China is dominant in the downstream sector with a clear strategy.
- Current lithium prices on all-time high levels (high price volatility).
- Potential key lithium salts classification as REPROTOX CAT 1A by the EU proposed by ANSES (France).
- Lithium demand for batteries (EVs) as major driver (≈ 90 % of total lithium demand in 2030)
- Primary lithium supply has to increase from 80 kt in 2020 to >320 - >550 kt in 2030 (4 to 7 fold).
- Demand projections difficult due to market dynamics (320 – 560 kt in 2030)
- Supply gap towards 2030 if no action from industry. Hard rock will dominate the market in 2030.
- Lithium is geologically not scarse. **Sufficient supply depends on timely development and investment.**
- Mine lead time 4 - 10 years. Refining lead time 12 – 24 months.
- CAPEX for 3 – 5 kt Lithium capacity approx. 300 - 500 Mio. € depending on location etc.
- Secondary supply will have to contribute and needs to be developed now (**DESIGN FOR RECYCLING**).
- Production and import of lithium chemicals has a certain water and CO_2 footprint which varies and depends mostly on the source (Brine vs. Hard Rock). ESG issues (high CO_2 emissions, mine and processing wastes).

Lithium

„Is the Hype over?“

NO…

It just started again…

Berlin, 23. Juni 2022

Rohstoffrisikobewertung – Lithium 2030
- *Update* –

THANK YOU

Michael Schmidt
Deutsche Rohstoffagentur (DERA)
in der Bundesanstalt für Geowissenschaften und Rohstoffe

Bundesministerium für Wirtschaft und Klimaschutz

Die Bundesanstalt für Geowissenschaften und Rohstoffe ist eine technisch-wissenschaftliche Oberbehörde im Geschäftsbereich des Bundesministeriums für Wirtschaft und Klimaschutz (BMWK).