

# FuLIBatteR – Future Lithium-Ion Battery Recycling for Recovery of Critical Raw Materials



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Coordinated by



Financially supported by





## K1-MET GmbH



## Initial Situation

E-mobility and CRM  
Green Technology and CRM  
Demand for CRM  
Supply Risk of CRM



## Project FuLIBatterR

Overview  
Structure  
Work Packages



## Summary

# K1-MET GmbH

Since 2015

Competence Center for  
Excellent Technologies in  
Advanced **Metallurgical**  
and **Environmental**  
Process Development

Budget: 22.7 M€

Main locations

- Linz
- Leoben

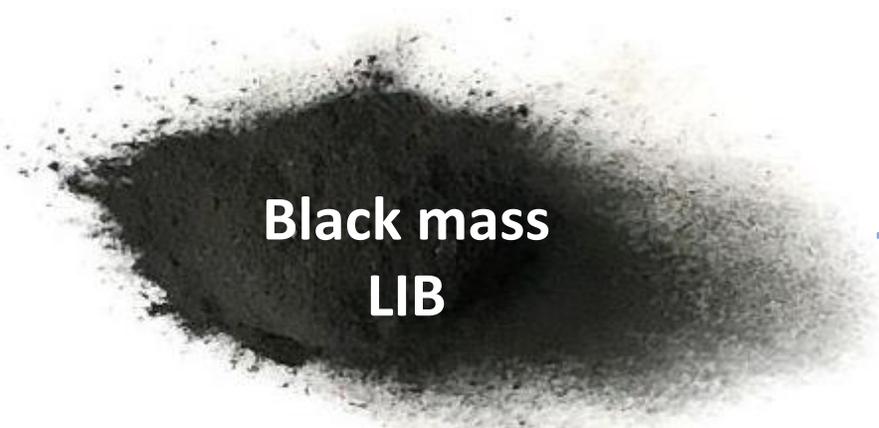
75 employees





## Four symbiotic areas:

- **Area 1: Raw Materials and Recycling**
  - Endeavours the best possible utilisation of all resources.
- **Area 2: Metallurgical Processes**
  - Unites the core topics of metallurgical process developments.
- **Area 3: Low Carbon Energy Systems**
  - Is dedicated to the developments of carbon-lean steel production.
- **Area 4: Simulation and Analyses**
  - Represents the enveloping area for numerical developments and data analyses.



Black mass  
LIB



### Four symbiotic areas:

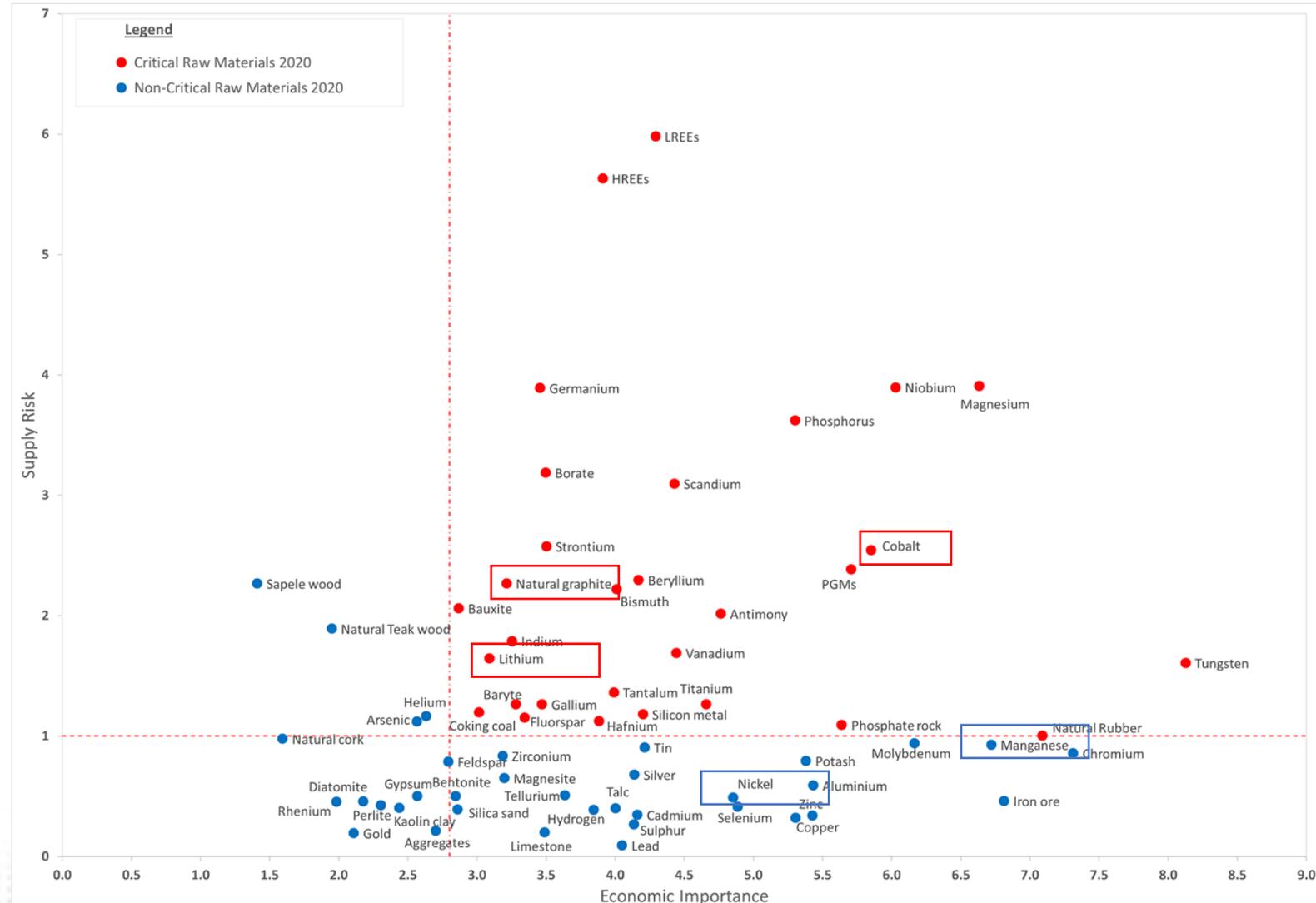
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# Initial Situation

## E-mobility and Critical Raw Materials

- **Energy Storage System (type NMC532)<sup>1</sup>**

- **8 kg Li**
- **35 kg Ni**
- **20 kg Mn**
- **14 kg Co**
- **Graphite**

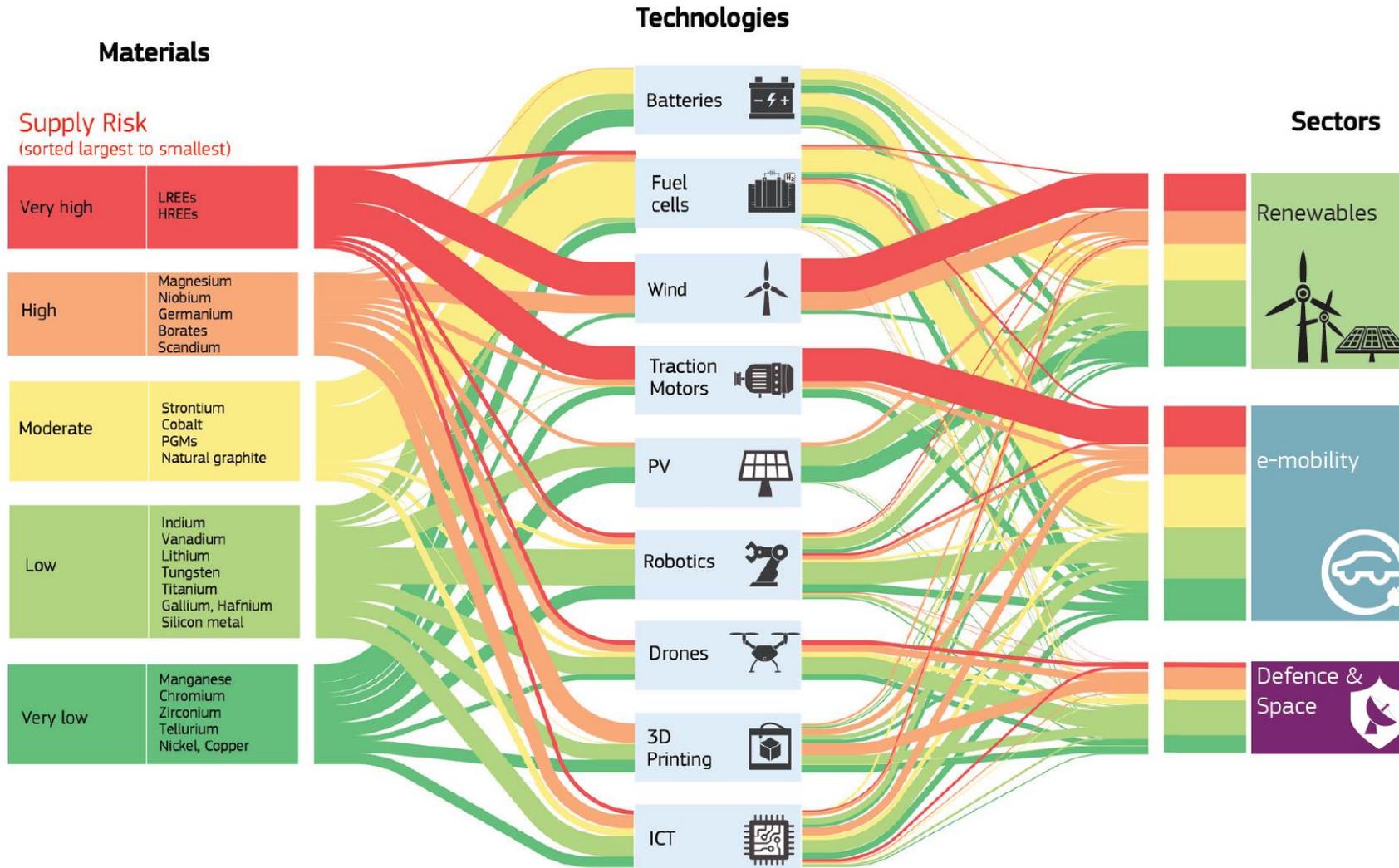


<sup>1</sup> Source: Argonne National Laboratory 2020

Figures: ESS BMWi3 Bmwblog 2017; RMIS - CRM list 2020

# Initial Situation

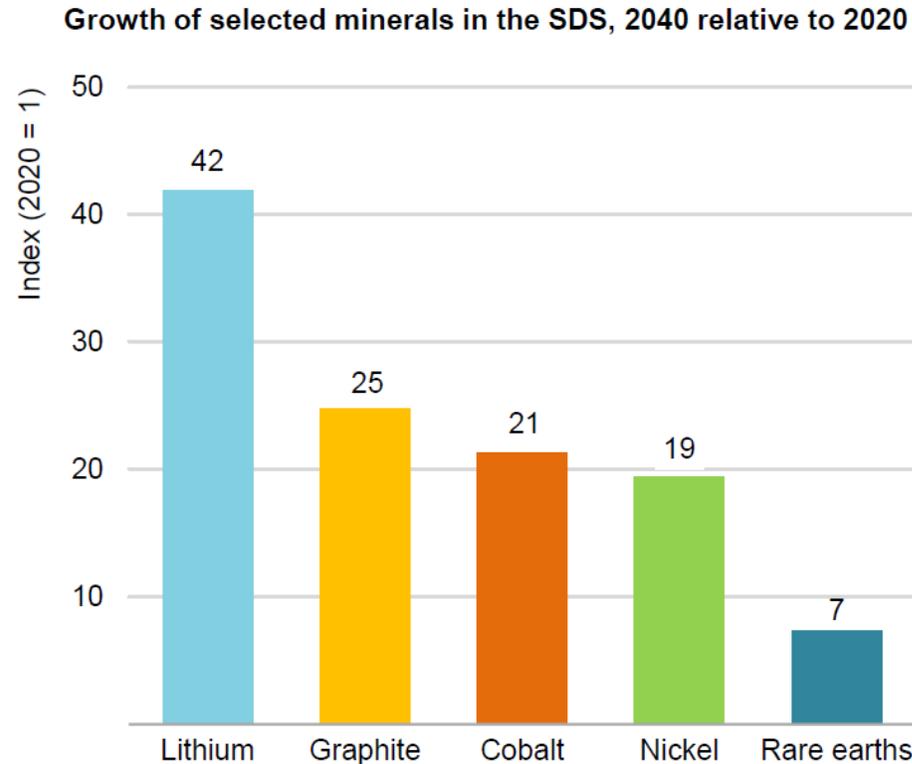
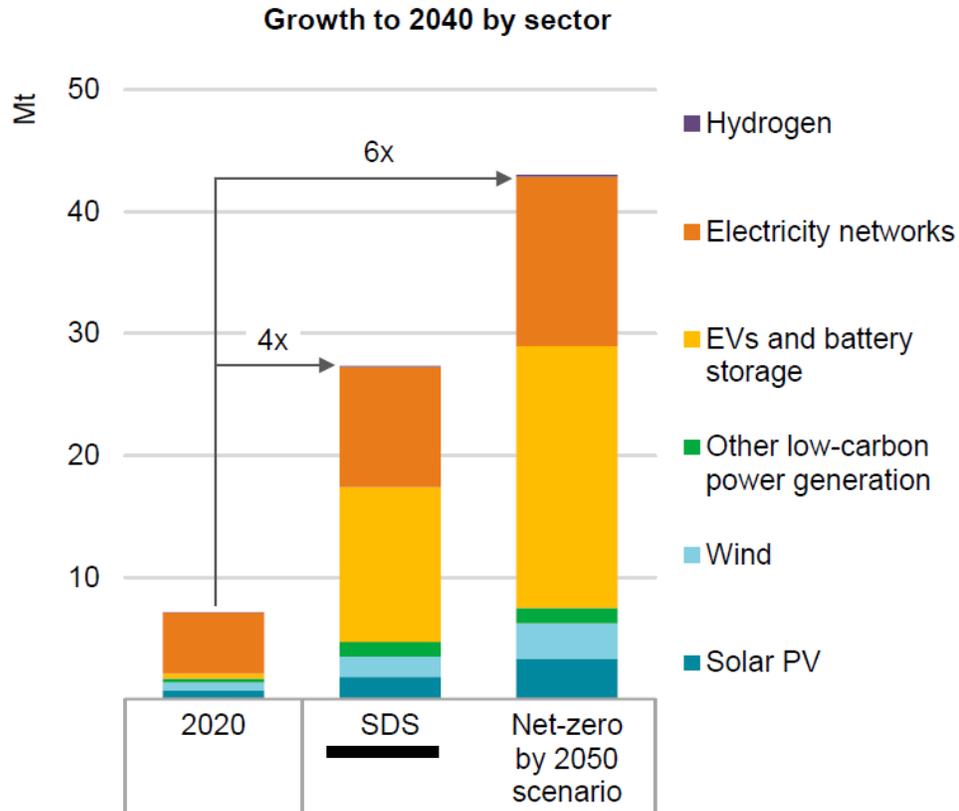
## Green Technologies and Critical Raw Materials



CRM are of significant economic importance for the EU

# Initial Situation

## Demand of Critical Raw Materials



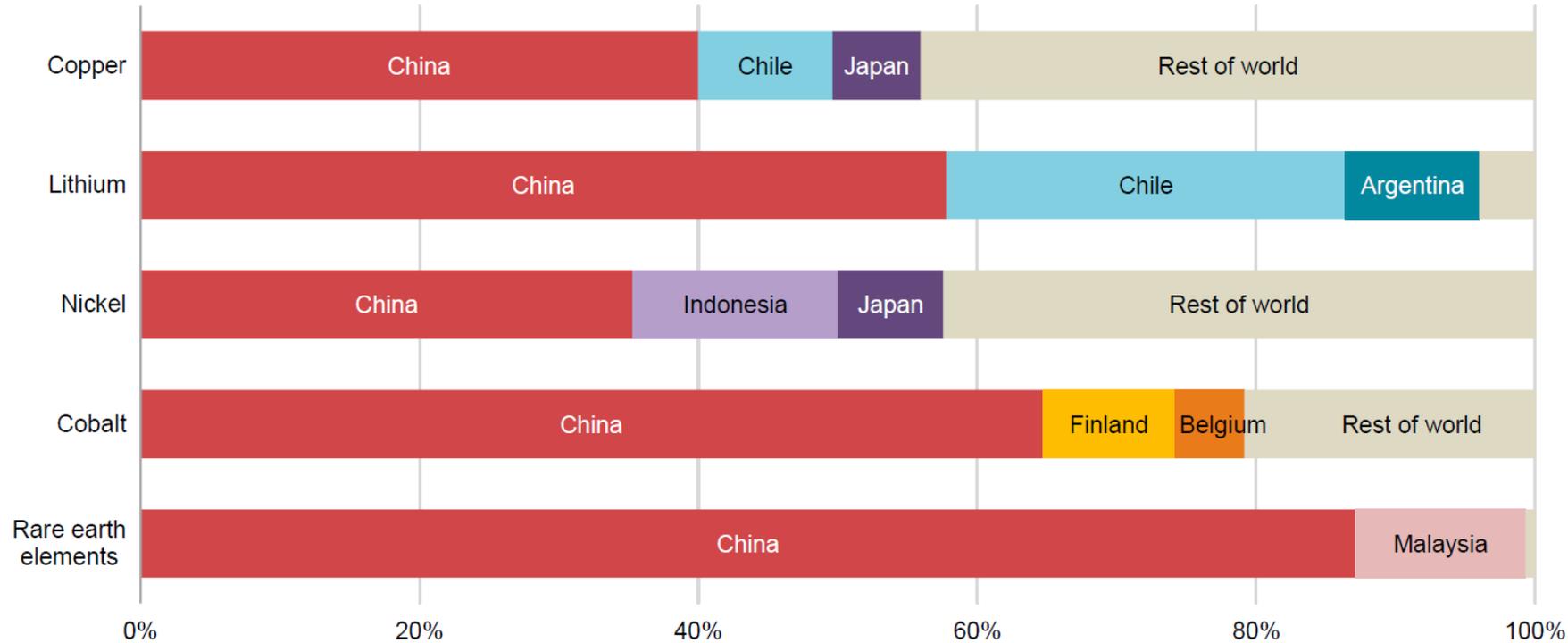
**SDS**  
Sustainable Development Scenario. Supply required to meet Paris Agreement Goals ( $\Delta T = +2,0^{\circ}C$ )

IEA. All rights reserved.

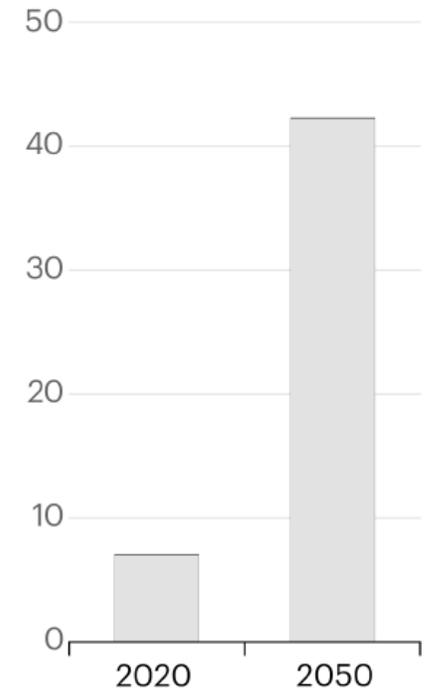
# Initial Situation

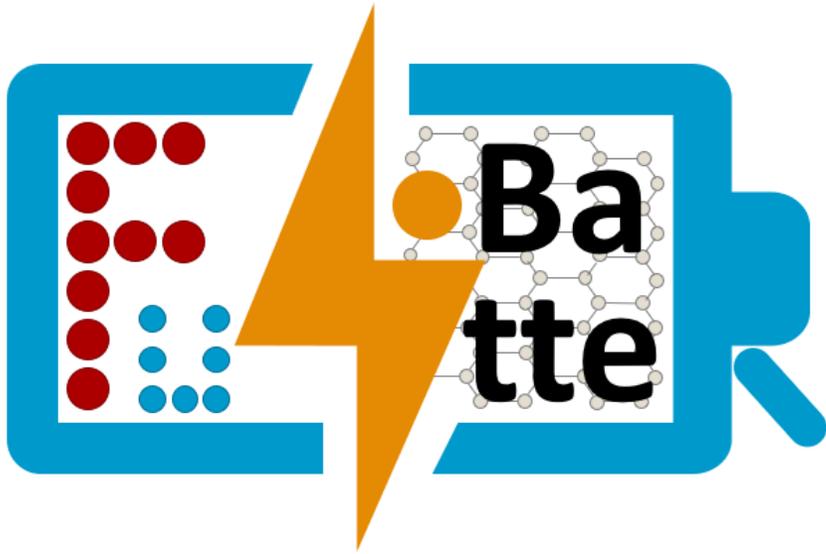
## Supply Risk of Critical Raw Materials

Share of processing volume by country for selected minerals, 2019



Critical minerals demand (Mt)





# Project FuLiBatter



# Project FuLiBatter

## Future Lithium-Ion-Battery Recycling for Recovery of CRMs



United Kingdom

Germany

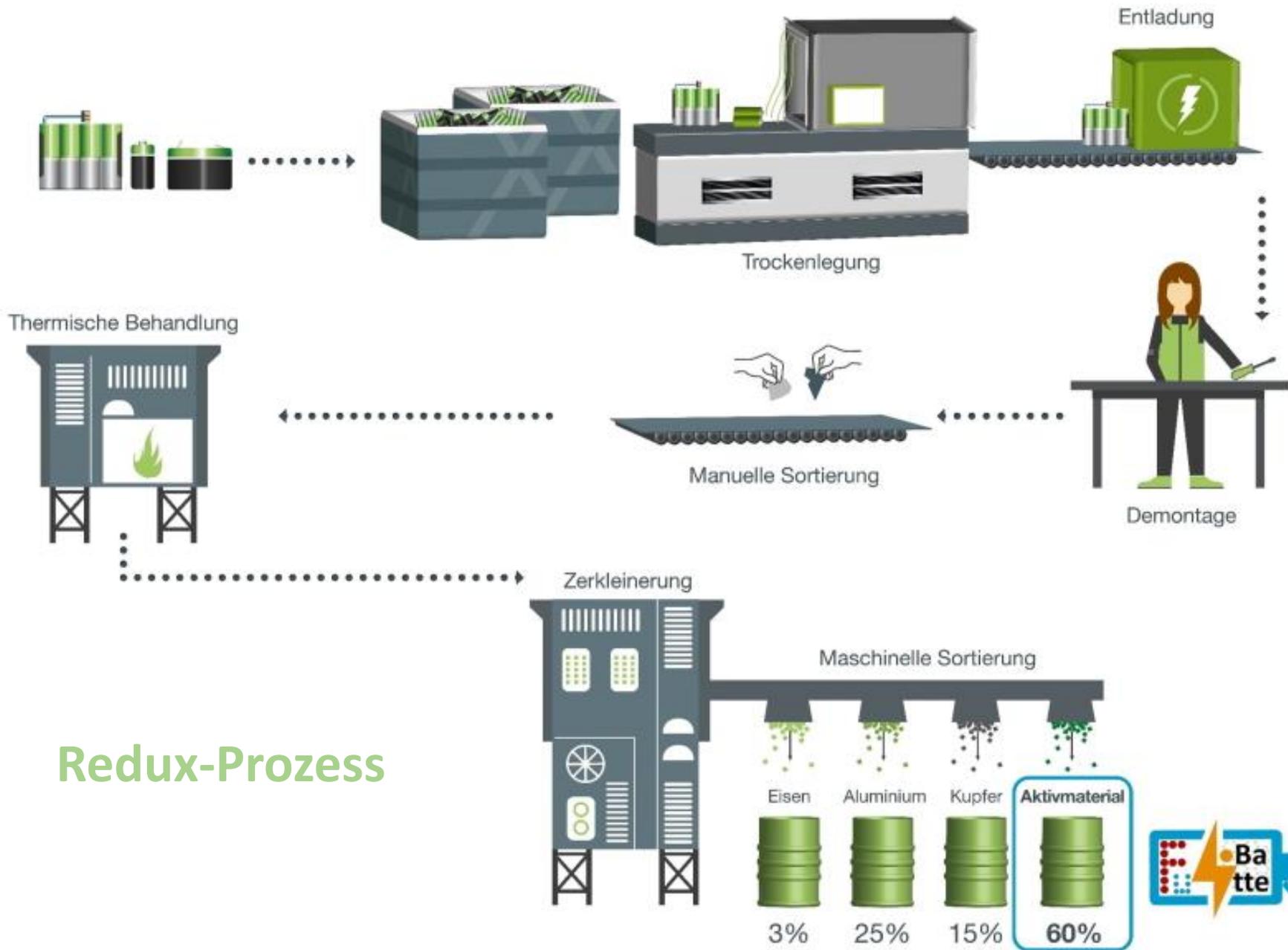


Duration  
Budget

07/2022 - 06/2026  
3.75 Mio €

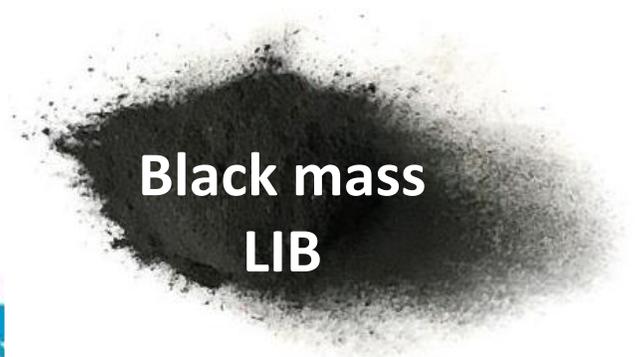
Austria

*Saubermacher*



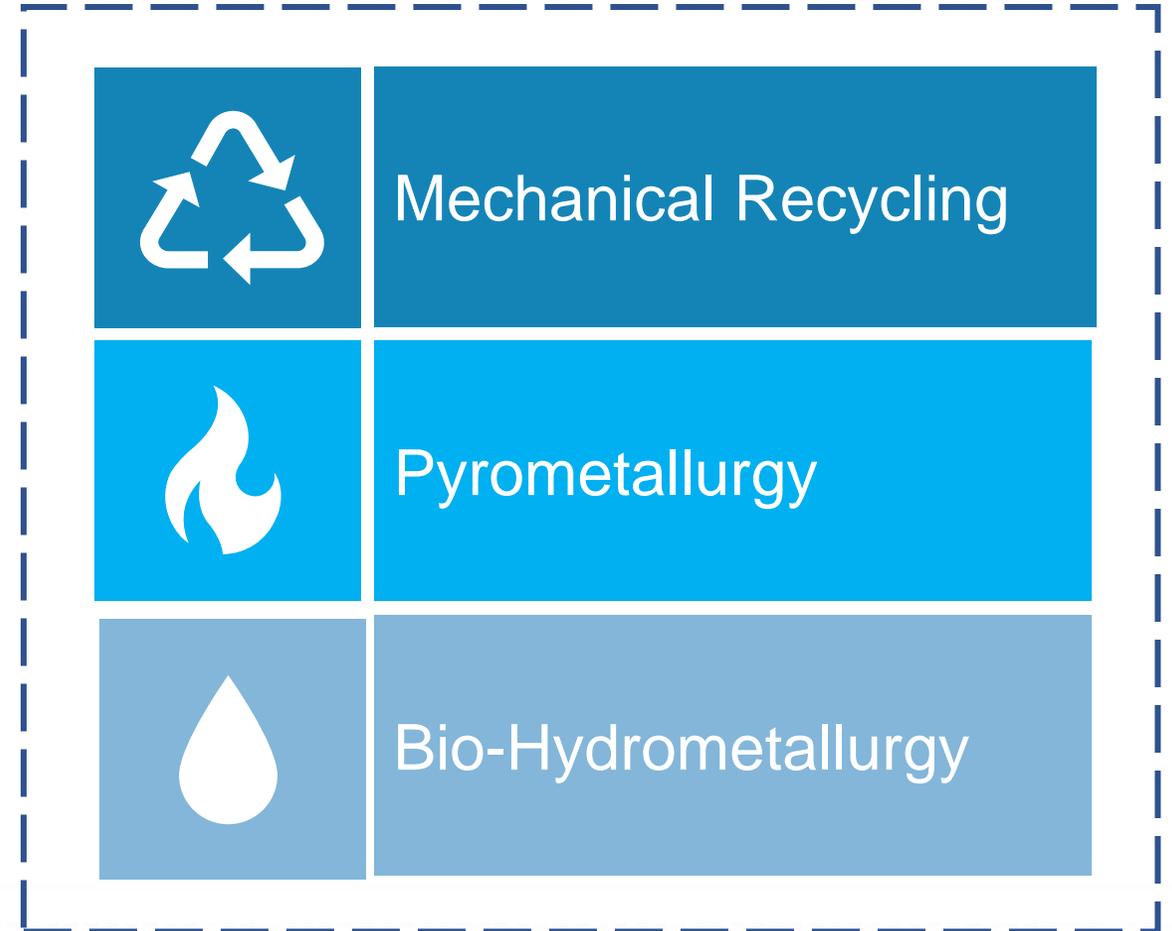
## LIB-ESS (type NMC532) <sup>1</sup>

- 8 kg Li
- 35 kg Ni
- 20 kg Mn
- 14 kg Co



Redux-Prozess

## LCA and Zero Waste Concept





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2026



Waste Management and Waste Technological Approaches for LIB Recycling



Pyrometallurgical Process of LIBs and Black Matter



Bio-Hydrometallurgical Treatment of LIB Residues

## 1 - Waste Management and Waste Technological Approaches for LIB Recycling



WP1.1: Physical separation of CRM fractions, quantitative evaluation, and quality verification

WP1.2: Processing of flotation liquid fraction

WP1.3: Materials characterisation and marketability evaluation of process outputs

WP1.4: Market analysis and identification of opportunities and challenges for LIB recycling

## 2 - Pyrometallurgical Process of LIBs and Black Matter



- WP2.1: Simulation and development of optimized thermal deactivation step in REDUX process
- WP2.2: Material specific investigations and process simulation based on thermodynamics
- WP2.3: High-temperature experiments in inductively heated packed bed reactor
- WP2.4: Post-treatment of pyrometallurgical recycling output

## 3 - Bio-Hydrometallurgical Treatment of LIB Residues



WP3.1: Selection and cultivation of microorganisms

WP3.2: Bioleaching batch tests and process scale-up advances

WP3.3: Catalysis of leaching reaction by biosurfactants and metal ions

WP3.4: Metal recovery from leaching solutions



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2026



Waste Management and Waste Technological Approaches for LIB Recycling



Pyrometallurgical Process of LIBs and Black Matter

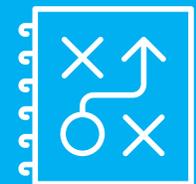


Bio-Hydrometallurgical Treatment of LIB Residues

MFA & LCA



Best option?



How to?

- **FuLIBatteR is committed to contribute its share to enable circularity**
- **Enable strategic resilience**
  - with regards to CRMs and other valuable raw materials on EU level (Li, Co, Ni, Mn, Cu, Al, P, C, Si)
- **Provide a solid basis for discussion of ecologically reasonable LIB recycling**
  - Life-cycle assessment of LIB recycling steps, Zero Waste concepts
- **Offer secondary raw materials for steelmaking and other resource intensive industries**
- **Transfer of science and technology**



**Please, feel free to visit our homepage or follow us on social media for updates!**

- <https://www.k1-met.com/>
- <https://www.researchgate.net/project/FuLIBatteR-Future-Lithium-Ion-Battery-Recycling-for-Recovery-of-Critical-Raw-Materials>
- <https://www.linkedin.com/company/k1-met/>



**Thank you for your attention!**



**DI Bettina Rutrecht**  
Area Raw Materials and Recycling

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