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

Bettina Rutrecht

Recy&Depotech, 9. November 2022

Coordinated by

Financially supported by

Content

K1-MET GmbH

Issues with LIB Recycling

Problem Definition

Project FuLIBatteR

Overview

Work Packages

Degree of Innovation

Objectives & Advantages

Expected Results

Take Home Message

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

Austrian funded research programme COMET

Research areas

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 steal production.
- **Area 4:** Simulation and Analyses
  - Represents the enveloping area for numerical developments and data analyses.

Austrian funded research programme COMET

Research areas

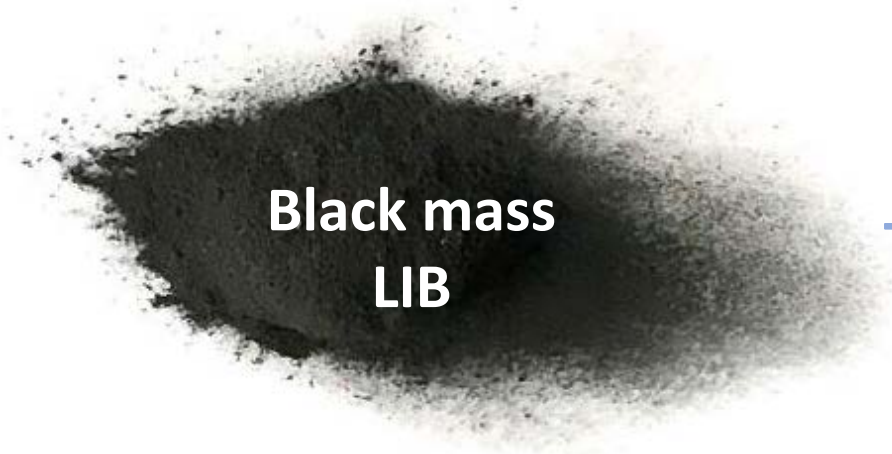


Figure: Bmwblog 2017

Four symbiotic areas:

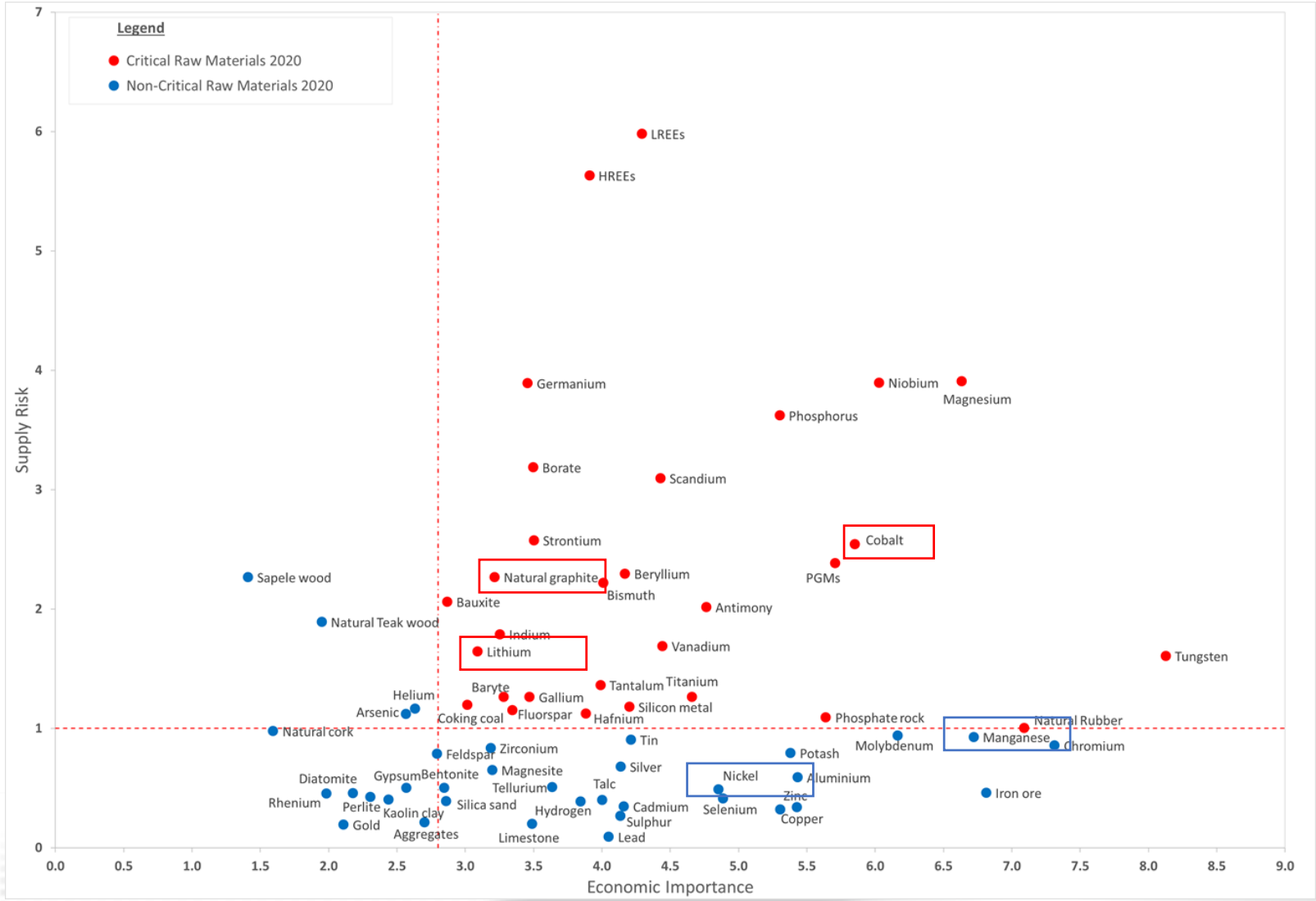
- **Area 1:** Raw Materials and Recycling
  - Endeavours the best possible utilisation of all resources.
- **Area 2:** Metallurgical Processes
  - Unites the core topics of metallurgical process developments.
- **Area 3:** Low Carbon Energy Systems
  - Is dedicated to the developments of carbon-lean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

Initial Situation

E-mobility and Critical Raw Materials

- **Energy Storage System (type NMC532)[1]**

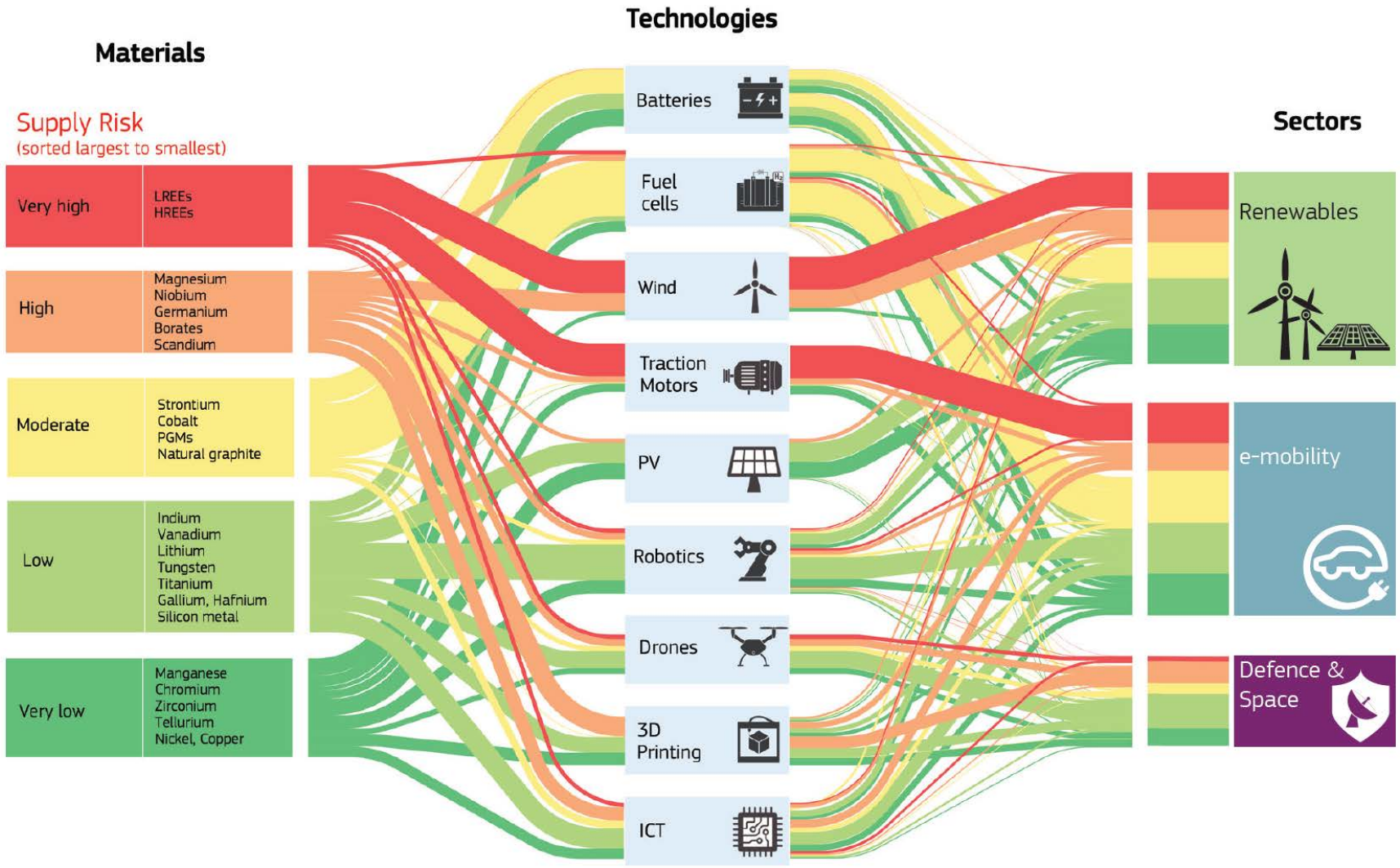
- **8 kg Li**
- **35 kg Ni**
- **20 kg Mn**
- **14 kg Co**
- **Graphite**



[1] Source: Argonne National Laboratory 2020
Figures: ESS BMWi3 Bmwblog 2017; RMIS - CRM list 2020

Initial Situation

Green Technologies and Critical Raw Materials

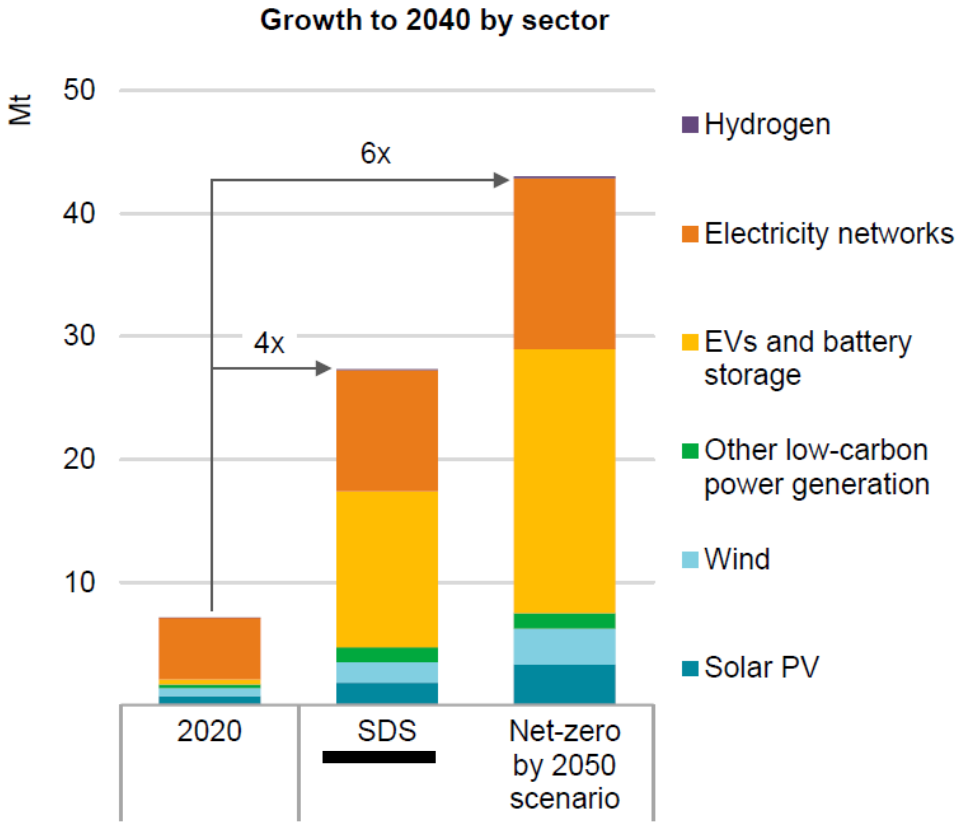


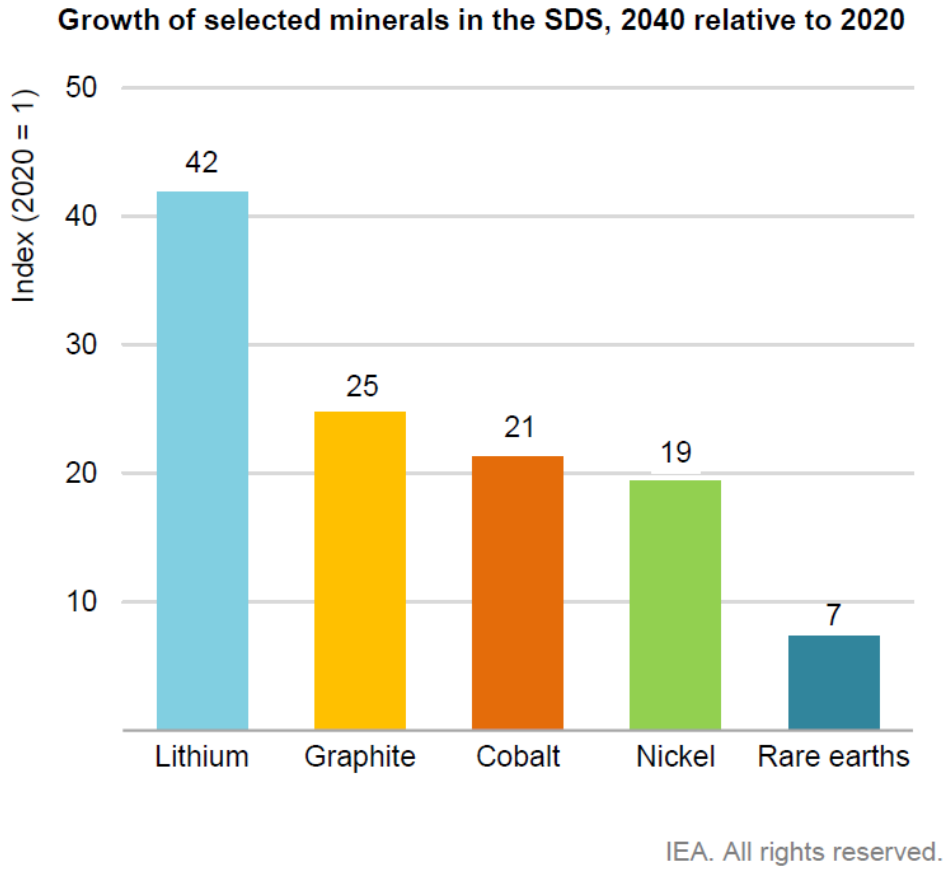
CRM are of significant economic importance for the EU

Figures: EC (2021) Critical Raw Materials for Strategic Technologies and Sectors in the EU – A foresight study

Initial Situation

Demand of Critical Raw Materials



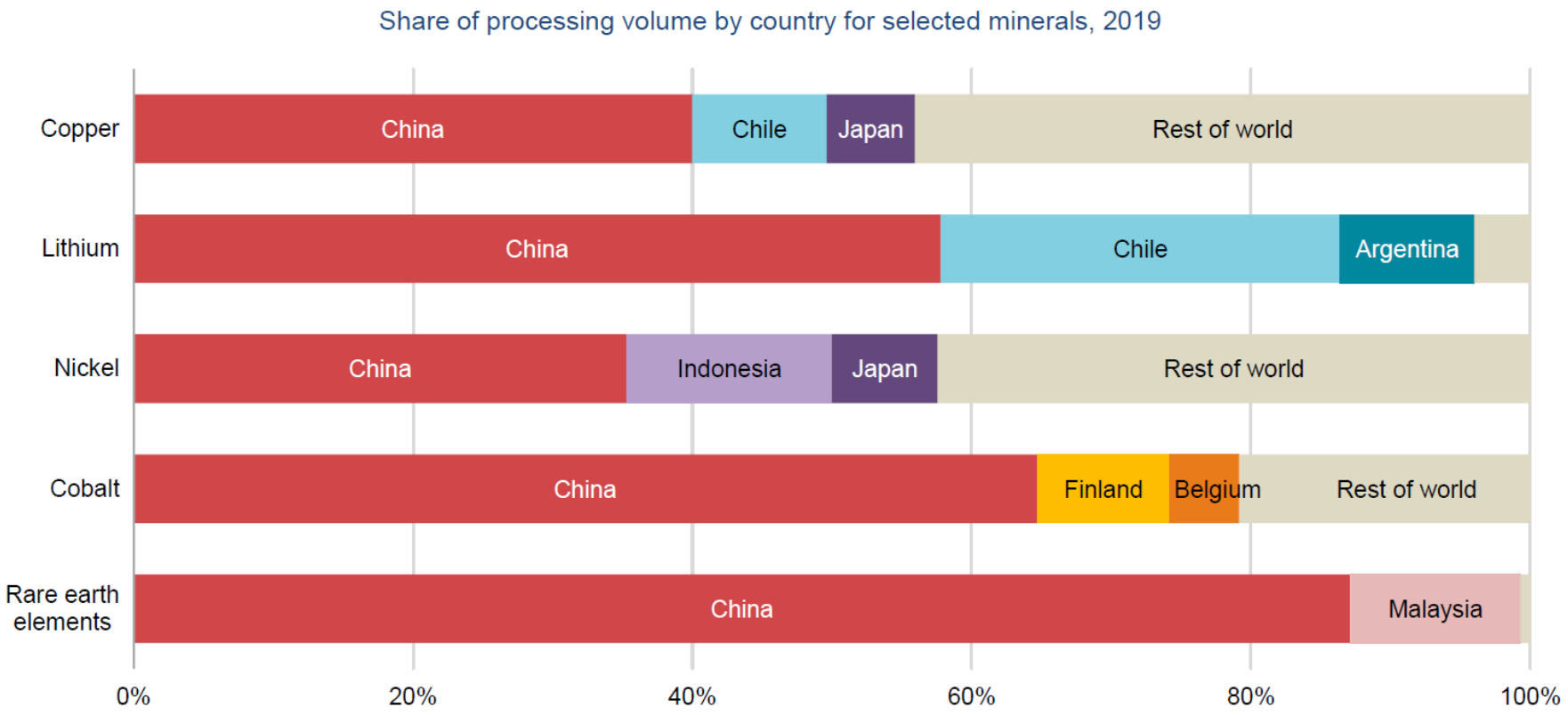


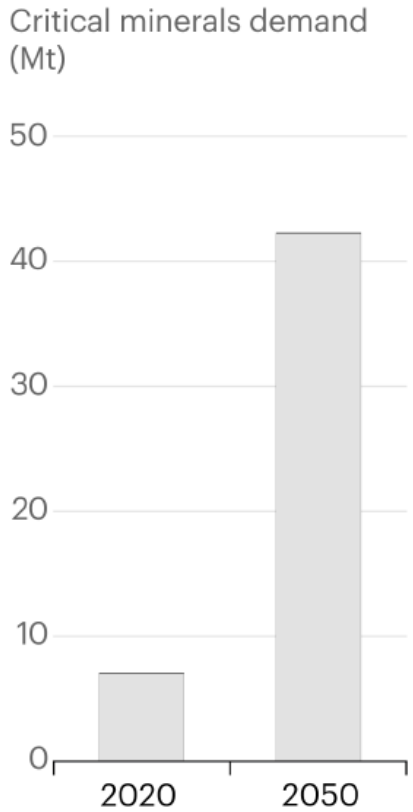
SDS
Sustainable Development Scenario. Supply required to meet Paris Agreement Goals (ΔT=+2,0°C)

Figures: IEA (2021) The Role of Critical Raw Materials in Clean Energy Transition

Initial Situation

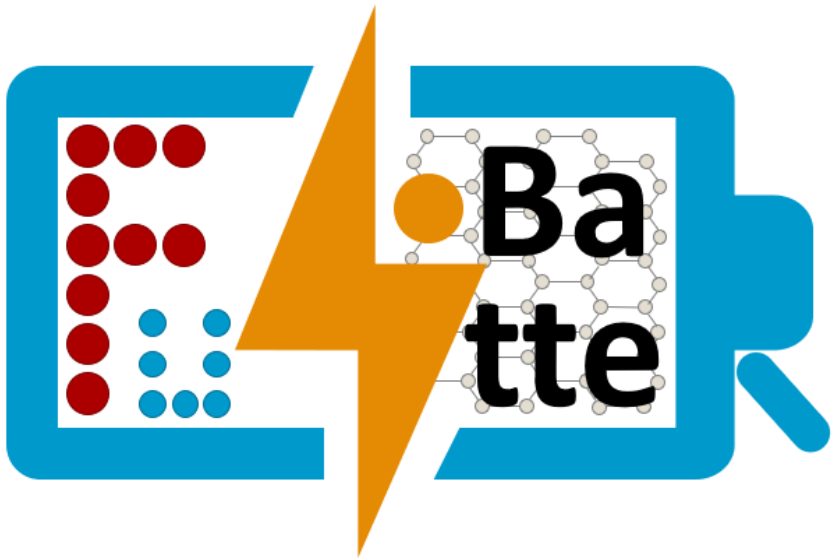
Supply Risk of Critical Raw Materials





Figures: IEA (2021) Net Zero by 2050 - A Roadmap for the Global Energy Sector

metallurgical competence center



Project FuLIBatteR

Project FuLIBatteR

Future Lithium-Ion-Battery Recycling for Recovery of CRMs

metallurgical competence center

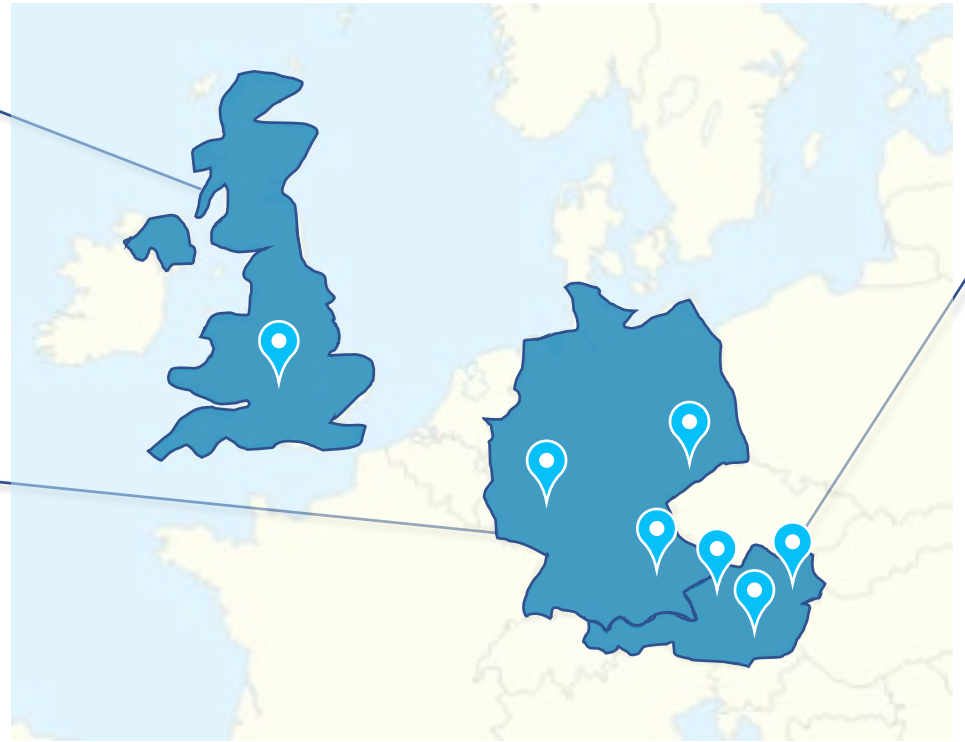
United Kingdom

Coventry University

Germany

UVR FIA VERFAHRENSTECHNIK FÜR ROHSTOFFE

B·R·A·I·N



Austria

EBNER®

K1 MET metallurgical competence center

RHI MAGNESITA

BOKU

christof industries

acib

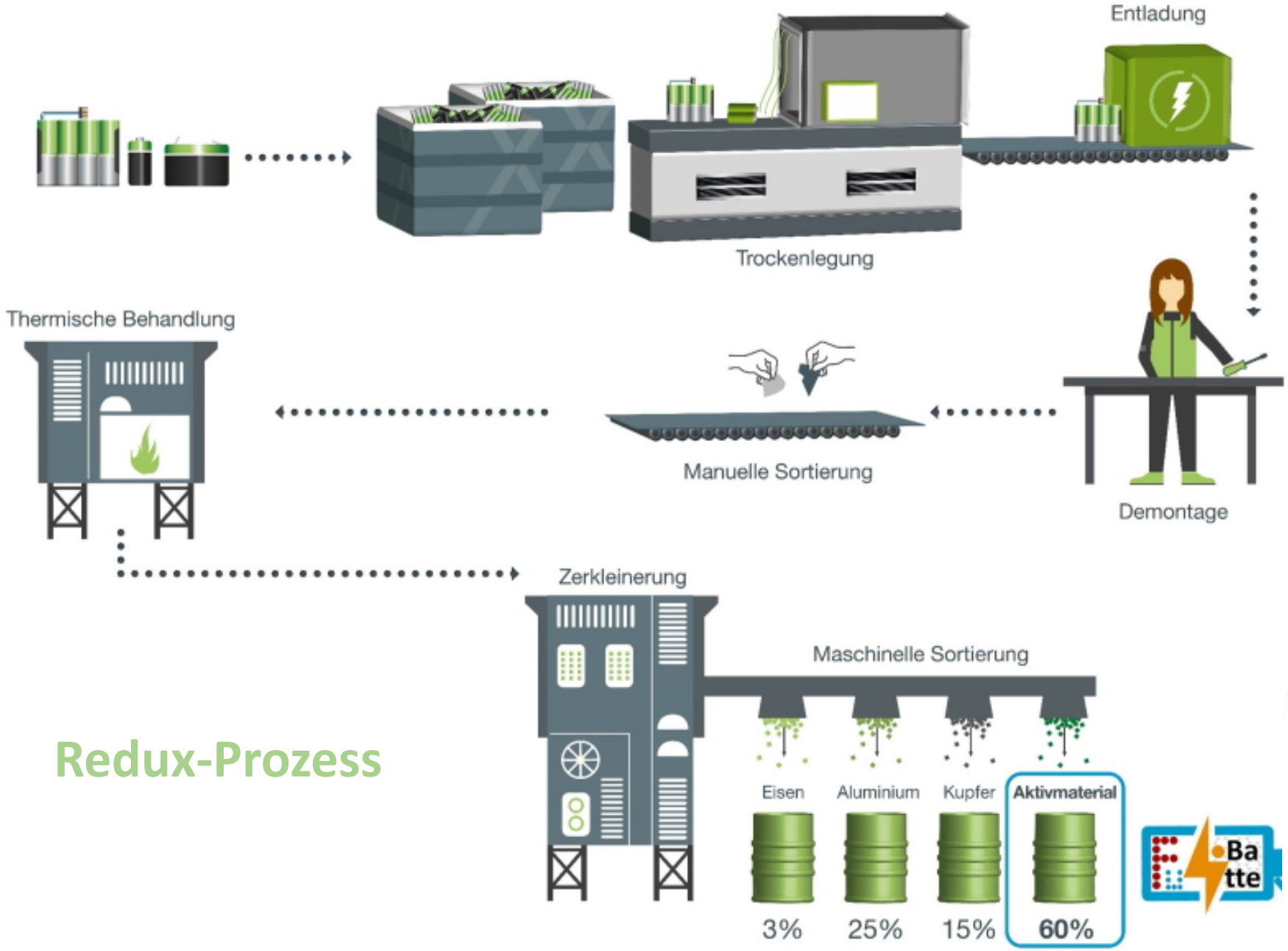
voestalpine ONE STEP AHEAD.

MONTAN UNIVERSITÄT

TÜV SÜD Landesgesellschaft Österreich

Saubermacher

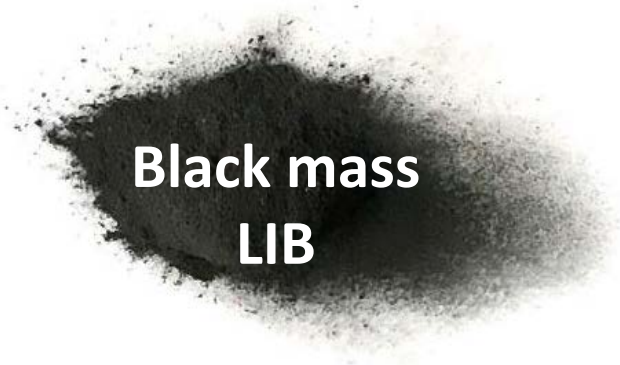
Duration	07/**2022** - 06/**2026**
Budget	**3.75 Mio €**



Redux-Prozess

LIB-ESS
(type NMC532) [1]

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



[1] Argonne National Laboratory (USA)

Project FuLIBatteR

LCA and Zero Waste Concept

- Mechanical Recycling
- Pyrometallurgy
- Bio-Hydrometallurgy

[1] Argonne National Laboratory (USA)

Project FuLIBatteR

FuLIBatteR 2026

Waste Management and Waste Technological Approaches for LIB Recycling

Pyrometallurgical Process of LIBs and Black Matter

Bio-Hydrometallurgical Treatment of LIB Residues

Project FuLIBatteR

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

Project FuLIBatteR

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

Project FuLIBatteR

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

Project FuLIBatteR

FuLIBatteR 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?

Summary Project FuLIBatteR

- **FuLIBatteR is commited 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 Follow us

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

K1-MET GmbH
Franz-Josef-Strasse 18
8700 Leoben, Austria
Phone: +43 / (0)3842 402 2274
Mobile: +43 / (0)664 590 85 22
Mail: bettina.rutrecht@k1-met.com
Web: www.k1-met.com