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Challenges and Chances in Battery Recycling and the Production of Secondary Raw Materials as a European Source for Battery Production

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Not all Batteries are the Same…

Batteries for Electric Vehicles

- Lithium- Ion
- Nickel-Metal Hydride

LMT and Industry

- Lithium- Ion
- Lead-Acid
- Nickel Cadmium
- …

Household Batteries

- Lithium
- Alkaline
- Nickel-Metal Hydride

Für eine lebenswerte Umwelt

Electric Vehicles: Lithium Ion Batteries

EV

Für eine lebenswerte Umwelt

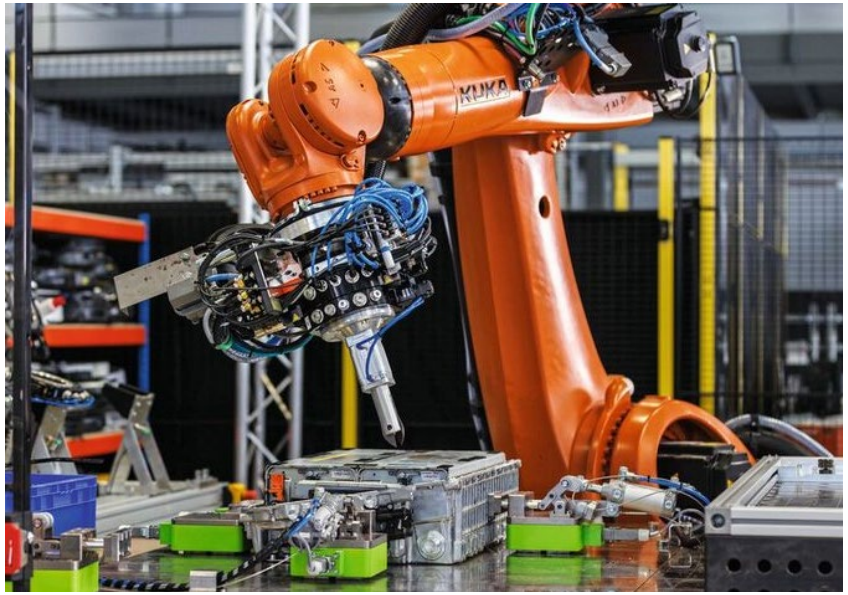
Field Services & Dismantling

Diagnostics & Sorting

Manual Dismantling

Discharging & safe deactivation

Storage, Packaging & Transport



Recycling

Thermal Pre-Treatment

Mechanical Treatment: Shredding and Separation

Black Mass

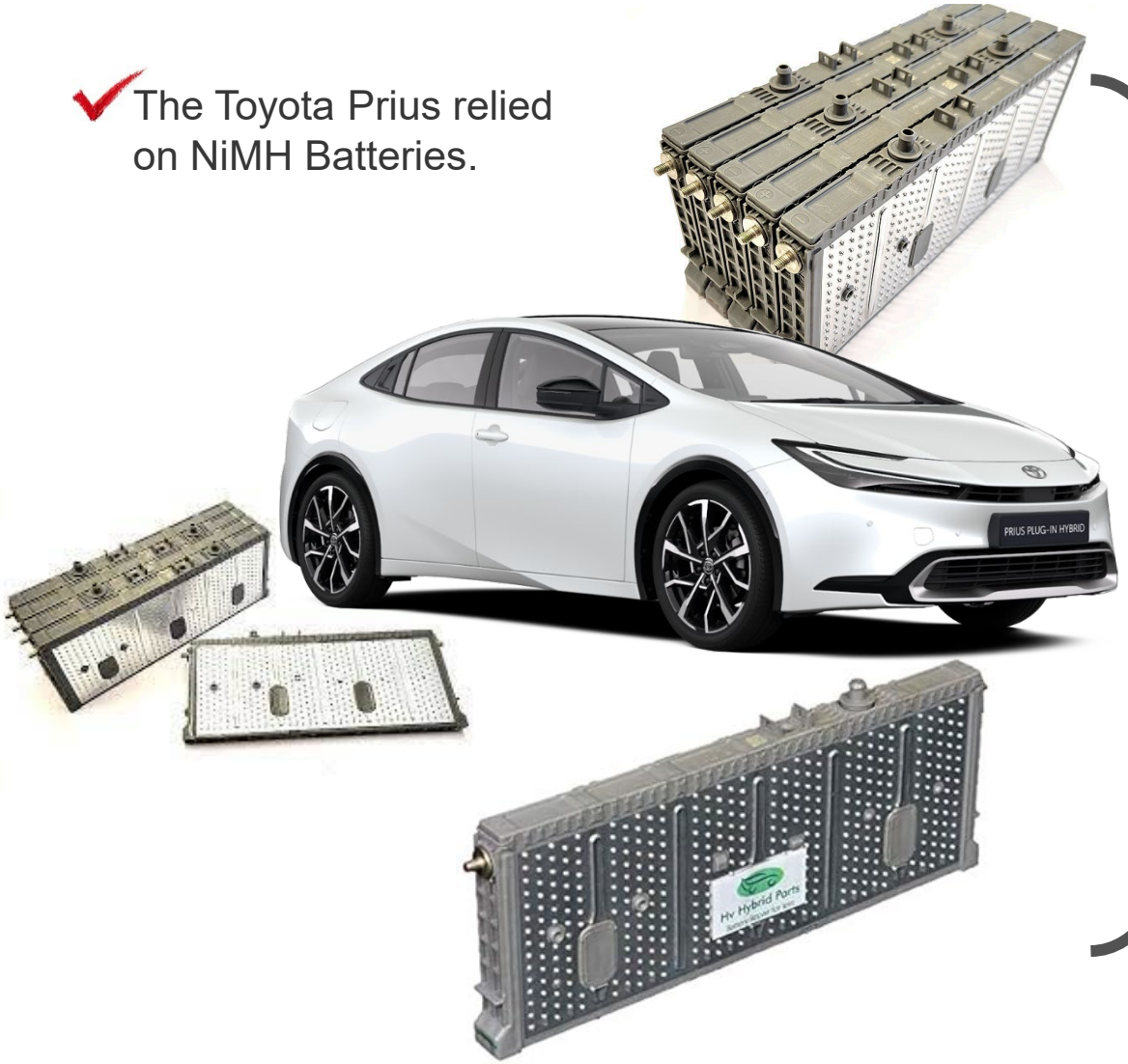
Metal Recovery

Electric Vehicles: Nickel-Metal Hydride

EV

Für eine lebenswerte Umwelt

- The Toyota Prius relied on NiMH Batteries.

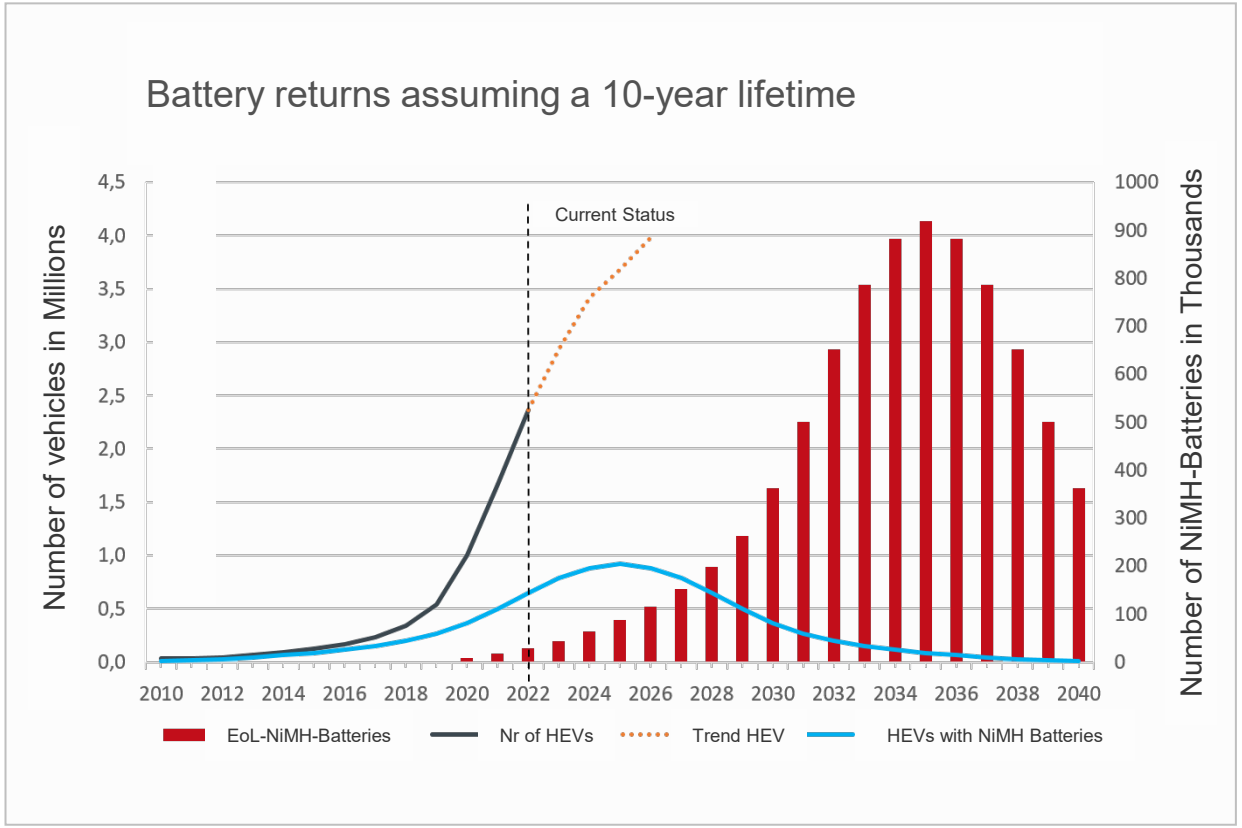


- Dismantled and discharged batteries proceed to recycling and recovery.

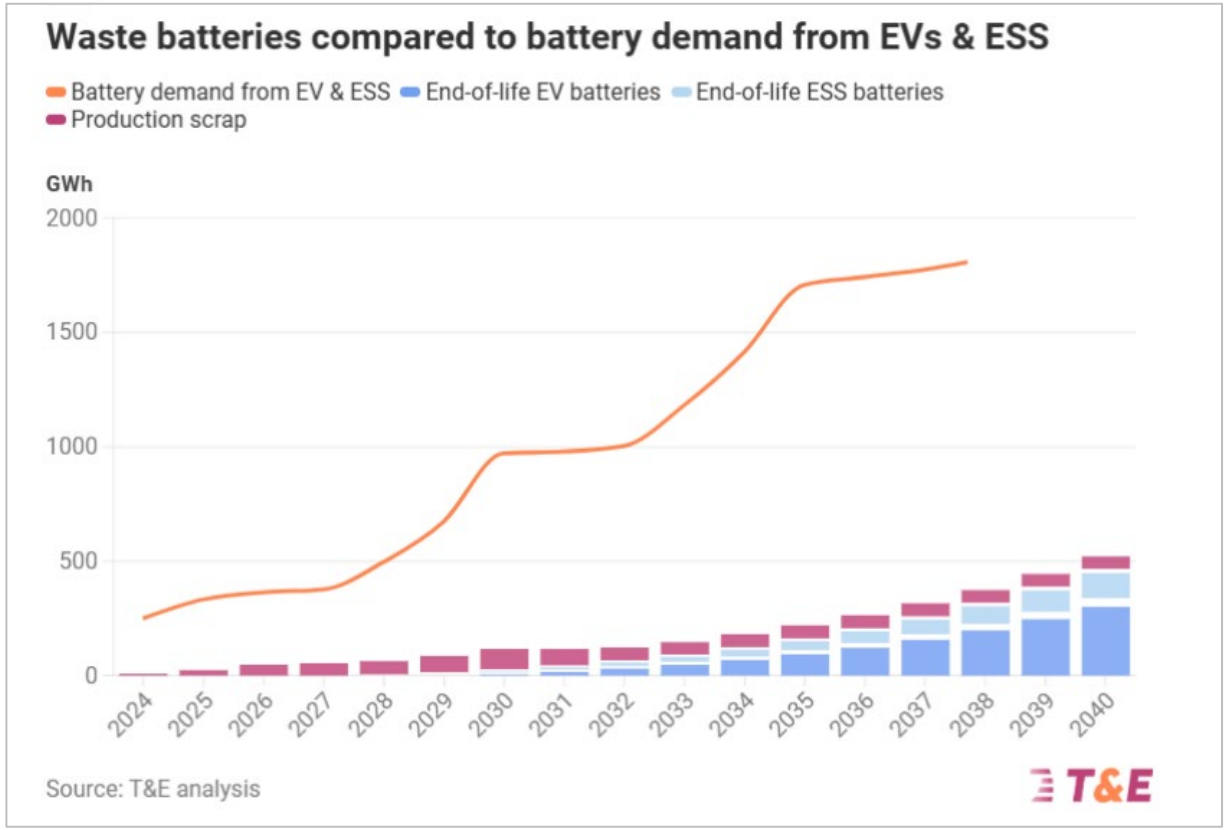
Volume development of Batteries

EV

NiMh-Batteries, Hybrid Electric Vehicles (HEV)



Li-Ion-Batteries, Electric Vehicles (EV)



Significant source of raw material from the HEV and EV sector – but not within the next years, but starting with 2030/35.

Household battery market

Germany, Austria and extrapolation EU

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Für eine lebenswerte Umwelt

DE 2023 / AT 2023:

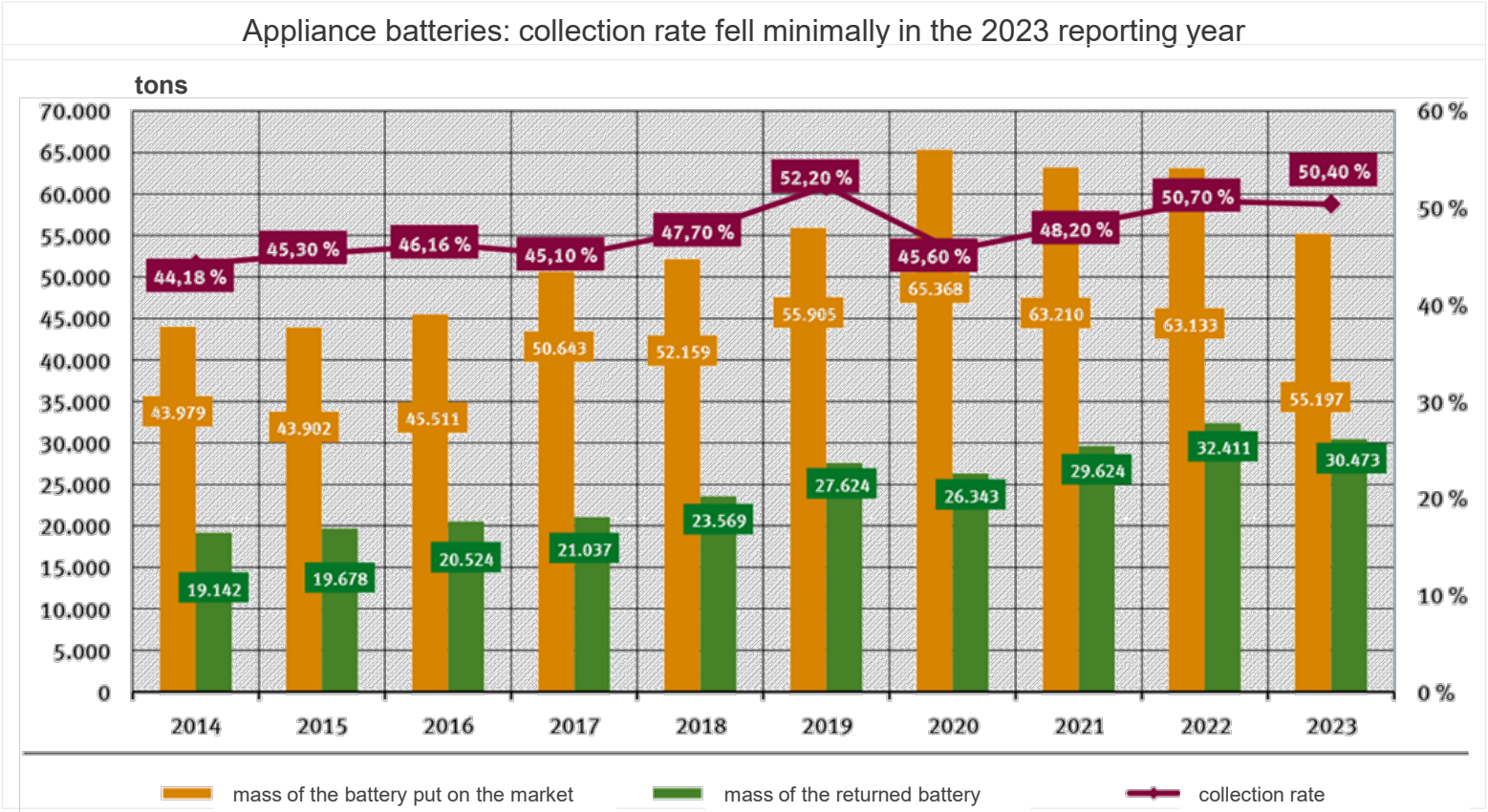
+ Batteries PoM: 55.197 t / 6.400 t
+ CFM: 30.473 t / 3.005 t
+ Collection Rate: 50,4% / 47%

EU 2023

extrapolation

+ Batteries PoM: ~ 300.000 t*
+ CFM:~120.000 t*
  (~40%* collection rate)

*extrapolation based on german residents to EU



Source: Altbatterien | Umweltbundesamt

Composition & development lithium-share

Increasing quantities of lithium lead to significant challenges

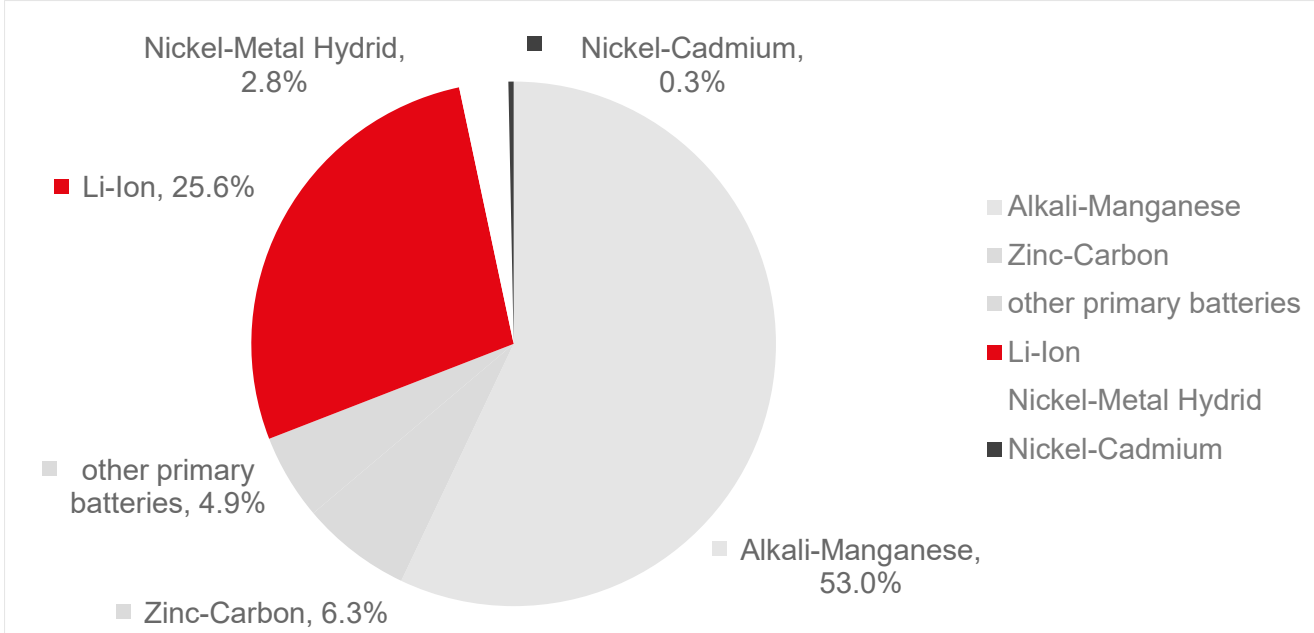
Safety risks:

+ High overheating and fire risk of lithium batteries
+ Strict packaging and transportation regulations for transport in accordance with ADR
+ Higher requirements for safe storage of mixtures with a high lithium content

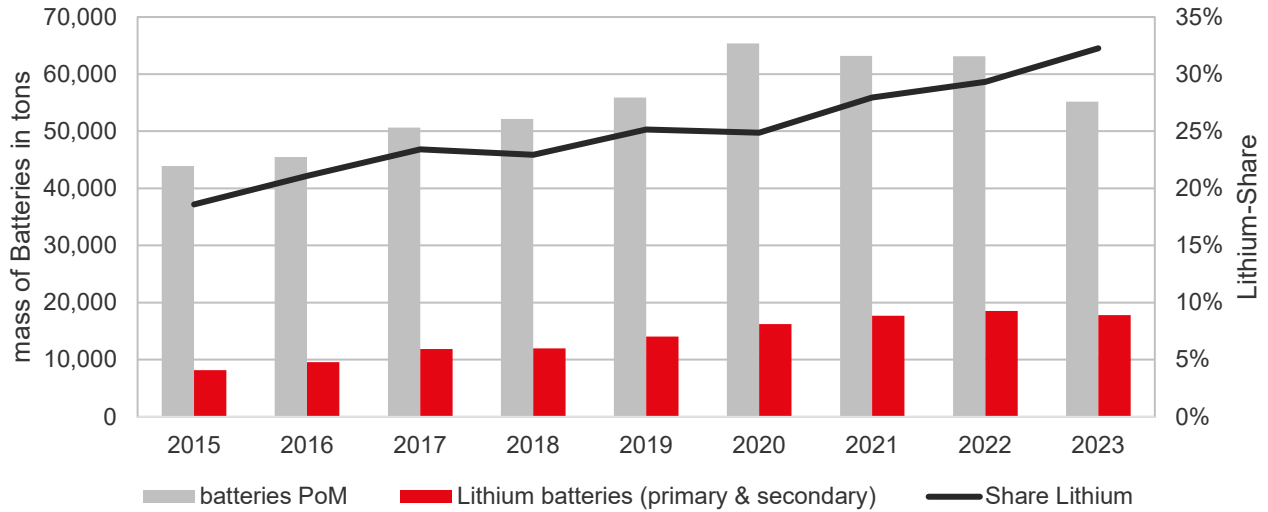
Economic risks:

+ The factors above lead to increased logistics costs
+ High insurance-requirements for sufficient insurance cover
+ High investment costs for plant fire protection

Share of batteries put on the market in 2023 – DE



Development of primary and secondary batteries put on market in Germany



CFM of secondary lithium-batteries in 2022[1]: 39%

Source graphs: Altbatterien | Umweltbundesamt
[1]DUH, 6.6.2023, Sammelmengen f. Batterien weiterhin auf Tiefstand:..

Challenges within the Lifecycle of Household batteries

Challenges arise along the entire disposal chain

Consumer

Transport

Recycling

Wrongly discarded batteries could cause problems

+ Only 50% of batteries collected separately
+ Millions of batteries units per year end up in residual waste or packaging (or stay at home)
+ Small WEEE products with battery a problem (Lila barrell project GRS)
+ This could lead to an increase in fires in trucks, waste treatment facilities and disposal facilities

Source: Kampagne zur Entsorgung von alten Batterien und Akkus gestartet | Umweltbundesamt

Transport becomes more difficult

+ For >330kg lithium batteries per truck definition as dangerous goods transport
+ Cross-border transportation of hazardous waste only with notification procedures

Revision of the european waste catalogue

+ Classification of black mass as hazardous waste adopted
+ Classification of mixed household batteries as hazardous waste planned
+ Holdup of hazardous waste requires changes to operating permits
+ Plants may fall within the scope of the major accident ordinance

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Project overview - Construction of Europe’s most modern recycling plant

+ AI-supported, automatic sorting of 15,000 t/a
+ On-site utilization/recycling of AlMn and NiMH batteries
+ Safe discharge & dismantling of EV batteries
+ EAG processing facility

Requirements

+ Battery recycling at the highest quality.
+ Assume ecological responsibility through material recovery.
+ Recycling and disposal processes must be safe and fully traceable.
+ High availability and top fire-protection standards.

Our Solutions in Practice

+ Proof of a sorting accuracy of 99%.
+ Genuine material recovery through product dismantling.
+ Kilogram-accurate traceability of material flows through fully digitalized data.
+ High availability and top fire-protection standards.

Recycling of Batteries

Foto: www.eu-recycling.com

- Lithium is an EU critical raw material and typically makes up 1–2% of a Li-ion battery by mass. Modern recycling routes can recover it from end-of-life batteries for new battery production, supporting EU circularity goals.
- Nickel, zinc and manganese are critical raw materials and are contained in 33-45 mass percent of batteries.
- Replacement of primary raw materials in steel production or the manufacture of new batteries is possible with today's technologies

[1] Informationsmaterial-zum-Batterierecycling-Deutsch.pdf

Co_2-footprint of different recycling methods

HH EV

- Pyro-Hydro: *"a combination of battery smelting in a pyrometallurgical process, followed by the further refining of the alloy via hydrometallurgy"*
- Thermomechanikcal-Hydro: *„a combination of (thermo)mechanical pretreatment and further hydrometallurgical refining of the resulting black mass"*

kg CO_2e/kg EOL Modules	'Pyro-Hydro'	'Thermomechanical-Hydro'
Burdens	2.07	2.64
Credits	−2.84.	−2.68
Net result	−0.77	−0.03

Towards Sustainable Battery Recycling: A Carbon Footprint Comparison between Pyrometallurgical and Hydrometallurgical Battery Recycling Flowsheets

For an environment living for

- Conserving resources is a central goal of the circular economy
- In the categories of entrophication, ozone formation and consumption of fossil resources, 90% less impact through the use of secondary raw materials
- 95% less energy consumption than in primary production

Source: Frauenhofer IWKS life cycle assessment

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Summary

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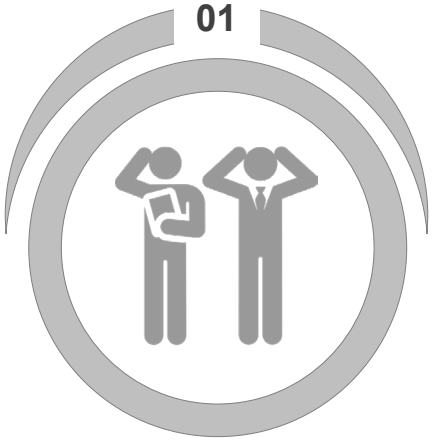
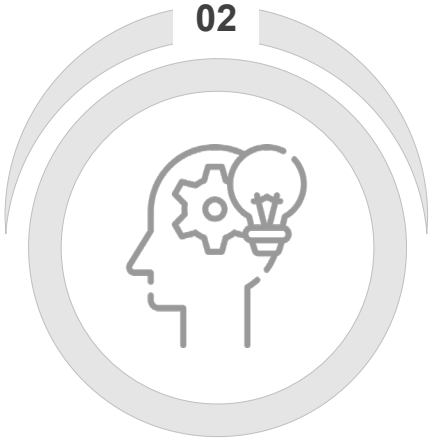


Problem

Battery use is rising, but EV return volumes are not there yet. In household batteries Lithium collection rates are too low. Small WEEE often includes hidden batteries, increasing fire risks, safety costs.

02



Solution

Not overinvest in EV-recycling facilities.

Update recycling rate metrics and WEEE/battery regulations.

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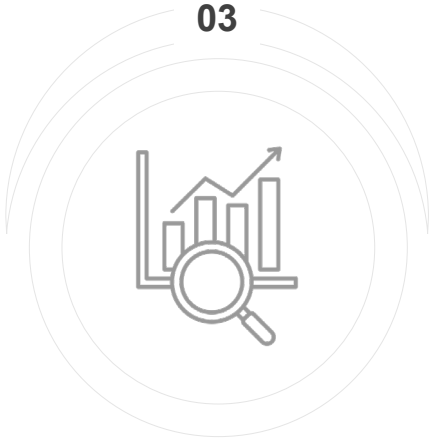

Industry

The battery industry should design for recyclability, cut hazardous materials, raise awareness, and share data to support updated recycling rate legislation.

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Mission

The goal is to keep all the raw material in Europe's industry and to support a circular battery economy through smart product design, sustainable materials, and efficient collection systems.

Thank you !

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