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Recycling of Lithium (LFP) batteries

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Co-funded by the European Union

At a glance

Sunlight Group is a global technology company, and manufacturer of industrial batteries and advanced Energy Storage Systems

30+ years experience in the battery market

Presence in **4** continents **14** countries

4 battery technologies

3,200+ employees

5 R&D hubs

35+ facilities worldwide

Serving very demanding global sectors

Industrial Mobility

- electric vehicles for intralogistics, robotics, Automated Guided Vehicles, excavators, GSEs

Leisure Mobility

- golf carts, mini-caravans

Energy Storage Systems (ESS)

- for grid-scale, commercial, industrial and home storage solutions

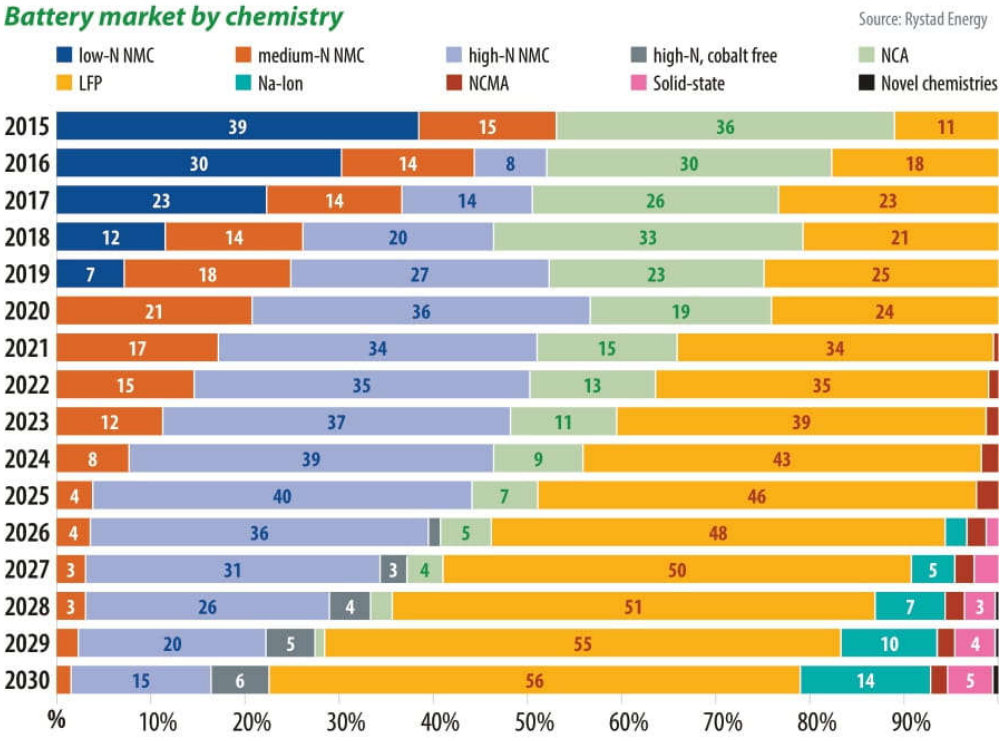
Recycling

- Lead Acid, Lithium

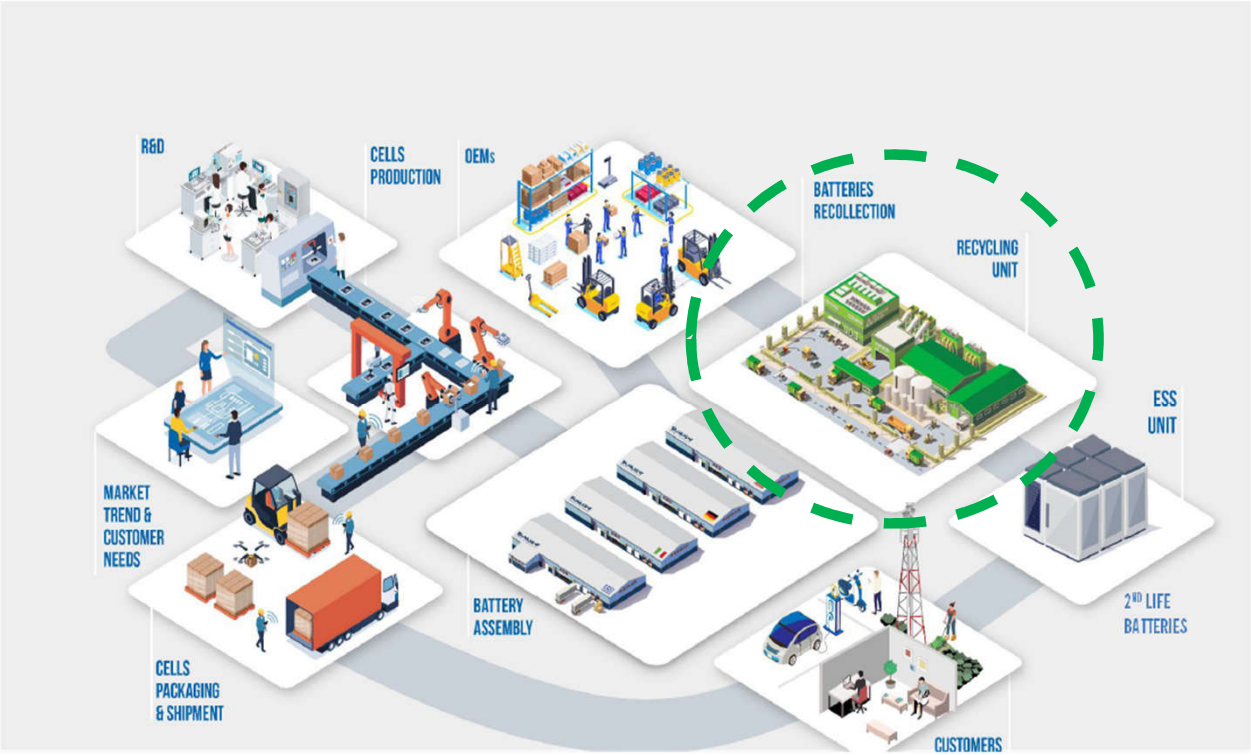
LFP batteries power industrial mobility and stationary applications

Equally important to EV applications

- Why LFP batteries?
  - High cycle life and intrinsic safety
  - Low production cost and toxicity levels
- LFP batteries expected to dominate the industrial mobility and stationary markets by 2030, with demand exceeding 3,000GWh



Sunlight Group gearing towards vertical integration of LFP production



- Establishing Pilot Line for LFP cells in company's industrial complex (SOP: 2023-2024)
- Envisioning Gigafactory, operative in 2027-2028
- LFP recycling essential in strategy implementation
- Aiming for same success as recycling of lead-acid batteries

Sunlight's Lead-acid Recycling Plant

Lead Acid Recycling Plant – Komotini, Greece

Europe's most advanced recycling plant for lead-acid batteries

- 42,000 sqm total rea
  8,000 sqm covered area
- €12m investment to more than double yearly output to 100,000tn
- 50%+ contribution to own production needs in raw lead
- Zero emissions and EMAS-certification

EMAS
Verified environmental management

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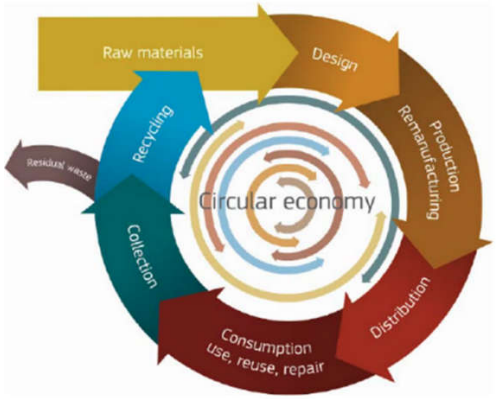
Management of LFP scrap and EoL

A complex multi-disciplinary challenge

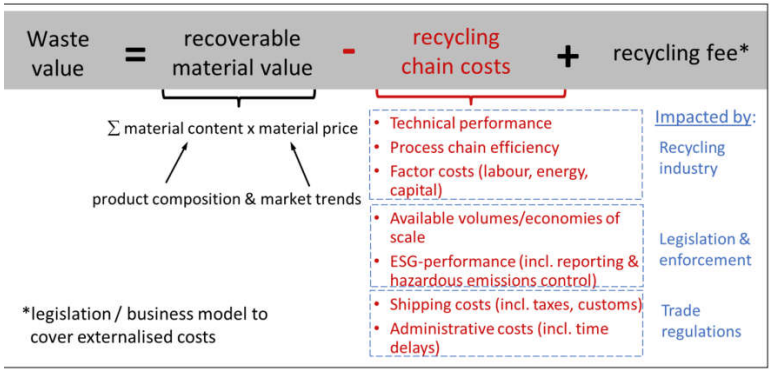
- Large amounts of LFP manufacturing scrap and EoL to occur from relevant production
- LFPs included in EU Battery Directive and therefore must be recycled
- LFP recycling financially less attractive than NMC chemistries
- Limited or missing industrial applicability of LFP recycling in EU region

EU vision and strategy



Mismatch for LFP batteries

Reality

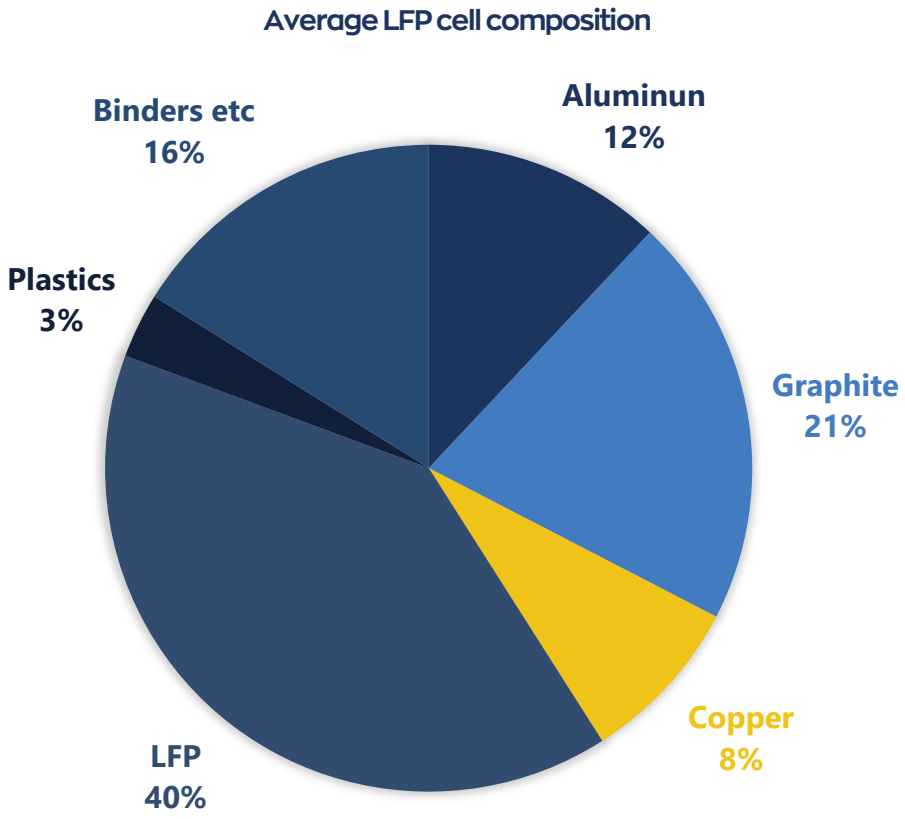


Hagelüken et al., 2022

Significance of LFP recycling

Key reasons to overcome challenges

- Recovery of CRMs (Li, P and graphite) and other metals (Cu and Al) contained in LFP batteries
- Application of near-zero waste approach in cell manufacturing phase
- Security of raw materials supply chain (needed for cell manufacturing)
- Elimination of environmental impacts caused by adopting a contaminant strategy for EoL LFP
- Offering of intergraded solutions to customers



ReLiFe RECYCLING LITHIUM FERROPHOSPHATE at glance

Supported by eit RawMaterials Connecting matters

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Highlights

500 tn of LFP scrap annual capacity

Partners
A well geared mix of academic and industrial partners

Goal
Demonstrate a sustainable metallurgical technology to recycle scrap LFP cells

Prospect
Pave the way for a 66 ktn/year LFP recycling plant

Budget and duration

YEAR	EIT Funding [€]	Co- Funding [€]	Total Funding [€]
2023	693,035	267,715	960,750
2024	1,546,610	755,765	2,302,375
2025	1,237,804	722,884	1,960,688
TOTAL	**3,477,449**	**1,746,364**	**5,223,813**

Consortium

- **Sunlight Group Energy Storage Systems S.A.** (Project leader)
- **TUBAF** (technology provider)
- **HZDR e.V.** (technology provider)
- **Monolithos Ltd.** (technology validation)
- **Hatch- Küttner GmbH & Co. KG** (engineering design)
- **SE & C IKE** (Life Cycle Assessment)
- **Greenhouse Investment Group Ltd.** (Business Plan)

Timeline

2023
- Preliminary studies
- Process optimization and technology establishment

2024
- Semi-pilot scale validation
- Pilot plant studies elaboration

2025
- Pilot plant demonstration
- Engineering studies for industrial commercialization

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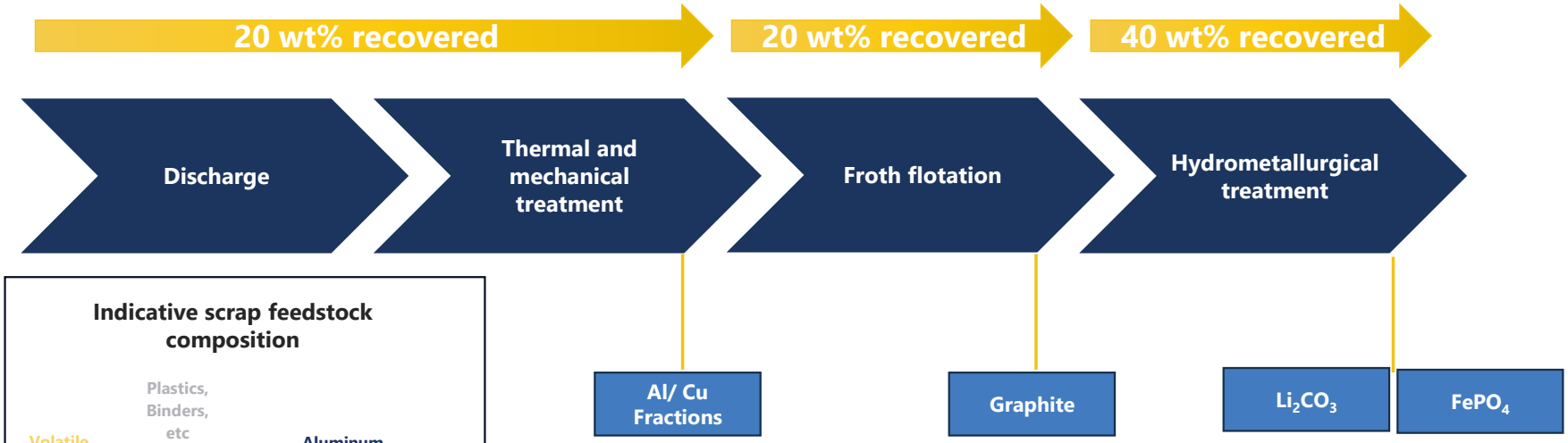
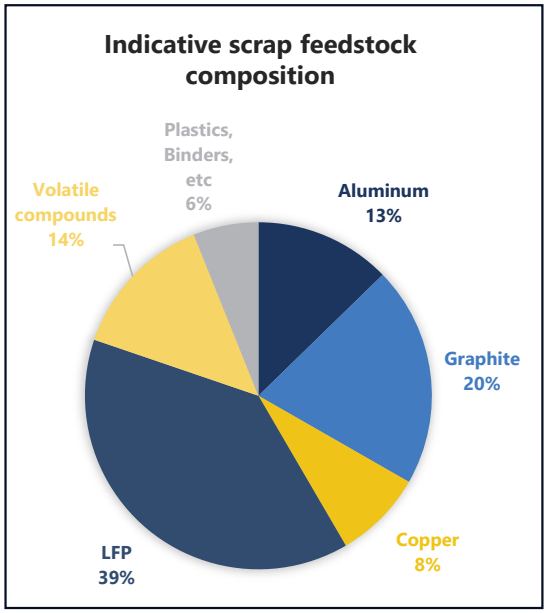
LFP recycling process



ReLiFe
RECYCLING LITHIUM FERROPHOSPHATE



- Recycling of LFP scrap and EoL via an environmental and economically friendly way
- More than 80 wt% of processed material recovered in 4 final products, 3 of which critical to EU economy (*i.e.* Li, Graphite and P)
- Froth flotation is introduced for upscaling for the first time
- Possibility to scale up whole flowsheet or part of it (*e.g.* processing till black mass or decide to process further).

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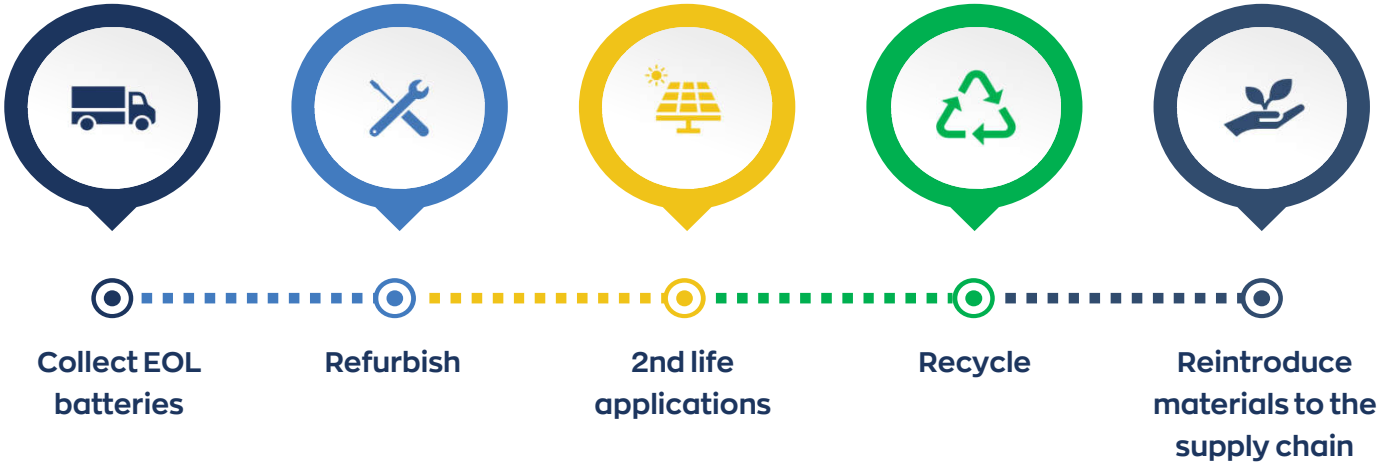
Key messages – Conclusions

- LFP batteries expected to dominate the industrial mobility and stationary market
- Large scrap quantities will occur from production; must be recycled per EU Battery Directive
- LFP recycling: a complex multi-disciplinary challenge
- Think beyond metals; recover and recycle as much materials as possible from batteries
- ReLiFe technology paving the path for Sunlight's Li-recycling vision, and aiming for same success as lead-acid batteries recycling



Acknowledgements

- Sunlight Group colleagues
- ReLiFe project partners
- EIT Raw Materials

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https://relifeproject.eu

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Thank you