Closed Loop Regeneration of High-Performance NCM & LFP Cathode Materials from Spent Lithium-Ion Battery

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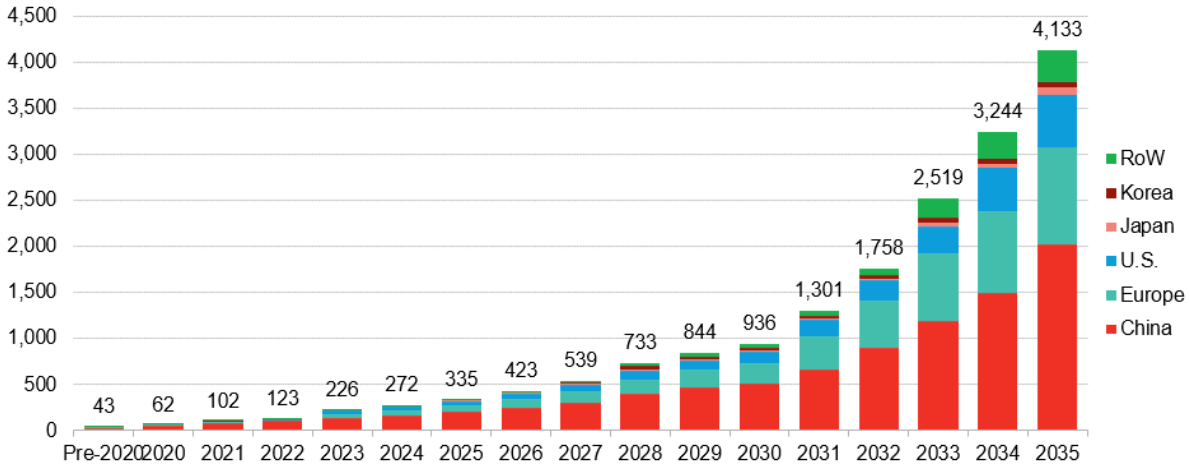
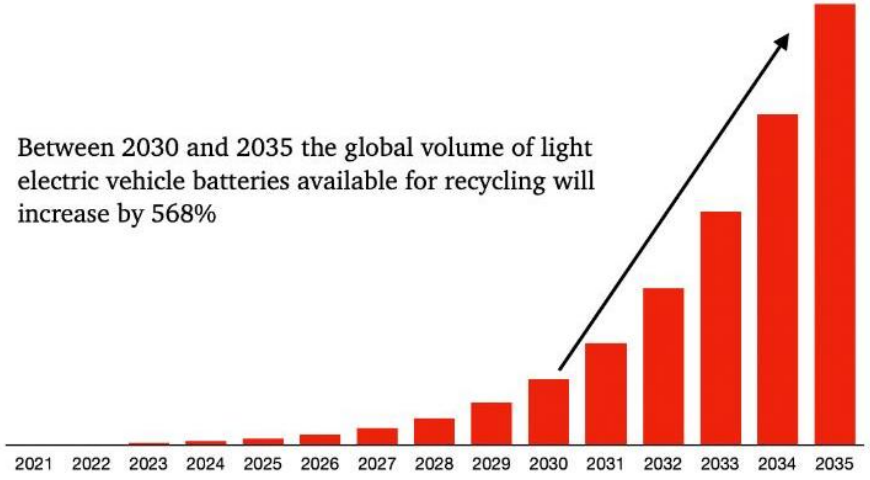
Enabling Renewable Energy Around the World

01 Regeneration Technology

Massive Spent LIB - time is getting closer

Spent LIB volume prediction[1]

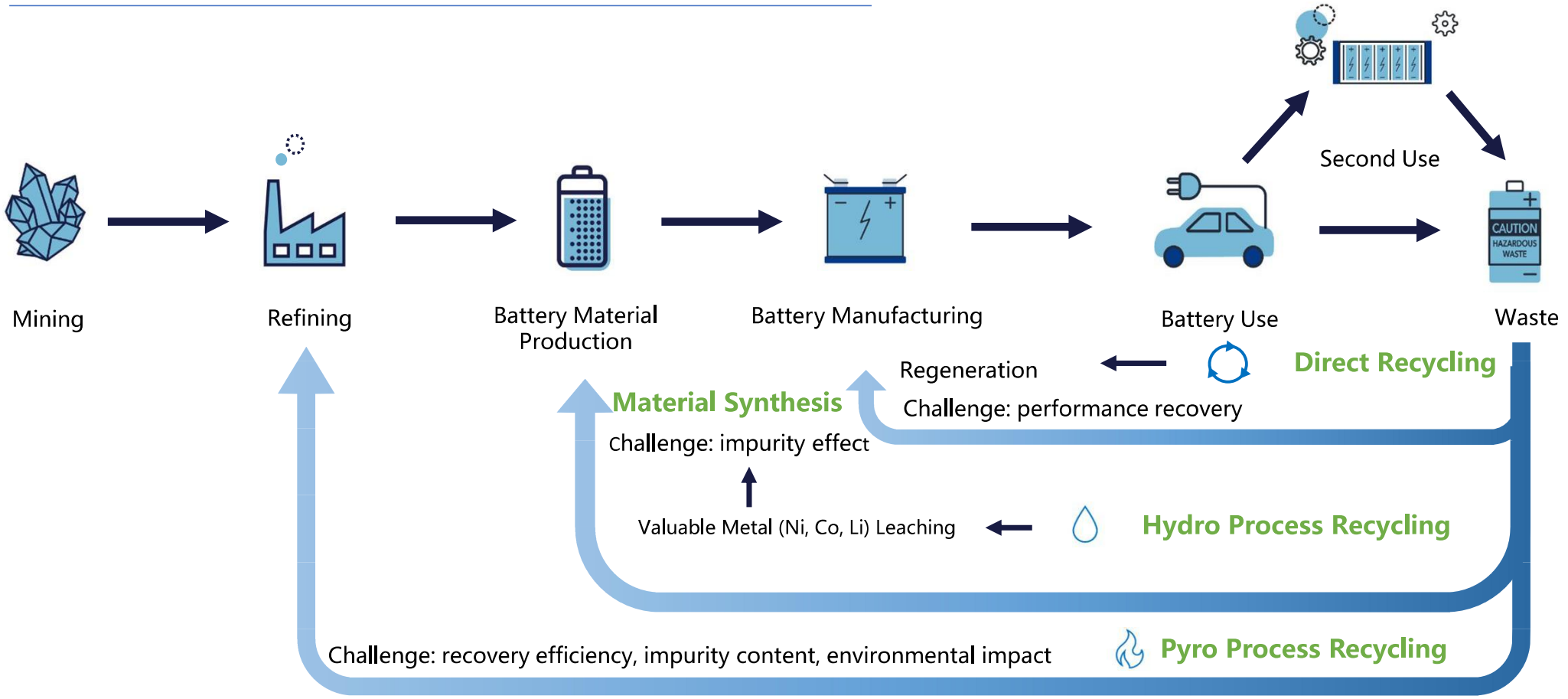




The time for massive spent LIB retirement is getting closer. Spent battery recycling not only solves environmental issues, more importantly, it achieves closed-loop for resources, helping the new energy system to get rid of the reliance on resources, accomplishing real “unlimited power” in carbon neutrallity.

[1] BNEF [2] Hans Eric Melin, The ketchup effect of the EV battery recycling market

Recycling Technology Pathways



Pretreatment, Extraction and Separation

Regeneration and Repair of Battery Material

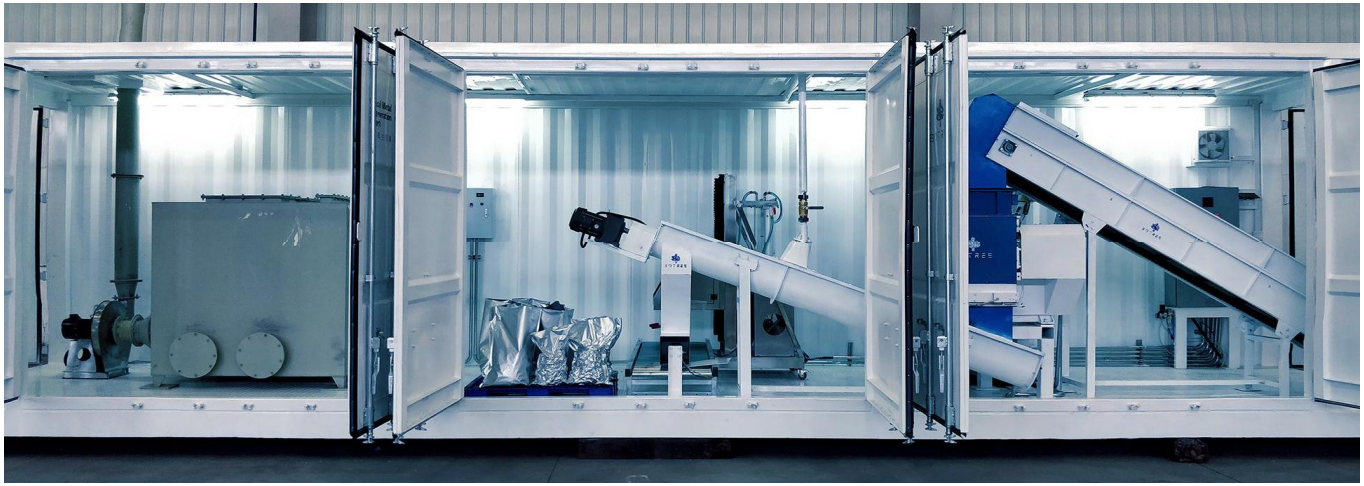
MFA/LCA/Carbon Footprint of Battery Industry Chain

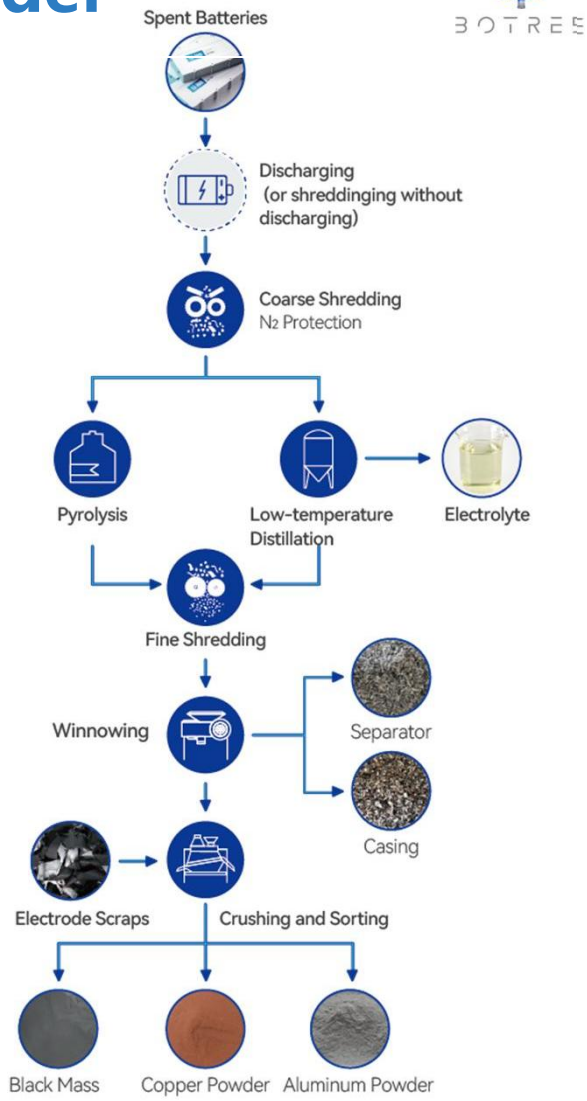
Battery bank/Battery Asset Management

Black mass-from battery cell to battery powder

Applicable to spent batteries such as NCM/LFP/NCA/LCO/LMO and electrode scraps

Black mass recovery rate > 98% Copper and aluminum impurities < 0.5%





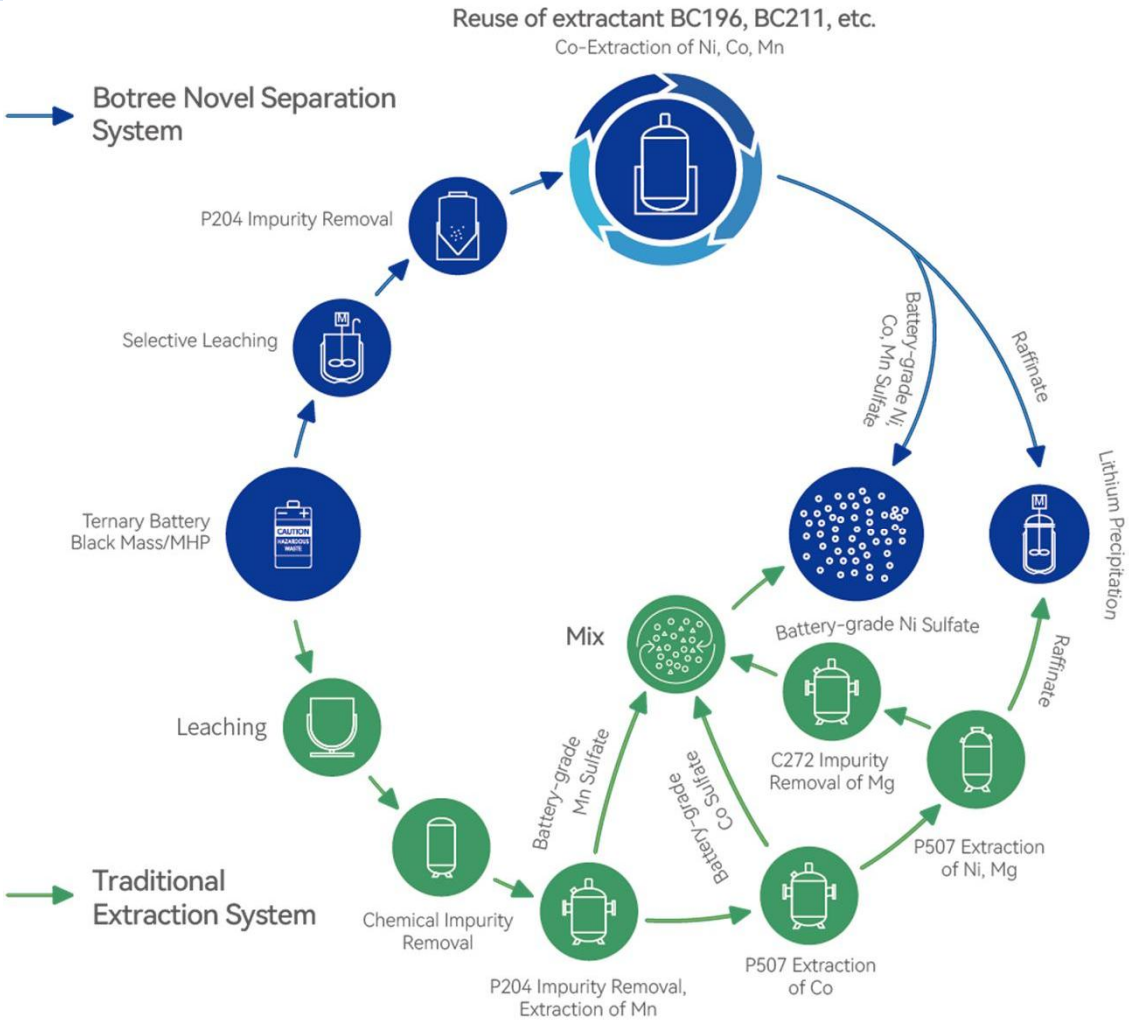
NCM Hydromet-from black mass to battery material

Applicable to ternary battery black mass and Nickel-cobalt **hydroxide precipitate (MHP)**

Direct recovery rate of nickel and cobalt > 98%

Advantages of co-extraction system

- Synchronous extraction of nickel, cobalt, and manganese, directly producing battery-grade materials, especially suitable for high-nickel systems
- Over 30% reduction in extraction equipment investment, over 10% reduction in extraction energy consumption, 5-20% reduction in extraction costs
- Compared with traditional processes, the carbon footprint of the full hydrometallurgical process is reduced by 6-8%[1]



LFP Hydromet-from black mass to battery material

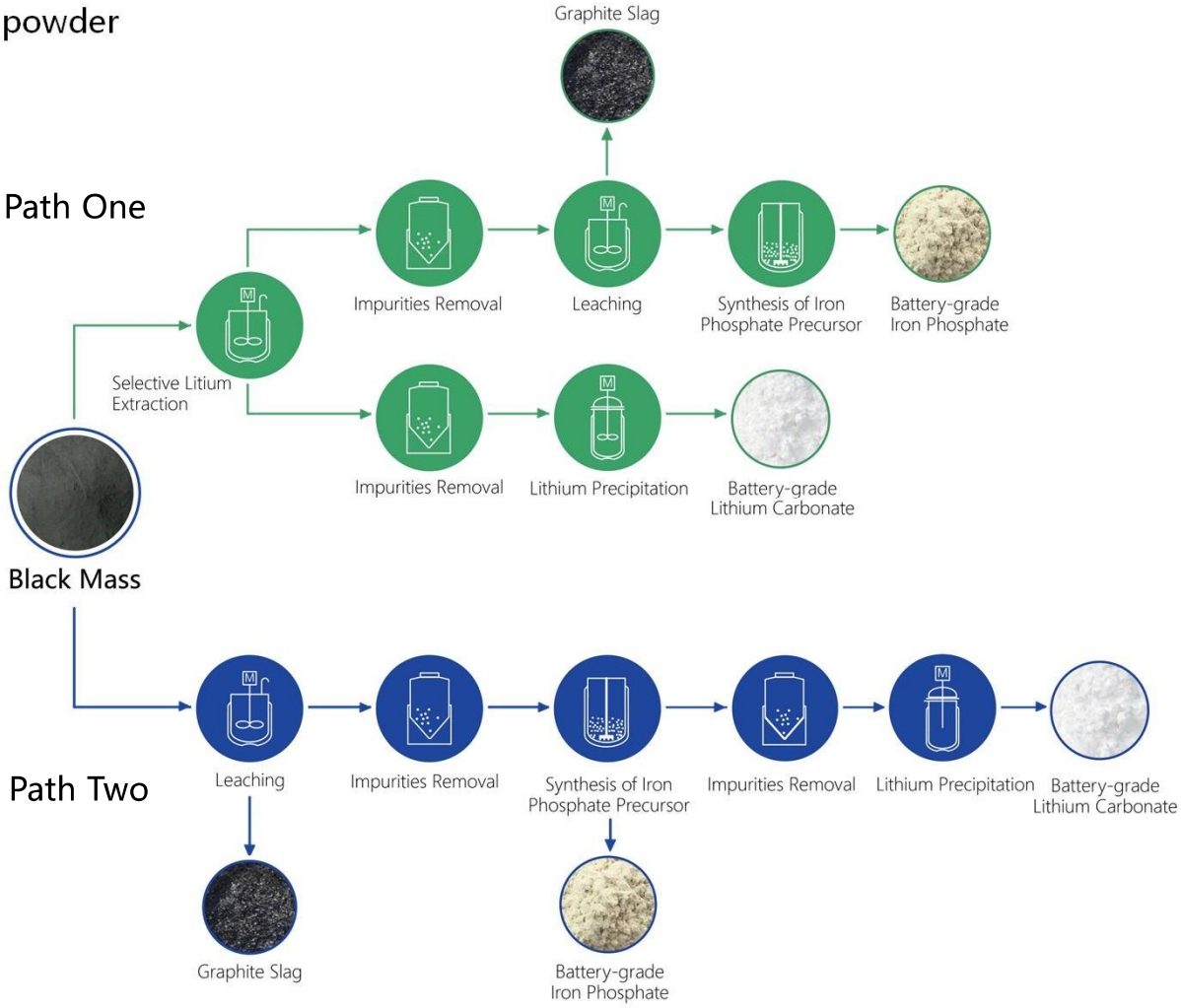
Applicable to spent LFP battery black mass, electrode scrap powder

Lithium recovery rate 90-95%

Battery-grade iron phosphate recovery rate 85-95%

Advantages

- Lithium leaching rate > 95%
- Low requirements for black mass impurities (electrolyte, copper, and aluminum, etc.) content
- Compared with lithium spodumene, the carbon footprint of battery-grade lithium carbonate produced by Botree's recycling process has been decreased more than 40%[1]



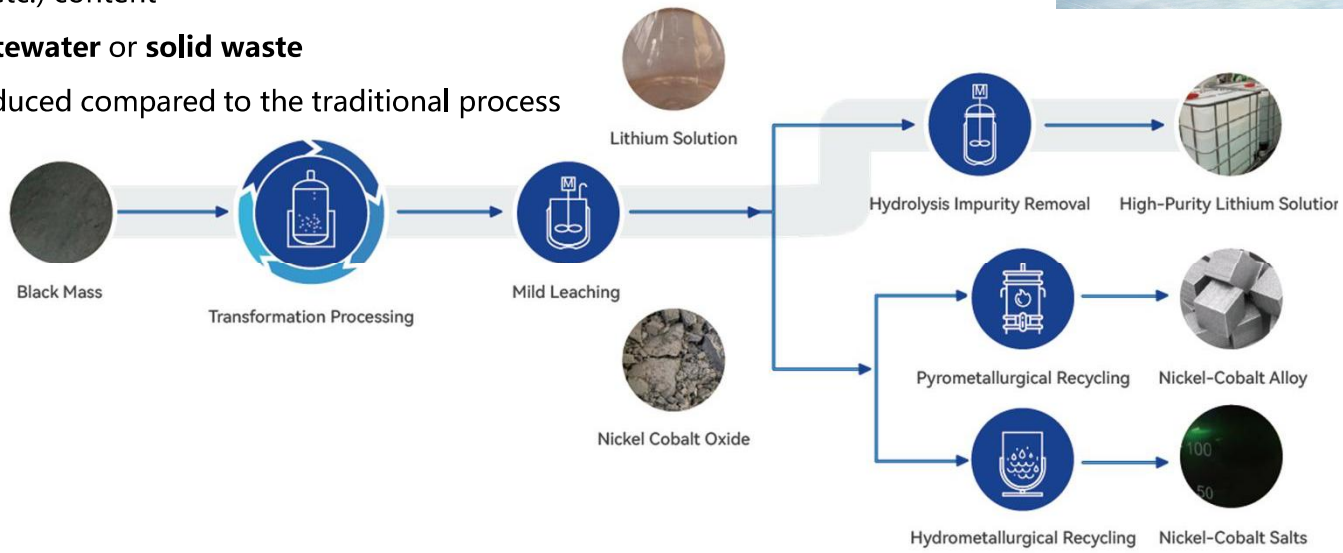
Short Lithium Extraction from black mass

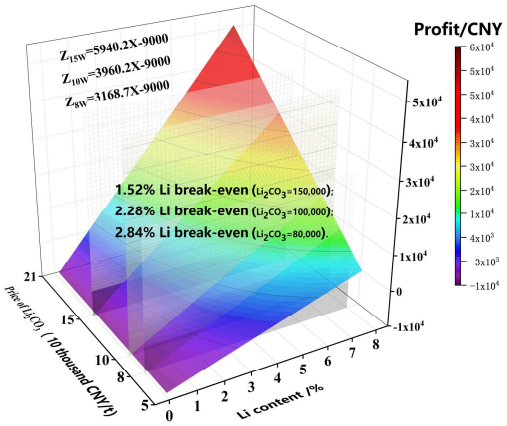
Applicable to various types of black mass such as LMO, LCO, NCM, NCA, etc.

Li Recovery rate 90-95% (5-10% more than the average process)

Advantages

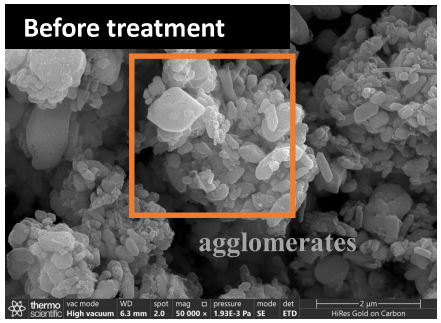
- **Remove most of the organic** and **reduce the moisture content** of the black mass
- **High-purity** lithium solution, Lithium concentration **> 20 g/L**
- Metal **impurities**: (1) **≤ 30 ppm** ; (2)**≤ 1 ppm** (battery grade)
- **High tolerance for black mass impurities** (electrolyte, Cu, and Al, etc.) content
- **No wastewater** or **solid waste**
- H_2O_2 reduced compared to the traditional process

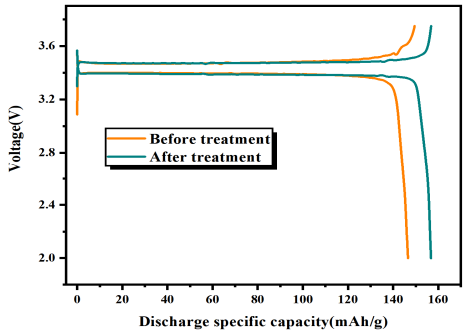


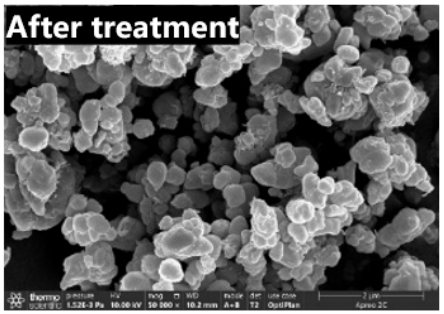


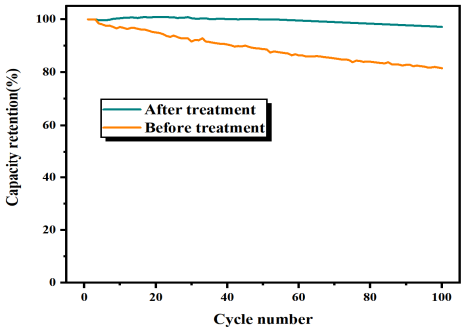
Direct Recycling-from battery to cathode material

Laboratory research









- Coin cell test: lab scale R&D demonstrates **obvious improvement** in 1st cycle discharge capacity and capacity retention during cycling, meeting the **industry standard (YS/T 1027-2015)** requirements.

Pilot scale

- **Electrode processing:** the direct recycled materials have been verified at batch and pilot scales;
- **Electrochemical performance:** rate and cycling performance, tested at batch and pilot scales, are satisfactory.

Direct Recycling-from battery to cathode material

Botree Electrode scrap → Separation → Impurity control → PSD recovery → Sieving & de-magn. → Packaging

- Key: balancing the recovery rate and the quality of LFP and Al particles.
- Typical cathode powder with Al < 400 ppm.

LFP electrode scrap

LFP cathode

Al particles

02 Case Study

Botree at a Glance

ABOUT BOTREE

Botree Recycling Technologies Is Committed to A Complete Solution for The Recycling of Critical Battery Materials

By developing advanced separation systems and smart equipment, we enable worldwide battery manufacturers, battery operators, automotive manufacturers, energy storage enterprises, and recyclers to realize a short-loop of battery materials, promoting the low-carbon and sustainable development of new energy key resources.

ONE-STOP SOLUTION

We Help Get Recycling Process Up and Running Quickly and Continue Operating Efficiently and Profitably

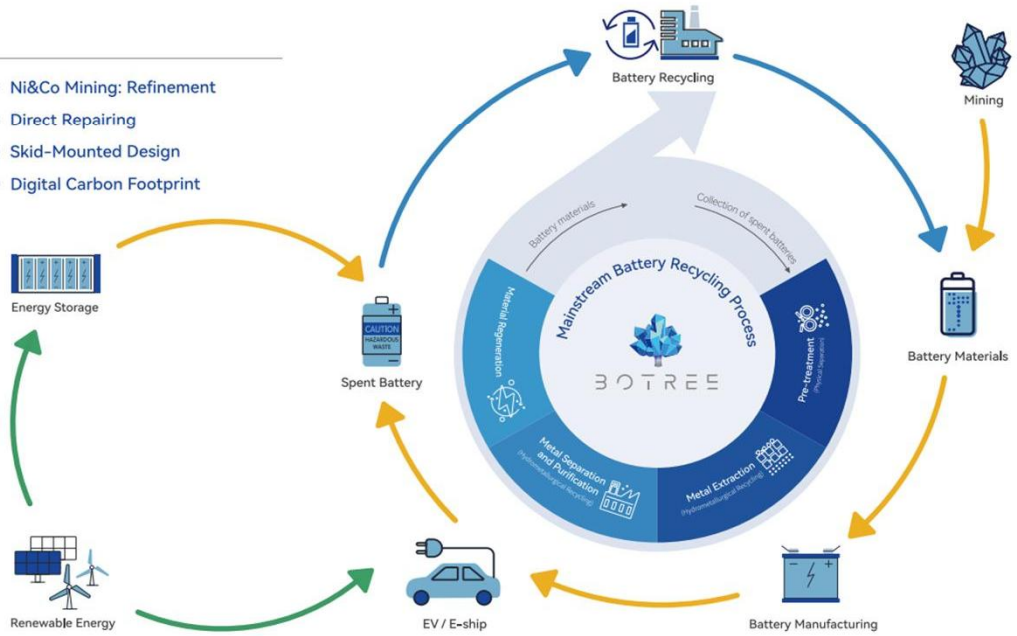
- Industry/ technical consulting
- Industrial solutions
- Smart equipment
- Operation and maintenance services
- CO_2 Sustainability Consulting

KEY TECHNOLOGIES

- Pre-Treatment
- Pre-Lithium Extraction
- LFP Multi-Component Recycling
- NCM Multi-Component Recycling
- Ni&Co Mining: Refinement
- Direct Repairing
- Skid-Mounted Design
- Digital Carbon Footprint

GLOBAL IMPACT

- Member of EBA, GBA, MBF, AVERE, NAATBatt, etc.
- Convenor of ISO/TC 333/AHG2: Carbon footprint for lithium product
- GBA Battery Passport Steering Committee member
- Operation agent of IEA HEV TCP Task48 Battery Swapping and co-manager of Task54 Recycled Materials for Electric Vehicles
- Invited reviewer of IEA reports including "Batteries and Secure Energy Transitions", "Energy Technology Perspective 2023", "Global EV Outlook 2024", "Global EV Outlook 2023" and "Global EV Outlook 2022"



Global Partnership

LFP BATTERY RECYCLING IN SPAIN

ILUNION, EFT-Systems y 博萃循环 crean una empresa conjunta de baterías de litio en España con el objetivo construir una planta de reciclaje de baterías LFP en España.

La planta estará ubicada en el Parque Tecnológico de Boecillo, en Valladolid, y tendrá capacidad para tratar 6.000 toneladas de estas baterías al año, y con este proyecto ayudará a mejorar las capacidades de reciclaje de baterías en Europa y promoverá el desarrollo sostenible de la nueva industria energética.

Más información: **https://lnkd.in/djxwTEQr**

#ILUNION #EconomíaCircular #Reciclaje #Baterías #TodosContamos #TodosIncluidos

Show translation

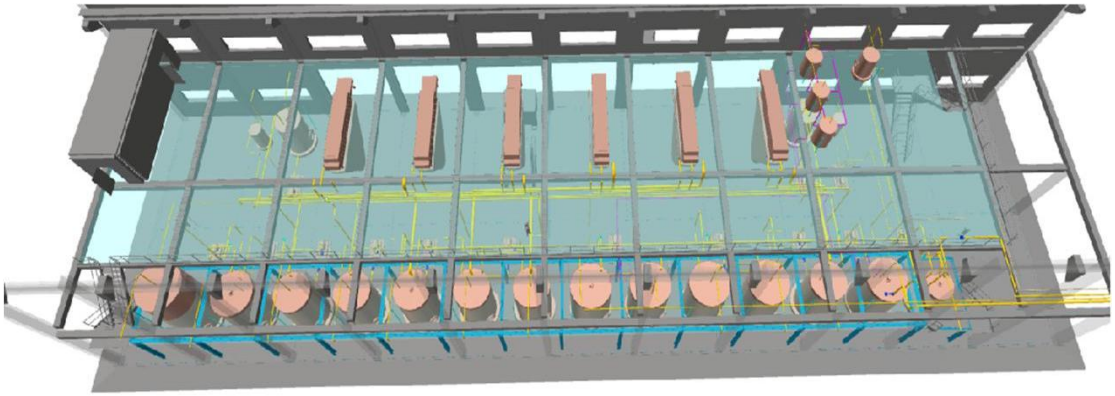
ILUNION, EFT-Systems y Botree crean una empresa conjunta de reciclaje de …

ilunion.com

Location: Valladolid’ s Boecillo Technology Park, Madrid, Spain

Capacity: Total 6,000tpa LFP Battery

Pretreatment + Hydromet Recycling



Global Partnership

MANGANESE-BASED BATTERY RECYCLING

星恒电源 PHYLION BATTERY

BOTREE 博萃循环

Location: Huaibei, China

Capacity: 40,000 tpa in total and 26,000 tpa for first phase construction

Pretreatment+Hydromet Recycling

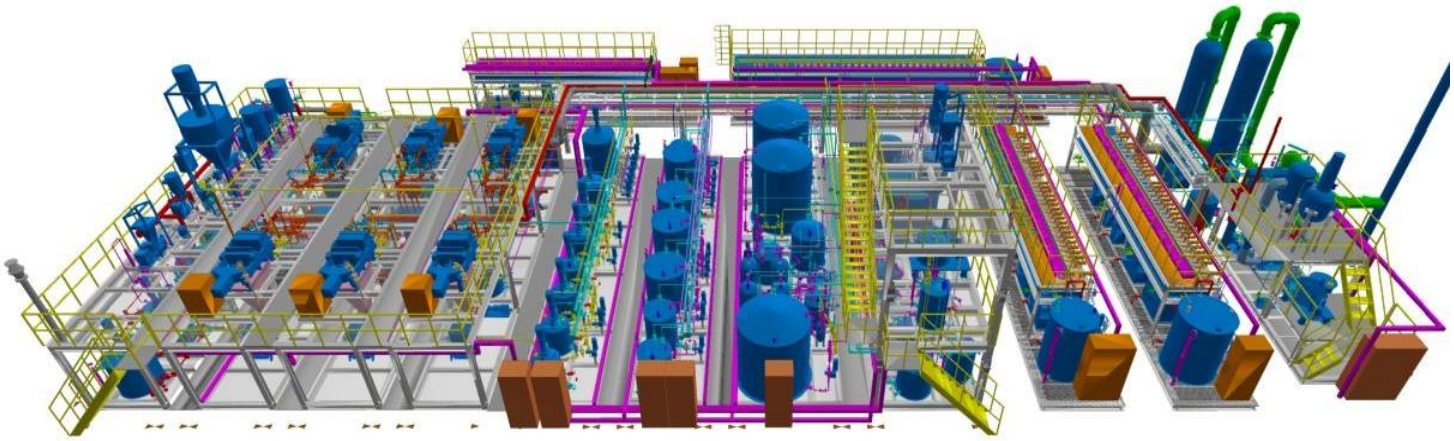
Worldwide first standard industrial recycling line for spent manganese-based lithium battery, industrial direct repairing line for manganese-based and LFP battery electrode scraps

Global Partnership

NCM HYDROMET RECYCLING
CE CERTIFICATIONS

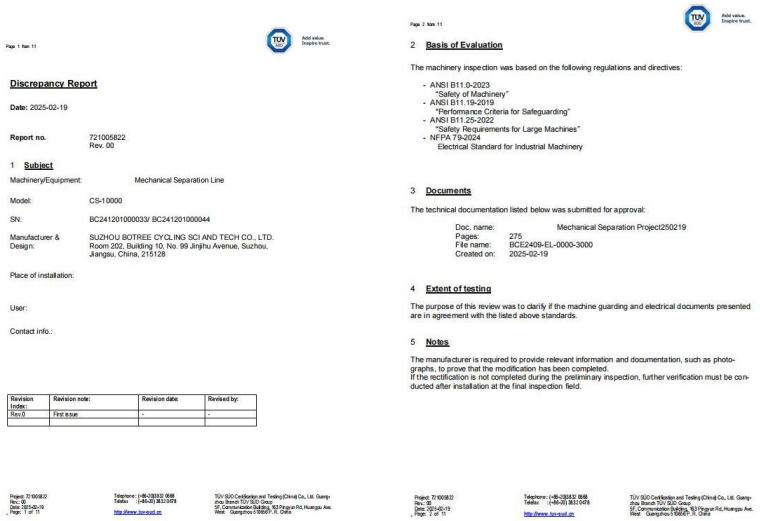
Location: Poland

Capacity: Demonstration line



Global Partnership

USA PRE-TREATMENT LINE
UL CERTITICATIONS



Discrepancy Report

Date: 2025-02-19

Report no. 721005822
Rev. 00

1 Subject

Machinery/Equipment: Mechanical Separation Line

Model: CS-10000

SN: BC241201000033/ BC241201000044

Manufacturer & Design: SUZHOU BOTREE CYCLING SCI AND TECH CO., LTD. Room 202, Building 10, No. 99 Jinjihu Avenue, Suzhou, Jiangsu, China, 215128

Place of installation:

User:

Contact info.:

Revision Index:	Revision note:	Revision date:	Revised by:
Rev.0	First issue	-	-

2 Basis of Evaluation

The machinery inspection was based on the following regulations and directives:

- ANSI B11.0-2023 "Safety of Machinery"
- ANSI B11.19-2019 "Performance Criteria for Safeguarding"
- ANSI B11.25-2022 "Safety Requirements for Large Machines"
- NFPA 79-2024 Electrical Standard for Industrial Machinery

3 Documents

The technical documentation listed below was submitted for approval:

Doc. name: Mechanical Separation Project250219
Pages: 275
File name: BCE2409-EL-0000-3000
Created on: 2025-02-19

4 Extent of testing

The purpose of this review was to clarify if the machine guarding and electrical documents presented are in agreement with the listed above standards.

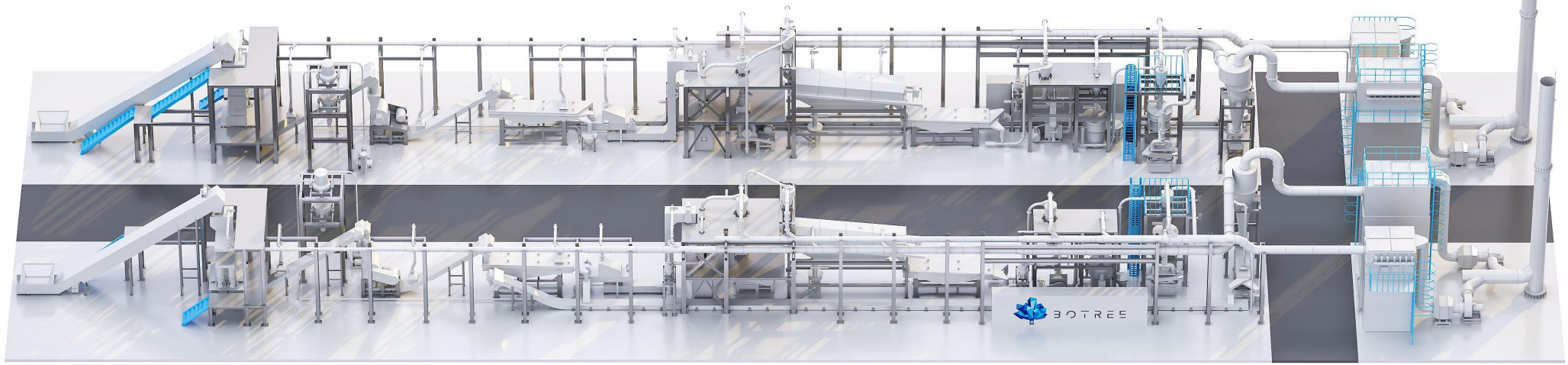
5 Notes

The manufacturer is required to provide relevant information and documentation, such as photographs, to prove that the modification has been completed.
If the rectification is not completed during the preliminary inspection, further verification must be conducted after installation at the final inspection field.

Location: USA

Capacity: 2×1.5 tph

pre-treatment for spent battery and waste electrodes



THANKS!

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