

# Power battery recycling insights from Asia: Upgrading resources efficiency on the whole life-cycle



BOTREE

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Critical Metal  
Regeneration  
Expert

金屬再生專家

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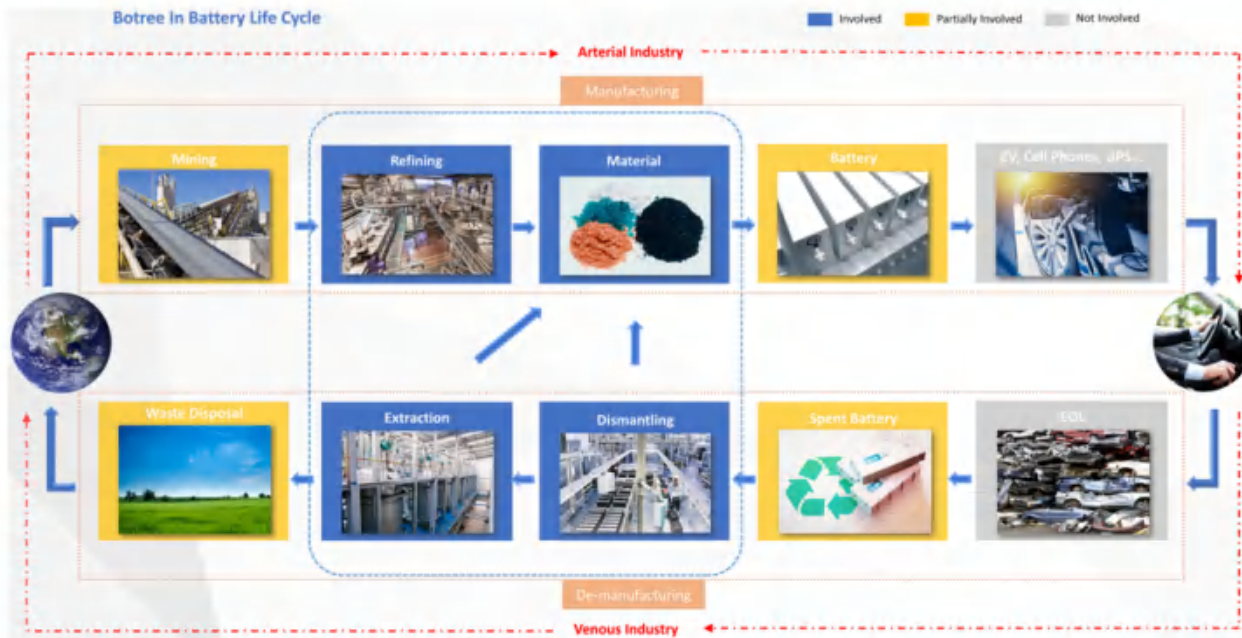
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# Resource generation: Solution for Supply & Environmental risk



# Botree cares battery metal

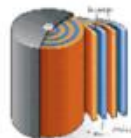


Botree provide full solutions for **battery metal refining and regeneration**, including Consulting, technology service, Equipment, Operation.

We're focusing on developing **innovative technology and processes** to support a **sustainable battery metal supply chain**.



Ores



Materials



Battery



EV

**CAUTION**  
**HAZARDOUS**  
**WASTE**

Waste



BOTREE  
博萃循环

**Closing the loop on Li-ion batteries  
by critical metal regeneration.**

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01

PART 01

**Overview of NEV & LIB Industry in 2020**

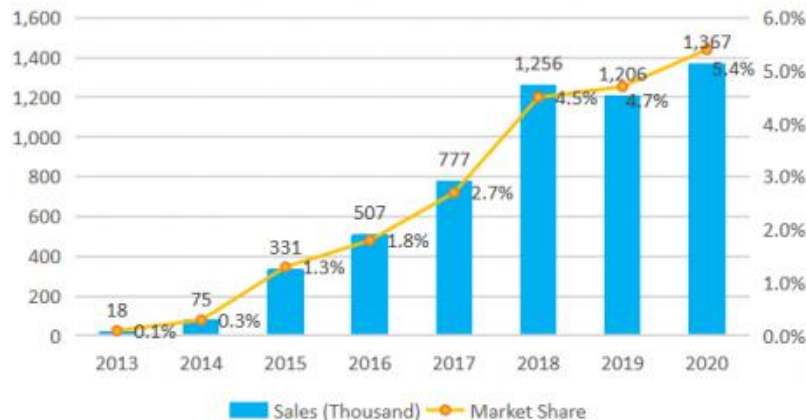
# NEV Market

## Global NEV Sales and Market Share



Source: EV Volumes, CATARC

## China's NEV Sales and Market Share

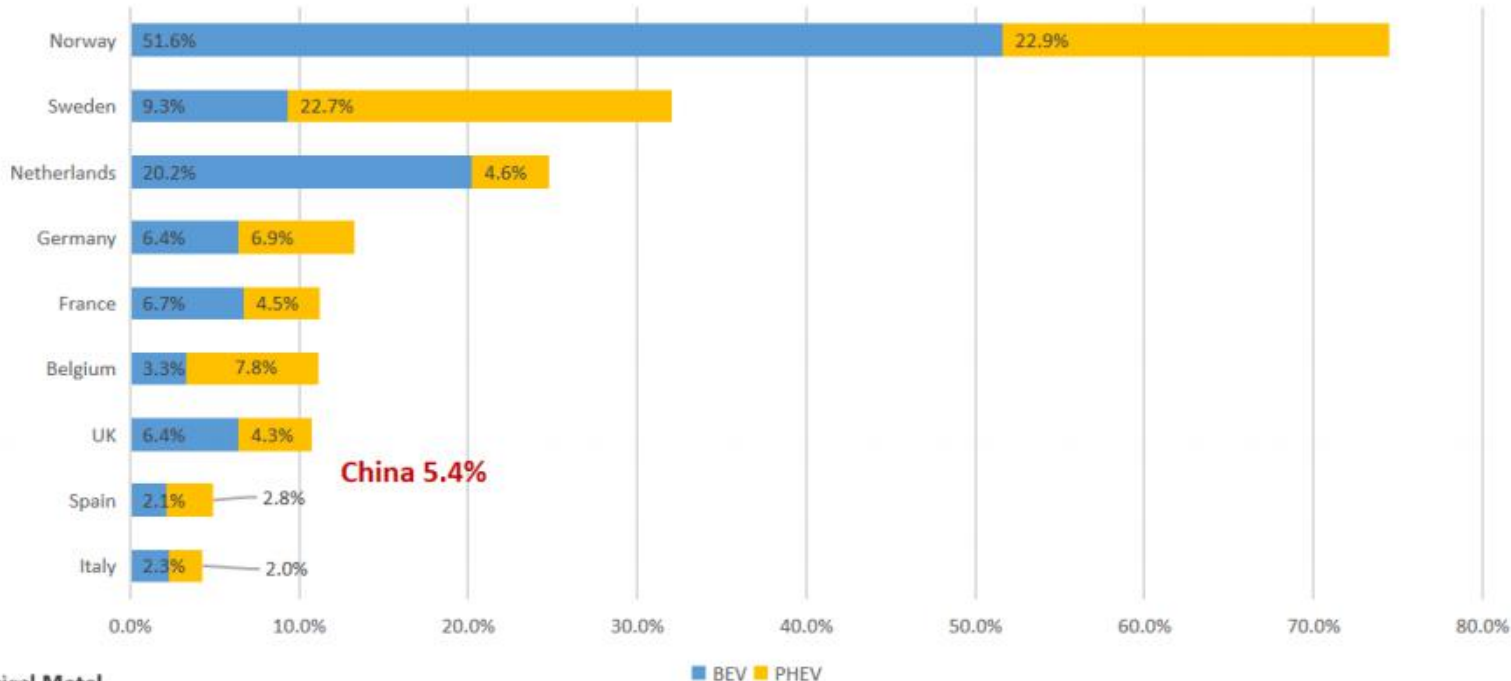


Source: CAAM



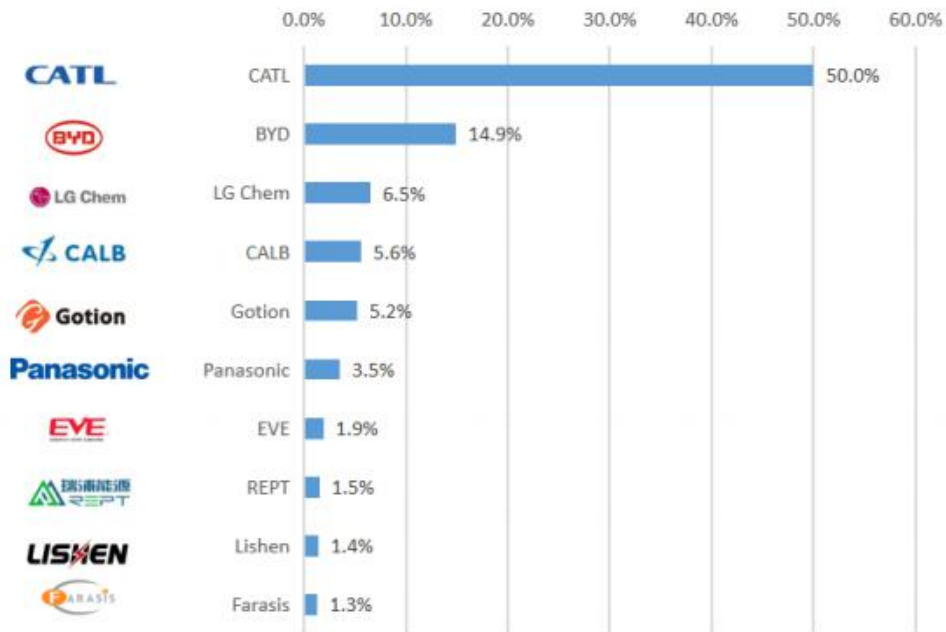
# NEV Market

NEV Market Share in Europe (by Mar. 2021)



# Power Battery Market

China's Power Battery Market Share in 2020



Source: CABA

# Plan & Ambition



**2030**

**Carbon Emission  
Reduction ~55%**

**2050**

**Carbon Neutrality**

2019.12.11

VS



**2030**

**Peak Carbon  
Dioxide Emissions**

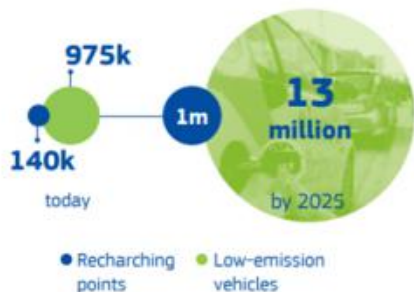
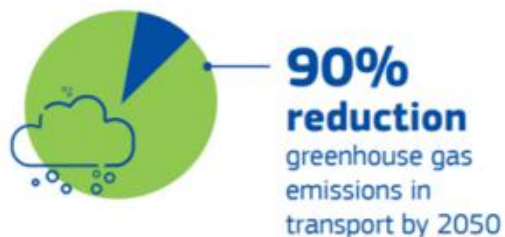
**2060**

**Carbon Neutrality**

2020.09.22

# Plan & Ambition

## Green Deal



Source: European Alternative Fuels

## Plan for Development of NEV Industry ( 2021-2035 )



'**Proposal for A Regulation** of The European Parliament and of The Council Concerning **Batteries and Waste Batteries**, Repealing Directive 2006/66/EC and Amending Regulation (EU) No 2019/1020'

- Circular Economy;
- Sustainability;
- Responsibly sourced materials;
- Collection Rate;
- Recycling Rate;
- Traceability;
- ...



'Technical Specification of Pollution Control for Treatment of Waste Power Lithium-ion Battery' (Draft for Comments)

- Pollution control in dismantling, shredding, recycling processes;
- Waste water, VOCs, Solid waste;
- Hydro, Pyro Processes;
- ...

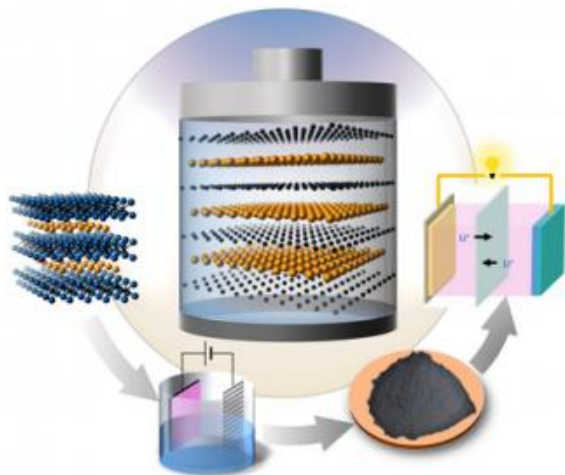


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02

PART 02

**Emerging Market of LIB in China**



Source: Drexel University

## Innovation of Battery Material

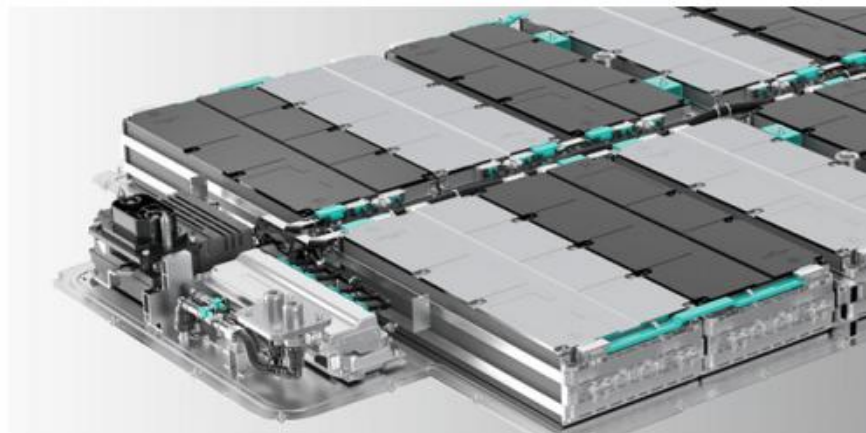
- High Nickel, Low Cobalt
- LFP
- LMO
- Solid-state
- ...

**Energy density & Safety**

## Innovation of Battery Design

- CTP
- GCTP (Blade Battery)
- Magazine Battery

Unified cell vs Specific cell



Source: Nio

**Energy density & Safety**



# New Application Scenarios



10K in 2020 (100K in 2021, 1M in 2025) customized EV for online car-hailing services/ride-sharing

## Battery Swap



Source : Nio, cctv, Souhu, EV Partner

# Emerging Market

Wuling MINI EV



Source: Bitauto

## Mini EV

2020: No.2 in China, No.3 in world

2021: No.1 in world

## Electric Bicycle

- Battery Upgrades: from lead to LIB
- >350 million by 2023





## Energy Storage & V2X



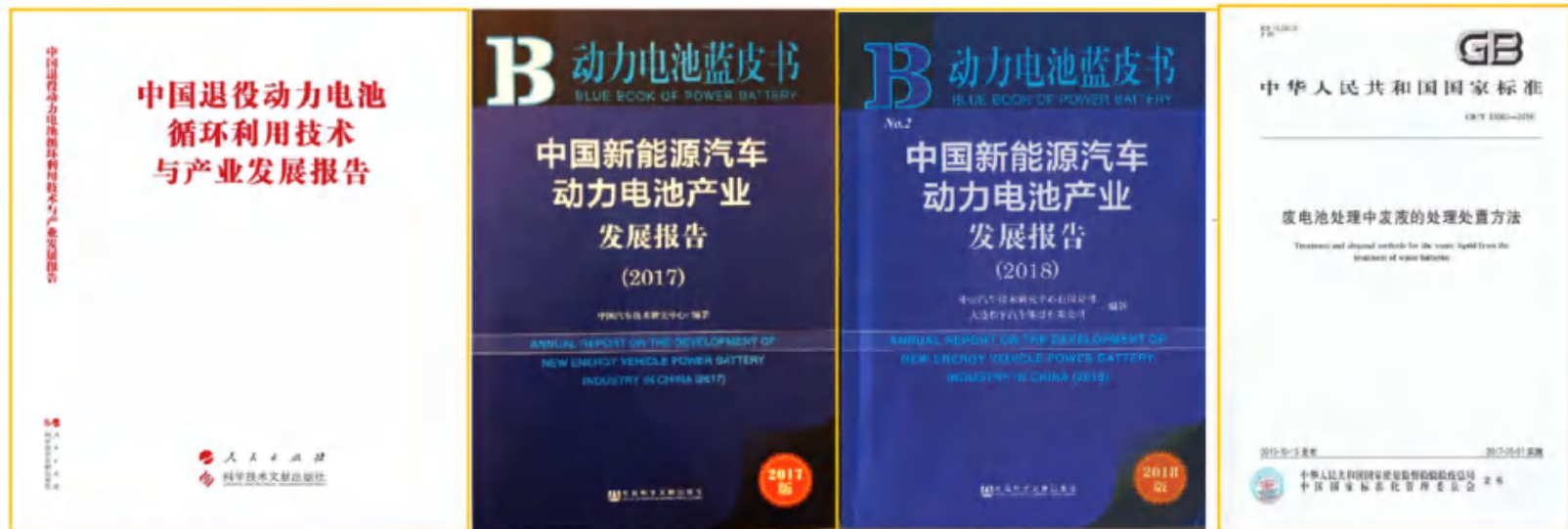
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03

PART 04

**Botree Cycling solutions for spent LIB recycling**

# Botree team in battery and battery recycling



Major authors of

- Blue book of power battery (Annual report NEV power battery industry in China)
- White book of spent power battery recycling technology and industry
- National standards related to spent battery recycling

# R&D and test platform



▲ 1000 hours continuous operation test

# Consulting & Technical Service

- Recycling of Critical Metals from spent LIB
- Refining of Critical Metals from Ores
- Battery materials preparation
- Intelligent Equipment design and manufacturing

- Front to end technical solution
- Market research and analysis
- Feasibility study
- Product and process development
- Laboratory characterization, analysis and synthesis

## Consulting & Technical Service





# Design & Engineering Service

- Requirements and process demand checklist;
- Raw materials analysis;
- Flowsheet and process details (including laboratory test to determine the preliminary parameters);
- Pilot scale test for process verification (if needed);
- Processes optimization and check.

## Process Feasibility Analysis

- Decision for materials of equipment.
- Comprehensive docking (including demand of process, automatic control, etc.);
- Engineering design regarding process, electrical, automatic control, civil engineering, etc.;
- Standard equipment procurement;
- Non-standard equipment manufacturing.

## Engineering Design & Procurement

- On-site installation;
- Debugging;
- Operation and training;
- Maintenance service;
- Process optimization and devices update;
- Lifecycle assessment and management (if needed) .

## Project Implementation

# Innovation and Core Technique in commercial plants

Comprehensive replacement of traditional processes, **significantly reducing construction cycle, investment, and operating costs**



## Innovation 1

(Already pass 10000 ton/year pilot test)

- ✓ True **automate** process, short process with high stability
- ✓ Achieve 0.1%-0.5% low Al impurities, and 90+% key metal materials recovery rate, well above market average

## Innovation 2

(Already pass 2500 ton/year pilot test)

- ✓ Manage to **pre-recover Li** from the hydrometallurgy process. Solve the low Li concentration major issue in the traditional process
- ✓ 94% High Li recovery rate, and reach battery level  $\text{Li}_2\text{CO}_3$  through one step

## Innovation 3

(Complete development, no magnification risk)

- ✓ Fundamental innovation from the ground level, develop a new leach-extraction system, especially suitable for "High Ni Low Co" battery type
- ✓ Dramatically simplify the process, can achieve 5-20% higher recovery rate, 10% less energy consumption with 60% less investment

# Dismantling process

**Shorter process, higher recovery & Product purity, fully automatic**



**Product index:** Total metal recovery rate >90%  
Major impurities (Cu,Al...) in Black powder <0.5%.

**Capability and product** (Take 18650 single battery as an example)

Spent LIBs t/a	product t/a			
	Cu powder	Al powder	Black powder	Shell
2000	236	170	826	74
5000	472	340	1652	150

# Separation process

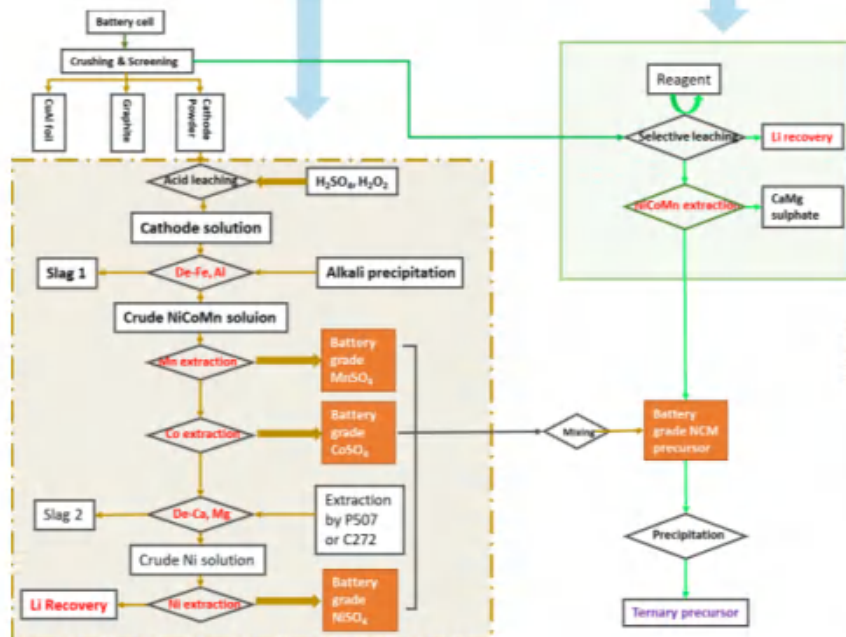
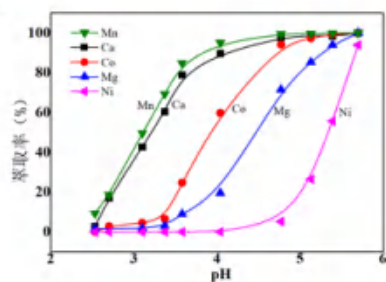
## Shorter process, higher recovery & Product purity, fully automatic

Market main process

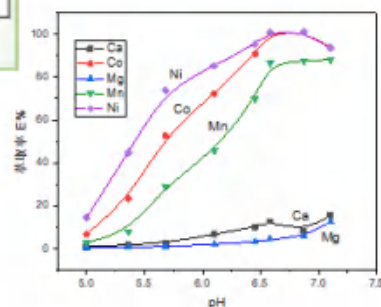
Botree Process

Designed for **high-Ni resource** like spent power battery / laterite leaching liquor

Traditional SX inside



Botree SX inside



# Equipment design & manufacturing

## Equipment Design

### Botree Dismantling Process (BCD)



- International leading disassembly technology, suitable for wide range of feeds, high stability.
- Impurities such as aluminum are stably controlled at 0.1 - 0.5%, and the recovery rate of valuable metals is greater than 90%, which is much higher than the industry level.

### Botree Leaching Process (BCL)



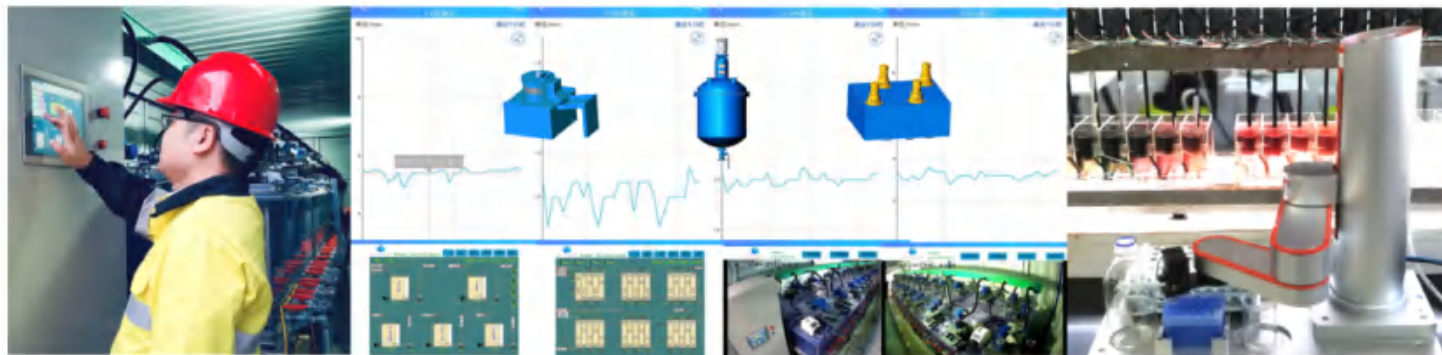
- Reduce the amount of reductant by 25%, and the leaching rate of lithium is greater than 94%.
- The lithium-rich solution has very low impurity content, and the purity of the lithium carbonate can reach to battery grade, which is higher than 99.93%.
- Single stage recovery rate of cathode metals: Nickel > 93.6%, Cobalt > 97.1%, Manganese > 91.3%.
- Comprehensive recovery rate of process is greater than 98.5%.

### Botree Extraction Process (BCE)



- Customized extraction and separation system to achieve efficient and synchronous recovery of critical metals such as nickel, cobalt to battery grade materials, especially suitable for high-nickel raw materials
- Compared with traditional separation systems, it reduces investment by more than 40%, reduces energy consumption by more than 10%, and improves recovery rate by 5-20%.

# Botree Cycling Process, Equipment and Engineering

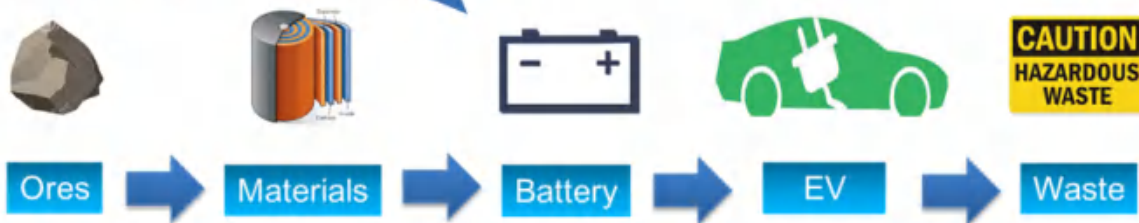


# Botree's ongoing projects of LIB battery recycling

1. >10,000 tpa project outside China  
(From pack to material regeneration)
2. 2,000 tpa project in China (Hydro-process)
3. 1,000 tpa project in China (Dismantling & Hydro)

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- Containerized design
- Fast reaction & Movable
- Flexible units & processes
- LCO, NCM, NIMH...

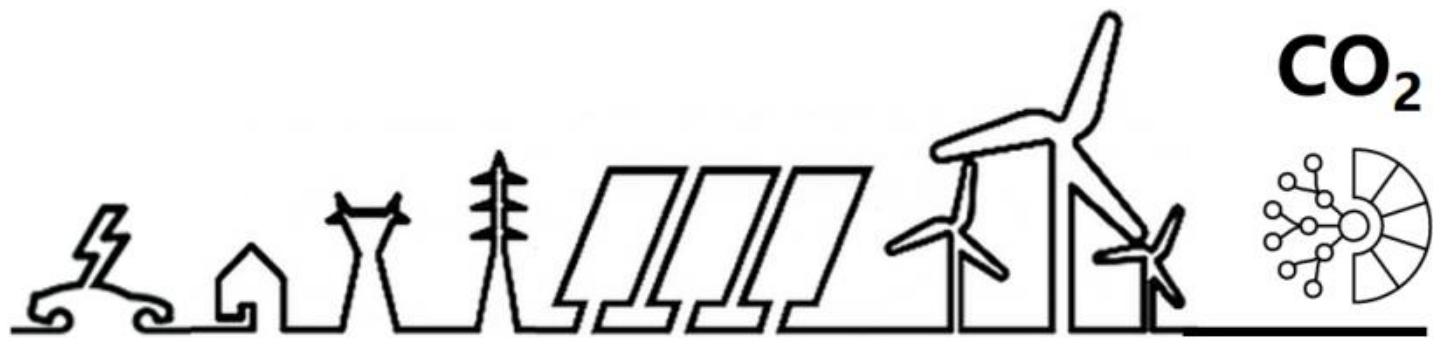


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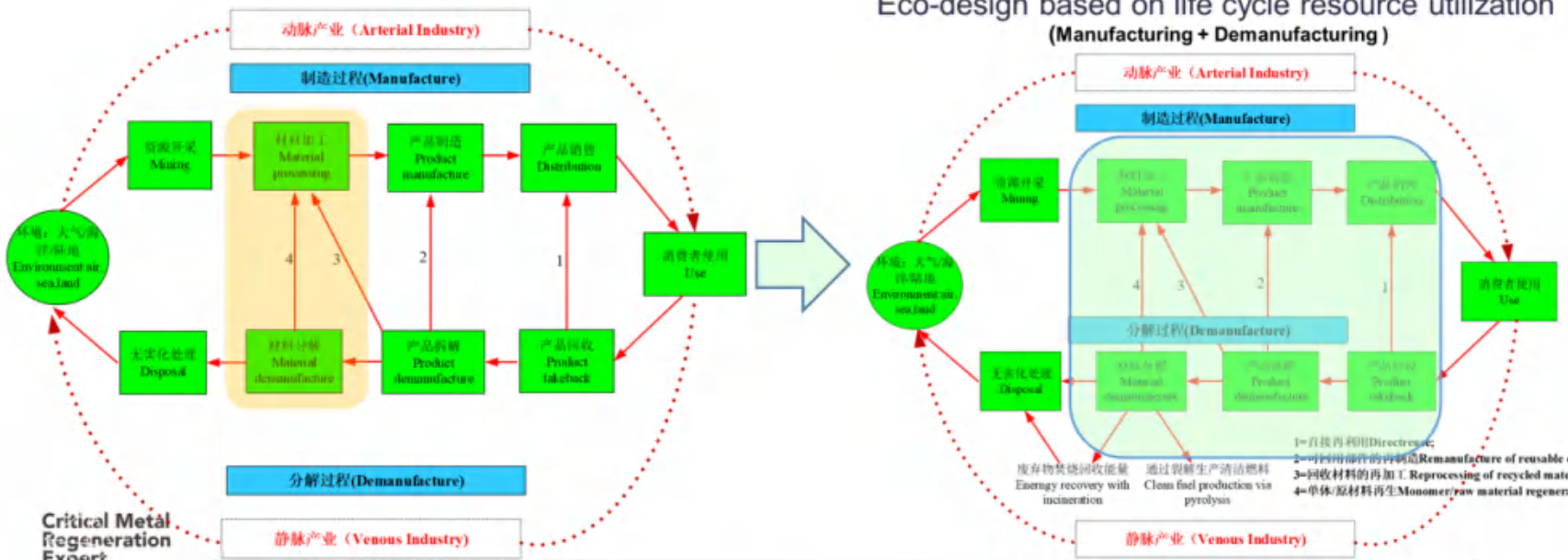
PART 03

Further challenge and cooperation

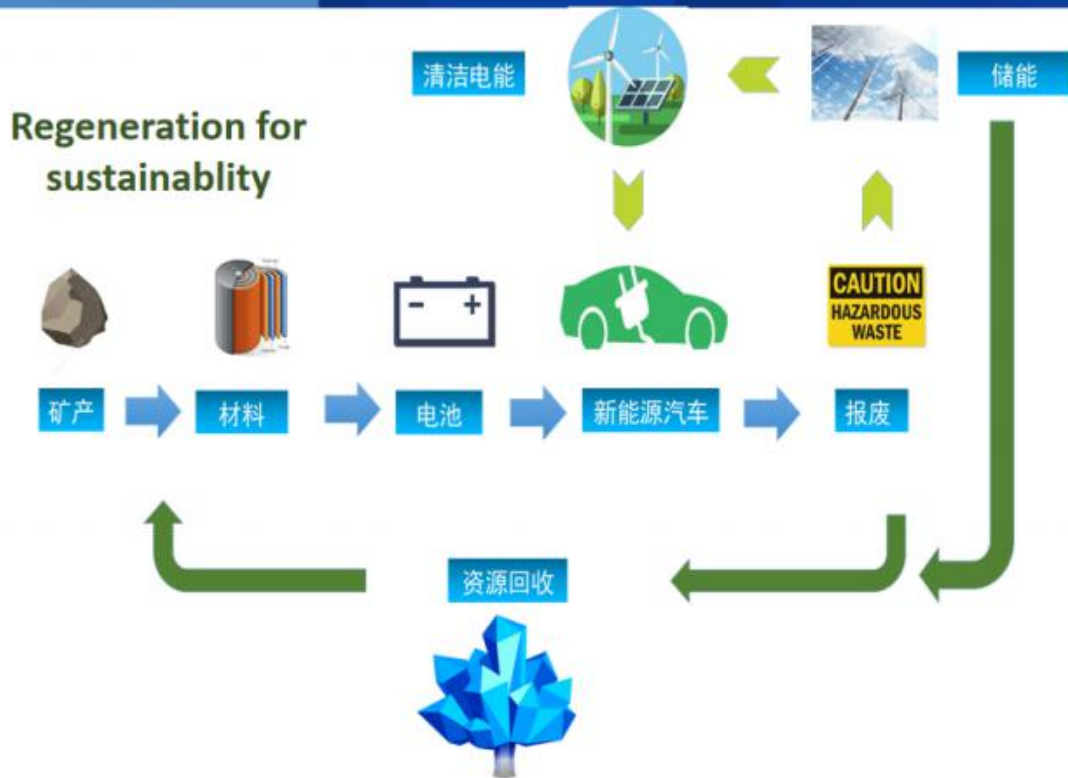




# Regeneration-native designed LIB for sustainable supply chain



# Sustainable resource and energy supply chain of EV



THANK YOU

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