

Final Workshop
Task 40 CRM4EV
2022.04.29 Online

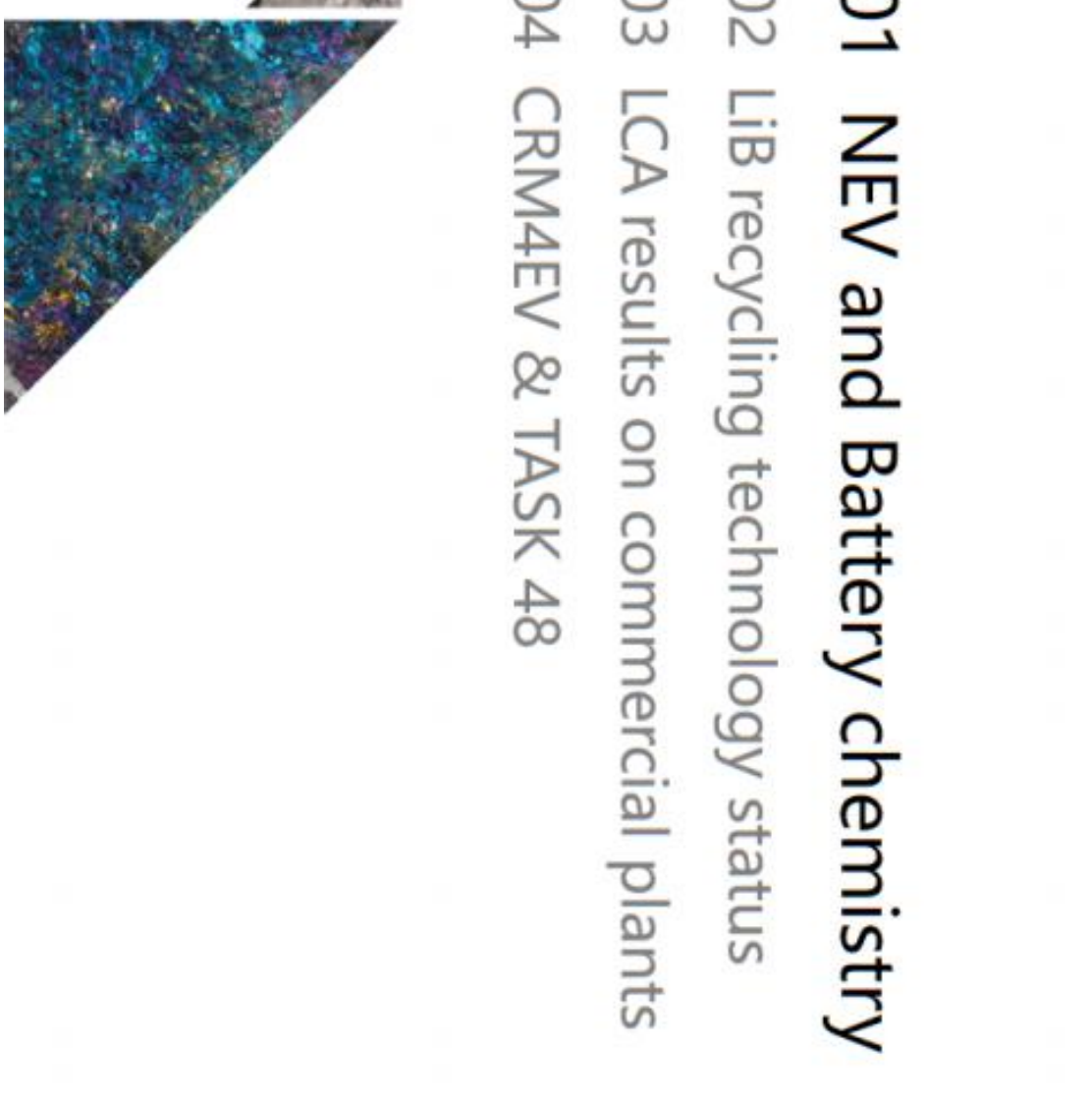
Li-ion Battery Chemistry and Recycling Activities in China

Xiao Lin

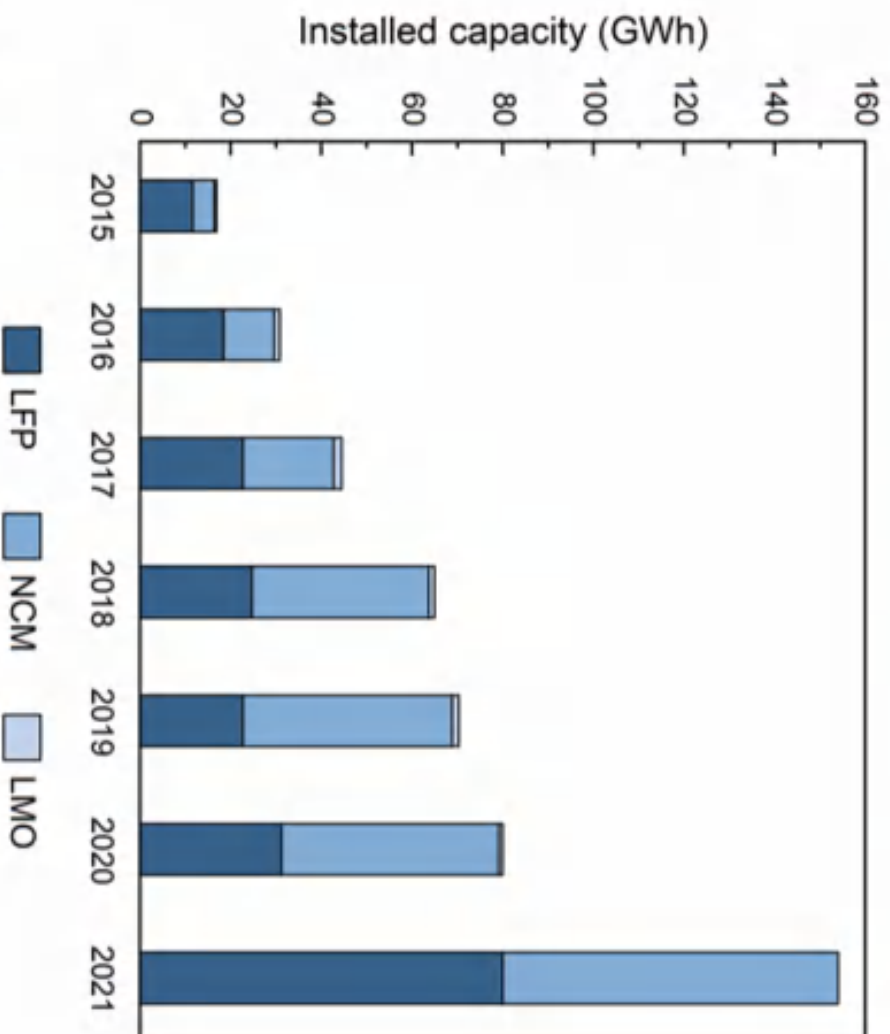




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- 01 NEV and Battery chemistry
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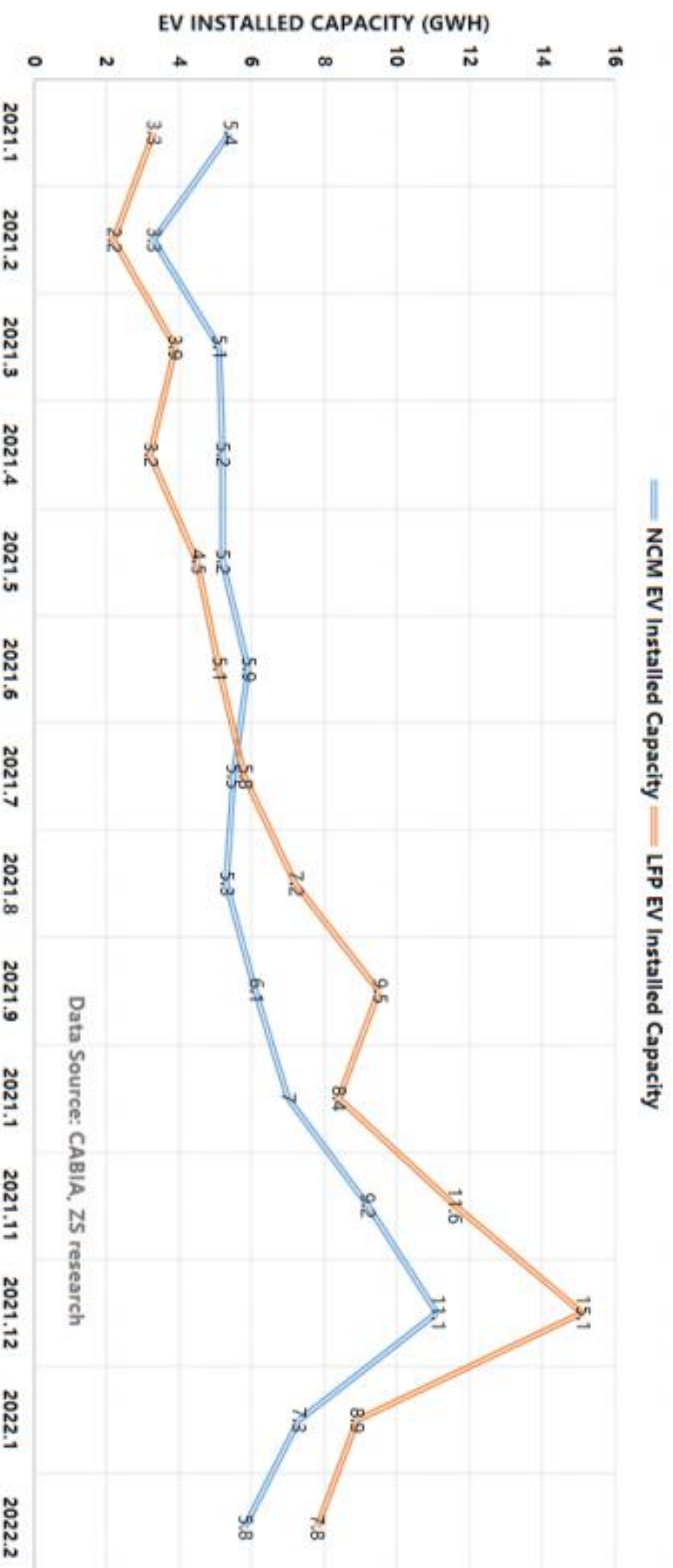
China's EV Battery Market Soared Again in 2021



- After experienced two years relatively gentle increase in year 2019 and 2020, China's EV battery market soared again in 2021
- The total installed EV battery capacity is 154 GWh, with year-on-year growth rate 142.8%
- The predominant battery chemistry are still NCM and LFP, though their rankings have exchanged again in 4 years

Source: SMM, Botree

LFP rapidly takes back its market share in China

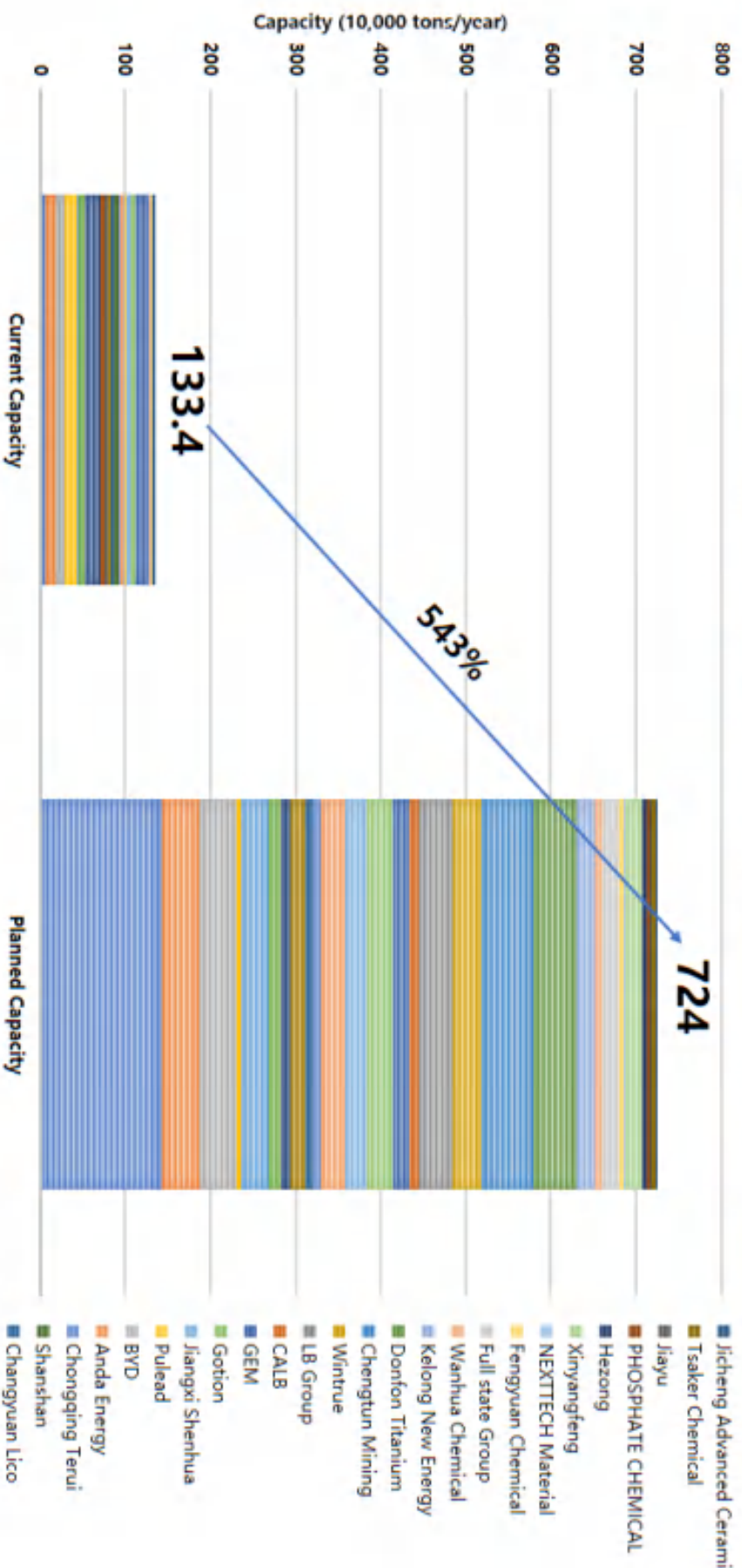


- LFP took back the China EV market leading position since July last year
- The total installed capacities of LFP and NCM in China (2021) are 79.8 and 74.3 GWh respectively
- The installed EV capacity in China from Jan to March of 2022 is 51.3 GWh, with a cumulative increase of 120.7%

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Planned cathode production capacity sharply increases



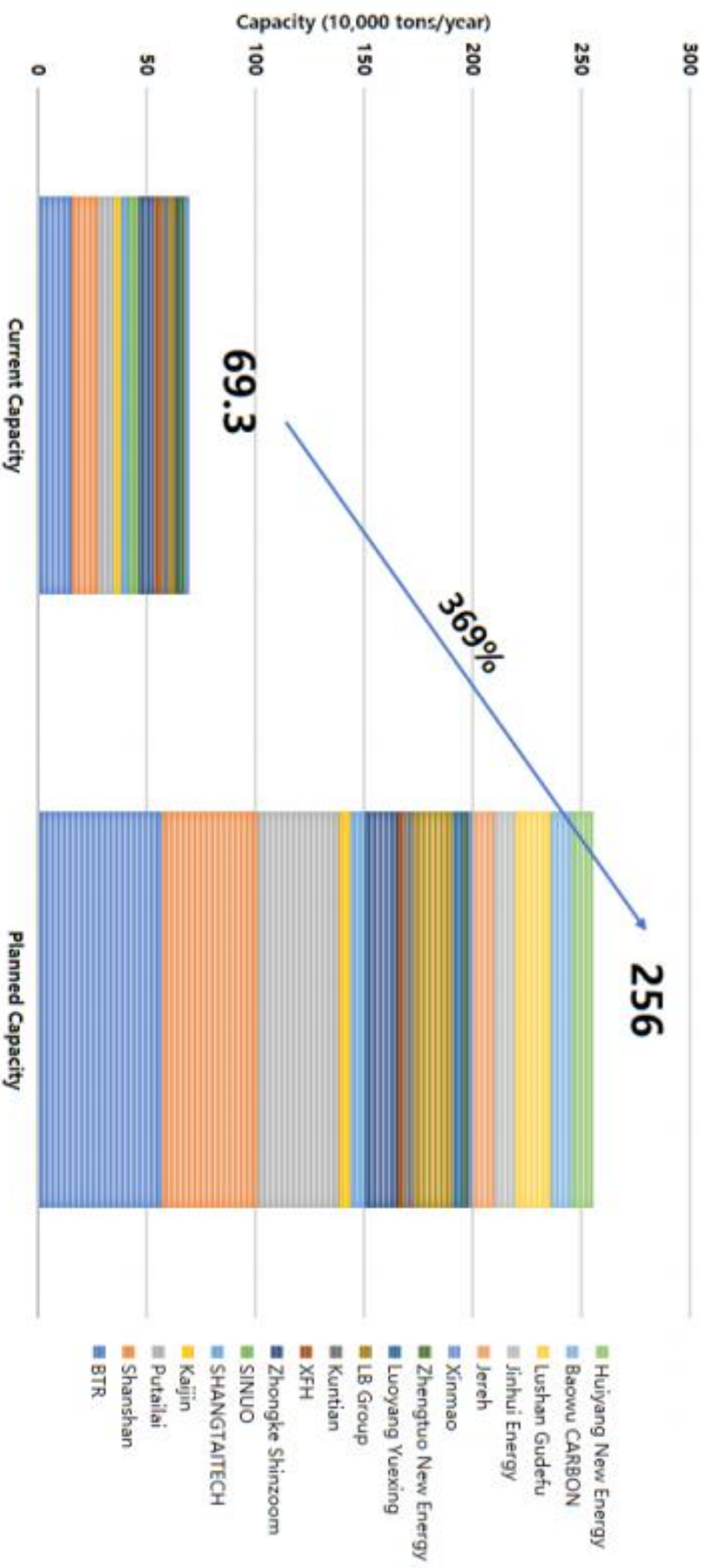
The planned cathode related material production capacity in China reaches 72,400,00 tons, which is 5.43 times current production capacity

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Data Source: Organized by Botree according to the company's public information

Planned cathode production capacity sharply increases



The planned anode material production capacity in China reaches 25,600,00 tons, which is 3.69 times current production capacity

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Data Source: Organized by Botree according to the company's public information



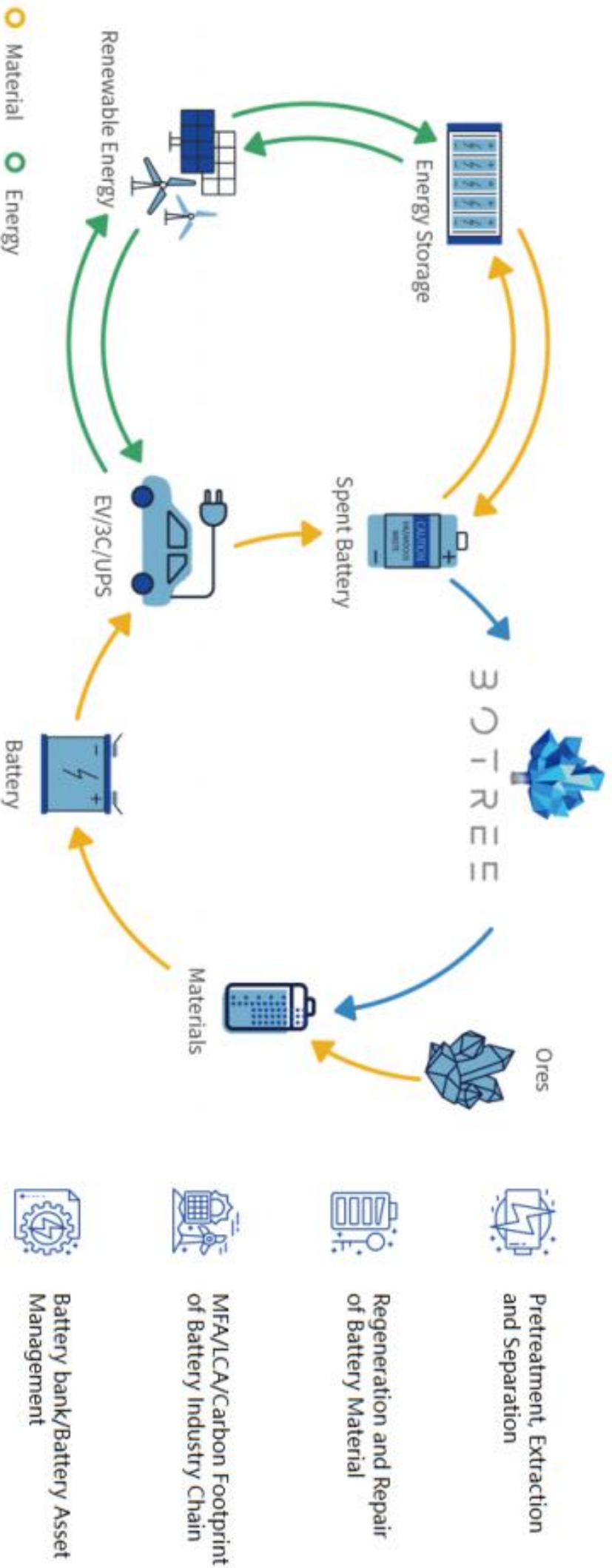
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ABOUT BOTREE CYCLING



Botree Cycling provide a full solution to promote critical materials and energy sustainably.



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BOTREE CYCLING SERVICE



R&D, Technical Consulting



Engineering Design



Intelligent Equipment



Operation Service

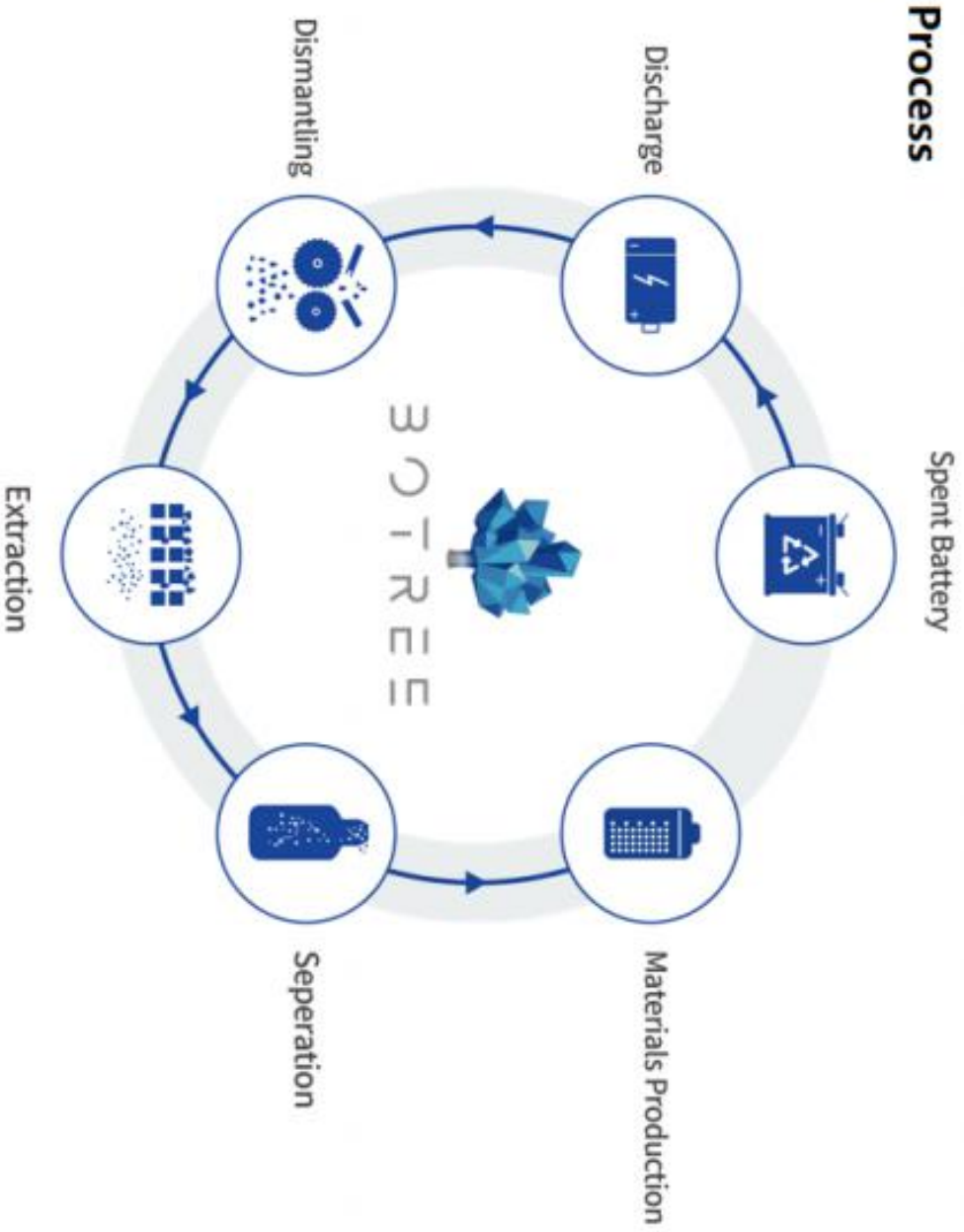
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PROCESS & TECHNIQUE



Spent LIB Recycling Process

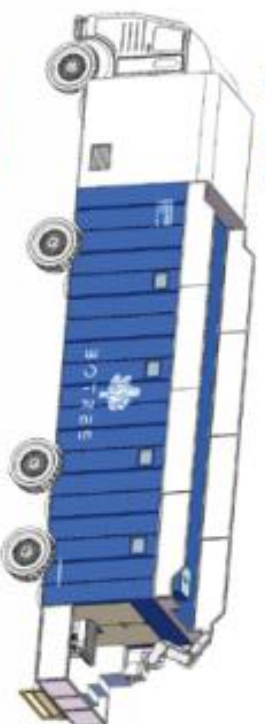


PRETREATMENT EQUIPMENT

Mechanical Pretreatment Test Platform

All type of spent batteries

Mobile Dismantling Equipment



Outputs



Copper foil



Aluminum foil



Black Mass



Shell

- Recovery Rate of Critical Metals > 95%
- Cu or Al Impurities < 0.5%



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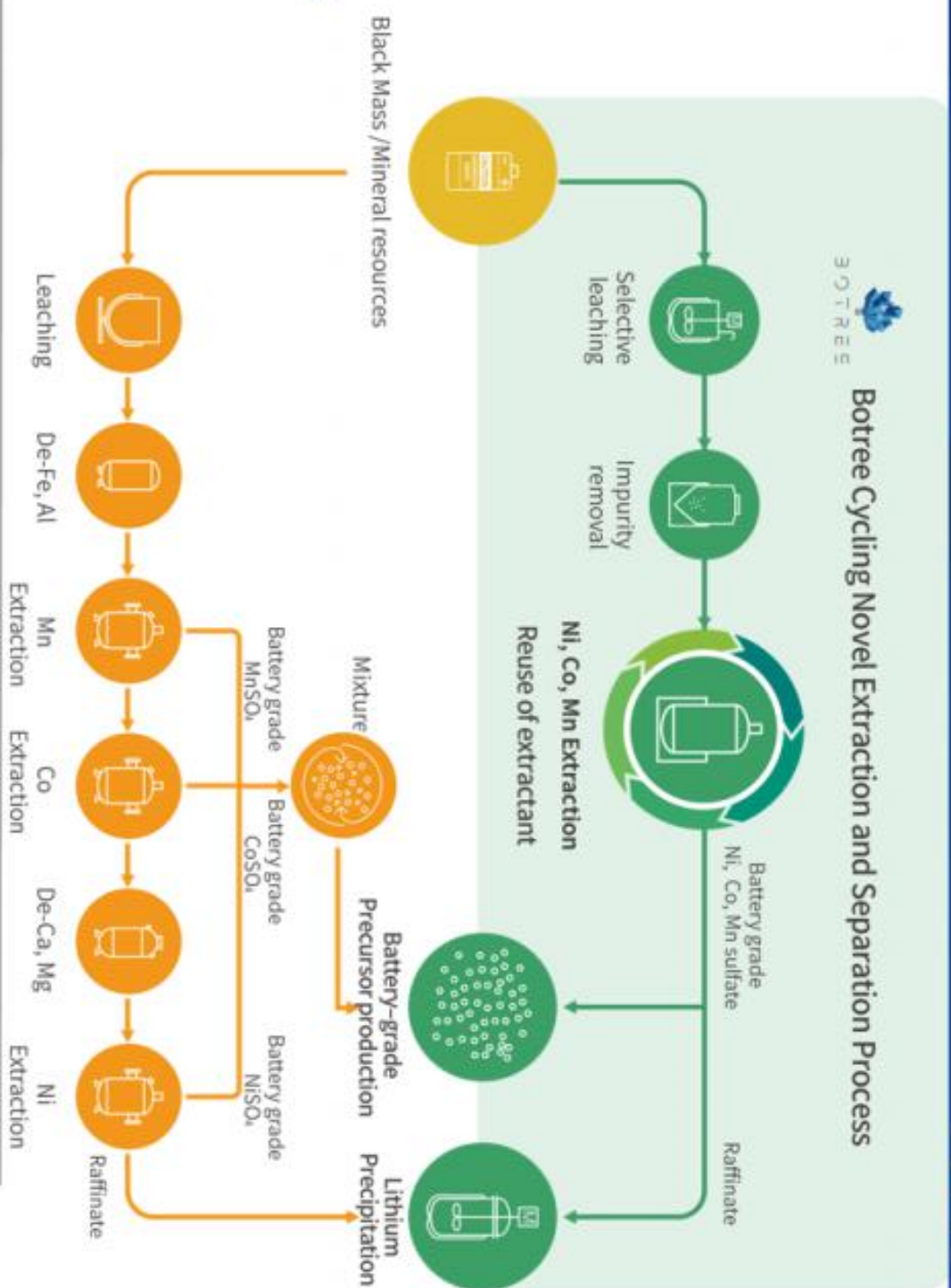
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Separation and Purification

NCM/NCA battery

Nickel-cobalt mineral resources

- SX to precursor directly
- Recovery rate > 98.5%
- Extraction cost reduced 5-20%

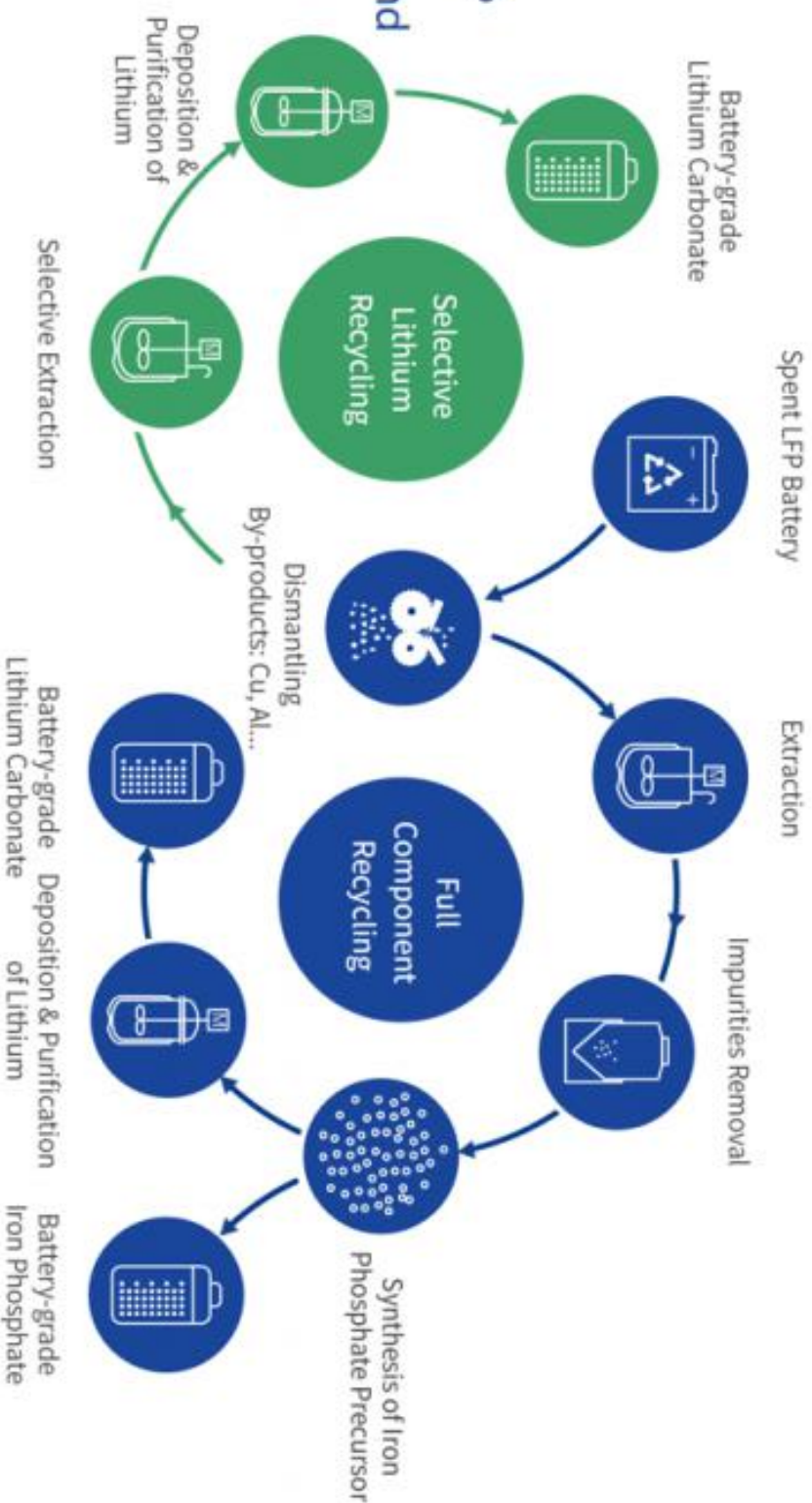


LFP Battery Recycling Process

LFP battery

LMFP battery?

- Recycling rate of Li > 95%
- Recycling Rate of Iron and Phosphorus > 90%



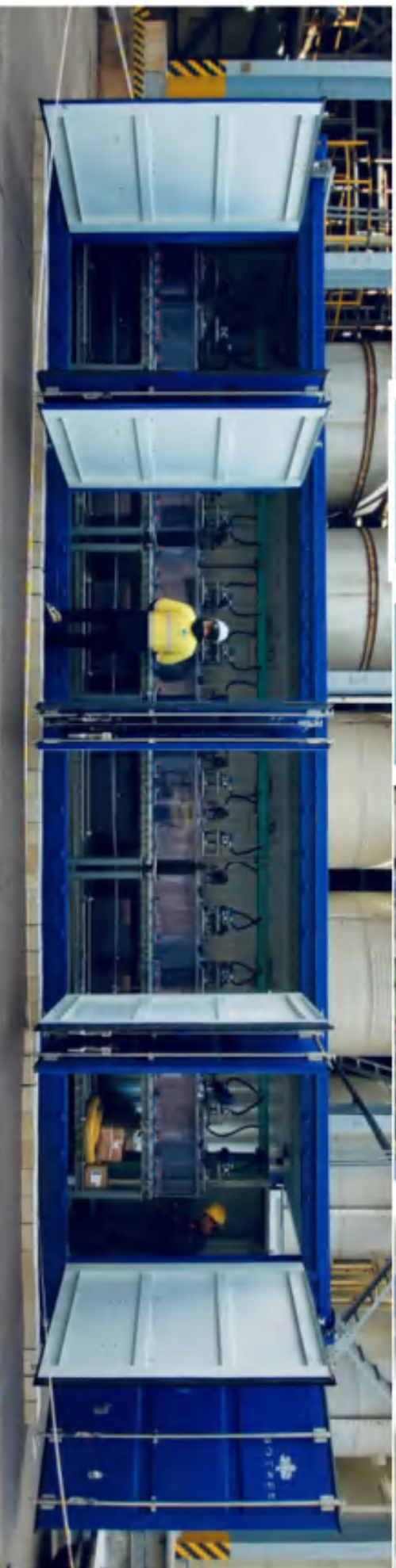
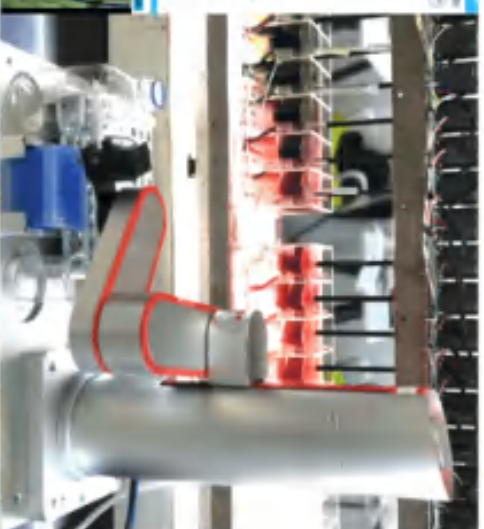
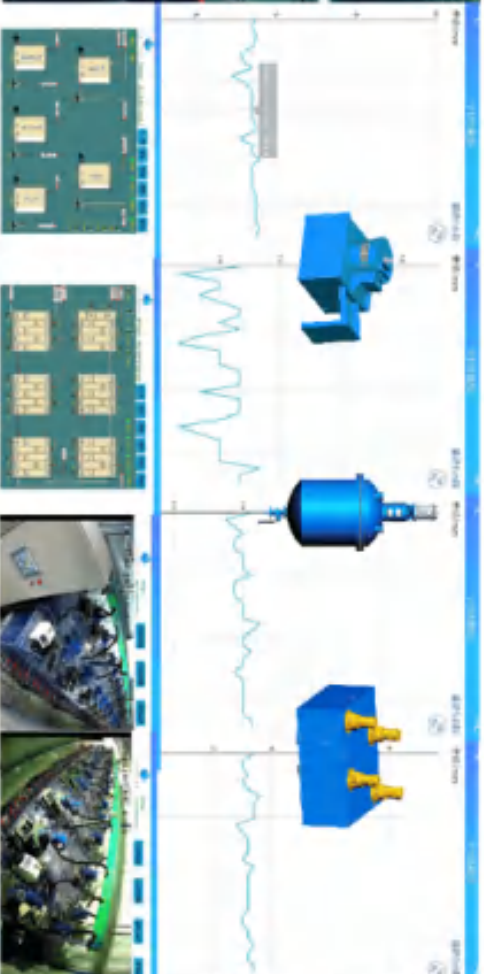
LAB SCALE TEST PLATFORM



1000 hours continuous operation test

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PILOT SCALE EQUIPMENT



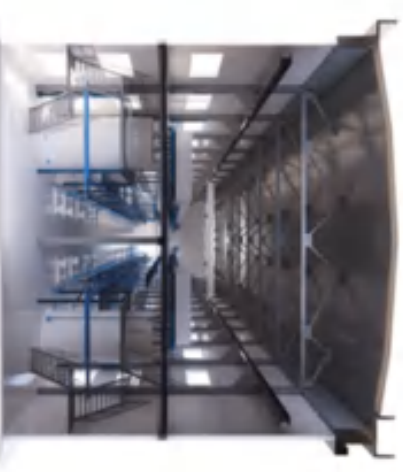
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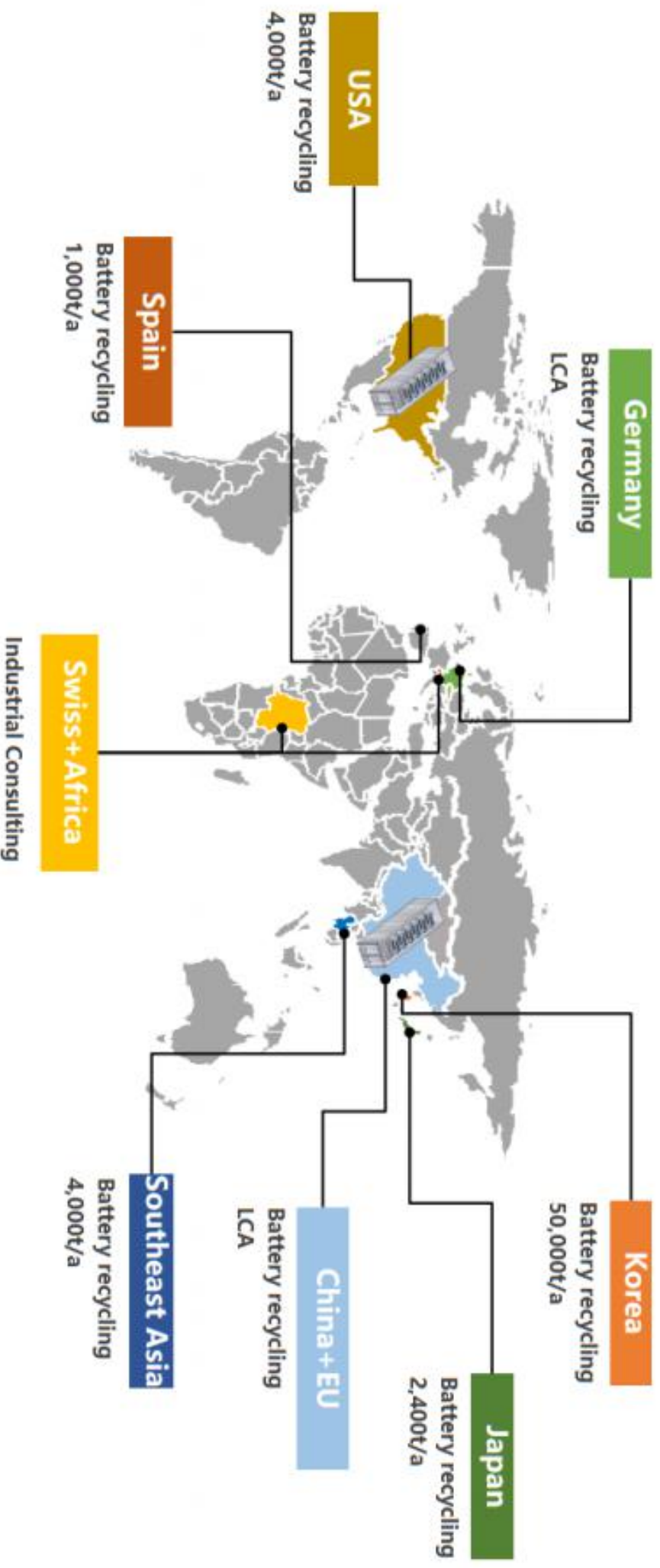


COMMERCIAL PROJECTS

Botree Cycling Leaching-Solvent Extraction commercial processes



Worldwide Project Reference





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LCA results based on commercial plants

Background information

- The LCI are based on real annual production data from 4 commercial plants, PEFCR method

	Recycler A	Recycler B	Recycler C	Recycler D
Recycled black mass quantity (tpa)	<1000	10000~20000	5000~10000	~20000

Note: Due to confidential issue, the exact amount will not be presented

- System boundary:** hydrometallurgical treatment of black mass into Ni, Co, Mn metal salt solution, lithium salt, and other by-products, including GWP contributions from raw materials input, raw material transportation, energy input (electricity and heat), waste disposal and direct emissions in the leaching, solvent extraction, lithium salt production and wastewater treatment processes, the **carbon credits** are calculated based on the avoidance of primary metal salts production



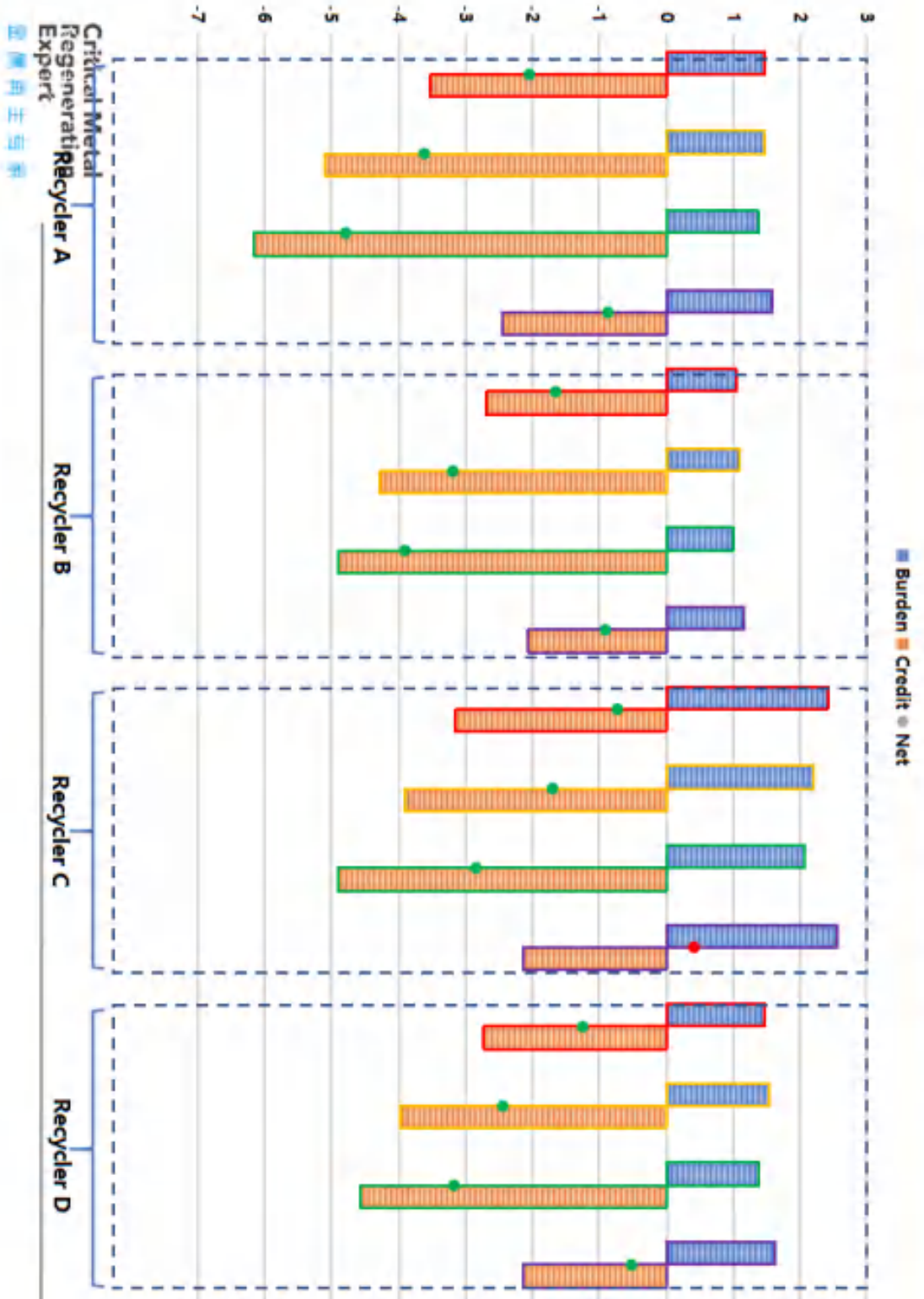
- Function unit:** treatment of 1kg of black mass

LCA results based on commercial plants

Background information

- Secondary data are based on A and B database
- Four scenarios have been calculated and compared, namely:
 - ✓ Scenario 1: all secondary data taken from A database
 - ✓ Scenario 2: all secondary data taken from B database
 - ✓ Scenario 3 (lowest burdens & highest credits):
Environmental burdens: item taken from either A or B, whichever is lower
Credits: item taken from either A or B, whichever is higher
 - ✓ Scenario 4 (highest burdens & lowest credits):
Environmental burdens: item taken from either A or B, whichever is lower
Credits: item taken from either A or B, whichever is higher
- All the data presented have been normalized due to confidential issues

LCA results based on commercial plants



- In general, due to the avoidance of primary production of energy-intensive metal salt products, recycling of the battery black mass will result in negative net GWP
- The choice of data sets from A or B database has huge impacts on the calculated results. The impact is more significant when calculating the credit compared to burden
- The impacts can be more obviously observed in Scenario 3 (lowest burden & highest credit) and Scenario 4 (highest burden & lowest credit), where positive new GWP is even obtained

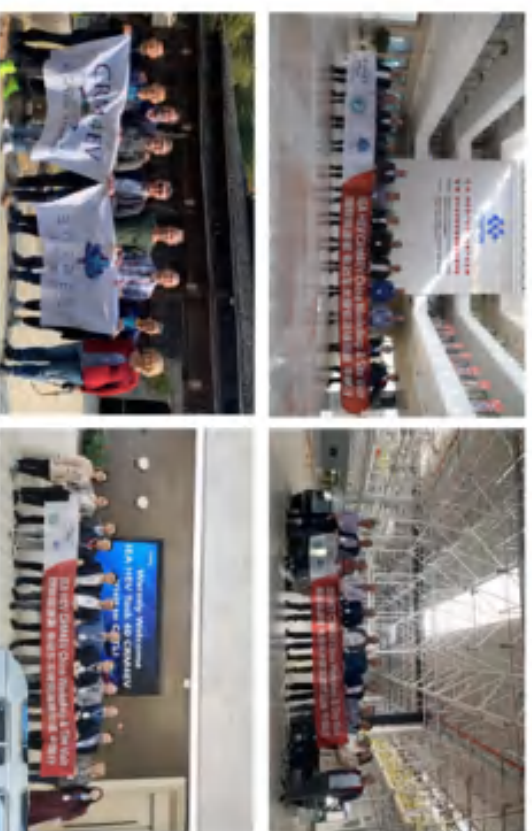
Scenario 1 —
 Scenario 2 —
 Scenario 3 —
 Scenario 4 —



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CRM4EV



China workshop in 2019



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WILEY-VCH
JOY TREE

WILEY-VCH

Xiao Lin, Xue Wang, Gangfeng Liu, and
Guobin Zhang

Recycling of Power Lithium-Ion Batteries

Technology, Equipment, and Policies



Publish in Oct. 2022

Emerging Market : battery-based energy system?

- Battery Swap
- Customized EV for online car-hailing services/ride-sharing
- Mini EV
- Electric Bicycle
- Energy Storage & V2X

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IEA HEV TCP Task 48 Battery swapping

Current participants (The kickoff meeting was held on the 22th of March, 2022)



Botree Cycling



vti

Swedish National Road and Transport
Research Institute



Piaggio Group



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Research



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IEA HEV TCP Task 48 Battery swapping

Welcome joining us

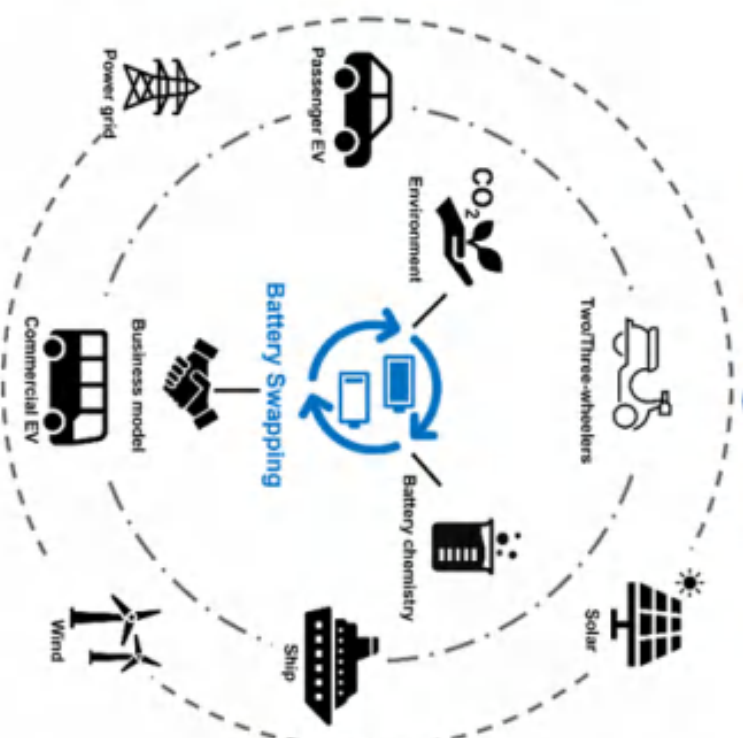


BATTERY SWAPPING

Scope

- Battery materials
- Environmental impact
- Power grid facilities
- Business model

Scenarios



Objectives

- Global info exchange
- Ecosystem and traceability mechanism
- Recommendations for policy makers and stakeholders

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THANK YOU

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