

Outlook for lead and lead batteries

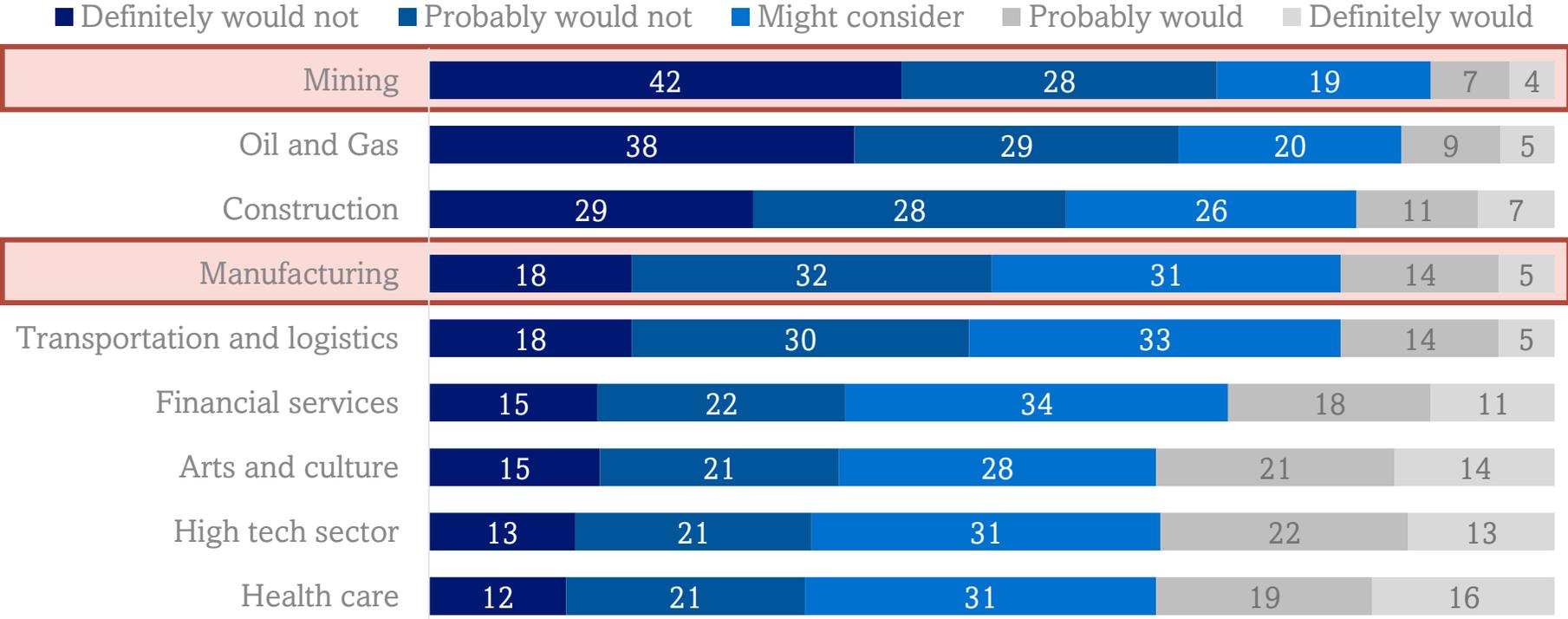
June 2023

Thea Soule – Sugarcane Fields to Battery Recycling



We have an attractiveness problem...

Percentage of respondents, ages 15 to 30, who do not think our industry is attractive:

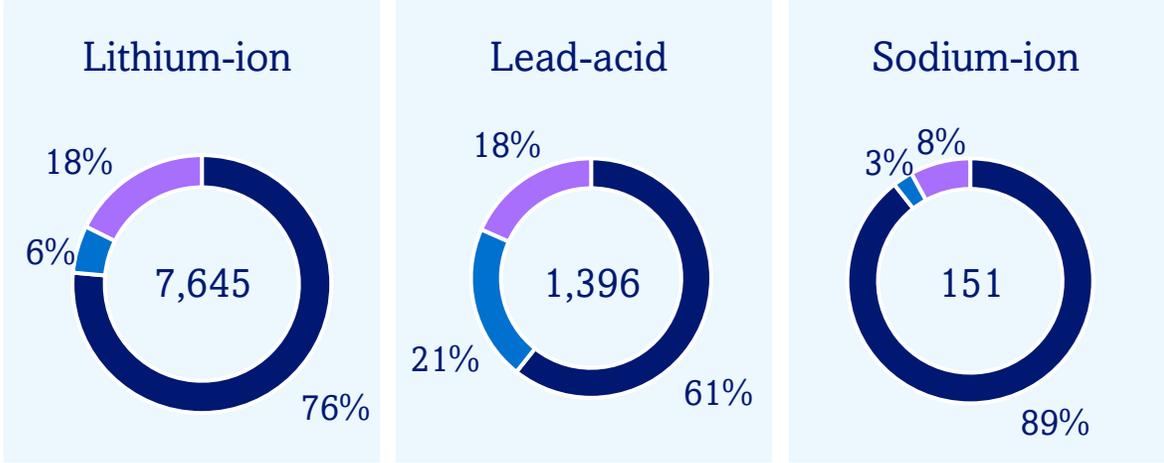


Note: MIHR commissioned Abacus Data to conduct a survey of 3,000 Canadians aged 15 to 30, during Dec 2020.
 Source: Ecobat Market Intelligence, Mining Industry Human Resources Council 2021

We have a research investment gap....

Number of granted patents per battery type (2000-2022)

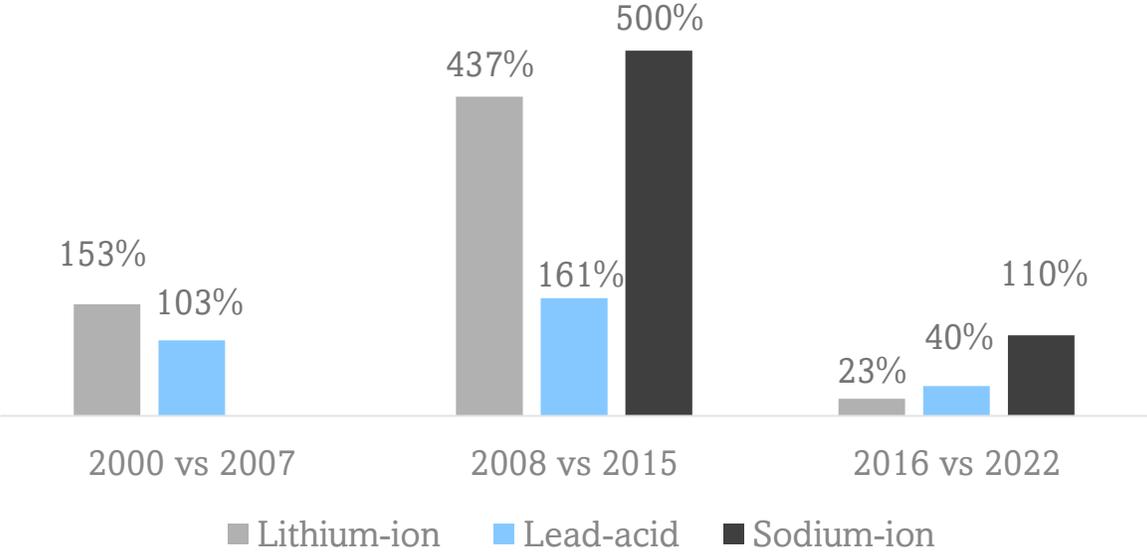
The estimated number of granted patents for lithium-ion is ~6x higher than for lead-acid



■ Active ■ Expired ■ Inactive

Granted Patents YoY growth per battery type

Sodium-ion gains momentum despite low number of granted patents



■ Lithium-ion ■ Lead-acid ■ Sodium-ion

Note: Patents selected by main battery types keywords and grouped by families.
 Source: Ecobat Market Intelligence, European Patent Office, The Lens Patents

And still, we have a lot of advantages...

Automotive



Motive



Stationary



E-bike



MAIN ADVANTAGES

LIB is the standard EV technology.

While LAB is essential in many segments, LIB have emerged as a formidable competitor, challenging the advantages of LAB.

**Lithium-ion battery
LIB**

- Charging time
- Energy density
- Durability

- Charging time
- Maintenance
- Durability

- Energy density
- Self-discharge
- Maintenance
- Durability

- Charging time
- Energy density
- Durability
- Regulation

**Lead-acid battery
LAB**

- Replacement batteries
- Auxiliary batteries
- ICE longer in some regions

- Cost (especially for one-shift operation)
- Counterbalance
- New technologies with low maintenance

- Cost
- Safety
- Regulation

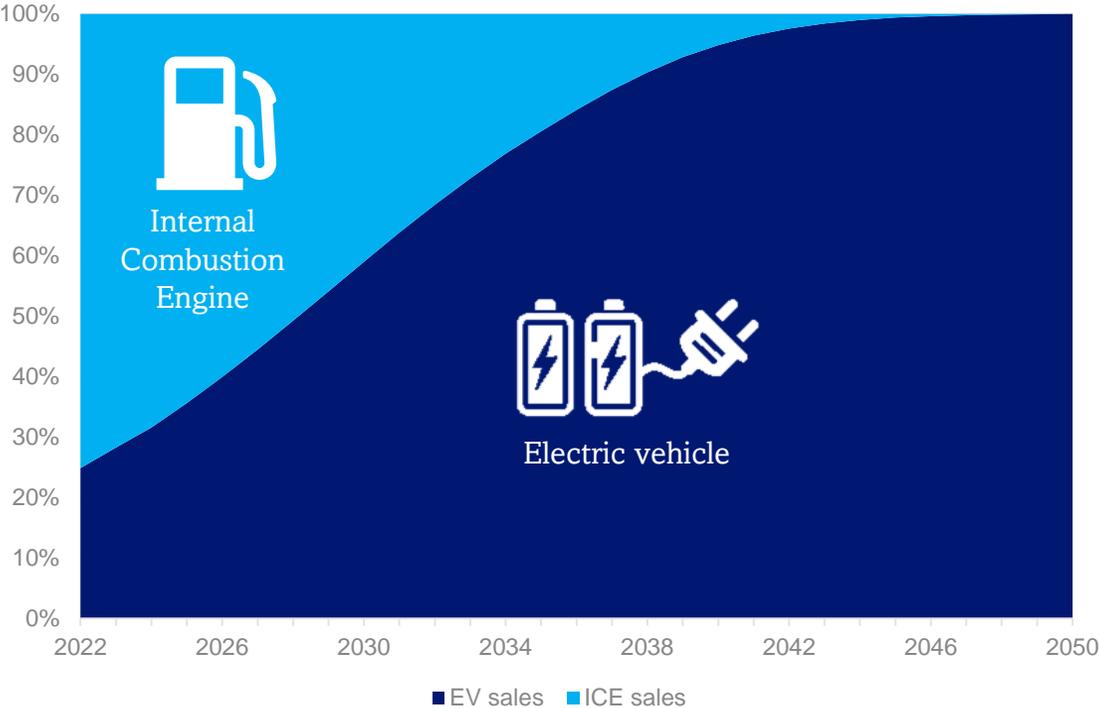
- Cost
- Safety

Source: Ecobat Market Intelligence

The news focuses on new vehicle sales...

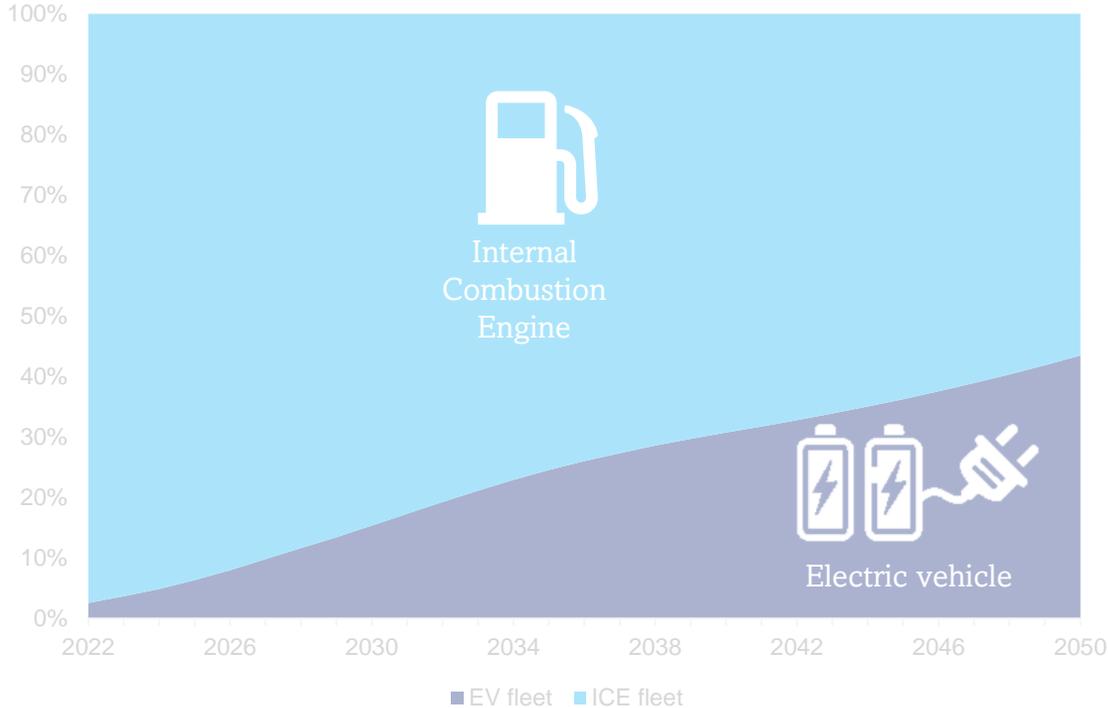
Potential: 100% penetration of EVs in the passenger fleet in Europe from 2045

Sales of passenger vehicle per vehicle type



Longevity: 58% share of ICE vehicle in the passenger fleet by 2050

Passenger vehicle fleet per vehicle type



Source: Ecobat Market Intelligence, ACEA, BNEF

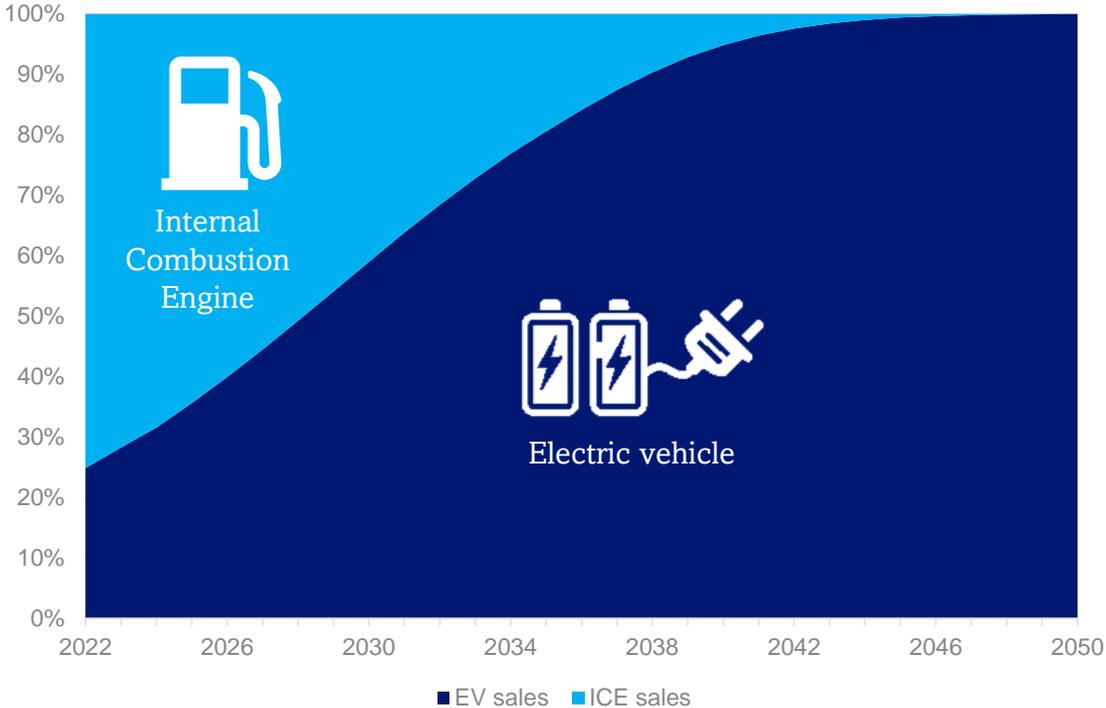
But the reality of the fleet transition is much slower...

Lead has a sizable and stable market, whereas lithium holds the growth story

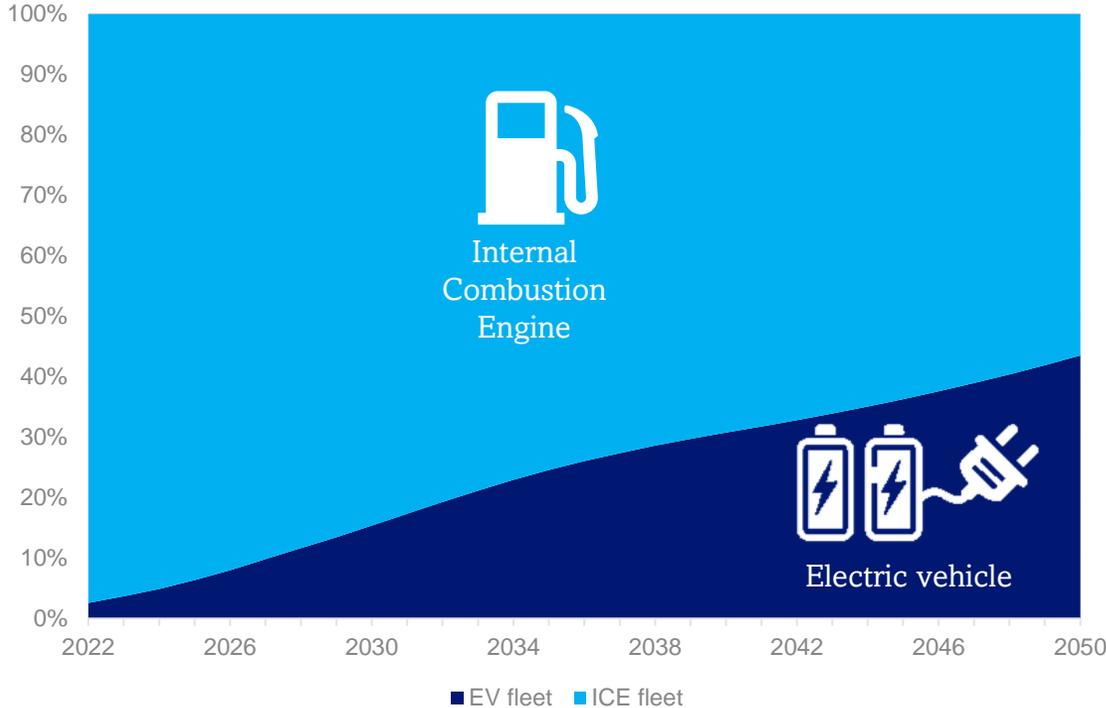
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Sales of passenger vehicle per vehicle type

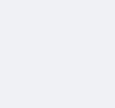
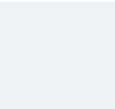
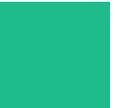
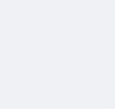
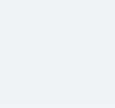


Passenger vehicle fleet per vehicle type



Source: Ecobat Market Intelligence, ACEA, BNEF

We win part of the CO2 footprint impact assessment...

	LIB	LAB	
Mining & Refining ¹			<ul style="list-style-type: none"> LIB metals supply highly concentrated LIB availability faces geo-political uncertainties
			<ul style="list-style-type: none"> Lead emissions intensity low but processes fossil fuel reliant Mined Lead easily available
Battery Manufacturing ²			<ul style="list-style-type: none"> Technical advantage Energy intensive manufacturing and chemical use and waste
			<ul style="list-style-type: none"> Established market Lower CO2 in avg. midsize ICEs batteries production than EVs
Use Phase ³			<ul style="list-style-type: none"> Lower to zero replacement rate Cleaner energy depending on the country energy matrix
			<ul style="list-style-type: none"> Relies on fossil fuel Higher replacement rate
End of Life ⁴			<ul style="list-style-type: none"> Recent recycling technology Stated recycling rate is 5%
			<ul style="list-style-type: none"> Mature recycling process Nearly 100% of Pb batteries are recycled

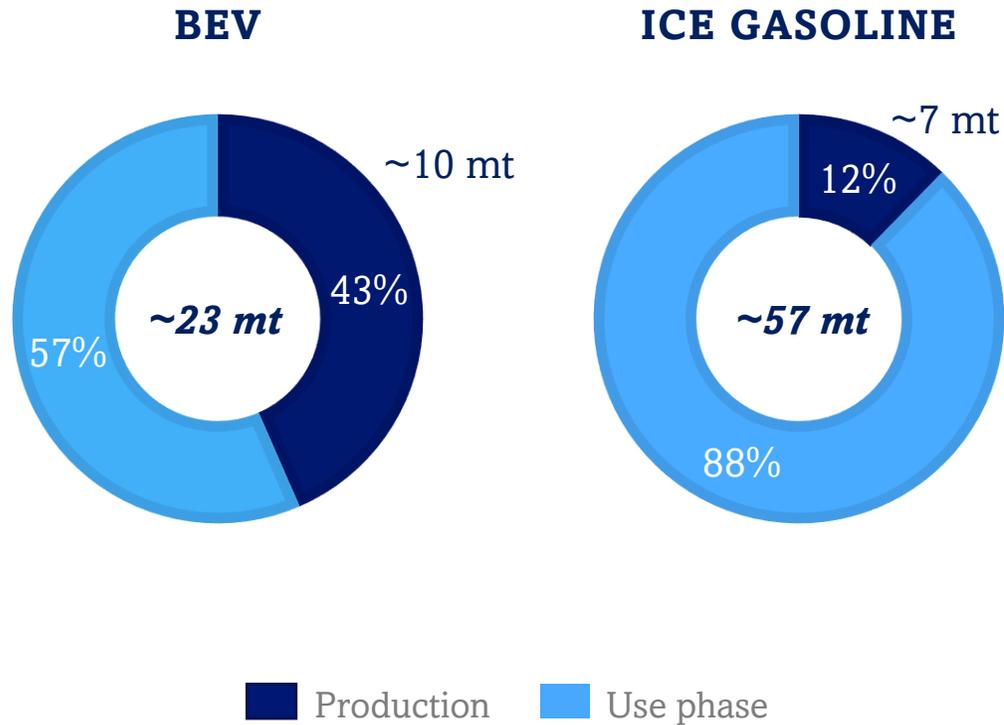
Lower Impact 

Higher Impact 

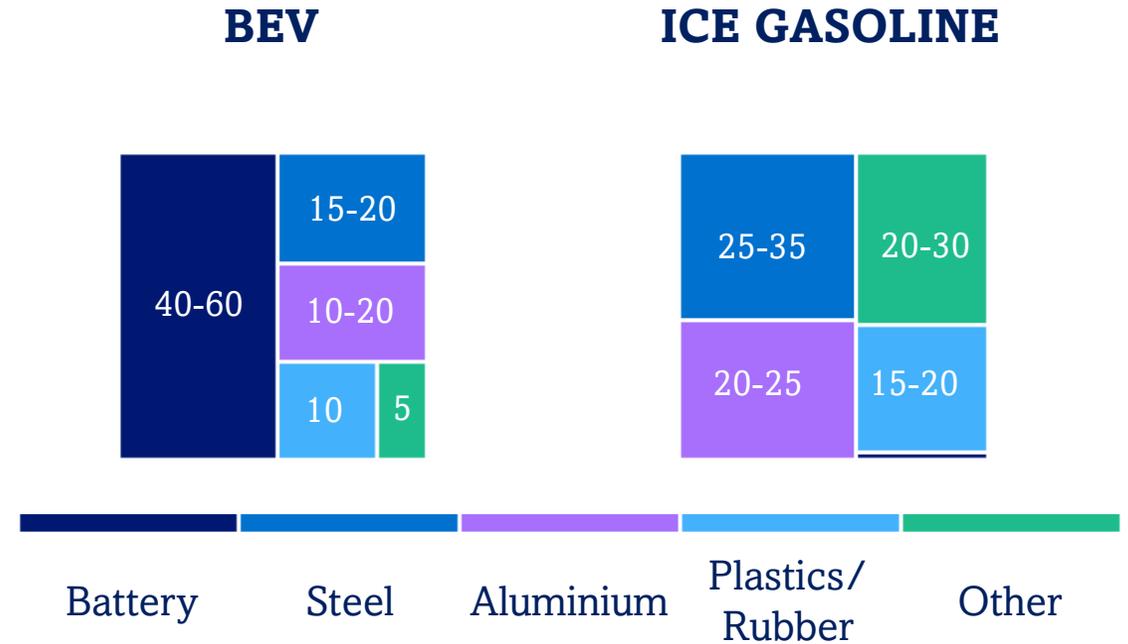
Sources: Ecobat Market Intelligence, ¹ Wood Mackenzie, ^{2,3,4} McKinsey Global Institute, MineSpans and Battery Insights, ^{2,3} MIT Climate Portal, ^{3,4} Tesla Impact Report.

But the full picture is less favorable for lead/ICE vehicles...

Carbon Footprint breakdown by vehicle (in CO2 mt)



Production Carbon Footprint Breakdown (%)



Sources: Ecobat Market Intelligence, McKinsey Global Institute, MineSpans by McKinsey, McKinsey Battery Insights

Recyclability of batteries is still our strength...

Lead-acid batteries are comparatively easier to recycle as they involve a smaller number of elements, and they have a well-established recycling process in place

Current collectors

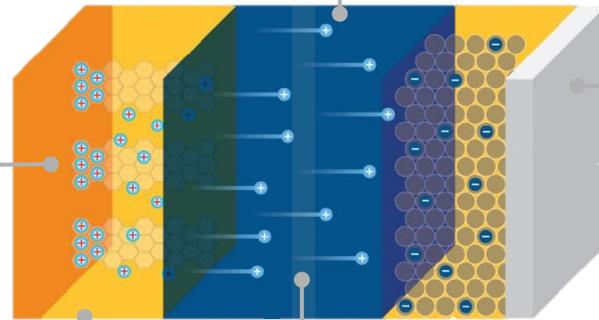
LAB	LIB
25%	15-25%
97-99%	90%

Case

LAB	LIB
7%	20-40%
80-95%	70-85%

Anode

LAB	LIB
25%	20%
97-99%	70-80%



Electrolyte

LAB	LIB
15%	10-15%
95-99%	0-5%

Cathode

LAB	LIB
25%	25-35%
97-99%	90%

Separator

LAB	LIB
3%	2-4%
80-95%	90%

Weight
 Recyclability

Lead-acid battery (LAB)

- ✓ 95-99% of a LAB can be recycled
- ✓ Collection rate is high
- ✓ Nearly 100% of LABs are recycled

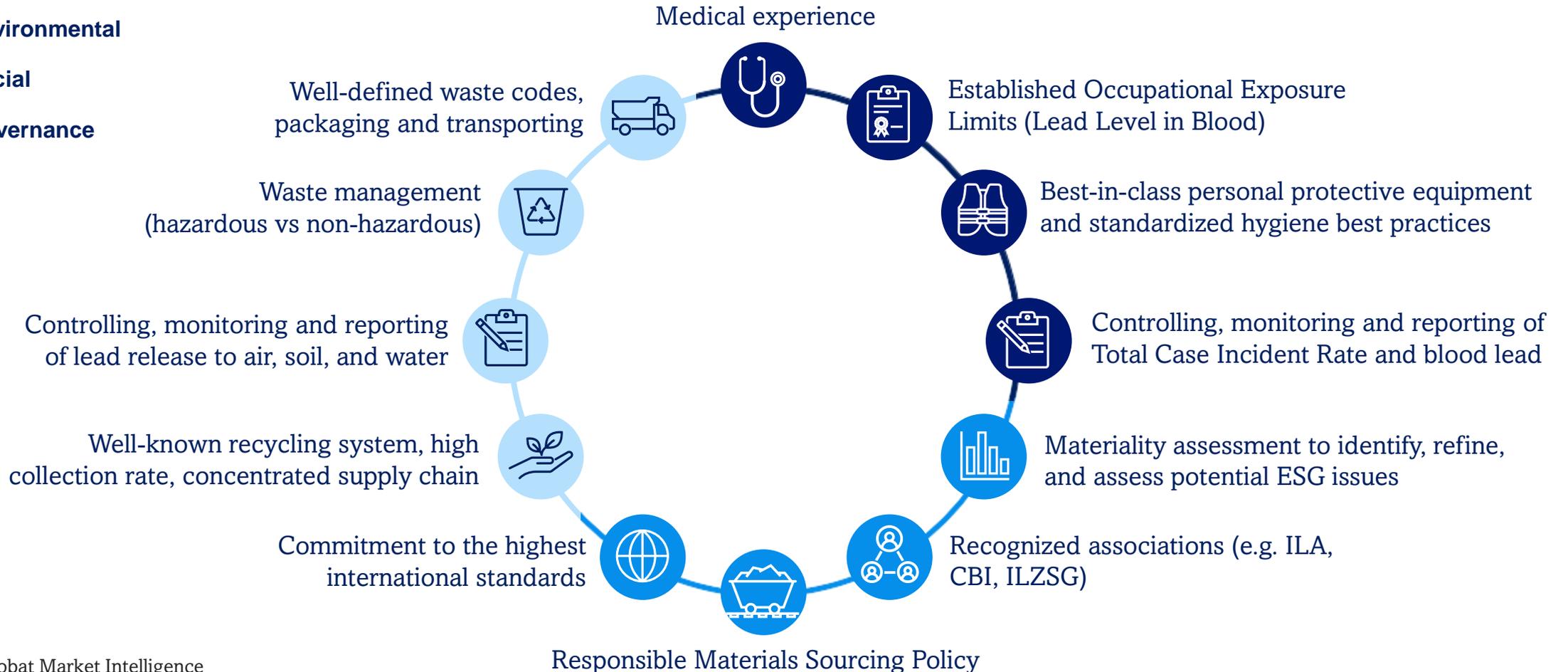
Lithium-ion battery (LIB)

- ✓ 70-85% of a LIB can be recycled
- ✓ Collection rate is low
- ✓ Stated recycling rate of 5%

Lead: a mature market with strengths to be leveraged

The lead sector has developed a robust network within the supply chain and recognized practices in ESG, bolstered by well-established regulations and years of hard work

- Environmental
- Social
- Governance



Source: Ecobat Market Intelligence



esoboot