Battery Recycling

Nathan Niese
February 2024

Today's presentation is based on two recent pieces of work

Striking Gold with EV Battery Recycling

DECEMBER 07, 2023

By Veronika Haas, Albert Waas, Andreas Jentzsch, Johanna Puetz, Nathan Niese, Timm Lux, Minjee Kim, and Eric Li

READING TIME: 12 MIN

As the fully electric vehicle (EV) continues to make inroads with consumers, heading towards a projected 40% of global car sales by 2030, securing sufficient battery materials—especially for the cathode of Lithium-Ion (Li-Ion) batteries—is taking on increased urgency. For battery manufacturers and automotive OEMs, potential supply chain disruptions and price volatility that reduce the availability of these materials or make them overly expensive are worrisome roadblocks to a fast expansion in EV battery production. Moreover, the carbon footprint of EV batteries is a concern for environmentally conscious potential buyers, which could also negatively impact EV uptake.

Li-BRIDGE

White Paper

Bridging the U.S. Lithium Battery Supply Chain Gap

Forum on Li-ion Battery Recycling and End of life batteries

February 2024

U.S. DEPARTMENT OF ENERGY

First, some facts and figures on the state of the industry

Striking Gold with EV Battery Recycling

DECEMBER 07, 2023

By Veronika Haas, Albert Waas, Andreas Jentzsch, Johanna Puetz, Nathan Niese, Timm Lux, Minjee Kim, and Eric Li

READING TIME: 12 MIN

As the fully electric vehicle (EV) continues to make inroads with consumers, heading towards a projected 40% of global car sales by 2030, securing sufficient battery materials—especially for the cathode of Lithium-Ion (Li-Ion) batteries—is taking on increased urgency. For battery manufacturers and automotive OEMs, potential supply chain disruptions and price volatility that reduce the availability of these materials or make them overly expensive are worrisome roadblocks to a fast expansion in EV battery production. Moreover, the carbon footprint of EV batteries is a concern for environmentally conscious potential buyers, which could also negatively impact EV uptake.

Li-BRIDGE

White Paper

Bridging the U.S. Lithium Battery Supply Chain Gap

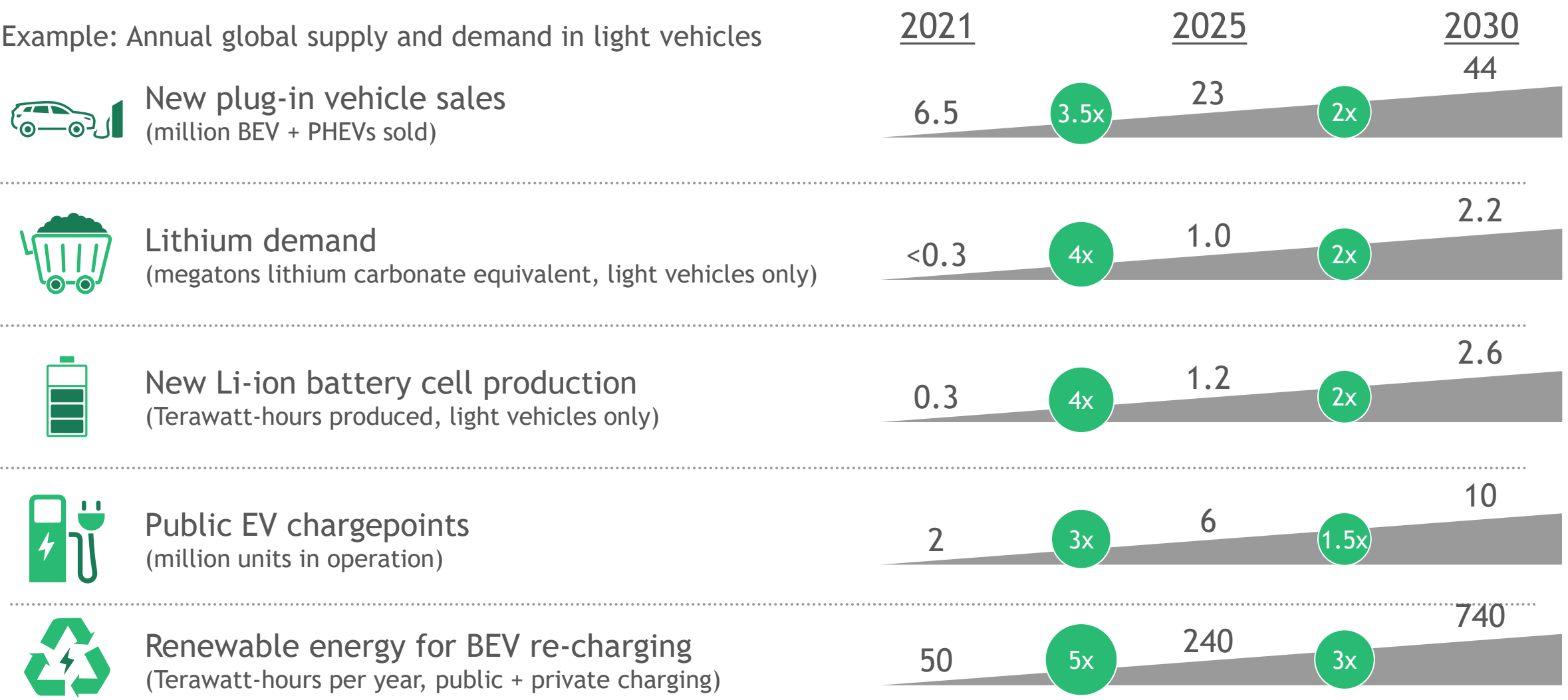
Forum on Li-ion Battery Recycling and End of life batteries

February 2024

U.S. DEPARTMENT OF ENERGY

Supply chains: a race to keep pace

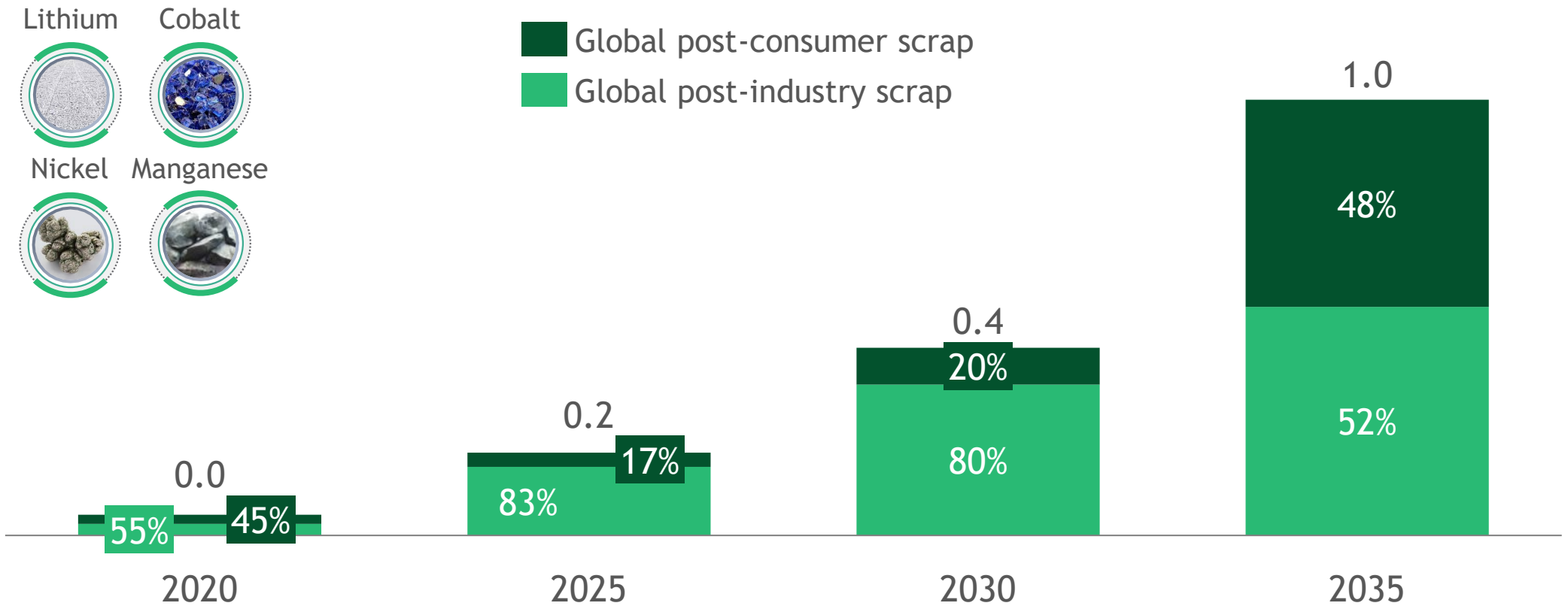
Example: Annual global supply and demand in light vehicles



Source: BCG analysis BEV = battery electric vehicle; PHEV = Plug-in hybrid electric vehicle

>1M tons of scrap could be available for our supply chains by 2035

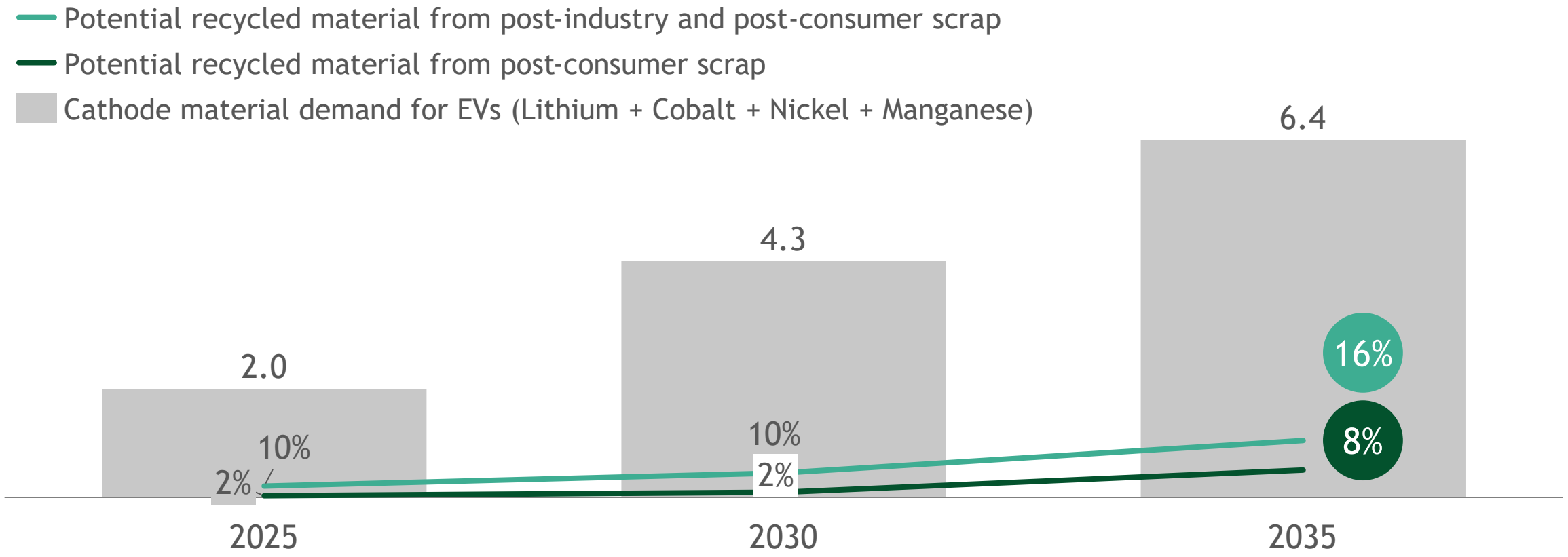
Total cathode material supply per scrap origin, 2025-2035 in millions tons



1. Post-consumer scrap accounts for collection, sorting and recycling efficiency losses after usage (for xEV incl. second life use) 2. Timing of ratio shift toward post-consumer scrap depending on production efficiencies and EV adoption rates and lifetime Source: BCG analysis

Yet, materials demand will only partly be met via recycling

Global cathode material demand vs potential material supply available from recycling, 2025-2035 in million tons

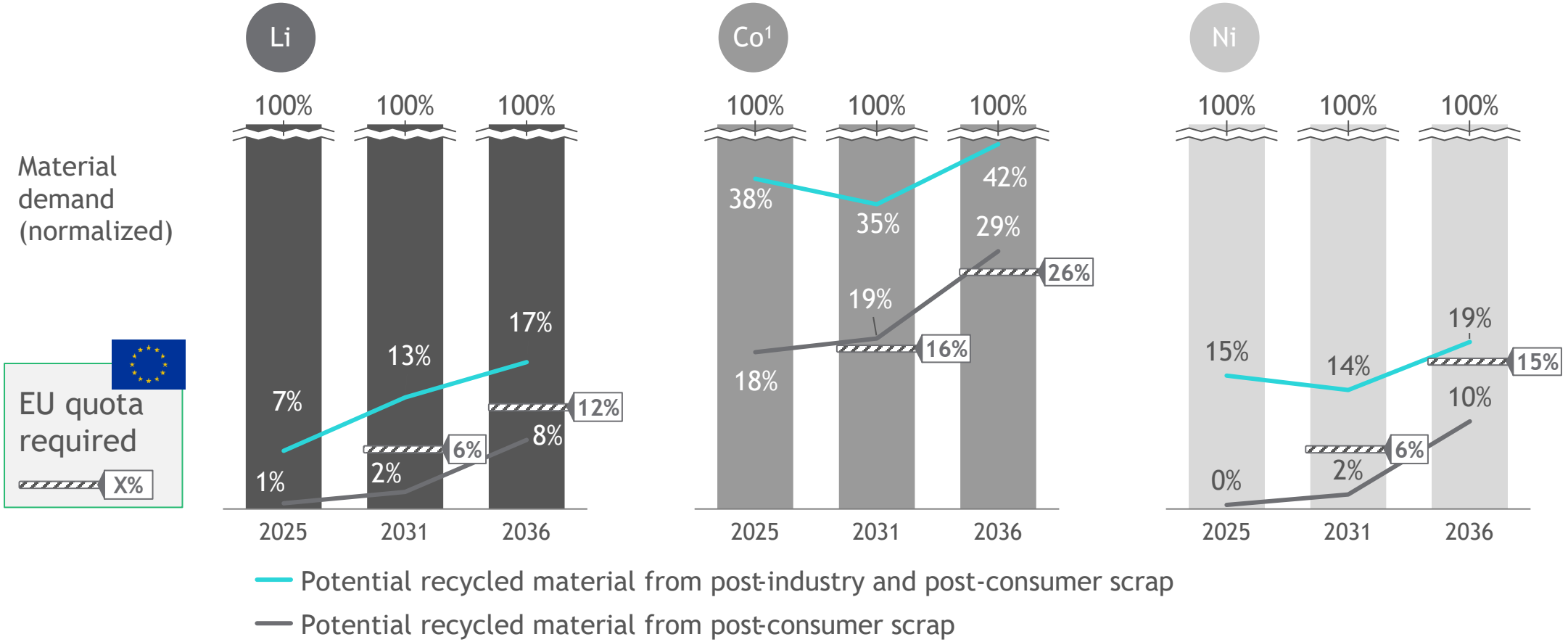


Note: Lithium, cobalt, nickel, and manganese only Source: BCG Analysis, BCG EV battery recycling model

Even so, policymakers are ensuring circularity remains in focus

European cathode material demand for xEV & recycled material supply, 2025-2035

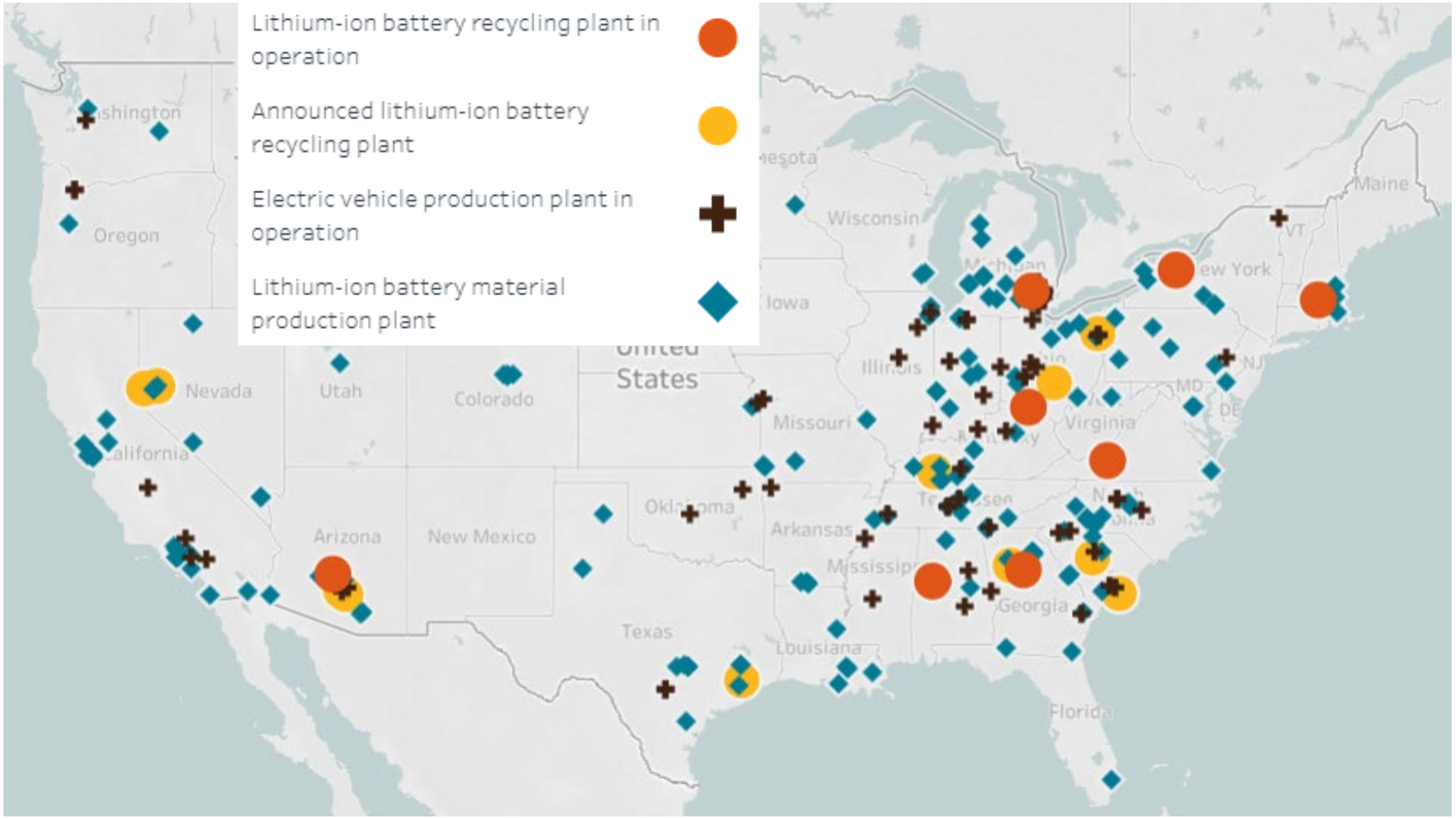
Considering Europe as a self-contained system (excl. trade/intercontinental outflows)



Note: Differences due to rounding. Quotas will be reviewed in 2027. No material Lithium recycling capabilities assumed pre-2030. Includes recycled material from consumer and stationary. 1. Assuming consumer batteries (mainly LCO) are recycled; 2. Relative date outlined in Regulation: 96 and 156 months after entry into force of Regulation;
Source: Regulation of the EU Parliament & of the Council concerning batteries & waste batteries (2023/1542), BCG EV battery recycling model.

Recycling facilities and regional offtakers are coming online

Li-ion battery recycling, battery material production, and EV production in U.S.



As of late 2023…

Recycled Material Producers

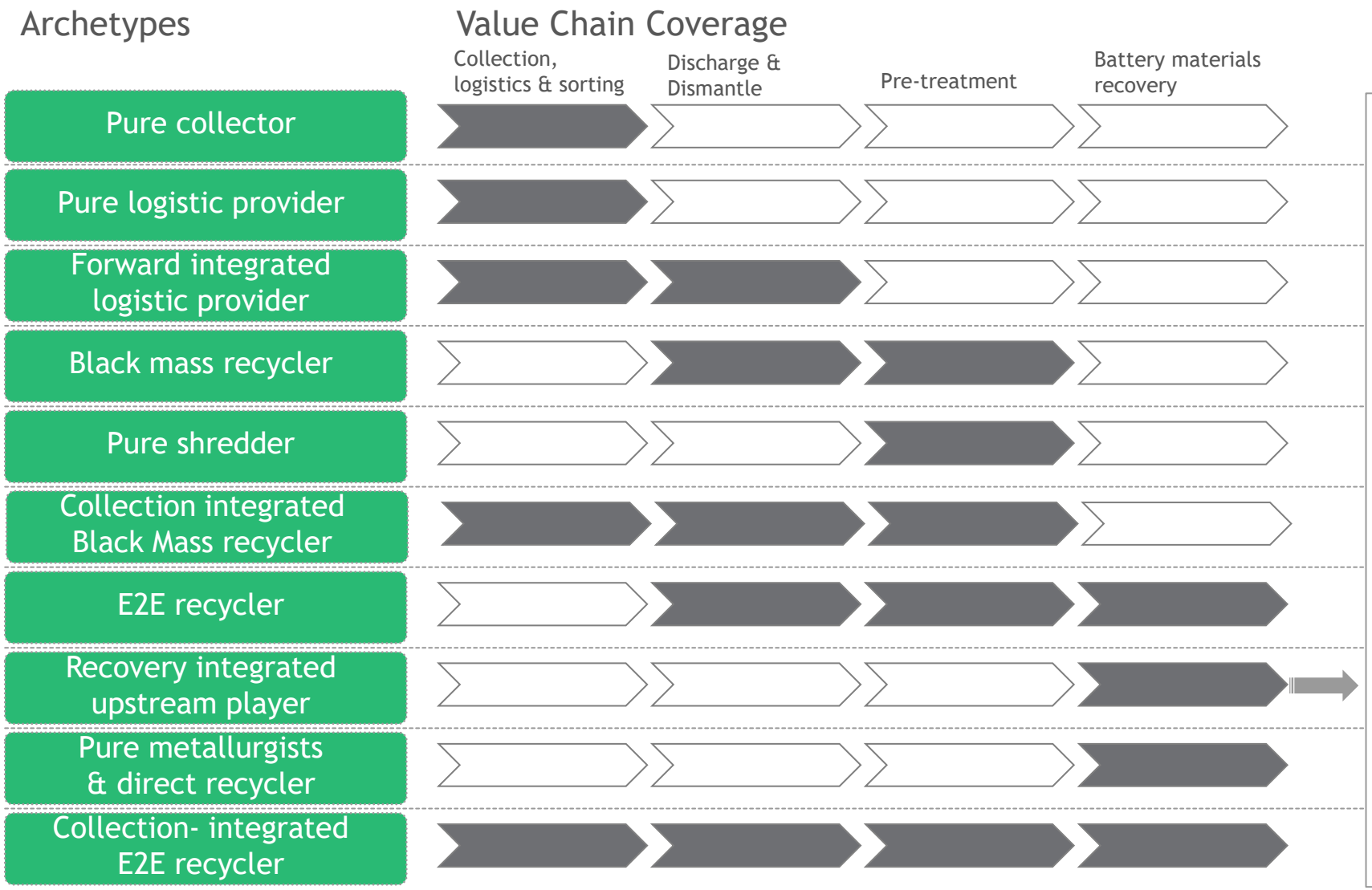
- Existing: >35 ktons
- Planned: >75 ktons

Intermediate Processing Facilities

- Existing: >175 ktons
- Planned:>200 ktons

Source: ICCT (2023), FCAB

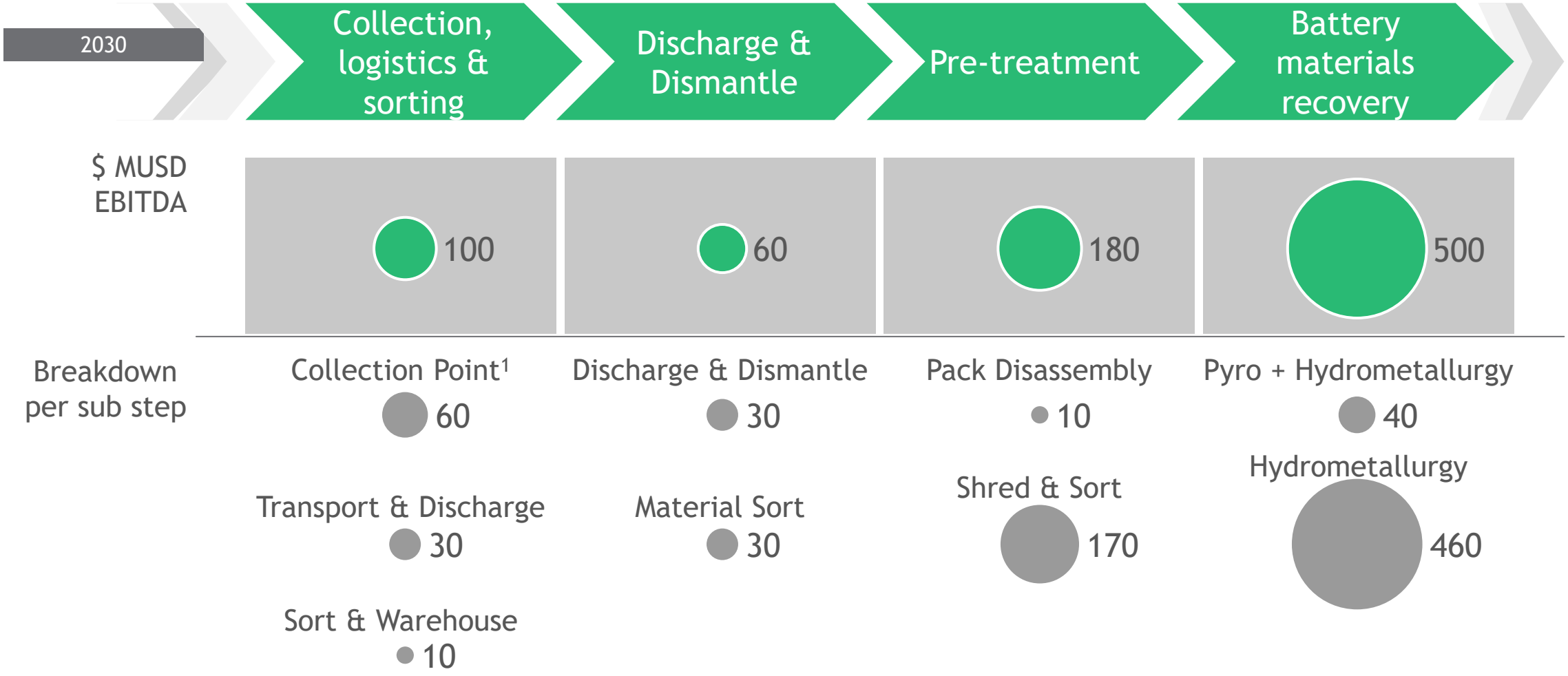
At least ten ways in which companies are participating in recycling



Success factors

- Technical know-how
- Reliable, sufficient supply
- Secure offtake & pricing
- Market proximity
- Network fit (high coverage, decentralized, specialized, etc)
- Inexpensive energy
- Scale (10+ ktons)
- Favorable regulatory environment

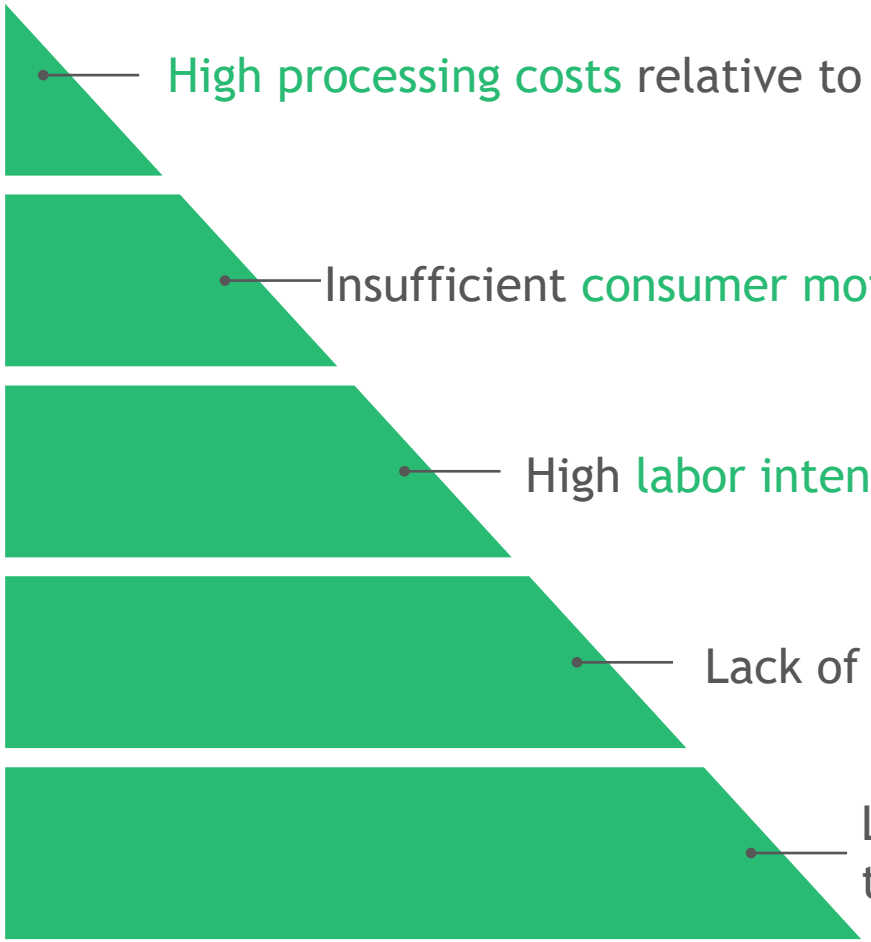
Profit pools are emerging, but are not guaranteed



1. Includes sales of remaining car parts
Source: Expert interviews, BCG analysis

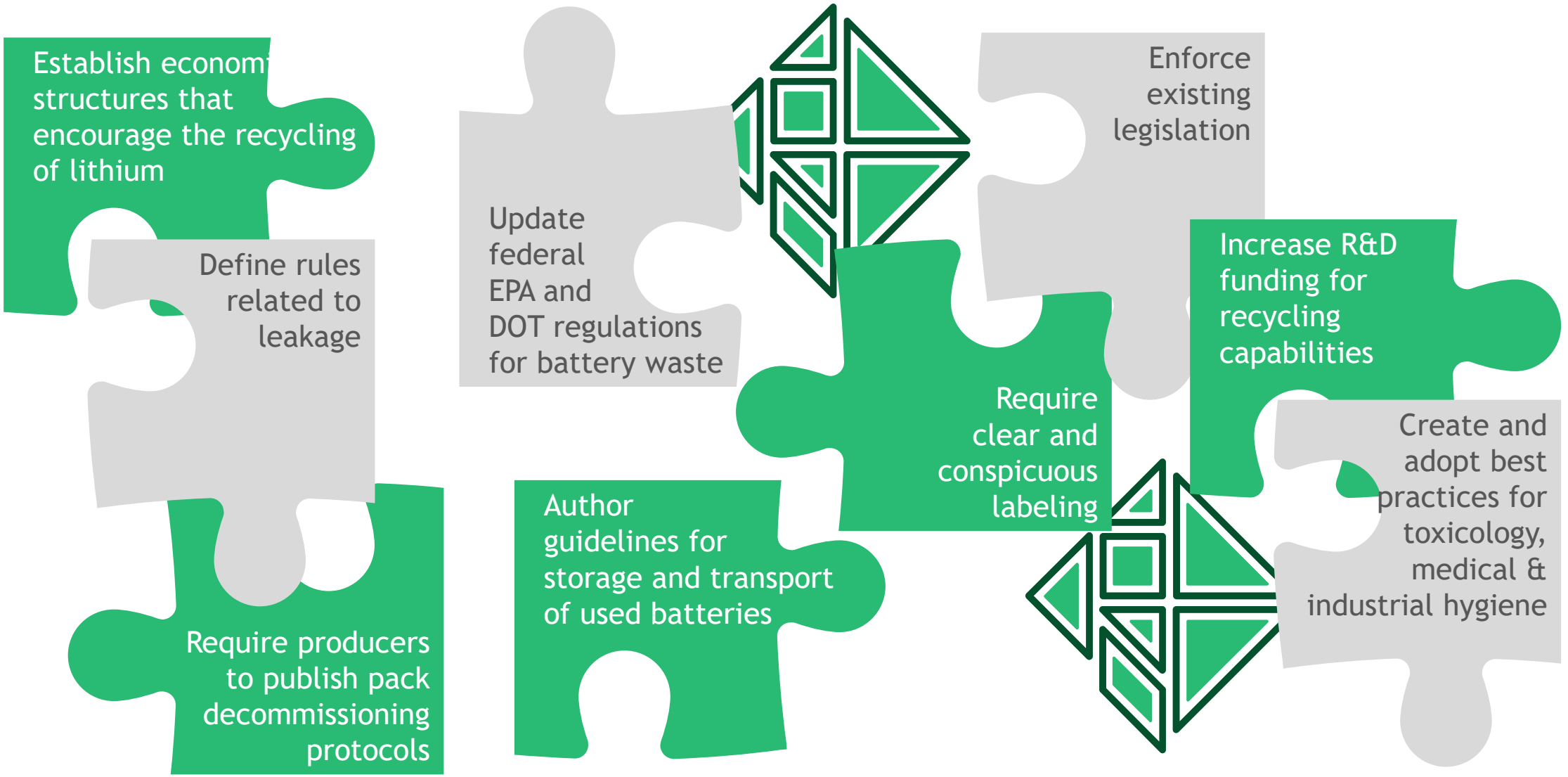
Li-Bridge 2023 End of Life forum aimed to help us go further, faster

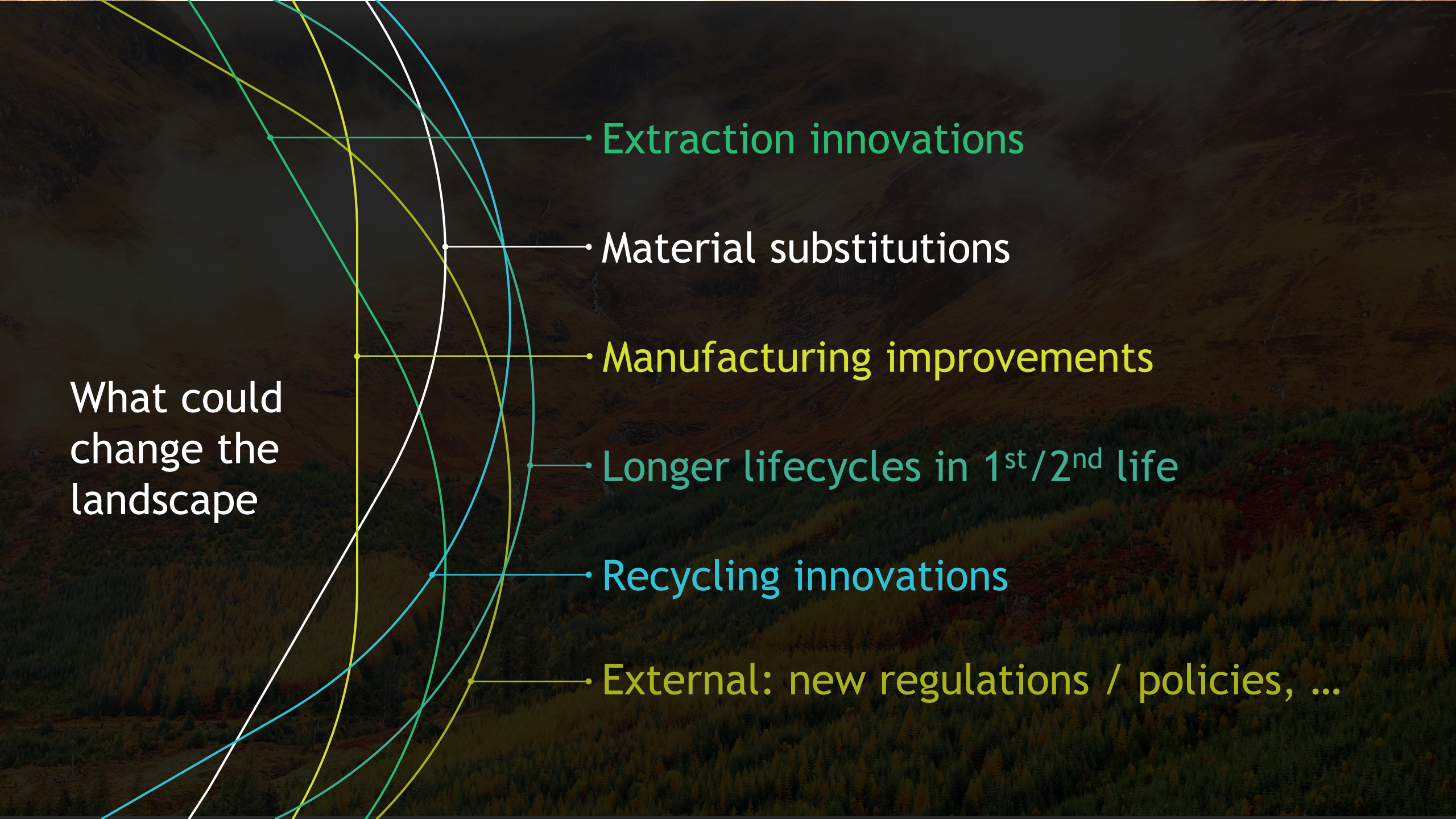
Participants discussed a wide range of nuanced challenges



- High processing costs relative to the intrinsic value of certain battery chemistries and components
- Insufficient consumer motivation to recycle batteries in sufficiently large volumes
- High labor intensity in collection, sorting, and disassembly
- Lack of customized classification frameworks for storage and transport
- Lack of knowledge / absence of safety best practices related to occupational and environmental health risks

We coalesced around several go-forward recommendations




What could change the landscape
Extraction innovations
Material substitutions
Manufacturing improvements
Longer lifecycles in 1st/2nd life
Recycling innovations
External: new regulations / policies, …


BCG
BOSTON
CONSULTING
GROUP
bcg.com