



Global battery raw material outlook 2030 and impact of US and EU regulations

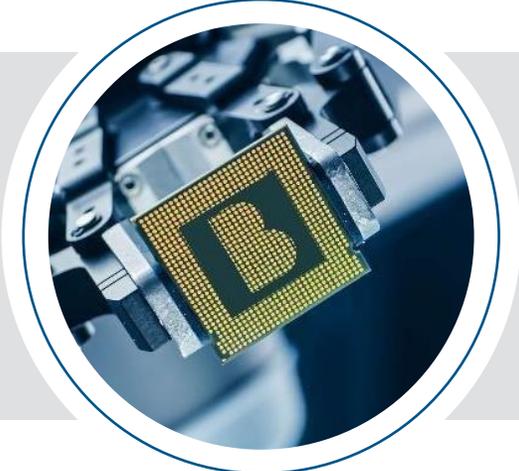
Conference presentation



Athens, 22 June 2023

Roland Berger's "Advanced Technology Center" supports clients from various industries in navigating through the technological transformations of the industry

Roland Berger Advanced Technology Center – Focus and set-up

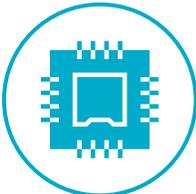


The **ADVANCED TECHNOLOGY CENTER** supports automotive, industrial, and technology clients globally to master the challenges and opportunities that new technologies bring to their businesses and markets. A global network of seasoned technology specialists with technology-focused educational backgrounds and working experience at leading-edge technology players

Cross-industry fields of expertise



Software architectures



Semi-conductors



HW, architectures, boxes & boards



Other electronic components



Quantum tech., photonics & optics



Focus of this presentation



Energy storage technologies

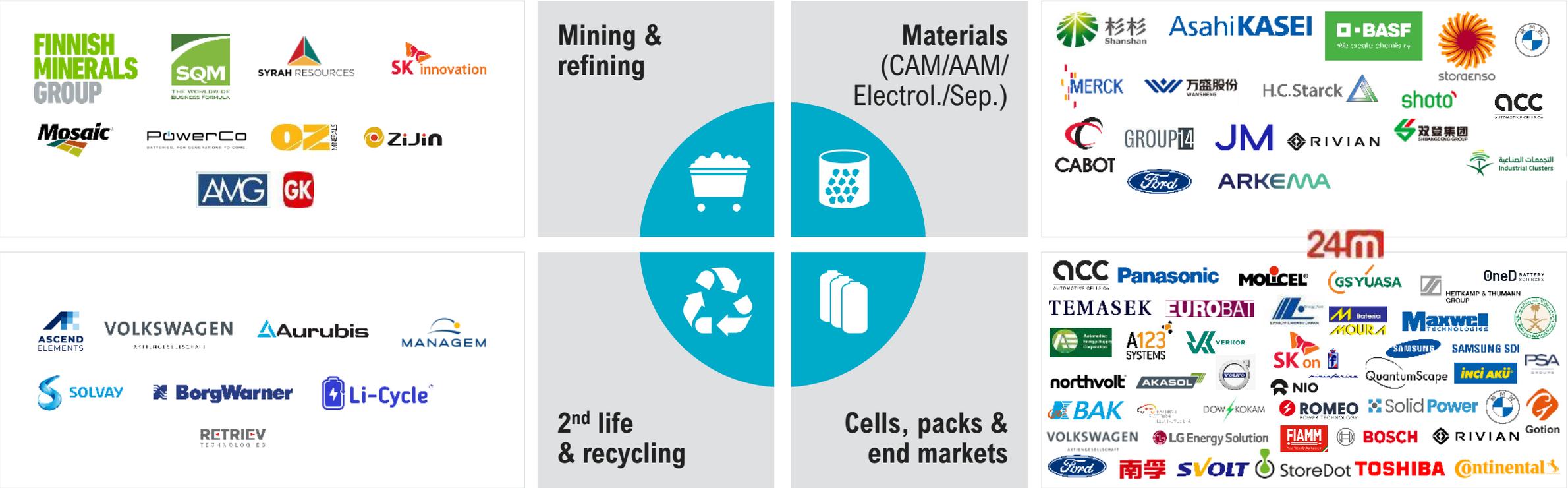


Advanced costing

Business models
Strategy
Organization
Transformation

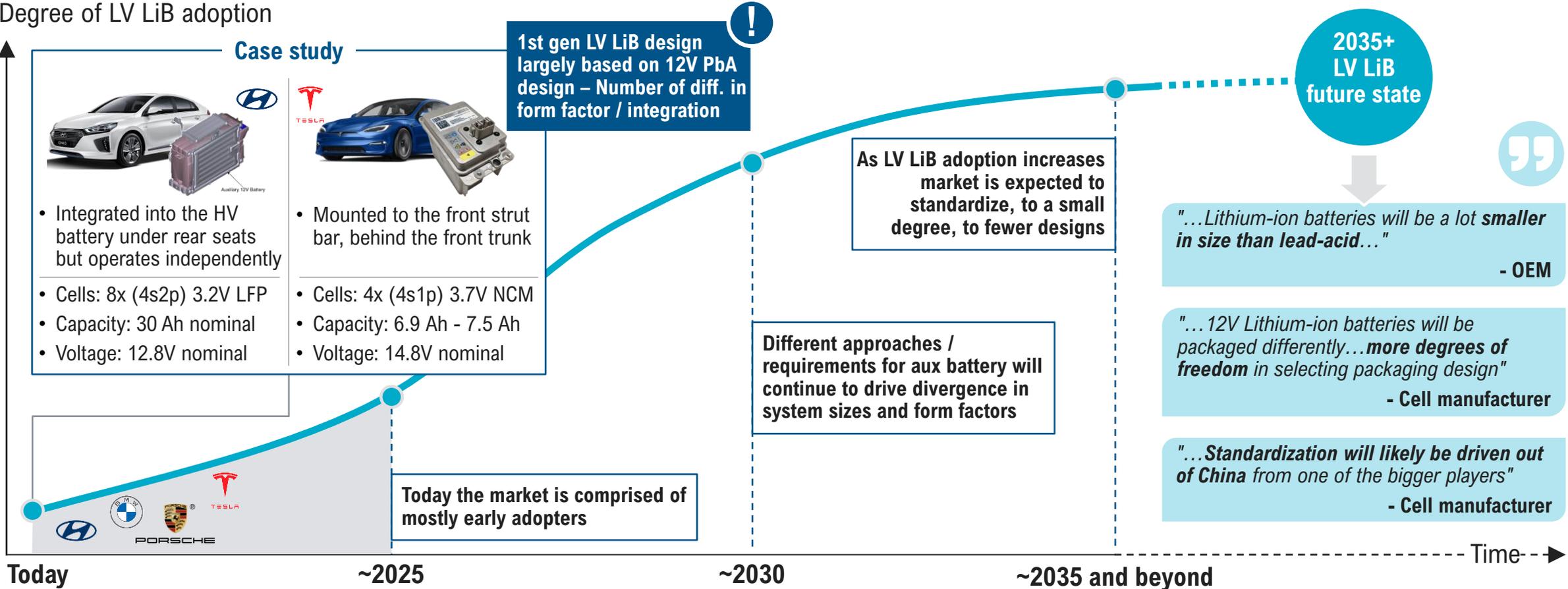
Roland Berger works with leading companies across the globe and along the entire LiB value chain from raw material mining to battery circularity

Unmatched expertise from ca. 120 projects in the last years in all countries relevant for Lithium-Ion batteries



LV LiB in early stages of adoption, differences in approach and requirements are driving divergence in systems – In later stages, wide adoption of LiB is expected

Pathway towards LV LiB future state

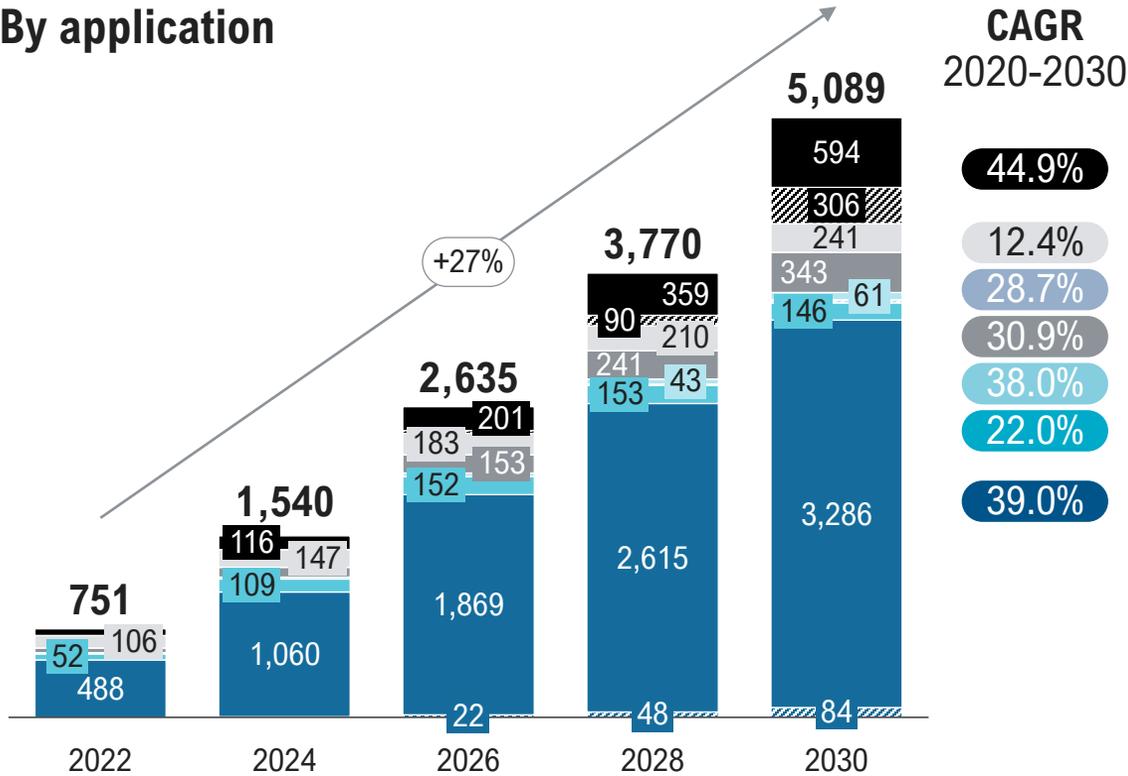


Source: Interviews with market participants, Roland Berger

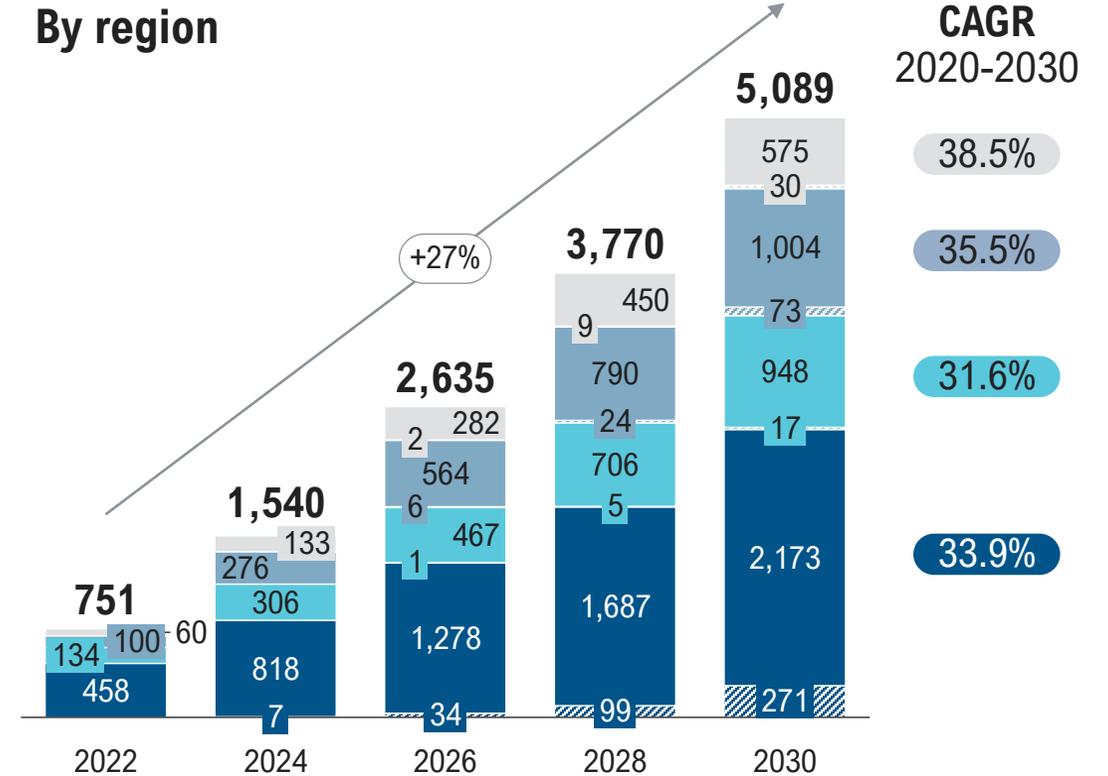
Increasing share of xEV is the main driver for Li-ion and Na-ion battery demand, which is expected to grow rapidly to c.5.1 TWh in 2030 – w/ China c.50% of demand

Market demand for Li-ion and Na-ion batteries by application and region [GWh]

By application



By region



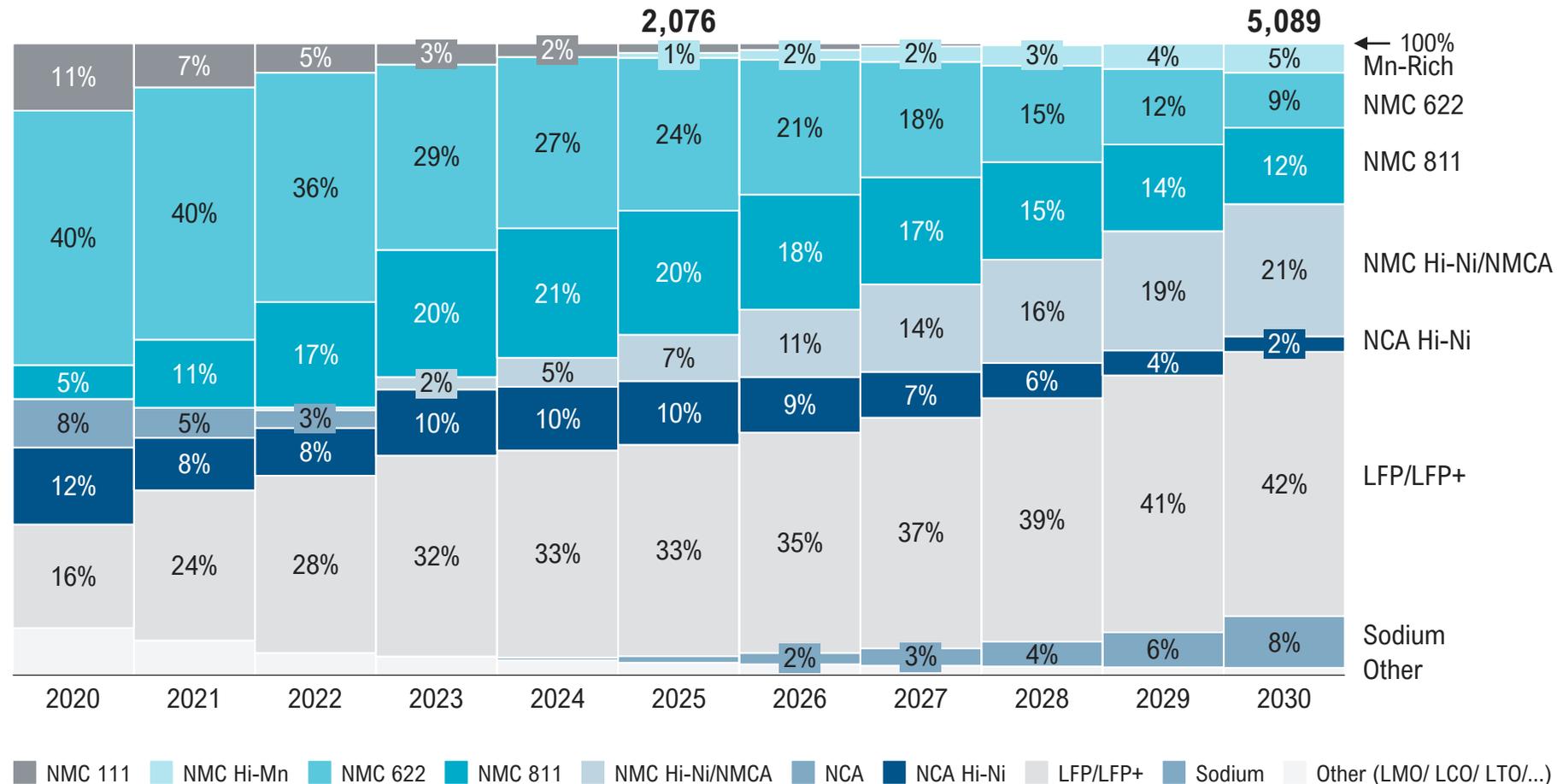
ESS
 Consumer electronics
 Commercial Vehicles
 2- & 3-W Na-ion
 BEV
 ESS Na-ion
 Other
 2- & 3-W
 MHEV, FHEV, PHEV
 BEV Na-ion

RoW
 North America
 Europe
 China
 RoW Na-ion
 North America Na-ion
 Europe Na-ion
 China Na-ion

Abbreviations: BEV: Battery Electric Vehicle; MHEV, FHEV, PHEV: Mild Hybrid, Full Hybrid and Plug-in Hybrid Electric Vehicle; Light vehicle: Passenger cars and light commercial vehicles with up to 6 tons; LSEV: Low Speed Electric Vehicle; 2W: Electric Two Wheelers

We expect a global shift towards LFP variants due to increasing share of LFP in the BEV segment as well as the ESS segment

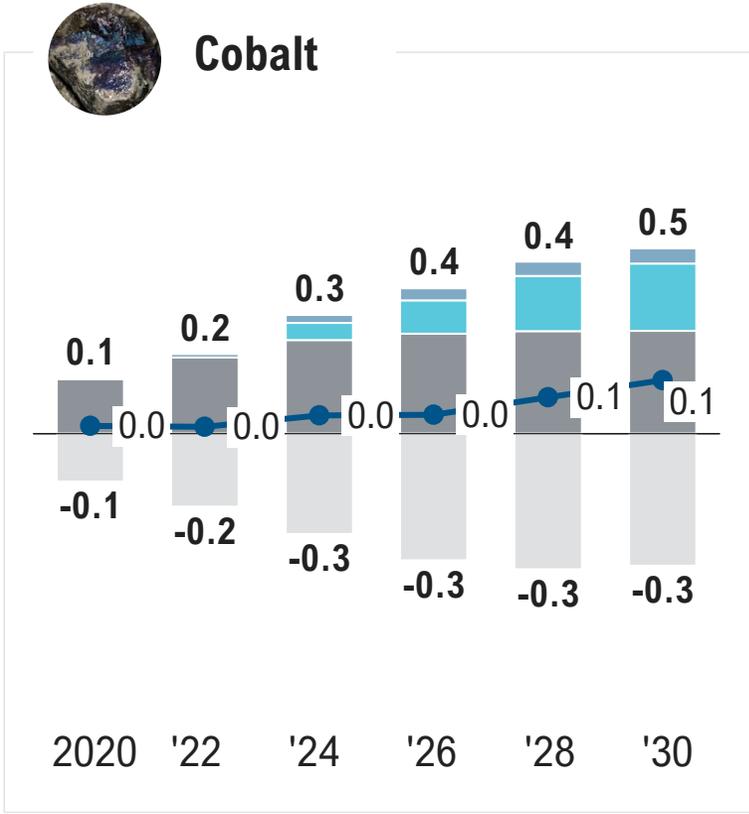
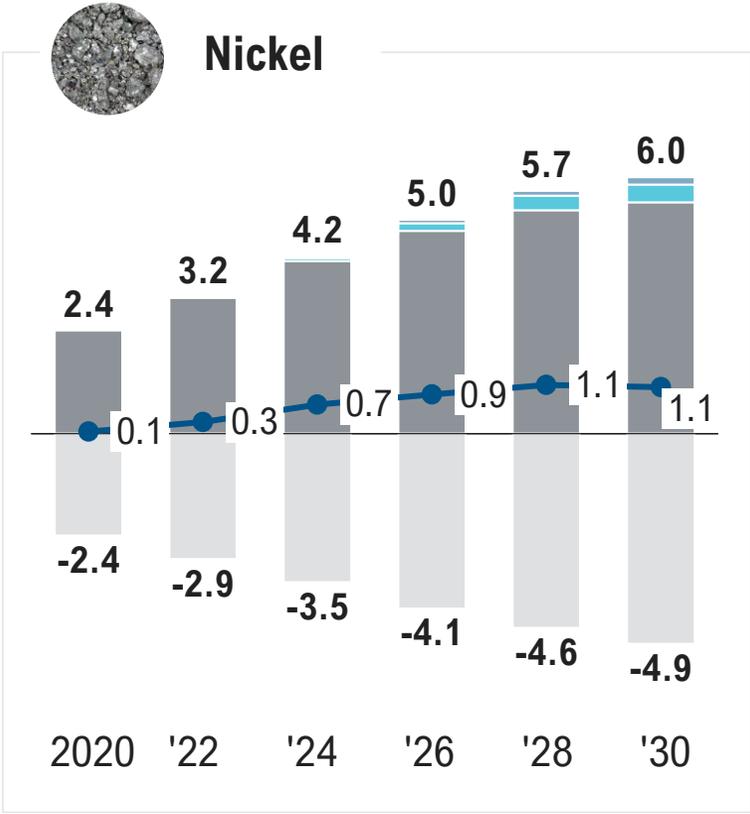
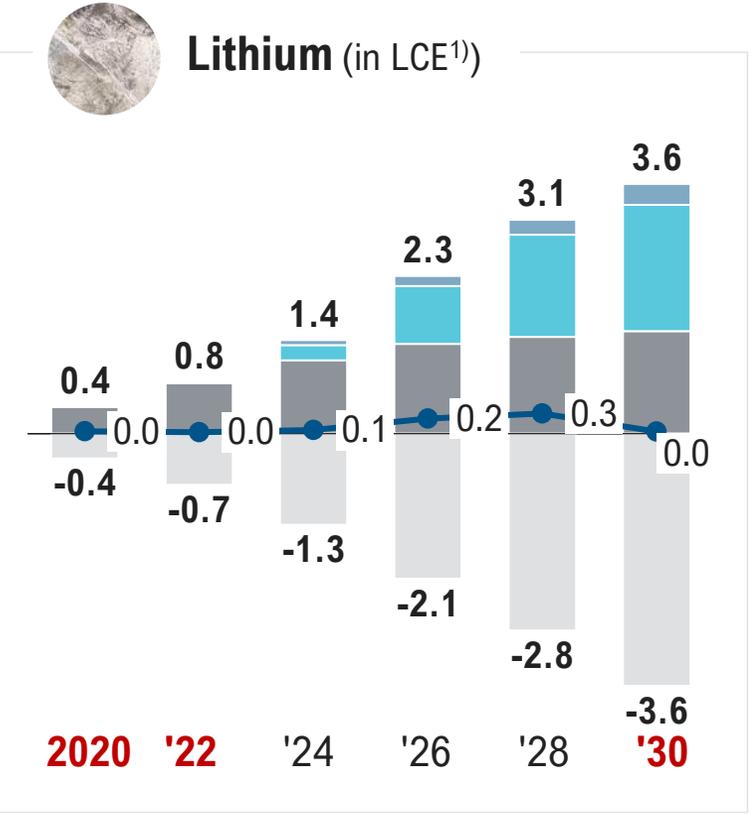
Expected battery cell demand by cathode chemistry for lithium-ion and sodium-ion batteries , 2020-2030 [GWh/ a]



- Growth of Ni-rich mat. in high performance automotive segment
 - Increase of specific energy density while reducing the critical material Co
- LFP is expected to grow significantly until 2030 addressing the low/ entry market segments with following benefits
 - Avoiding Ni/Co cost drivers
 - Sustainable sourcing
- Hi-Mn-rich announced for volume BEV segment
- Sodium with first applications expected in 2024 in China – Automotive suitability outside China remains to be proven

From a mining perspective, Lithium, Nickel and Cobalt are expected to be tight with currently visible projects – especially Lithium with potential gap

Lithium, nickel and cobalt mined supply vs. demand forecast 2020-2030 [mt metal equivalent]



● Gap ■ Total demand ■ LiB recycling supply ■ Additional early stage supply ■ Existing projects and expansions

1) Lithium carbonate equivalent; 2) Democratic Republic of the Congo; 3) Recovery of conversion for Spodumene ~ 83-88%, leadint to potential supply gap

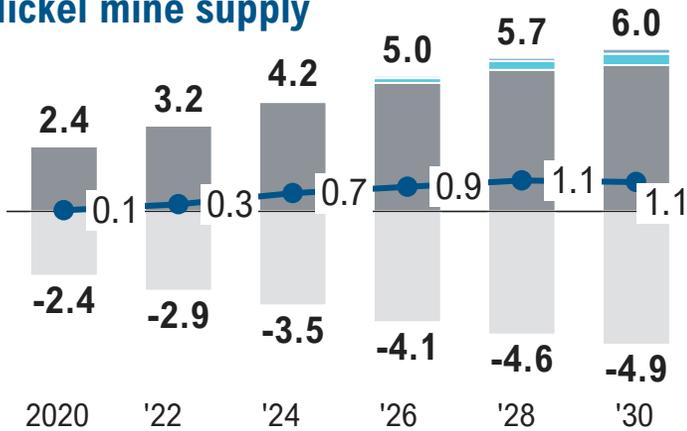
Total Nickel mining supply potentially exceeds demand – Supply response to Nickel sulfate demand however not sufficient yet

Nickel mining, class 1 and sulfate expected supply vs. demand forecast 2020-2030 [mt metal equivalent]

Mining

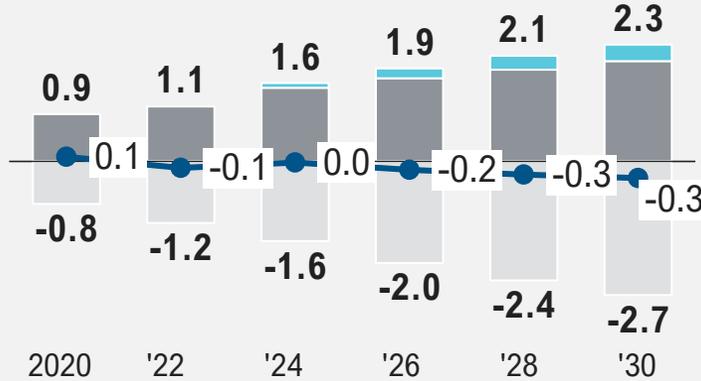
Refining & Sulfatization

Nickel mine supply



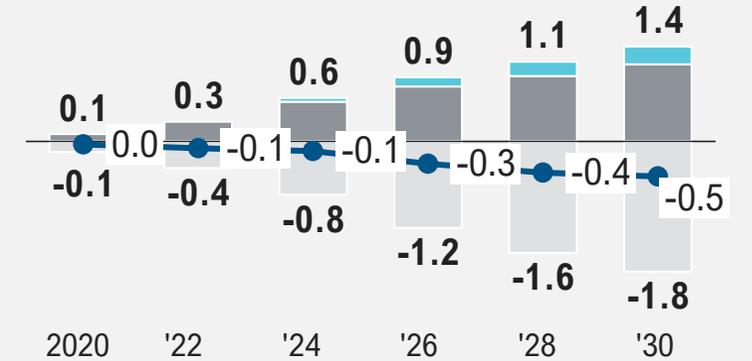
- Largest activities - Indonesia: c. 3,500 kt, Philippines: c. 440 kt, Australia: c. 320 kt
- Project lead times of up to 6-13 yrs. – Indonesian HPAL plant for 4 yrs. for MHP production (interm.)
- Includes class 1 and 2 supply

Nickel class 1



- **Class 1 demand: stainless steel, non-ferrous alloys and other production** with relatively constant demand (c. 700 – 800 kt), **Sulfate demand from LiB industry**
- **Demand growth driven by LiB industry**, 15% of class 1 in 2020 to 70% in 2030

Nickel sulfate

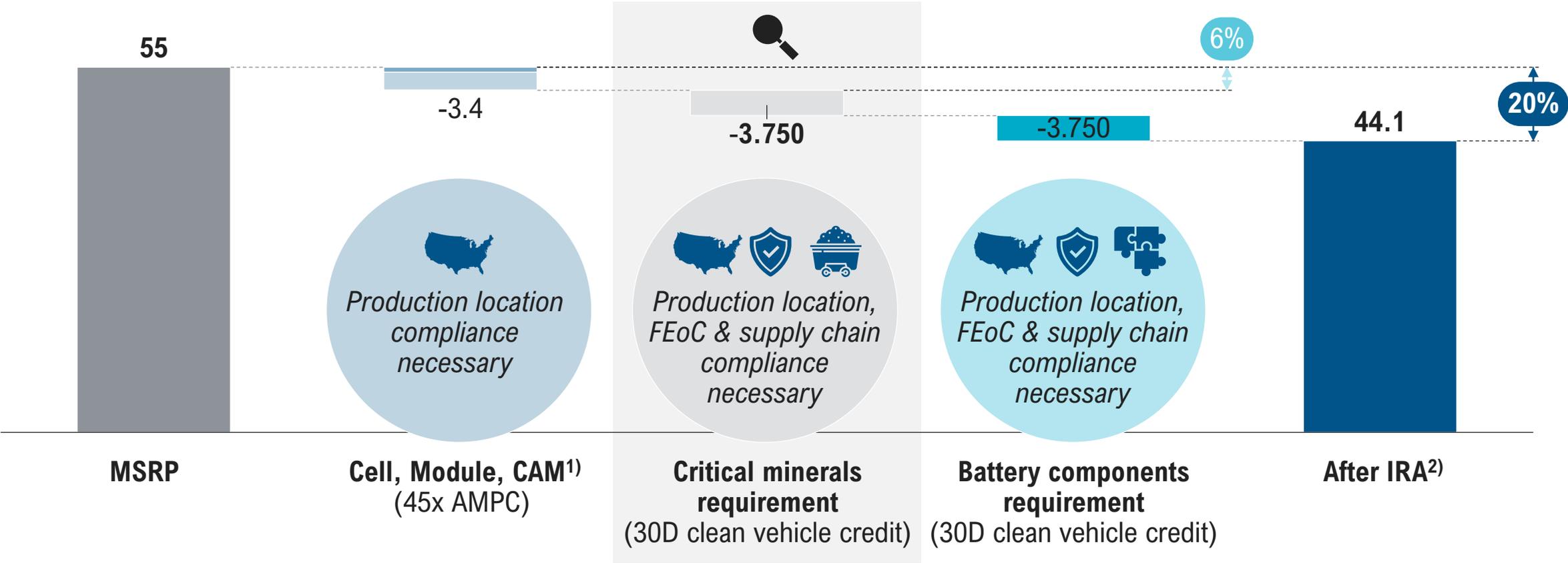


- **Demand nearly exclusively from LiB**
- **Additional supply through class 1 Nickel metal possible with sulfatization in pCAM production**
- Most new projects in Indonesia planned

Legend: ● Gap, □ Demand, ■ LiB recycling supply, ■ Additional early stage supply, ■ Existing projects and expansions

Excursus: US IRA tax credits offer significant MSRP benefit on select models – Compliant supply chain w/o Foreign Entities of Concern (FEOC) necessary to qualify

AMPC (45X) and clean vehicle credit (30D) vehicle-level benefit potential example for 75 kWh BEV [k USD]



■ MSRP ■ Module ■ Cell ■ CAM ■ Critical mineral ■ Component ■ Actual acquisition price

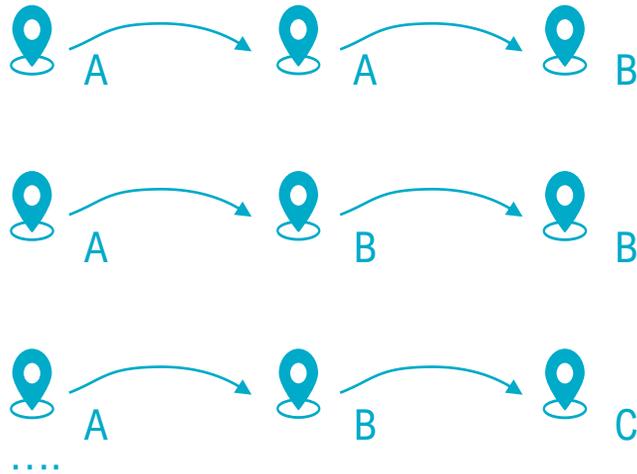
1) Only accounting for CAM production costs of assumed USD 5 per kWh to calculate tax credit; 2) All benefits count towards consumer benefit

The Critical Mineral requirement is clustered in three steps, requiring a full transparency over the value chain from mining to CAM processing

Summary of the Notice of Proposed Rulemaking – Critical Mineral requirement



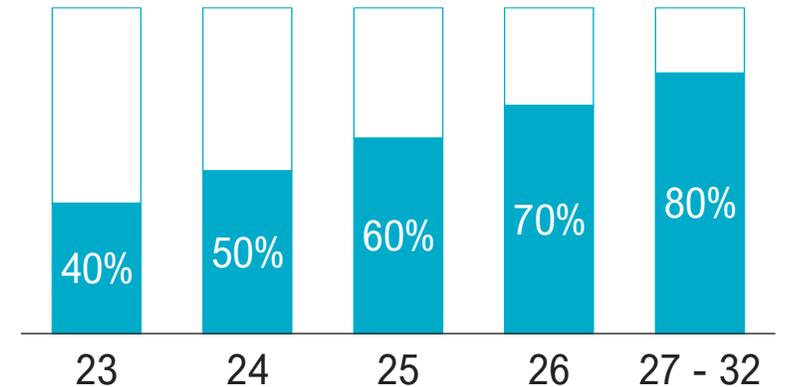
Full value chain transparency



50% value add rule for every identified qualifying minerals in 2023 and 2024
Anticipation to move to a more stringent regulation looking forward



Qualifying critical mineral content to a defined time / timeframe³⁾
Total value of qualified critical minerals:



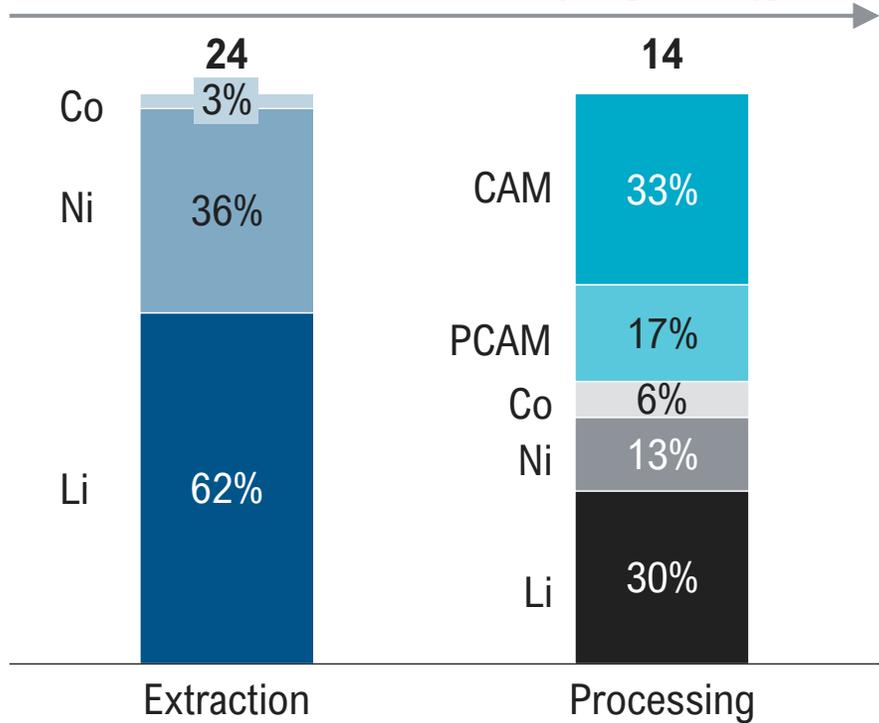
■ value of CM in US, FTA, CMA country

1) FTA countries: Australia, Bahrain, Canada, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Israel, Jordan, Korea, Mexico, Morocco, Nicaragua, Oman, Panama, Peru, and Singapore; Critical Mineral Agreement (CMA): Japan; 2) China, Russia, North Korea; 3) Timestamp of qualifying critical mineral content needs to be stated – for fleets, time period averages possible

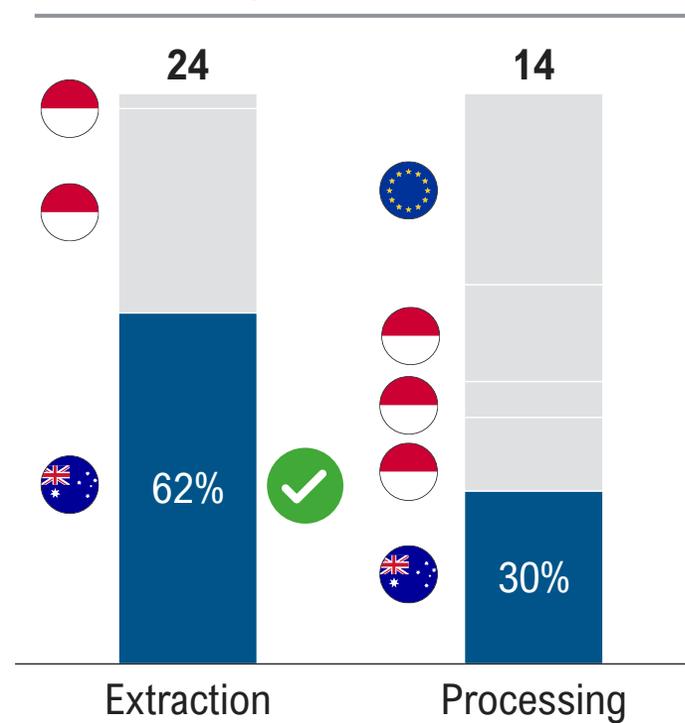
For IRA compliant CAM, 50% of extraction or 50% of processing value add need to come from compliant countries – PCAM + CAM production very close to be sufficient

IRA compliant NMC 811 cost split based on current market prices and processing fees¹⁾ – Mn not reflected [USD/kg]

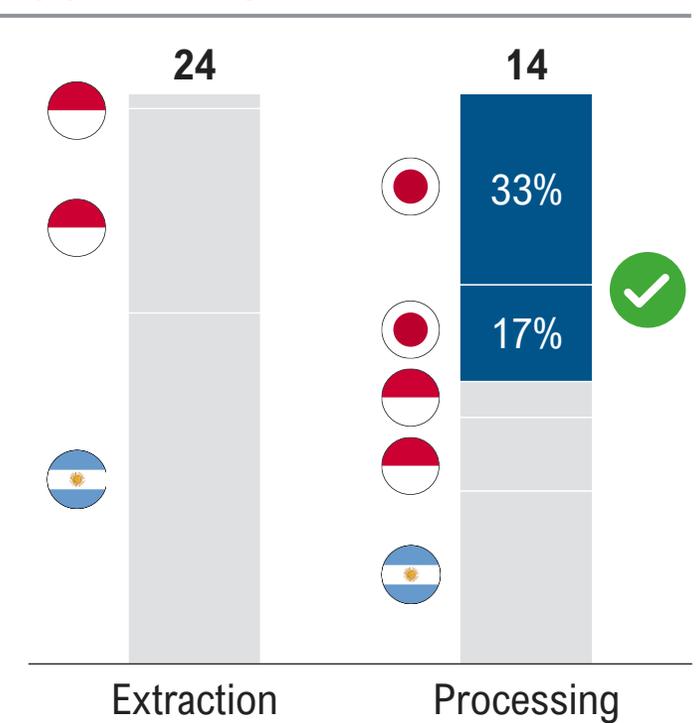
Reference NMC 811 CAM cost split [USD/kg]



Lithium compliant scenario



(P)CAM compliant scenario

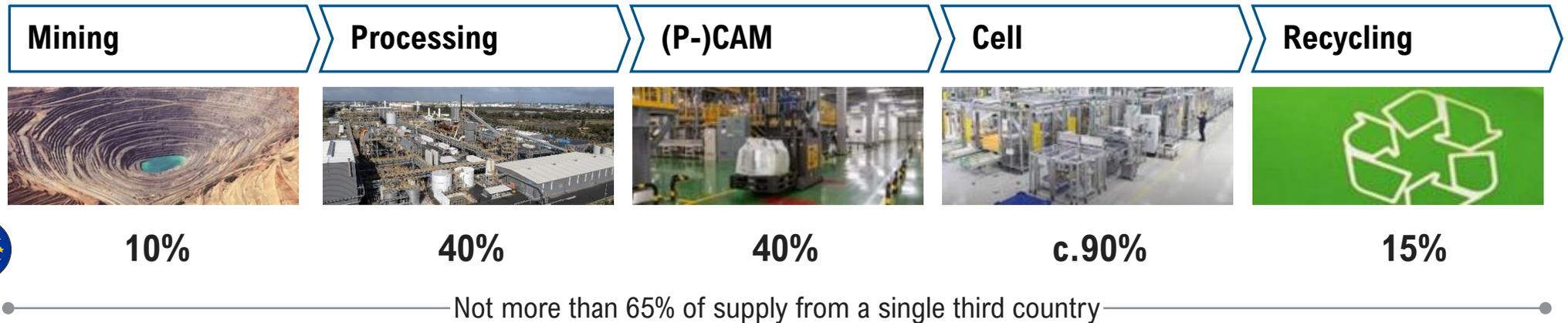


■ Li-extract. ■ Ni-extract. ■ Co-extract. ■ Li-process. ■ Ni-process. ■ Co-process ■ PCAM ■ CAM

1) spot market prices from 20/04/2023: Li Spodumene-concentrate 6% (SC6): USD 5,312 / tonne SC6, LiOH: USD 40.50 / kg LiOH H₂O; Ni in MHP: 18.05 / kg, Ni-Sulfate: USD 4.875 / kg, Co in MHP: USD 10.574 / kg, Co-Sulfate: 5.26 / kg – conversion factors between different metal/hydroxide/... forms reflected – processing fees / value add calculated as difference between Hydroxide/Sulfates and input materials (SC6, MHP); 2) PCAM and CAM processing fees incl. all overheads & margins from RB cost model; 3) Critical Mineral Agreement

Along the battery value chain, the EU has set 2030 targets for production within the EU but without explicit incentives for following or penalties for not complying

Overview Critical Raw Materials Act and Net-Zero Industry Act as of March 2023



2030 targets for EU production share



Critical Raw Materials Act



- Speed up expansion of mining and processing capacities
 - Selection of **strategic raw material projects** with **significantly shortened permitting process and access to public funding**
- Further expansion of partnerships and free trade agreements
 - Special focus on **Australia and Indonesia for Ni, Latin America for Li**
- **Audit on strategic raw materials supply chains** for **selected large companies** to mitigate risks

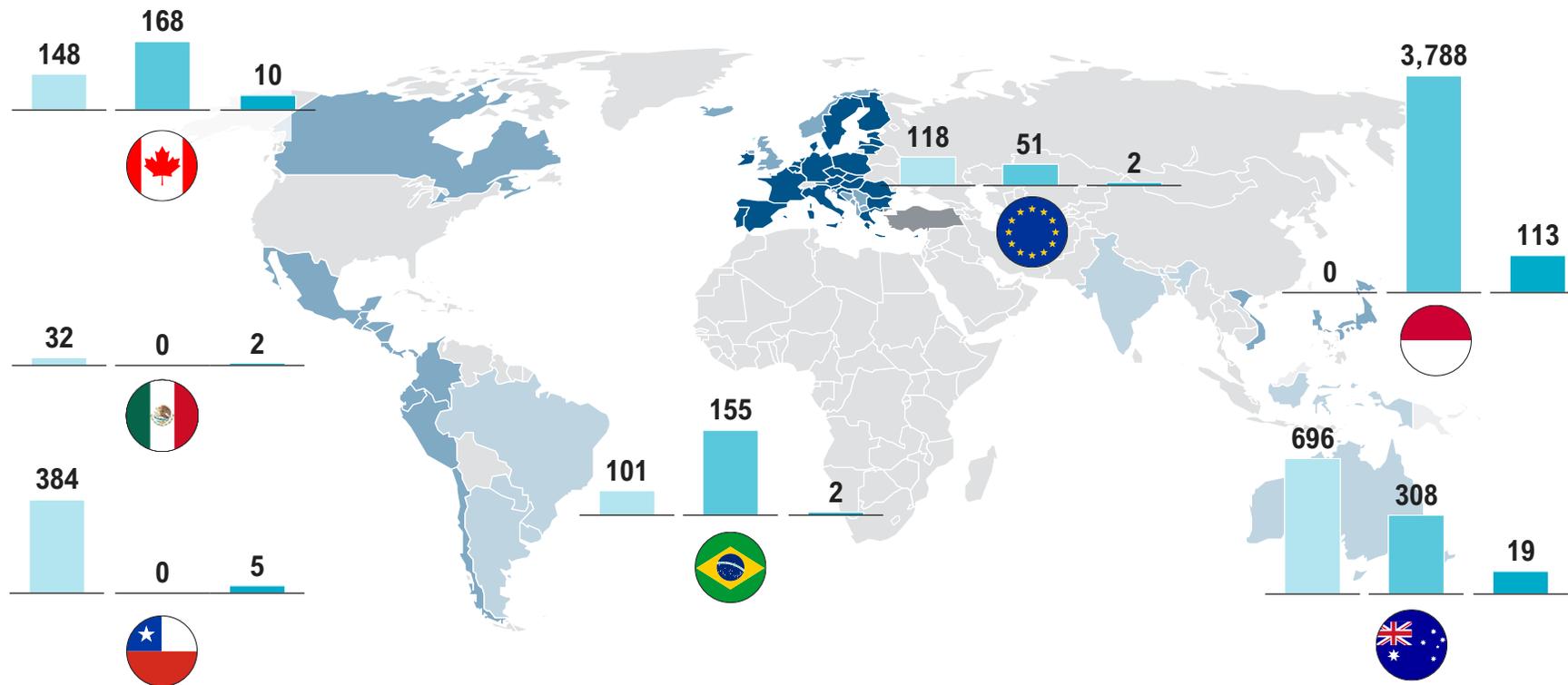
Net-Zero Industry Act



- Selection of **net-zero strategic projects** for prioritized promotion
- **Max. of 18 month for permits of battery plants > 1 GWh (incl. component plants) – max. of 12 month for net-zero strategic projects**

To cover supply outside the local production target of the EU, several free trade agreements have been closed – further trade agreements in negotiation

EU free trade agreements¹⁾ (in negotiation) incl. production forecasts²⁾ [2030; Li in kt LCE³⁾, Ni and Co in kt metal eq.]



Critical Raw Materials Club

- Connect raw material consumers and countries that are rich of those materials,
- Foster cooperation and improvement of the situation in resource-rich developing countries
- Delivery of a secure, sustainable and affordable global supply of raw materials

■ EU member state
 ■ Existing free trade agreement
 ■ Trade agreement in negotiation
 ■ Customs union EU-Türkiye
 ■ Lithium
 ■ Nickel
 ■ Cobalt

1) The EU negotiates a renewal of the agreement with Mexico and Chile; 2) Production number are estimates for 2030; 3) Lithium carbonate equivalent;

Players must build-up resilient supply chains for critical materials and components besides the necessary skills, tools, and processes

Key-take aways



- **LiB players cannot afford to not strategically secure the critical value chains**

Cell demand is rapidly growing to >5 TWh in 2030 – raw material supply chains especially for Lithium and Nickel tight

- **Flexibility in cell chemistry roadmap must be ensured**

Raw material prices will impact the market penetration of single chemistries and technologies, e.g. LFP or sodium-ion technology

- **Strategic hedging of supply chain risks must be proactively marketed to customers**

Hedging costs will otherwise negatively impact operative business results

- **USA and Europe are pushing for local mining and refining capacities**

US IRA benefits are strongly dependent on raw material prices and specific supply chain setups – multiple scenarios to be considered

Europe pushing for local supply, but currently no carrot, no stick

Please don't hesitate to reach out



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