

Gigafactories & Raw Materials

The key to successful battery EV adoption

August 2022

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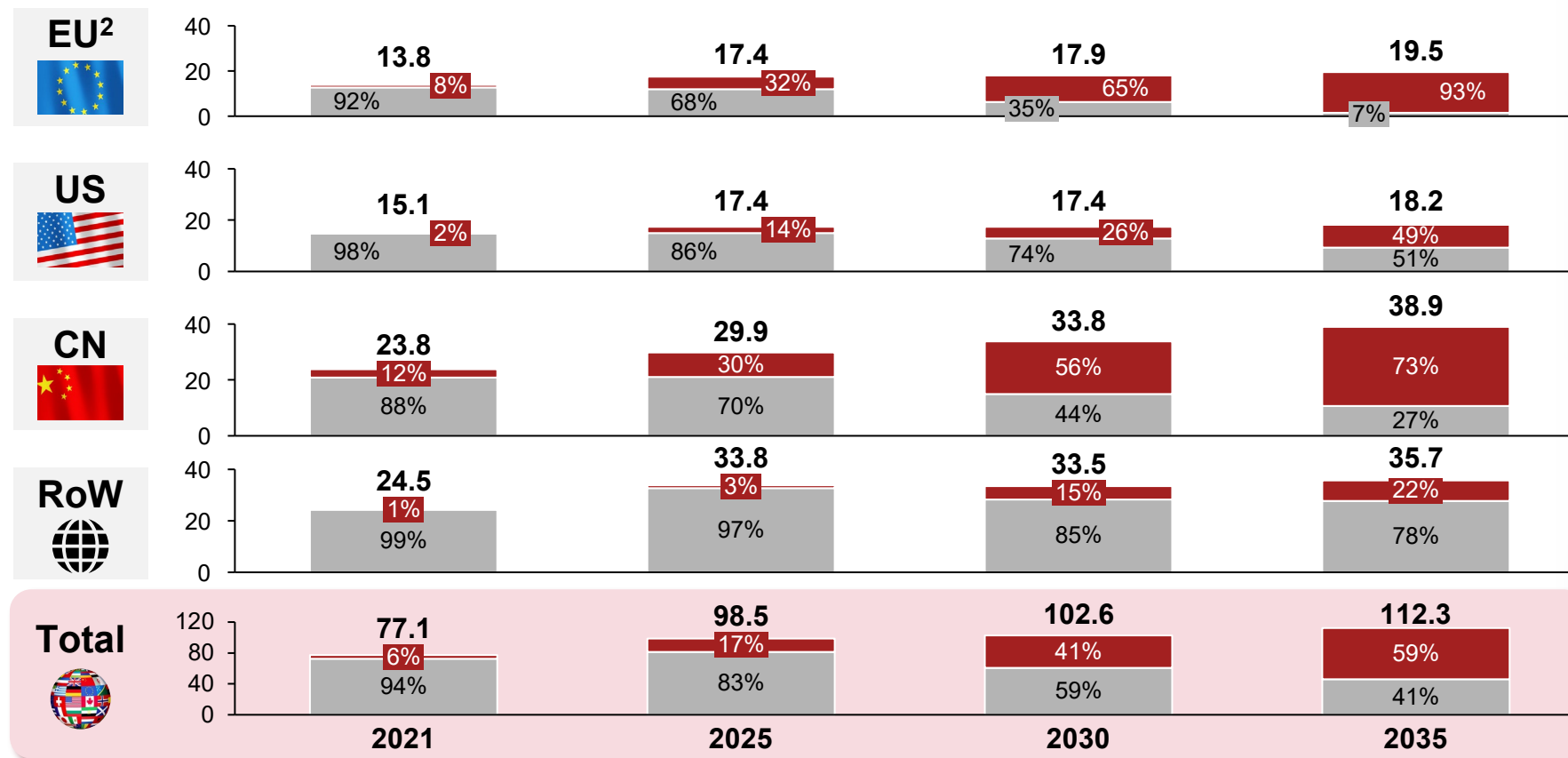
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The transformation of the car industry is in full swing – electric vehicles will dominate key markets by 2030

Regional BEV diffusion (Passenger cars and light vehicles)

Realistic scenario¹ (Vehicle sales in million)



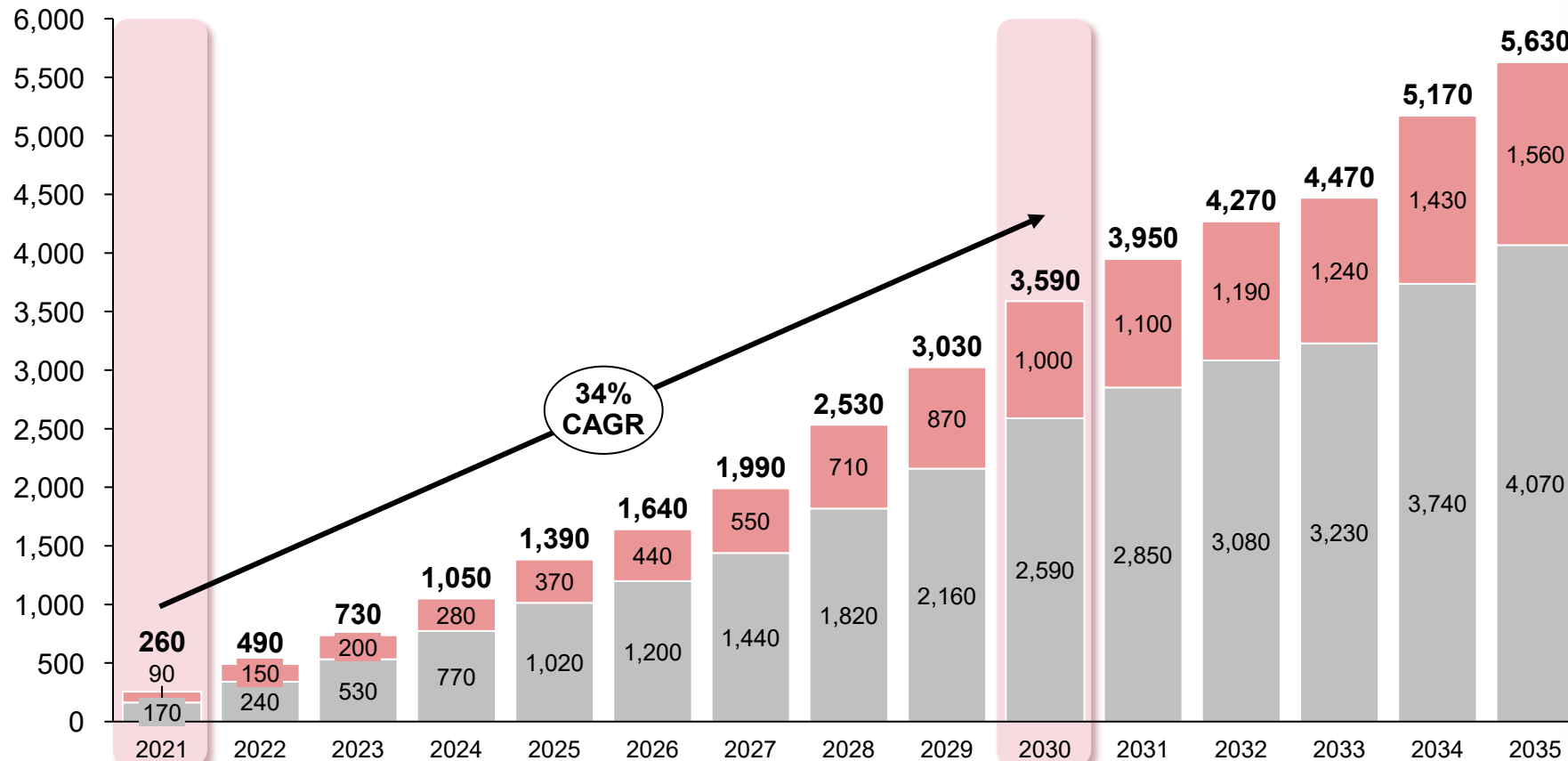
Key takeaways

- In 2030, almost **every second car** sold worldwide **will be a battery electric vehicle** (totaling 42 million units)
- **Leading markets are China** (19 million BEV) **and EU** (12 million BEV), both above 50% BEV share
- **US as third main BEV market**, with a **time lag of ~5 years** compared to EU and CN

Fueled by the EV diffusion, we expect a significant demand increase for automotive batteries – up to 3.6 TWh in 2030

Battery demand – PC¹ & LCV² market

Global battery demand forecast (GWh)



Key takeaways

- Global battery demand will grow by ~35% CAGR to 3.6 TWh from 2022 to 2030
- Market growth is driven by both increased BEV sales share and increasing battery size per BEV
- The most relevant battery chemistry remains NMC, with about ~70% market share, while LFP remains relevant at ~30%

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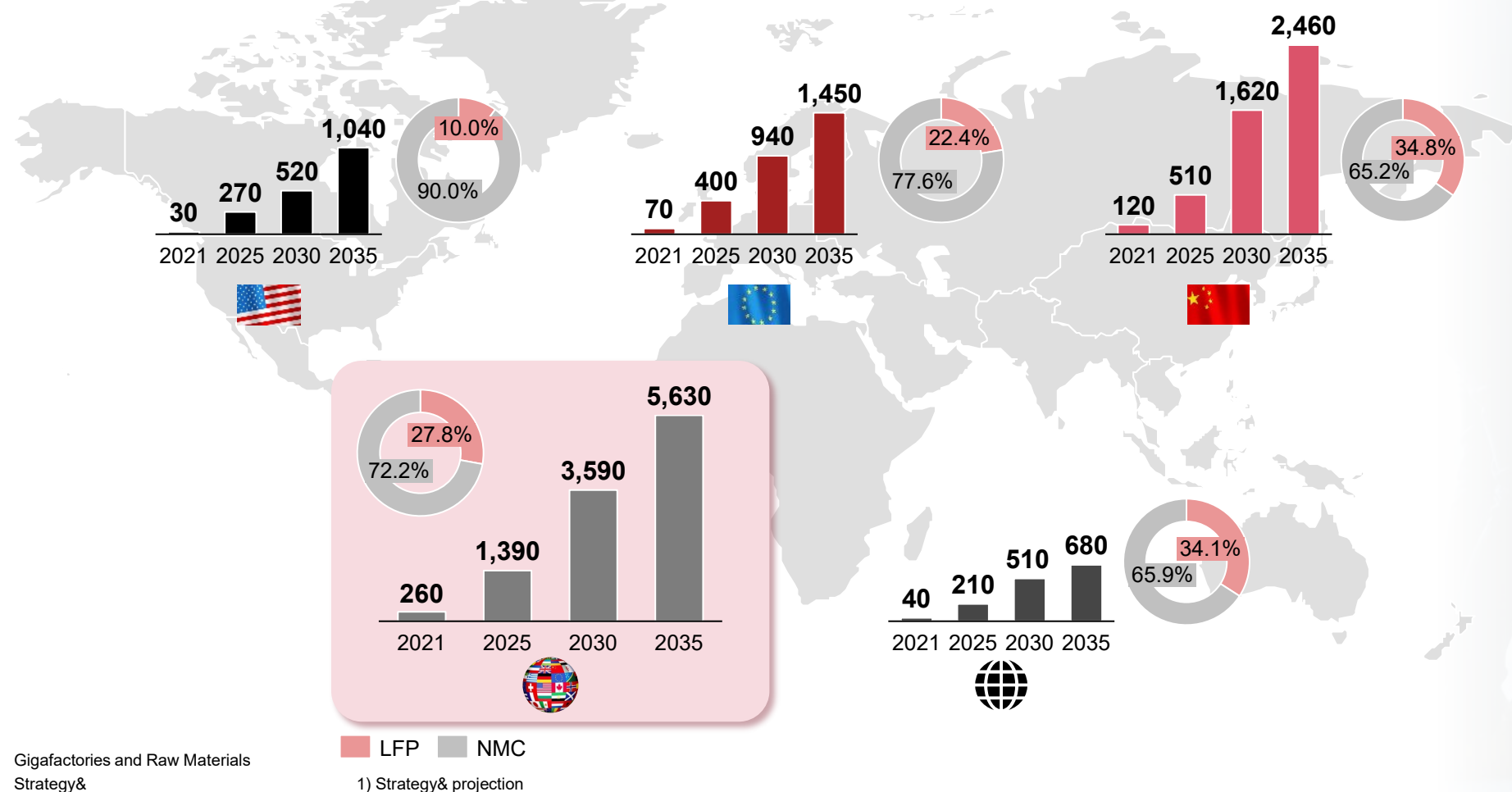
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Global battery demand is driven particularly by China – Europe and North America with higher NMC demand share

Regional battery demand

Regional battery demand in GWh and cell chemistry¹ (2030)



Key takeaways

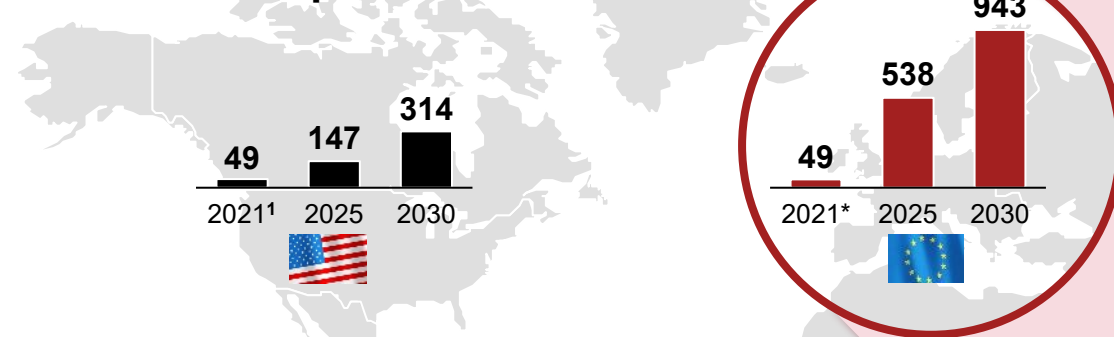
- Regional battery demand is **strongest in China**, with **1.6 TWh in 2030** (followed by EU at 0.9 TWh)
- NMC technology has largest market shares in both EU and US** (>70% market share),
- LFP has a strong presence in China and RoW** (>30% market share)

We expect a US deficit of ~200 GWh and sufficient supply in Europe in 2030 – consolidation potential for cell producers

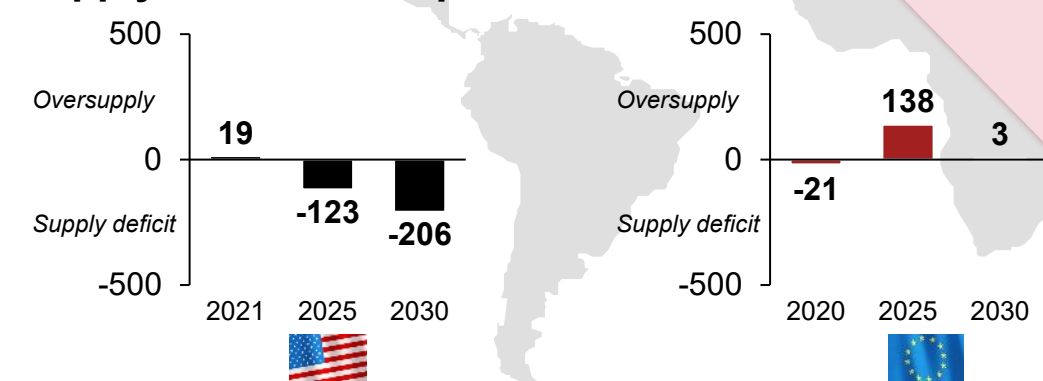
Regional battery supply: Projected Supply – Demand comparison

Battery Cells: Announced Capacity vs. Demand (GWh)

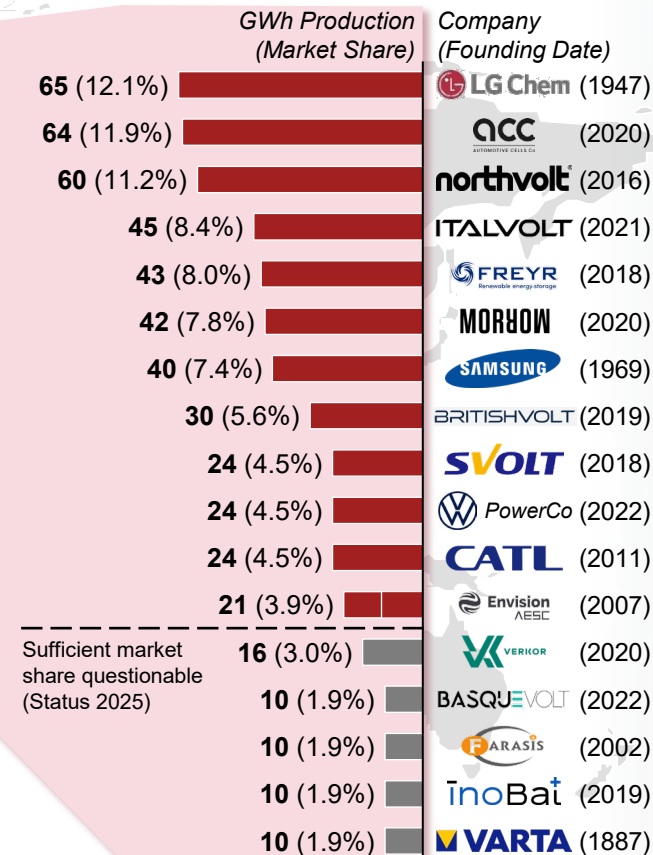
Announced capacities



Supply-demand comparison



Planned production (EU 2025)



Key takeaways

- Comparing announced capacities with battery demand shows a **regional battery deficit in the US towards 2030**
- Announced **EU battery capacities match with demand in 2030**
- The European battery **cell manufacturing landscape shows high potential for consolidation**

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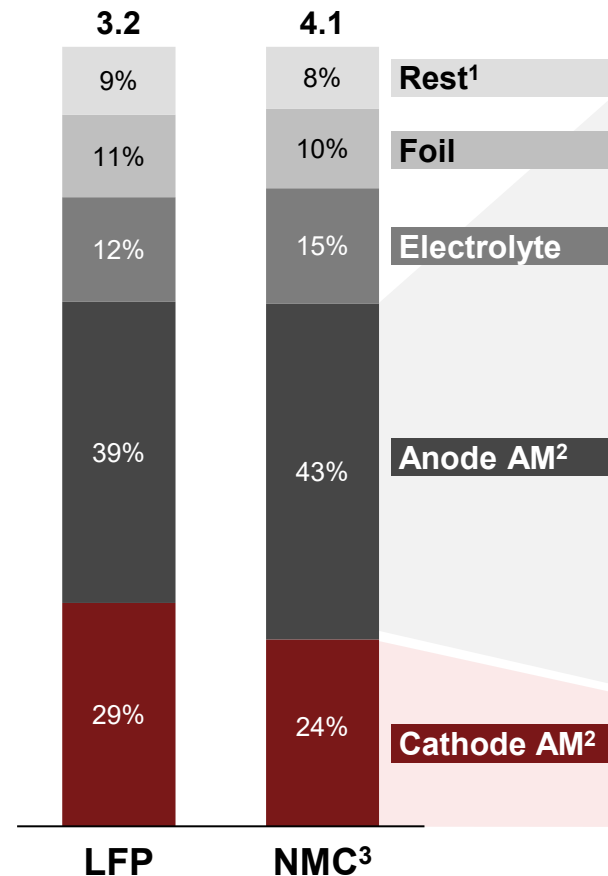
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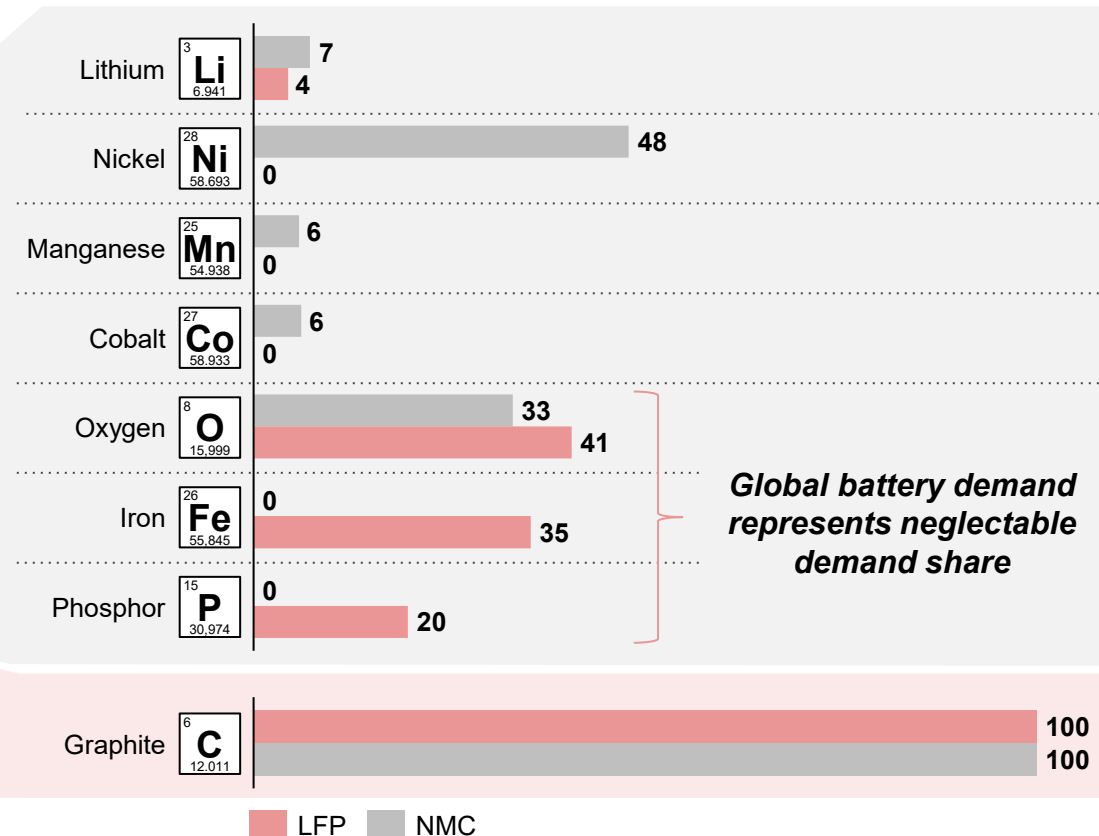
Electrification increases global demand for multiple key cell raw materials – focus on Anode and Cathode Active Materials

Key cell raw materials

Cell weight distribution (kg/kWh)



AAM/CAM material weight distribution (%)



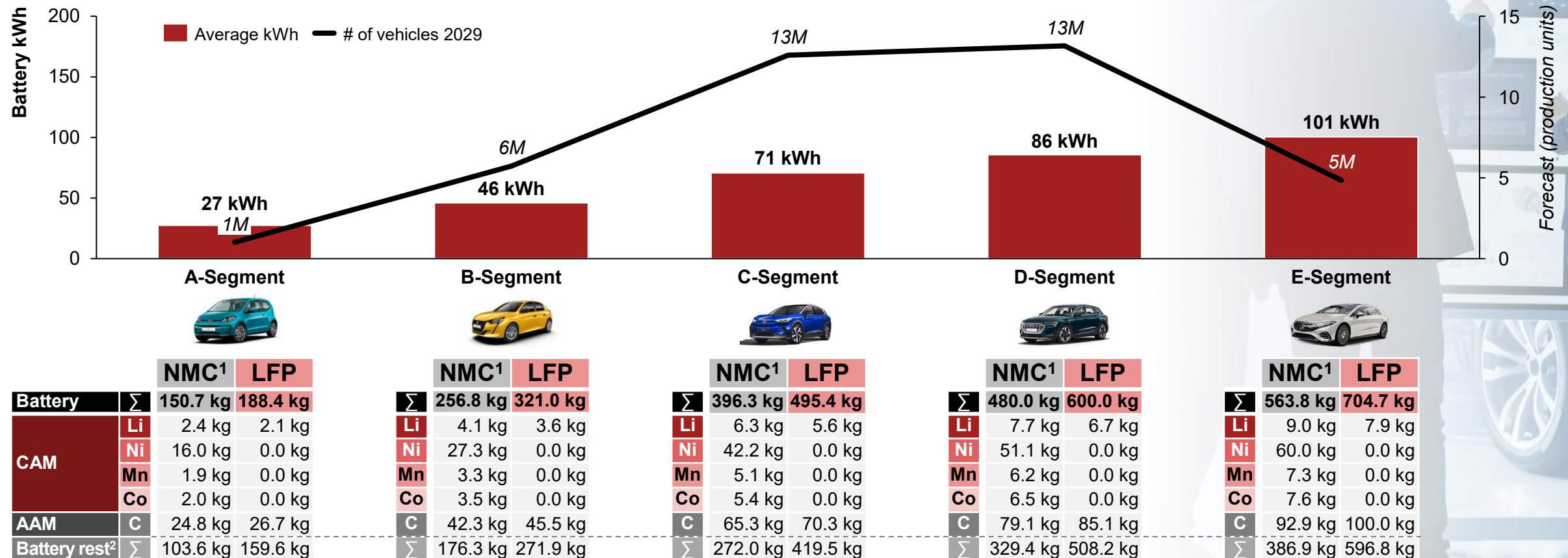
Key takeaways

- **Anode and Cathode Active Material (AAM & CAM)** correspond to **~70% of the Battery Cell weight**
- **Graphite, lithium, nickel, manganese and cobalt** demand account for a relevant **share of battery materials**
- **Oxygen, iron and phosphorus** demand through EV batteries not crucial compared with their overall global demand (e.g. phosphorus for fertilizer)

Depending on the vehicle segment and relevant battery chemistry, active material weight is between 90 and 420 kg

Battery sizes, active material weight and production units

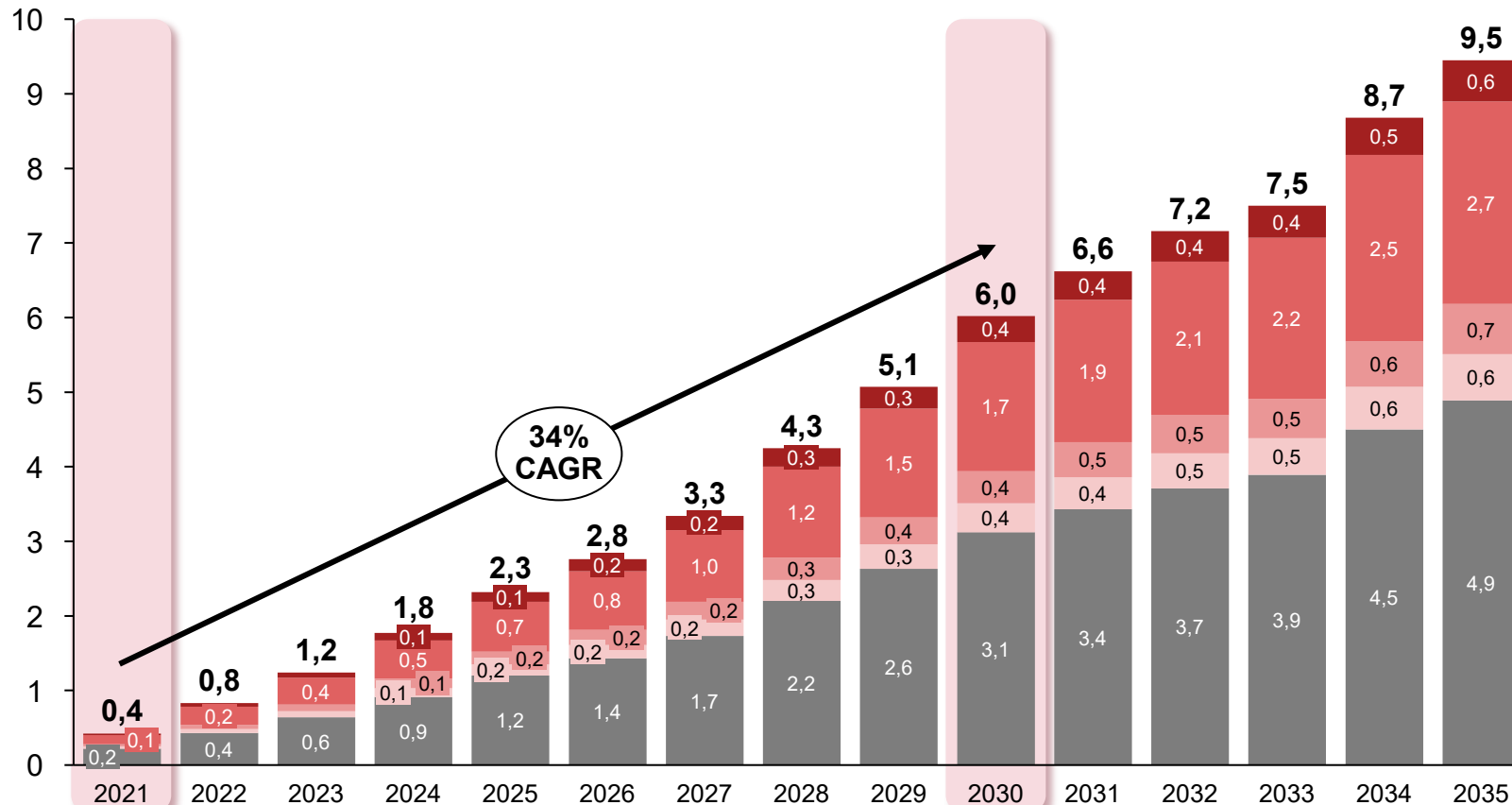
Battery sizes, active material weight and production forecast by vehicle segments (passenger cars, 2030)



Demand for most relevant active materials grows from ~0.4m to 6m tons in 2030 – main drivers are graphite and nickel

Active material demand in million tons

Global active material demand ramp-up¹ (million tons)



Key takeaways

- The global market for active materials will grow by a factor of 15 from 2021 to 2030 (from ~0.4m to ~6m tons)
- Graphite constitutes the main weight share of all relevant active materials
- Nickel accounts for the main weight share of relevant CAM (> 50%)
- Other relevant CAM are of nearly equal relevance in terms of quantity (lithium, manganese, cobalt)

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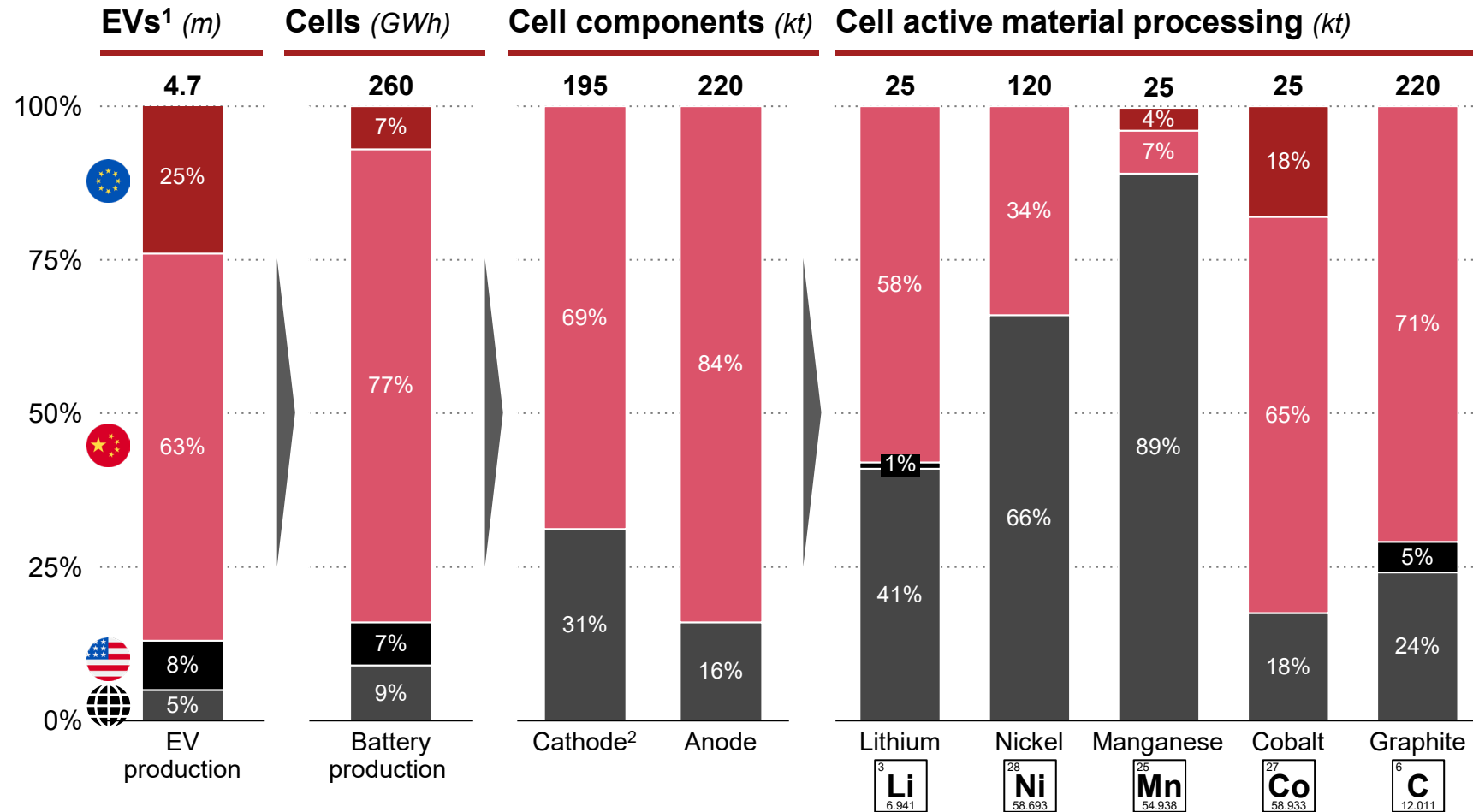
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Processing and subsequent value chain steps currently dominated by China – great potential for European players

As-Is: Geographical distribution of the global EV battery supply chain (2021)



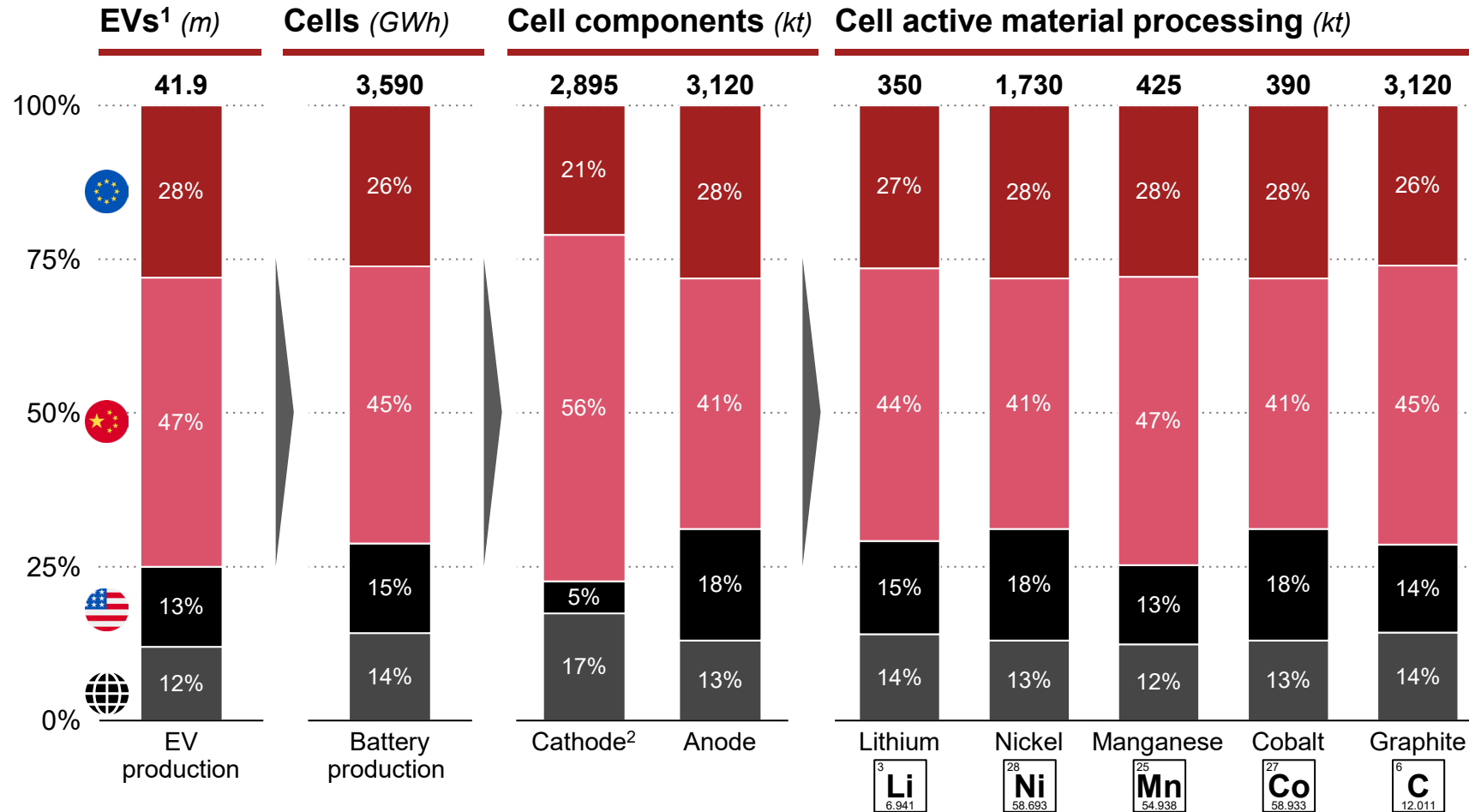
Key takeaways

- While **Europe currently comprises ~30% of EV production**, its local production accounts for:
 - **<10% of global battery cell production**
 - **<1% of global active material production**
 - **~1% of global active material processing**
- The battery supply chain has a **strong Chinese footprint with ~80% of global battery cell and component production**

Assuming a localized AM processing supply chain based on local EV demand, EU requires ~30% of global supply chain

To-Be: Geographical distribution of the global EV battery supply chain (2030)

Assumption: Localized battery value chain

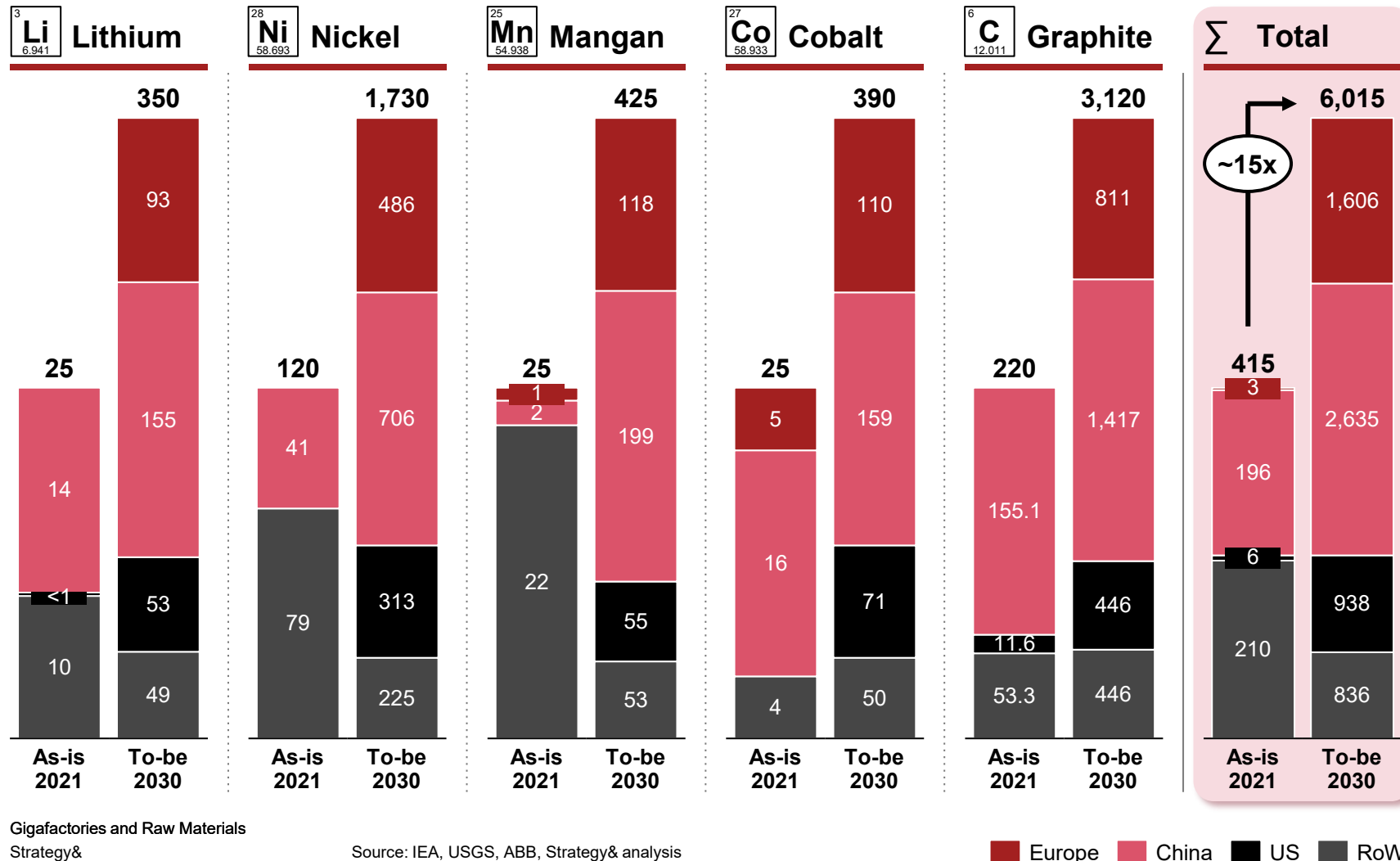


Key takeaways

- A future **localized battery supply chain** would have a **rebalanced global footprint**, with **EU and US** providing **~40% of EV demand**
- While **Europe will comprise ~28% of EV production**, its local production would account for **~27% of global battery cell production, AM production and processing**

Compared with today, active material processing has to grow by a factor of 15 and be re-balanced towards demand in regions

Absolute growth of required raw materials by regions (2021 to 2030, in kt)



Key takeaways

- **Massive scale-up of active material processing by a factor of ~15 by 2030**
- **EU active material processing scale-up from 3 kt (2021) to 1.6 Mt (2030) required to localize battery production in the supply chain and meet high EU demand for EVs**
- **Special focus on lithium, nickel and graphite as currently no localized EU active material processing**

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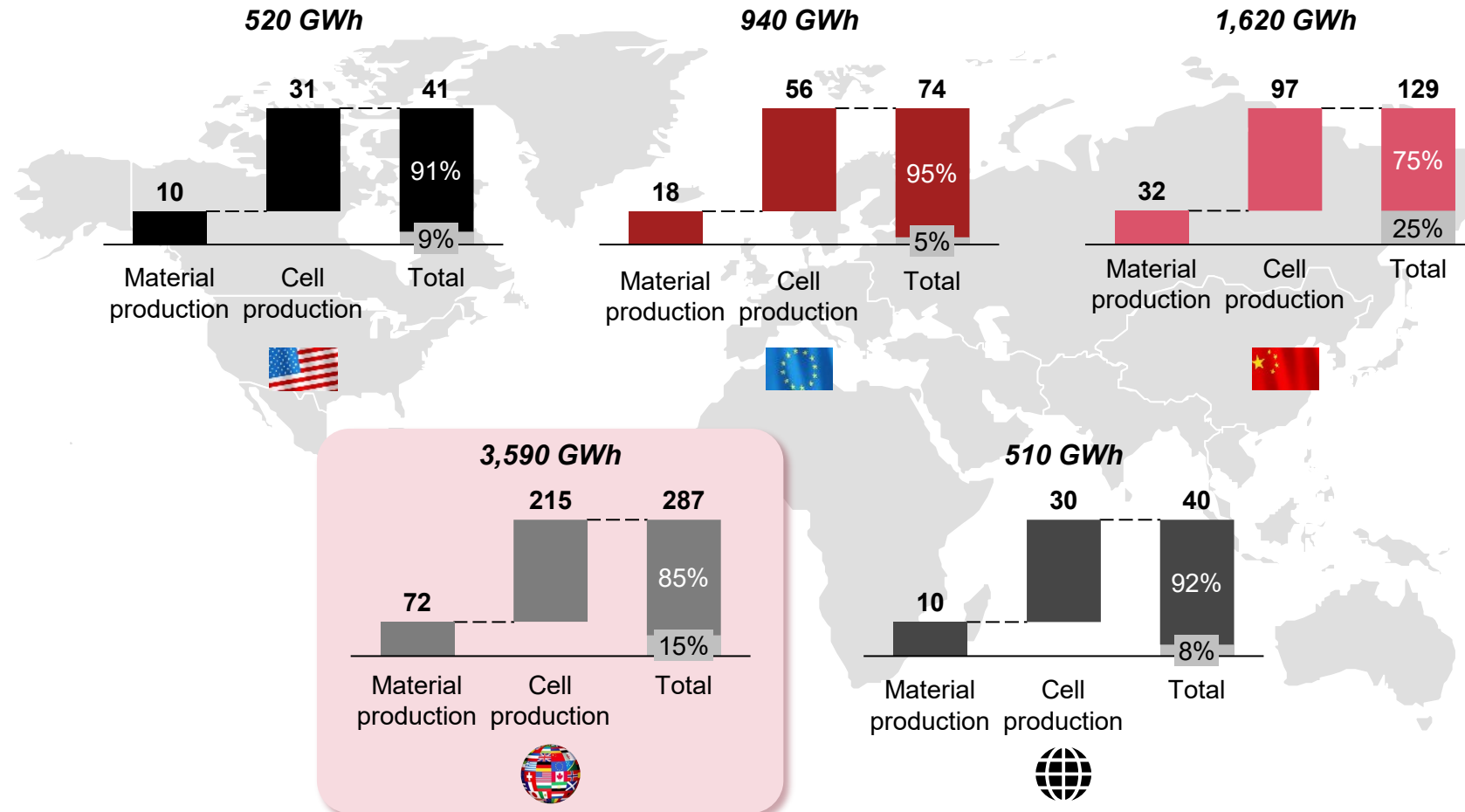
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To supply the global demand of ~3.6 TWh battery capacity by 2030, a total CAPEX investment of € ~290bn is required

CAPEX investment for battery cell value chain (until 2030)



Key takeaways

- A global **CAPEX investment of ~ € 290bn** is required by 2030 for **battery cell production ramp-up – 15% already invested**
- **China as front-runner**, with **25%** of locally-required CAPEX volume **already invested**; **EU lags behind at 5%**
- Multiple **possible scenarios to cover investments** (e.g. state funding, joint ventures, public SPACs, private equity)

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The fast-growing battery production market presents enormous opportunities throughout global value and supply chains

Key take-aways and implications

Battery market

Massive battery demand growth curve (34% CAGR) substantiates the urgency to keep up with fast market growth by taking immediate action

Global required investment of € 300bn provides low-risk investment opportunities for building the industry infrastructure of the future

Supply chain

The risk of local supply deficits underlines the importance of **securing sufficient supply at cell level** (both right capacity and chemistry)

The key risk of EU supply-demand deficit in lithium and nickel emphasizes the significance of **securing sufficient supply at the main active material level**

Business scale-up

Active material **value chain localization**, along with EV demand, offers **high business potential** by building up large active material processing and cell component capacities

The European battery cell manufacturing landscape with high density of players offers **high potential for consolidation**

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