

# Gigafactories & Raw Materials

## The key to successful battery EV adoption

*August 2022*



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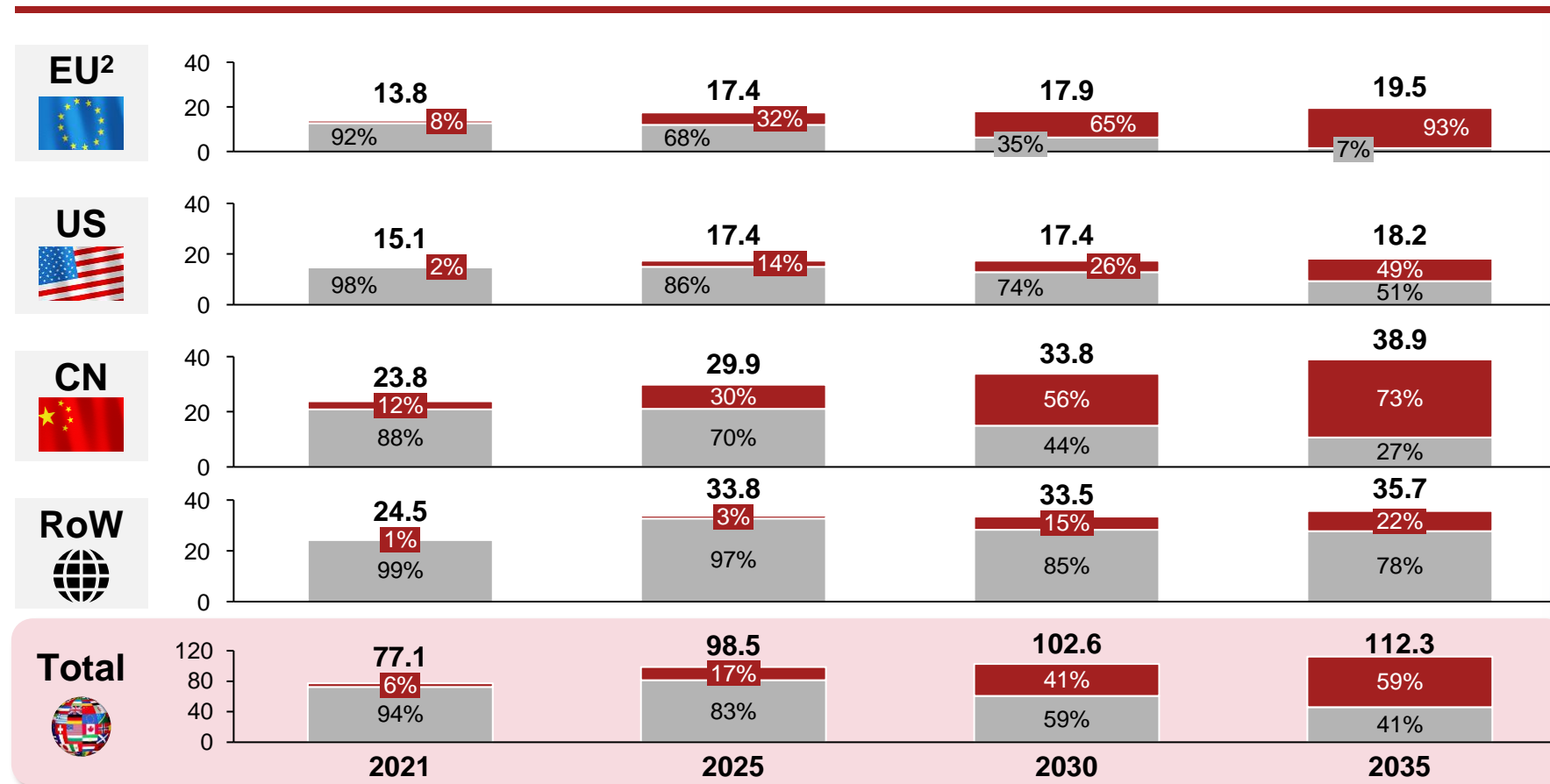
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# The transformation of the car industry is in full swing – electric vehicles will dominate key markets by 2030

## Regional BEV diffusion (Passenger cars and light vehicles)

Realistic scenario<sup>1</sup> (Vehicle sales in million)



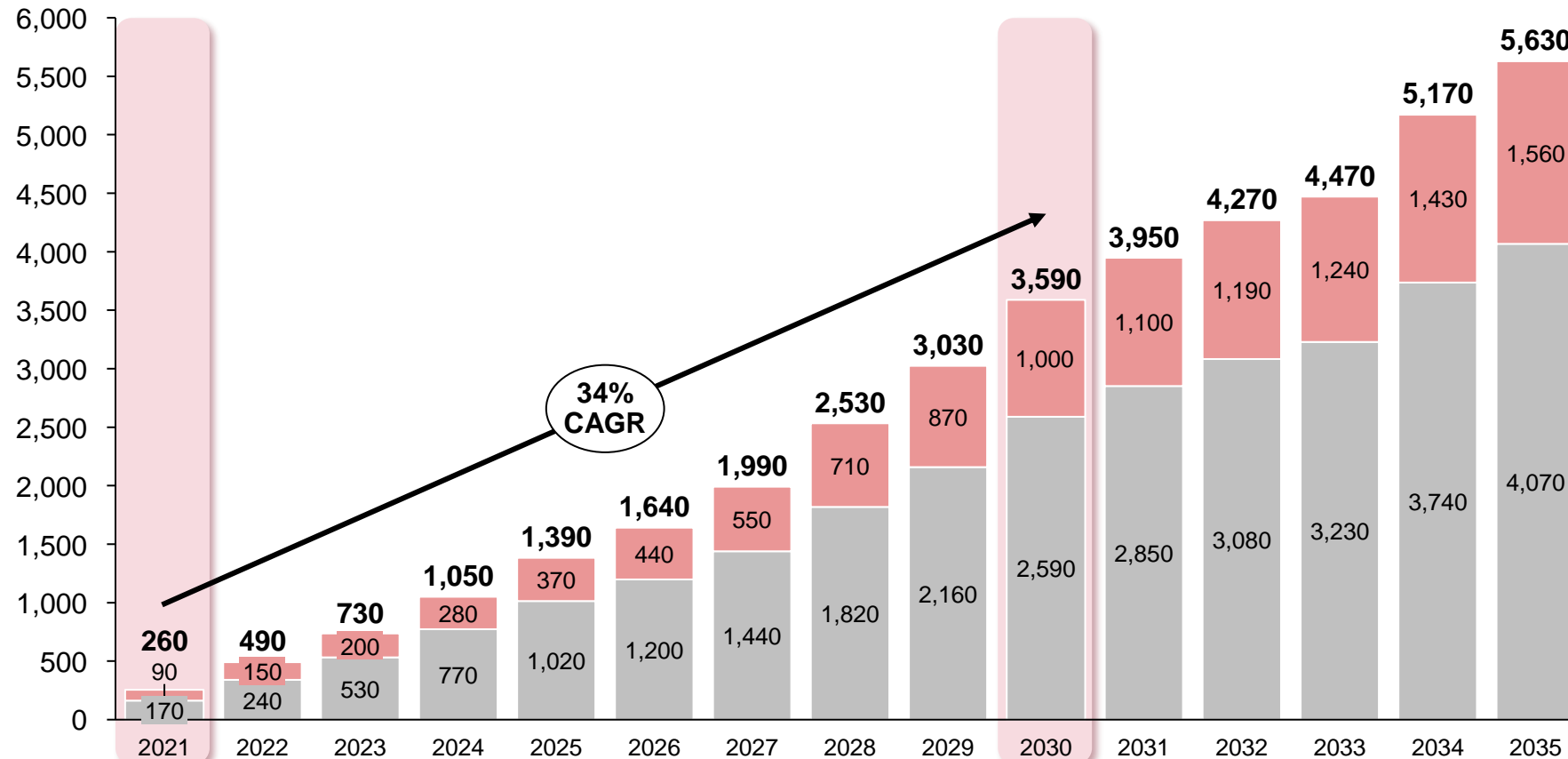
## Key takeaways

- 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 – PC<sup>1</sup> & LCV<sup>2</sup> 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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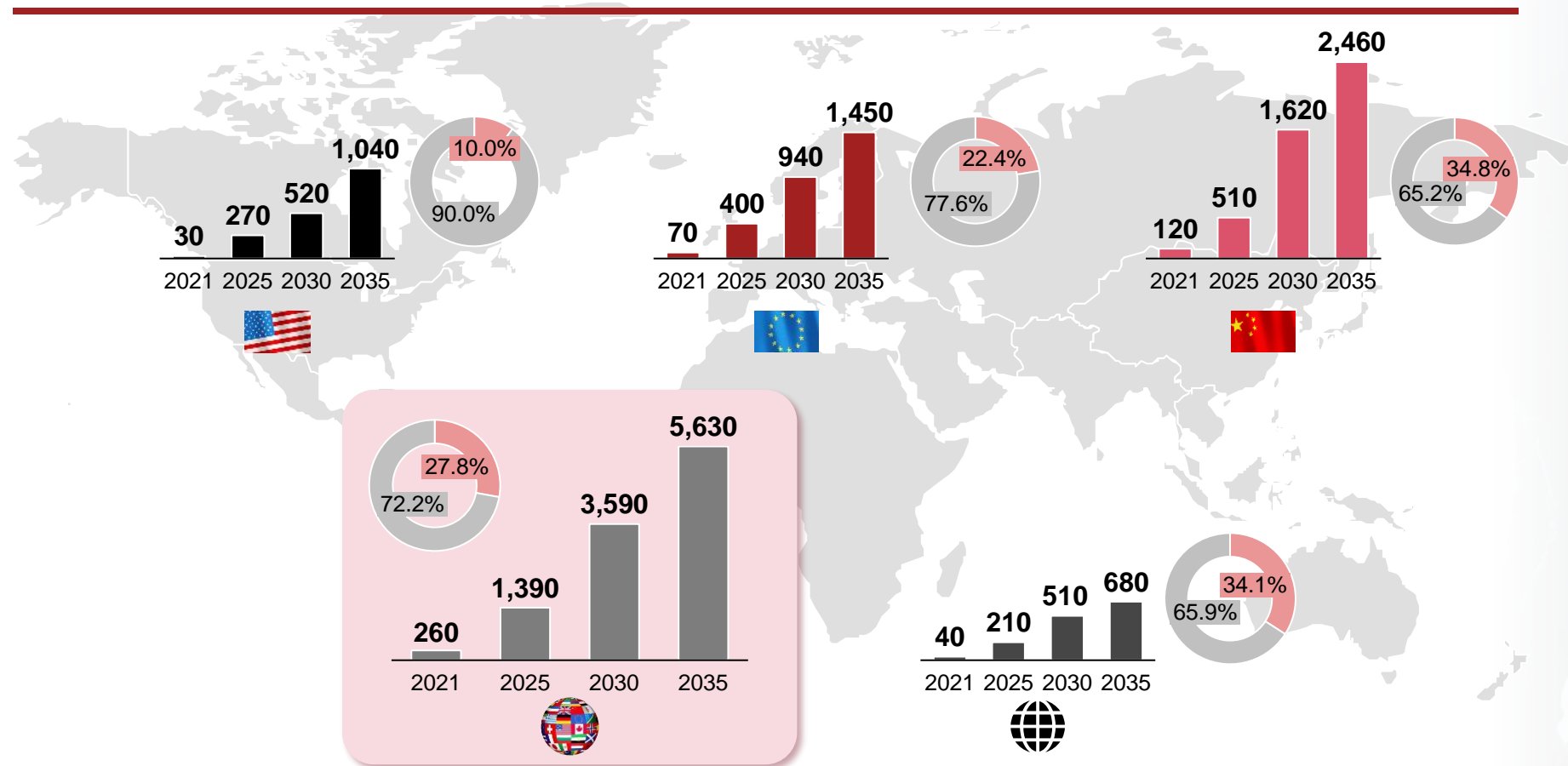
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# Global battery demand is driven particularly by China – Europe and North America with higher NMC demand share

## Regional battery demand

Regional battery demand in GWh and cell chemistry<sup>1</sup> (2030)



■ LFP ■ NMC

1) Strategy & projection

## Key takeaways

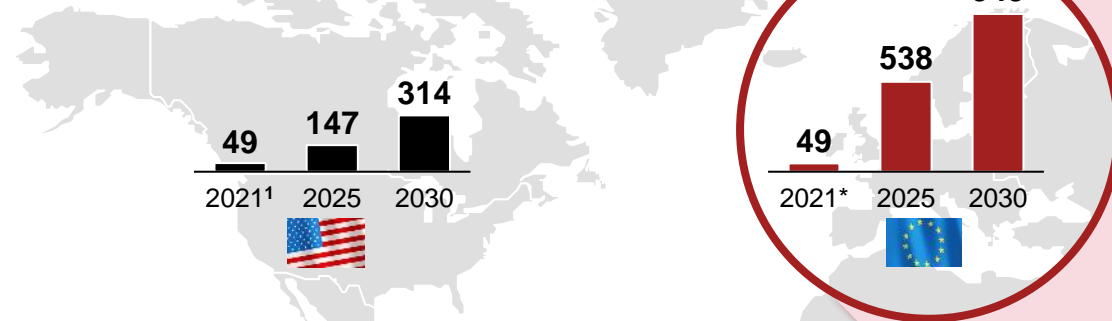
- Regional battery demand is **strongest in China**, with **1.6 TWh in 2030** (followed by EU at 0.9 TWh)
- NMC technology has largest market shares in both EU and US** (>70% market share),
- LFP has a strong presence in China and RoW** (>30% market share)

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

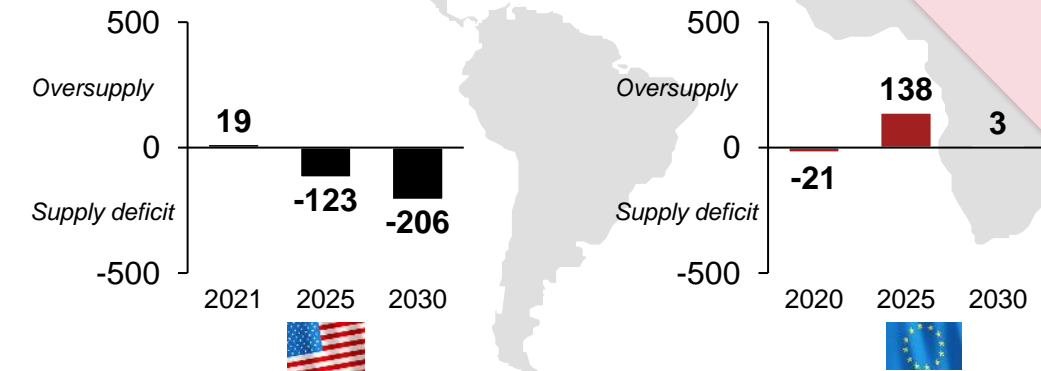
## Regional battery supply: Projected Supply – Demand comparison

### Battery Cells: Announced Capacity vs. Demand (GWh)

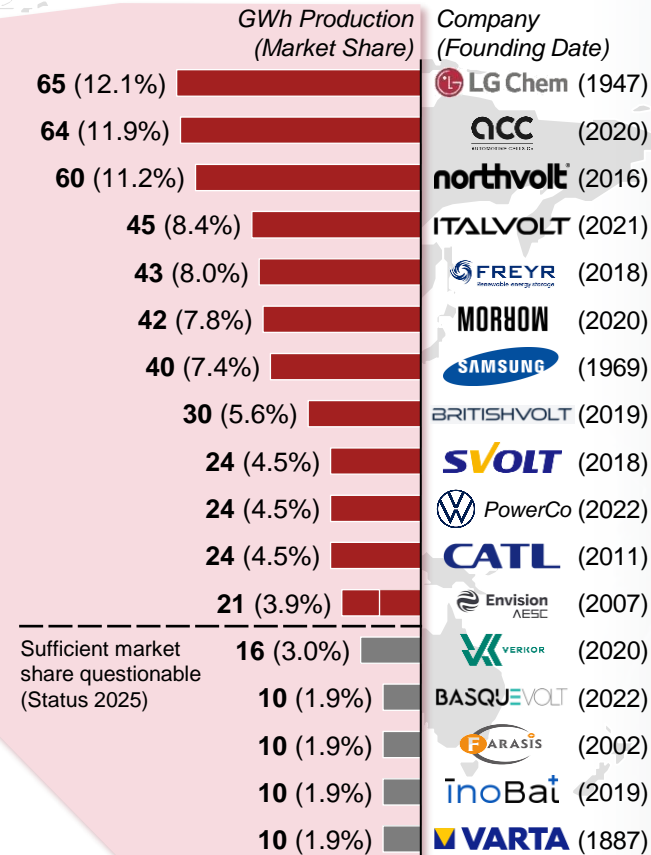
#### Announced capacities



#### 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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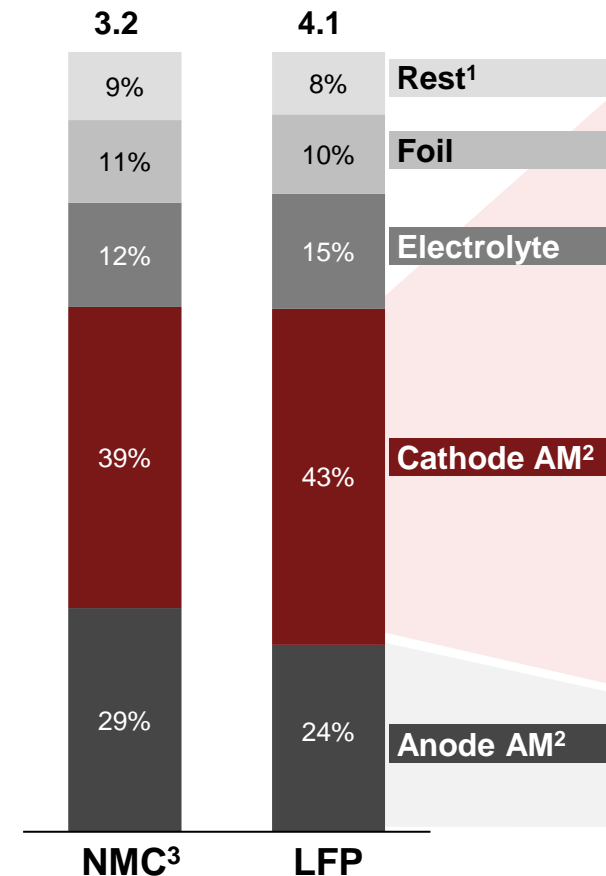




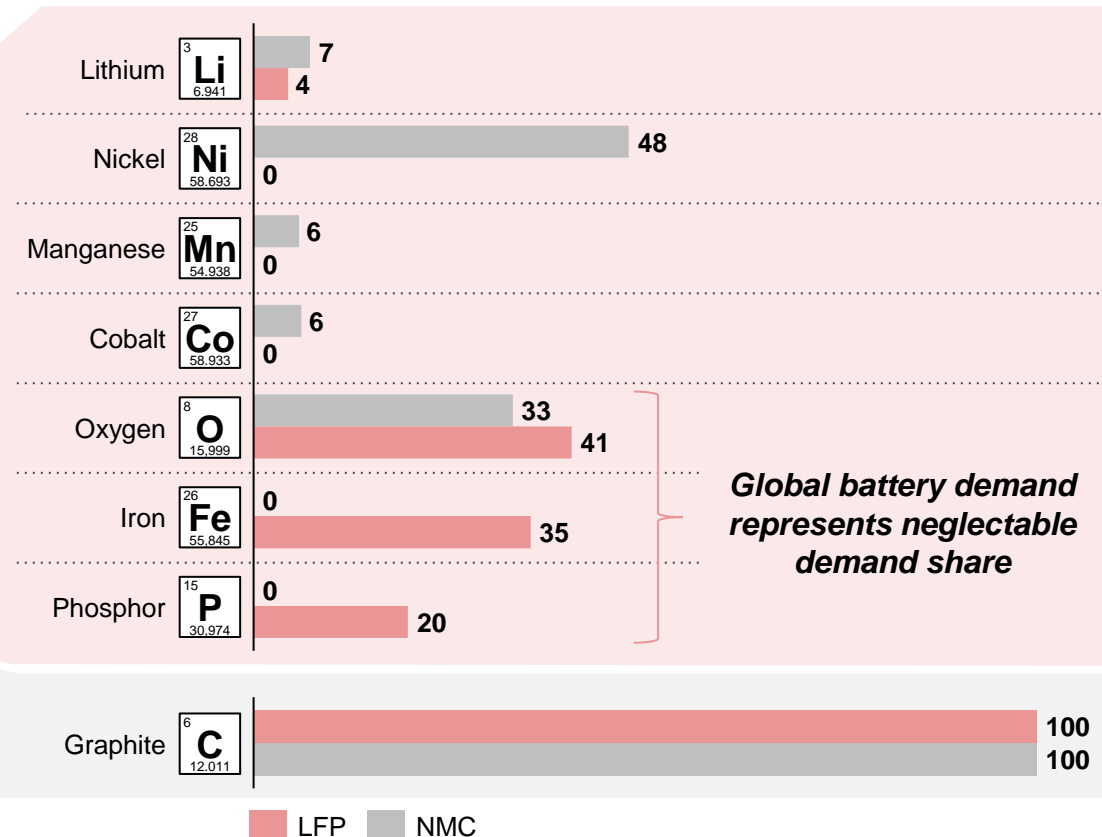
# Electrification increases global demand for multiple key cell raw materials – focus on Anode and Cathode Active Materials

## Key cell raw materials

Cell weight distribution (kg/kWh)



AAM/CAM material weight distribution (%)



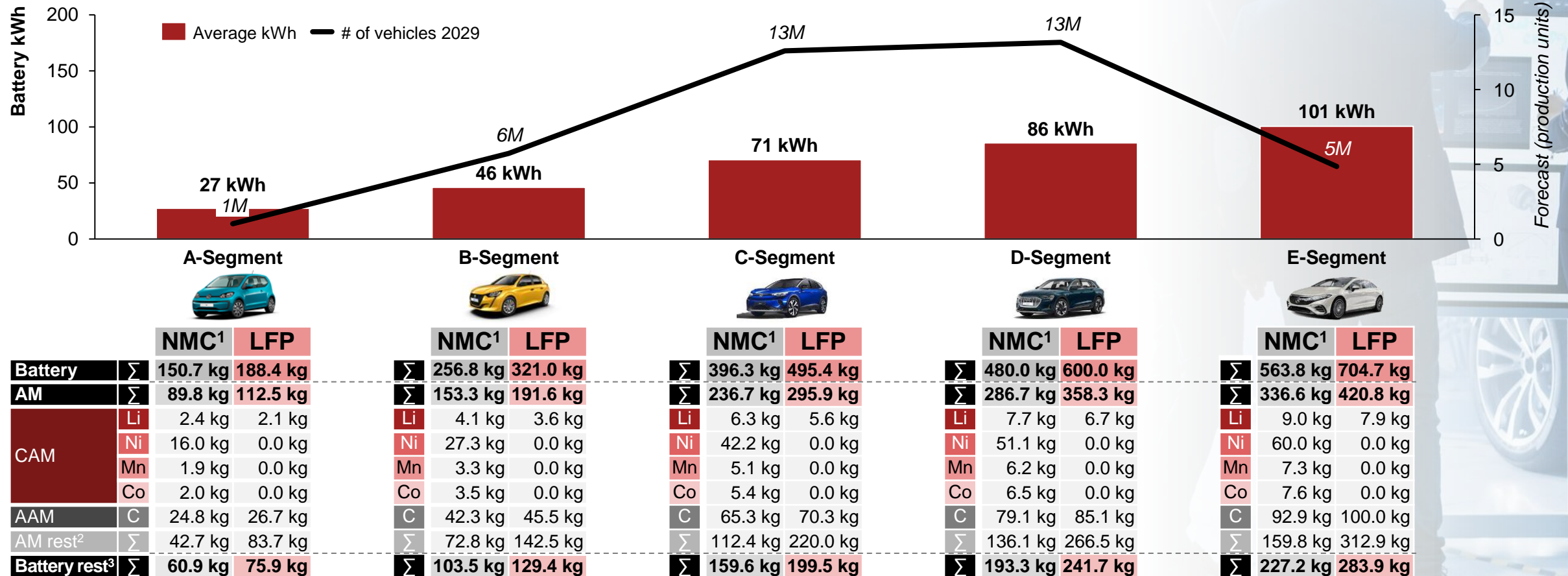
Key takeaways

- **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

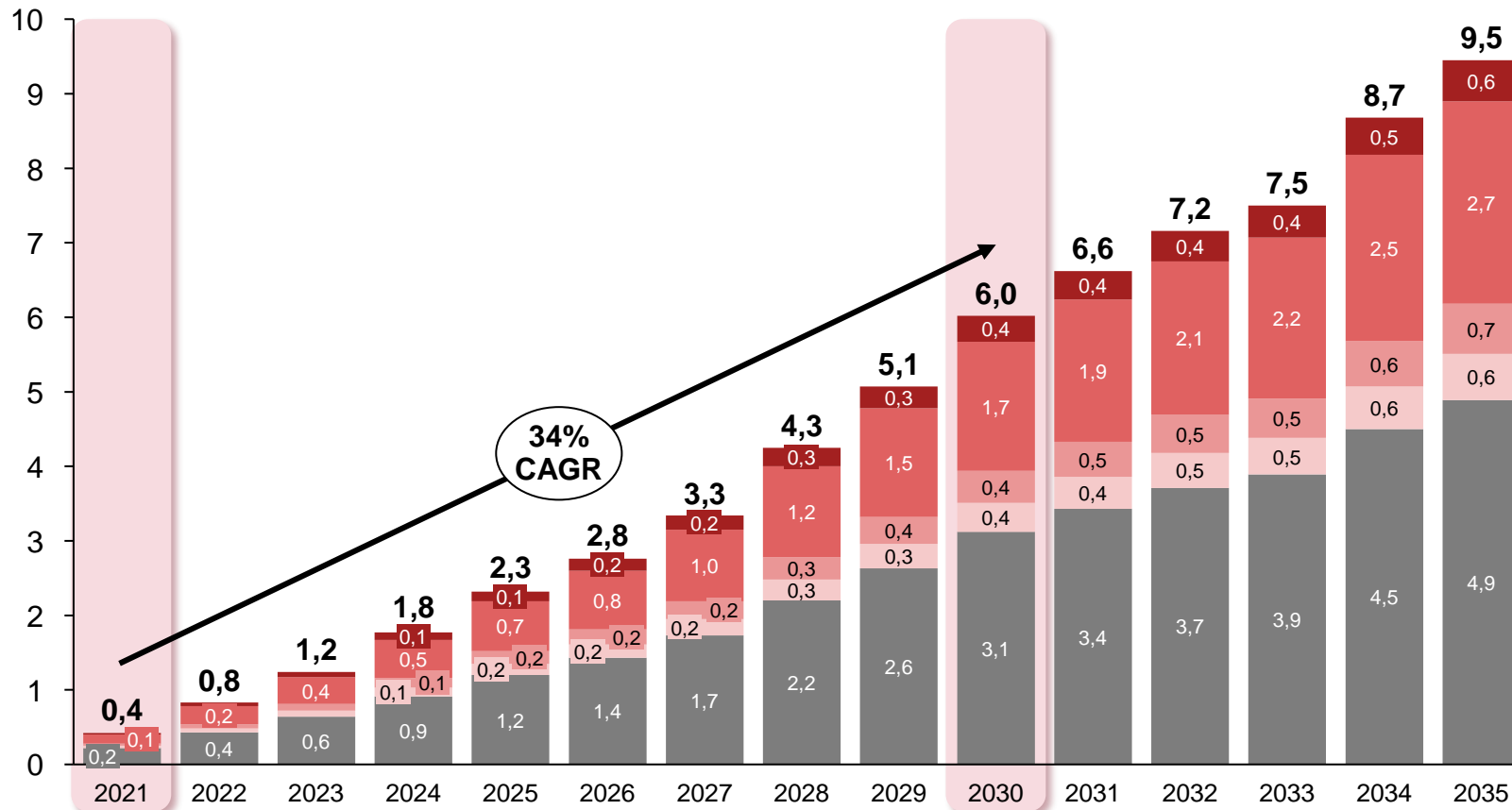
Battery sizes, active material weight and production forecast by vehicle segments (passenger cars, 2030)



# 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-up<sup>1</sup> (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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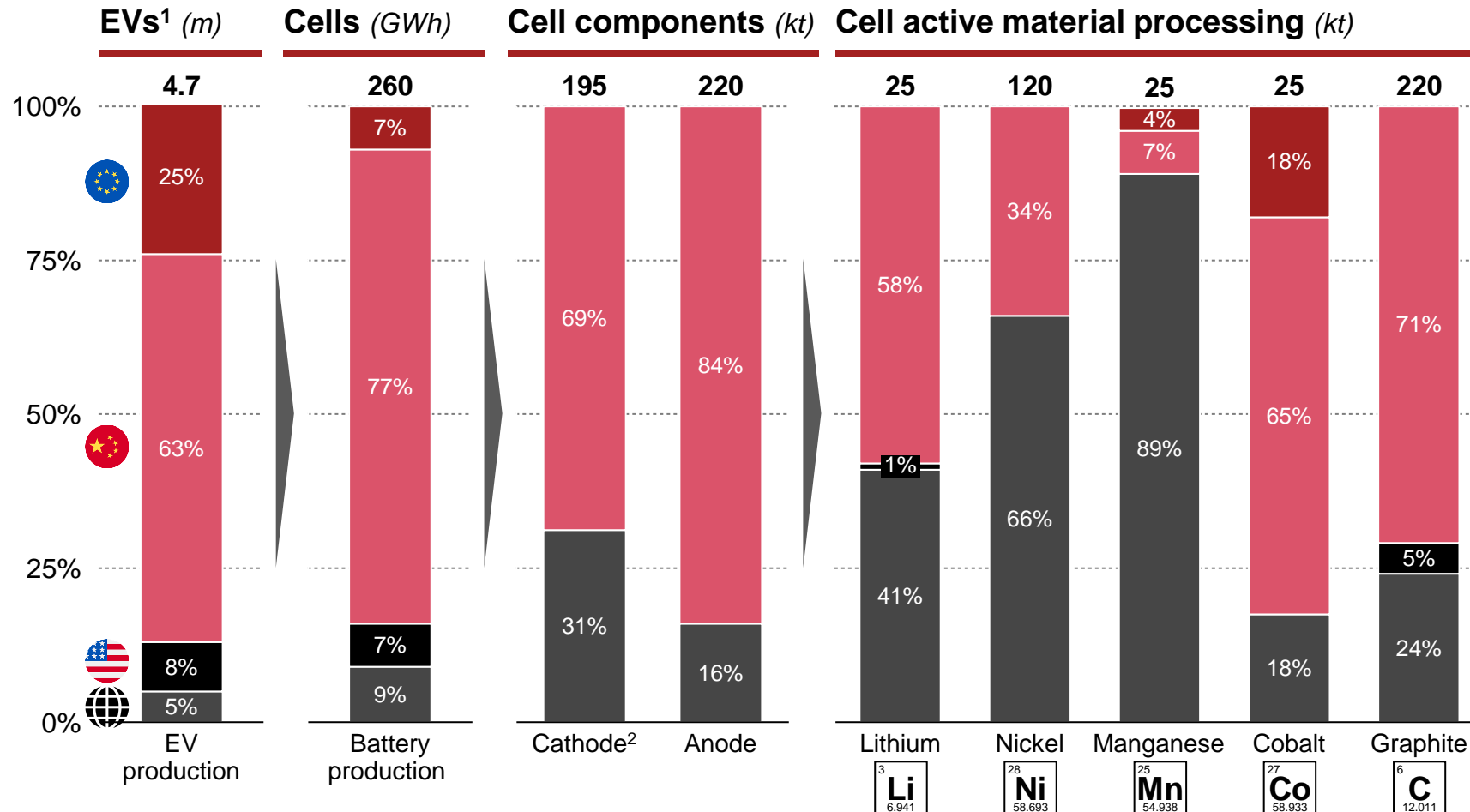
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# Processing and subsequent value chain steps currently dominated by China – great potential for European players

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



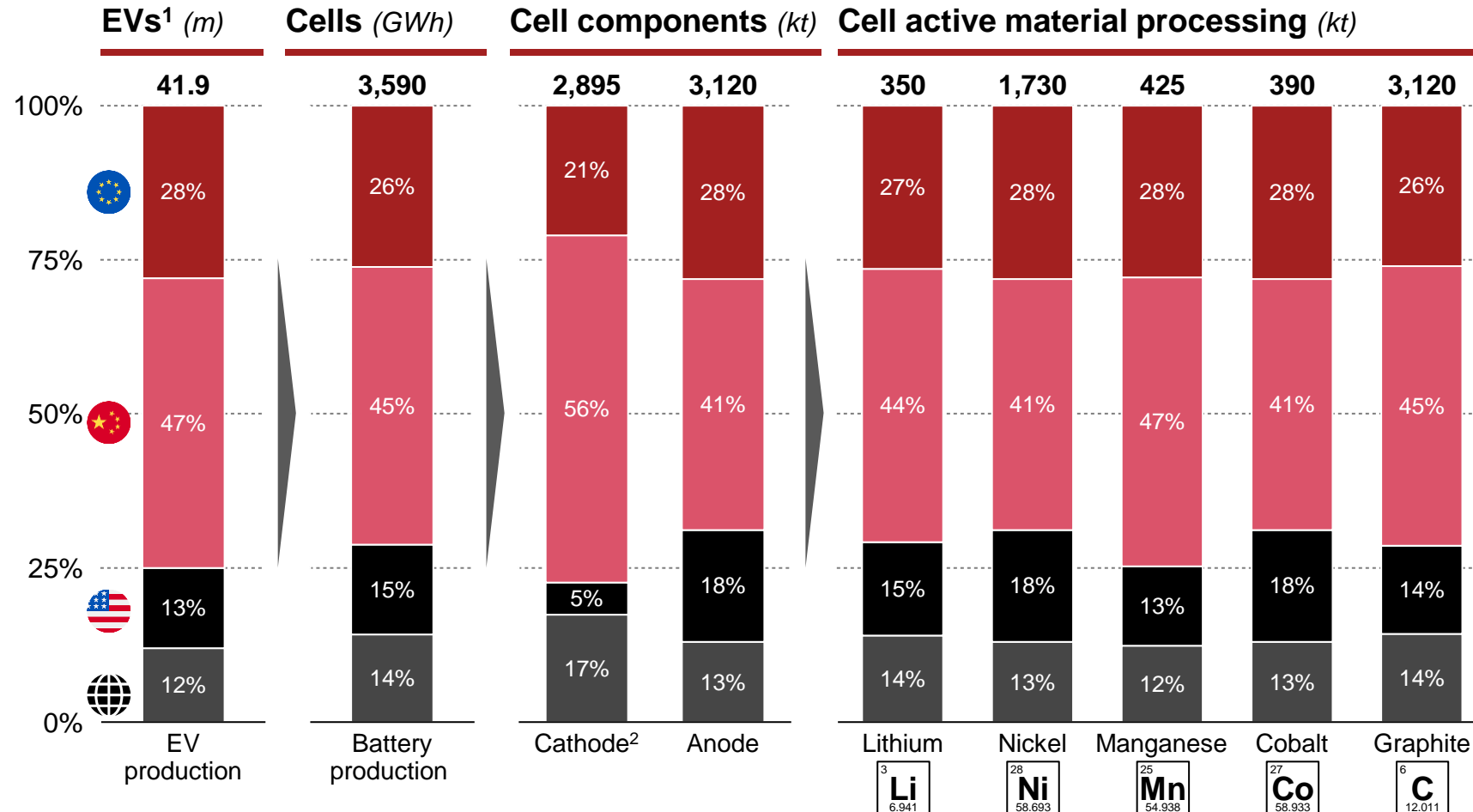
## Key takeaways

- 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

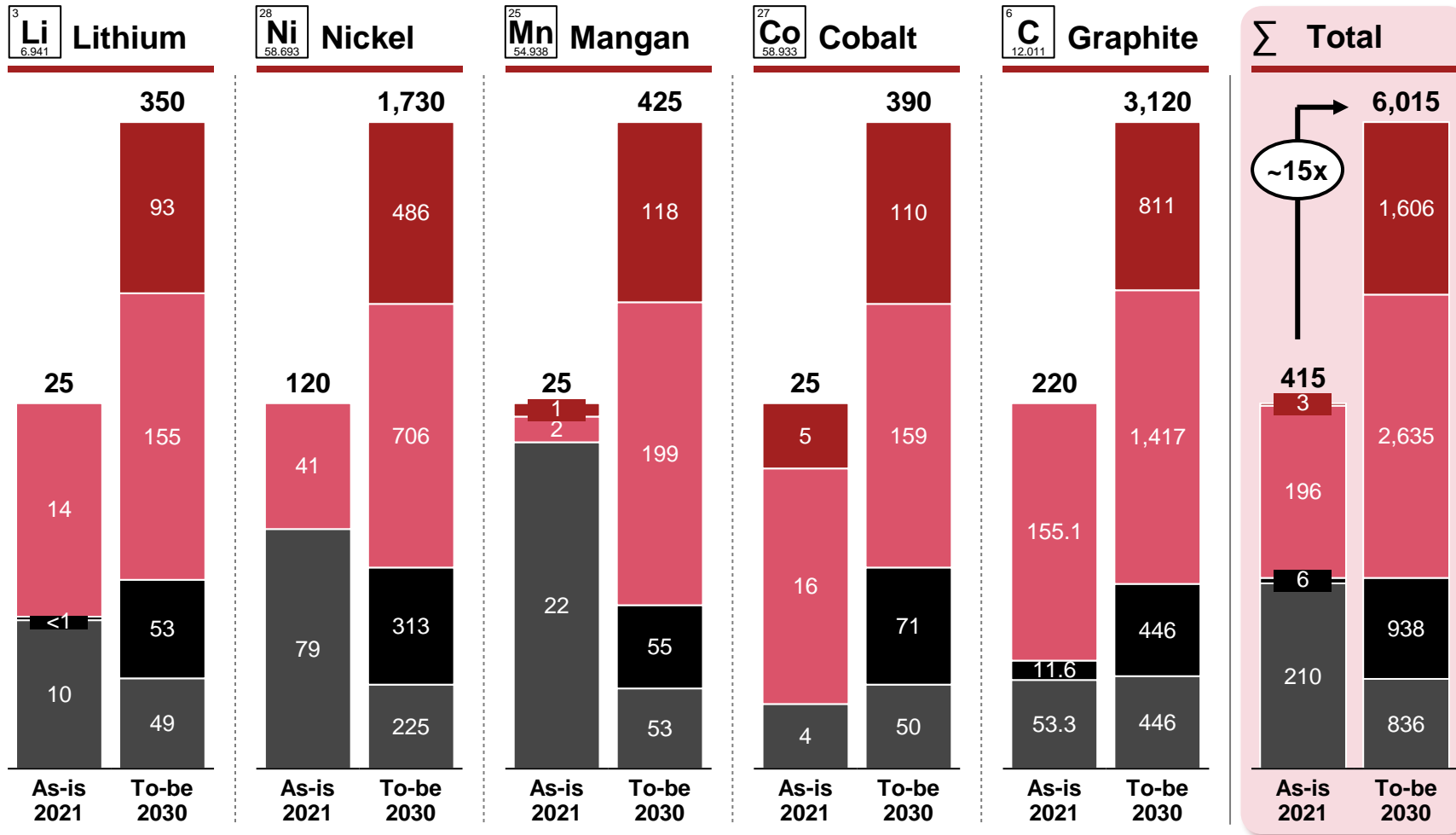


### Key takeaways

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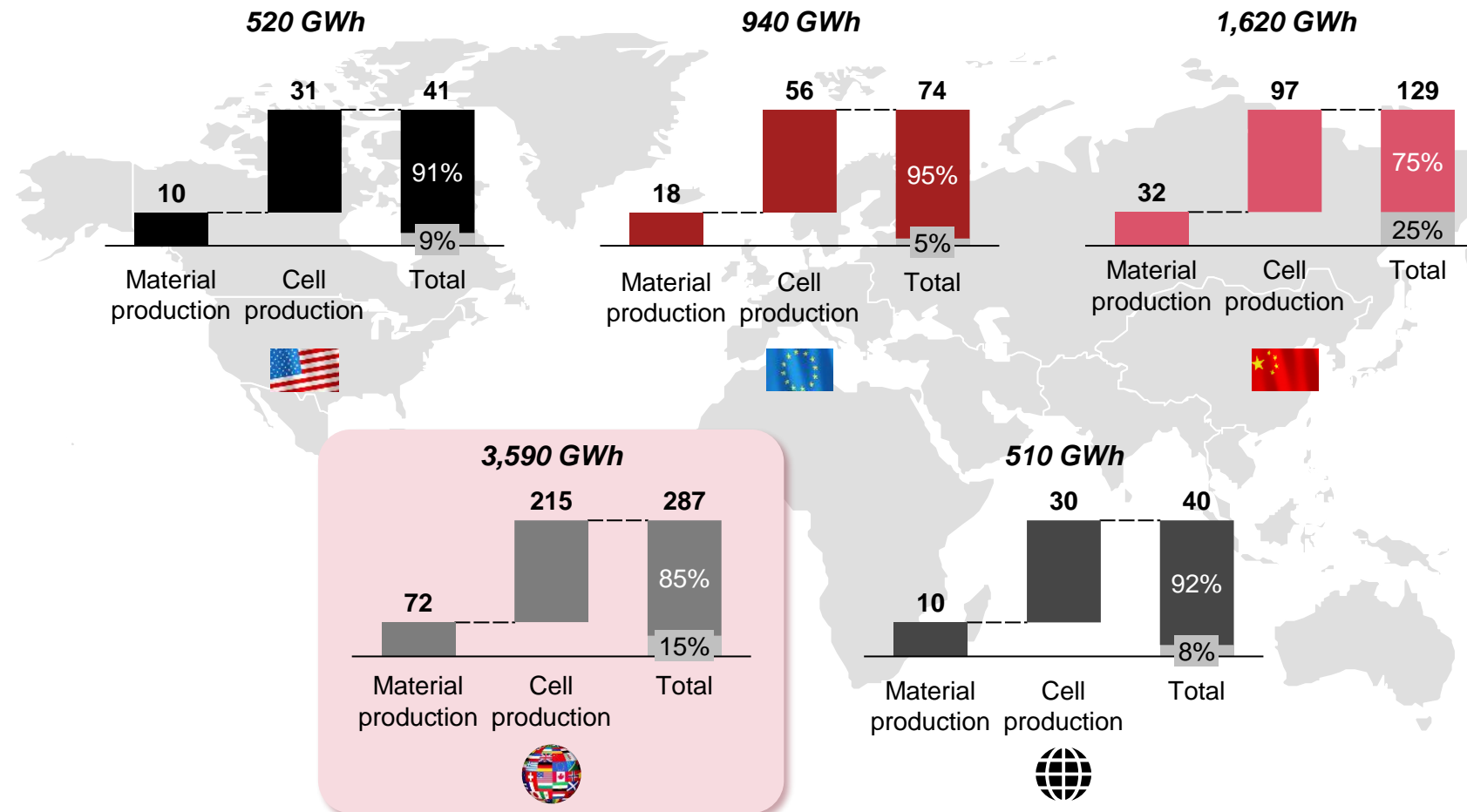
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# To supply the global demand of ~3.6 TWh battery capacity by 2030, a total CAPEX investment of € ~290bn is required

## 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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