



# Driving battery materials into the future

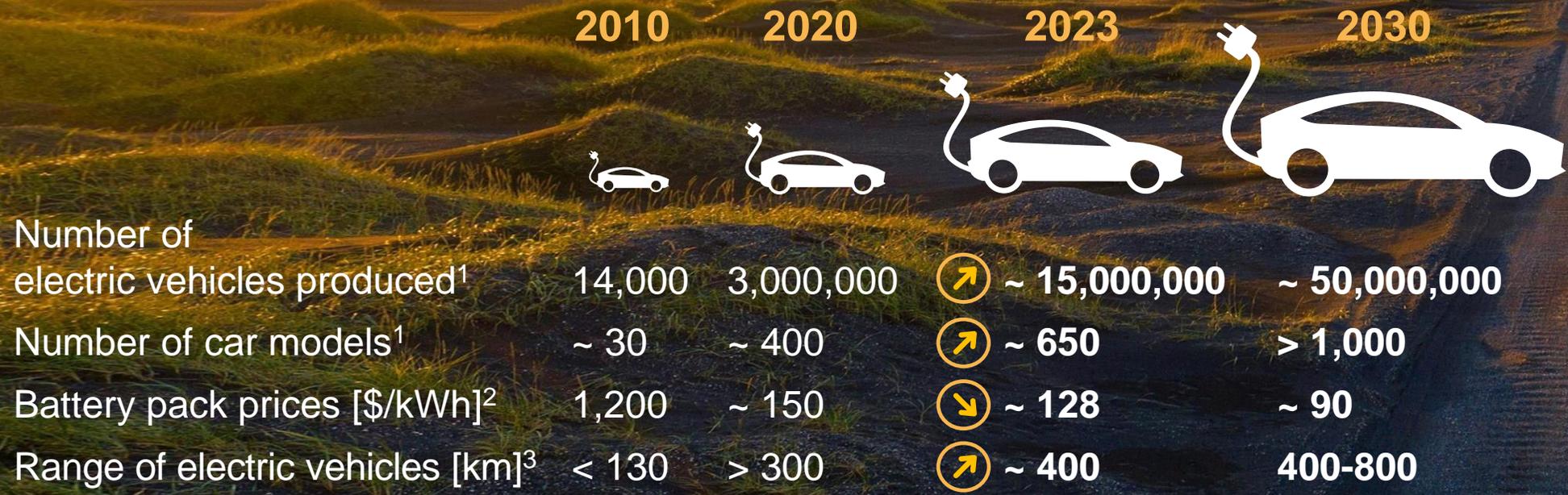
**Dr. Heiko Urtel**

Vice President, R&D Battery Materials &  
Recycling

BASF Research Press Conference, December 1, 2023

# The rapidly growing market of e-mobility

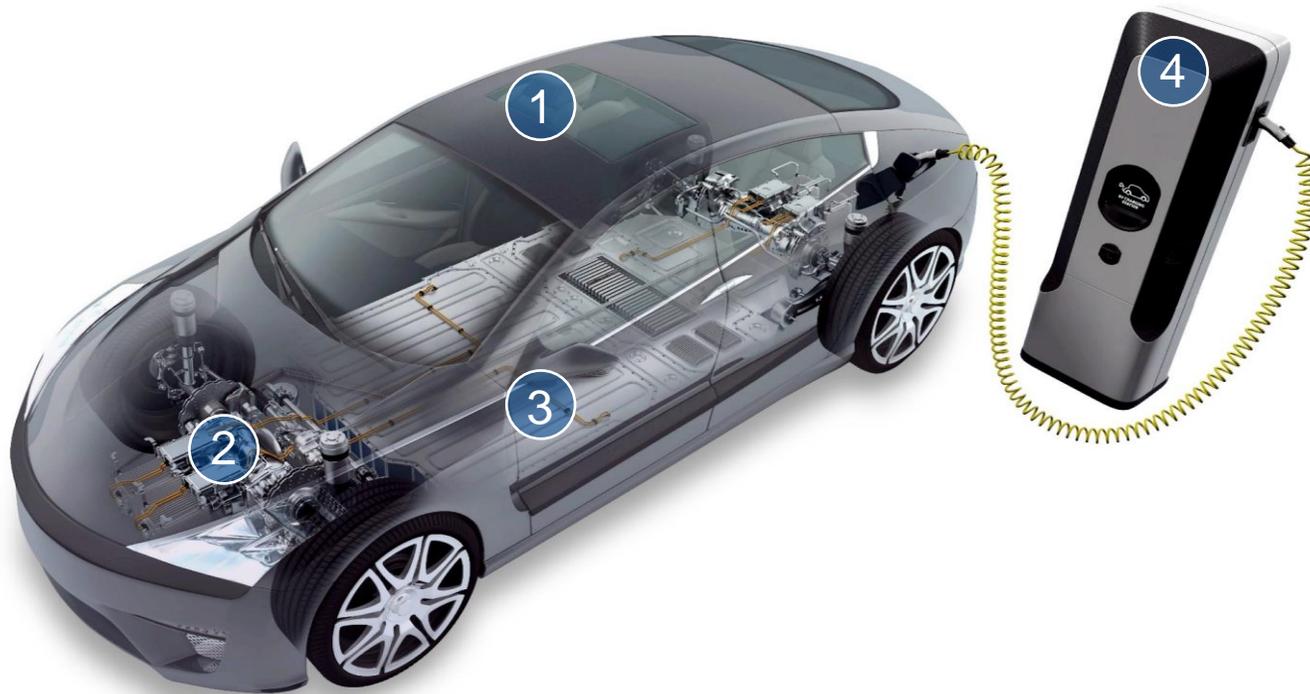
## Innovation is key to support market growth



<sup>1</sup> S&P Global 2023, includes EVs and Plug-in Hybrids <sup>2</sup> Bloomberg, Internal Data <sup>3</sup> for avg. battery electric vehicle (IEA.org), Strategy&

<sup>2</sup> BASF Research Press Conference, December 1, 2023 | Battery Materials & Recycling

# Solutions for e-mobility applications: where BASF comes into play



## 1 Thermal management

### Car body

- NIR-reflective pigments
- NIR-reflective coatings
- Insulation materials

### Interior parts

- NIR-reflective pigments

## 2 Electric powertrain

### Power electronics

- Coolants (Glysantin®)
- Media-resistant plastics
- Thermally conductive plastics
- Flame-retardant plastics
- EMI shielding for engineering plastics

### Electric motor

- Metal pretreatment chemicals
- Components for lubricants
- Coolants (Glysantin®)
- Media-resistant plastics
- Motor mounts (Cellasto®)
- Subframe mounts (Cellasto®)
- Motor cover for NVH

### Driveline

- Axle and gear lubricants
- Components for lubricants

### Fuel cell

- Coolants (Glysantin®)
- Coolant pipes
- End plate & media distribution plate

## 3 Battery pack

### Battery cells

- **Cathode active materials (CAM)**
- Solvent for cathode production
- Solvent for electrolyte
- Anode binder

### Battery modules and packs

- Metal pretreatment chemicals
- Anti-corrosive coatings
- Flame-retardant plastics
- EMI shielding for engineering plastics
- Battery mounts (Cellasto®)

### Thermal management & power supply

- Coolants (Glysantin®)
- Media-resistant plastics
- Thermally conductive plastics
- High performance thermal insulation

## 4 Charging infrastructure

### Housing and structural parts

- Metal pretreatment chemicals
- Anti-corrosive coatings
- Flame-retardant plastics

### Cable and connectors

- Cable jacketing
- Flame-retardant plastics

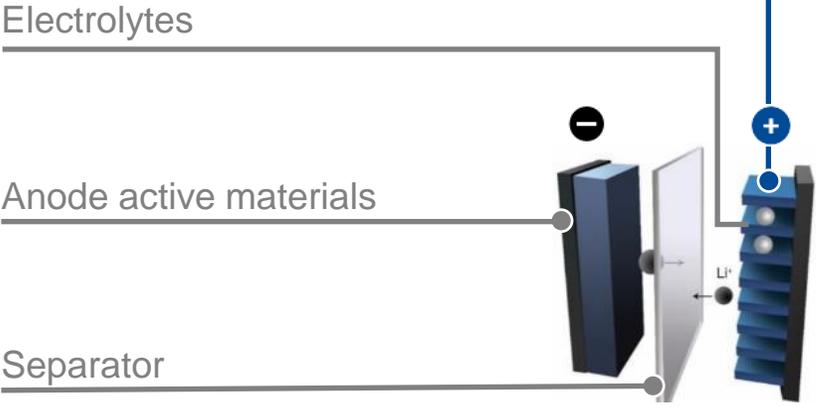
### Thermal management

- Media-resistant plastics
- Thermally conductive plastics

# BASF focuses on high performing Cathode Active Materials (CAM): The value-adding core of lithium-ion battery cells

## Setup of a lithium-ion battery cell

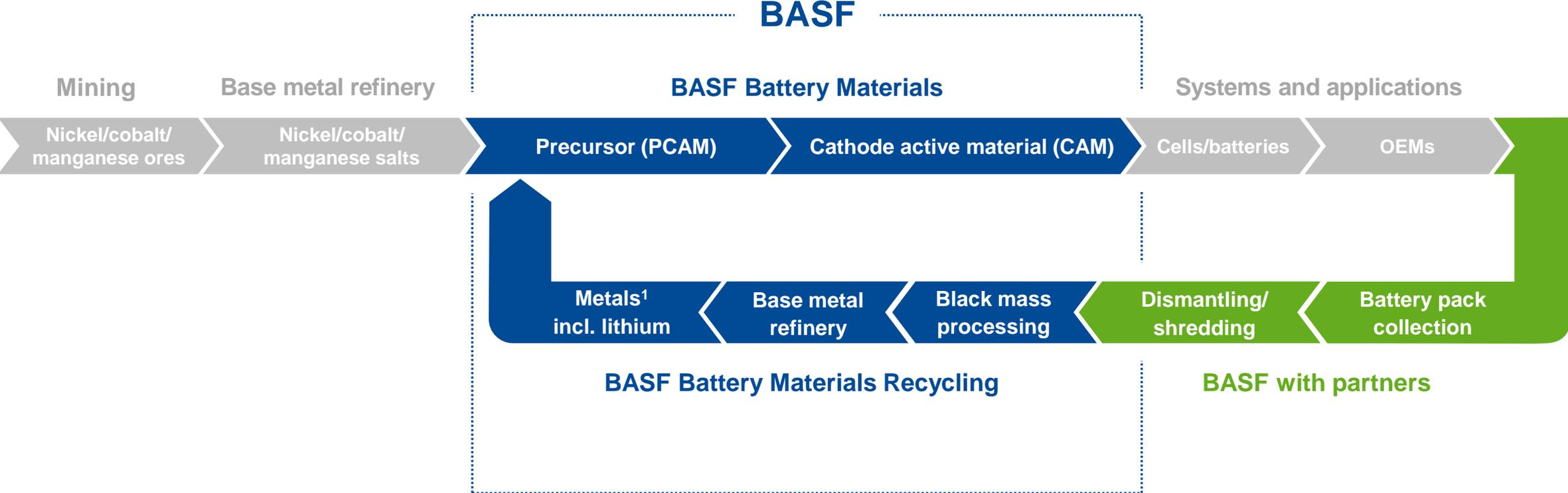
**BASF Cathode Active Materials (CAM)**  
Lithium-Nickel-Cobalt-Manganese oxide (NCM)  
Lithium-Nickel-Cobalt-Aluminum oxide (NCA)



## Complex system with many interdependencies



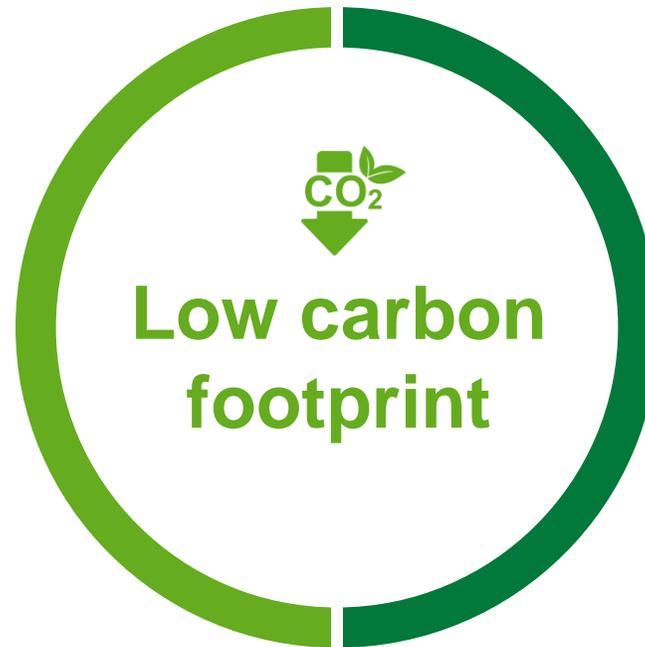
# BASF's leading position in battery value chain: An integrated Battery Materials & Recycling solution tailor-made for our customers



<sup>1</sup> Nickel, cobalt, manganese, copper

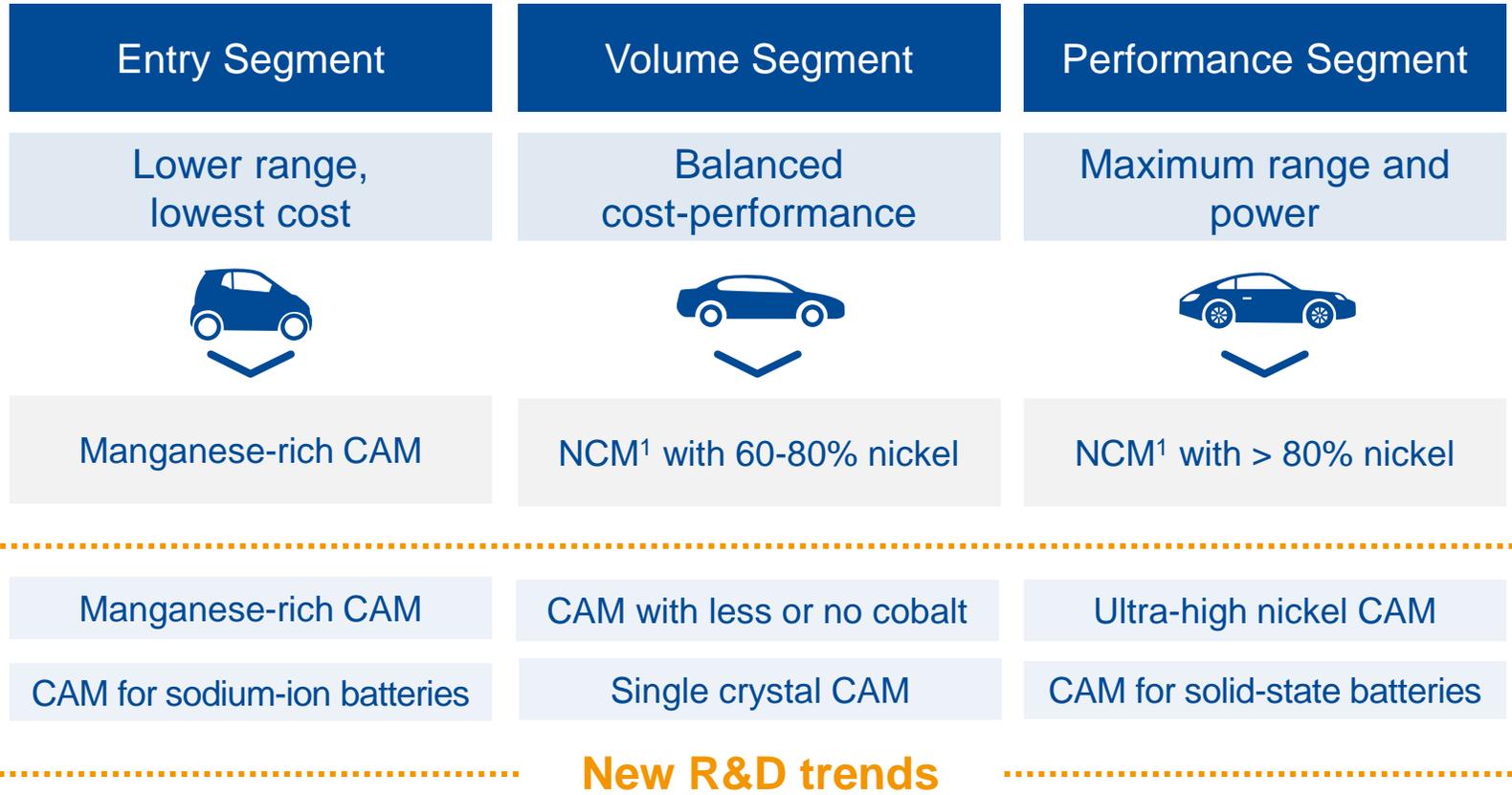
# Closing the loop: How we contribute to a low carbon footprint with innovative research and development, technology and production

- **Research** into new and improved cathode active materials with improved utilization of the valuable metals
- **Smart process development** for an efficient manufacturing process
- Use of **recycled metals** for CAM production instead of new ones, including development of an optimized recycling process



- Use of **renewable energies** for production
- Leverage our **broad academic network**
- Implementation of **data science and computational modeling and simulation** to enhance quality and speed of R&D

# BASF develops tailored CAM for each car segment with a strong intellectual property (IP) portfolio

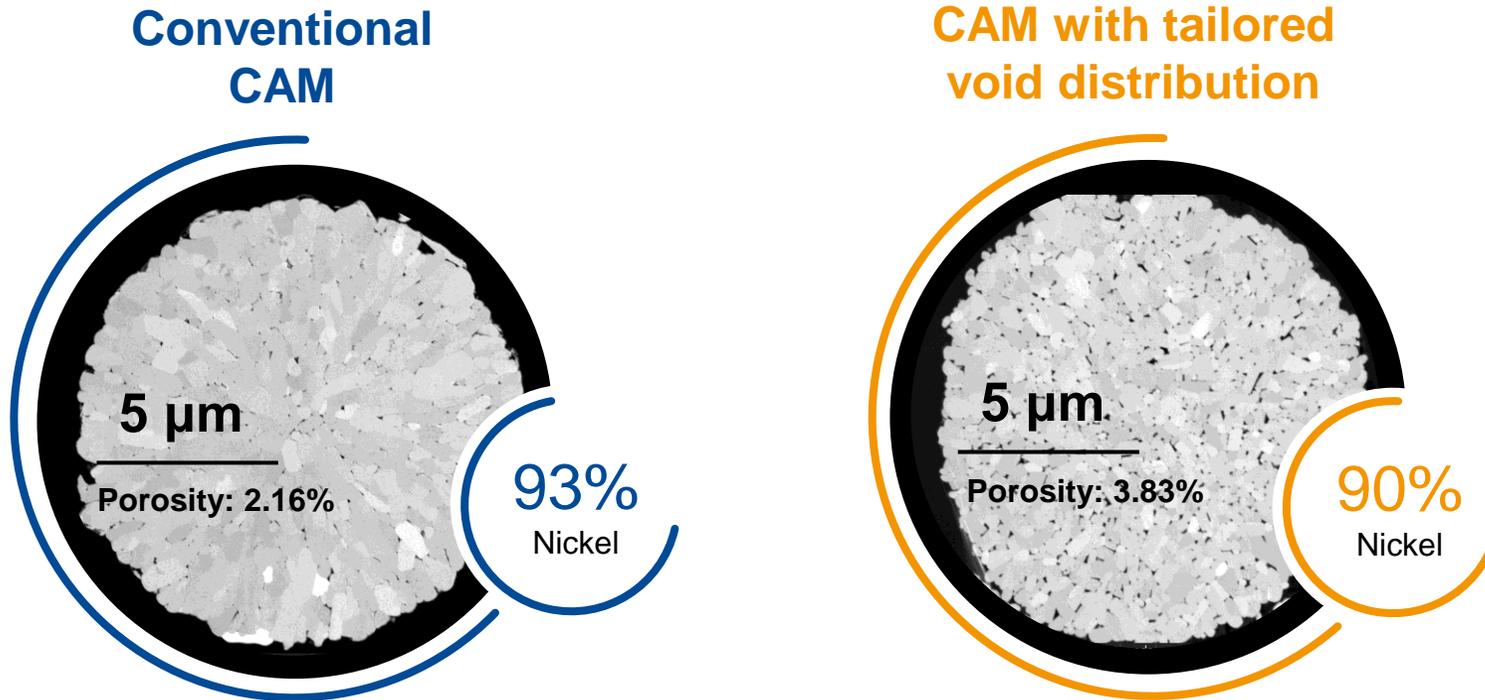


With customized cathode active materials, we are able to optimize cost and performance for every segment

Each car segment offers different opportunities to drive sustainability

<sup>1</sup> Nickel, cobalt, manganese

# Tailored CAM microstructures to reduce nickel content



- Tailored void distribution in CAM to enhance the dynamic behavior of lithium-ion diffusion
- Capacity of this new material with **only 90% nickel** corresponds to a conventional material with 93% nickel

These new materials achieve higher capacities at lower nickel contents, resulting in enhanced sustainability at reduced material cost

# Precursor (PCAM) manufacturing using digital clones accelerates the scale-up process and reduces material consumption



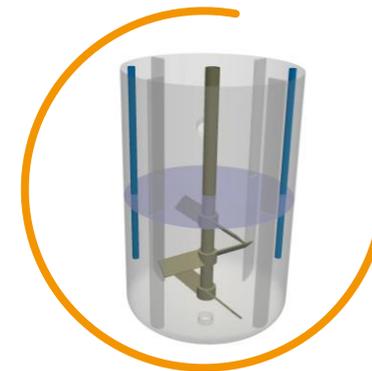
Lab  
reactor  
8 l



Pilot  
reactor  
50 l



Prototype  
reactor  
10,000 l



CFD  
digital twin<sup>1</sup>

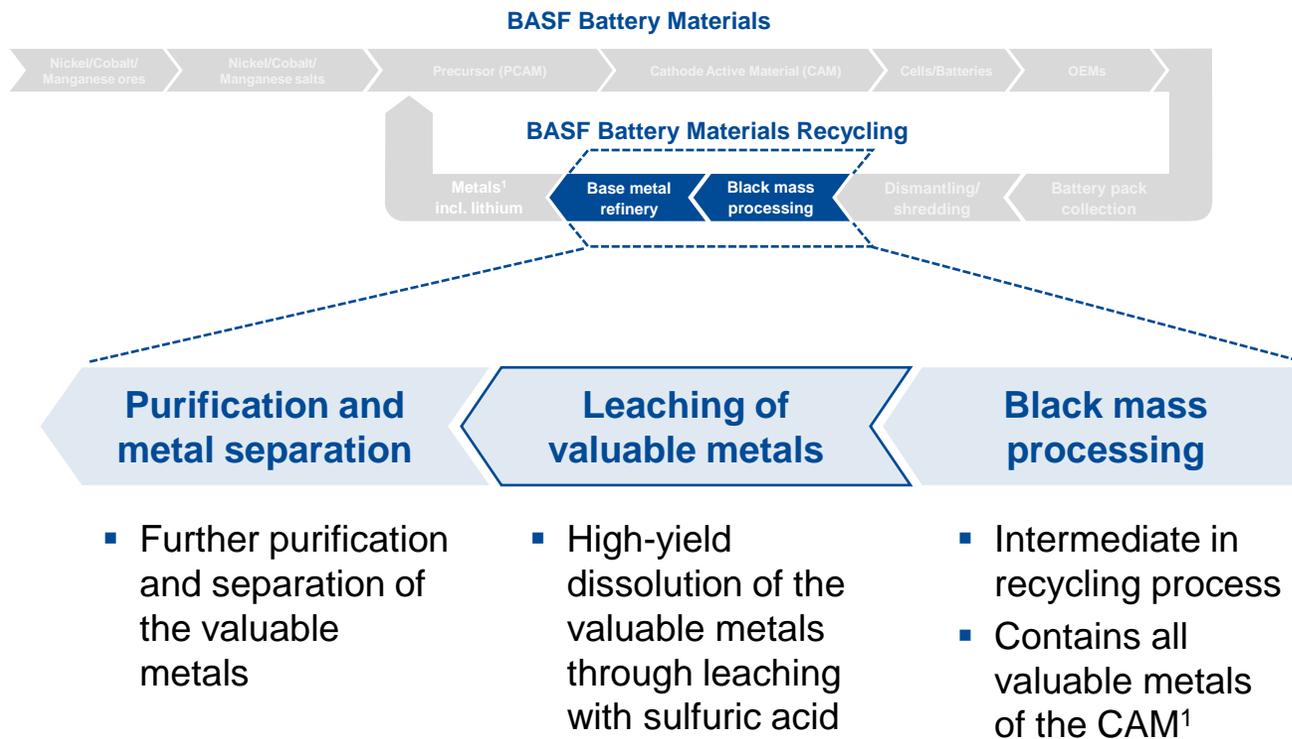
**Computer Fluid Dynamics (CFD) modeling know-how:**  
Combining flow field, thermodynamics, mixing of reactants and solid formation to model the reaction regime

**Result: Faster product development – Reduced number of scale-up trials – Production of in-spec material**

<sup>1</sup> Exemplary picture and video

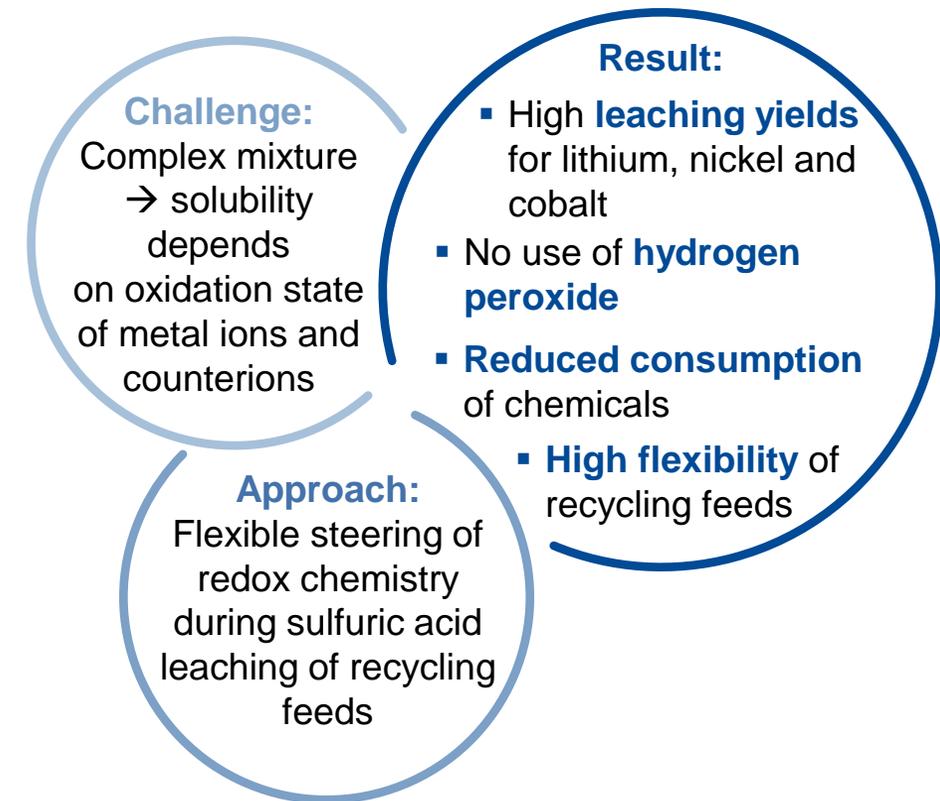
# BASF's recycling concept: Making existing technologies even more sustainable with innovations

## BASF's recycling process

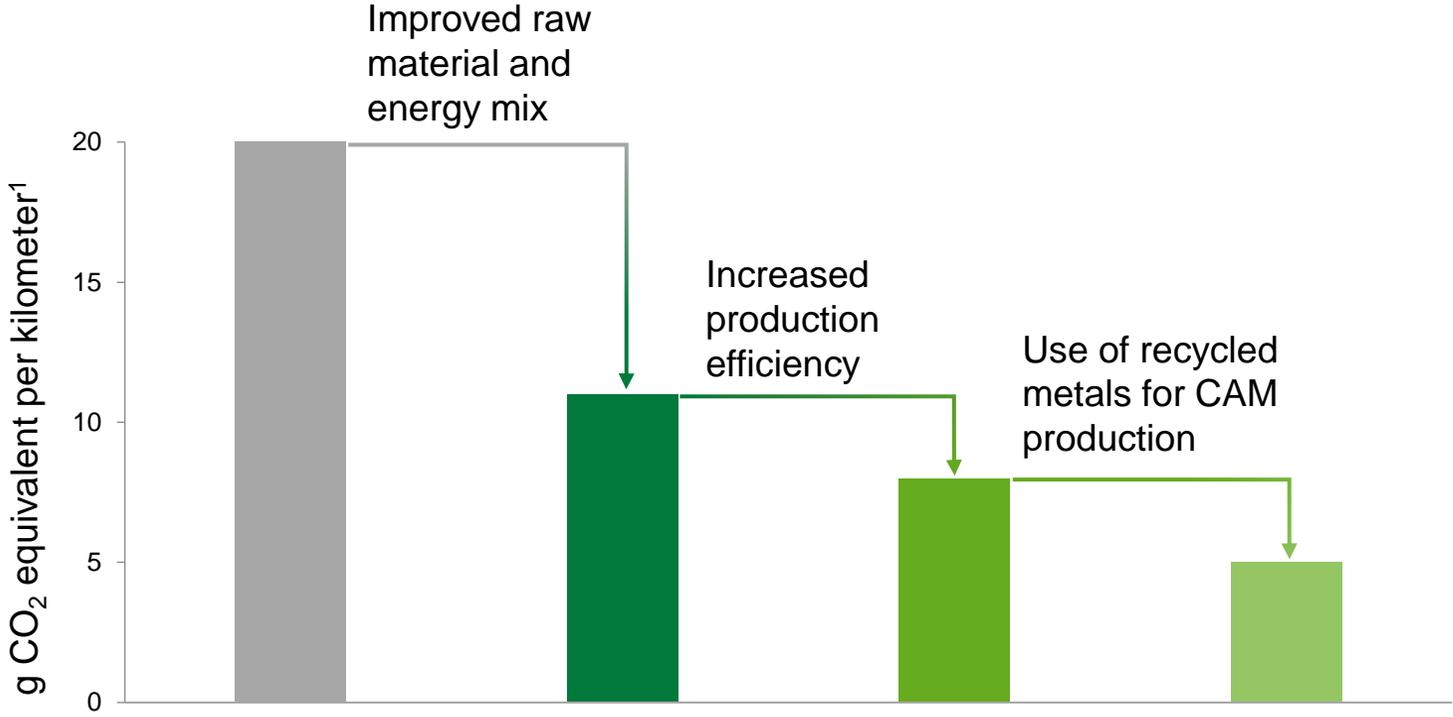


<sup>1</sup> Nickel, cobalt, manganese, lithium

## Leaching of valuable metals (BASF process)



# BASF offers industry-leading CO<sub>2</sub> footprint for battery materials: Recycling is one of the biggest levers



**Recycling  
contributes  
20-35% of CO<sub>2</sub>  
reduction**

<sup>1</sup> BASF values: Estimation depending on the CAM, car and energy mix used

# When research becomes reality: new CAM plant in Schwarzheide, Germany, operational since June 2023 – easily expandable for new customers and products



# Driving battery materials into the future

**1** We are committed to building a global, sustainable and resilient battery value chain

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**2** With our innovative battery materials, we serve our customers with a broad variety of CAM solutions tailored to their use case

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**3** We develop competitive and advanced manufacturing assets and processes that boost sustainability

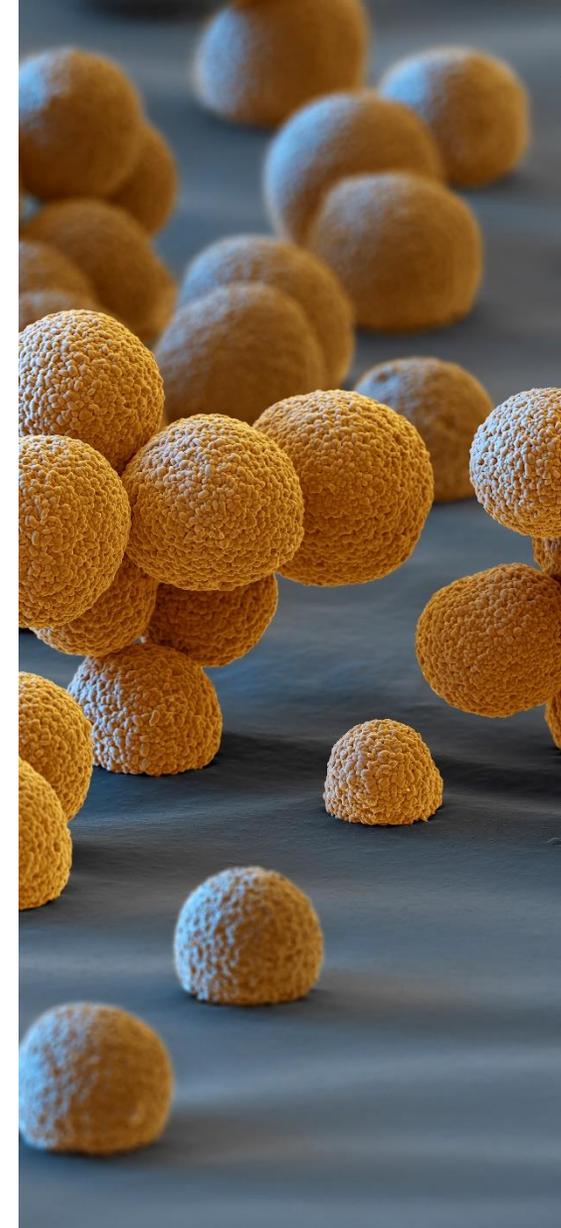
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**4** The implementation of advanced metal recycling into our value chain leads to an additional reduction of CO<sub>2</sub>

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**5** The use of renewable energies for our production process even further reduces the carbon footprint of our products

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We create chemistry