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Sustainability Starts in Research

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Cautionary note regarding forward-looking statements

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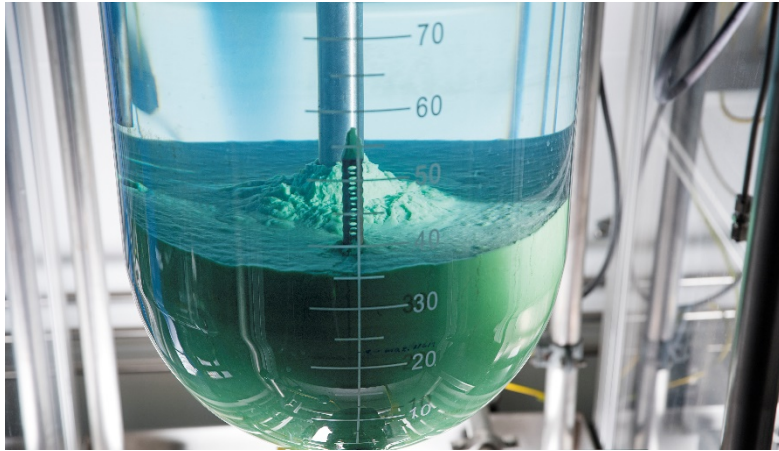
An aerial photograph of a coastline at sunset. The sun is low on the horizon, creating a bright orange and yellow glow that transitions into a clear blue sky. The water is dark, and the land is a mix of green and brown, with a prominent road or path visible.

We live in a time of tremendous challenges...

“ We are leaving the comfort zone of our climate system ... and moving into completely uncharted territory. ”

Dirk Notz, lead author of IPCC Report 2021

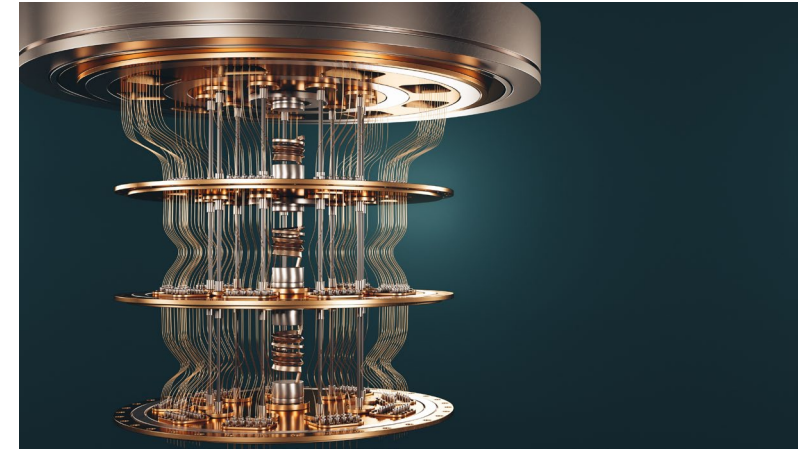
...and we live in a time of groundbreaking innovations



Battery materials



Renewable energies



Quantum computing



**Innovation is the key
enabler for the
sustainability
transformation**

We operate the industry-leading innovation platform



Global expenditures of **~€2 billion** for research and development, world leader in chemical industry

Approximately **10,000** employees worldwide involved in research and development

Around **950** new patents filed in 2020

8 Academic Research Alliances and **245** university cooperations

New setup to benefit our customers and support the transformation towards sustainability

Strengthen customer proximity

Moving closer to our customers by **embedding research units** into operating divisions

New innovation setup

Leverage BASF's Know-how Verbund

Bundling research capabilities into **one research division** with presence in all regions

Act faster on rapidly evolving market trends

Cater to differentiated customer requirements

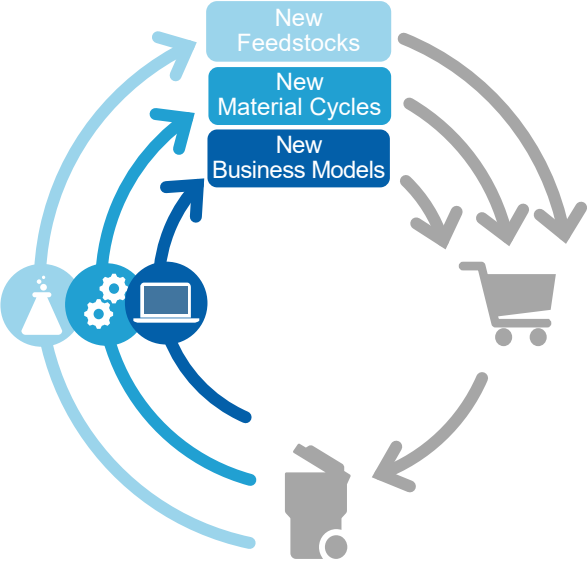
Bundle capabilities to drive innovation

Our purpose leads the way: We create chemistry for a sustainable future

Climate protection



Circular economy

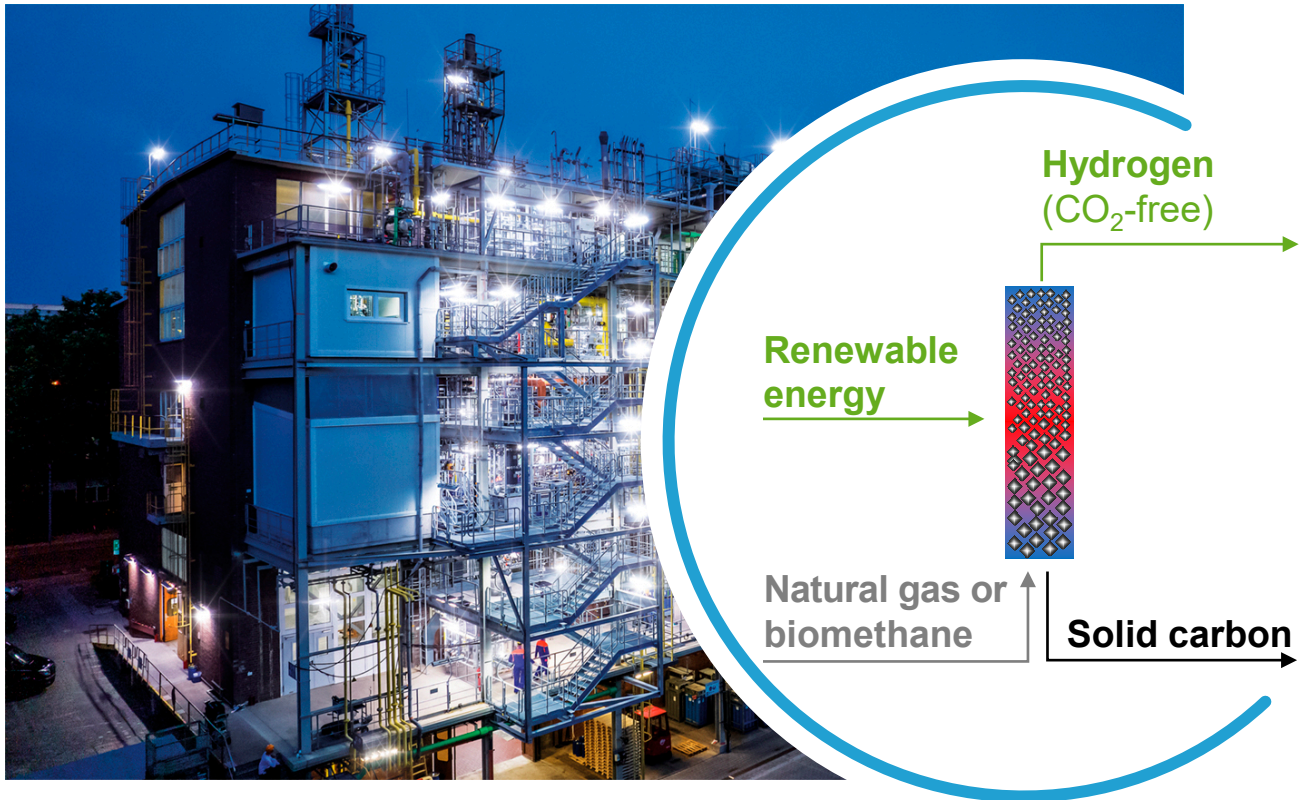


Sustainable solutions



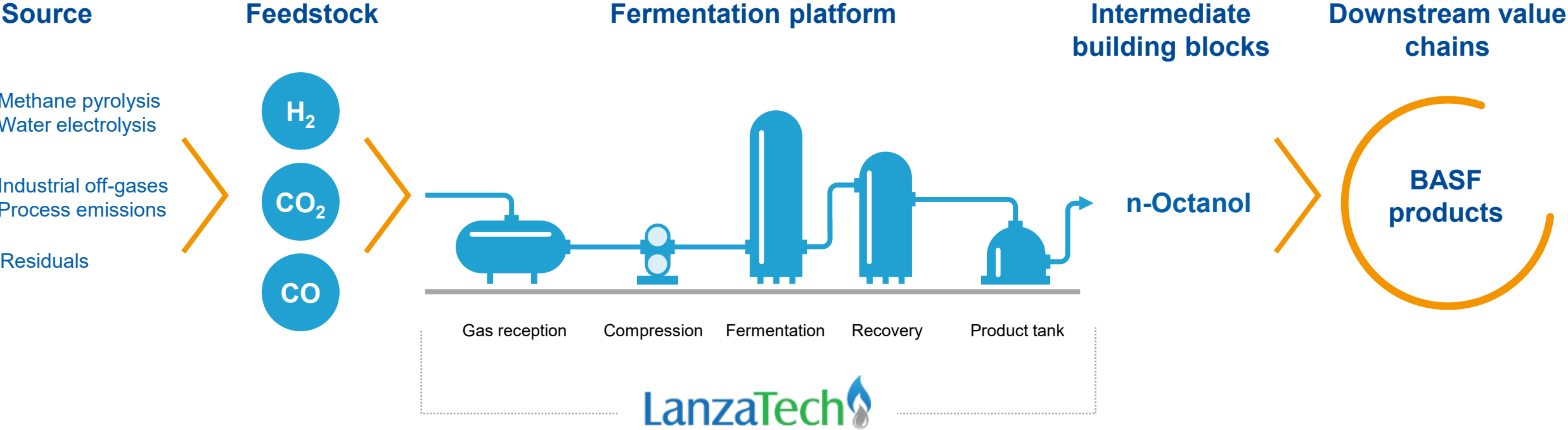
¹ Scope 1 and Scope 2; 2030 target compared with 1990: 60% CO₂ reduction

Methane pyrolysis – process innovation to reduce CO₂ emissions



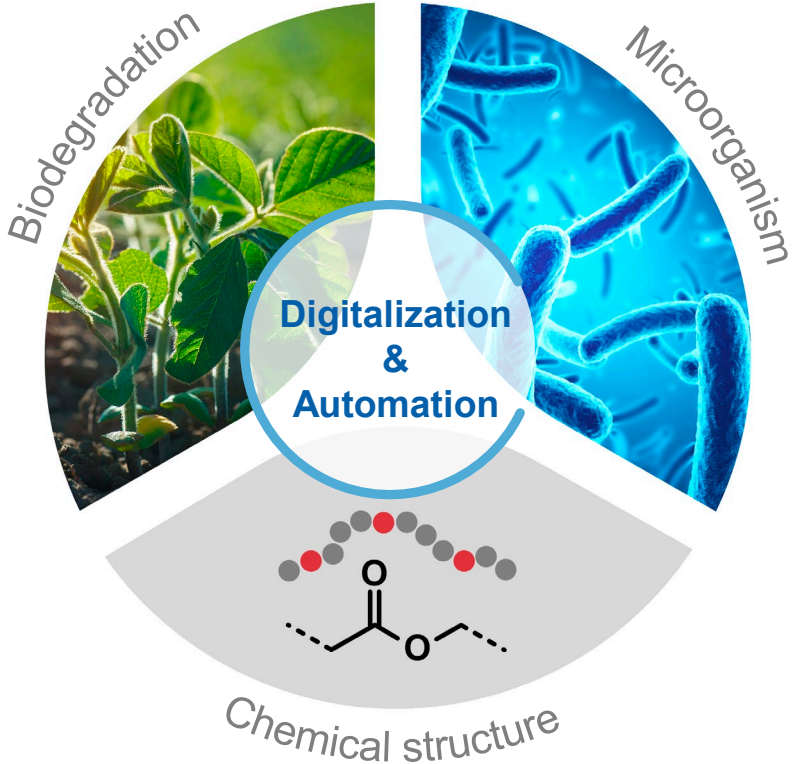
- **Test plant** at the Ludwigshafen site in trial operation
- **Funding granted** by German Federal Ministry of Education and Research
- Key challenges are **process technology and control**
- **Methane pyrolysis** requires around **80% less electricity** than water electrolysis

Gas fermentation for carbon-neutral and circular products



New biodegradable chemistry – significant acceleration of development through digitalization and automation

Understanding the relationship between structure and biodegradability

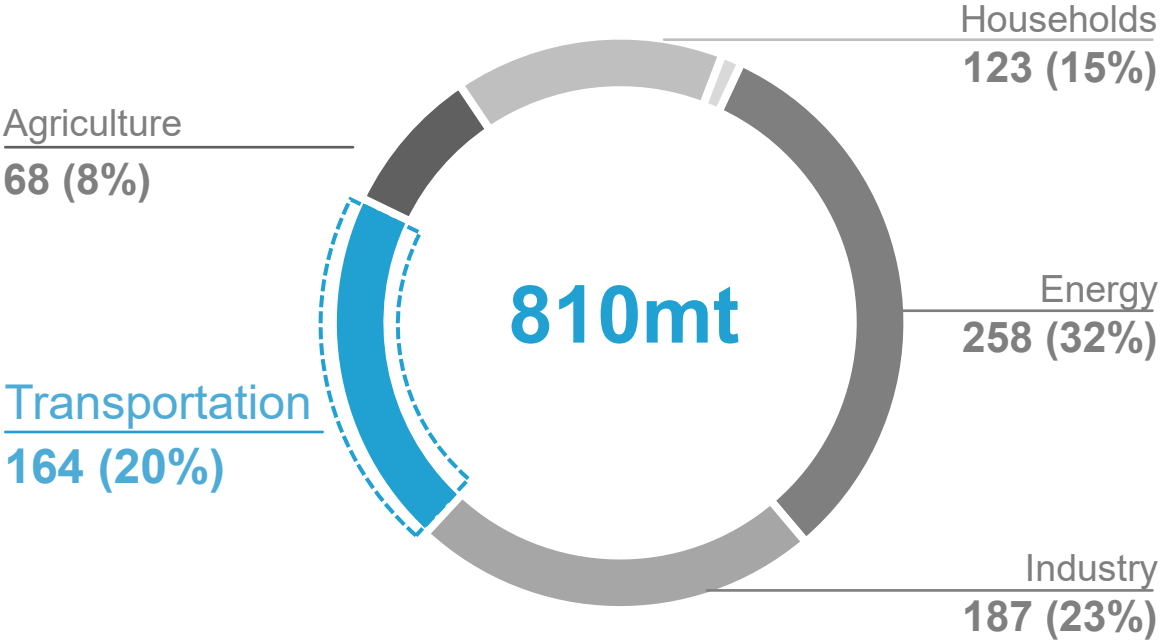


Development of new tailor-made biodegradable materials



Chemical industry as enabler for the reduction of CO₂ emissions in other sectors

Greenhouse gas emissions 2019 in Germany by sector¹
million metric tons

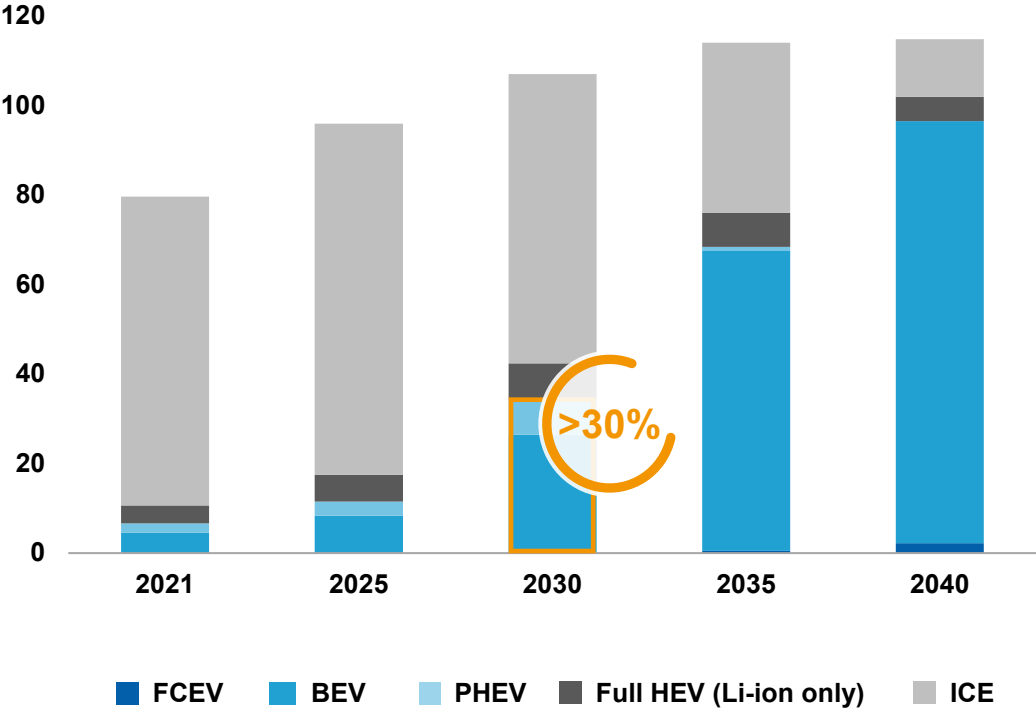


- Main greenhouse gas emitters are the **energy** (32%) and **industry** (23%) sectors
- Sectors such as **transportation and agriculture** are also significant emitters and important customer industries for BASF
- Products from the chemical industry can make a significant contribution to help **decarbonize customer value chains**

¹ Source: German Environment Agency (Umweltbundesamt – UBA), August 2021

The transformation of the automotive industry towards electric mobility is in full swing – with significant opportunities for BASF

30% of new cars BEVs and PHEVs by 2030
Light-duty vehicle production volume, million units

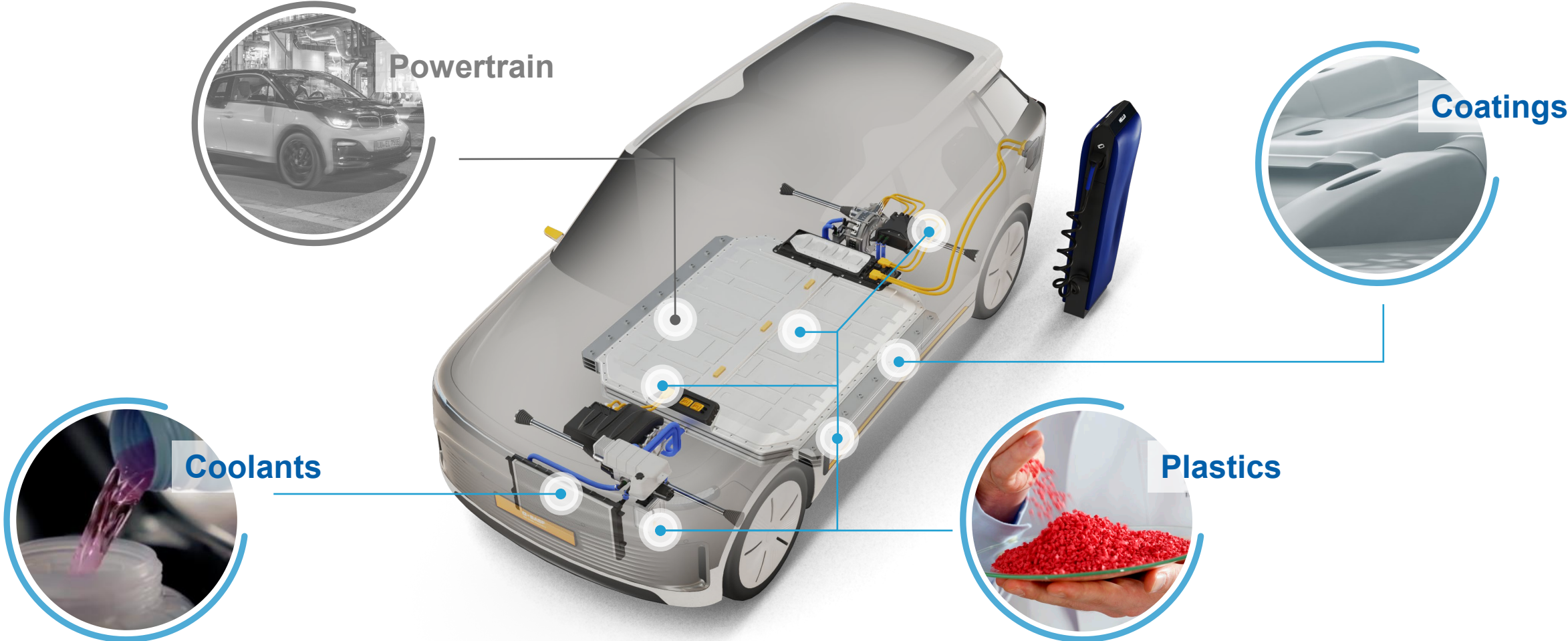


Chemical content per car
2.5x higher (by value)¹



¹ Including metals

BASF innovations enable electric mobility in various applications



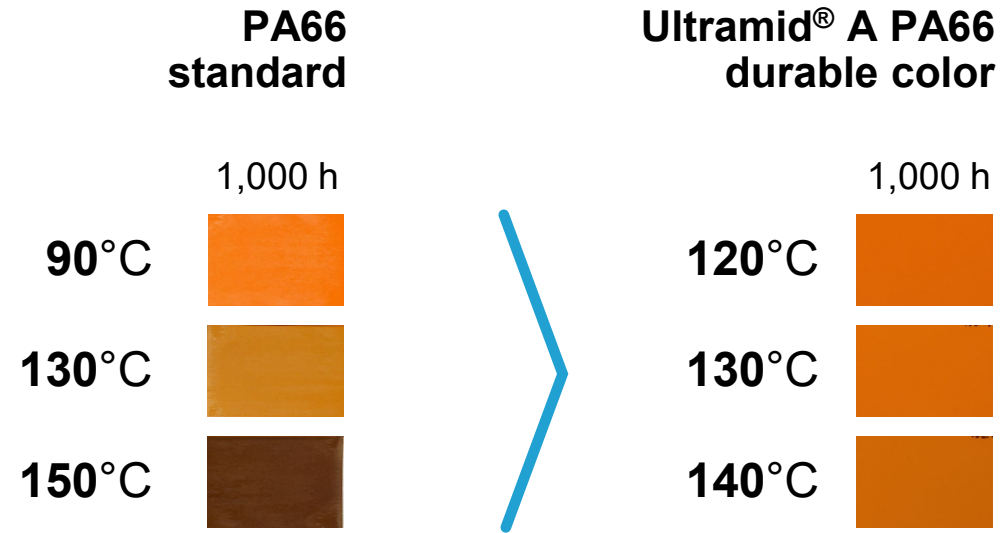
Enabling safe handling of high-voltage components – a portfolio of durable orange-colored polyamides

Innovating plastics and colors used in high voltage components

- Orange¹ is the standard signal color for high-voltage connections in electric vehicles
- Color stability requirement: 1,000 hours at 140°C
- Challenge: Polyamides tend to severely discolor due to heat ageing
- Durable orange color achieved through novel formulation of polyamide and pigment



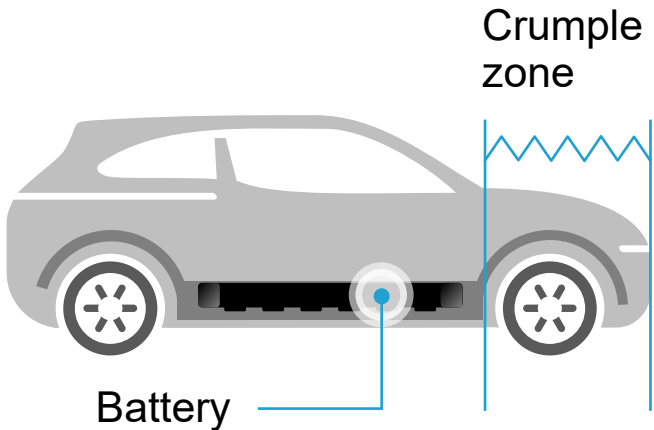
Comparison of orange color stability in standard and reformulated polyamide



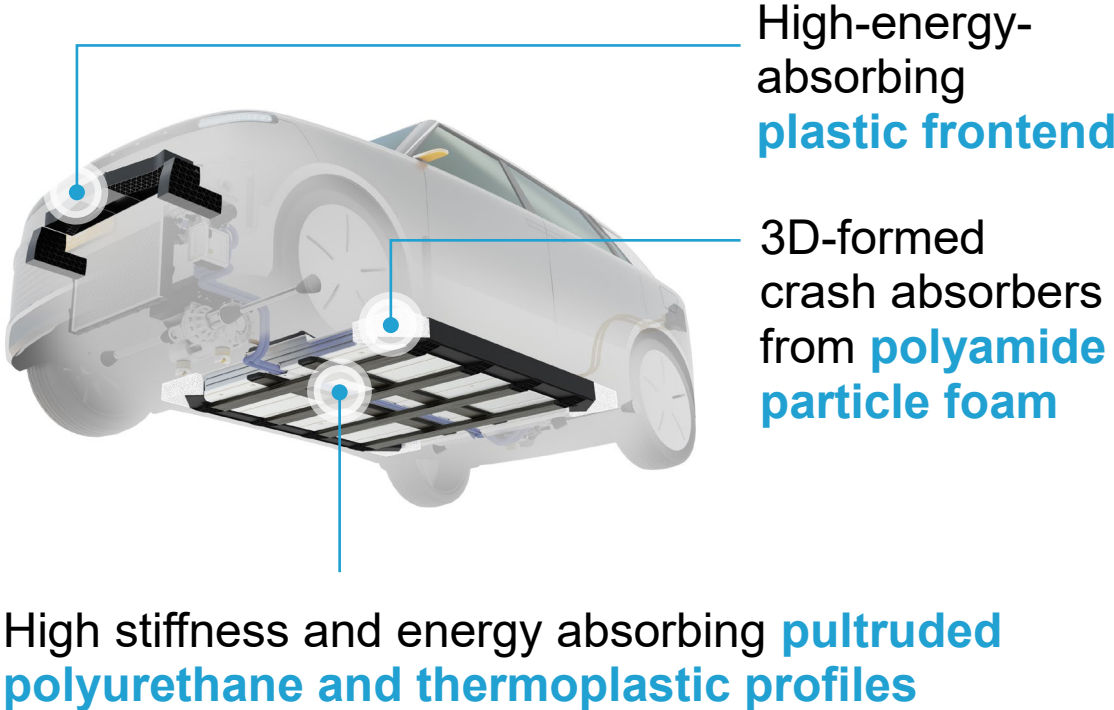
Ensuring passenger safety – a new vehicle architecture requires new safety concepts

Safety requirements of electric vehicles

- Shorter frontends reduce crumple zone
- Need for crash protection of the battery
- Higher overall vehicle weight resulting in higher impact mass

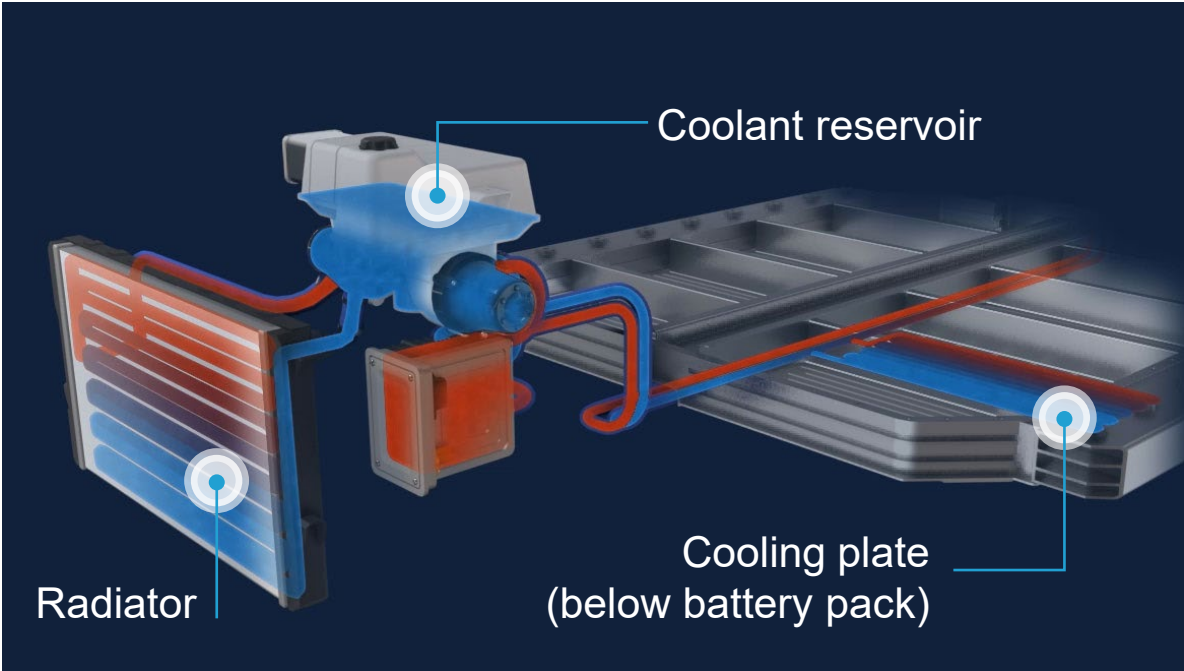


New material classes for next crash safety level



Thermal management of the battery requires increased volume of liquid coolant

Schematic view of BEV cooling system

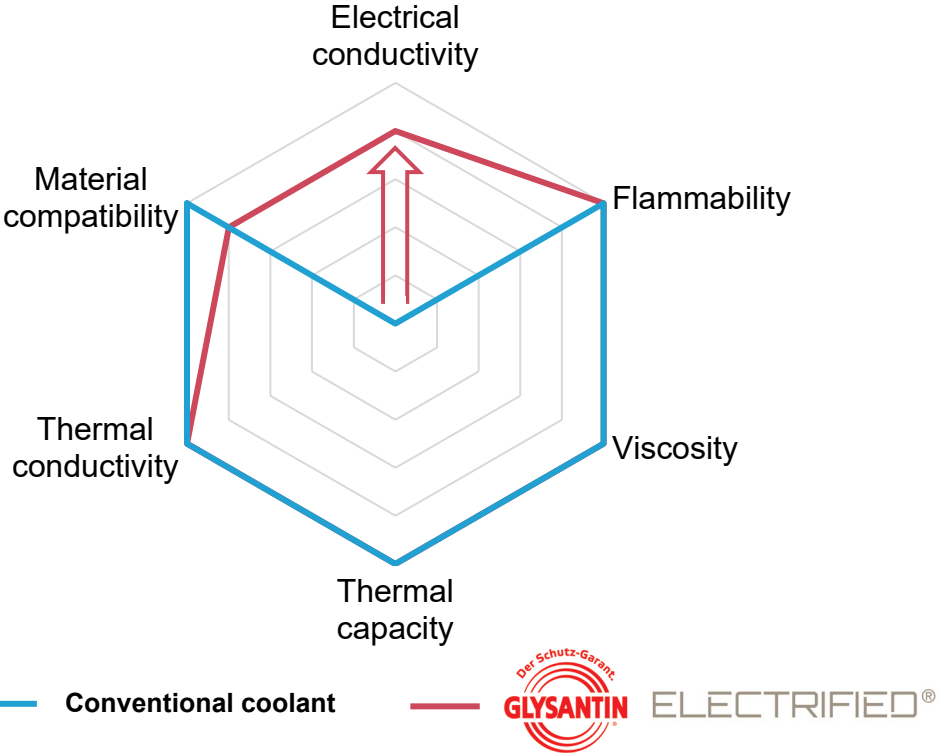


Thermal management in battery electric vehicles

- BEVs rely on a thermal management system for optimal operating conditions
- Heat dissipation from the battery pack is typically achieved through cooling plates or pipes
- Coolant volume in BEVs is twice as high compared to internal combustion engines
- Glycol/water-based coolants represent the predominant fluid technology

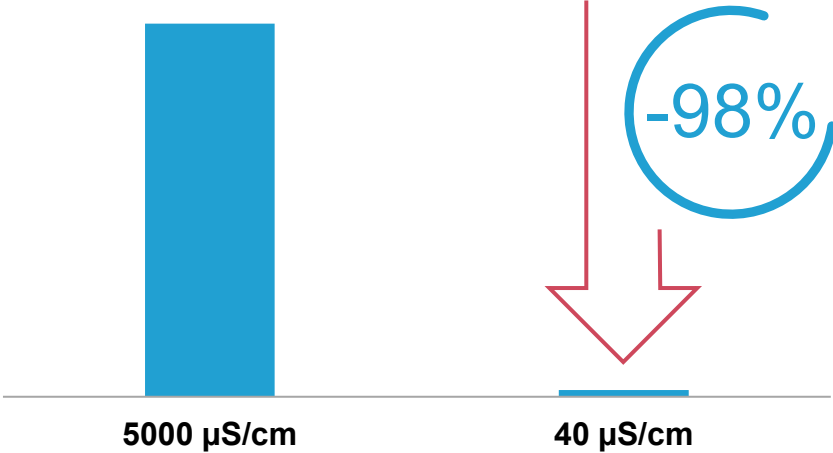
Coolant's electrical conductivity is a key determinant in minimizing risk associated with hydrogen generation

New BASF coolant achieves significantly lower electrical conductivity



Lower electrical conductivity markedly reduces hydrogen generation

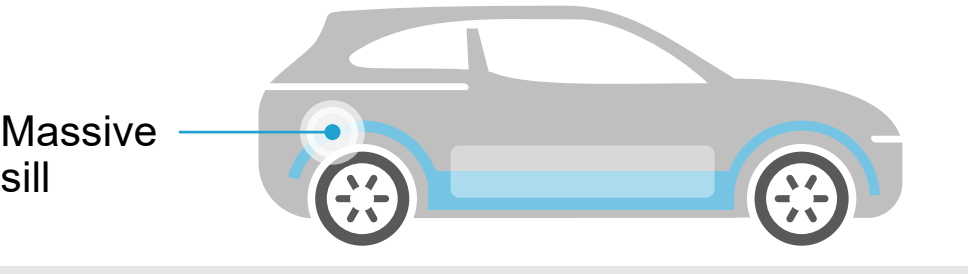
Rate of hydrogen evolution



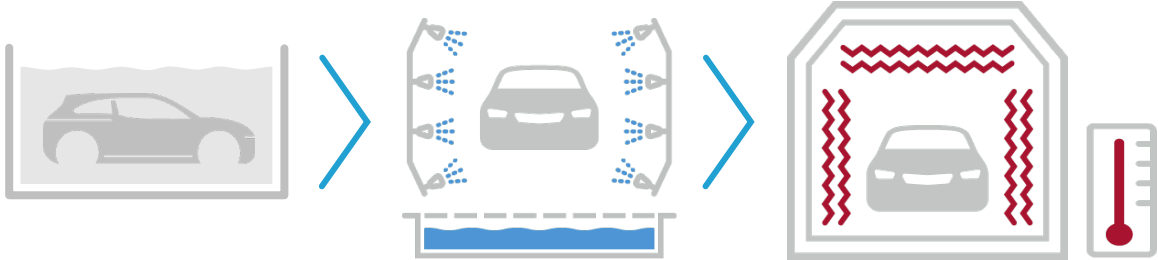
Significantly lower hydrogen generation minimizes risk of fires after crash

New BASF e-coat technology meets OEMs' demand for one paint solution for all platforms and fulfills high sustainability standards

BEVs pose specific coatings challenges



1. Increased reactivity in dip-coating application

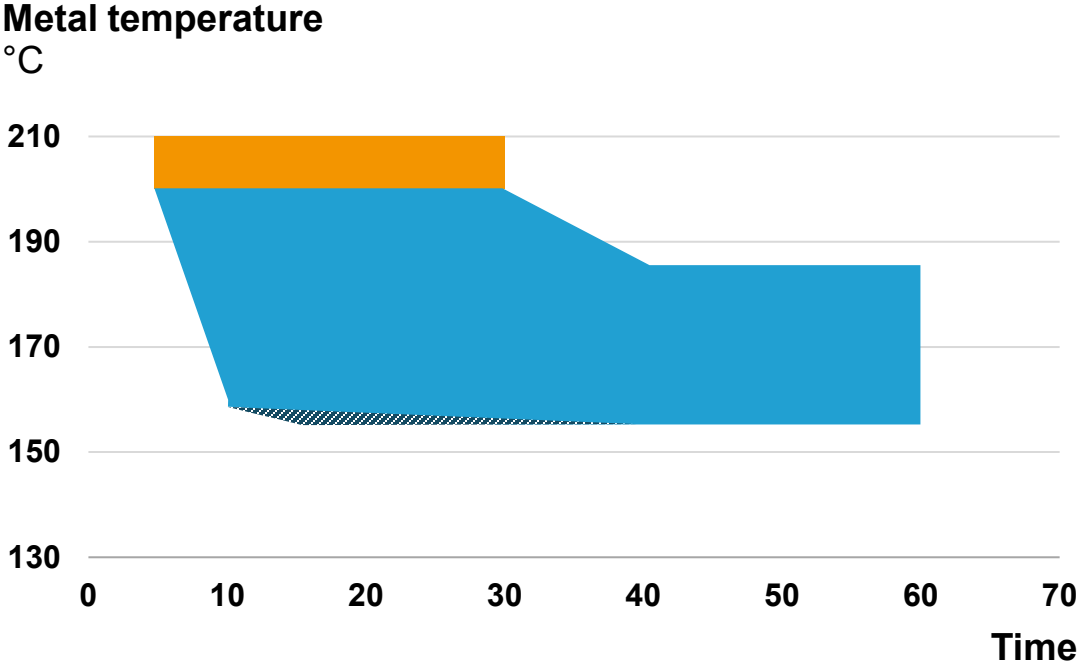


2. Fulfills all key sustainability industry standards

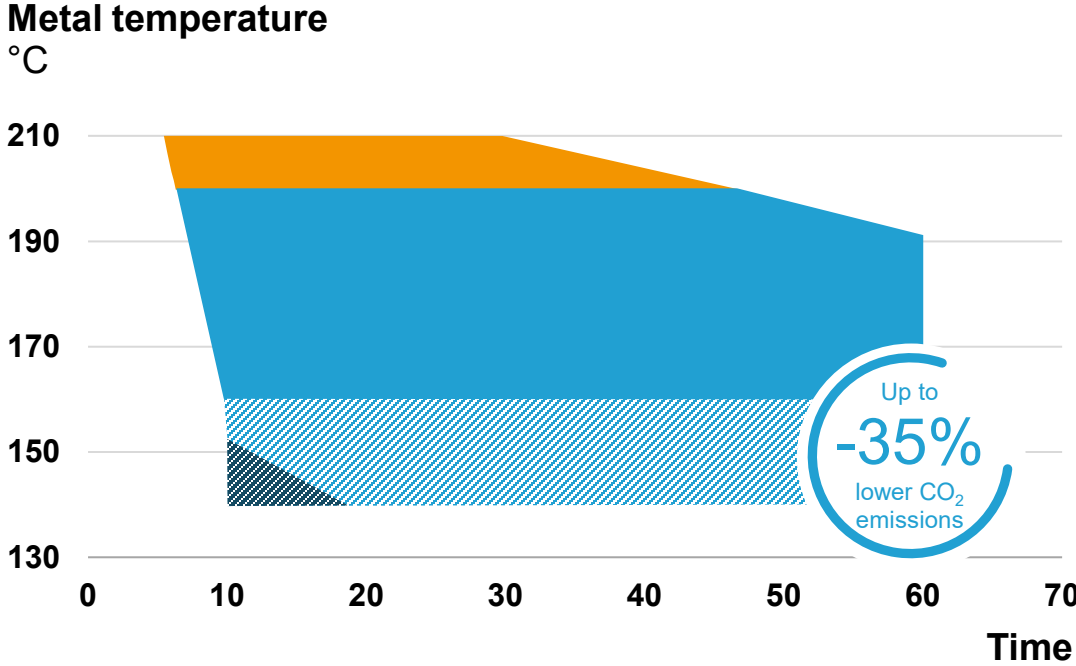
- Tin-free
- Free of hazardous air pollutants (HAPs)
- Low volatile organic compounds (VOCs)
- Material efficiency >95%

Meeting novel requirements: A broader baking window enables reduction of energy consumption

Standard technology allows curing only at temperatures of >155° Celsius




New CathoGuard® technology enables curing already at temperatures ≥140° Celsius



- Higher temperature must be tested under line-specific conditions
- Meets specifications for curing of interior-facing parts of chassis
- Optimal curing range

Pipeline of selected solutions for electric mobility

	2021 >>>	2022 >>>	2023 >>>	2024+ >>>
 <p>Plastics</p>	<p>New Elastollan® for busbars commercialized</p>	<p>Launch product portfolios for durable orange, new crash absorbers, thermally conductive adhesives</p>	<p>Novel materials for sound optimization of battery electric vehicles</p>	<p>Catalyze battery and vehicle development with high-performance material solutions</p>
 <p>Coolants</p>	<p>Launched GLYSANTIN® Electrified™ product family</p>	<p>Add further low electrical conductivity coolants to the portfolio</p>	<p>OEM approvals for low electrical conductivity coolants</p>	
 <p>Coatings</p>	<p>Started first serial production with CathoGuard® solution 140°C</p>	<p>Launch CathoGuard® solution 140°C globally</p>	<p>Global production upscale and registration of 130°C solution</p>	<p>Global market launch 130°C solution</p>



BASF's R&D team is committed to helping our customers become more sustainable.



We create chemistry