BMW GROUP

# WORKSHOP

## GEN6 BATTERY CELL TECHNOLOGY & PURCHASING AND SUPPLIER NETWORK.

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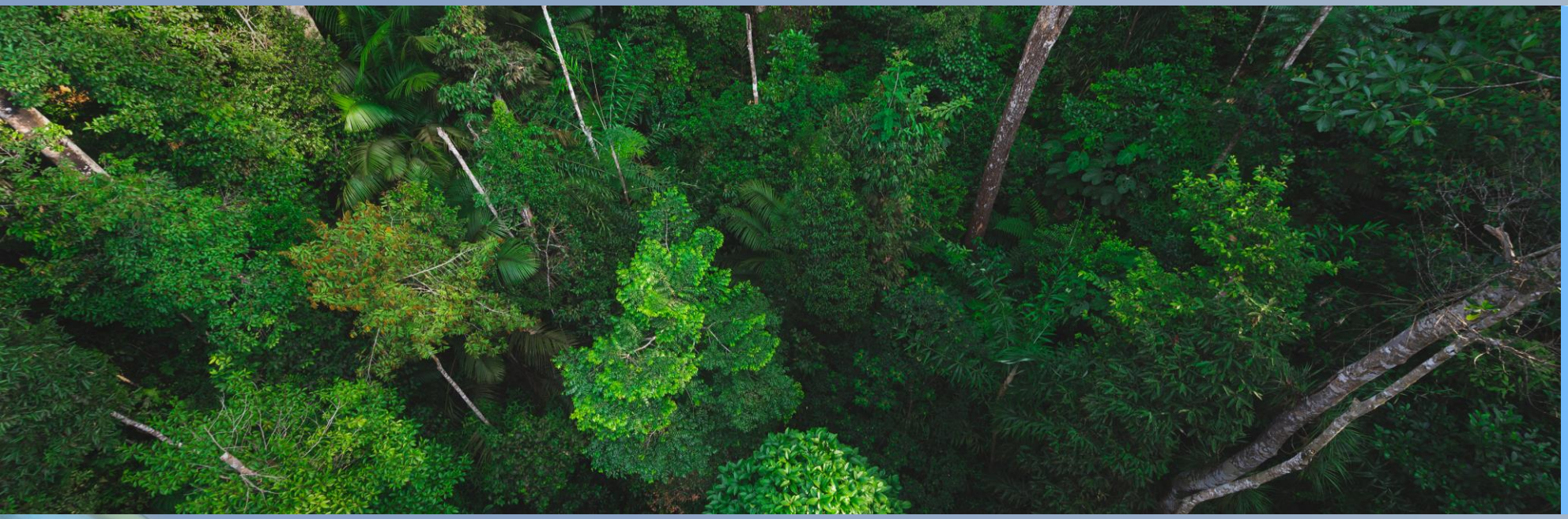
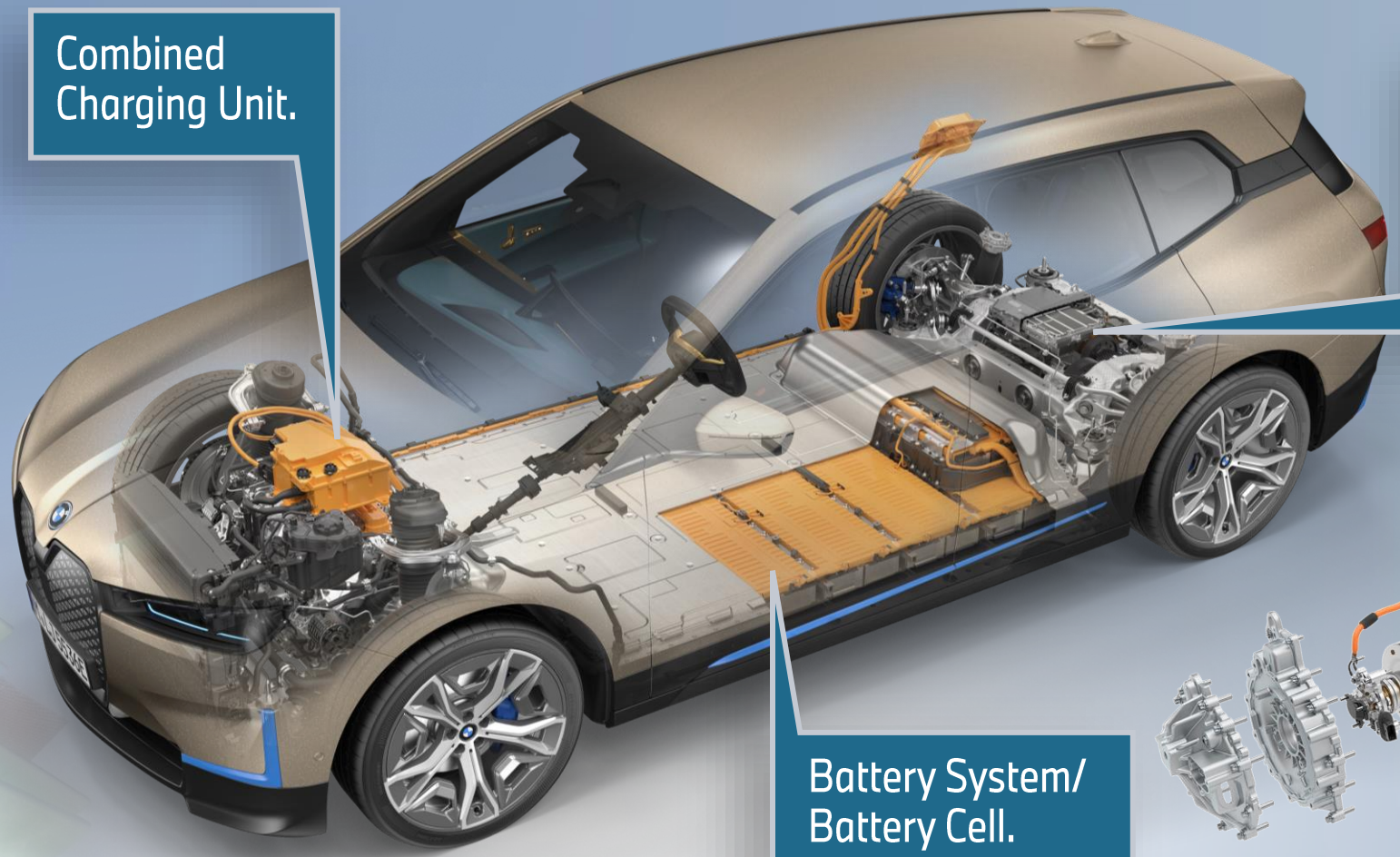


# THE NEXT GENERATION OF BATTERY CELLS. TECHNOLOGY.

**DR. PETER LAMP**
General Manager Battery Cell Technology

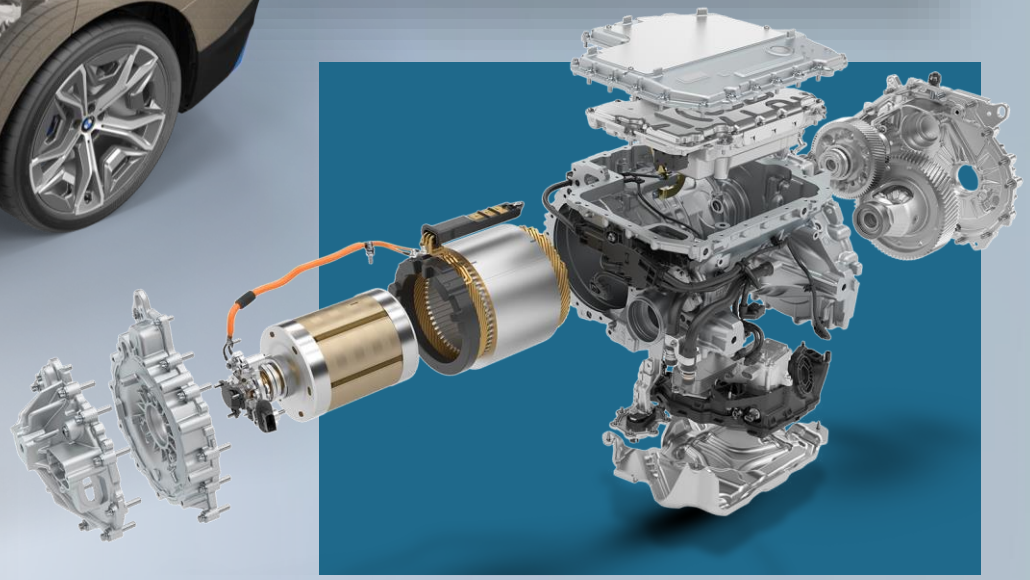
# KEY COMPONENTS OF OUR GEN5 ELECTRIC POWERTRAIN.



Combined Charging Unit.

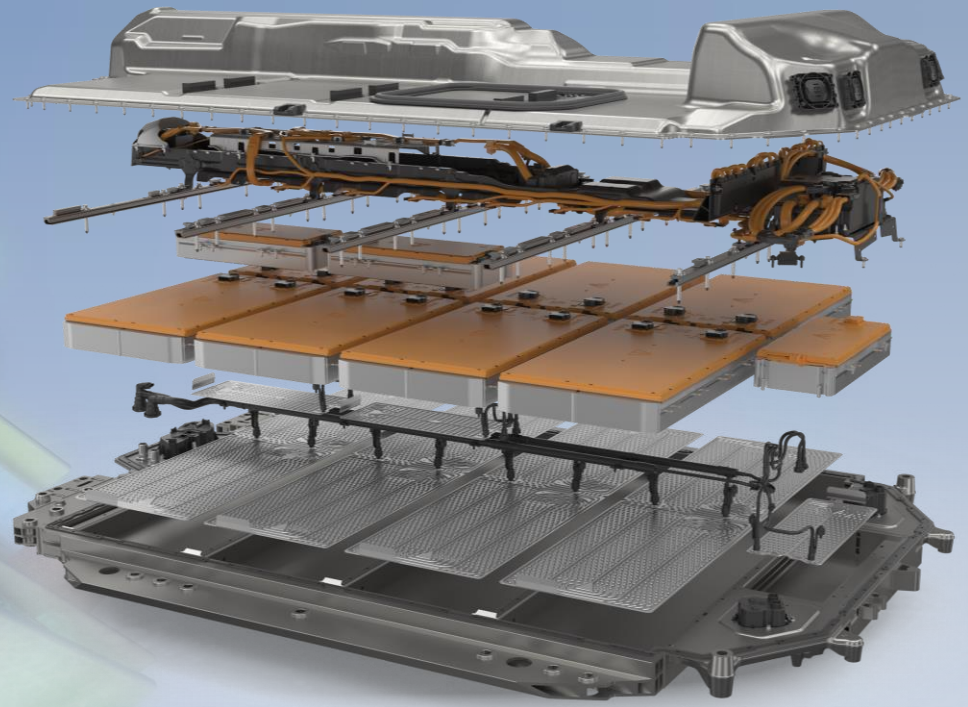
**Gen5**
Highly Integrated E-Drive.
E-Motor, Power Electronics and Gear Box.

Battery System/ Battery Cell.

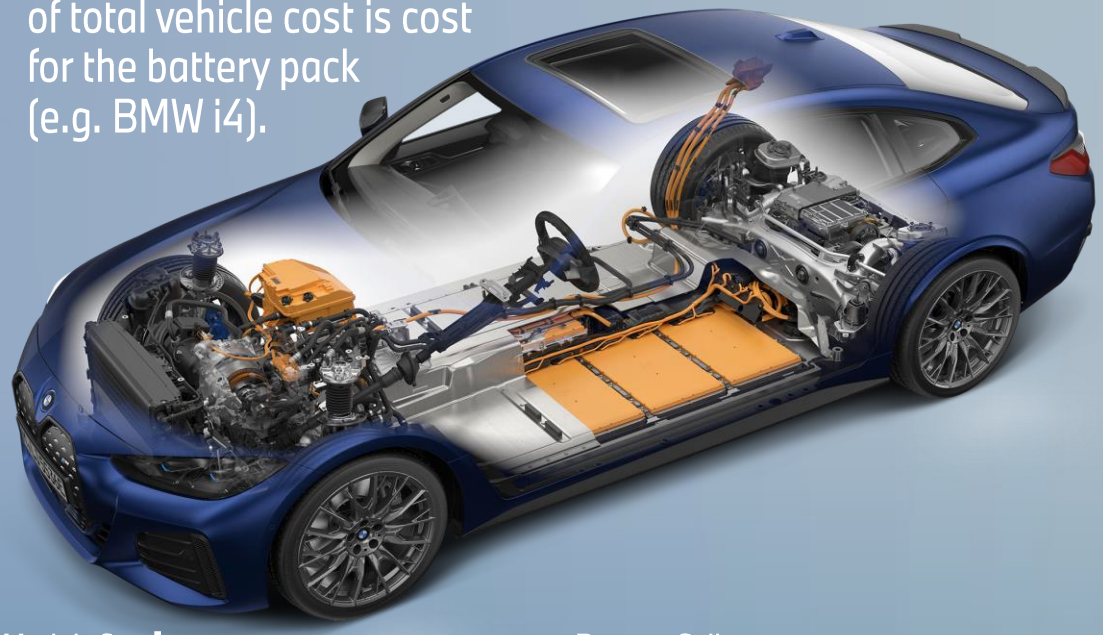


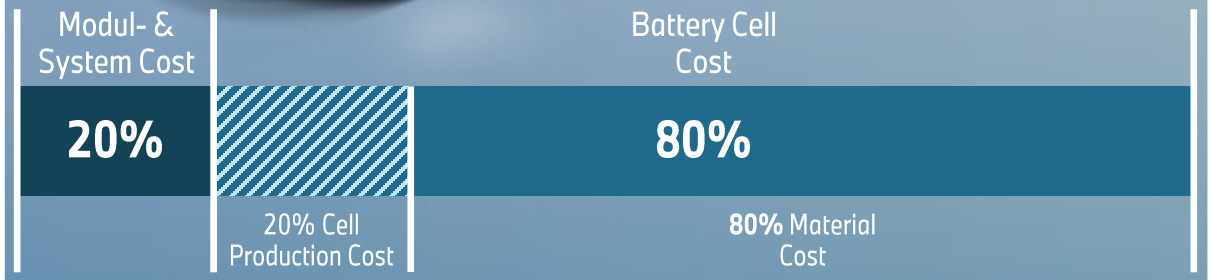
# THE HIGH VOLTAGE BATTERY – DEFINING KEY FEATURES.

Range | Charging time | Driving power | Cost



Approx. **40%** of total vehicle cost is cost for the battery pack (e.g. BMW i4).





# LONG TERM COMPETENCE FROM MOLECULES TO CELL AND FROM BASIC RESEARCH TO APPLICATION.

**2022**

Start build-up of ASSB lab & prototype line
Completion 2023

**2020**

Start build-up of pilot line Cell Manufacturing Competence Centre (CMCC)
Completion 2022

**2017**

Start build-up of BMW Group Battery Cell Competence Center (BCCC)
Completion 2019

**2012**

Start dedicated R&D project on battery cell technology
Deep dive, parallel top product development

**2008**

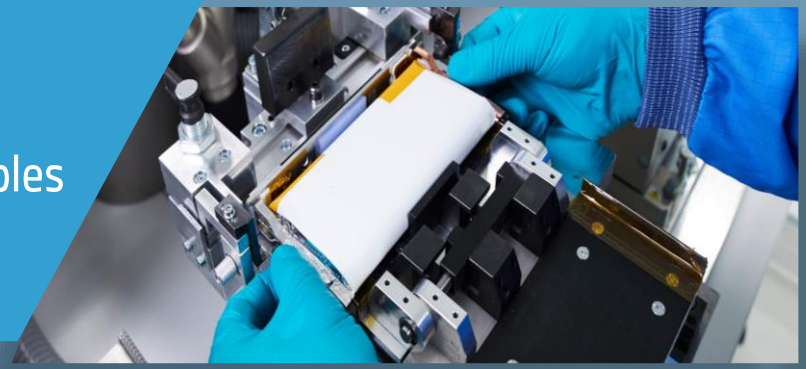
Start Li-ion development
In particular for BMW i3 / BMW i8

Cells

Electrodes / Subcomponents

Materials

Fundamental Working Principles



# BMW COMPETENCE FROM BASIC RESEARCH TO CONCEPT VALIDATION OF PRODUCT AND PROCESS.

## R&D

- Institutes
- Academia
- Start-Ups
- OEMs
- Industry

## LAB

- Material Characterization
- Chemistry Development
- Development Recipes
- Performance and Safety Tests
- Post Mortem Analysis

## PROTOTYPE-CELL

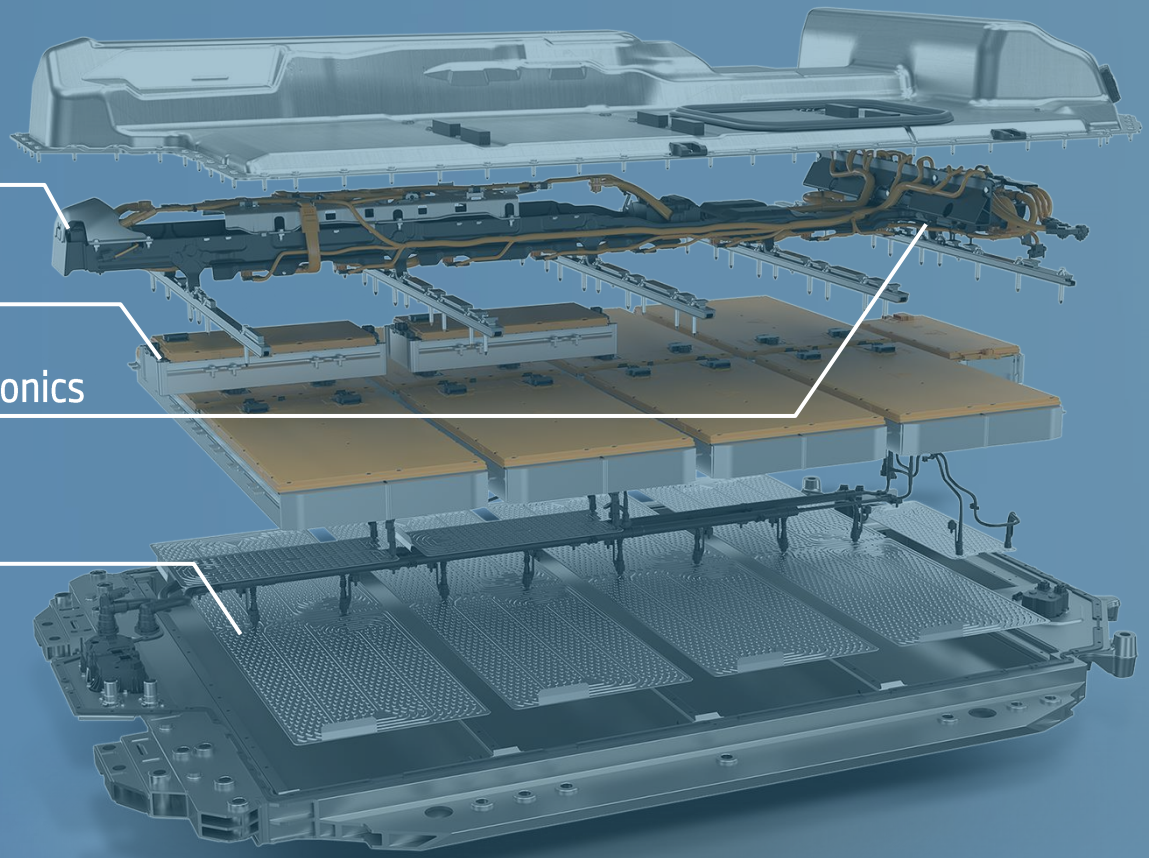
## PILOT-PRODUCTION


scaling by factor 10

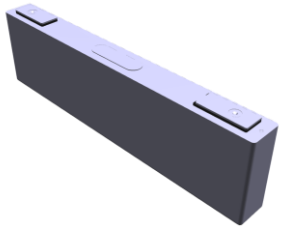
PRODUCT INNOVATIONEN

PROCESS INNOVATIONEN

# THE GEN5 BATTERY – PRESENT TECHNOLOGY AND SYSTEM ARCHITECTURE.



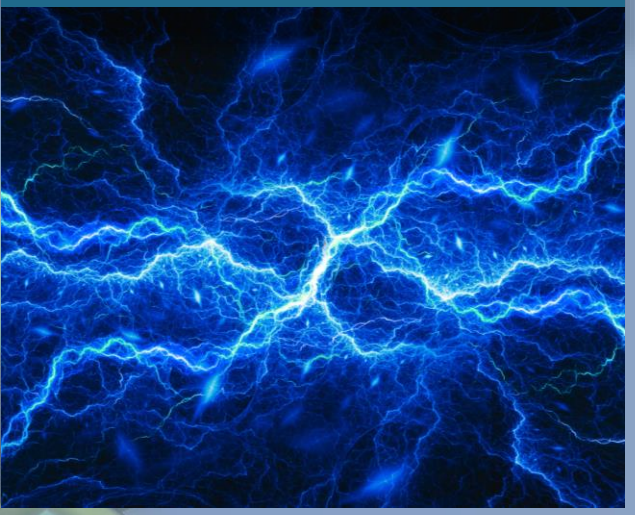

Cell module



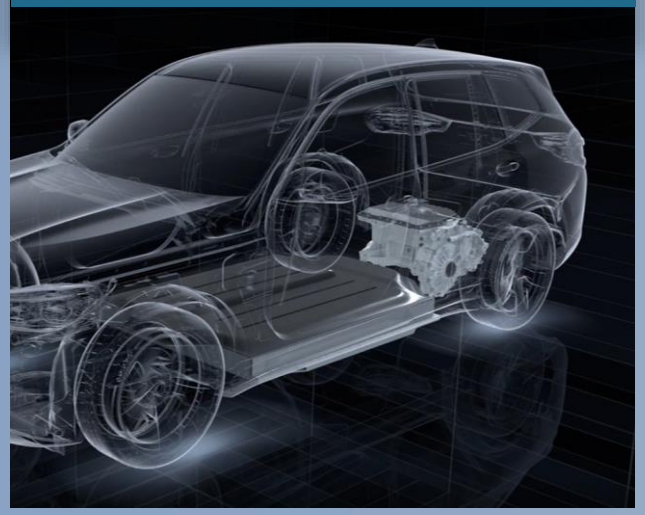
Prismatic Cell

# BATTERY SYSTEM DEVELOPMENT – EACH GENERATION DEFINED BY REQUIREMENTS, TECHNICAL ADVANCES AS WELL AS REGULATORY MEASURES.

## Energy



## Integration



## Safety

## Sustainability

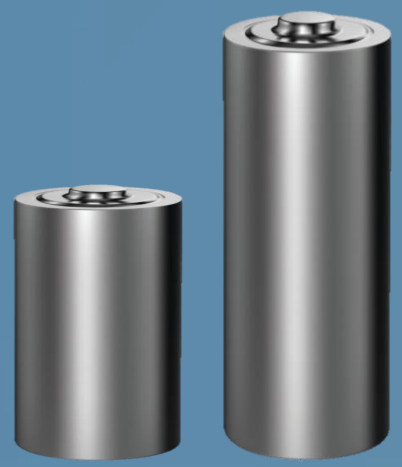
Trends/changes in requirements influence cell technology choice (pouch, cylindrical, prismatic hardcase).

- Higher capacity materials and optimized cell filling factor.
- Higher integration to optimize battery system energy per volume (e.g. cell-to-pack, pack-to-chassis). Different structural requirements for cells as consequence.
- Safety on battery system level has highest priority. Best solution: “propagation stop”.
- Battery carbon footprint declaration 2024 on-wards. Amount of recyclate used and recycling rates will become regulated for most relevant materials.

# OUR STRATEGIC DECISION: CYLINDRICAL CELL FOR OUR 6th GENERATION.

## Advantages

- Integration
- Energy
- Safety
- Sustainability



**-30%** Charging Time
(10%-80% SOC)

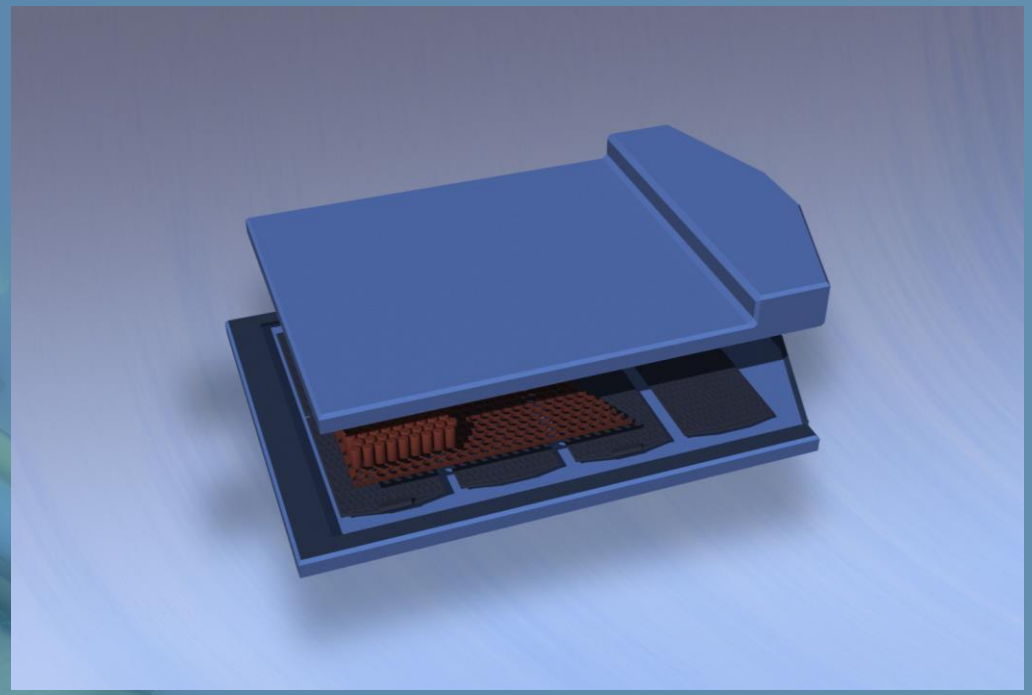
**-60%** $CO_2$

**+30%** Range

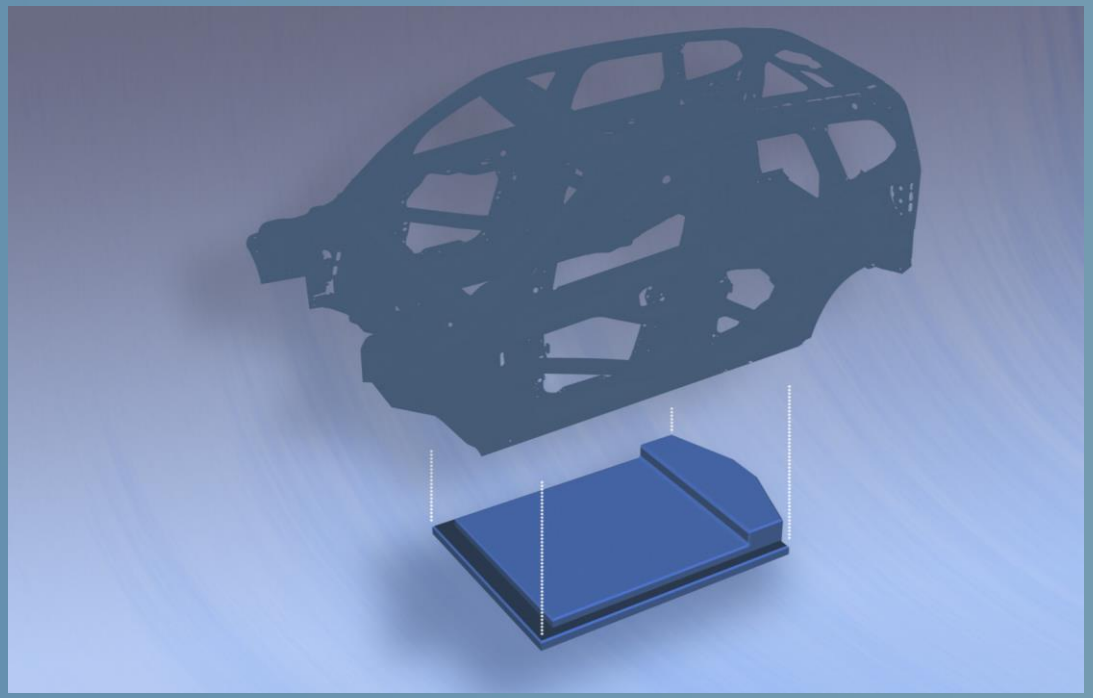
**-50%** Cost
(on pack level)

# HIGH INTEGRATION FOR MAXIMIZED ENERGY CONTENT AND RANGE. HIGH STRUCTURAL STRENGTH AND SAFETY.

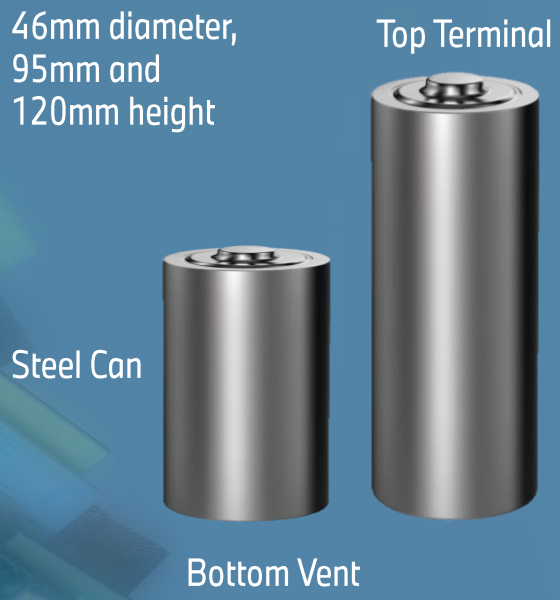
## CELL-TO-PACK



## PACK-TO-OPEN-BODY



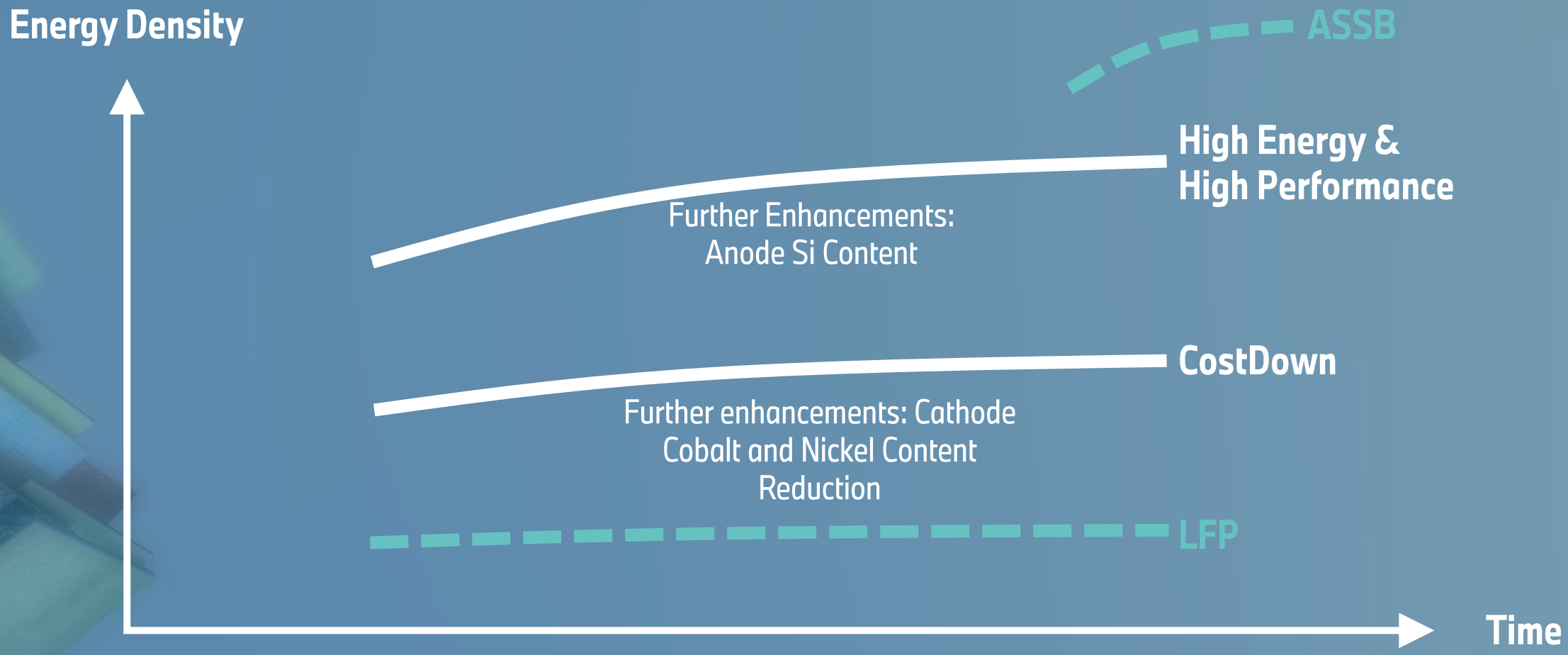
# GEN6 CELL – SOME DETAILS (E.G. HIGH ENERGY DENSITY CELL).




## Gen5 to Gen6 Cell Optimizations

| | |
|---|---|
| **Cathode** | +10% spec. capacity (active material)<br>-50% Co content |
| **Anode** | >15% spec. capacity (active material)<br>-20% Graphite content |
| **Anode Cu Foil** | Up to 40% Cu saving |
| **Housing** | Improved safety behaviour<br>-3g $CO_2$ footprint / Wh |

# GEN6 BATTERY CELL/PACK AND INTEGRATION ARE ROBUST TOWARDS FUTURE REQUIREMENTS AND INNOVATIONS.



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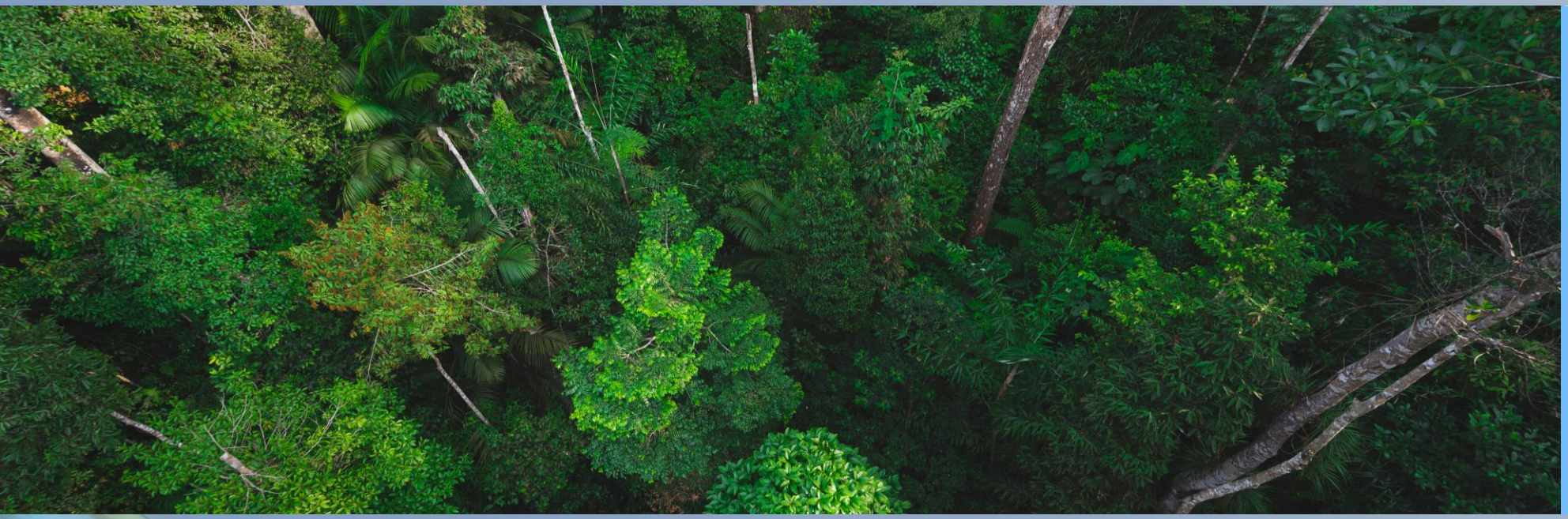

# THANK YOU FOR YOUR ATTENTION!

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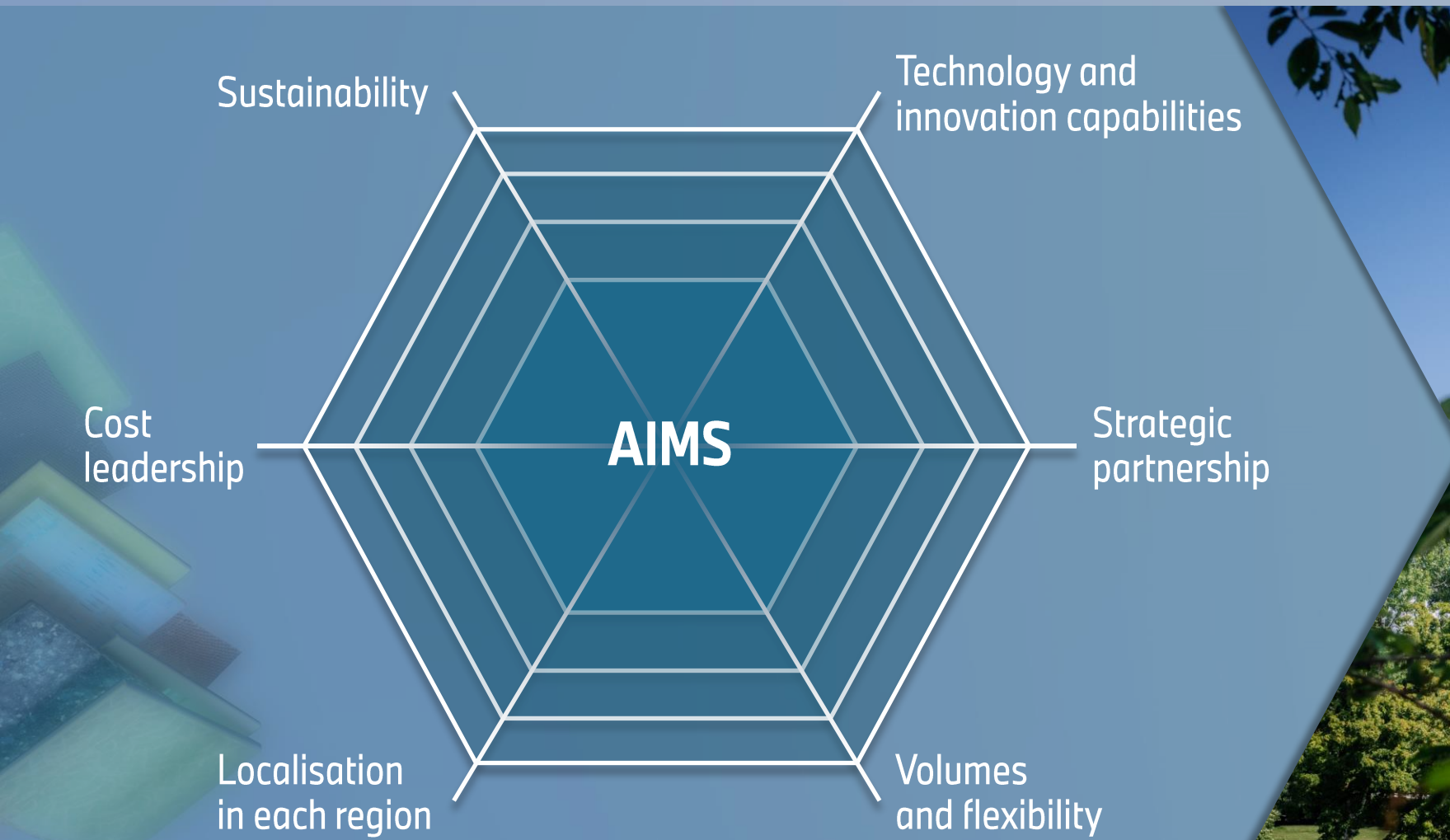
# THE NEXT GENERATION OF BATTERY CELLS. PURCHASING AND SUPPLIER NETWORK.

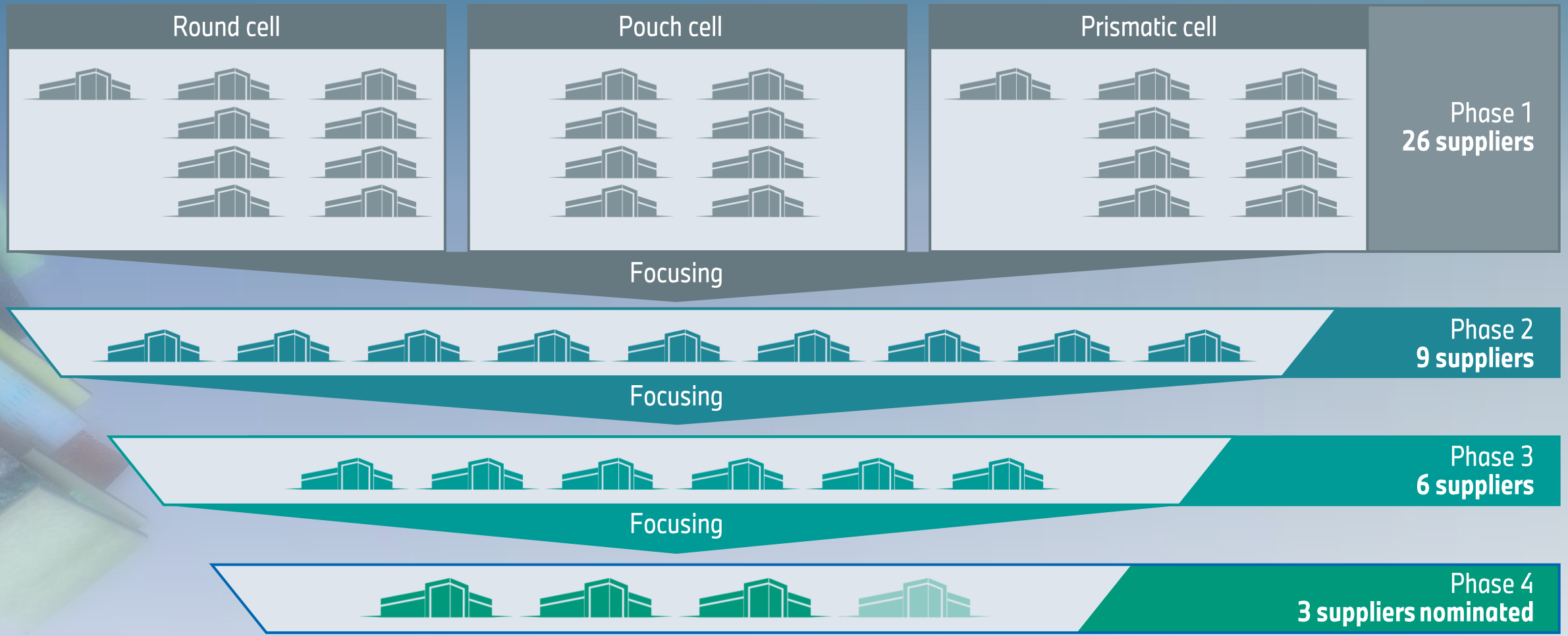
**JÖRG GHANBARI**
Head of Purchasing Sixth-Generation Battery Cell

# PURCHASING FOR THE NEXT GENERATION OF BMW GROUP BATTERY CELLS. OUR OBJECTIVES.

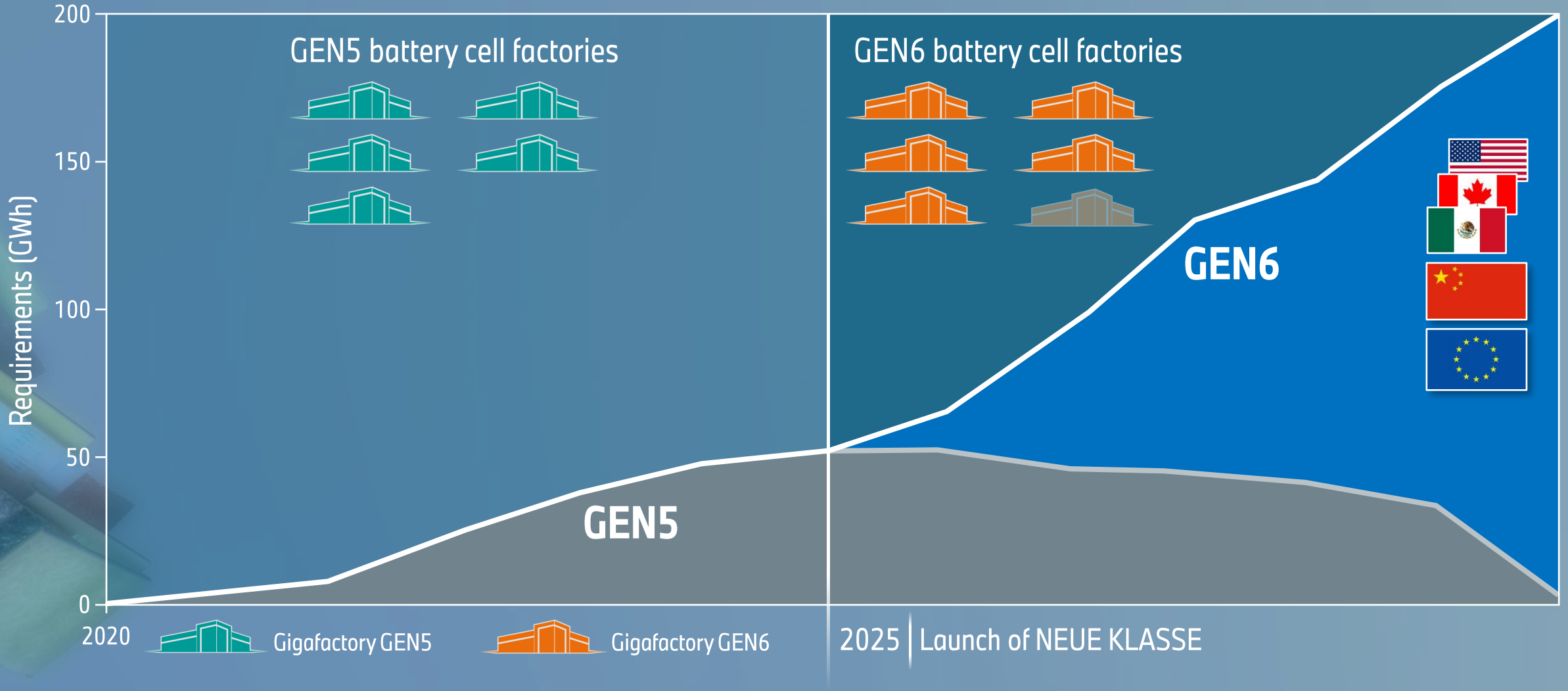



# HOW DID WE APPROACH THE CHALLENGE?

Open-technology approach with comprehensive worldwide market screening in sprint team mode.



# INDUSTRIALISATION OF NEW BATTERY CELL: SIX ADDITIONAL BATTERY CELL FACTORIES WORLWIDE.



# STRATEGIC PARTNERSHIPS AND "LOCAL FOR LOCAL": BATTERY CELL FACTORIES WITH UP TO 20 GWH/A IN EU AND 30 GWH/A IN USA.

GEN6 (in stages from 2025)

GEN5

Battery cell factories in key markets, close to BMW Group production sites.

# BMW GROUP IS LEVERAGING IN-HOUSE EXPERTISE TO PROVIDE MAXIMUM SUPPORT FOR INDUSTRIALISATION AND RAMP-UP OF PARTNER CELL FACTORIES.


**Nomination of the partner**

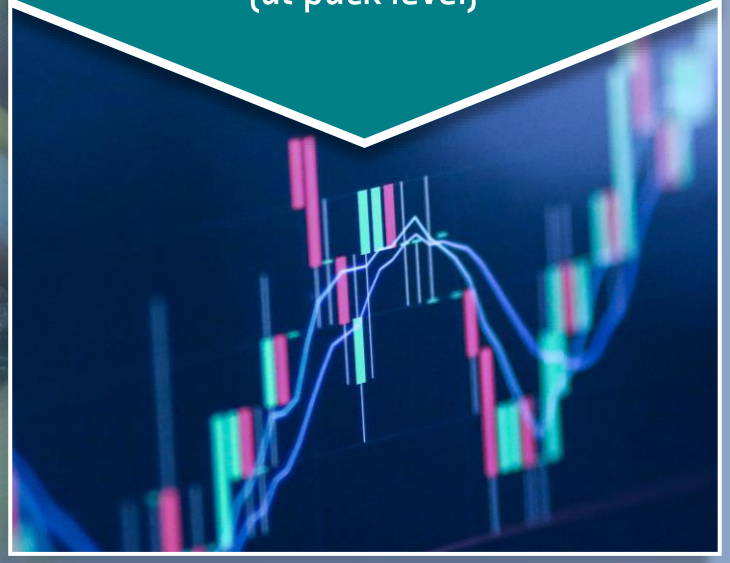
**Enabling through in-house competence:**
**Battery Cell Competence Centre &**
**Cell Manufacturing Competence Centre**

**Series production**

# MUCH LOWER COSTS AT HVB LEVEL.
# $CO_2$-REDUCED AND RESOURCE-EFFICIENT PRODUCTION.

## New round cell and new integration concept.

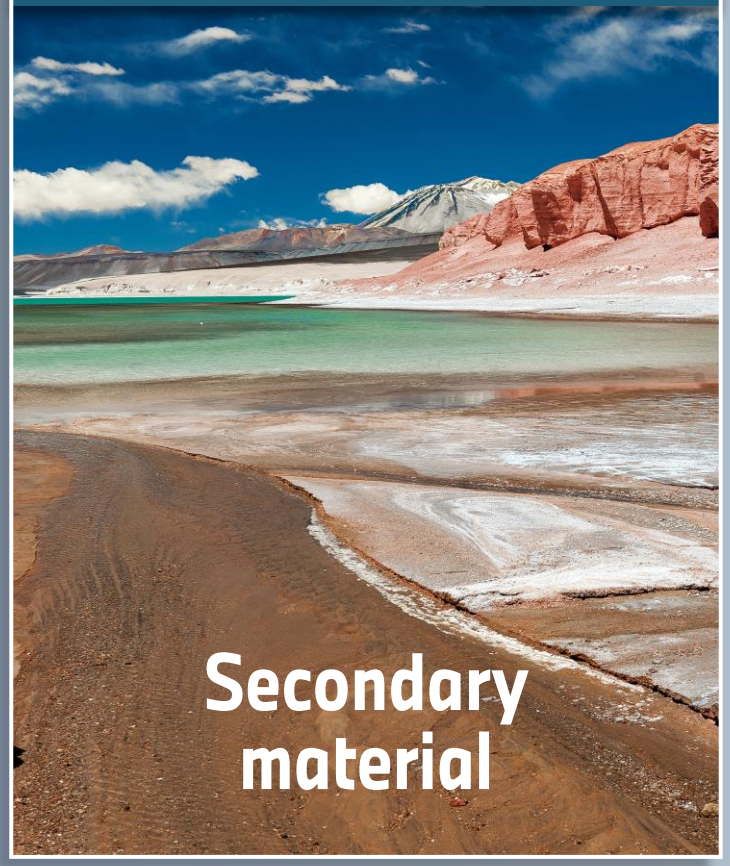
**-50%**
cost
(at pack level)



## $CO_2$ reduction in the supply chain.

**-60% $CO_2$**
(in cell production)

## Use of secondary material to conserve resources.



**Secondary material**

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# THANK YOU FOR YOUR ATTENTION!

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# $CO_2$ E-REDUCTION SUPPLY CHAIN AND CIRCULARITY.

HILKE SCHAER AND ANDREAS VETTER,
PROJECT MANAGEMENT $CO_2$ E-REDUCTION BODY, INTERIOR & EXTERIOR.

# THE BMW 360° SUSTAINABILITY APPROACH MEANS MUCH MORE THAN JUST PRODUCING AND SELLING ELECTRIC VEHICLES.

# ONE MAIN FOCUS IS AT LEAST - 40% $CO_2$ e PER VEHICLE BY 2030 AS A MEASURABLE MILESTONE TOWARDS CLIMATE NEUTRALITY.

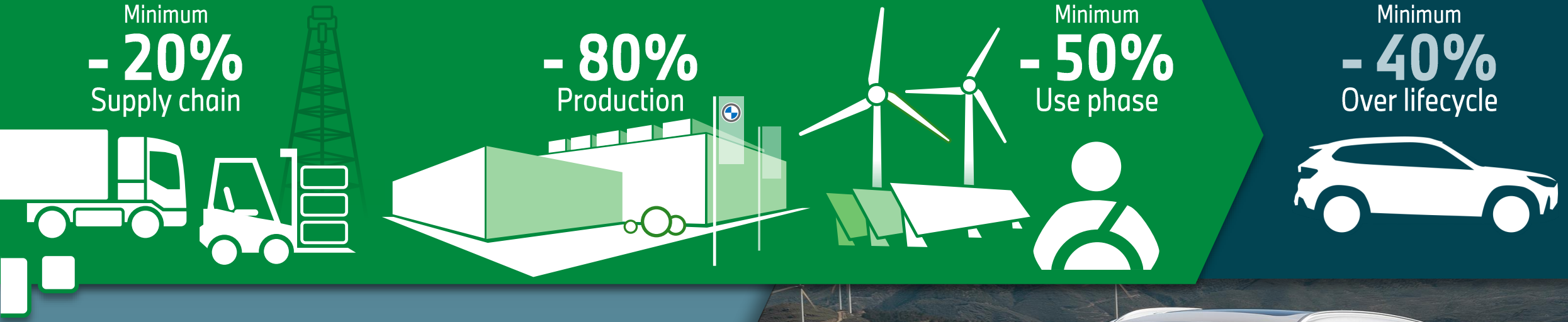
$CO_2$ e per car 2030 vs. 2019

Minimum
**- 20%**
Supply chain

**- 80%**
Production

Minimum
**- 50%**
Use phase

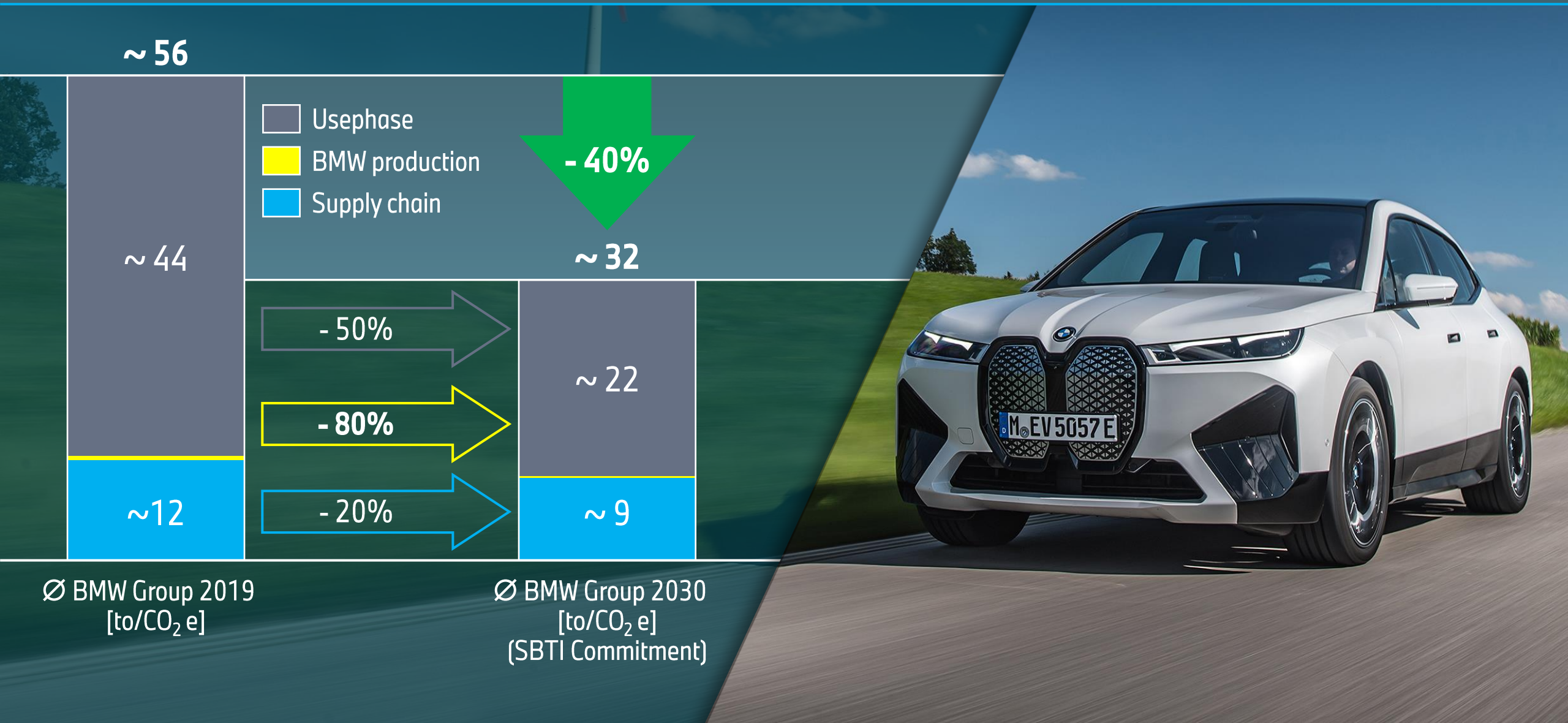
Minimum
**- 40%**
Over lifecycle



## Main actions for $CO_2$ e reduction.

- Electrification of the drive.
- $CO_2$ e reduction in electrical and thermal energy.
- Electrification of material production.
- Reducing the consumption of primary fossil materials through recycling.

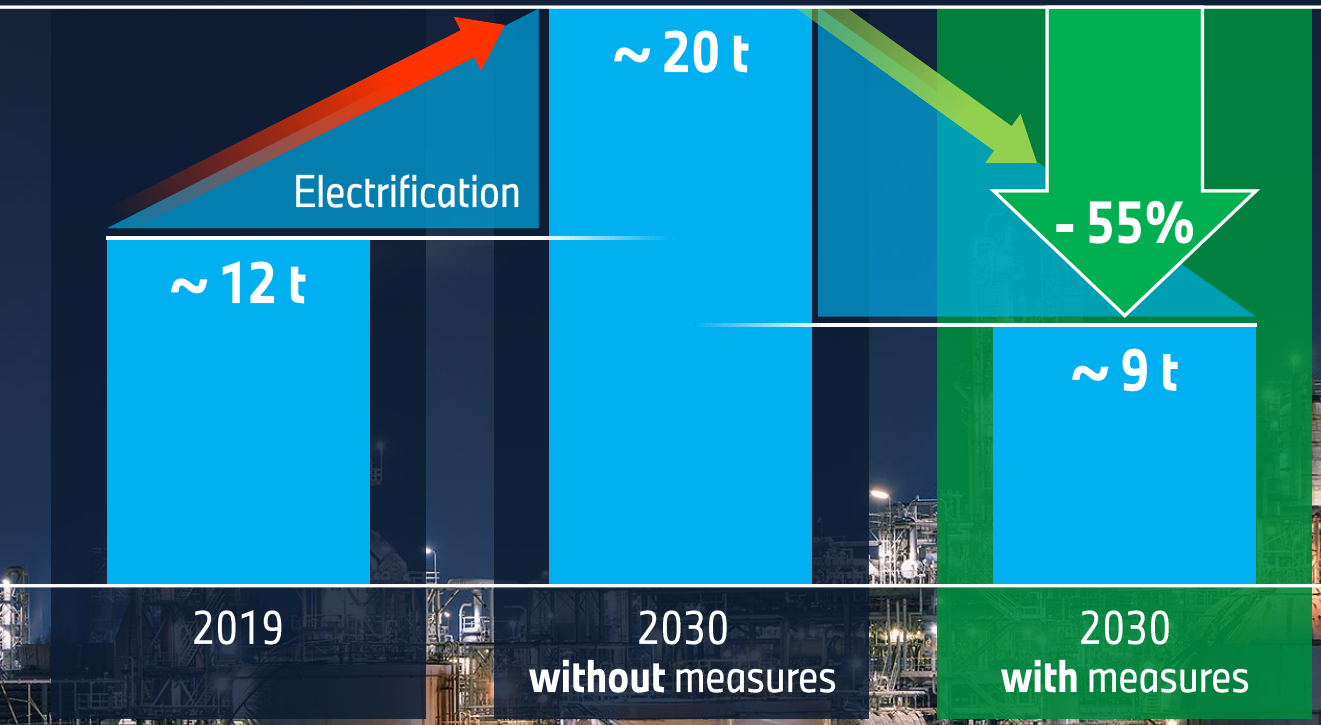
# WHAT IS THE AVERAGE $CO_2$ e REDUCTION TARGET FOR 2030 COMPARED TO 2019 PER VEHICLE.



# $CO_2$ e EMISSIONS IN THE SUPPLY CHAIN.

**Carbon footprint per vehicle in the supply chain.**

» Without additional measures, the electrification would lead to a rise of greenhouse gas emissions of ~ 50% in the supply chain.



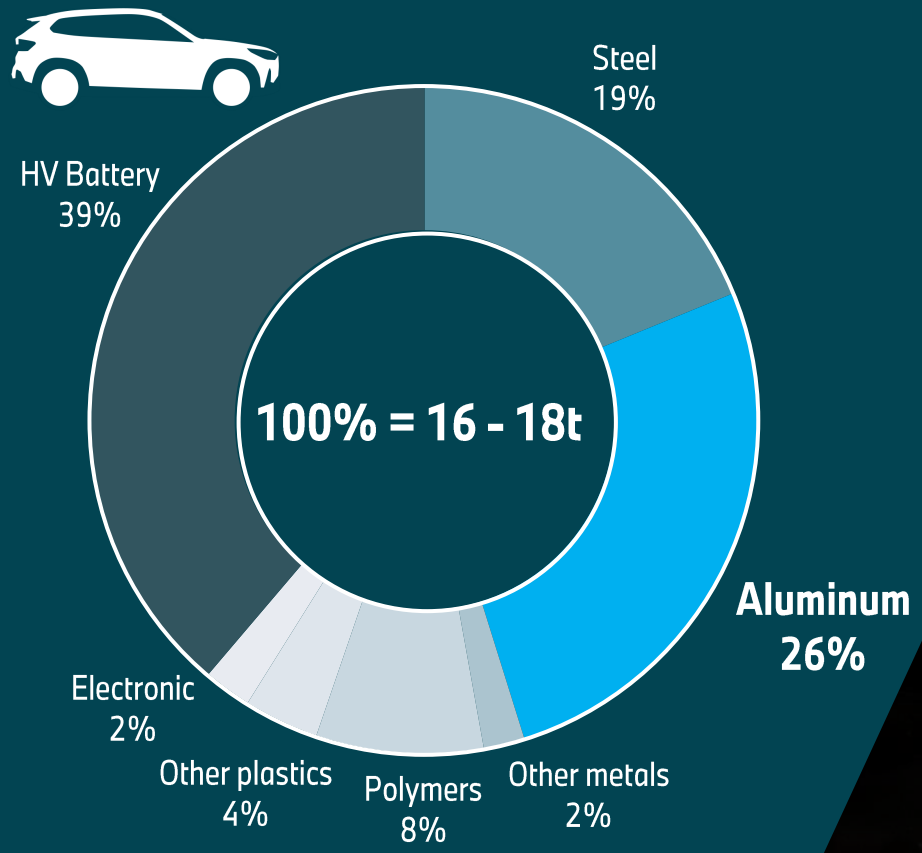

## 2030

» Avoiding an increase by approx. + 50% per vehicle and trend reverse.

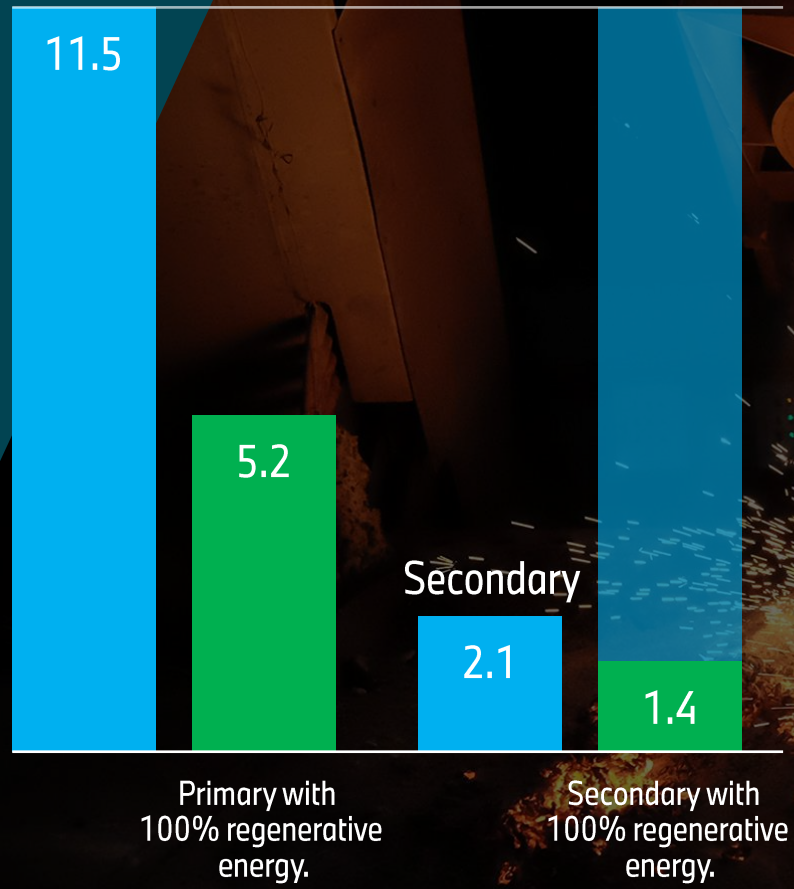
» - 20% $CO_2$ e per vehicle vs. 2019 in the supply chain.

# USE OF SECONDARY RAW MATERIALS.

Share of $CO_2$ e emissions in the supply chain per material for a medium-sized BEV.




$CO_2$ e emissions from aluminum [t $CO_2$ e/ton]



# $CO_2$ e REDUCED ALUMINUM AND STEEL.

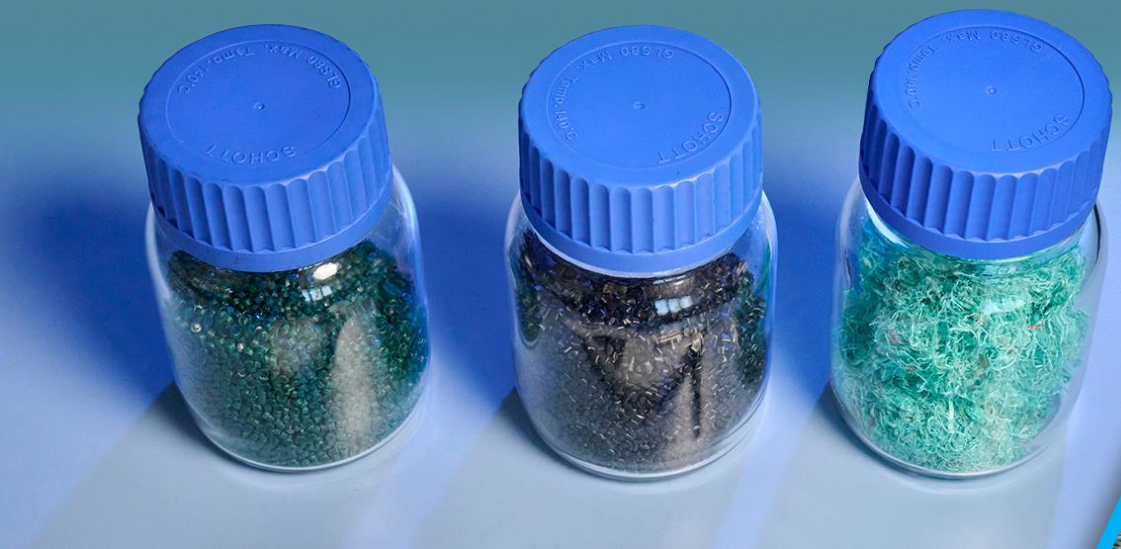
The recycling of high-quality scrap and the complete hydrogenization and electrification of production processes with renewable energies are the most important levers for decarbonization.

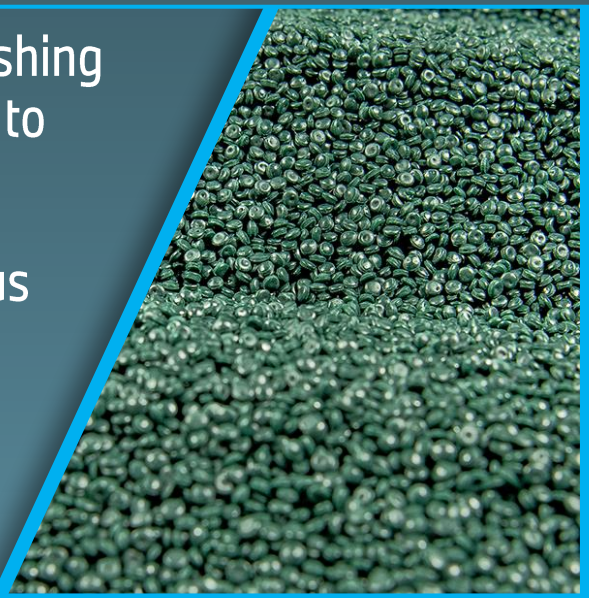
» Latest examples at BMW Group:

- Up to 50% of EAF steel is currently being used in the car body in US production.
- 70% secondary material quota (SRQ) in all newly developed cast aluminum wheels from 2023.
- 100% SRQ in all newly developed aluminum forging shops.
- Closed loop for aluminum and steel sheets in all BMW plants.
- Delivery contracts for HDRI-Steel.

# RECYCLED PLASTICS.

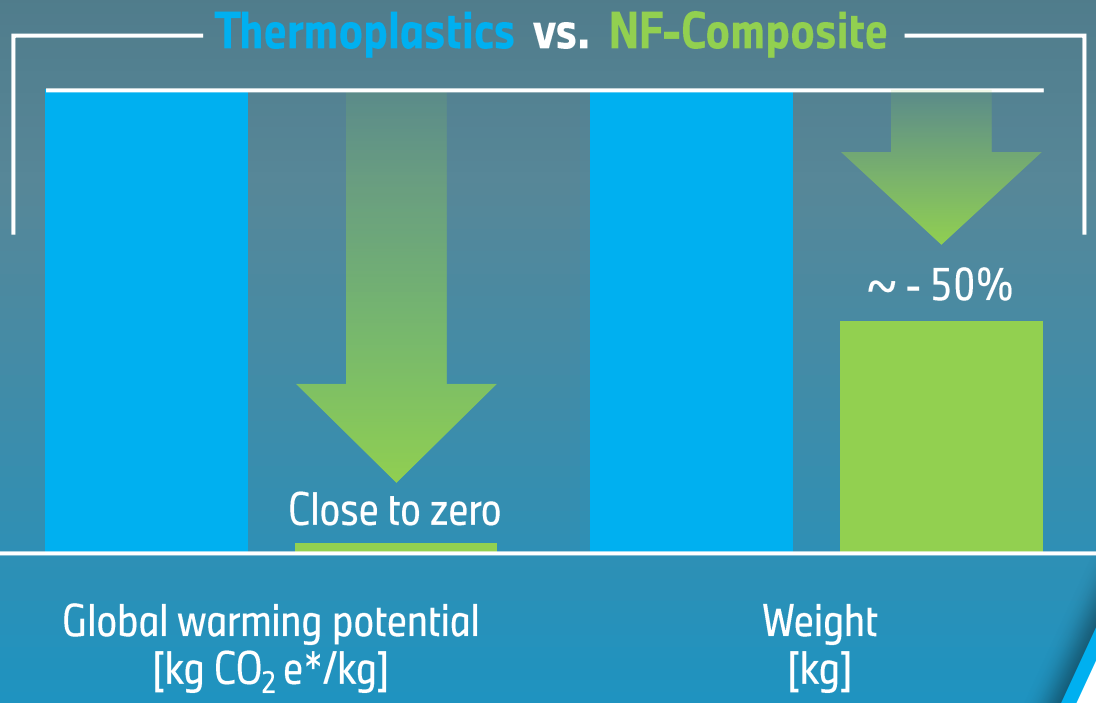
- A first in the automotive industry: parts made from recycled fishing nets, unique recycling process transforms waste from the sea to plastic recyclate.
- Recycled PET-Bottles as a source for polyester fibers in various textiles (e.g. seat, floor covering).
- PP, PA, PC and ABS recyclates are used in visible and non-visible components.



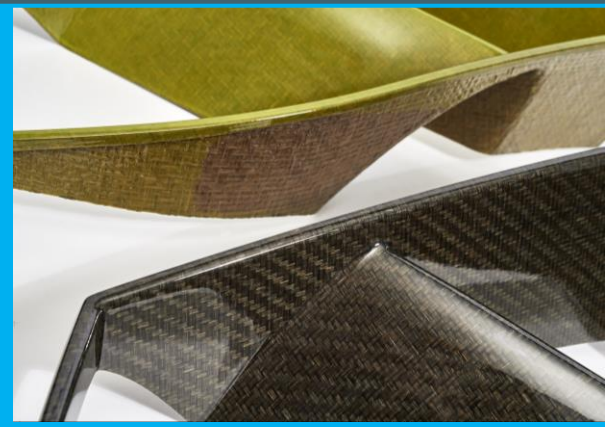


# NATURAL FIBRES.

- The BMW Group acquired a stake in Bcomp, a Swiss company that manufactures sustainable reinforcement solutions. Joint R&D work for production vehicles gets underway.
- Weight reduction up to 50% vs. thermoplastics and 30% vs. renewable composites with the same mechanical properties.







# SUSTAINABLE INTERIOR SURFACES IN DEVELOPMENT.

- Use of chrome-free tanned leather.
- Vegan leather alternatives under development with recycled backings and partially bio-based materials.
- 100% recycled Polyester / Polyamid and use of natural fibers.
- Mirum® as biobased leather alternative made from 100% renewable raw materials, vegan and crude-oil-free.
- FSC-certified woods for decors and components.



# $CO_2$ e EMISSION ALONG SUPPLY CHAIN.
# > 50% $CO_2$ e REDUCTION BY EXAMPLE MID-SIZE SAV BEV.

Secondary material quota: **< 30%**

Secondary material quota: **> 40%**

21

Concepts / Material substitution [to $CO_2$ e]

HVS GEN 6* [to $CO_2$ e]

Aluminum* [to $CO_2$ e]

Steel (BOF/EAF)* [to $CO_2$ e]

Steel (HDRI)* [to $CO_2$ e]

Thermoplastic* [to $CO_2$ e]

**> 50%**

<10

**$CO_2$e reduction through $CO_2$e prevention.**

Mid-size SAV BEV [to $CO_2$ e]

* Including use of renewable energy in production of material and components. HDRI-Steel: Implementation starting 2026.

# CIRCULAR ECONOMY.

» The circular economy is the ideal and most sustainable form of business.

» We are driving forward the development of the circular economy in a targeted manner.


## Resource efficiency

» Conservation of resources:
**Minimal use** of primary raw materials.

## Material cycle

## Product cycle

# TRANSFORMATION TO CIRCULAR ECONOMY.


Share of secondary materials today

**< 30%**
on average per car

## $CO_2$ Reduction

- Increase in recycled content.
- Increase in the use of pre-consumer waste.
- Increase in dismantling and recycling.
- Increase in market availability of recyclates.

Share of secondary materials will **increase to**

**50%**
on average per car

Enabling use of post-consumer waste.

Start of Life — End of Life

Life cycle 15-20 years

**Design for Circularity**

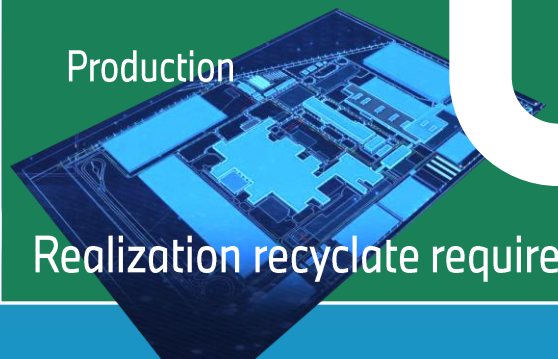
Start of Life — End of Life

Life cycle 15-20 years

$CO_2$ neutrality

# CIRCULAR ECONOMY.

» Mid- and long-term developments have to be considered while developing technical solutions and cooperation strategies.

| | Pre ~ 2030 | Post ~ 2030 |
|---|---|---|
|  Collaboration with recyclers. | Feedstock.<br>› Opening up new sources of secondary raw material.<br>› Raise recyclate quality.<br>  <br>15 - 20 year old ELV (built ~ 2010 - 2015) |  <br>End of Life: 2045 - 2050<br>„Ready for Circularity".<br>› „Design for Circularity" -ELVs further boosting circular economy. |
|  Technical enablers. | › Maximize recyclate content.<br>› „Design for Circularity".<br>  <br>Production<br>  <br>SOP ~ 2030<br>Realization recyclate requirements. |  Product life (15 - 20 yrs). |

# ECONOMICALLY VIABLE HIGH QUALITY RECYCLED MATERIALS. OPTIMAL USE OF END-OF-LIFE VEHICLES AS A RAW MATERIAL SOURCE.

§

Regulatory required disassembly

€

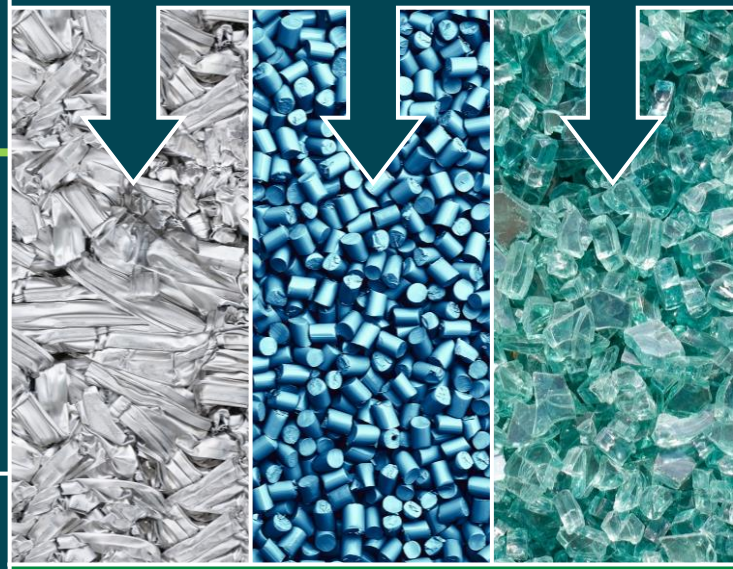
Design for circularity influences recycling and recovery processes and technologies.

Optimum between disassembly and shredding

Material revenue

Profit

Dismantling costs



**100%** shredded vehicle

**0%** disassembled vehicle

**0%** shredded vehicle

**100%** disassembled vehicle

# SUMMARY.

## » 360° sustainability approach across the entire value chain.

- › $CO_2$ e reduction in the supply chain through $CO_2$ e prevention, not compensation.
- › $CO_2$ e reduction in material production and processing through the use of renewable energy, hydrogen and innovative concepts.
- › $CO_2$ e reduction and resource conservation by significant increase in secondary material quota.
- › Turning component design towards optimized recyclability.