BMW GROUP

TECHNOLOGY OPENNESS FOR SUSTAINABLE MOBILITY.

JOSEF HONEDER FOR ECO-MOBILITY, 16.11.2023

CONTENT.

- Introduction BMW Group / plant Steyr
- Transformation process plant Steyr
- BMW strategy for climate neutrality
- Current and future drive technologies for sustainable mobility

CV - JOSEF HONEDER.

born 1971, married, three children

Education: Federal Secondary College of Engineering, Linz/Austria
Industrial-/Mechanical-Engineering Studies,
Technical University, Graz/Austria

Professional Background:

1996-2011 BMW Motoren GmbH, R&D Center, Steyr/Austria

2011-2013 Husqvarna Motorcycles, Varese/Italy
Head of R&D

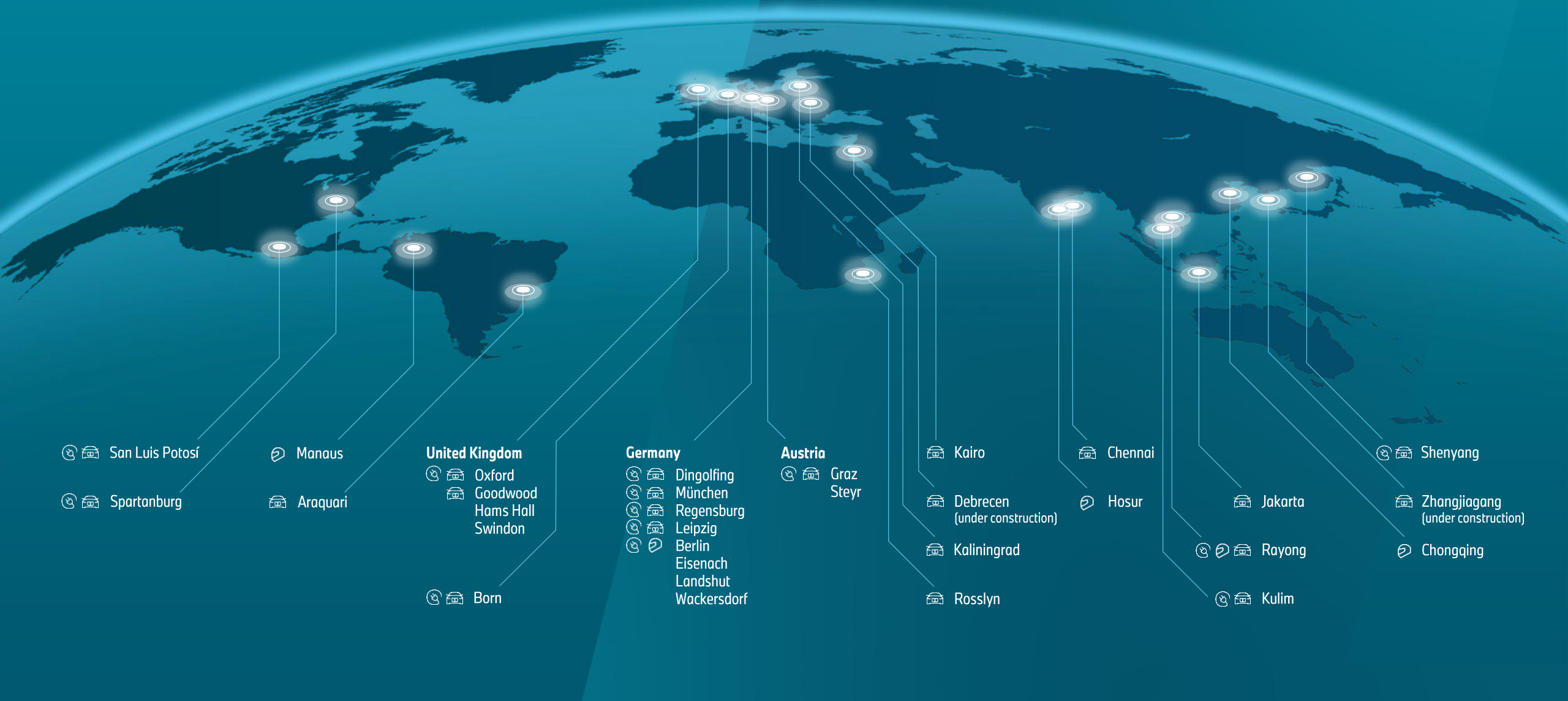
2013-2017 BMW AG, Munich/Germany,
Head of Concepts, Design and Integration

2017-2020 Development Total Vehicle
Vice President Acoustics and Vibration
Vice President Efficient Dynamics

2020-2021 Development Powertrain
Vice President Concepts and Integration

2022- today BMW Motoren GmbH, Steyr/Austria
Vice President Electric Drive Machine,
Diesel Engine, Fuel Cell, Thermal Management

BMW GROUP PRODUCTION NETWORK WORLDWIDE.



BMW GROUP WORLDWIDE. FACTS AND FIGURES 2022.

Sales Automotive	**2,399,632**	(-4.8 %)
Sales Motorcycles	**202,895**	(+4.4 %)
Sales (in Mio. Euro)	**142,610**	(+28.2 %)
Employees	**149,475**	

Compared to 2021


WE ARE THE LEADING
DRIVETRAIN PLANT.
IN PRODUCTION AND R&D.

FACTS & FIGURES.

TURNOVER

- Plant Steyr 2022: EUR 3,6 billion turnover

PRODUCTION, R&D

- 1.1 million engines produced in 2022 (Steyr)
- Development site Steyr: e-drives, diesel engines, thermal management for e-cars

INVESTMENTS

- since 1977: EUR 8,5 billion in Austria
- Plant Steyr 2022: EUR 302 billion invested

EMPLOYMENT

- Plant Steyr: 4.500 Employees
- including 700 at R&D center

DEVELOPMENT CENTER.
BMW GROUP PLANT STEYR.

- The drives of the future are created here.
- At the development center, more than 700 technicians and engineers design and test new generations of e-drives and diesel engines for the BMW Group's future vehicles.
- Special Highlight:
  The development of high-performance e-drives for the next generation of BMW M models.
- Thermal management for all new BEV is developed exclusively at R&D Center.

TRANSFORMATION BMW GROUP PLANT STEYR.
PRODUCTION AND DEVELOPMENT OF ELECTRIC DRIVETRAINS.

- **06/22** Announcement e-drive production plant Steyr
- **09/22** Start of building production halls
- **01/24** Start plant construction
- **07/24** Production pre-series
- **08/25** Serial production new generation e-drive

Total investment (until 2030):

1 Billion Euro

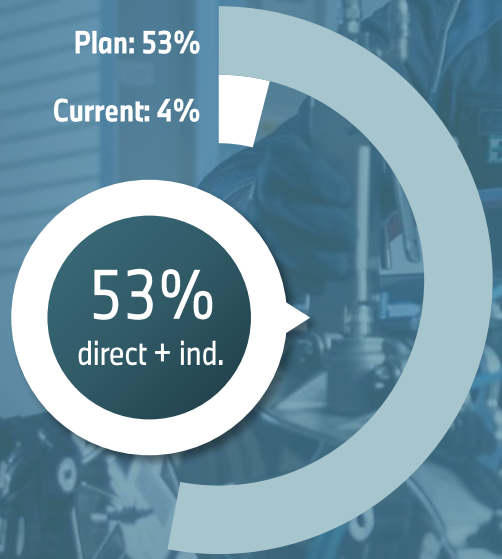
until 2030:

50%

Employees
for E-Mobility

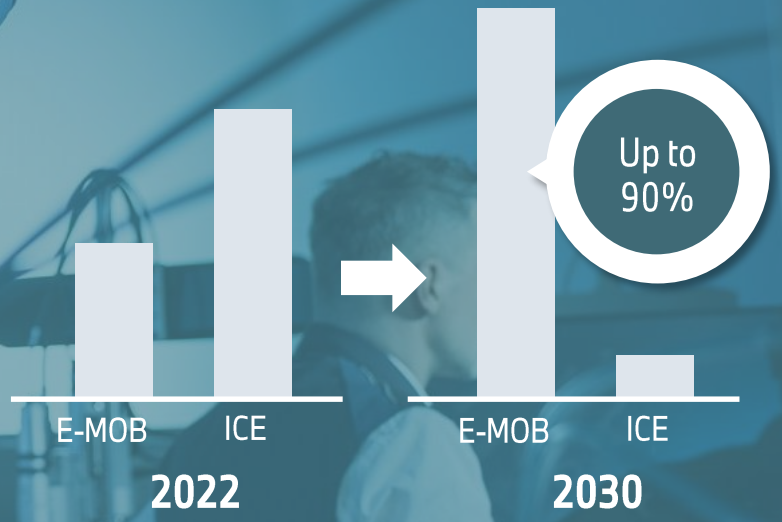
E-MOBILITY: INVESTMENTS AND EMPLOYMENT TILL 2030. PRODUCTION OF E-DRIVE FROM 2025. DEVELOPMENT FOR E-MOBILITY.

PRODUCTION AS OF 2025: EMLOYEES AND INVESTMENT



One-Time expense **710** Mio. €

DEVELOPMENT HIGH PERFORMANCE-E-DRIVE:



Development costs **230** Mio. €

BMW GROUP IS COMMITTED TO THE 1,5°C TARGET.

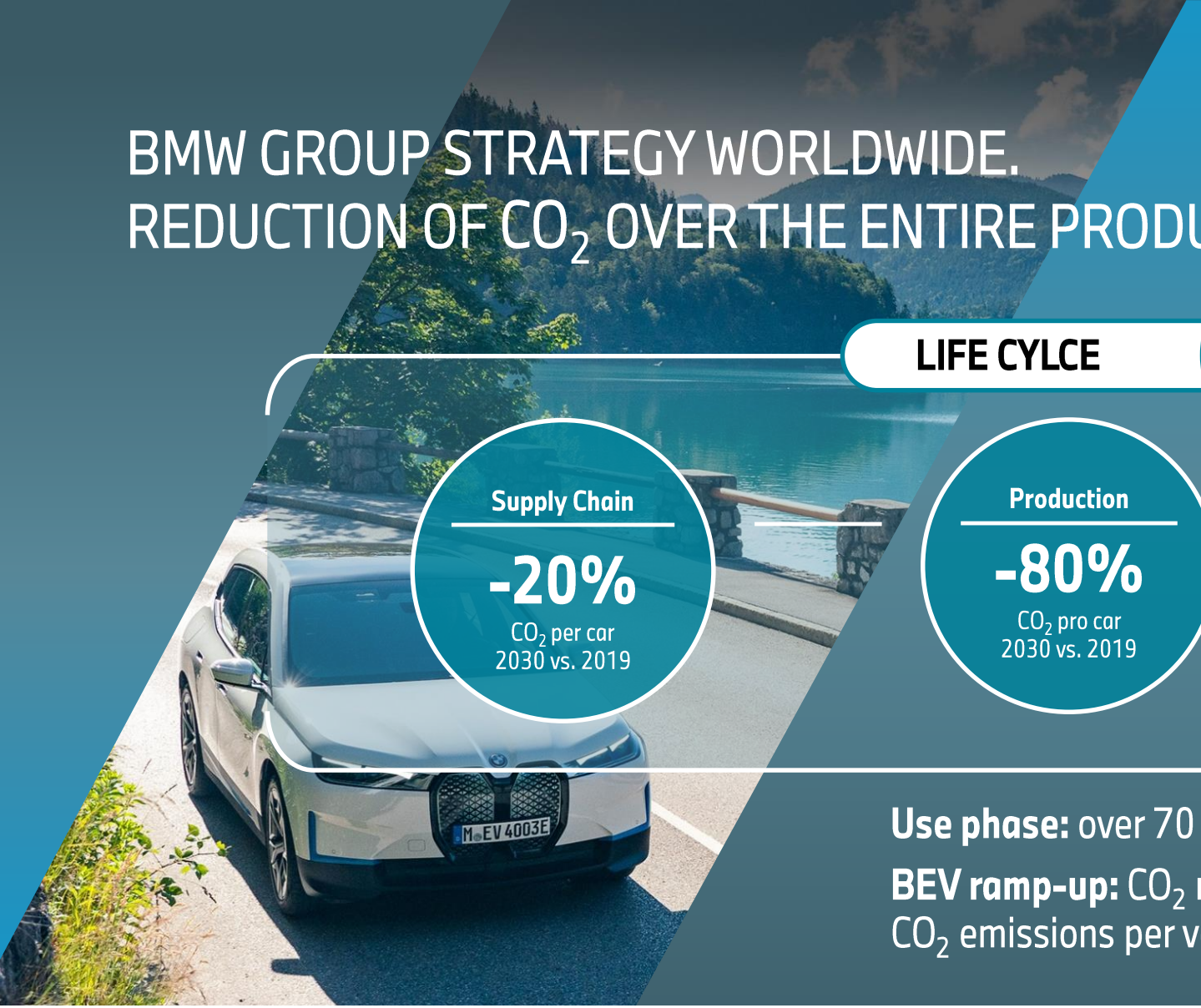
SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

BMW Group is the first German car manufacturer to join **“Business Ambition for 1,5°C”.**

Target: Climate neutrality across value chain by 2050 at the latest.

BMW GROUP STRATEGY WORLDWIDE.
REDUCTION OF CO_2 OVER THE ENTIRE PRODUCT LIFE CYCLE.



LIFE CYLCE — At least **-40%**

Supply Chain
-20%
CO_2 per car
2030 vs. 2019

Production
-80%
CO_2 pro car
2030 vs. 2019

Usage
at least
-50%
CO_2 per car
2030 vs. 2019

Use phase: over 70 % of the BMW Group's CO_2 balance.

BEV ramp-up: CO_2 reduction in the use phase of at least 50 % by 2030. CO_2 emissions per vehicle will therefore fall by at least 40 % by 2030.

In the most recently published Dow Jones Sustainability Indices (DJSI) the BMW Group achieved 1st place in the "Automobiles" category.

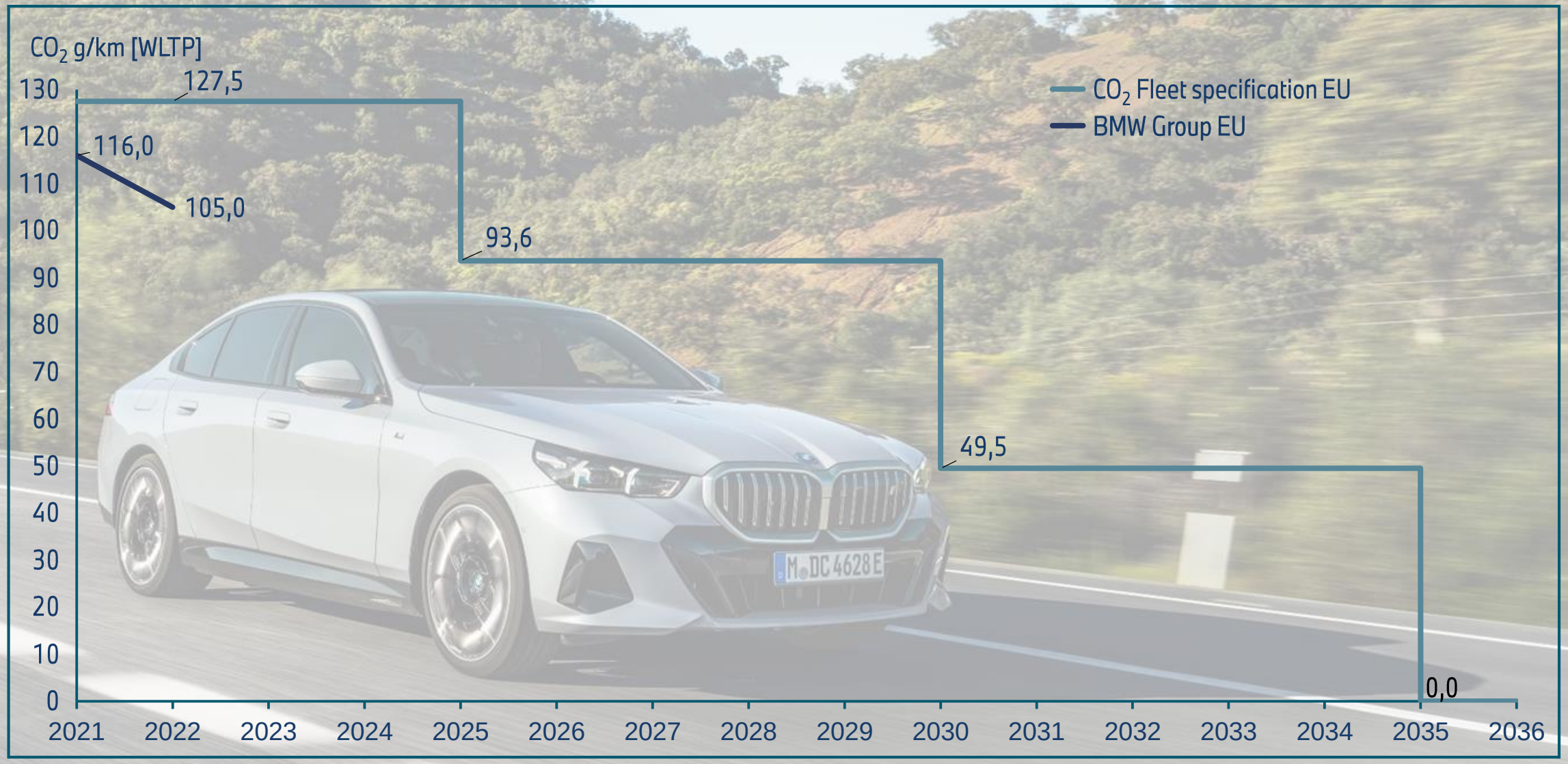
→ **Most sustainable car manufacturer in the world!**

TECHNOLOGY OPENNESS AS KEY FACTOR FOR SUSTAINABLE MOBILITY

WHICH TECHNOLOGIES ARE WE TALKING ABOUT?

- Further development of combustion engines (gasoline/diesel)
- BEV
- Hydrogen

CO2 TARGET EU.



FOCUS ON E-MOBILITY.
FROM FIRST MOVER TO NEUE KLASSE.

I

2013

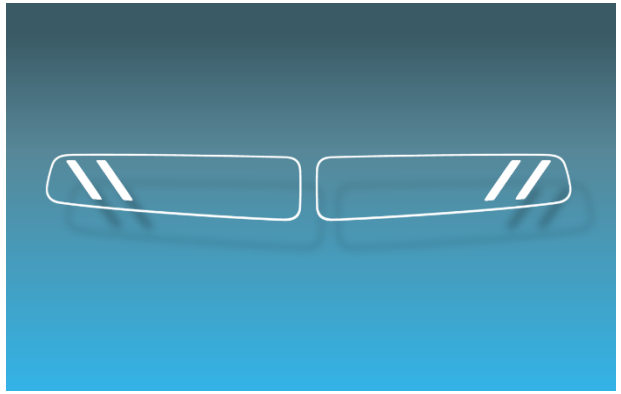
Pioneering work
in electric mobility.

II

today

Elektrification of the
entire portfolio.

III

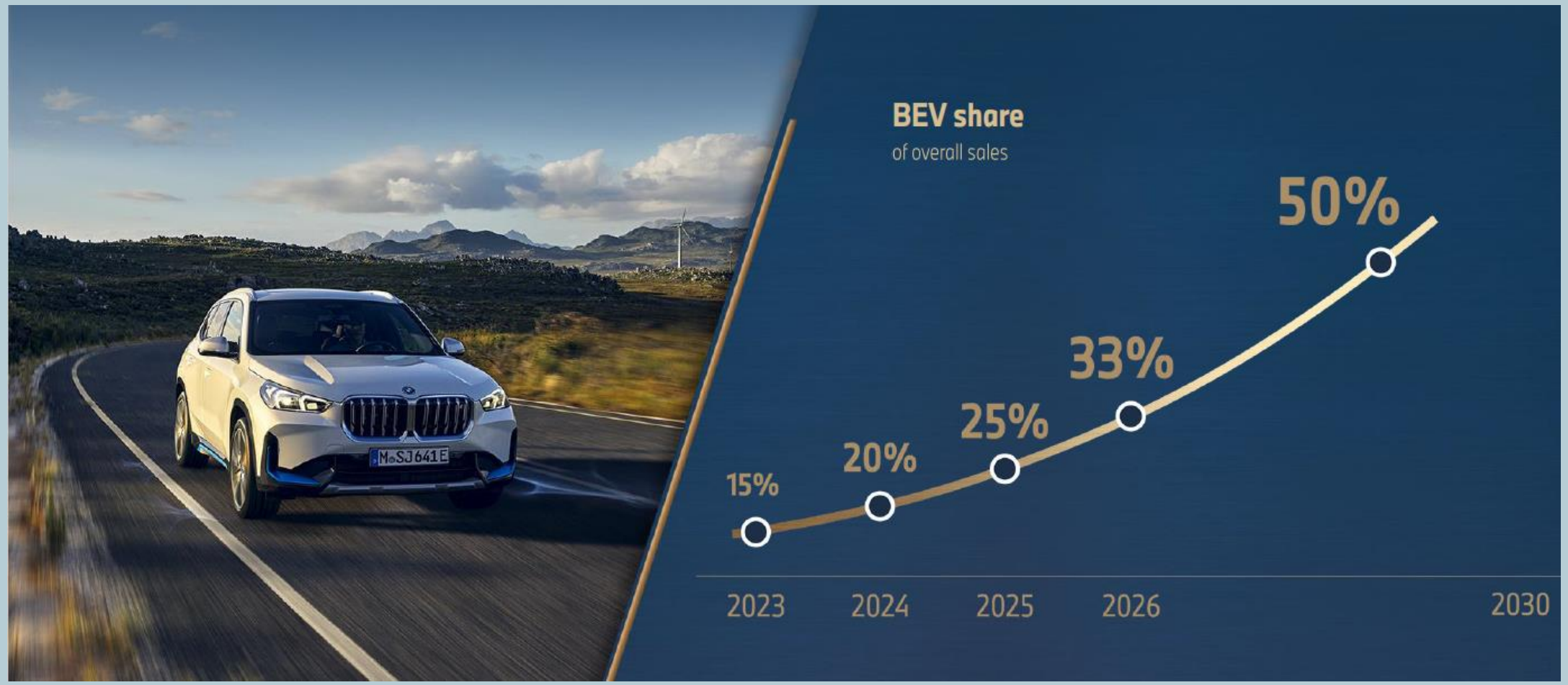


from 2025

E-Mobility first:
Large BEV-Volume and next steps of digitalization.


BMW VISION
Neue Klasse

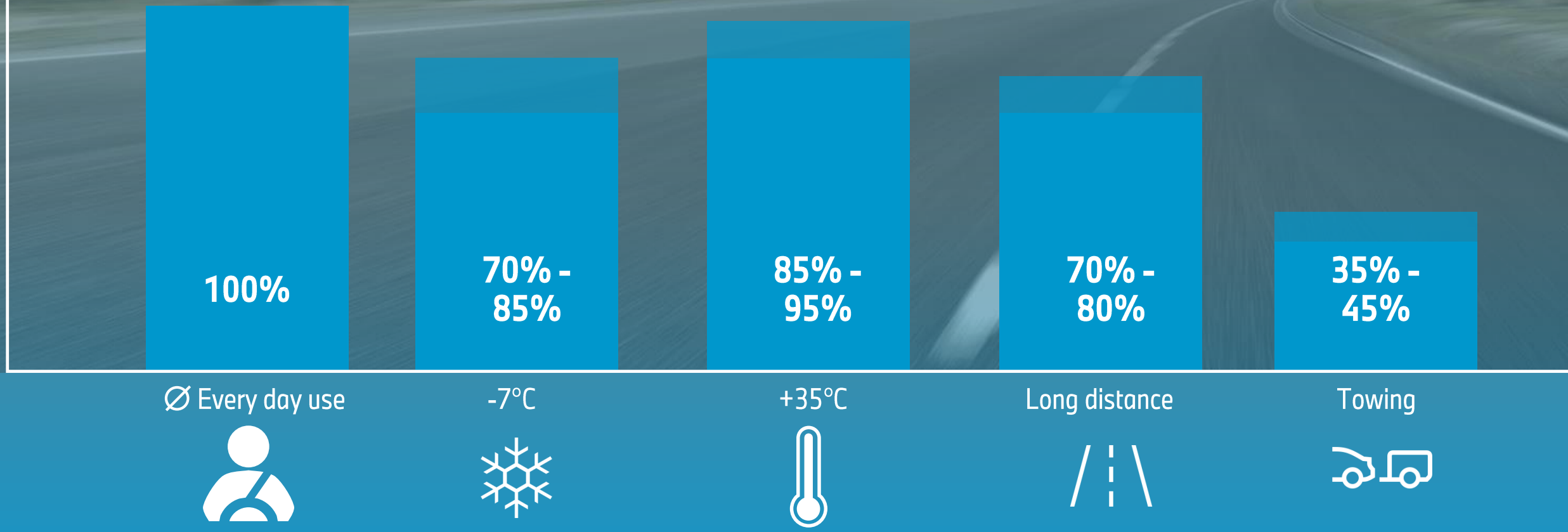
FOCUS ON E-MOBILITY.
GROWTH OF BEV-SHARE: OVER 50 % IN THE NEXT FEW YEARS.



DEFINING FACTORS FOR EFFICIENCY DEPEND ON COSTUMER BEHAVIOR.

Efficiency experienced on a daily basis - beyond regulatory rules.

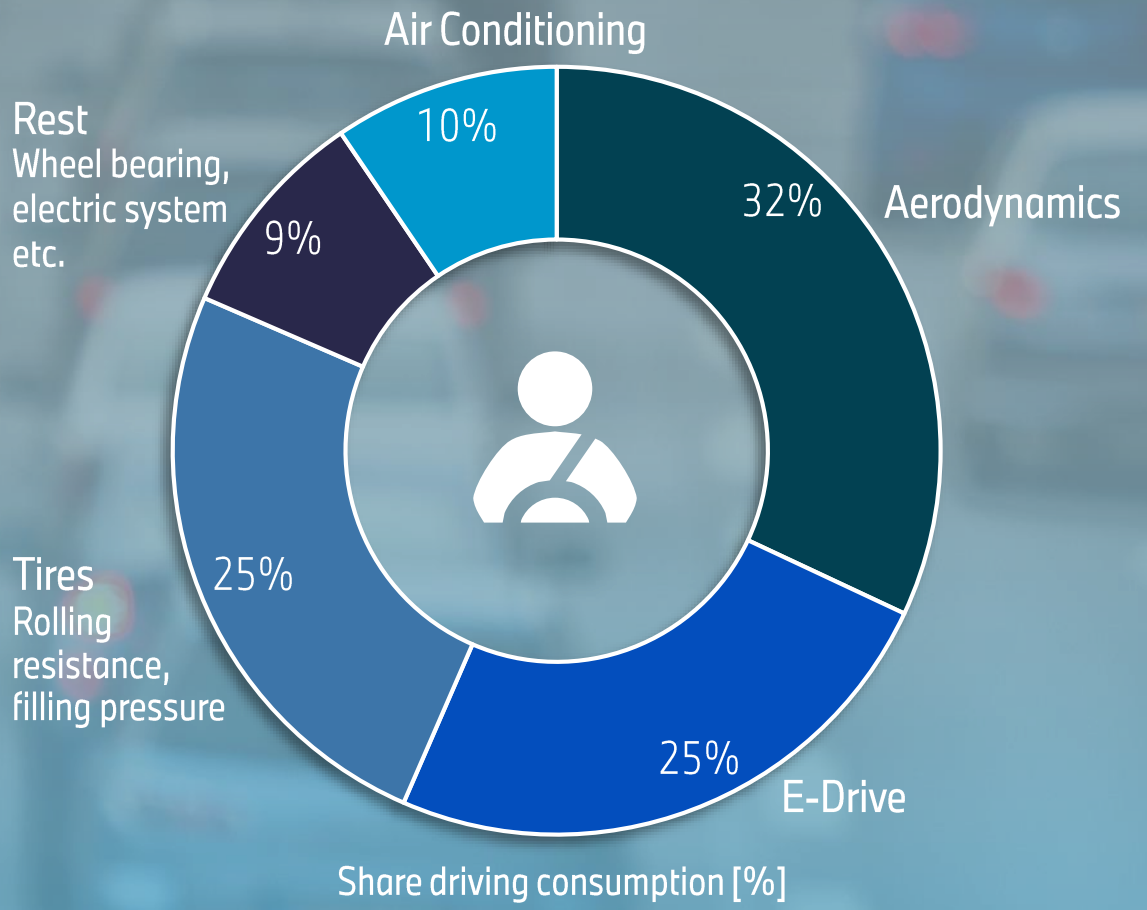
E-Range in customer specific use cases.



DISTRIBUTION OF DRIVING LOSSES AT MODERATE AMBIENT TEMPERATURES.

The impact of the different factors depend on the actual use of the customer (Example: BMW i7 xDrive 60).

Daily use in changing situations



HYDROGEN.
AN IMPORTANT KEY PLAYER IN DECARBONIZATION CHALLENGE.

Direct use of electricity
(grid, batteries)

The challenge of electrification

H_2

Indirect use of electricity
(H_2, e-fuels)

- Industry, machines, tools
- Public transport in cities
- Urban deliveries
- **Passenger Car, Urban & Commuter**
- **Large passenger cars (long-distance)**
- Coaches, light commercial vehicles
- Heavy-duty trucks
- Aviation & maritime
- Industry (high heat)

BEVS AND FCEVS COMPLEMENT EACH OTHER.

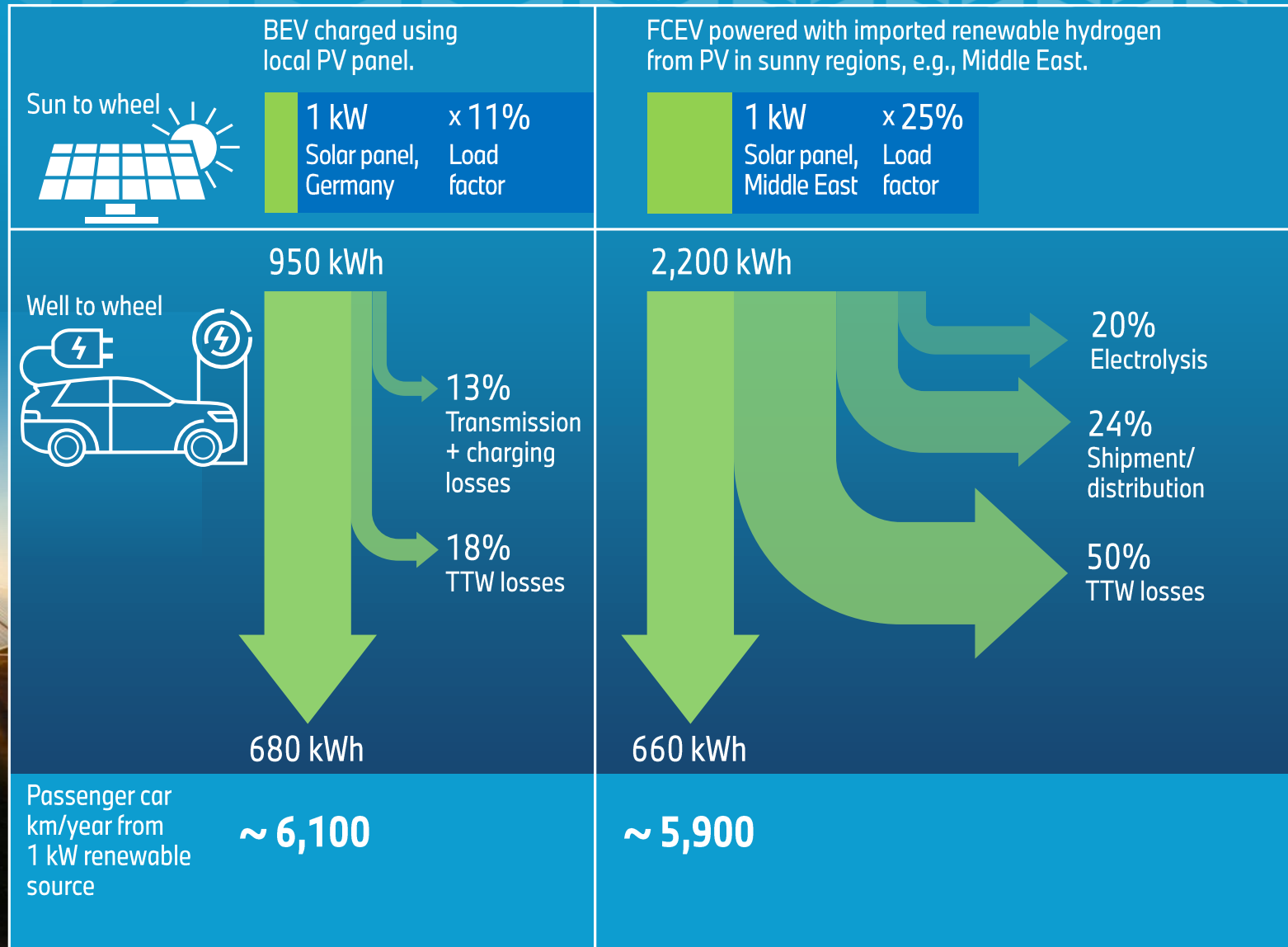
- **Technology:**
  both are EVs – FCEV enables fast refueling.
- **Customer:**
  BEVs fulfill most use cases – but not all.
  FCEV and BEV combined can help to decarbonize faster.
- **Infrastructure:**
  2 are cheaper than 1.
- **Energy system:**
  Cost and feasibility are more important than efficiency.
- **Raw materials:**
  diversity increases resilience.

https://hydrogencouncil.com/wp-content/uploads/2021/10/Transport-Study-Full-Report-Hydrogen-Council-1.pdf

ENERGY SYSTEM: "SUN-TO-WHEEL".

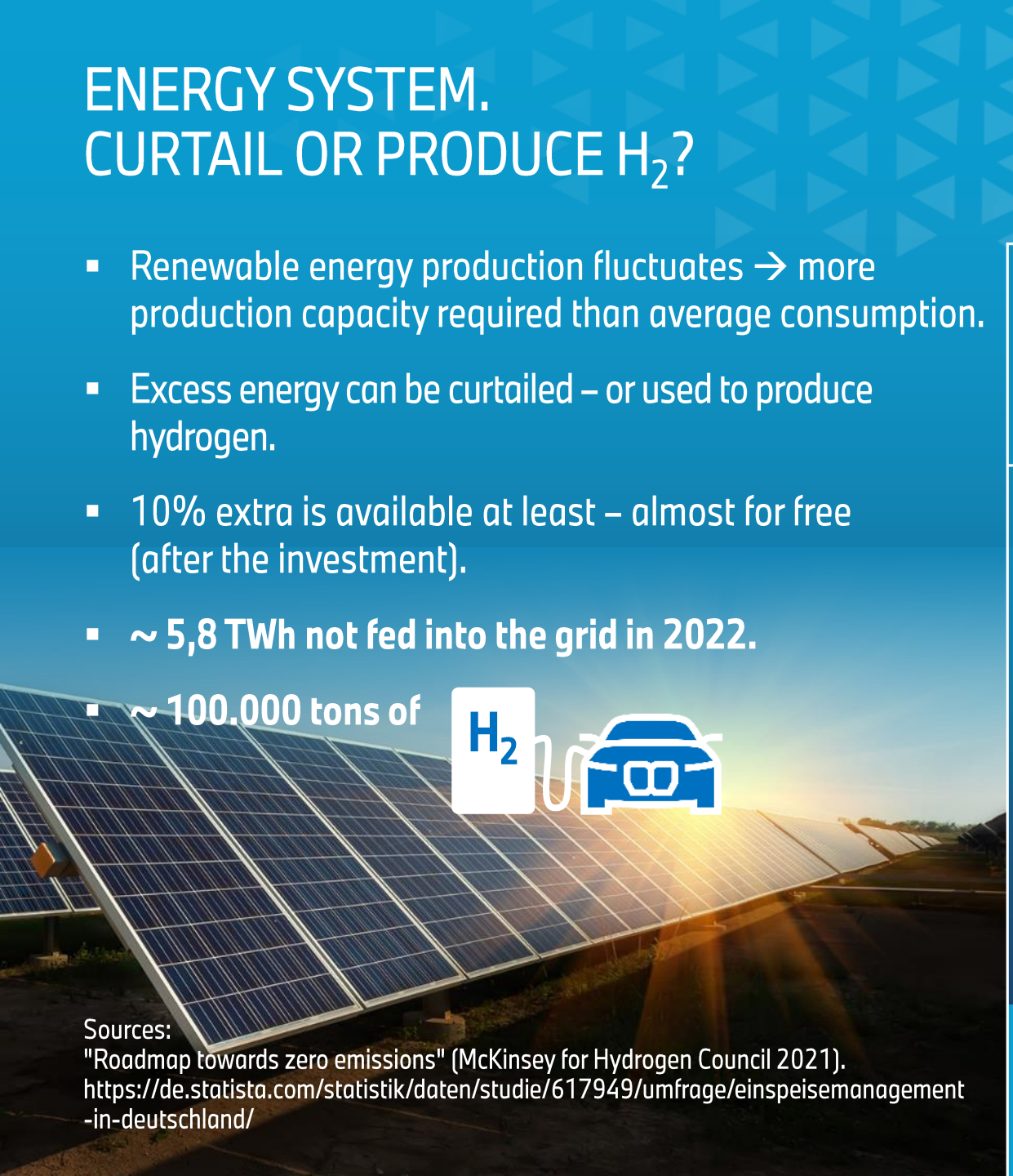
- BEVs are more efficient than FCEVs due to the conversion losses.
- Higher yield of renewable energy production in certain regions compensates for the losses.
- **Cost and feasibility are more important than efficiency.**

Source: "Roadmap towards zero emissions" (McKinsey for Hydrogen Council 2021).



ENERGY SYSTEM. CURTAIL OR PRODUCE H_2?

- Renewable energy production fluctuates → more production capacity required than average consumption.
- Excess energy can be curtailed – or used to produce hydrogen.
- 10% extra is available at least – almost for free (after the investment).
- **~ 5,8 TWh not fed into the grid in 2022.**
- **~ 100.000 tons of** H_2



BEV charged using local PV panel; peak supplies renewable hydrogen for FCEV fuelling.

1 kW Solar panel, Germany

x 11 + 2% Load factor

950 kWh

+ 200 kWh

13% Transmission + charging losses

18% TTW losses

Curtailment Renewable curtailment at peak times to prevent grid overloading can be offset by producing hydrogen instead.

680 kWh

+ 70 kWh

~ 6,100

+ ~ 600

Sources:
"Roadmap towards zero emissions" (McKinsey for Hydrogen Council 2021).
https://de.statista.com/statistik/daten/studie/617949/umfrage/einspeisemanagement-in-deutschland/

HIGHER PERSPECTIVE THAN EFFICIENCY: GREEN HOUSE GAS EMISSION LIFE CYCLE ANALYSIS.

› FCEV and BEV are similar in LCA, as several studies and assessments have shown.

- BEVs and FCEVs only help decarbonise road transport when produced and operated with renewable or low-carbon energy.
- Even when accounting for the additional emissions from long-distance LH_2 shipping, FCEV and BEV have similar lifecycle emissions.

Production

Use Phase

Recycling

[1] ADAC: https://www.adac.de/verkehr/tanken-kraftstoff-antrieb/alternative-antriebe/klimabilanz/
[2] Fraunhofer: https://www.ise.fraunhofer.de/content/dam/ise/de/documents/news/2019/ISE_LCA-BEV-FCEV-Results.pdf
[3] HydrogenCouncil: https://hydrogencouncil.com/wp-content/uploads/2021/10/Transport-Study-Full-Report-Hydrogen-Council-1.pdf

CUSTOMER USE CASES OF HYDROGEN VEHICLES.

› Customers **without convenient access to e-charging.**

› Customers who require **high flexibility** or travel frequently.

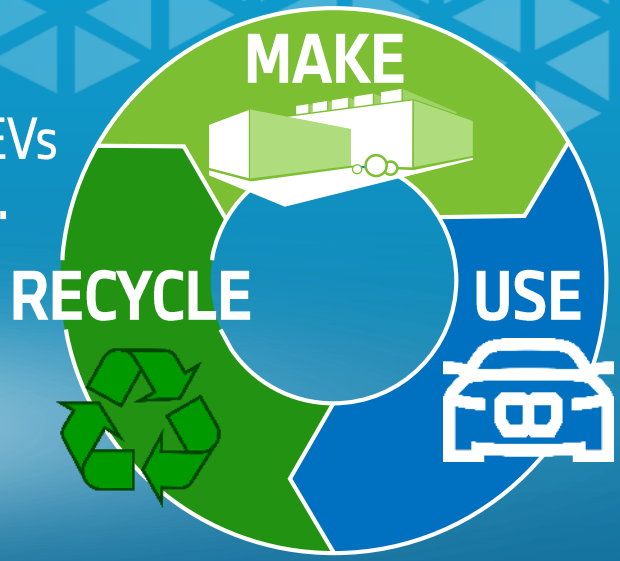
› Customers in **cold climates** (no range reduction).

› Customers with regular **towing use cases.**

LIFE CYCLE AND RAW MATERIALS PERSPECTIVE: DIVERSITY INCREASES RESILIENCE.

› **Diversity increases resilience and decreases risk.**

› Circularity is important for BEVs and FCEVs alike.



› FCEV need **>100 kg** less raw materials than BEVs.

› FCEV batteries need **90 %** **less** critical raw materials than BEV batteries.

› Platinum (main raw material for fuel cells) already has high recycling rate, which will increase with phase-out of combustion engines.

BMW iX5 HYDROGEN.
ALL ADVANTAGES OF ELECTRIC DRIVING COMBINED WITH FAST FUELING.

» Great acceleration » Zero emission » Smooth, silent ride » 3-4 minutes fueling

BMW i HYDROGEN FUEL CELL

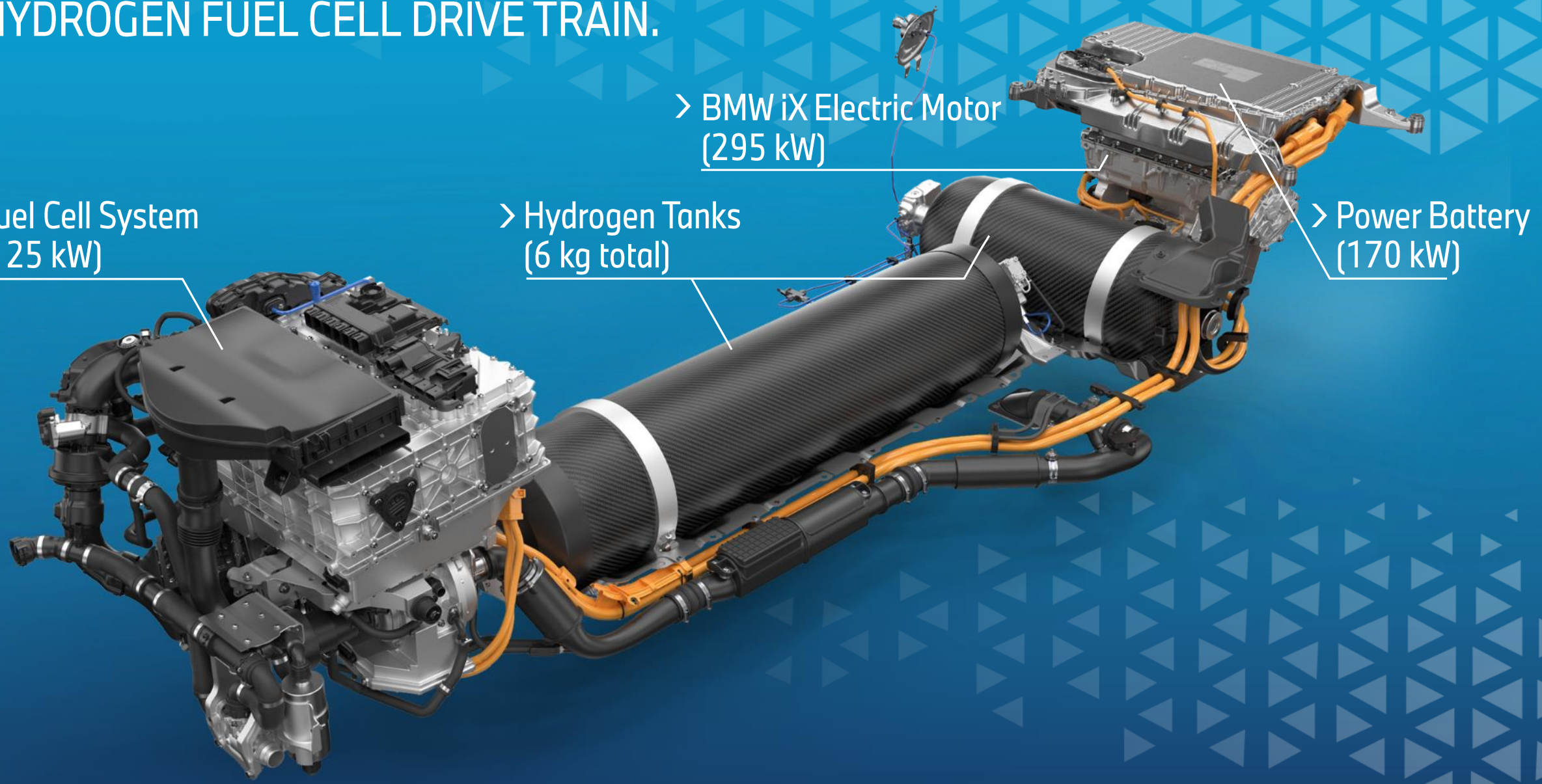
BMW iX5 HYDROGEN.
BMW DRIVING DYNAMICS.

WORLD'S MOST POWERFUL PASSENGER VEHICLE FUEL CELL SYSTEM

+

HIGH POWER BATTERY

BMW iX5 HYDROGEN.
HYDROGEN FUEL CELL DRIVE TRAIN.



BMW iX5 HYDROGEN.
TECHNICAL DATA.

Electrical power fuel cell	125 kW / 170 hp
Total power output	295 kW / 401 hp
Hydrogen tank capacity	≈ 6 kg
Range (WLTP)	≈ 500 km
Maximum speed	≈ 185 km/h
Acceleration (0-100 km/h)	< 6 s
Vehicle weight	≈ comparable PHEV < comparable BEV

TECHNOLOGY OPENNESS AS KEY FACTOR FOR SUSTAINABLE MOBILITY.

THANKS FOR YOUR ATTENTION!

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