



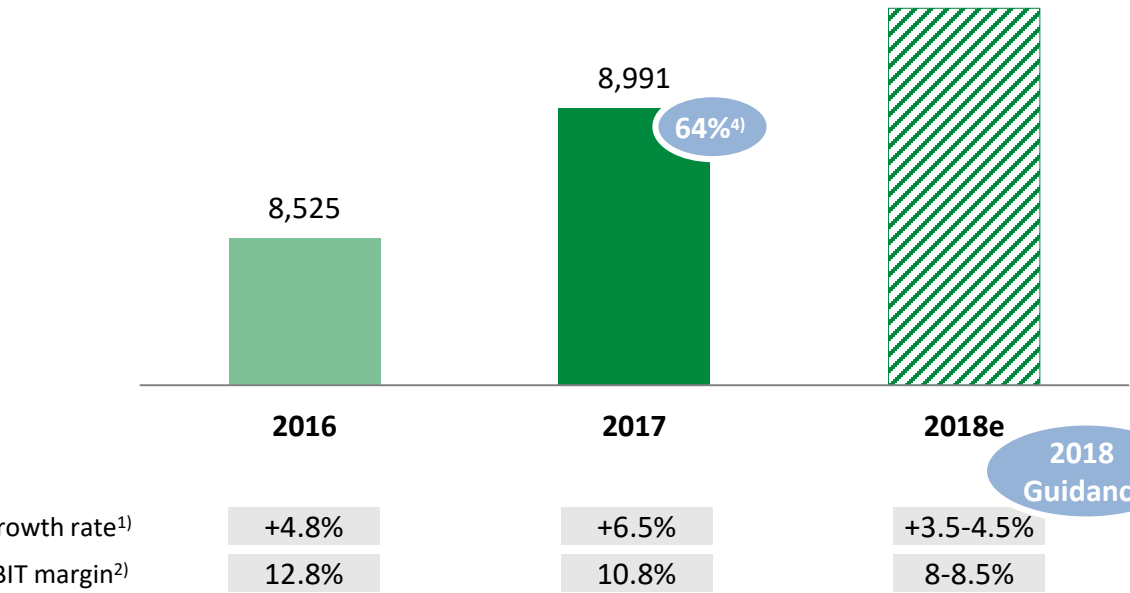
## Deep-dive E-Mobility

**Dr. Jochen Schröder**  
President Business Division E-Mobility

January 8, 2019  
CES - 17th Annual J.P. Morgan Auto Tech Conference  
Las Vegas

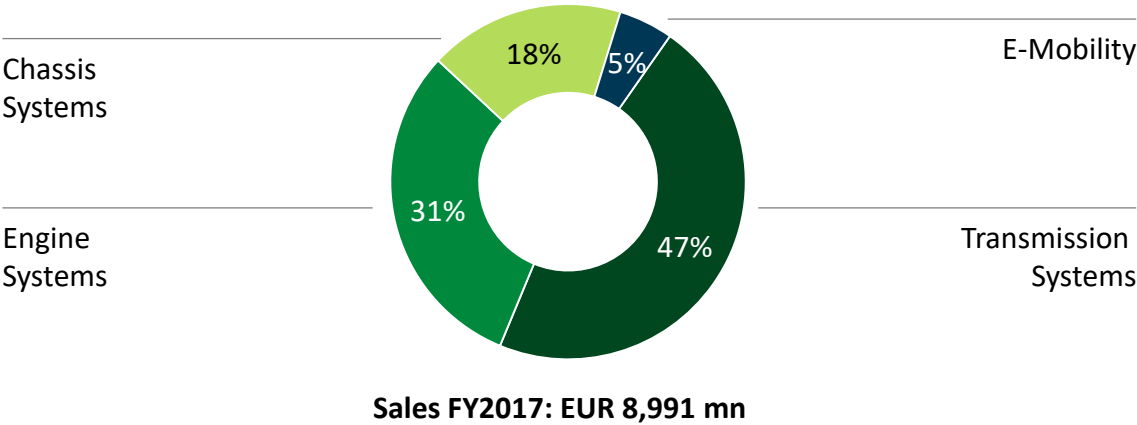
Sales and EBIT margin<sup>3)</sup>

in EUR mn



1) FX-adjusted  
2) Before special items  
3 FY 2017  
4) In % of Group Sales 2017

Sales by business division<sup>3)</sup>



Sales split by customer mix



## Vehicle test cycle



Vehicle registration difficulties due to the new WLTP-cycle

## Trade environment



Risk of new trade wars rising

## China



Economic growth slow down

Macroeconomic environment and risks

Market has become more challenging

Industry-specific development

## Electrification



Paradigm shift in technology leading to a transformation of the industry

## Autonomous driving



Evolution of new mobility solutions creates new market opportunities

## Price pressure



OEMs need to compensate increased investment costs



**Engine systems**  
**31%**

of Automotive OEM sales in 2017

**E-Mobility**  
**5%**

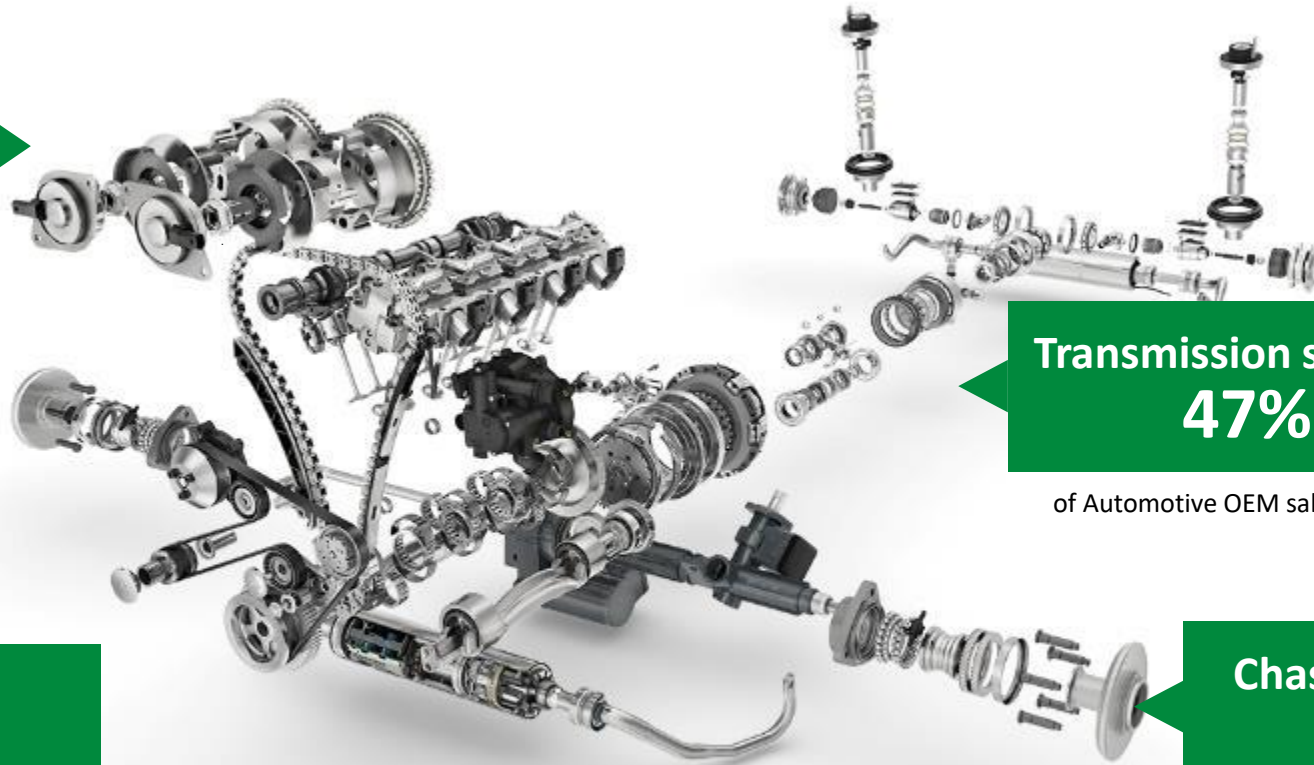
of Automotive OEM sales in 2017

**Transmission systems**  
**47%**

of Automotive OEM sales in 2017

**Chassis systems**  
**18%**

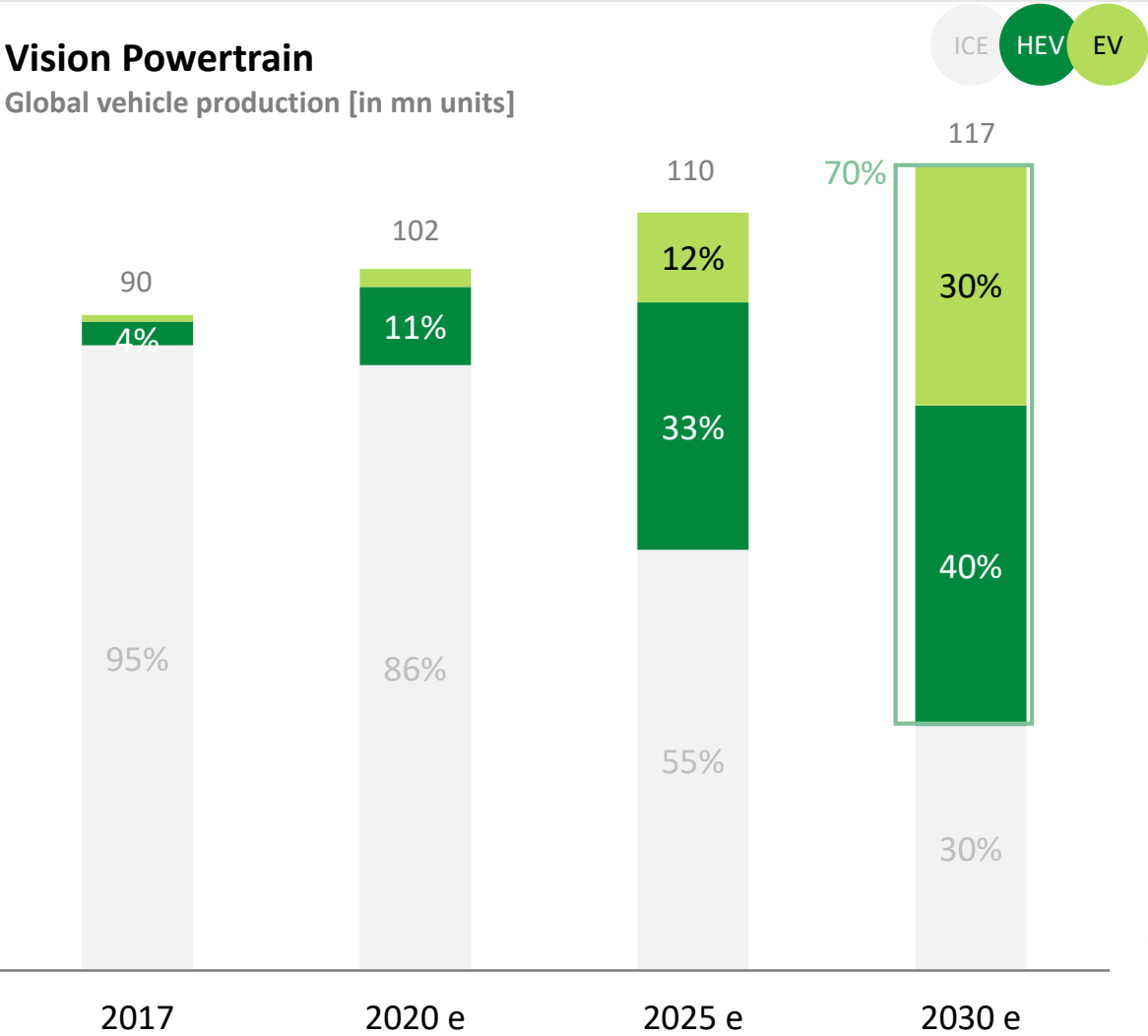
of Automotive OEM sales in 2017



# Mobility for Tomorrow – Our E-Mobility Strategy

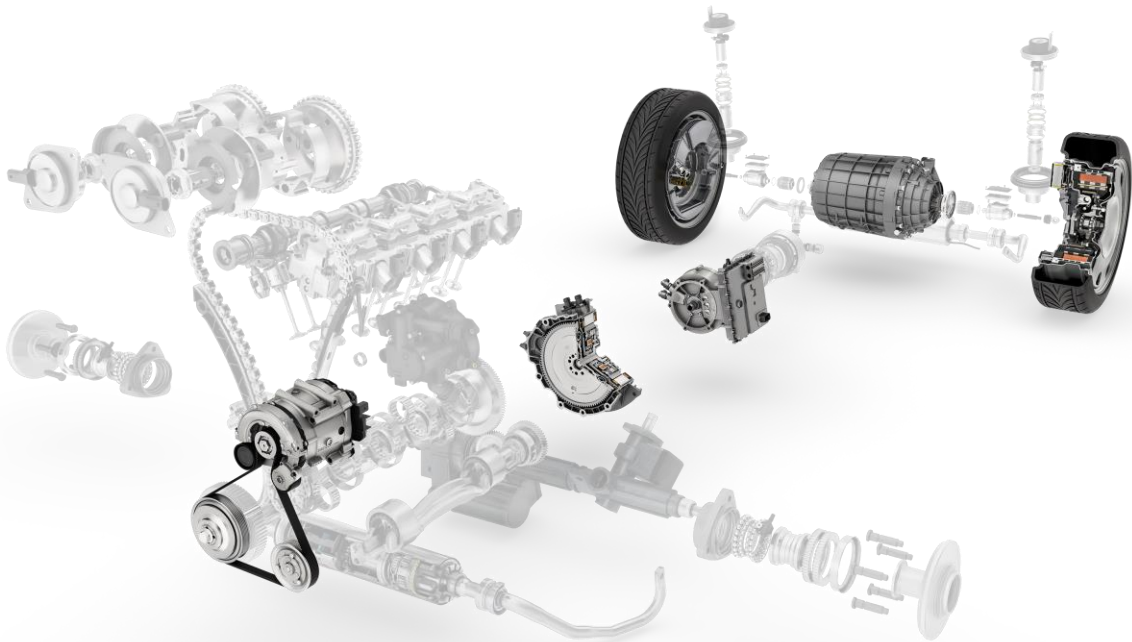
## Vision Powertrain

Global vehicle production [in mn units]



Source: IHS and Schaeffler Assumptions / Values based on Light Vehicles < 6 tons only, ICE = Internal Combustion Engine; HEV = Hybrid Electric Vehicles ranging from 48V Mild Hybrid to PHEV, BEV = Battery Electric Vehicles (incl. Fuel Cell Electric Vehicles)

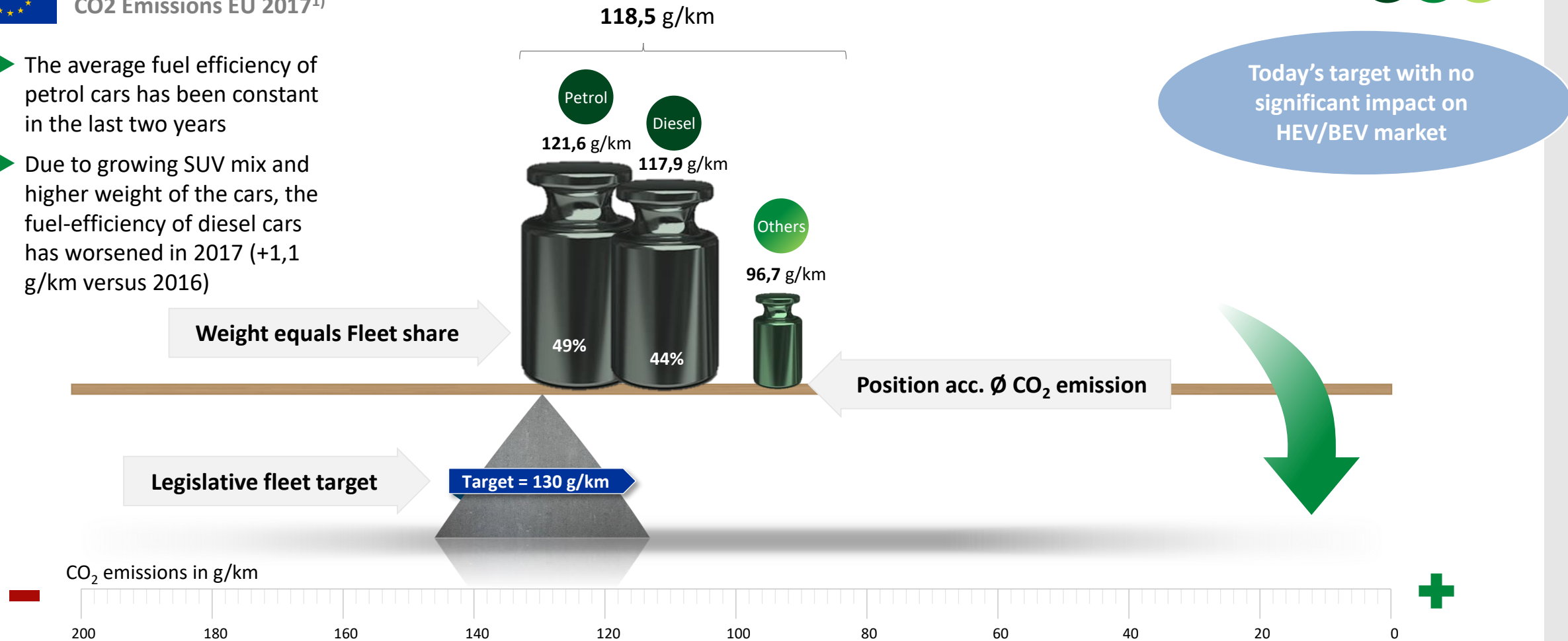
## Electrified Drivetrain Portfolio





## Balancing the scale – No regulatory impact CO2 Emissions EU 2017<sup>1)</sup>

- ▶ The average fuel efficiency of petrol cars has been constant in the last two years
- ▶ Due to growing SUV mix and higher weight of the cars, the fuel-efficiency of diesel cars has worsened in 2017 (+1,1 g/km versus 2016)



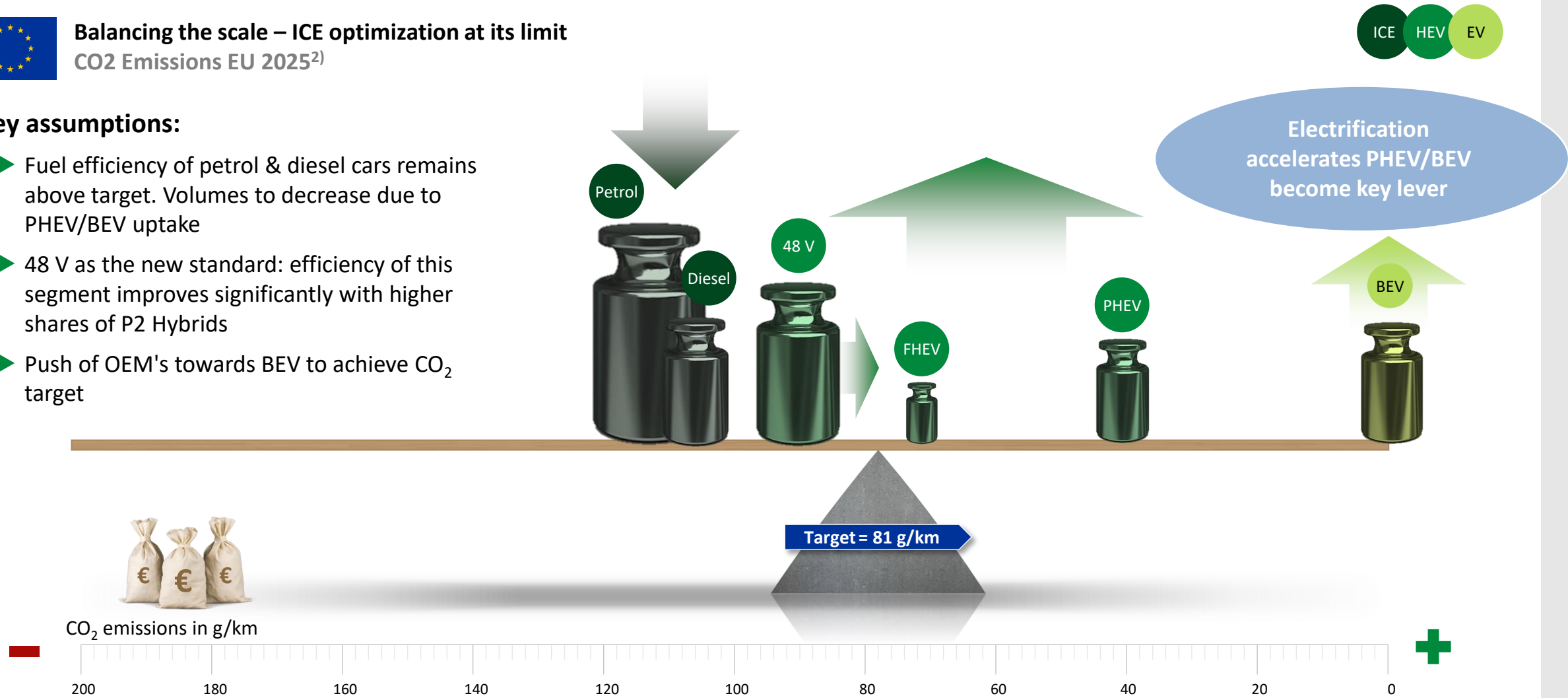
<sup>1)</sup> Data Source: EAA (European Environment Agency): "Monitoring of CO2 emissions from passenger cars - Data 2017 - Provisional data"



## Balancing the scale – ICE optimization at its limit CO2 Emissions EU 2025<sup>2)</sup>

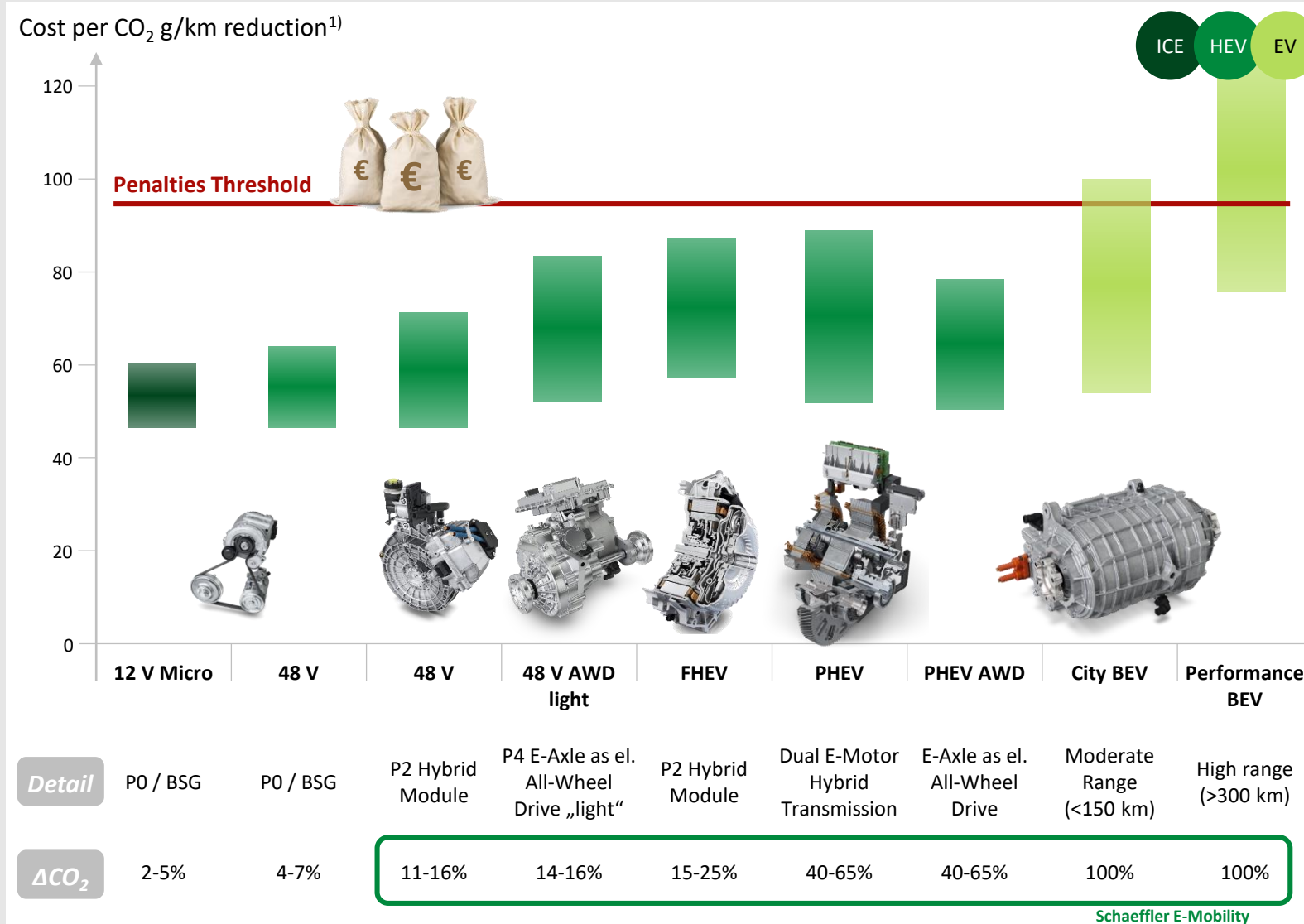
### Key assumptions:

- ▶ Fuel efficiency of petrol & diesel cars remains above target. Volumes to decrease due to PHEV/BEV uptake
- ▶ 48 V as the new standard: efficiency of this segment improves significantly with higher shares of P2 Hybrids
- ▶ Push of OEM's towards BEV to achieve CO<sub>2</sub> target



2) Qualitative presentation only )

# Powertrain Scenario – Cost per CO<sub>2</sub> reduction is key factor for successful business



## Key aspects

- ▶ Hybrid share becomes major lever for OEM to balance CO<sub>2</sub> scale
- ▶ Strong future potential with 48 V P2 architectures at good cost-to-benefit ratio
- ▶ All of Schaeffler E-Mobility portfolio allows for CO<sub>2</sub> emission reductions below the penalty threshold (95 EUR/g)

Portfolio with focus on high-efficiency solutions below penalty threshold

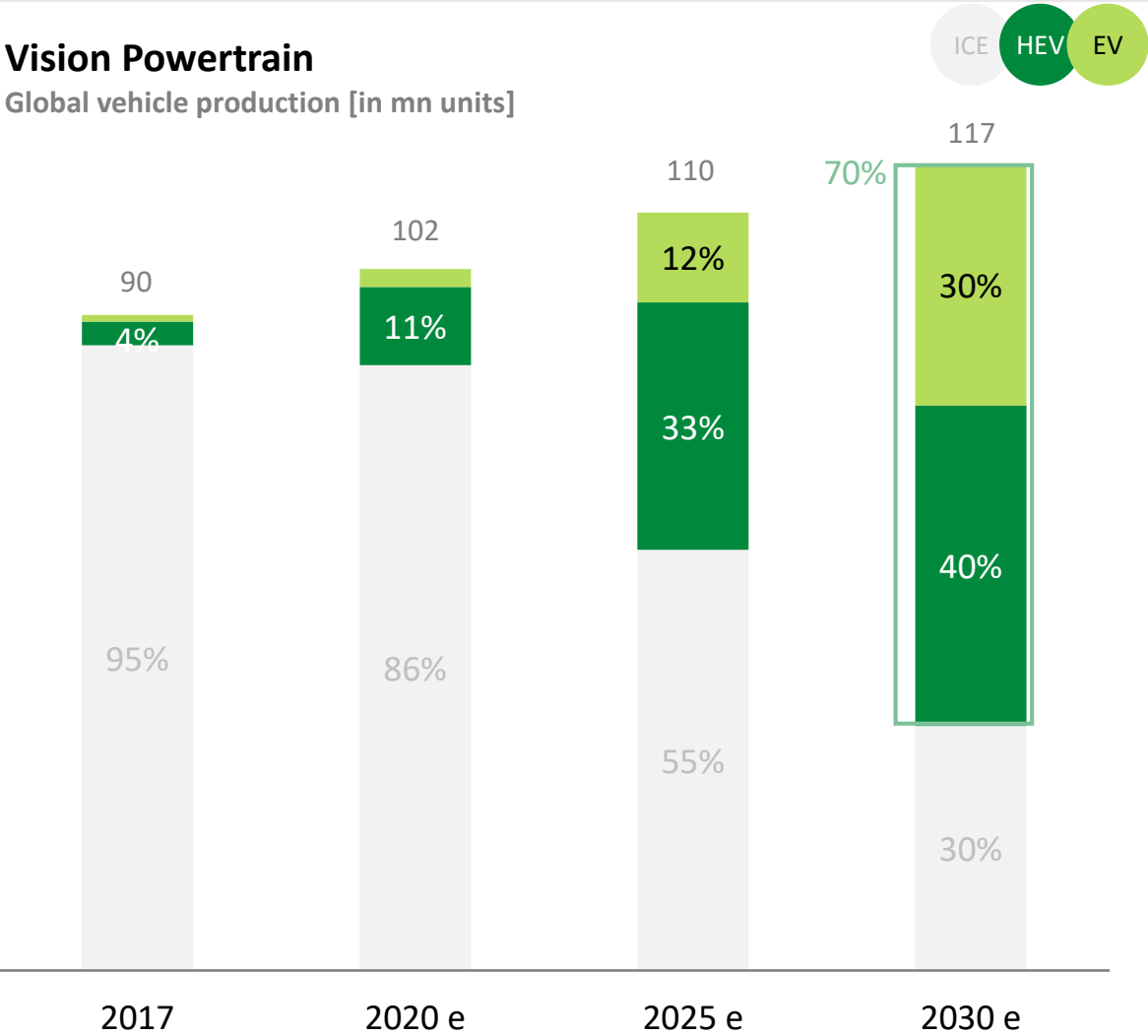
1) Compared to C-Segment basic ICE vehicle. Battery price as per expectation 2020



# Mobility for Tomorrow – Our E-Mobility Strategy

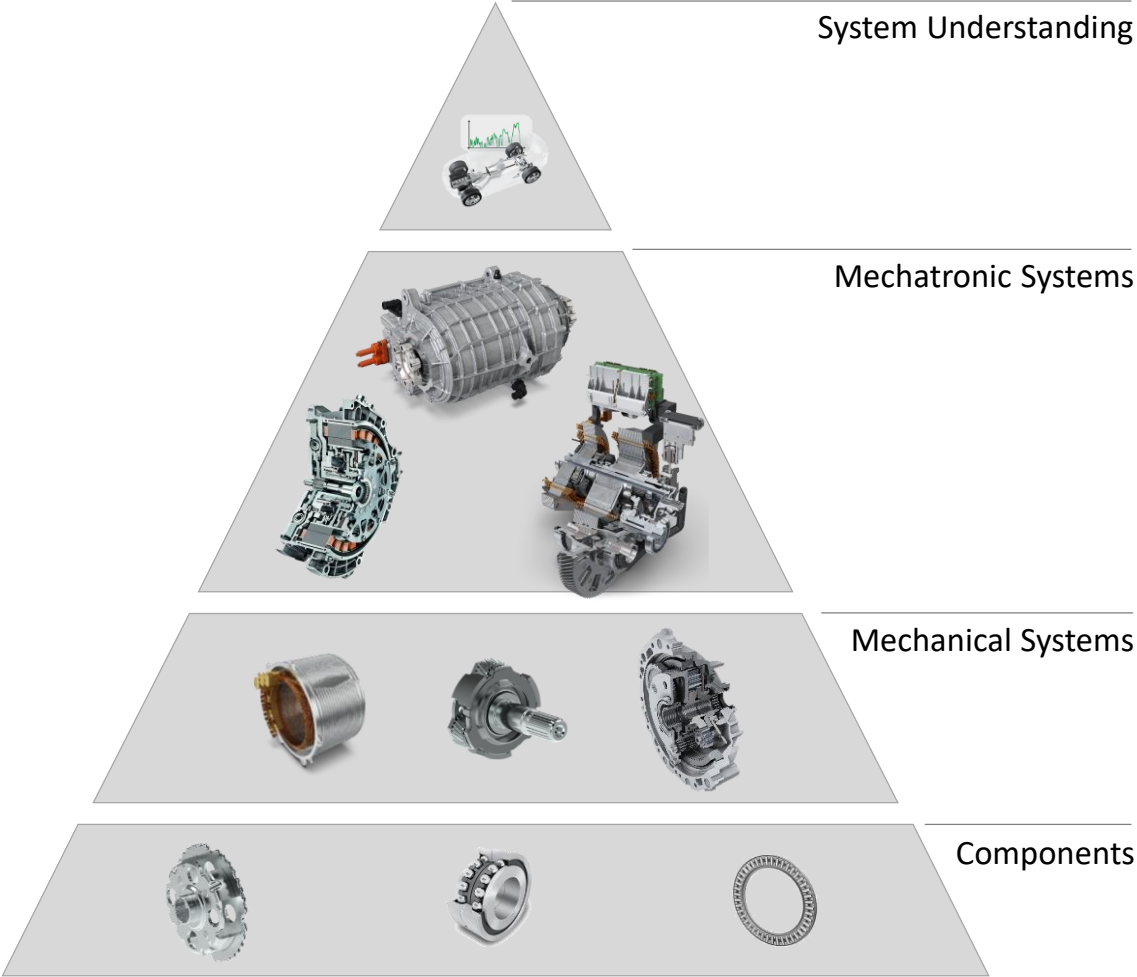
## Vision Powertrain

Global vehicle production [in mn units]



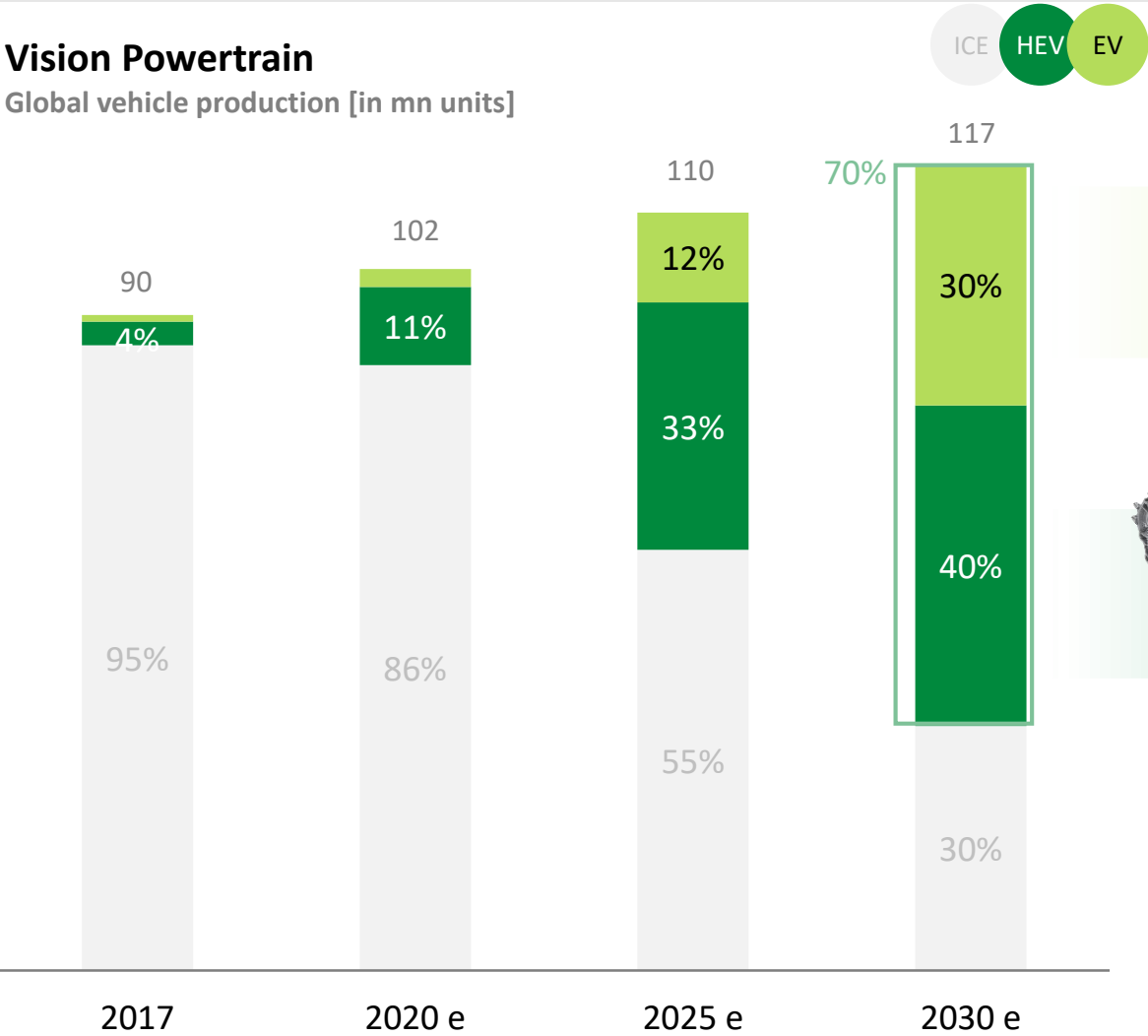
Source: IHS and Schaeffler Assumptions / Values based on Light Vehicles < 6 tons only, ICE = Internal Combustion Engine; HEV = Hybrid Electric Vehicles ranging from 48V Mild Hybrid to PHEV, BEV = Battery Electric Vehicles (incl. Fuel Cell Electric Vehicles)

## E-Mobility Pyramid



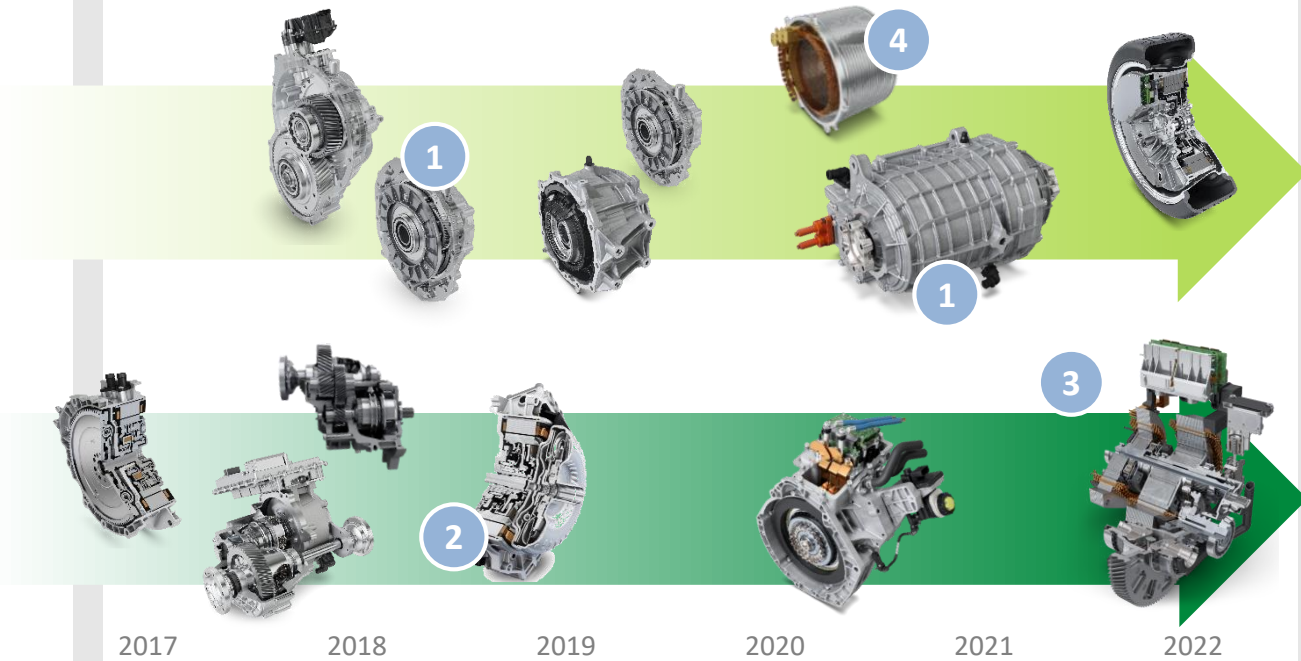
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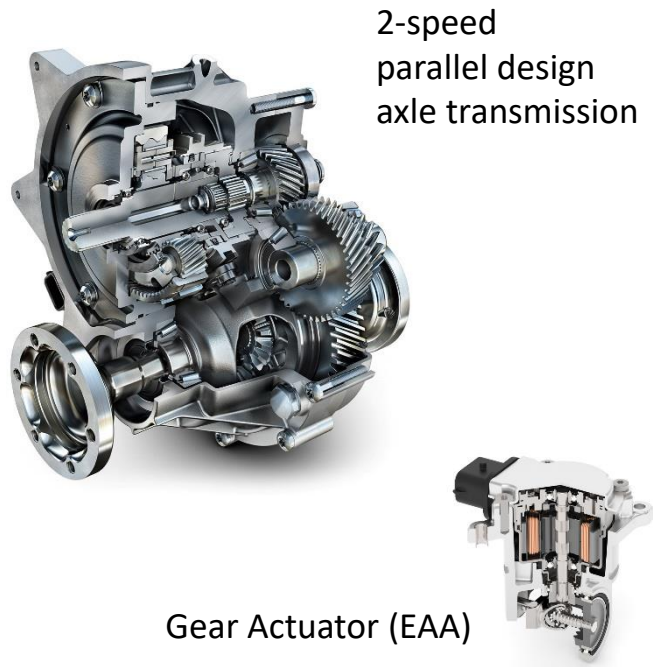
## E-Mobility Production Roadmap



- ▶ Hybrid Module Gen.2 and 2-speed E-Axle Transmissions for HEV applications in Series production
- ▶ Coaxial and parallel design 1-speed E-Axle Transmission for BEV application Europe SOP in process
- ▶ Hybrid Module Gen.3 with integrated Torque Converter to follow 12/2018

2-Speed Axle Transmission

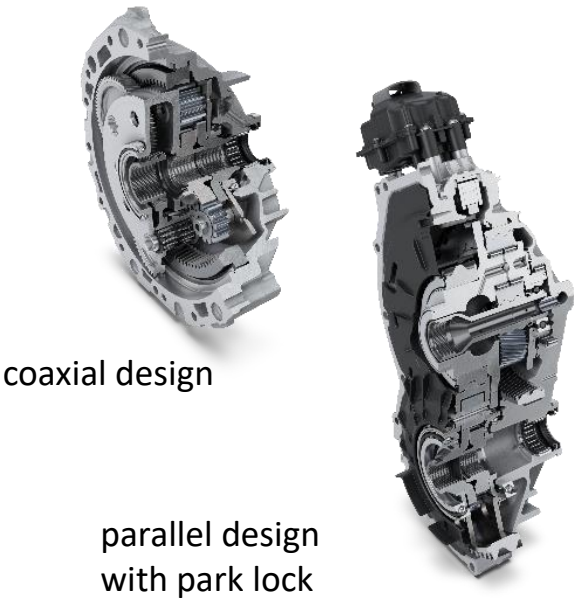
for HEV applications, with integrated gear actuation and based on conventional bevel differential



in series production

1-speed Axle Transmission

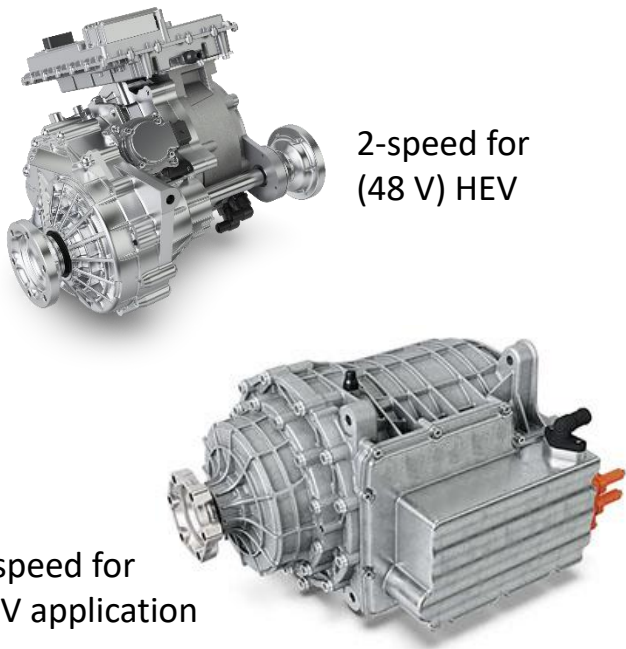
based on Schaeffler Lightweight Differential with best in class Power Density, with optional parking lock actuation



In series production

E-Axle Systems

based on high power density transmission design kits, with integrated E-Motor and Power Electronics



Target SOP 2020/21





## Basics:

- Schaeffler Light Weight Differential in combination with planetary gear set and spur gear stage
- Optional additional functions: parking lock, decoupling device
- stand alone transmission or integrated gear set

## Modular design kit for different T/M ratios

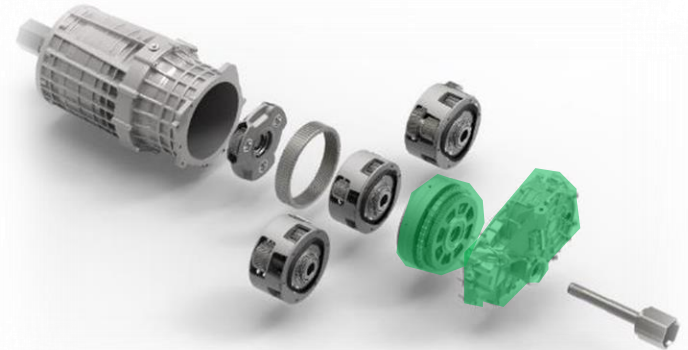


...for coaxial & offset arrangements

## 2-speed solutions possible

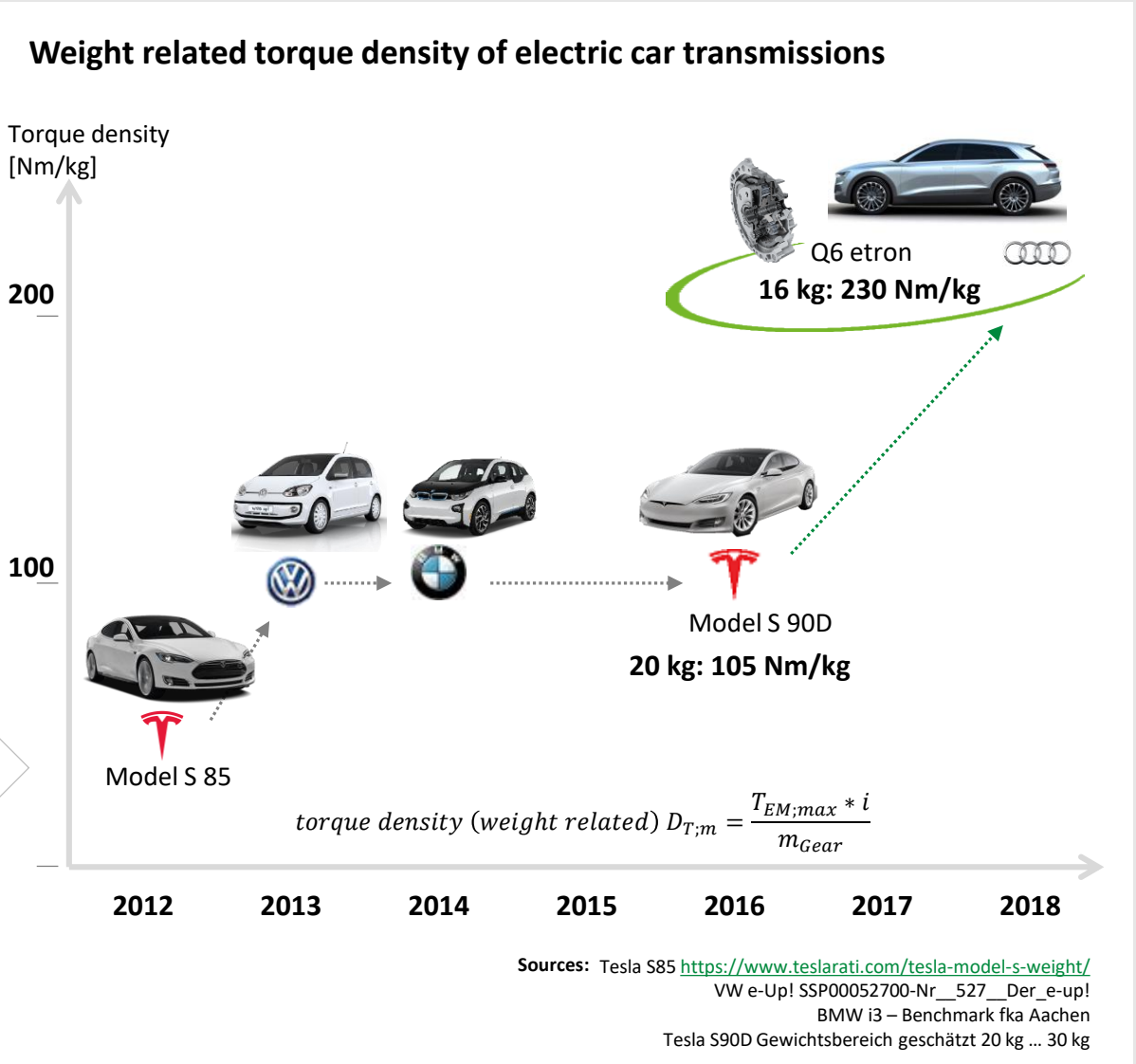


## Torque Vectoring units can be added





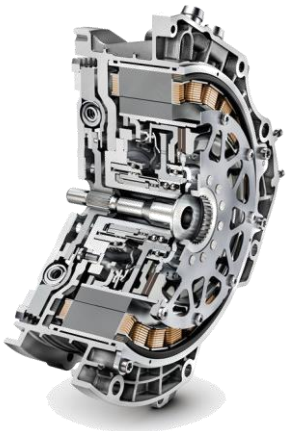
# Schaeffler is supplier for the new Audi eTron front & rear axle transmission! 1



## P2 Hybrid Modules: Variants & Portfolio Roadmap 2

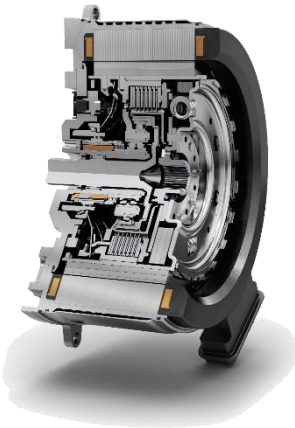
### Generation 2

highly integrated Hybrid Modules for Mild-, Full- and Plugin Hybrid applications



integrated wet KO clutch

integrated dry KO clutch



in series production

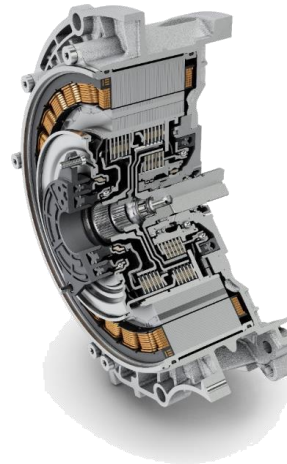
### Generation 3

integration of Start-up element to further reduce required design space and system costs



integrated Triple Clutch (3K)

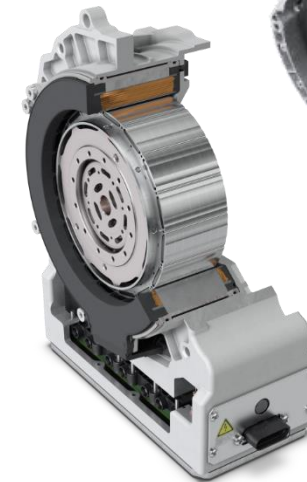
integrated Torque Converter



SOP Q4/2018

### Generation 4

integration of power electronics to further reduce packaging requirements and costs

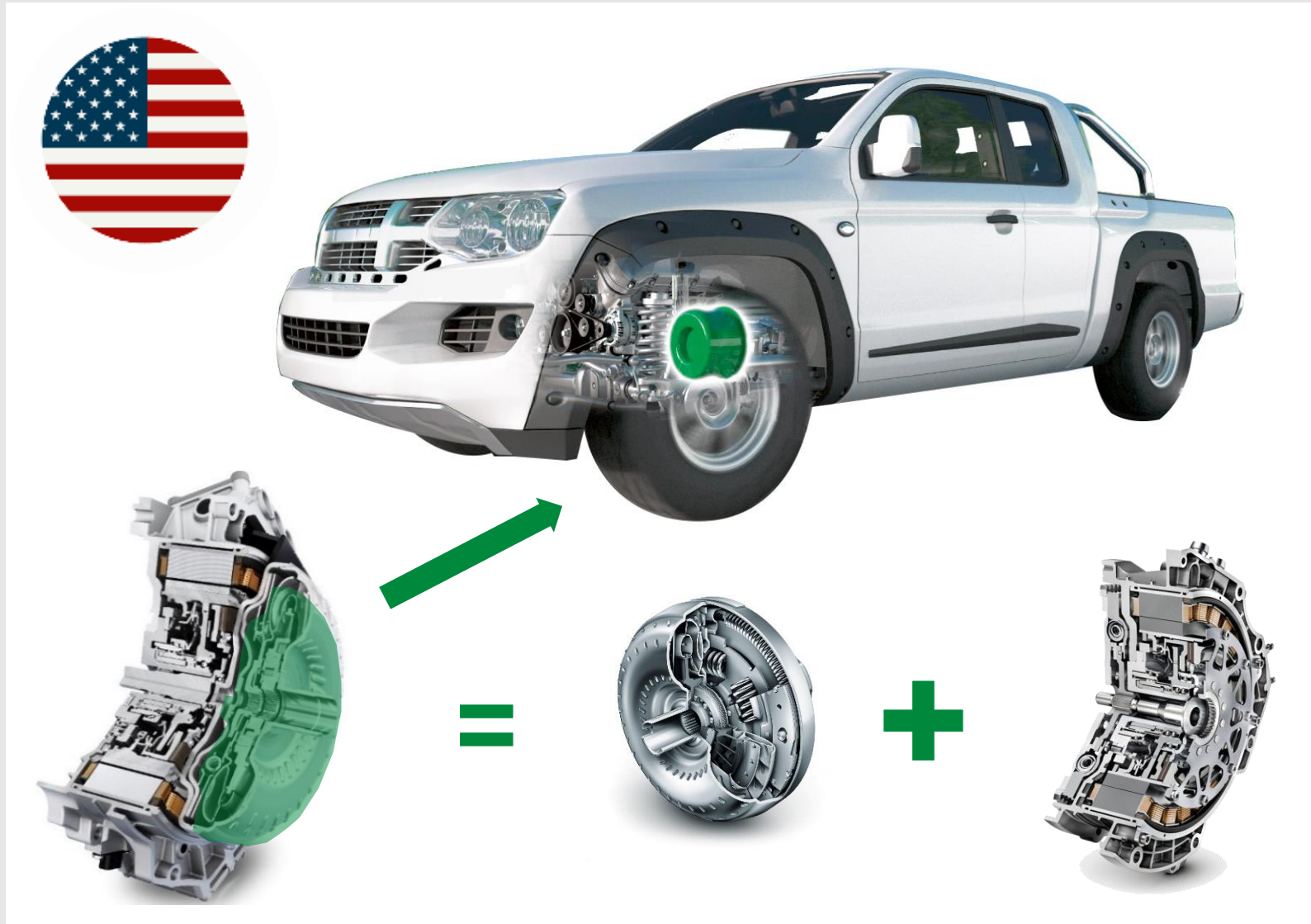


integration of Power Electronics HV or 48 V

Target SOP 2020/21

## P2 High Voltage Hybrid Module with integrated torque inverter 2

SCHAEFFLER



### Top facts of P2 HV Hybrid Module with integrated torque converter:

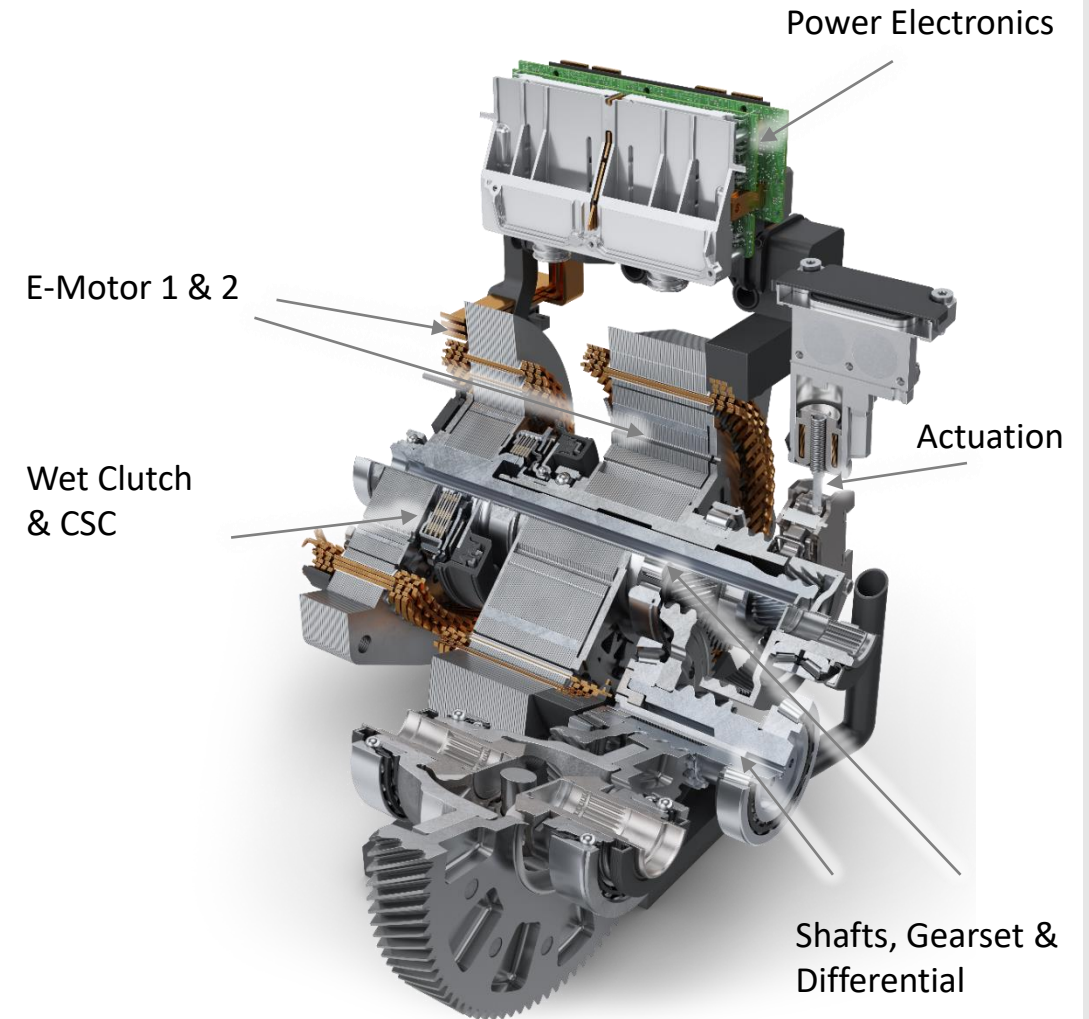
- High E-motor constant power up to 70 kW with active oil cooling at rotor and stator
- ICE torque up to 600 Nm; TC input to 700 Nm
- Compact design requires significantly less space than conventional P2 architecture
- Combined optimization of the damping system
- Available for the first time in 2020 in North America

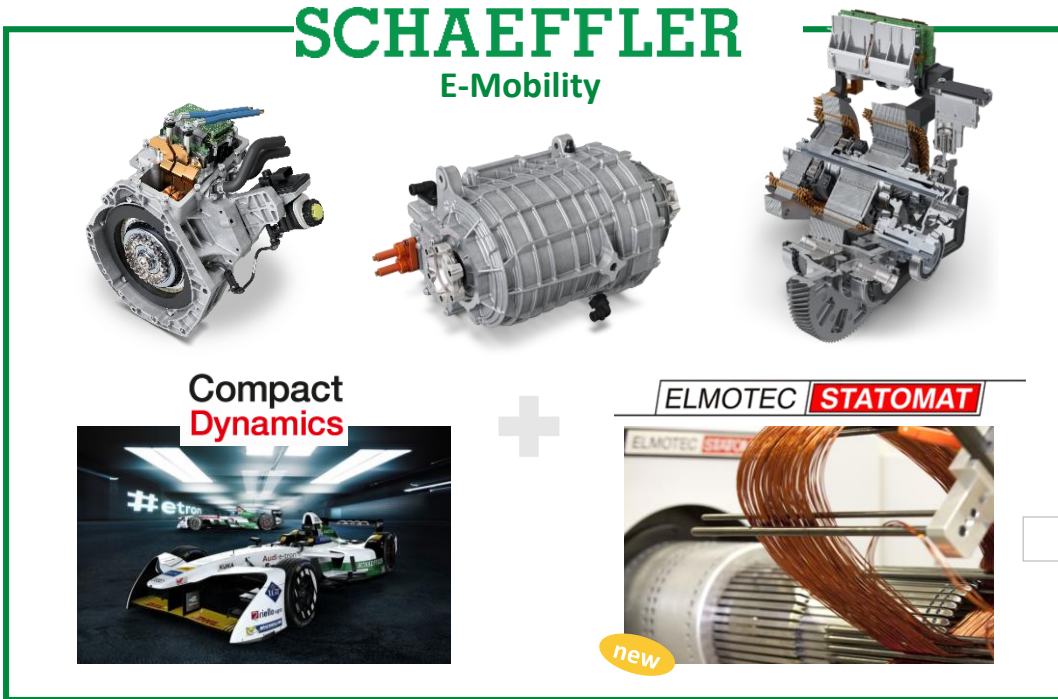
Market specific solutions  
based on Schaeffler core  
Know-How in Transmission  
Systems



**Technology:**

- Highly simplified & innovative transmission concept for Full- & Plugin-Hybrid applications based on two electric machines combined with Schaeffler clutches, actuation and differential expertise.
- Outstanding driving comfort without any shifting (EVT = Electrically variable transmission) and good driving performance (2,500 Nm / 125 kW).
- Compact design allows for integration into existing vehicle platforms without any additional space requirements.
- High fuel efficiency & very good price potential (<2.000 EUR)

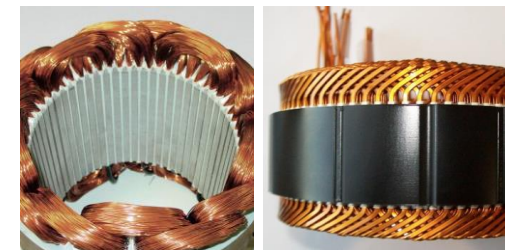
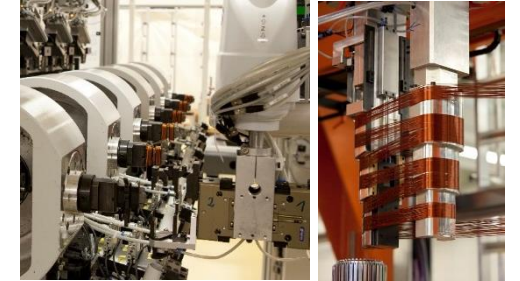




Development, industrialization  
& mass production expertise for  
the Mobility for Tomorrow

### About Elmotec Statomat

- Elmotec is a pioneer in the production of stator manufacturing machines and world's largest supplier of machines for the production of stators for electric motors, alternators and generators
- The headquarter of Elmotec Statomat GmbH is located in Karben near Frankfurt am Main (Germany) and has around 200 employees
- Elmotec has been focusing on the round wire, flatwire and hairpin process technologies, and holds several over 50 patents for innovative winding technology (e.g. wave-winding)

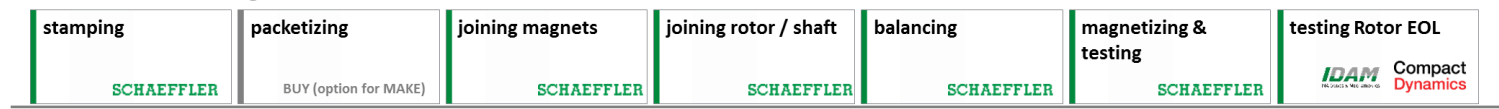




## Stator Manufacturing Processes



## Rotor Manufacturing Processes



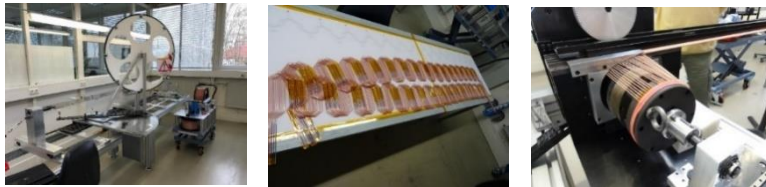
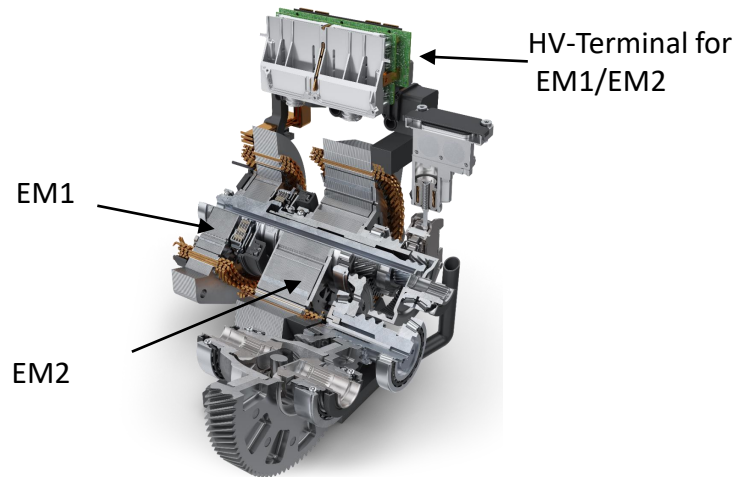
- in series production at Schaeffler today
- prototyping machines available at Schaeffler
- ext. supplier technology as of today
- Production Technology Elmotec Statomat

**SCHAEFFLER E-Motor**  
with wave-winding technology

Schaeffler already covered the majority of the E-Motor production processes  
With this acquisition we are closing now the last remaining production technology gap

Ready to produce  
by 2020

## Dedicated Hybrid Transmission



- Highly simplified & innovative transmission concept for Full- & Plugin-Hybrid applications based on **two electric machines** combined with Schaeffler clutches, actuation and differential expertise

## P2 Hybrid Modul

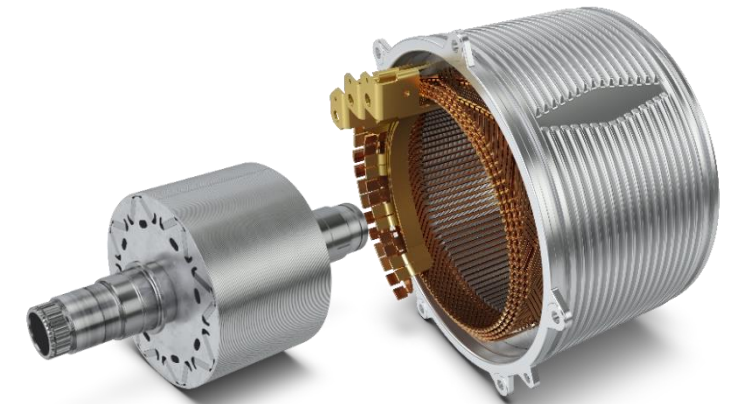


Coil winding & joining machine



- Schaeffler P2 Hybrid E-Motor in **single tooth winding** technology
- Rotor and stator cooling with oil (supplied by transmission)
- E-Motor Peak Power up to 125 kW

## 400V/800V E-motor



- High traction power
- Reduced charging time
- Power 400 V class up to 250 kW
- Power 800 V class up to 500 kW





# Thank You!

E-Mobility - a Business Division of the Schaeffler Group

Dr. Jochen Schröder  
08.01.2019