2.2 Deep-dive E-Mobility

Dr. Jochen Schröder
President Business Division E-Mobility

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Capital Markets Day 2018
Berlin
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2.2 Deep-dive E-Mobility

Dr. Jochen Schröder – Today's E-Mobility speaker

Dr. Jochen Schröder (47)
President Business Division E-Mobility

- 2001 – 2006  transmission development & head of E/E transmission at BMW AG
- 2006 – 2009  Head of Electric/Electronics at BMW-Sauber Formula 1, BMW AG
- 2009 – 2013  Head of system design & advanced development E-Drive at BMW AG / BMW-Peugeot-Citroën Electrification
- 2013 – 2016  Various leadership positions at BMW AG
- 2016 – 2018  CTO Valeo-Siemens eAutomotive
- Since 2018   President BD E-Mobility at Schaeffler
2.2 Deep-dive E-Mobility

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)
Powertrain Scenario – More than just assumptions

- Weight equals Fleet share
- Position acc. ∅ CO₂ emission
- Legislative fleet target

CO₂ emissions in g/km

ICE
HEV
EV
Balancing the scale – No regulatory impact
CO2 Emissions EU 2017\(^1\)

- 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).

Today’s target with no significant impact on HEV/BEV market

1) Data Source: EAA (European Environment Agency): “Monitoring of CO2 emissions from passenger cars - Data 2017 - Provisional data”
Powertrain Scenario – Regulations in 2021 will accelerate the market change

Balancing the scale – Fines will impact OEM offering

CO2 Emissions EU 2021

Key assumptions:
- The average fuel efficiency of petrol & diesel cars improve but move above target, share of diesel vehicles likely to decline further
- Hybrid technology as major steering element to achieve emission targets

CO2 regulation to impact electrification push

2) Qualitative presentation only
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Powertrain Scenario – Hybrid Technology will become key to achieve regulatory equilibrium

Balancing the scale – ICE optimization at its limit
CO2 Emissions EU 2025

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 CO2 target

Electrification accelerates PHEV/BEV become key lever

2) Qualitative presentation only | * Target 2025 currently in discussion. Latest proposal is -30% in 2030 compared to 2021 (~66 g/km in 2030)
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Powertrain Scenario – Different approaches per OEM and Region

Key aspects
- CO₂ and Emission Targets can be achieved with many different strategies
- Even a Hybrid-only strategy could lead to target achievements
- Penalties vs. additional costs per Powertrain is key aspect of OEMs strategy

OEM A
Full powertrain mix strategy

OEM B
Hybrid focus

OEM C
Battery-electric focus
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Powertrain Scenario – Cost per CO₂ reduction is key factor for successful business

Key aspects

- Hybrid share becomes major lever for OEM to balance CO₂ scale
- Strong future potential with 48 V P2 architectures at good cost-to-benefit ratio
- All of Schaeffler E-Mobility portfolio allows for CO₂ 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
Vision Powertrain
Global vehicle production [in mn units]

<table>
<thead>
<tr>
<th>Year</th>
<th>ICE</th>
<th>HEV</th>
<th>EV</th>
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<tbody>
<tr>
<td>2017</td>
<td>90</td>
<td>11%</td>
<td>4%</td>
</tr>
<tr>
<td>2020 e</td>
<td>102</td>
<td>12%</td>
<td>11%</td>
</tr>
<tr>
<td>2025 e</td>
<td>110</td>
<td>30%</td>
<td>33%</td>
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<tr>
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Vision Powertrain
Global vehicle production [in mn units]

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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
Best-in-class power density for E-Axle transmissions: 230 Nm/kg

2011-2014: BEV Concept Car Active-E-Drive

E-Axle System solution with 2-speed transmission and torque vectoring unit

2018 Schaeffler E-Axle Transmissions

SOP Q3/2018

Best-in-class power density for E-Axle transmissions: 230 Nm/kg

Schaeffler E-Axle System Solutions 2020+

Weight and material reduced by ~15 kg

Peak Torque x2 and peak Performance x2.5

Additional cost benefits due to modular design kits
### 2017/2018 Schaeffler Hybrid Modules in Series Production

<table>
<thead>
<tr>
<th>Module Type</th>
<th>SOP Date</th>
<th>Image</th>
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<tbody>
<tr>
<td>Gen. 2 Hybrid Module</td>
<td>Q4/2017</td>
<td>![Module Image]</td>
</tr>
<tr>
<td>Gen. 3 Hybrid Module</td>
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### Schaeffler Hybrid System Solutions 2020+

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<tr>
<td>Dedicated Hybrid Transmission</td>
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**Market specific solutions based on Schaeffler core Know-How in Transmission Systems**

- Hybrid Modules with integrated Power Electronics, as well as full dedicated Hybrid Transmissions (DHT) to meet future CO2 requirements at attractive costs, for all global markets.
- Additional Content potential per vehicle of up to **+100%** compared to Gen. 2 Hybrid Modules.
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E-Motor – Production expertise in place. Ready to produce!

Stator Manufacturing Processes*

- Stamping: Schaeffler
- Packetizing: (Option for M4AE)
- Slot insulating: Compact Dynamics
- Copper wire forming: Schaeffler
- Slot closure: IDAP
- Mechanical fixing & thermal cond.: Schaeffler
- Contacting: Schaeffler
- Insulating of el. contacts: Schaeffler
- Joining temp. sensors: Schaeffler
- Joining stator / carrier: Schaeffler
- Testing Stator EOL: Schaeffler

Rotor Manufacturing Processes*

- Stamping: Schaeffler
- Packetizing: (Option for M4AE)
- Joining magnets: Schaeffler
- Joining rotor / shaft: Schaeffler
- Balancing: Schaeffler
- Magnetizing & testing: Schaeffler
- Testing Rotor EOL: Schaeffler

* Prototyping machines available at Schaeffler
* Ext. supplier technology as of today

Ready to produce by 2020
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„We are ready“ – Ready when you are!