Power to the Wheels
Wege zur skalierbaren Mobilität

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Agenda

• Future Regulation and impact
• Different customer expectation
• Manage complexity by Building Blocks
• Magna Scalability approach
• e2- Demonstrator
• Summary & Outlook

• Future regulation triggers electrification.
• Considering segmentation of the market several solutions from Mild Hybrid up to BEV will need to satisfy different consumer expectation
• Complexity of powertrain solutions
• The obvious increase of Powertrain solutions needs to be managed.
• How Magna sees the reduction in complexity by our scalability approach: from Mild hybrid to BEV with scalable building blocks
Air Quality Concerns drive Zero Emission Powertrains

- Transition from fossil fuels to renewable energy sources reduces NOx and PM
- Less fossil fuel consumption reduces quantity of all pollutants

There is significant uncertainty in regional legislation

- Global platform approach is questionable for powertrain systems
- Number of powertrain architectures will expand to ~50 globally
- Modular and scalable powertrain products are needed to support the wide range of architectures that will emerge

Consumer buying preferences will also drive electrification

- SUV boom (heavier vehicles with more power needed)
- Diesel shares are dropping, resulting in higher fleet CO2
Regional Legislation

CO₂ Fleet Average Emissions Standards

Total Lifecycle Assessment
Paris Agreement perspective

Co2 regulation for USAGE of vehicles

**Co₂ Emissions (g/km)**
Normalized to NEDC for all regions

**Passenger Car**
- 2006: 160
- 2015: 130
- 2020: 81
- 2025: 95
- 2030: 59

**Light Duty Truck**
- 2006: 294
- 2015: 219
- 2020: 186
- 2025: 197
- 2030: 154

**China Industry Development Roadmap 2030**
- Agreement: 2025 15%, 2030 37.5%
- Phase-in: 2020 95%; 2021 100%

**Fleet analysis range**
- 63%
- 50-66%

**Proposed Regulation**
- 48-64%
- 60%

**Perspective**
- Paris Agreement

**Co₂ Regulation for USAGE of Vehicles**
- Fleet analysis range
- Proposed Regulation

10/11/2019
D.E. Barnhart
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Powertrain Share 2025
Global and 3 Major Markets

**Global 2025**
Powertrain Technology share
For Passenger Cars and Light Duty Trucks
*Powertrain share: average out of considered scenarios*

**Global in Millions**
- 41%: 37.6
- 28%: 26.2
- 18%: 16.9
- 14%: 12.4
- 6%: 5.7
- 2%: 1.6

**Source:** Magna Fleet Analysis, 11.2018
Market Trends and Electrification of the Powertrain

**Market:** Magna and other forecasting agencies foresee market growth through 2025 (1.5% - 2.5% CAGR)
- Most significant growth will occur in China (+6M units 2018 – 2025)
- China market has unique legislation and consumer preferences which impacts local product requirements

**Legislation:** Increasing uncertainties and regional differences on regulation: Powertrain suppliers must:
- Build scale on key building blocks (eMotor, Inverter, Software) as market shifts towards electrified products
- Focus on modular & scalable platforms based on modular & scalable building blocks for all new products

**Magna Fleet Analysis tool enables MPT & OEMs to jointly analyze powertrain architecture options**
- Analysis based on compliance with regional legislation and OEM forecasted segment / model mix
- Collaborative studies can lead to significant findings regarding optimum powertrain product portfolio

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The variety and complexity of the powertrain increases with electrification.

Magna Powertrain’s products support 29 out of 42 possible electrified powertrain architectures.

Mild Hybrids
- # 21

Hybrid Electric Vehicle / Plug-in Hybrid Electric Vehicle
- # 17

Battery Electric Vehicle
- # 4

The variety and complexity of the powertrain increases with electrification.
Brand Differentiation

Legislation

End Consumer Expectations

Model Differentiation

Powertrain Differentiation

SCALABILITY

WE MASTER COMPLEXITY
Performance Path ICE and Hybrids

Shift from scalable ICE power to scalable ePower

History
Scalable on ICE Power

Future
Scalable on ePower

ICE Power [kW]
We are setting new benchmarks with our broad electrification portfolio that includes highly integrated systems from 48V to High Voltage.
Well to Wheel

- **100% CO2 Reduction**
- **PHEV**
- **EV**

**CO2 Reduction**
- **MILDHYBRID**
- **HEV**

**Up to 80% CO2 reduction depending on Well to Tank**
- **20% Sustainable CO2 reduction by ReGen Tank to Wheel**

**START STOP**
- **ICE**
- **28%**
- **2%**
- **6%**
- **20%**
- **60%**
- **80%**

**5-15%**
11 MPT Building Blocks defined

- Gearsets & Differentials
- Synchro
- Shifting System
- Housing & Covers
- Clutches & Decoupling
- Parklock
- Oil
- Hydraulics
- Control HW & Actuation
- Electric Drive (Traction Motor and Inverter)
- SW & Control Algorithms
Scalability Approach

offering electrified systems with scalable building blocks, is key to reflect varying customer requirements.
Driveline Layout

- Scalable CO₂ benefits
- Scalable lateral dynamics
- Scalable longitudinal dynamics
- Scalable All-Wheel Drive
- Scalability SW functions to support diversified OEM branding

Hybrid DCT
- Scalable functionality from mild to plug-in (400V)
- Scalable eMachine from 48V to HV Systems (15kW – 120kW)
- Exclusive torque-split concept for hybridization

Highly Integrated eDrive System
- Scalable PSM Motor from 48V to HV Systems (25 - 160 kW)
- Up to 15,000 rpm
- AWD Functionality
- Optional Torque Vectoring -function
Scalability Approach

SYSTEM POWER

Low Power ICE + DCT

Low Power ICE + HDT/P4 Low 48V

Low Power ICE + HDT and P4 Low 48V

PERFORMANCE

Low Power ICE + HDT and P4 MID HV

Low Power ICE + HDT or P4 MID HV

LEVEL OF ELECTRIFICATION

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Hybrid Scalability: Performance PHEV P2.5+P4

- eMotor Power
- Acceleration 0-100 kph
- CO₂ Improvement
- Vehicle Dynamics
- Gradeability

- ICE Power
- 48V Mild Hybrid
- PHEV 25 kW P2.5+P4 25 kW
- PHEV 85 kW
- PHEV 78 kW P4
- PHEV 85 kW P2.5+P4 78 kW

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e2 Demonstrator nominiert

Österreichischer Staatspreis Mobilität 2019

CONVENTIONAL ICE
Conventional Combustion Engine Front-Wheel Drive

48V MILD HYBRID
48V Mild Hybrid – Front-Wheel Drive
48V Mild Hybrid – All-Wheel Drive

HV PLUG-IN HYBRID
HV Plug-in Hybrid – Front-Wheel Drive
HV Plug-in Hybrid – All-Wheel Drive

BATTERY ELECTRIC VEHICLE
Battery Electric Vehicle Rear-Wheel Drive
Battery Electric Vehicle All-Wheel Drive
Battery Electric Vehicle All-Wheel Drive

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Conventional Combustion Engine
Front-Wheel Drive

HV Plug-in Hybrid – All-Wheel Drive

48V Mild Hybrid – All-Wheel Drive
Conventional Combustion Engine
Front-Wheel Drive

48V Mild Hybrid – All-Wheel Drive

HV Plug-in Hybrid – All-Wheel Drive

Conventional Combustion Engine
Front-Wheel Drive

48V Mild Hybrid – All-Wheel Drive

HV Plug-in Hybrid – All-Wheel Drive
Hybrid Scalability: Performance PHEV P2.5+P4

CO₂ Savings
Acceleration
Traction Snow
Cost

Scalable functions on modular platform architectures

ICE Start/Stop 12V
Low Power eMachine 48V
2x Low Power eMachine 48V
Medium Power eMachine HV
2x Medium Power eMachine HV
Vehicle Dynamic 4WD TV Longitudinal

100% RA

Efficiency

100% FA

Efficiency

50%

Acceleration

Regeneration (Braking)

Traction Incline / Step-µ

Handling Performance

Handling Stability / Safety
Vehicle Dynamic RWD + TV Lateral

- Acceleration
- Traction Incline / Step-µ
- Efficiency
- Regeneration (Braking)
- Handling Performance
- Handling Stability / Safety

50%
Vehicle Dynamics 4WD TV Longitudinal+ TV Lateral

100% RA

Efficiency

50%

100% FA

Efficiency

Traction Incline / Step-µ

Handling Performance

Acceleration

Regeneration

Handling Stability / Safety

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Delivering a scalable modular platform for driving performance and CO$_2$ reduction

SHAPING THE FUTURE

MASTERING COMPLEXITY