MAGNA

New Technologies for All-Wheel Drive

A journey through the challenges of electrified AWD Powertrains

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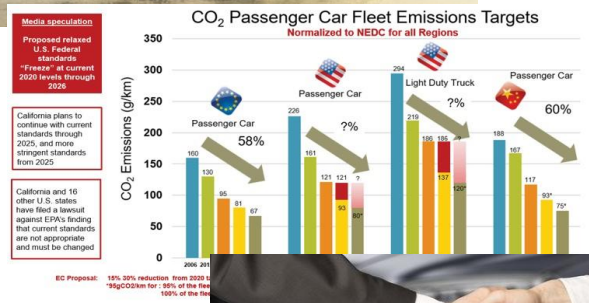
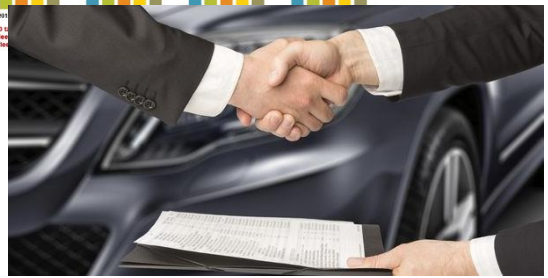
What Future Powertrains Must Deliver

Air Quality Concerns drive Zero Emission Powertrains



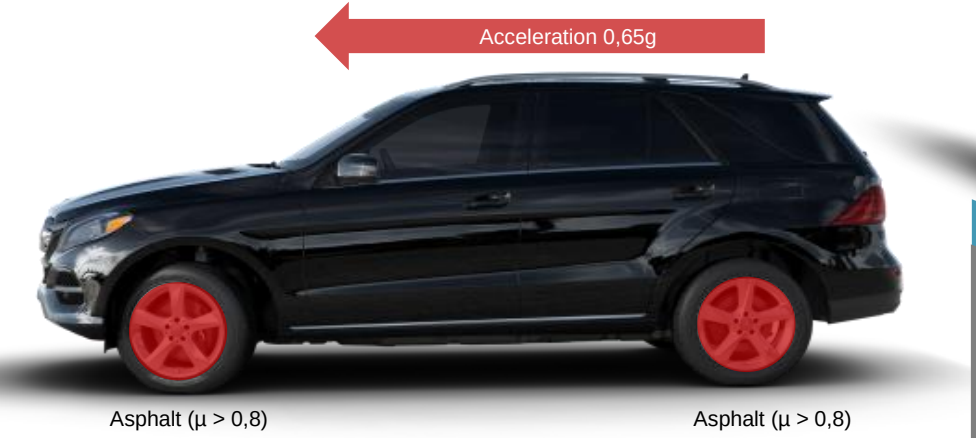
There is significant uncertainty in regional legislation



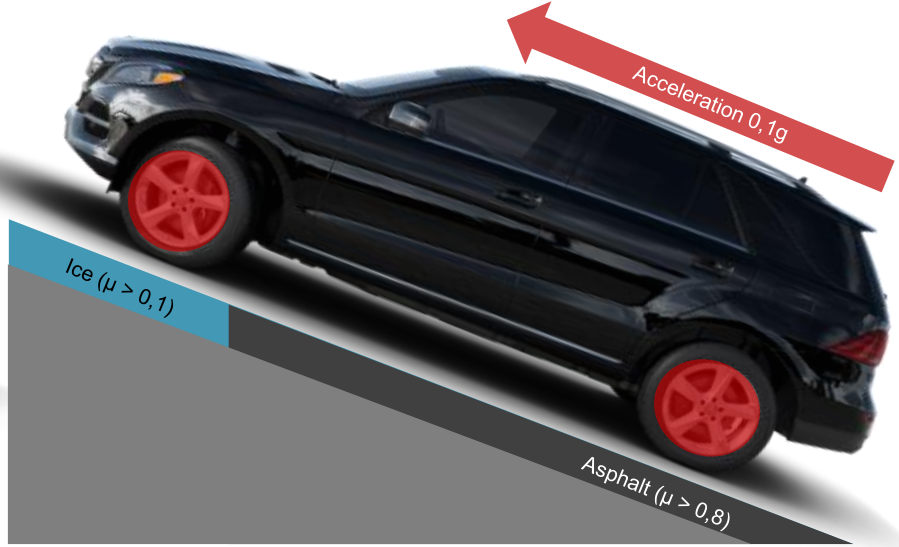
Consumer buying preferences will also drive electrification

The History of 4WD Systems: Traction Focus

Maximum Acceleration



Maximum Gradeability



All-wheel drive systems are well known for improved traction to ensure mobility under severe conditions

Todays Customer Demand beyond Traction Focus

- Desired natural drivability
- Appropriate performance and safety
- Optimized traction for all driving conditions
- Differentiable modesplit
- Optimum efficiency for all day driving condition
- Excellent comfort of control
- Perfect handover and interaction to ESP

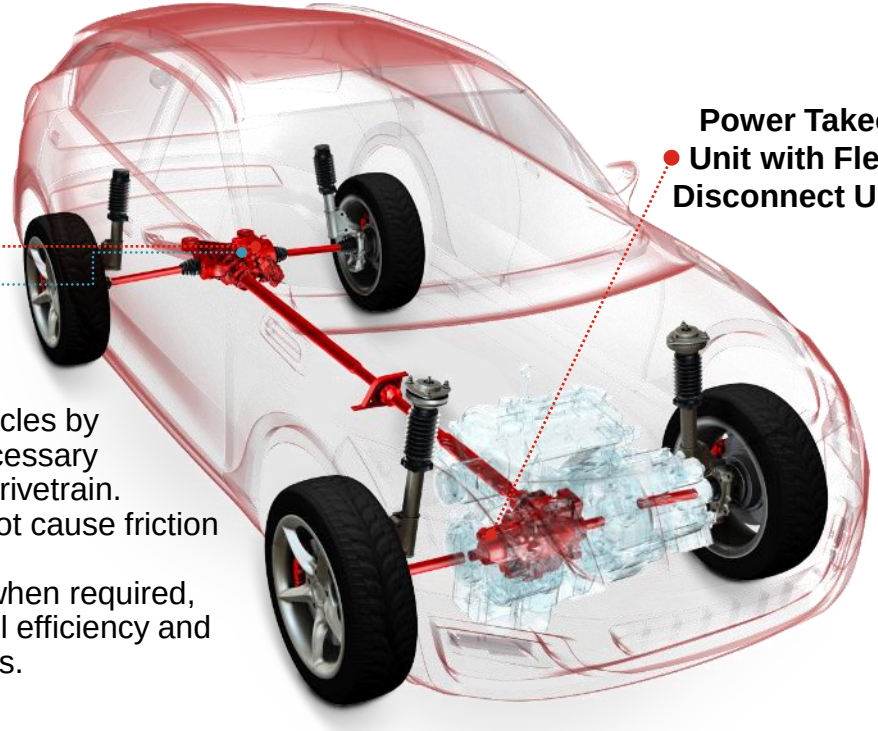
All-wheel drive: Needs-based, highly efficient and comfortable

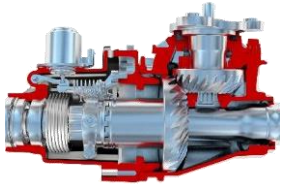
Scaling Efficiency and Performance

Flex4 – Disconnect System

Flex4. The seamless connection.

Magna Powertrain's FLEX4™ is a preemptive disconnect system which greatly increases the fuel efficiency of 4WD vehicles.

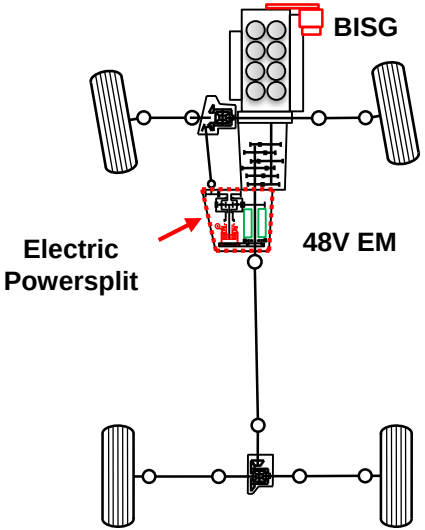




- True 2WD to 4WD vehicles by disconnecting all unnecessary components from the drivetrain.
- Non-moving parts do not cause friction and churning losses.
- 4WD is engaged only when required, therefore improving fuel efficiency and reducing CO_2 emissions.

4WD Torque Vectoring – Functional Benefits

- **Traction**
  - Ideal traction at high steering angle or kinematic slip
  - No trade off between drivetrain bending and wheel slip
  - Optimal vehicle shunting comfort at full 4WD performance
- **Vehicle dynamics**
  - True longitudinal torque vectoring and optimized self steering behavior
  - Torque distribution independent of kinematic slip
  - Realization of different vehicle dynamic modes possible
- **Additional functionalities**
  - “Wear free torque distribution”
  - Compensation of tire diameter differences due to tolerances or wear



Functional Comparison of 4WD Architectures

4WD architectures	WLTP CO_2 impact vs. 2WD	Vehicle Dynamics
Standard 4WD	+5% to +9%	O
Disconnect 4WD	+2%	O
eTC 48V 4WD System (el. Compound Planetary Gear)	approx. -5%	++

- **Trade off in current 4WD driveline architectures**
- **eTransfercase 48V 4WD System is able to provide superior vehicle dynamics while reducing CO_2 emissions**
- **Longitudinal TV in 4WD/TV mode via ICE/EM powersplit**
- **Electric creeping in 2WD/Recup mode via P3 architecture**

Scaling Hybrid Powertrains


BRAND
DIFFERENTIATION
SCALABILITY
POWERTRAIN
DIFFERENTIATION
MODEL
DIFFERENTIATION

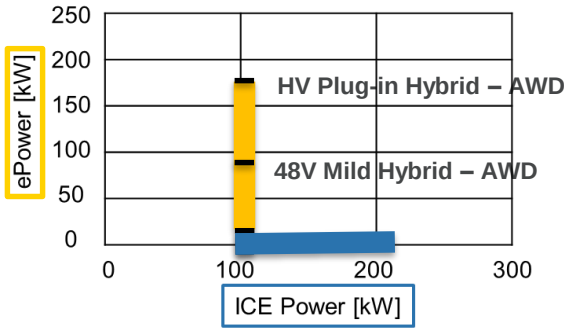
Modular and scalable Building Blocks

Scalability means:

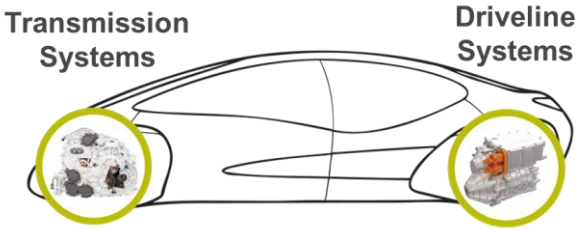
- Scalable functions on the entire vehicle
- Scalable powertrain functions
- Scalable software functionality
- Scalable components performance

E-Motor – the Key for Scaling Efficiency and Power

Scalability shifts from ICE to eMotor



Modular & Scalable Platform



Capabilities

DCT family

HDT family

DHT

Capabilities

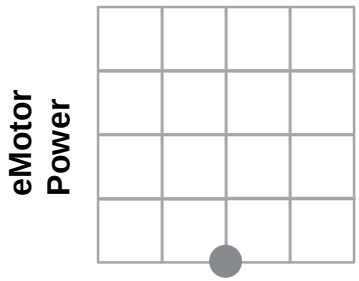
Full AWD/4WD portfolio

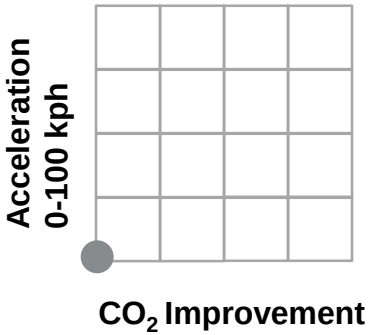
eDrives

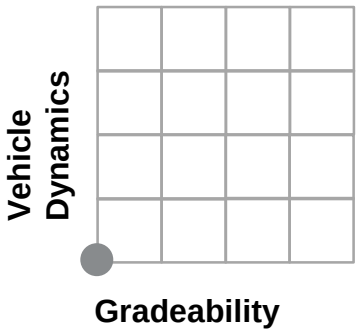
OEM Benefit

- Reduced complexity
- Scalable functions
- Diversified OEM branding
- Package advantage
- High re-use of content

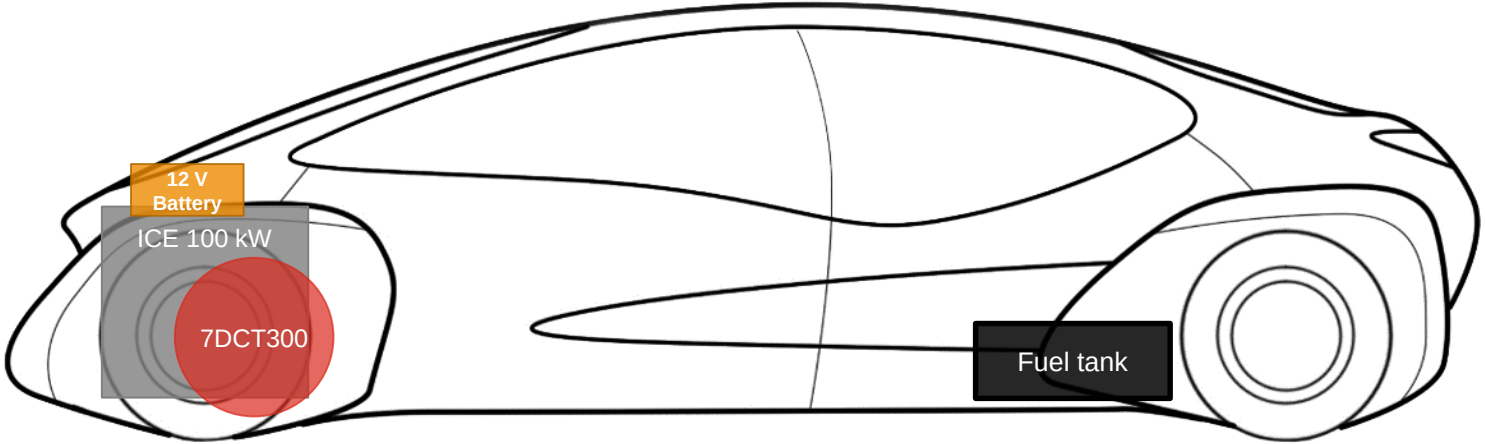
Base Architecture Conventional ICE with DCT



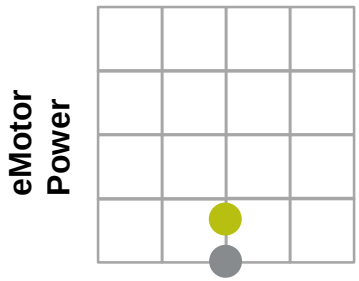


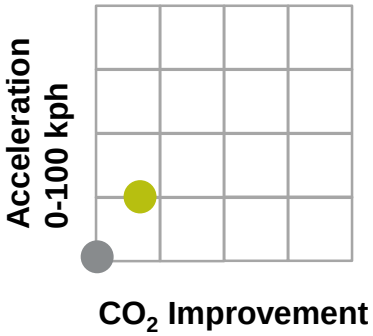


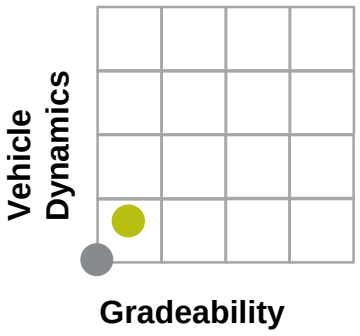
Conventional ICE



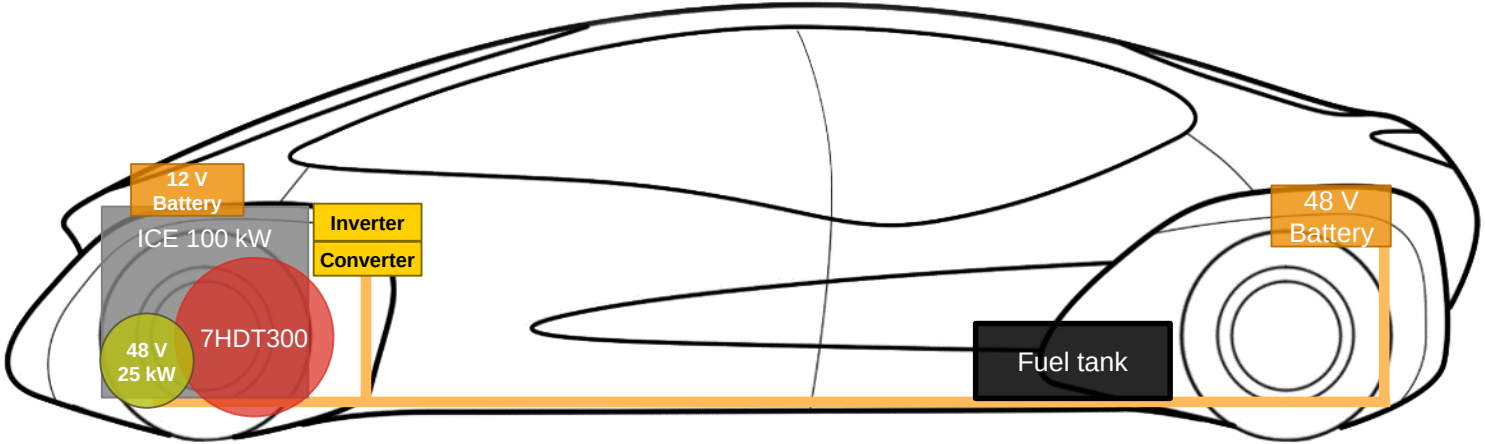
Hybrid Scalability: 48V Mild Hybrid HDT 25 kW P2.5



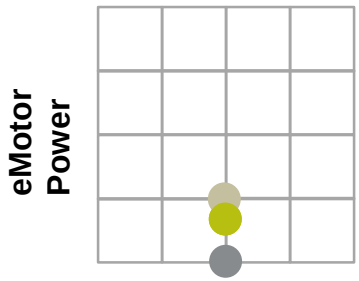




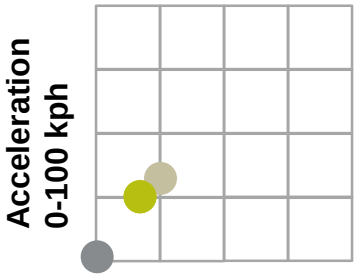
- Conventional ICE
- 48V Mild Hybrid



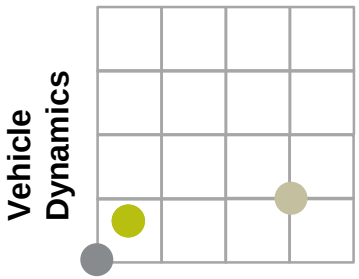
Hybrid Scalability: Performance MHEV P2.5+P4



ICE Power



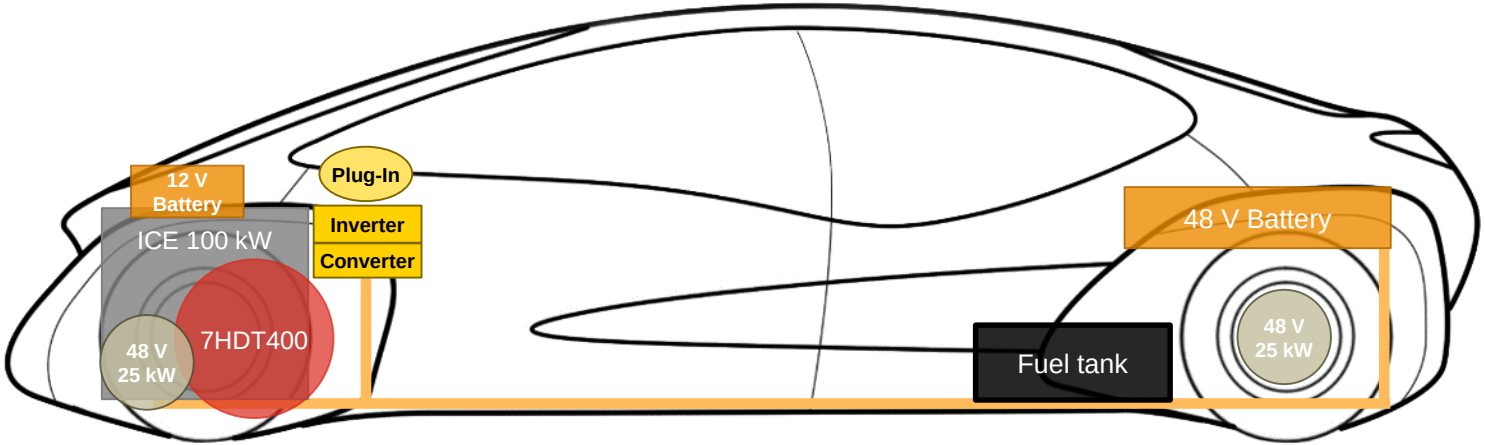
CO_2 Improvement



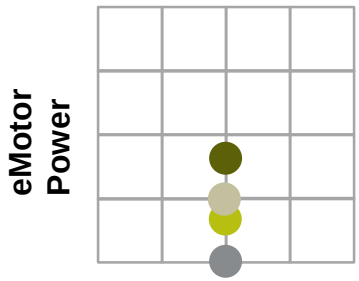
Gradeability

ZERO EMISSION CAPABLE

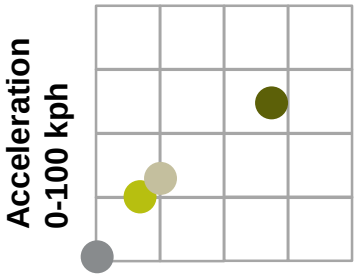
- Conventional ICE 2WD
- 48V Mild Hybrid 2WD
- 48V : 25 kW P2.5 + 25kW P4



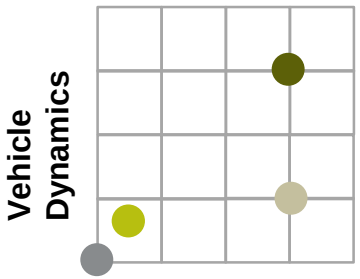
Hybrid Scalability: Performance PHEV P4



ICE Power



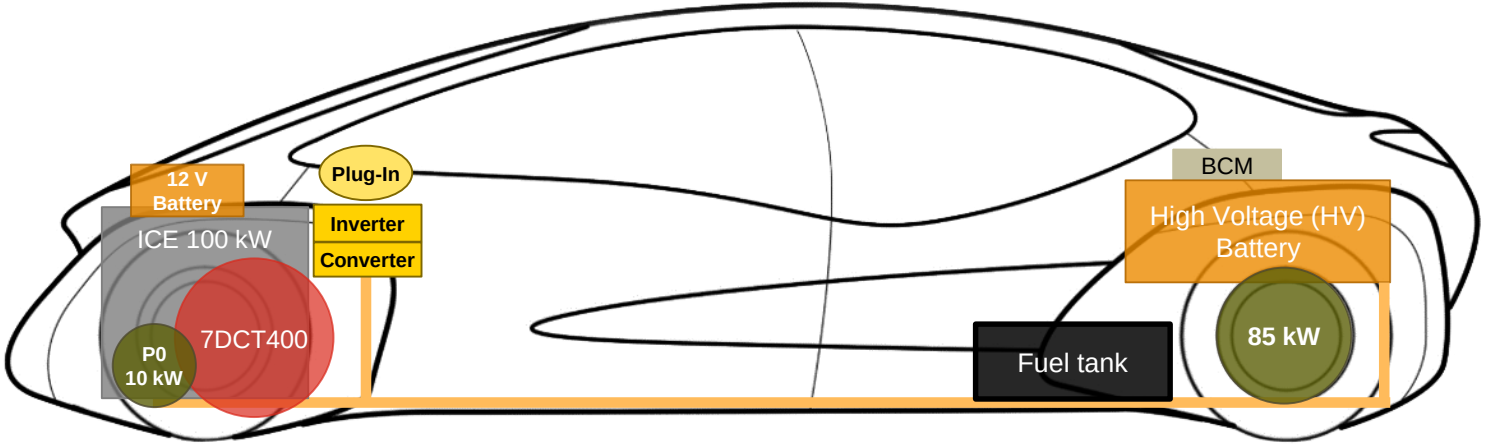
CO_2 Improvement



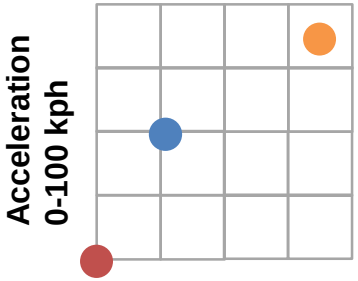
Gradeability

ZERO EMISSION CAPABLE

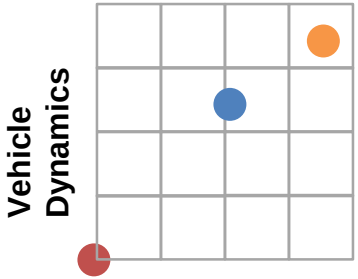
- Conventional ICE
- 48V Mild Hybrid
- 48V : 25 kW P2.5 + 25kW P4
- Conv. FR / P0 + PHEV 85 kW P4



BEV Scalability: Differentiation by eDrive Power Range + Dynamics Performance



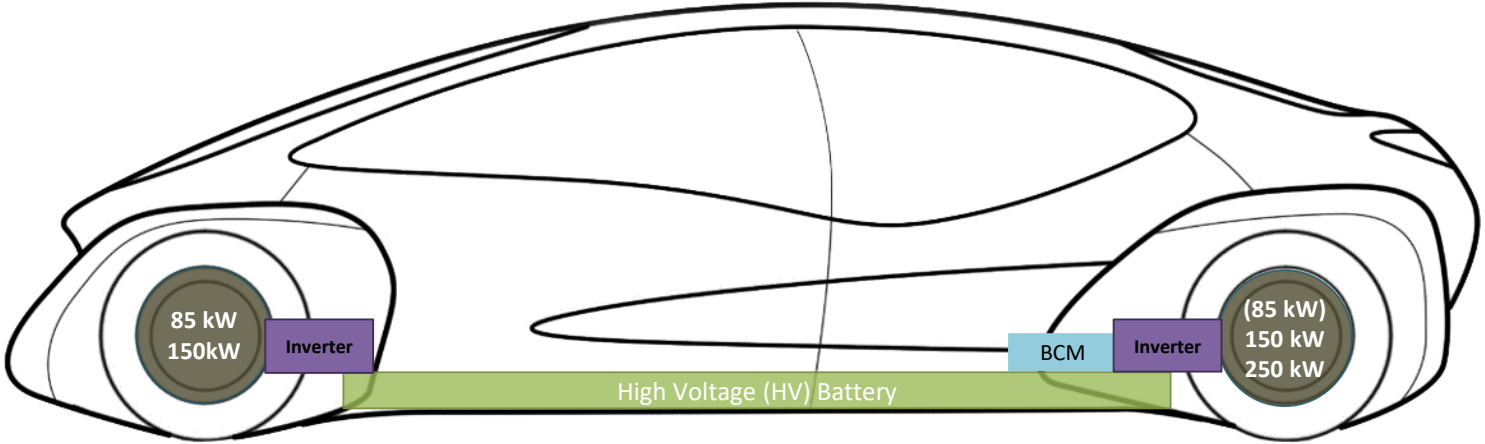
eMotor Power



Gradeability

ZERO EMISSION CAPABLE

- BEV FA + RA P4 Low (85 kW + 85 kW) Entry
- BEV FA P4 Low + RA P4 Mid (85kW + 150kW) Volume Performance
- BEV FA P4 Mid + RA P4 High (150kW + 250kW) Sport Performance



Summary

Challenges of electrified AWD Powertrains

1. **Change in significance of AWD with regard to image and functions**
   - from permanently available with physically maximum drive torque
   - to needs-oriented, efficient and comfortable
2. **Electrification offers new possibilities for brand and model differentiation**
   - Scalability of performance and functions
   - Number of possible architectures grows strongly - complexity increases
3. **Technology change offers opportunities for improved AWD functionality**
   - New possibilities for vehicle handling, performance and safety
4. **Competence in AWD systems only is not sufficient**
   - Integration understanding for the entire electrified powertrain required
   - A huge challenge, but also a chance