Individual E-Mobility System Solutions for Automotive and Off-Highway Applications

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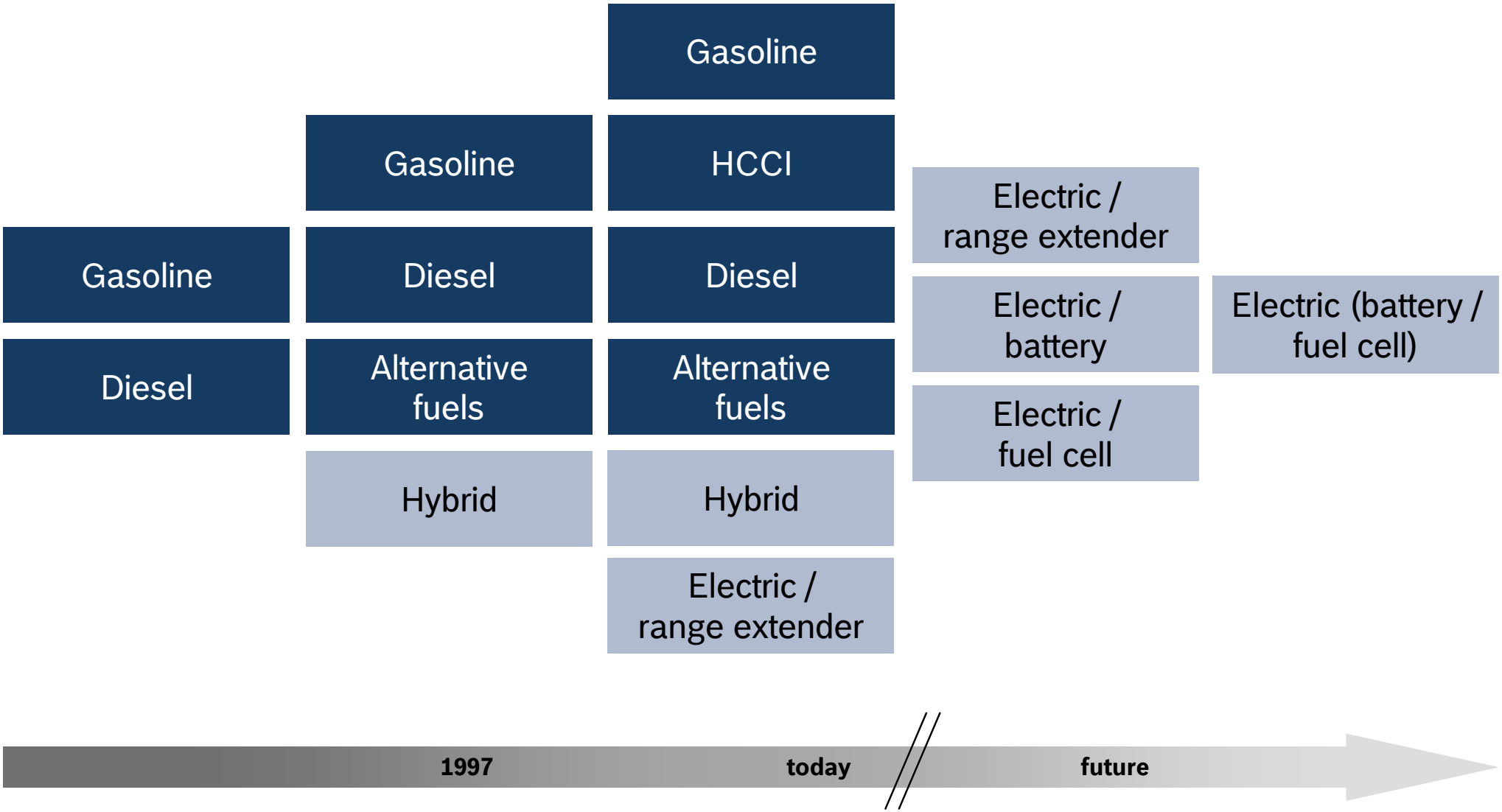
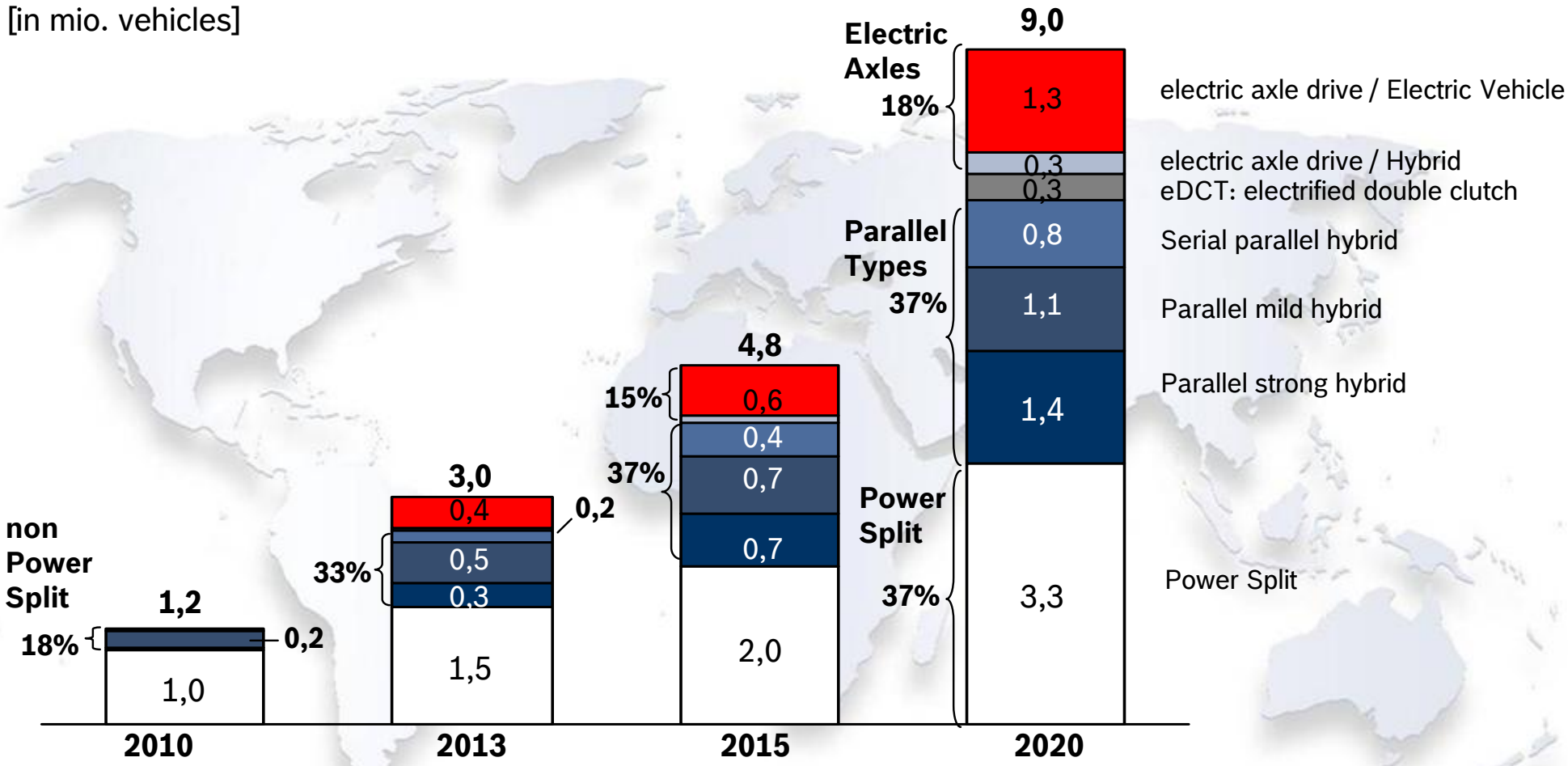
The “Powertrain-Map”



Market Trends: Electrification Systems



- Non-Powersplit Systems gaining ground.
- Parallel and Electric Axle systems w/ high shares.

“We provide individual E-Mobility solutions”

Development areas E-mobility

System definition and development

Prototype & demonstrator construction

E/E-architecture, control units, (CAN, Flexray), safety

Chassis & brake system, vehicle dynamics

Engineering powertrain

Infotainment, HMI, cluster

Engineering power electronics

Energy & battery management

SB LiMotive
A joint company of Samsung and Bosch

E-Infrastructure

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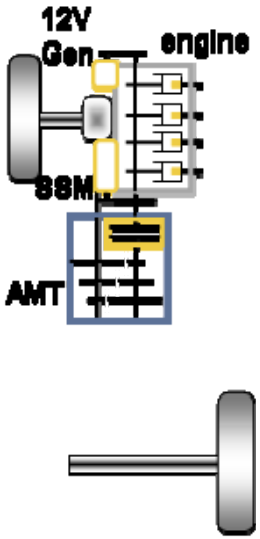
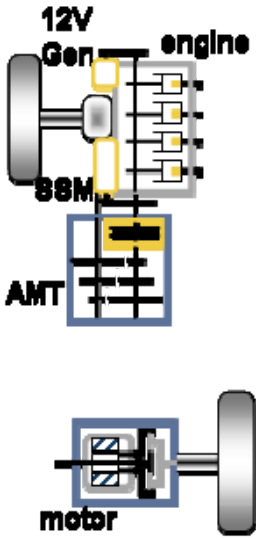
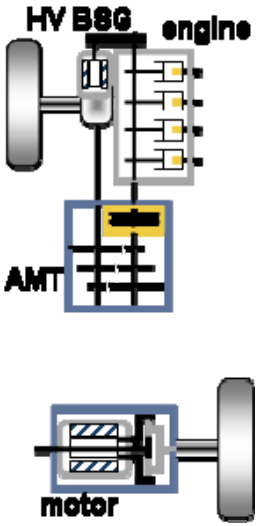
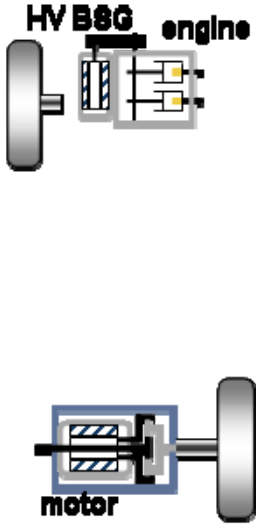
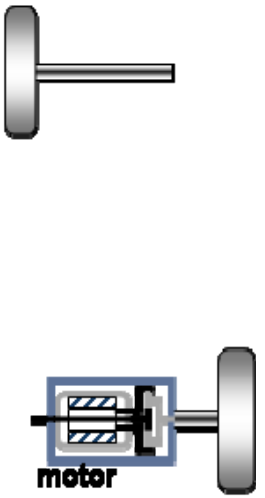
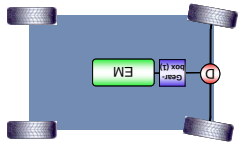
System development

	Conv. ICE	HEV	PHEV	EV REX	EV
Add. components		Inverter 20kW	Inverter 85kW	Inverter 60kW	Inverter 60kW
			Charger	Charger	Charger
	Battery 12 V	Battery HV 1.3 kWh	Battery HV 12 kWh	Battery HV 15 kWh	Battery HV 20-30 kWh
Powertrain incl. EM					

Powertrain Investigation expl. EV

Operation Strategy

Transmission

E-Machine / Topologies	PSM	ASM	ESM	New Technol.
	Reference →			
				
				
				
...				

PSM: Permanent Magnet Synchronous Machine
ASM: Asynchronous Induction Machine
ESM: Electric Induction Synchronous Machine

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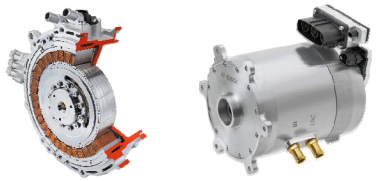
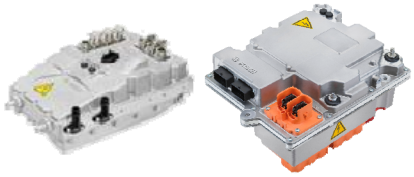
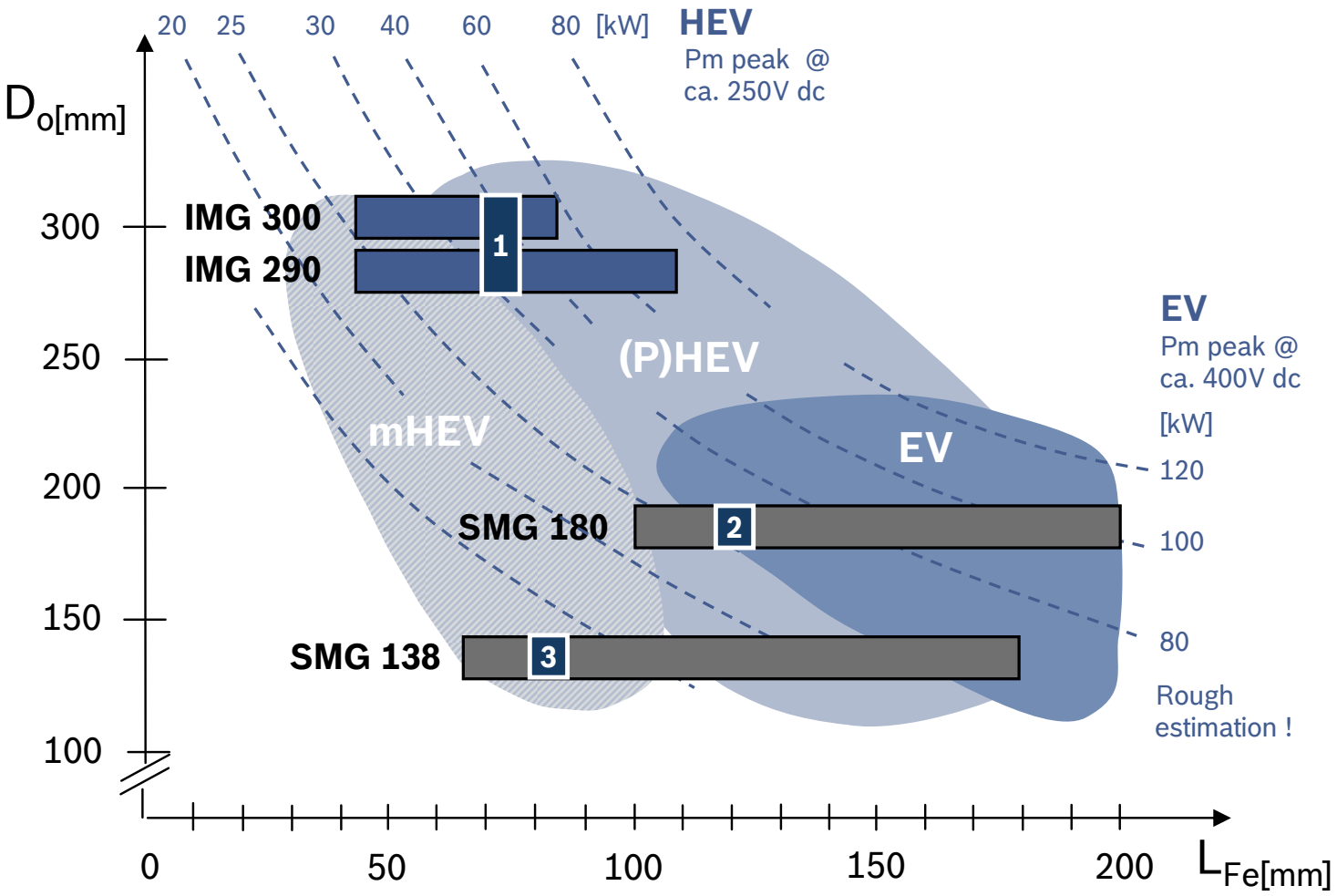
Bosch hardware portfolio

Products	Mild hybrid	Full hybrid	Plug-in hybrid	EV
	Motor-generator: 2 product lines Platform development for various performance levels			
	Power electronics (inverter, DC/DC, AC/DC) Platform modular for various performance requirements			
	Li-Ion battery (SB LiMotive, joint venture Bosch with Samsung SDI) Platform modular for various system requirements			
	Regenerative braking system Based on conventional systems with adjustments for using brake energy			
	Vehicle control unit Based on controller from conventional powertrain systems			

Electric Machine – Product Portfolio



SMG

IMG

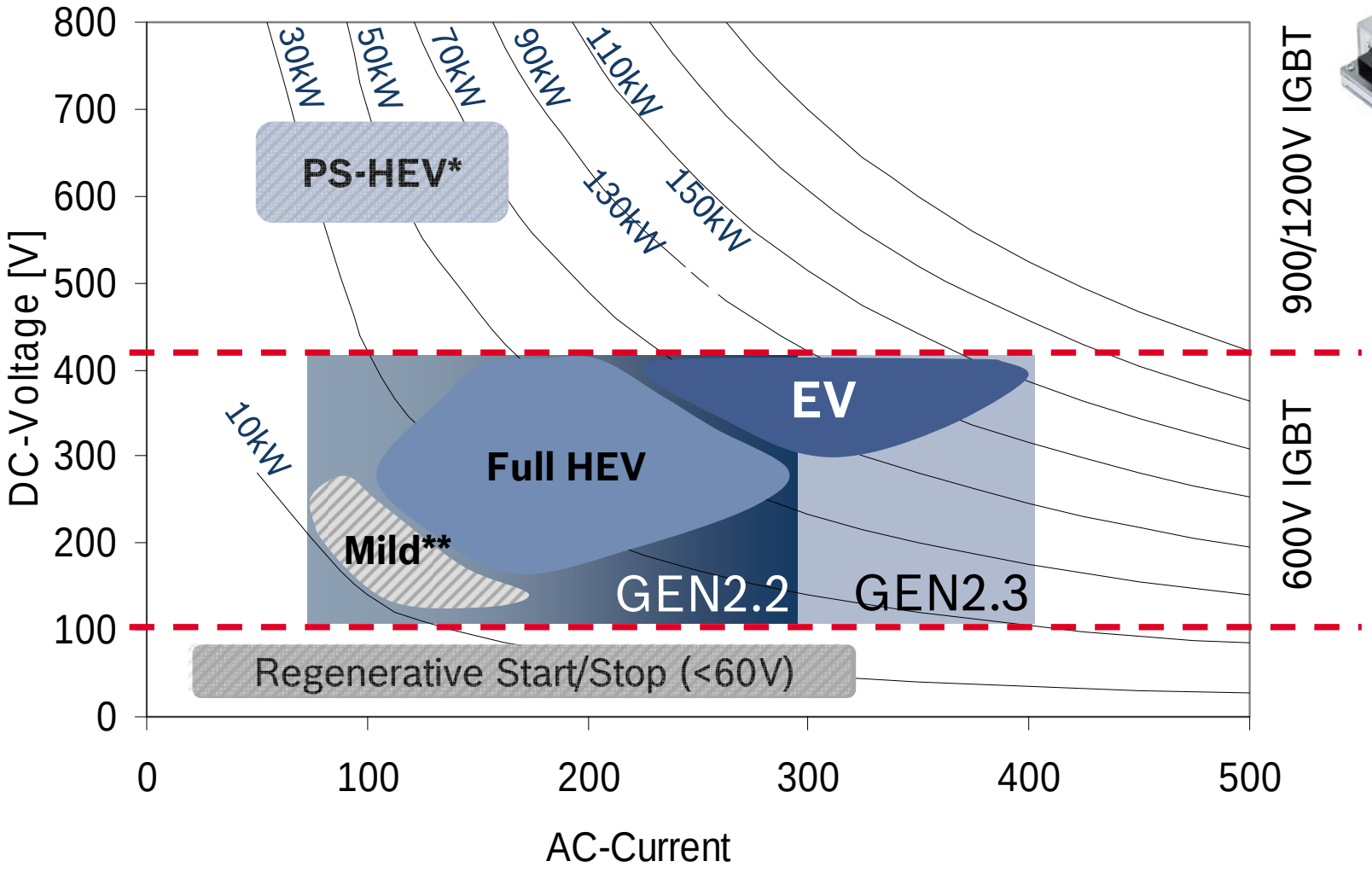
1 P2 Hybrid
2 HEV eAD / eDCT
City / Compact EV
3 BSG

IMG: Integrated Motor Generator
SMG: Separate Motor Generator

D_o: Outer stator diameter
L_{Fe}: Iron length

Bosch covers major (P)HEV / EV market requirements
Flexible construction kit w/ scalable design and production line concept

Power Electronics Segmentation



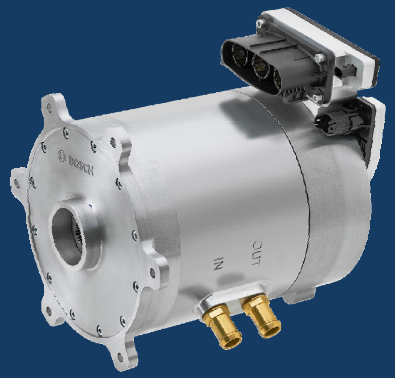
INV2CON

Requirements:
*) Power Split /w boost converter
**) low cost system

Bosch “e-Drive” components

SMG 180/120

Separate Motor Generator



Product specification

Active diameter / lengths	180 mm / 120 mm
Peak torque max.	up to 200 Nm [@ 400A_{rms}]
Speed max.	12,500 rpm
Mechanical power max.	40 kW (INVCON 2.2) 80 kW (INVCON 2.3)
Total mass	28 kg
Cooling	Water-jacket 8l/min 85°C_{max}
Sensor type:	Resolver

INVCON 2.3

Inverter + DC/DC-Converter

Product specification

Dimensions L x W x H	310 x 190 x 156 mm (w/ connectors)
Volume	Inverter approx. 5 l (w/o DC/DC connectors)
Weight	< 7 kg
Input voltage	100-365 / 100- 430V
Phase current [A] INVCON 2.3	400 A (continuous) 450 A (Peak 5 s)
Cooling	65 °C, max. 85 °C (flow-rate 8 l/min)
DC/DC-converter	1,8-2,5 kW / 0,7 kW; unidirectional

Vehicle control unit

Inverter
Control Unit **

Battery Management
System

Charge Controller

HMI/Navigation

Vehicle Control
Unit (VCU)

ABS/ESP®

Range
Extender ECU *

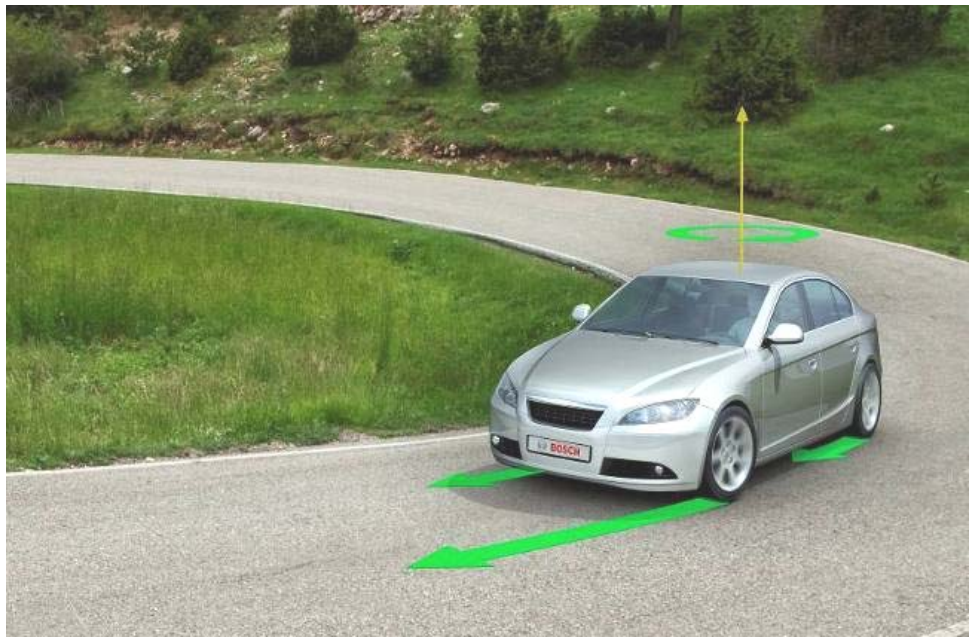
Service and diagnosis

HVAC controller

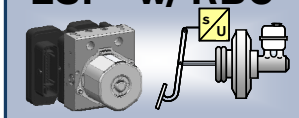
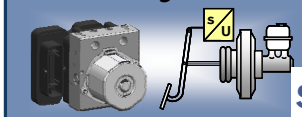
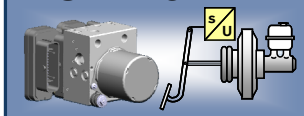
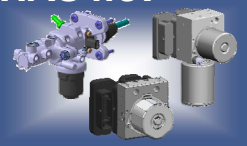
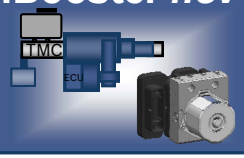
* optional
** DC/DC converter included

Chassis system solutions E-Mobility

- Brake systems
  - Component setup
  - Recuperation
  - Torque coordination
- Vehicle driving dynamics
  - Safety
  - Traction control
  - Torque vectoring



Recommended CRBS for different HEV/EV types

Brake System	HEV mild	HEV strong	Plug-in HEV	EV
ESP® w/ RBC  SOP 2010	• Combination w/ MVP or EVP • Low recuperation < 0,1g • Low cost			
ESP® *hybrid*  SOP 2014*	• Combination w/ MVP or EVP • Recuperation < 0,2g for x-split circuit • Cost & performance optimized			
ESP® *hev*  SOP 2012	• Combination w/ MVP or EVP • Recuperation < 0,2g for II-split circuit • Modest cost for enhanced performance			
HAS *hev*  SOP 2011		• Vacuum independent • Recuperation up to 0,3g • High performance		
iBooster *hev*  SOP 2014		• Vacuum independent • Recuperation up to 0,3g • High perform., improved cost & package		

***Target**

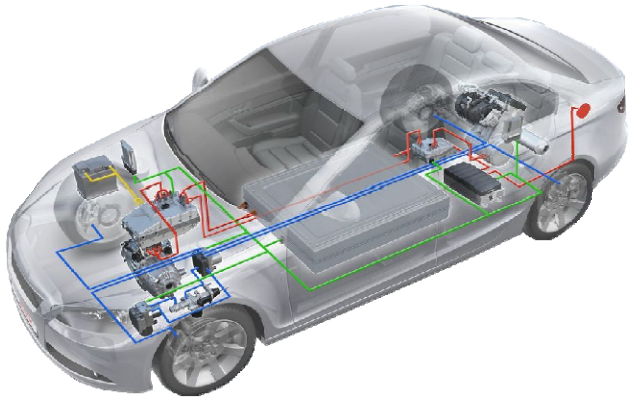
HEV: Hybrid Electric Vehicle; PHEV: Plug-In Hybrid Electric Vehicle; EV REX: Electric Vehicle with range extender; EV: Electric Vehicle

Product safety and functional safety

- New challenges regarding product safety and functional safety
  - Laws and regulations (e.g. ECE R100, FMVSS 305)
  - Standards (e.g. ISO 6469, ISO 26262)
  - Customer requirements (e.g. HV)







- We provide safety concepts for
  - Electric shock (e.g. U~ 400V)
  - Fire (e.g. I ~ 300A)
  - Unintended acceleration / deceleration
  - Battery hazards (battery fire, hazardous chemicals)




Active sound enhancement interior and exterior

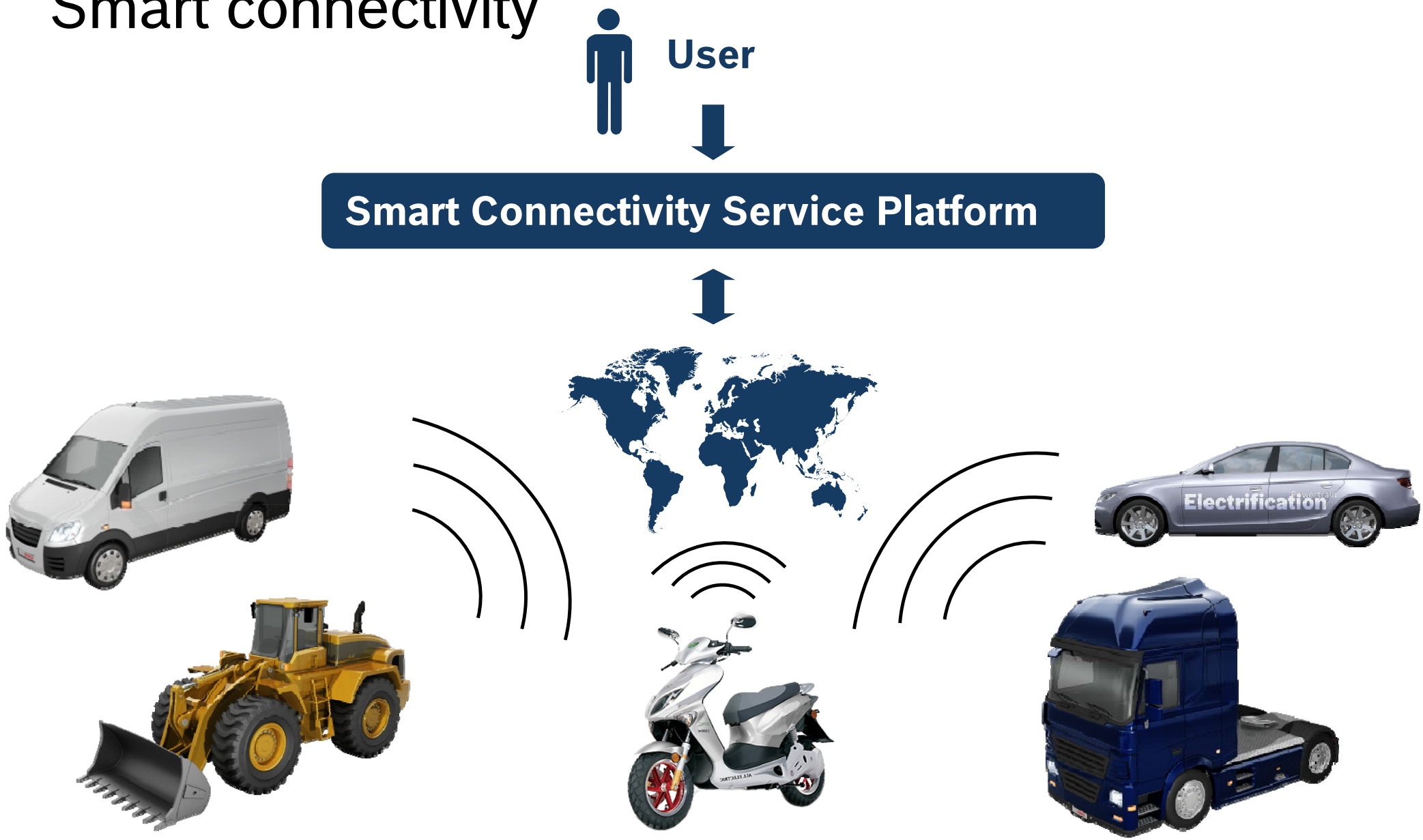
- Generation of a synthetic engine sound according to driving situation
- Driving-noise emulation for pedestrian safety in electric / hybrid vehicles

- Customer specific applications and adaptation for individual solutions

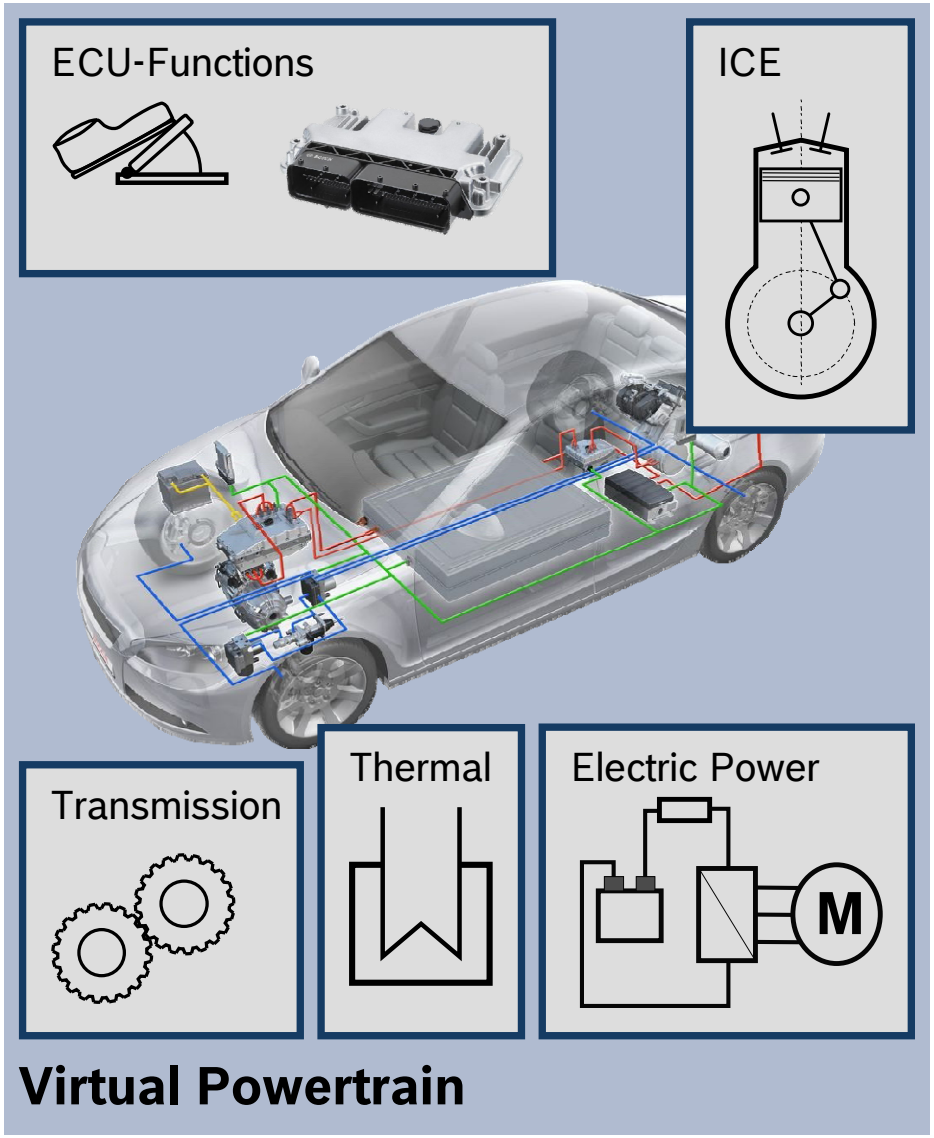
Charging systems engineering

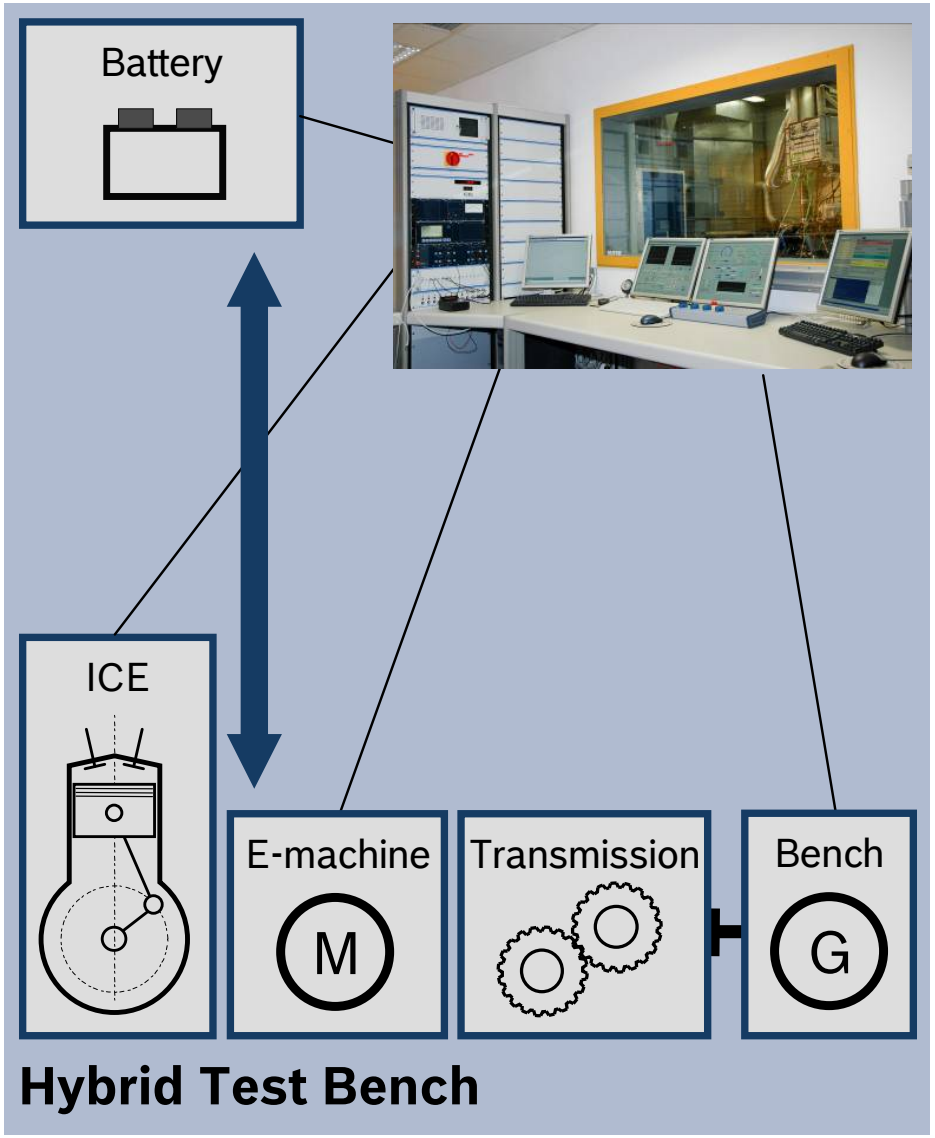
- In-Vehicle Solution
  - Hardware
  - Software
  - Calibration
  - Integration
- Non-Conductive Concept
  - Hardware ECU
  - Software
- Alternative Concept
  - Investigation

Smart connectivity



Powertrain simulation and testing

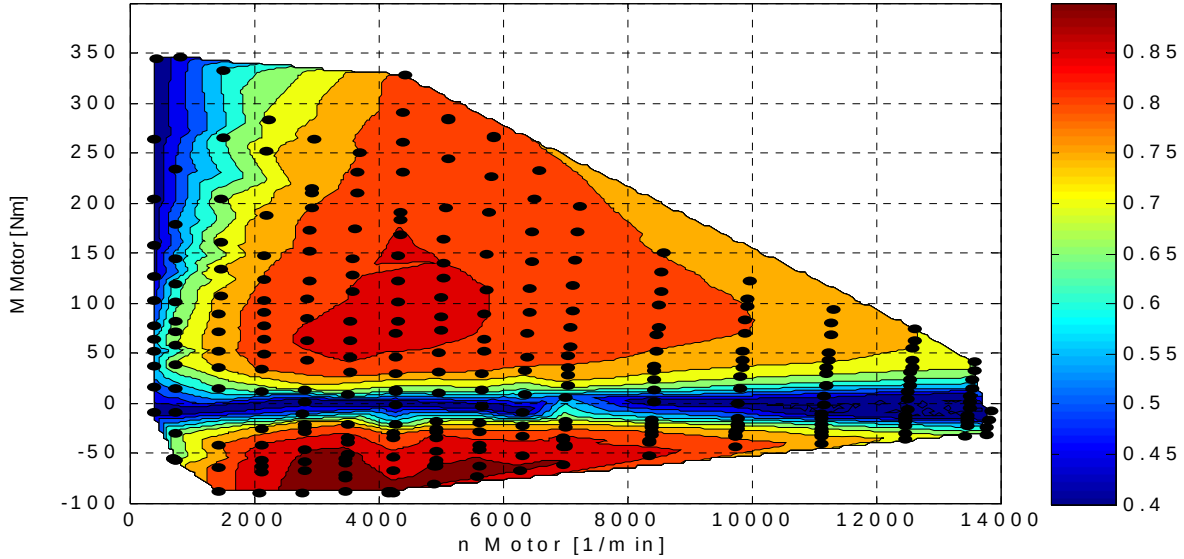




Test procedures for hybrid and electric vehicles

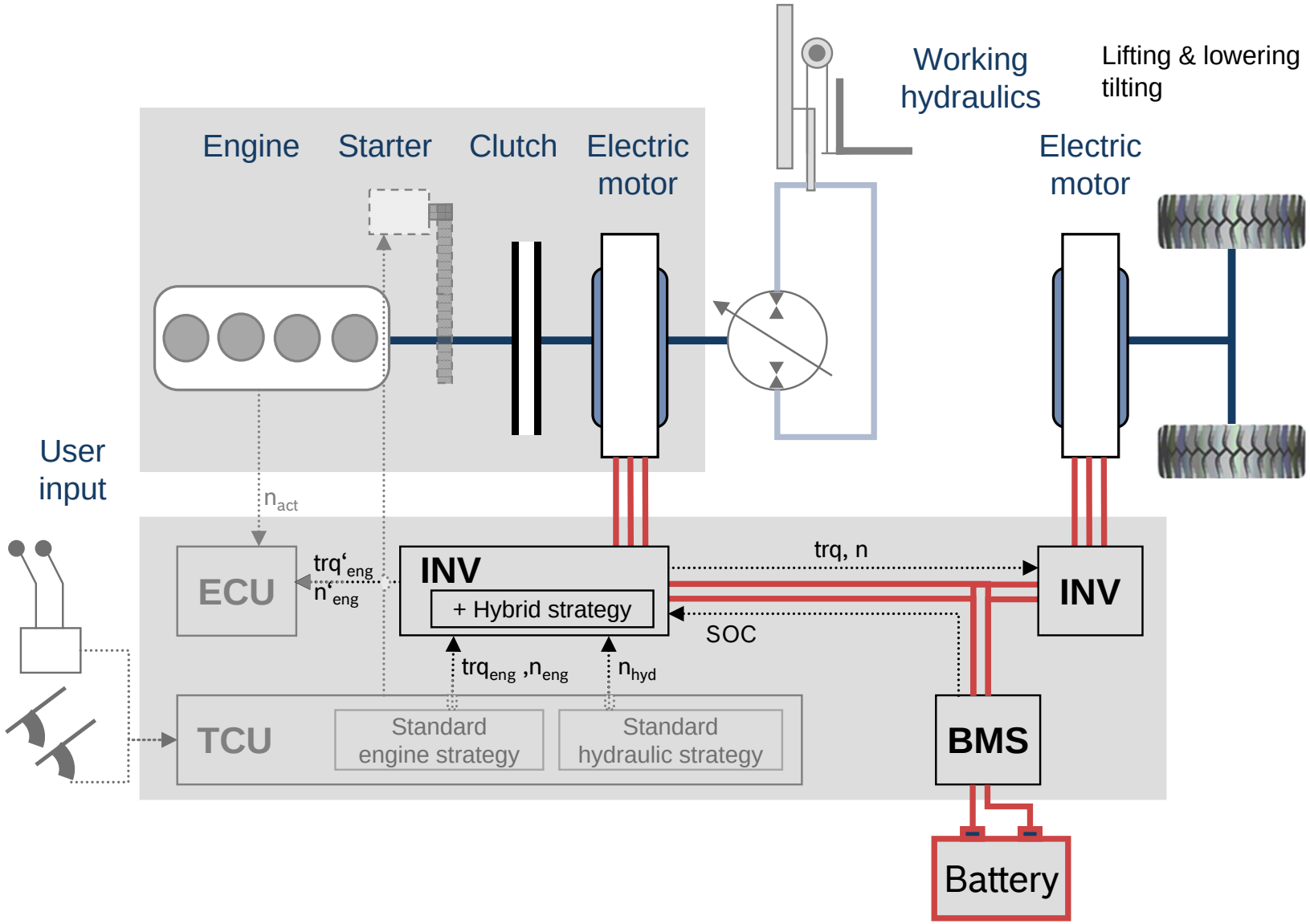
- Consumption measurement in accordance with the test procedures ECE-R101 or CFR40-Part96
- Determination of “real life” fuel consumption and optimization of the operation strategy (drive cycle, ambient temperature etc.)
- Gradient profiles to verify the robustness of the electric system
- Efficiency measurement for different speed-load setpoints

Customer specific driving cycles



Efficiency map

Electric powertrain fork lift trucks



Control

- Information flow
- Existing SW/HW
- Additional SW/HW

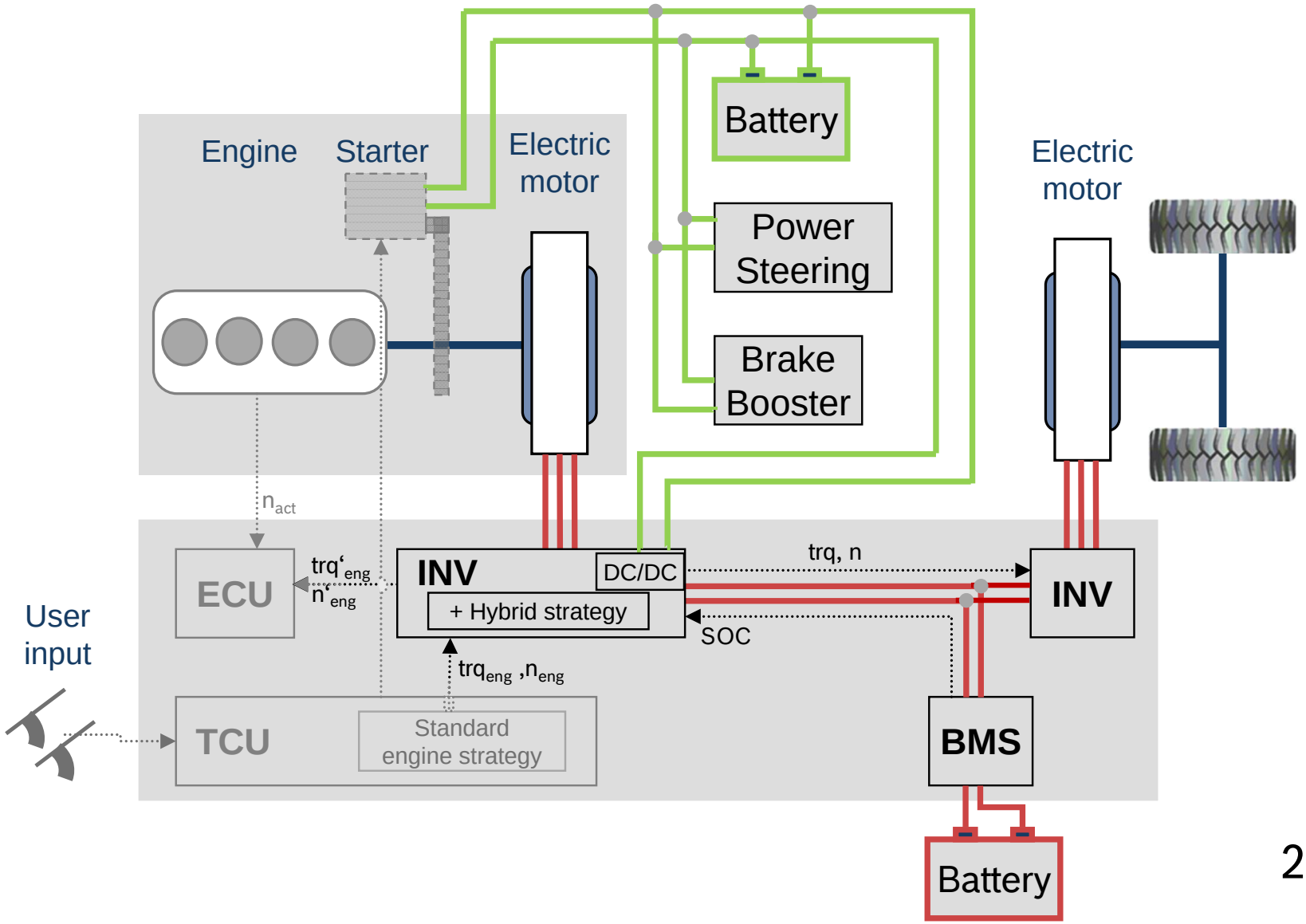
Energy flow

- Hydraulic
- Electrically
- Mechanically

ECU	Engine Control Unit
TCU	Truck Control Unit
BMS	Battery Manage-ment System
INV	Inverter

2x 

Electric powertrain tow truck



Control

- Information flow
- Existing SW/HW
- Additional SW/HW

Energy flow

- Electrically (LV)
- Electrically (HV)
- Mechanically

ECU	Engine Control Unit
TCU	Truck Control Unit
BMS	Battery Manage-ment System
INV	Inverter

2x  2x 

Thank you for your attention !

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