



In-wheel Electric Drive

Center for Automotive Research

Business of Plugging In

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BRABUS high-performance EV based on the Mercedes-Benz E-Class



BRABUS high-performance EV based on the Mercedes-Benz E-Class

- **Four Protean Electric motors**
- **Demonstrates a peak combined:
320 kW (430 hp)
3,200 Nm (2,350 ft.-lbs.) torque**



◎ Protean Electric Inc.

- American Company
- Patented In-wheel Motor Design for:
 - EV
 - PHEV
 - Hybrid

◎ Product Offering:

- High Efficiency Direct Drive
- Regenerative braking
- Simpler Vehicle Integration
 - Built-in inverter & control electronics
 - No transmissions or drive shafts



© Superior power density

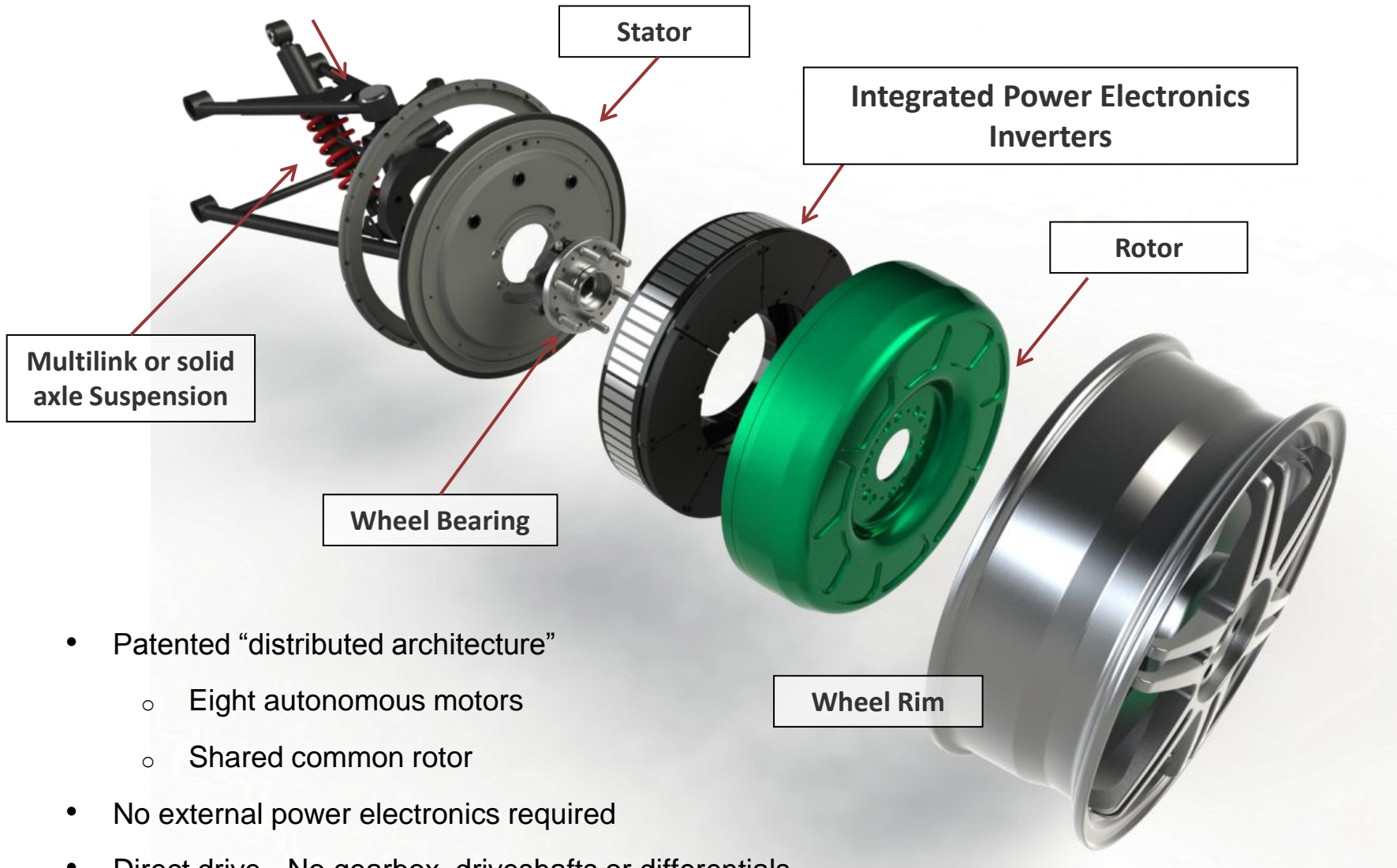
- High power and torque
 - Peak Power: 81 kW
 - Continuous Power: 64 kW
 - Peak Torque: 800 Nm
 - Continuous torque: 500 Nm
- 420mm dia. /115mm width
- 31kg mass

Applications:

- New and existing vehicles
- Light duty vehicles up to 7500 GVW
- 18" wheel or larger required
- Supports gas, diesel or CNG
- Applicable to FWD, RWD or AWD



Protean Electric In-Wheel Motor




- Patented “distributed architecture”
 - Eight autonomous motors
 - Shared common rotor
- No external power electronics required
- Direct drive - No gearbox, driveshafts or differentials

Protean Electric In-Wheel Motor



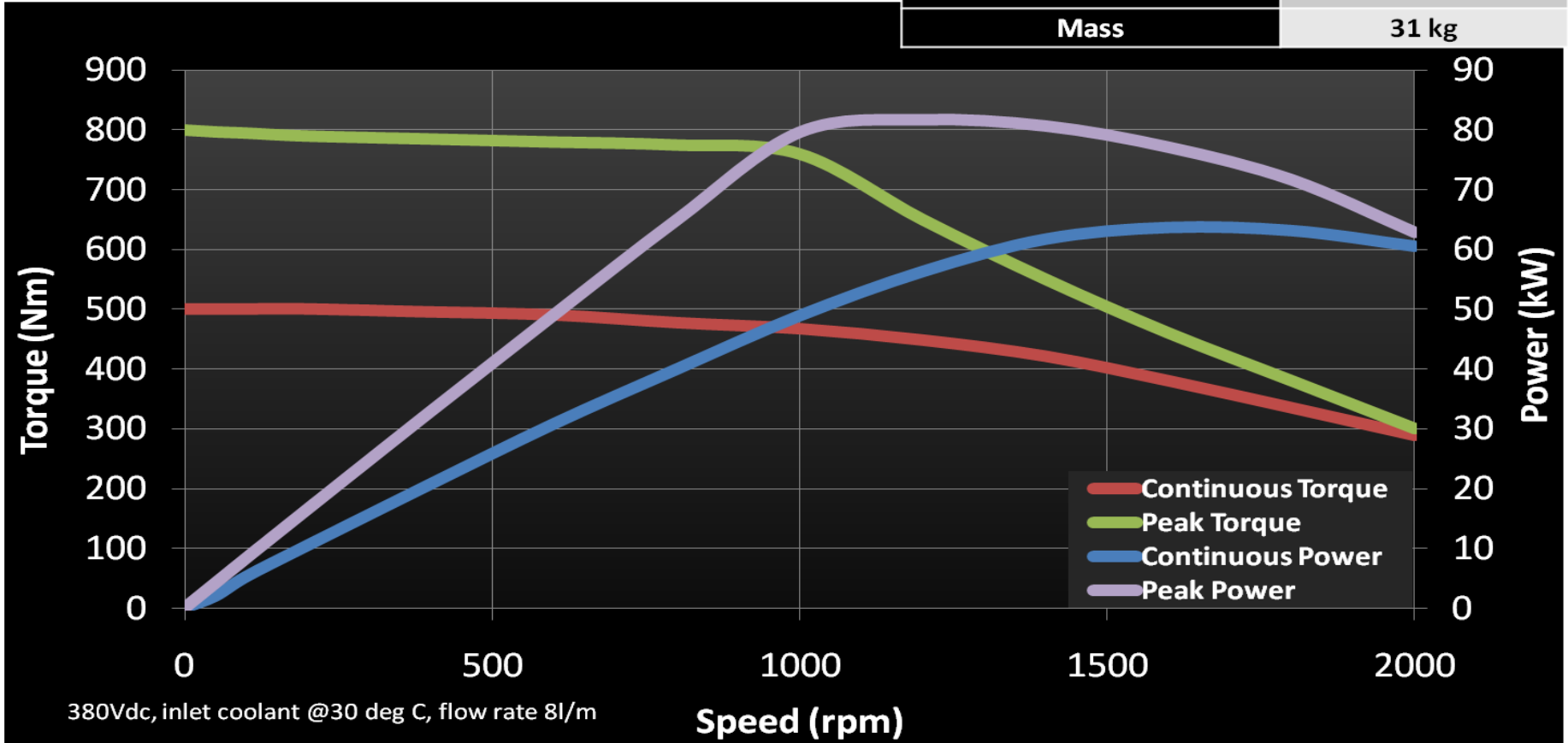
Protean Electric In-Wheel Motor

	Metric	English
Peak output power @400Vdc	81 kW	110 HP
Continuous output power @ 400Vdc	64 kW	86 HP
Peak output torque*	800 Nm	590 ft-lb
Continuous output torque	500 Nm	370 ft-lb
Width	115 mm	4.5 in
Diameter	420 mm	16.5 in
Total motor mass	31 kg	68 lb

* Values stated at 70% maximum motor current.
Peak torque at 100% current is approximately 1100Nm.

Protean Electric In-Wheel Motor

	PD18-3
Peak/Continuous Power	81/ 64 kW
Peak/Continuous Torque	800/ 500 Nm
Diameter x Width	420 x 115 mm
Mass	31 kg



Market Viability

○ Protean Drive - Excels in a variety of applications

	OEM Mainstream HEV - PHEV	Electric Vehicles	Performance Cars	Drivetrain Suppliers	Fleet / Aftermarket	Police Packages	Military
Fuel Savings							
Emission Reduction							
High Torque Density							
Design Freedom							
Torque Vectoring							
Simpler Integration							
Stealth Performance							

Volvo C30 PHEV

- Four Protean Drive™ motors
- One motor at each wheel
- AWD battery EV
- 0-60 mph in 5 seconds
- Over 130 mph top speed



GAC Triumphchi EV



- Two Protean Drive motors in the rear
- RWD battery EV
- Debut in Guangzhou International Motor Show

Ford F-150 EV



- **Four Protean Drive motors**
- **One motor at each wheel**
- **AWD battery EV**
- **Over 7,000 lbs. GVW EV**
- **ICE Engine Removed**

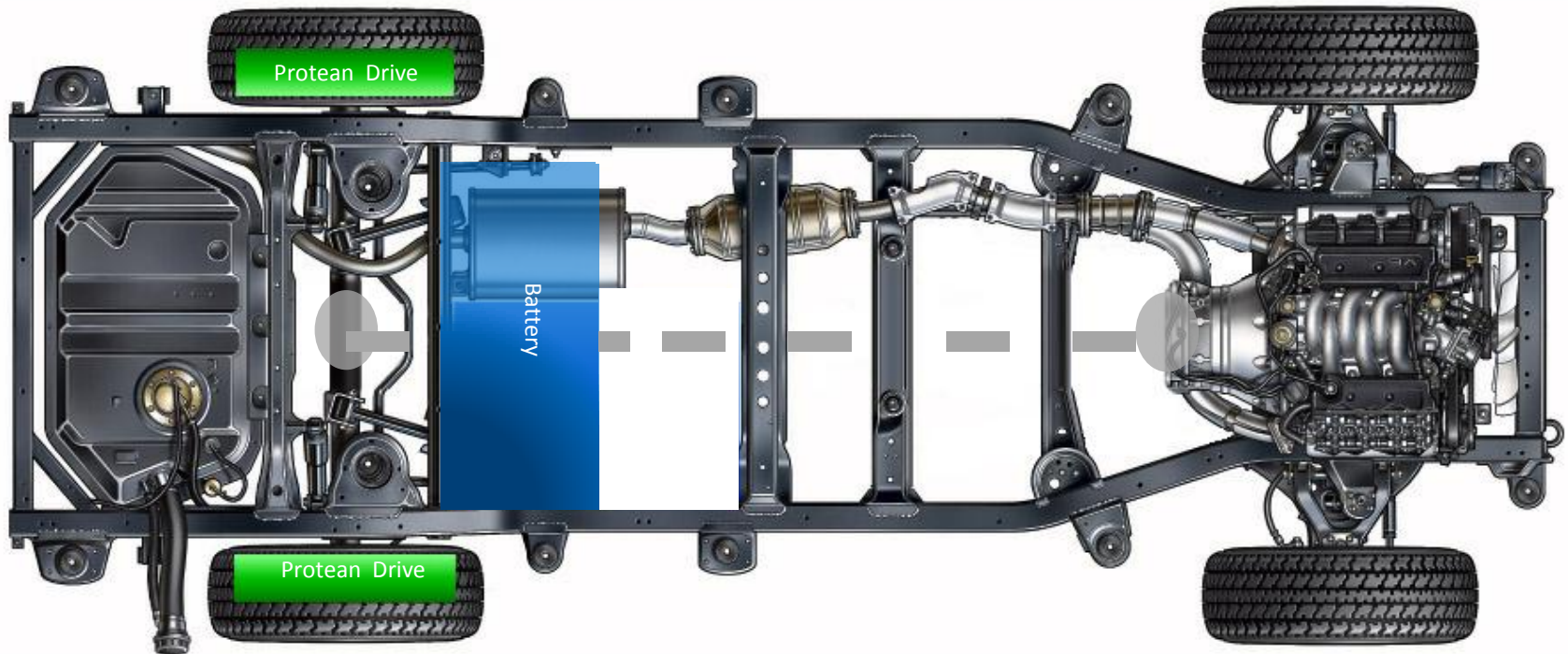
EV – PHEV – “Through the Road” Hybrid

- Additive torque/power performance
- Regenerative braking system helps improve fuel economy
- Enables the driver to select the various drive modes (conventional ICE, hybrid and pure EV)

Through-the-road hybrid:

Maintain the ICE engine drive

- Add Protean drive to rear of FWD car
- Add Protean drive to rear of RWD car



Vauxhall Vivaro PHEV

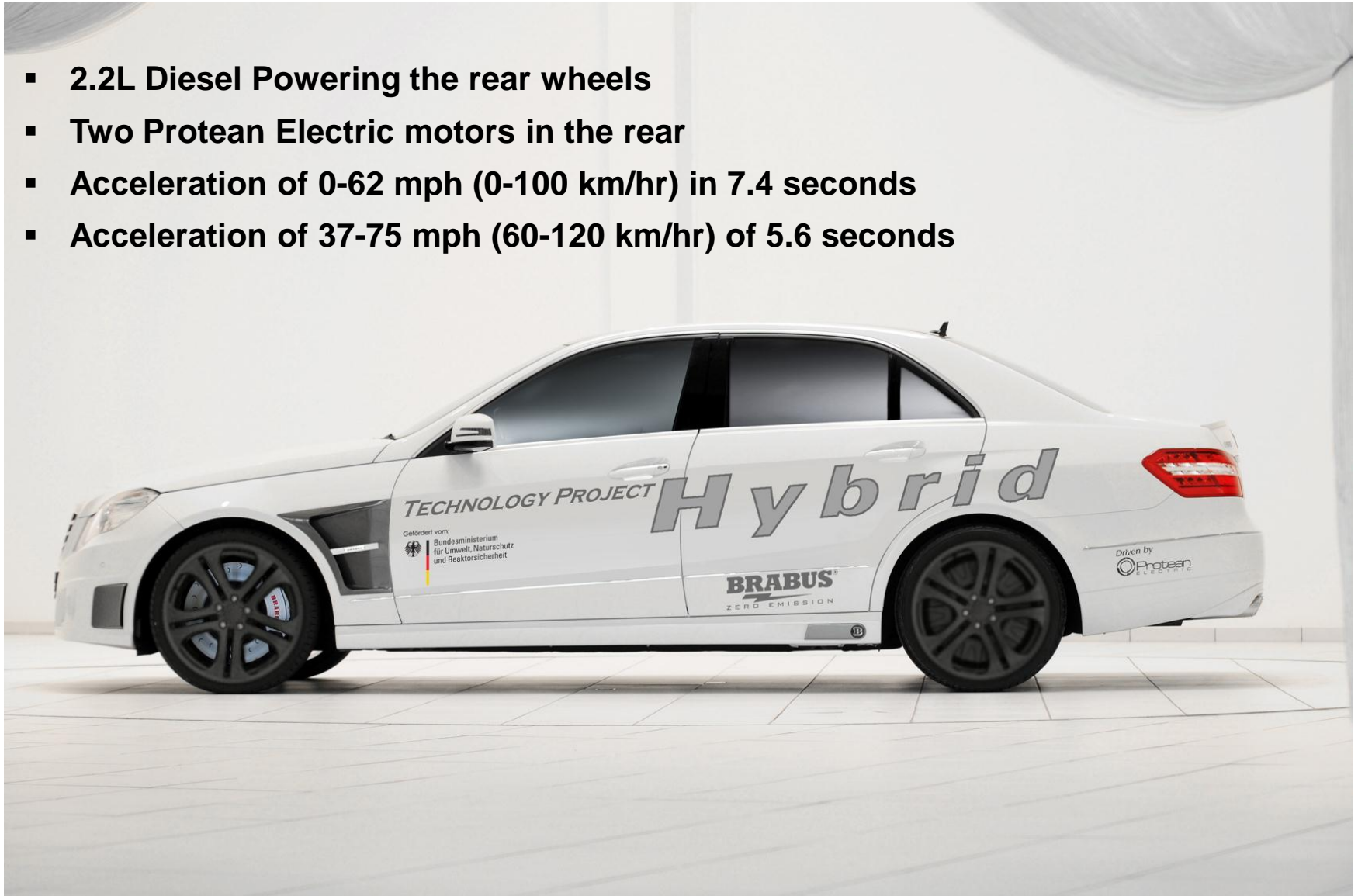
Can achieve an effective 60% fuel economy improvement in charge depleting mode (Electricity + Diesel) as compared to charge sustaining mode (Diesel Only)



- FWD diesel powertrain
- Two Protean Drive motors in the rear
- PHEV - 55 miles pure electric range
- Driver may select the drive mode

BRABUS Hybrid based on the Mercedes-Benz E-Class

- **2.2L Diesel Powering the rear wheels**
- **Two Protean Electric motors in the rear**
- **Acceleration of 0-62 mph (0-100 km/hr) in 7.4 seconds**
- **Acceleration of 37-75 mph (60-120 km/hr) of 5.6 seconds**



Vehicle Interface



Mechanical

- Compatible flange interface
- Commercial off the shelf bearing
- Compatible with off the shelf rims

Cooling

- Minimal heat transfer between mechanical brake and motor
- 6 L / min. flow requirement
- Use of standard radiator components

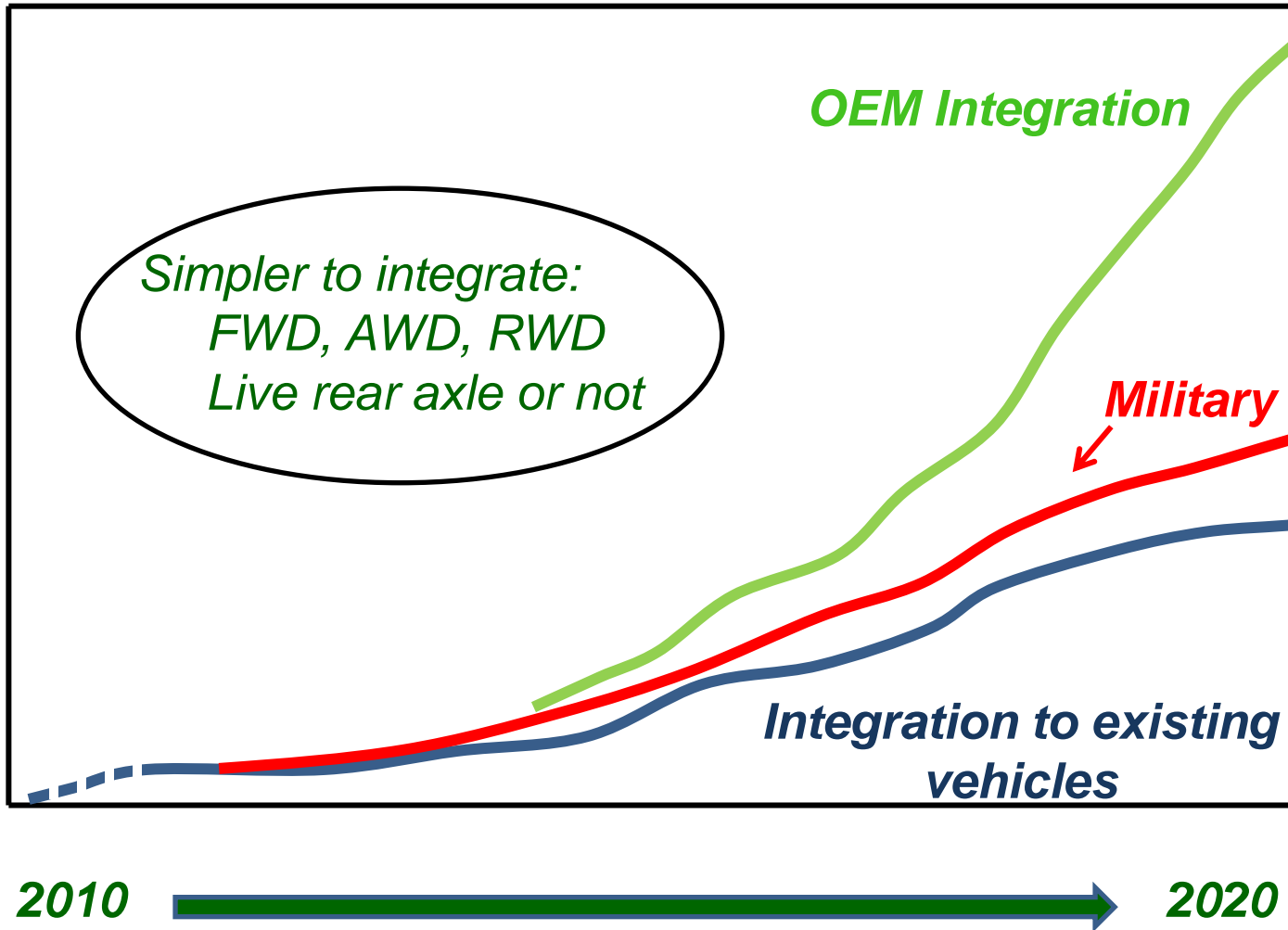
High Voltage

- All HV switching inside the motor minimising EMC issues
- Common interface
- To meet automotive standards

Electronic Control

- Open architecture to ISO 26262
- High 5 ms speed refresh to allow advanced vehicle control
- Use of off the shelf ECU hardware

The Protean Drive™ Global Path to Market





ProteanElectric.com

