

Zukunft in Bewegung





Technische Hochschule
Ingolstadt
Fakultät für Maschinenbau

*New Trends in
Automotive Mobility*
Hybrid Drive Train

Prof. Dr. Harald Göllinger 11/2016

Hybrid Drive Train
Example: BMW i8



2 Prof. Dr. Harald Göllinger / November 2016 http://www.bmw.com/com/en/newvehicles/i/i8/2014/showroom/images_and_videos.html#c=0&i=3

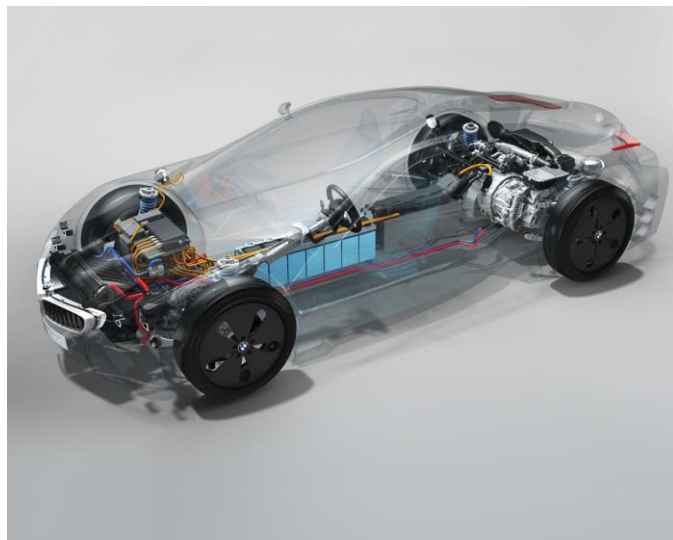
Hybrid Drive Train Example: BMW i8



0-100 km/h	4.4 sec
EU test cycle	2.1 l / 100 km
CO2 emissions	49 g/km
	11,9 kWh / 100 km
3-cylinder engine	170 kW / 231 hp 320 Nm, rear axle
Synch. E-motor	96 kW / 131 hp 250 Nm, front axle
Combined power	266 kW / 362 hp
Battery:	Lithium-Ion, 5,2 kWh
Max velocity:	250 km/h
Gross weight:	1 485 kg
Cw	0,26.
Price:	US\$135,925 (€103,000 or GB£86,800)

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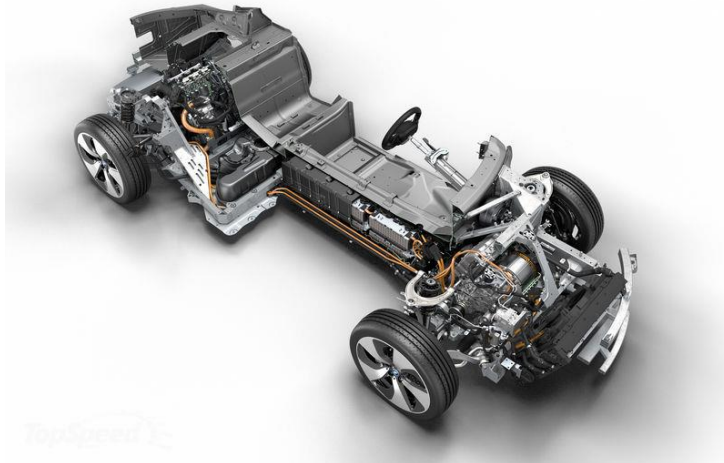
Hybrid Drive Train Example: BMW i8



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<http://www.bimmertoday.de/wp-content/uploads/BMW-Vision-EfficientDynamics-Wallpaper-041.jpg>

Hybrid Drive Train Example: BMW i8



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<http://www.topspeed.com/cars/bmw/2015-bmw-i8-ar99499/picture518243.html>

Hybrid Drive Train Hybrid-electric drive train



Definition according to IEC/TC69:
at least two different energy converters and two different energy storages that are used in a drivetrain.
(typically combustion engine and electric motor, fuel and batteries)

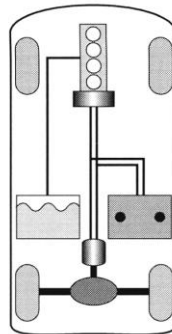
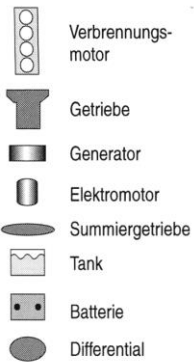
Advantages of a **combustion engine**: Advantages of an **electric motor**:
> driving performance, > low noise
> fuel is available due to infrastructure > emission-free

Advantages of a hybrid power train:
> reduced consumption
> low emissions, locally emission-free
> low noise
> improved driving performance

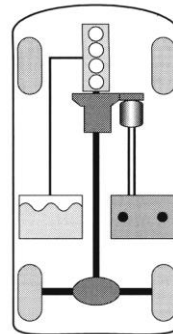
the use cases define the characteristics of a hybrid power train and the characteristics of the advantages.

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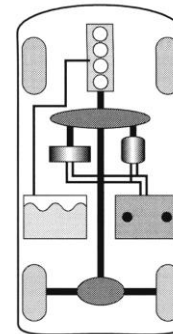
Hybrid Drive Train Serial, Parallel and Mixed Hybrid



Serieller Hybrid



Parallel Hybrid



Misch-Hybrid

source: Braess, Seiffert

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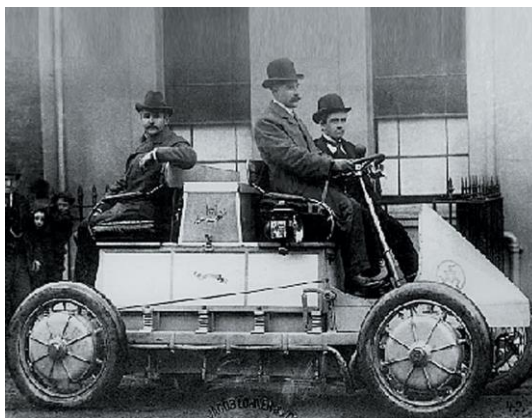
Hybrid Drive Train Serial Hybrid: Lohner-Porsche Mixte



one of the first hybrid vehicles, developed by Ferdinand Porsche in 1901
serial hybrid vehicle with batteries and a generator

4 wheel hub motors
(2.5 - 3.5 hp, Peak 7 hp)

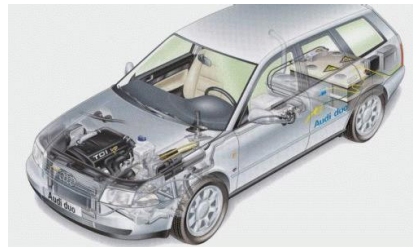
lead batteries,
44 cells, 80 V, 1800 kg



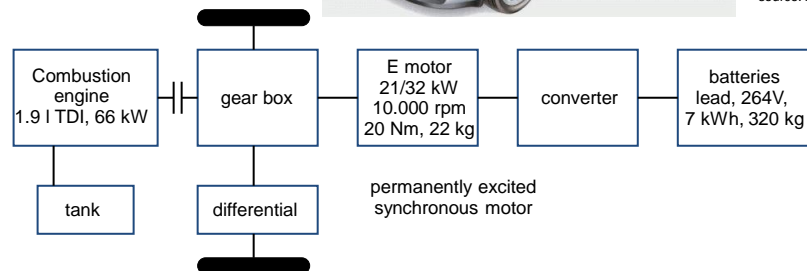
source: wikipedia.de

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Hybrid Drive Train Parallel Hybrid: Audi DUO



source: Audi AG



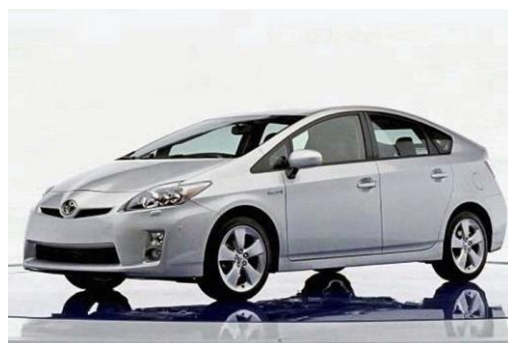
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Hybrid Drive Train Mixed Hybrid: Toyota Prius



air drag coefficient 0,26

hybrid motor:
1,8 l Otto-cycle engine 73 kW
+ electric motor MG2 60 kW

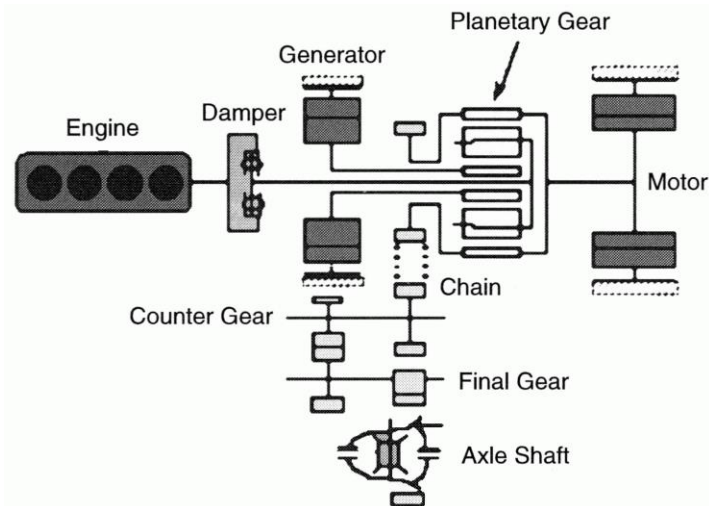


- recuperation,
- electrohydraulic brakes,
- hydraulic back-up brake system
- all auxiliary consumers are driven by electricity (air conditioning system, power steering, electrohydraulic brakes, water pump)

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source: http://i.auto-bild.de/fr_img/5/2/6/7/3/4/Toyota-Prius-III-729x486-8da2360357c6282c.jpg

Hybrid Drive Train Mixed Hybrid: Toyota Prius



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Hybrid Drive Train Example: Toyota Prius batteries



Prius I : NiMH, 273,6 V, 1,8 kWh. -> range 8 km
 Prius II : NiMH, 201,6 V, 1,3 kWh, 39 kg. ~ 40 kW peak power -> range 3 km.
 Prius III: same as Prius II



source: www.priuswiki.de

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Hybrid Drive Train

Example: Porsche 918 Spyder



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<http://performedrive.com.au/porsche-918-spyder-production-car-revealed/porsche-918-spyder-with-weissach-package/>

Hybrid Drive Train

Example: Porsche 918 Spyder

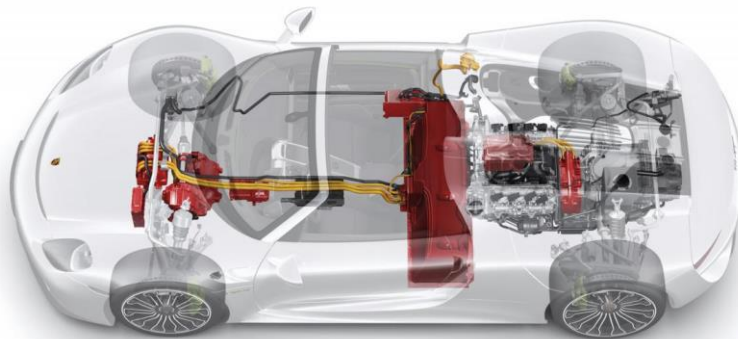


Combustion engine	4.6-litre naturally aspirated V8 447kW / 8700rpm
Rear Electric motor	154 hp (115 kW) drives the rear wheels in parallel with the engine also serves as the main generator.
Front electric motor	125 hp (93 kW) directly drives the front axle
Total system power	887 hp (661 kW) and 1,275 Nm torque
0-100km/h	2.8 seconds
0-200km/h	7.7 seconds
0-300km/h	22 seconds
top speed	345 km/h
Price	US\$ 845,000

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<http://www.bimmertoday.de/wp-content/uploads/BMW-Vision-EfficientDynamics-Wallpaper-041.jpg>

*Hybrid Drive Train
Example: Porsche 918 Spyder*



<http://performedrive.com.au/wp-content/uploads/2013/09/Porsche-918-Spyder-production-version-powertrain.jpg>

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*Hybrid Drive Train
Example: VW XL1*



<http://blog.meinauto.de/wp-content/uploads/2013/02/Der-neue-VW-XL1-2013.jpg>

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Hybrid Drive Train
Example: VW XL1



<http://blog.meinauto.de/wp-content/uploads/2013/02/Der-neue-VW-XL1-2013-Cockpit.jpg>

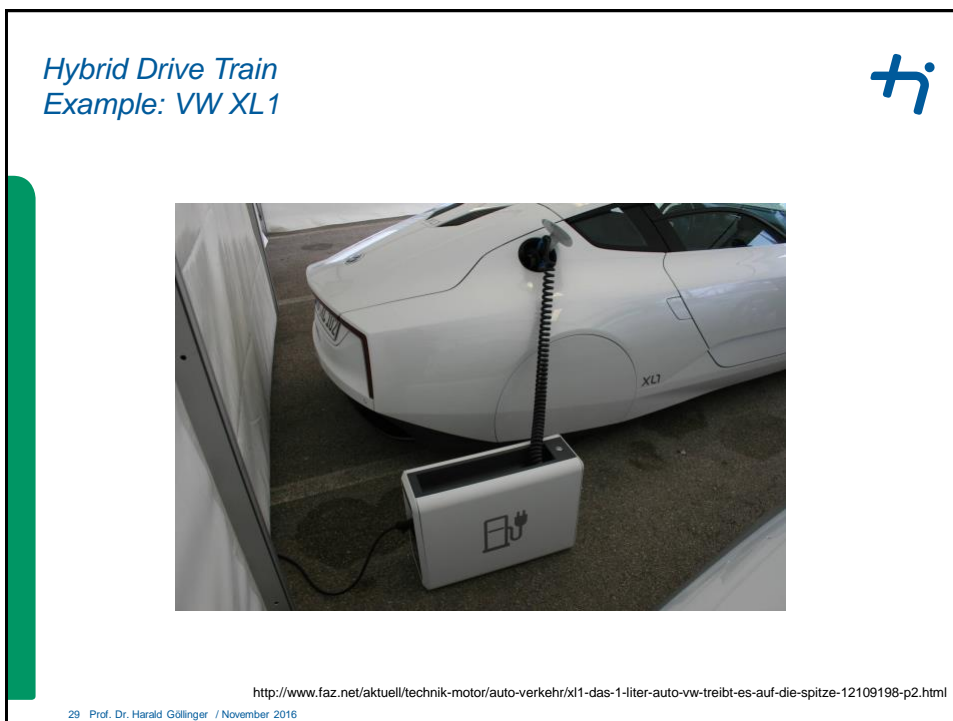
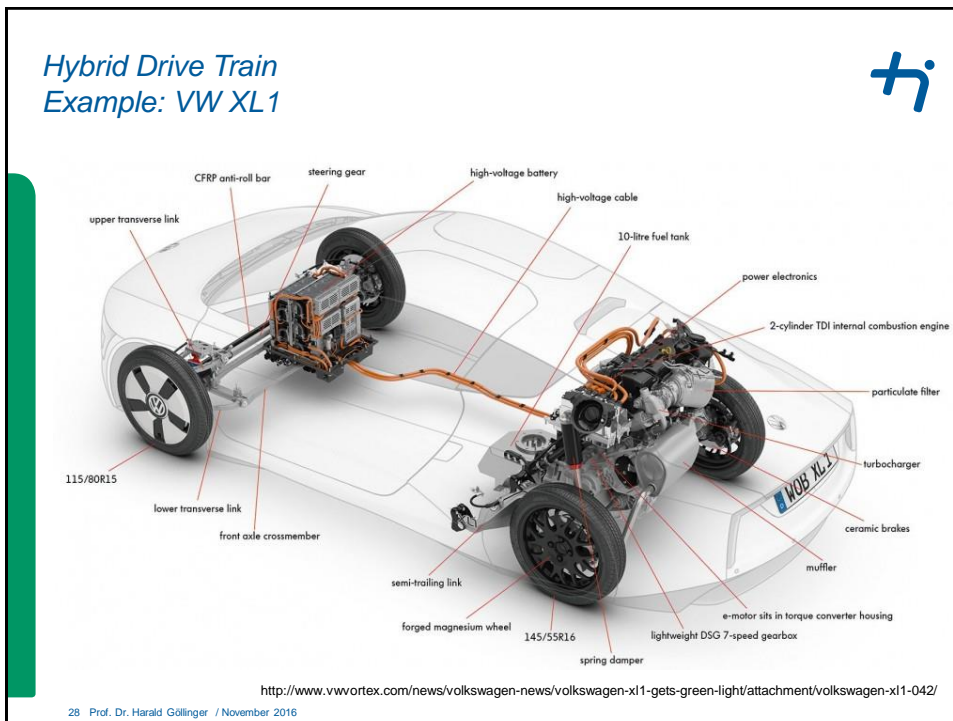
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Hybrid Drive Train
Example: VW XL1



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Hybrid Drive Train

Example: VW XL1



Plug-In Hybrid

$C_w = 0,189$

Weight	795 kg
Electric motor	20 kW / 27 hp, 140 Nm
2-cylinder TDI-Motor	35 kW / 48 hp, 120 Nm

Boost:	140 Nm, 51 kW
Double clutch gear box	7 gears

Battery:	Lithium-Ion, 5,5 kWh
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Electric range:	50 km
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0 – 100 km/h	12,7 s
Top speed	160 km/h

EU test cycle	0,9 l/100 km, 21 g/km CO ₂
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<http://www.vwvortex.com/wp-content/uploads/2013/02/volkswagen-xl1-013-e1361549995951.jpg>