New Trends in Automotive Mobility
Hybrid Drive Train

Example: BMW i8

## Hybrid Drive Train
### Example: BMW i8

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-100 km/h</td>
<td>4.4 sec</td>
</tr>
<tr>
<td>EU test cycle</td>
<td>2.1 l / 100 km</td>
</tr>
<tr>
<td>CO2 emissions</td>
<td>49 g/km</td>
</tr>
<tr>
<td></td>
<td>11.9 kWh / 100 km</td>
</tr>
<tr>
<td>3-cylinder engine</td>
<td>170 kW / 231 hp 320 Nm, rear axle</td>
</tr>
<tr>
<td>Synch. E-motor</td>
<td>96 kW / 131 hp 250 Nm, front axle</td>
</tr>
<tr>
<td>Combined power</td>
<td>266 kW / 362 hp</td>
</tr>
<tr>
<td>Battery</td>
<td>Lithium-Ion, 5.2 kWh</td>
</tr>
<tr>
<td>Max velocity</td>
<td>250 km/h</td>
</tr>
<tr>
<td>Gross weight</td>
<td>1 485 kg</td>
</tr>
<tr>
<td>Cw</td>
<td>0.26</td>
</tr>
<tr>
<td>Price</td>
<td>US$135,925 (€103,000 or GB£86,800)</td>
</tr>
</tbody>
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**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)

[Hybrid Drive Train Example: BMW i8](http://www.bimmertoday.de/wp-content/uploads/BMW-Vision-EfficientDynamics-Wallpaper-041.jpg)
Hybrid Drive Train
Example: BMW i8

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.
Hybrid Drive Train
Serial, Parallel and Mixed Hybrid

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

Prof. Dr. Harald Göllinger / November 2016
Hybrid Drive Train
Parallel Hybrid: Audi DUO

- Combustion engine: 1.9 l TDI, 66 kW
- gear box
- E motor: 21/32 kW, 10.000 rpm, 20 Nm, 22 kg
- converter
- batteries: lead, 264V, 7 kWh, 320 kg
- permanently excited synchronous motor

source: Audi AG

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)

source: http://i.auto-bild.de/ir_img/5/2/6/7/3/4/Toyota-Prius-III-729e486-8da2360357d628c.jpg

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Hybrid Drive Train
Mixed Hybrid: Toyota Prius

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
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
Hybrid Drive Train
Example: Porsche 918 Spyder


Hybrid Drive Train
Example: VW XL1

Hybrid Drive Train
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**Hybrid Drive Train**

*Example: VW XL1*

<table>
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<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plug-In Hybrid</strong></td>
<td></td>
</tr>
<tr>
<td>Cw</td>
<td>0.189</td>
</tr>
<tr>
<td>Weight</td>
<td>795 kg</td>
</tr>
<tr>
<td>Electric motor</td>
<td>20 kW / 27 hp, 140 Nm</td>
</tr>
<tr>
<td>2-cylinder TDI-Motor</td>
<td>35 kW / 48 hp, 120 Nm</td>
</tr>
<tr>
<td><strong>Boost:</strong></td>
<td>140 Nm, 51 kW</td>
</tr>
<tr>
<td>Double clutch gear box</td>
<td>7 gears</td>
</tr>
<tr>
<td><strong>Battery:</strong></td>
<td>Lithium-Ion, 5.5 kWh</td>
</tr>
<tr>
<td><strong>Electric range:</strong></td>
<td>50 km</td>
</tr>
<tr>
<td>0 – 100 km/h</td>
<td>12.7 s</td>
</tr>
<tr>
<td>Top speed</td>
<td>160 km/h</td>
</tr>
<tr>
<td><strong>EU test cycle</strong></td>
<td>0.9 l/100 km, 21 g/km CO2</td>
</tr>
</tbody>
</table>