

  
 Technische Hochschule  
**Ingolstadt**  
 Fakultät für Maschinenbau


*New Trends in  
 Automotive Mobility*  
*New Drive Trains: other concepts*

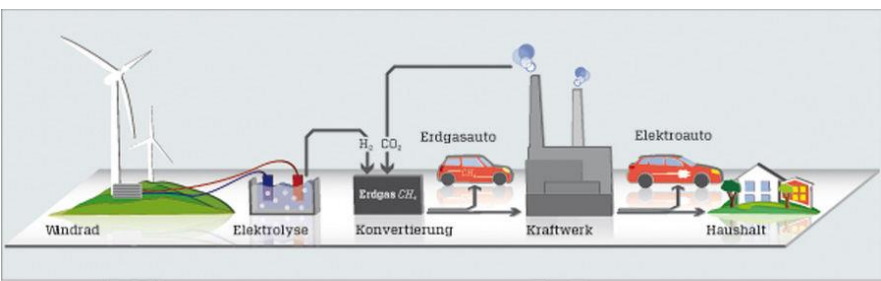
Prof. Dr. Harald Göllinger    11/2016

Zukunft in  
 Bewegung




*New Drive Trains*  
**CNG**





**Audi g-tron**



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*New Drive Trains*  
*Example: Hyundai ix35 with a fuel cell*



Source: [http://i.auto-bild.de/ir\\_img/1/0/9/0/1/7/8/Hyundai-ix35-FuelCell-Wasserstoff-560x373-95a1534a98fab410.jpg](http://i.auto-bild.de/ir_img/1/0/9/0/1/7/8/Hyundai-ix35-FuelCell-Wasserstoff-560x373-95a1534a98fab410.jpg)

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*New Drive Trains*  
*Example: Hyundai ix35 with a fuel cell*



Lithium-Polymer battery  
 100 kW/136 hp electrical motor  
 Front wheel drive  
 acceleration: 0-60mph in 9 s  
 Top speed: 180 km/h  
 Range: 600 km

65.450 € or 1290 €/month



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 source: [http://i.auto-bild.de/ir\\_img/1/0/9/0/1/7/8/Hyundai-ix35-FuelCell-Brennzelle-Display-560x373-5e32007b60abb01d.jpg](http://i.auto-bild.de/ir_img/1/0/9/0/1/7/8/Hyundai-ix35-FuelCell-Brennzelle-Display-560x373-5e32007b60abb01d.jpg)  
[i.auto-bild.de/ir\\_img/1/0/9/0/1/7/8/Hyundai-ix35-FuelCell-Tank-560x373-1c1d06912601177a.jpg](http://i.auto-bild.de/ir_img/1/0/9/0/1/7/8/Hyundai-ix35-FuelCell-Tank-560x373-1c1d06912601177a.jpg)

## New Drive Trains

Example: Toyota Mirai with a fuel cell



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source: <http://p5.focus.de/img/fotos/origs4283803/0456563943-w531-h354-o-q75-p5/artikel15789-bild13.jpg>

## New Drive Trains

Example: Toyota Mirai with a fuel cell



155 hp, 114kW 335 Nm  
acceleration: 0-60mph in 9,6 s  
Top speed: 178 km/h  
78.540 € or 1219 €/month

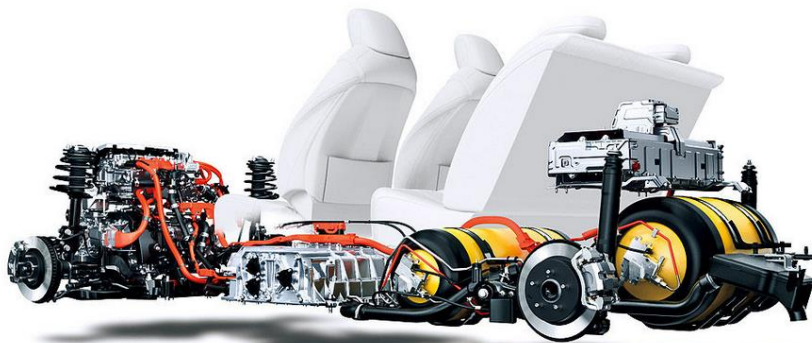
Front wheel drive  
Range: 500 km  
Weight: 1850 kg

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source: <http://p5.focus.de/img/fotos/origs4283793/3803455547-w467-h311-o-q75-p5/artikel15789-bild03.jpg>

## New Drive Trains

Example: Toyota Mirai with a fuel cell



Tank with 122.4 liters, stores 5 kg of hydrogen with 700 bar

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source: <http://www.autobild.de/bilder/toyota-mirai-fcv-vorstellung-und-preis-5178298.html#bild7>

## New Drive Trains

Daimler, Ford, Nissan cooperate on fuel cells



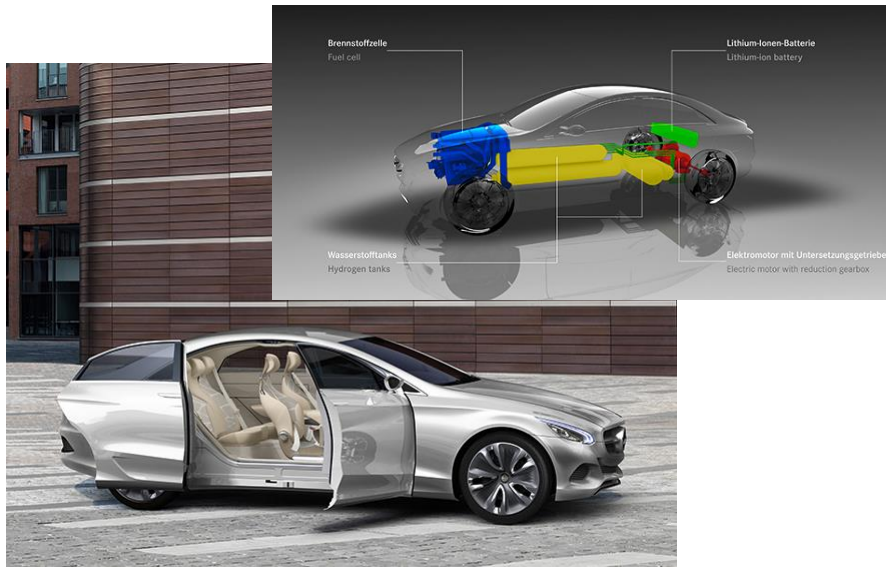
Raj Nair (Ford), Thomas Weber (Daimler) und Mitsuhiro Yamashita (Nissan)



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source: [http://i.auto-bild.de/fir\\_img/1/0/9/0/1/7/8/Hyundai-ix35-FuelCell-Brennzelle-Display-560x373-5e32007b60abb01d.jpg](http://i.auto-bild.de/fir_img/1/0/9/0/1/7/8/Hyundai-ix35-FuelCell-Brennzelle-Display-560x373-5e32007b60abb01d.jpg)

New Drive Trains  
 Research Vehicle Mercedes-Benz F800 with fuel cells



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New Drive Trains  
 Where do you get hydrogen in Germany?



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source: [www.autobild.de/bilder/bilder-damier-e-will-wasserstoff-tanken-bauen-1798199.html#bild1](http://www.autobild.de/bilder/bilder-damier-e-will-wasserstoff-tanken-bauen-1798199.html#bild1)



## New Drive Trains

### Example: BMW Hydrogen7



drivetrain:  
 combustion engine 6 liter, V12  
 with bivalent hydrogen/gasoline-engine  
 hydrogen: 260 PS, 390 Nm  
 gasoline: 445 PS, 600 Nm



starting in 03/2006 100 cars are given to chosen customers

the fuel injection system is changed: fuel direct injection and  
 hydrogen injection at the air intake



a lot of tradeoffs:

- reduction of power and available space
- 200 kg additional weight
- boil-off: hydrogen vanishes through the double-walled tank in about 9 days.

source: [www.auto-motor-und-sport.de](http://www.auto-motor-und-sport.de)

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## New Drive Trains

### Example: BMW Hydrogen7 tank system



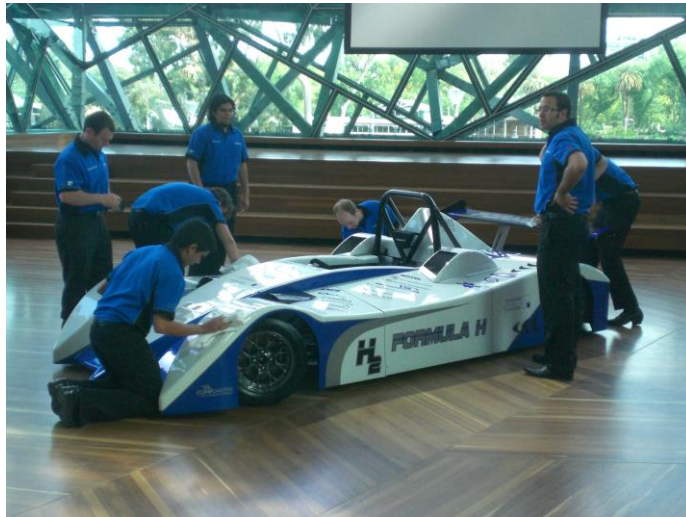
storage tank for 8 kg of liquid, cryogenic hydrogen, 200 kilometer range.



Quelle: [www.bmw.de](http://www.bmw.de)

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New Drive Trains  
Example: TH Ingolstadt Formula H



source: Prof. Weinitz, TH Ingolstadt

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New Drive Trains  
Example: TH Ingolstadt Formula H



motor

- manufacturer: Rotax for the BMW F800s
- 2 cylinders
- 4 valves
- capacity 798cm<sup>3</sup>
- 62,5kW / 85hp at 8000 1/min
- 85Nm at 5800 1/min

tank

- carbon fibre tank
- 28,1kg weight
- pressure 200bar
- dimensions (d/l): 386mm/864mm
- hydrogen 1,075kg
- Volume 72 litres



source: Prof. Weinitz, TH Ingolstadt

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## New Drive Trains

### Example: TH Ingolstadt Formula H



Quelle: Prof. Wellnitz, TH Ingolstadt



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## New Drive Trains

### KERS



Max Mosley, president of the Fédération Internationale de l'Automobile (FIA):

"It is necessary to demonstrate to society that F1 is doing something useful, and it is essential for F1 teams to be able to demonstrate to major companies that they are able to really make a contribution. The F1 racing engine is fully developed; there is no need to develop it any further. Instead, we will allow manufacturers to spend money on technology that is really useful. The first part of that is the KERS device, which we are introducing in 2009."



source: www.spiegel.de

<http://www.autoevolution.com/news/how-kers-work-2815.html>

**KERS Kinetic Energy Recovery System**

2009 storage capacity 400 kJ per lap, 60 kW during 6.67 sec.

2011 storage capacity 800 kJ per lap, 100 kW

2013 storage capacity 1.600 kJ per lap, 200 kW

How could you store energy?

By mechanical means, electrical means and hydraulic means.

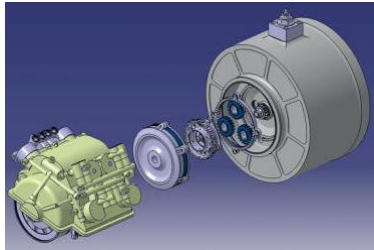
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## New Drive Trains KERS



using a mechanical storage system,  
e.g. Flybrid

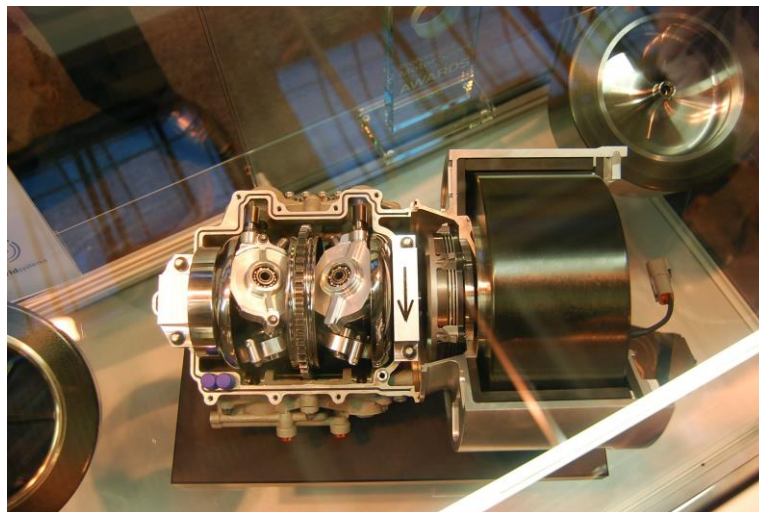


Energy storage in a flywheel with max. 64,500 rpm,  
weight of the flywheel 5 kg, total weight 25 kg

<http://www.racecar-engineering.com/articles/f1/182017/f1-kers-flybrid.html>

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## New Drive Trains KERS using a mechanical storage



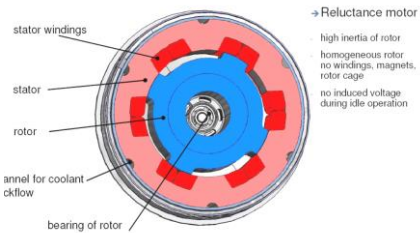
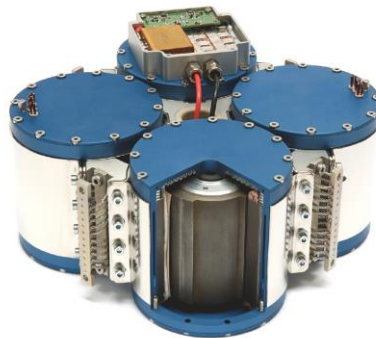
source: <http://www.f1fanatic.co.uk/wp-content/uploads/2009/01/kersf1.jpg>

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## New Drive Trains KERS



- Compact Dynamics DYNASTORE
- energy storage of 4 x 190 kJ
  - output power of energy storage: 4 x 18 kW
  - gross weight 24 kg incl. power electronics
  - size: 4 x 150 mm x 170 mm diameter
  - water cooling



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## New Drive Trains Vegetable oil from rapeseed



Source: [www.wikipedia.de/Rapsfeld2007.jpg](http://www.wikipedia.de/Rapsfeld2007.jpg)  
<http://www.auto-motor-und-sport.de/bilder/mobiltaetsreport>

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## New Drive Trains

### Diesel engine running on vegetable oil



In Germany rapeseed oil is commonly used:

- variations in quality,
- higher flashpoint than diesel (chip fat!),
- less viscous than diesel,
- lower ignitability (cetane number).

modifications:

- heating of fuel, ductwork, motor,
- additional filters,
- adjustment of the engine control unit,
- adjustment of the fuel injection, if necessary,
- control elements and relays.



source: [www.elsbett.com](http://www.elsbett.com)